Keeyask Generation Project

Environmental Impact Statement

Responses to Request for Additional Information from TAC & Public Reviewers, Round 2

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KEEYASK
Hydropower Limited Partnership

April 2013

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KEEYASK
Hydropower Limited Partnership

2012 04 26

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

Attention: Ms. Tracey Braun

Dear Tracey:

Re: RESPONSES TO SECOND 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. 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.

Subsequent to the November filing of the Partnership's *Responses to Requests for Additional Information from TAC and Public, Round 1*, Manitoba Conservation and Water Stewardship coordinated a review of these responses with provincial government departments. The Canadian Environmental Assessment Agency coordinated a similar review with the federal review team and, on November 21, 2012, also invited the public to comment on the potential environmental effects of the Keeyask Generation Project (the Project) and the proposed measures to prevent or mitigate those effects as described in the Environmental Effects Summary document. From these reviews, the Canadian Environmental Assessment Agency provided the Partnership with subsequent Requests for Additional Information on December 28, 2012 and Manitoba Conservation and Water Stewardship provided additional requests on January 29 and 30, 2013. In accordance with the Canada-Manitoba Agreement on Environmental Assessment Coordination, Manitoba

Conservation and Water Stewardship continues to coordinate the process for ensuring the information requested is organized and provided back to federal and provincial reviewers.

The Partnership is pleased to respond to this second round of requests. Our responses are contained in the attached binder titled *Responses to Requests for Additional Information from TAC and Public Reviewers, Round 2*. Please note that responses to the following requests are still being finalized and will be provided as soon as they are available:

- TAC Public Rd 2 CEAA-0009, regarding the assessment of effects of potential accidents and malfunctions.
- TAC Public Rd 2 CEAA-0014, regarding the use of the Keeyask area by other Aboriginal groups, namely the Metis, Pimicikimak Cree Nation/Cross Lake First Nation and Shamattawa First Nation.
- TAC Public Rd 2 CEAA-0015, regarding the capacity of renewable resources and received from CEAA on April 19, 2012.
- TAC Public Rd 2 EC-0026, EC-0027 and EC-0031, regarding clearing and blasting during the breeding bird period.

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

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

KRFA/
Enclosure

c: Ms. Shauna Sigurdson
Mr. Dan McNaughton

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	Proponent Response
Canadian Environmental Assessment Agency									
5	CEAA	Map Figure Folio	Section 4.0	Map 4-10	Terrestrial	Biophysical Environmental Mitigation Areas Map - A potential high quality wetland area identified on the map will be fragmented by the south access road development. The road location has the potential to impact the wetland mitigation.	Please provide a rationale for developing the wetland mitigation in an area that is also identified for the development of proposed south access road corridor.	Given that the road will be located through the wetland area, what measures will be in put place to create a suitable buffer area between the road and the wetlands? Please describe the mitigation measures that will be employed to protect the new 'potential high quality wetland' from impacts due to the presence of or operation and maintenance of the proposed road and water control structures, including erosion and sedimentation from the road surface.	**see TAC Rd 2 CEAA-0005**
9	CEAA	R-EIS Gdlines	Section 4.78	N/A	Project Description	Assessment of Accidents and Malfunctions - There is no assessment of the effects of accidents and malfunctions as required in the EIS Guidelines. There is little discussion on contingency and emergency response procedures developed in the event of an accident or malfunction. The EIS does not include a list of emergency response plans to be developed and implemented over the life of the project.	Please provide this information.	Proponent has identified a number of potential accidents and malfunctions; however, the assessment of the potential adverse environmental effects resulting from these occurrences has not been adequately described. As stated in the EIS guidelines, the potential consequences of accidents and malfunctions including the environmental effects, must be considered and described in the EIS documentation. The proponent must consider the significance of the potential environmental effects as a result of accidents and malfunctions using the significance criteria described in section 9.4 of the Guidelines (magnitude; geographic extent; timing, duration and frequency; reversibility; ecological and social context; level of confidence and probability; and existence of environmental standards, guidelines or objectives for assessing the impact).	**TO BE FILED AT A LATER DATE**
10	CEAA	R-EIS Gdlines	Section 6.2.3.2.5 Section 6.2.3.4.8	N/A	Physical Environment	EIS Guidelines required the proponent to provide the present mercury and methylmercury data and analysis in soil. The is very little detail provided.	Please provide this information.	Proponent indicated that total mercury, along with other metals and nutrients, were analysed in soil samples from the flooded area; however, the EIS indicates that the report documenting this work has not been completed. Please provide the data and analysis to support the assessment.	**see TAC Rd 2 CEAA-0010**

KEEYASK Hydropower Limited Partnership

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14	CEAA	SE SV	Part 2: Resource Use Section 1.2.2	1-7	Socio-Economy	CEAA requires consideration of environmental effects, including the effects of changes to the environment on the current use of lands and resources for traditional purposes by aboriginal persons. The EIS notes that the effects on domestic resource use are predicted for KCN communities only, and therefore the primary mitigation involves the effective implementation of the Adverse Effects Agreement offsetting programs (see as an example p 1-27, s. 1.2.4.1.1 Domestic Fishing Construction Phase Effects and Mitigation) which apply only to the KCN communities and members. Use in the Local Study Area by other Aboriginal groups has not been identified through the Public Involvement Program; however, the EIS also acknowledges that this information may be outstanding, in that there are ongoing discussions with the MMF and CLFN/PCN regarding how the resources are used by those communities. Further, notes from the PIP meeting with Shamattawa indicate that this community believes that their treaty rights may be impacted, implying effects to resource use. Finally, the proponent acknowledges that contact with some potentially affected Aboriginal groups has not been completed. The extent of hunting and fishing by Aboriginal groups or persons other than the KCN communities or members is not identified 'to date.'	We require further information to confirm the extent of use (or lack of use) for traditional purposes by Aboriginal persons of the resources likely to be affected by the project. If further information is collected indicating resource use by Aboriginal persons not party to the Adverse Effects Agreements, assess these effects and describe measures that will be undertaken to mitigate effects to current use of lands and resources by Aboriginal persons not party to the Adverse Effects Agreements off-setting programs.	The Proponent response reiterates efforts to involve Aboriginal communities via the Public Involvement Program (PIP) and summarizes efforts to explore the interests of members of the Manitoba Metis Federation (MMF), Cross Lake First Nation (Pimicikamak Cree Nation) and Shamattawa First Nation. The Proponent response does not provide information for the environmental assessment with respect to the current use of lands and resources for traditional purposes by Aboriginal persons other than those who are members of KCN communities. While the effects to the use of those lands for traditional purposes could be similar for all Aboriginal persons, the mitigations for effects to traditional use for non-KCN Aboriginal persons are not identified. Current mitigation strategies for this effect only apply to KCN partner Aboriginal groups because mitigation is tied directly to the Adverse Effects Agreements negotiated with the KCN communities. The Proponent response notes that if effects to other users are identified, "appropriate mitigation strategies will be considered." The EIS Guidelines (s. 8.3.4 Land and Resource Use) require the Proponent to provide information on current and proposed use of land and resources by each Aboriginal group (not just the KCN partners) "based on information provided by the Aboriginal groups or, if Aboriginal groups do not provide this information, on available information from other sources...". The proponent has described the ongoing process to collect accurate information from the other Aboriginal groups. While this information may more accurately inform ongoing effects identification and mitigation strategies, in its absence, the Proponent is required to: (a) provide a description of current and proposed use of resources for affected non-KCN Aboriginal groups based on available information from other sources, if not provided by the Aboriginal group; (b) assess the effects (if any) on those uses; (c) identify mitigation and residual effects (if any) for non-KCN Aboriginal groups.	**TO BE FILED AT A LATER DATE**

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	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.	**see TAC Rd 2 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.	**see TAC Rd 2 DFO-0002**
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.	**see TAC Rd 2 DFO-0003**

KEEYASK
Hydropower Limited Partnership

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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.	**see TAC Rd 2 DFO-0004**
5	DFO	AE SV	Section 3.4.2.3.1	N/A	Aquatic Environment	"intermittently-exposed zone" Uncertain as to whether the "intermittently-exposed zone" is in the forebay, below the GS or both. There is no mention or study of the effects of water control on dewatering and re-watering areas below the GS and whether habitat losses and fish fills will occur as a result of this.	Please confirm whether the "intermittently-exposed zone" is in the forebay, below the GS or both. Please also provide an analysis of the effects of water control on dewatering and re-watering areas below the GS and whether habitat losses and fish fills will occur as a result of this.	Requested information not provided.	**see TAC Rd 2 DFO-0005**
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)?	**see TAC Rd 2 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.	**see TAC Rd 2 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.	**see TAC Rd 2 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.	**see TAC Rd 2 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.	**see TAC Rd 2 DFO-0026**
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	**see TAC Rd 2 DFO-0033**

KEEYASK
Hydropower Limited Partnership

Requests for Additional Information - Federal Reviewers

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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.	**see TAC Rd 2 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).	**see TAC Rd 2 DFO-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.	**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.	**see TAC Rd 2 DFO-0047**
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.	**see TAC Rd 2 DFO-0048**

KEEYASK Hydropower Limited Partnership

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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.	**see TAC Rd 2 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?	**see TAC Rd 2 DFO-0051**
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.	**see TAC Rd 2 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.	**see TAC Rd 2 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	**see TAC Rd 2 DFO-0057**

KEEYASK
Hydropower Limited Partnership

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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	**see TAC Rd 2 DFO-0058**
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.	**see TAC Rd 2 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.	**see TAC Rd 2 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.	**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.	**see TAC Rd 2 DFO-0065**

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66	DFO	R-EIS Gdlines	Section 8.0	N/A	Physical Environment	Sedimentation - TSS	Suggest that discrete data loggers (TSS) are better than continuous collection data loggers. Discrete loggers should be verified using point sampling to verify data loggers especially in the first year. The use of discrete data loggers for existing environment and post project post project environment. The continuous data loggers are too variable and subject to error due to bio-fouling.	Would the proponent please extract those parts of any sediment management plan (their answer states that it will be provide in the first quarter of 2013) that provides additional information pertinent to the question? Proponent plan still in production and not available for review.	**see TAC Rd 2 DFO-0066**
67	DFO	R-EIS Gdlines	Section 8.0	N/A	Physical Environment	Sedimentation - TSS	EIS proposes to have the first post project monitoring station 1km downstream of the construction site in the "fully mixed zone". The location of the first monitoring station downstream of Keeyask construction site is too far away to assess impacts and effectiveness of mitigation. It is recommended that a turbidity/TSS monitoring site be placed at the construction site.	Would the proponent please extract those parts of any sediment management plan (their answer states that it will be provide in the first quarter of 2013) that provides additional information pertinent to the question? Proponent plan still in production and not available for review.	**see TAC Rd 2 DFO-0067**
68	DFO	R-EIS Gdlines	Section 8.0	N/A	Physical Environment	Sedimentation - TSS	Can the Proponent provide an analysis showing that its monitoring will have a high degree of confidence, or the power, to detect TSS above the action threshold?	Would the proponent please re-state their answer to the question rather than refer to another response? Proponent plan still in production and not available for review.	**see TAC Rd 2 DFO-0068**
69	DFO	AE SV	Section 2.5.2.2.5	2-66 to 2-68	Physical Environment	Sedimentation - TSS	The Proponent appears not to discuss effects of TSS specific to the individual VEC fish species. The Proponent's impact assessment appears to rely primarily on lethal TSS concentration effects. Can the Proponent provide an expanded discussion of sub-lethal or chronic impact risk assessment for anticipated TSS changes?	Would the proponent please extract those parts of the EIS referred to and re-phrase them in a manner that provides a more detailed answer to the question?	**see TAC Rd 2 DFO-0069**

KEEYASK Hydropower Limited Partnership

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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.	**see TAC Rd 2 DFO-0070**
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?	**see TAC Rd 2 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?	**see TAC Rd 2 DFO-0072**

KEEYASK Hydropower Limited Partnership

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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.	**see TAC Rd 2 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.	**see TAC Rd 2 DFO-0074**
75	DFO	PE SV	Section 7.4.1	N/A	Physical Environment	The EIS notes "Placement and removal of cofferdams/groins during Stage II Diversion will occur over three years (2017, 2018, and 2019) during the open water seasons. Most of these activities are predicted to result in increases in TSS of less than 5 mg/L above background, which would be within the…CCME guidelines for the protection of aquatic life. The exceptions include placement of the South Dam Rock Fill Groin, which is predicted to result in TSS increases of up to 15 mg/L above background, with increases of greater than 5 mg/L for a period of approximately 10 days in early September 2017. An increase in TSS of 7 mg/L for a period one month is also predicted during removal of the Tailrace Summer Level Cofferdam in September/October 2019.	The Proponent predicts several instances of average TSS increases greater than the CCME guideline for longer term impacts (e.g., inputs lasting between 24 h and 30 d should not exceed 5 mg/L above background). Are there additional opportunities, both reasonable and practical, to further prevent and mitigate sediment releases such that the guidelines can be met? For example, if a given TSS exceedance is in part due to shoreline erosion, would pre-emptive shoreline stabilization be an option?	Proponent plan still in production and not available for review.	**see TAC Rd 2 DFO-0075**

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	Proponent Response
76	DFO	PE SV	Appendix 7A	N/A	Physical Environment	The EIS notes "Prediction of the post-impoundment…environment upstream…was carried out by…numerical modelling…Depth-average mineral suspended sediment concentrations were estimated for average (50th percentile) flow for prediction periods of 1 year, 5 years, 15 years and 30 years after impoundment. Sediment concentrations were also predicted for low (5th percentile) and high (95th percentile flow conditions for…1 year and 5 years after…impoundment. While outside the zone of hydraulic influence, a qualitative assessment was carried out for…sedimentation…in Stephens Lake…"	Can the Proponent provide some explanation, or direct reviewers to its location, of why TSS modeling at selected flow percentiles, e.g., 50th percentile or 5th and 95th percentile, or other model settings, provide good estimates of likely effects on the aquatic environment?	Can the proponent clarify why a median is used for the first, fifth, fifteenth, and thirtieth years while 5th, 50th, and 95th percentiles are only estimated for one and five years after impoundment? Proponent plan still in production and not available for review.	**see TAC Rd 2 DFO-0076**
77	DFO	AE SV	Section 2.5.2.2.5	2-66 to 2-68	Physical Environment	The EIS notes "Placement and removal of cofferdams/groins during Stage II Diversion will occur over three years (2017, 2018, and 2019) during the open water seasons. Most of these activities are predicted to result in increases in TSS of less than 5 mg/L above background, which would be within the…CCME guidelines for the protection of aquatic life. The exceptions include placement of the South Dam Rock Fill Groin, which is predicted to result in TSS increases of up to 15 mg/L above background, with increases of greater than 5 mg/L for a period of approximately 10 days in early September 2017. An increase in TSS of 7 mg/L for a period one month is also predicted during removal of the Tailrace Summer Level Cofferdam in September/October 2019…"	If increases in TSS exceeding the CCME guidelines appear to be unavoidable, can the Proponent provide additional discussion and rationale (or direct reviewers to the location of that information in the EIS) for why the exceedances, in the Nelson River at Keeyask case, are not likely significant adverse environmental effects. For example, can the Proponent indicate that an exceedance of 7 mg/L TSS above background for 30 days in September/October is not likely to be in the sublethal or lethal severity of effect range for fish, fish eggs or larvae, benthic macroinvertebrates, or other aquatic organisms. In addition, can the Proponent say that the exceedance when added to the expected background range for that time of year is within the anticipated natural range of TSS in the Nelson River at the Project site, and in one case downstream to the estuary, at that time of year?	Would the proponent please provide an expanded discussion of the type and extent of expected sub-lethal effects, extracting information as necessary from the EIS sections referred to?	**see TAC Rd 2 DFO-0077**

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	Proponent Response
78	DFO	PE SV	Appendix 7E	N/A	Physical Environment	The EIS notes "data collected in the open water periods of 2005 to 2007 indicates…suspended sediment concentration generally lies within the range of 5 mg/L to 30 mg/L…from Clark Lake to Gull Rapids…sediment concentrations can vary within their normal range at a given location in a given day…variations…over a short period…can be due to many reasons, including local turbulences in the waterbody, changes in the meteorological environment, and local bank erosion processes…suspended sediment concentrations…in the open water period…2001 to 2004…show similar ranges (2 mg/L to 30 mg/L with an average of 12 mg/L)…A report prepared by Lake Winnipeg, Churchill and Nelson Rivers Study Board in 1975…documents a suspended sediment concentration range of 6 mg/L to 25 mg/L with an average of 15 mg/L based on…measurements in 1972 and 1973. Field studies…on the Burntwood and…Lower Nelson River reach also show a concentration range of 5 mg/L to30 mg/L (Acres…2004…2007b, KGS Acres 2008b…KGS Acres 2008c)…Suspended sediment concentration measurements during…winter…(January to April), of 2008 and 2009 reveal that sediment concentration variations in the winter period are larger than the open water period. A limited data set collected at monitoring locations in Gull Lake show a concentration range of 3 mg/L to 84 mg/L, with an average of 14.6 mg/L…"	The Proponent provides some ranges, point estimates, and expected durations of TSS changes. Would it be possible to provide, or direct reviewers to where this information is in the EIS, sample sizes and standard deviations for estimates? Where intervals that are not ranges, would it be possible to specify the level of confidence? E.g., are they 95% confidence intervals for a mean?	Would the proponent please provide a description of the extent to which the historic TSS information can be expected to represent seasonal and year-to-year variation in TSS? Would the proponent please propose one or more composite sample sizes, averages and standard deviations as background criteria for expected TSS during construction for determining the power of its proposed monitoring program?	**see TAC Rd 2 DFO-0078**
80	DFO	AE SV	Appendix 2A 2.5.2.2.5 4.2.4.2	N/A	Physical Environment	The EIS says "Mineral TSS would generally remain within the chronic Manitoba PAL water quality objective and the CCME PAL guideline (a change of less than or equal to 5 mg/L relative to background, where background TSS is less than or equal to 25 mg/L). The exceptions would occur in the immediate reservoir (reach 9) and reach 8 (the area north of Caribou Island) under high flow conditions, where decreases may be larger than the Manitoba water quality objective…"	When discussing TSS decreases the Proponent refers to TSS guidelines as being for changes. In fact, the guidelines talk about increases only – not changes in general – so that they do not really apply to decreases in TSS. Can the Proponent explain in more detail its criteria for discussing changes?	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?	**see TAC Rd 2 DFO-0080**

KEEYASK Hydropower Limited Partnership

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	Proponent Response
83	DFO	PE SV	Section 7.4.1	7-22	Physical Environment	"Water Quality: Project Effects, Mitigation, and Monitoring…Construction Period…Total Suspended Solids, Turbidity, and Water Clarity…" p 2-40 ff "Cofferdam Placement and Removal…during Stage I and II Diversions have the potential to increase TSS in the Nelson River…results…presented in detail in the PE SV, section 7.4.1…Predicted increases in TSS refer to the fully mixed condition, approximately 1 km downstream of Gull Rapids…"	The Proponent notes that it has modeled TSS downstream at 1km from the construction area in the fully mixed zone. Will the Proponent be able to monitor TSS closer to the construction areas? What sort of area might be affected by construction TSS increases greater than those predicted upstream of the fully mixed zone. What are the, at source, sediment loading TSS concentrations likely to be, how extensive might they be in area, and what might their durations be?	Would the proponent please re-iterate information provided for a previous question so that the reader does not have to refer to another response? The answer refers to information not provided with the EIS. Please use information from documents developed after the EIS to provide an answer to the question. Would the proponent please describe the extent and nature of plumes exceeding effect thresholds and evaluate them for potential lethal and sub-lethal risks?	**see TAC Rd 2 DFO-0083**
84	DFO	R-EIS Gdlines	Section 8.0	N/A	Physical Environment	Information does not appear to be present in the EIS but is required to determine if monitoring can adequately determine potential problems and appropriate actions taken to mitigate unexpected events.	Can the Proponent provide an analysis showing that its monitoring will have sufficient power with high confidence, to detect TSS above the action threshold (regulatory guideline)? For example, how likely is it that the Proponent can detect environmental changes that result in elevated TSS that exceed critical effect sizes such as 5 mg/L above background? Will the number of samples collected during monitoring be sufficient to correctly conclude, with a confidence of say 95% [i.e., a high confidence], that there is a difference of, say, 5 mg/L or more above background?	Proponent plan still in production and not available for review.	**see TAC Rd 2 DFO-0084**

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85	DFO	AE SV	Section 2.5.2.2.5	2-64	Physical Environment	The EIS, in the aquatic effects supporting document section 2 on water and sediment quality, notes: "There are few studies that have reported the acute or chronic toxicity of TSS to fish species represented in the Aquatic Environment Study Area. Lawrence and Scherer (1974) reported that the 96-hour lethal concentration (LC50) for lake whitefish (Coregonus clupeaformis) was 16,613 mg/L. McKinnon and Hnytka (1988) found relatively high increases in TSS (instantaneous maximum = 3,524 mg/L and 1-day average concentration = 524 mg/L) caused by winter pipeline construction did not have any direct effect (no downstream emigration and no mortalities) on the fish community of Hodgson Creek, NT. This study is notable as four of the fish species found in Hodgson Creek - northern pike (Esox lucius), lake chub (Couesius plumbeus), longnose sucker (Catostomus catostomus), and burbot (Lota lota) - are also found in the Aquatic Environment Study Area. As indicated in Section 5.4.2, northern pike may spawn in the nearshore areas of the Keeyask reservoir, even during the initial years of operation. Therefore, early life history stages of northern pike may be exposed to elevated concentrations of TSS for several years post-impoundment. No information on the acute or chronic toxicity of TSS to northern pike eggs or larvae could be located. Information for early life history stages of other species represented in the Aquatic Environment Study Area is also sparse and many of the available studies do not differentiate between the effects of suspended particulate materials and sediment deposition. However, the available scientific literature indicates a potential for reduced hatching success in salmonids exposed to elevated TSS concentrations on the order of two months or more, at concentrations ranging from 6.6–157 mg/L (Table 2-17). In addition, northern pike eggs would also be exposed to the combined effects of sedimentation and elevated TSS. Therefore, should northern pike spawn in the nearshore, flooded areas of the reservoir in the initial years of operation where organic TSS will be notably elevated, reduced hatching success of northern pike eggs is likely. Conversely, elevated TSS and turbidity can provide benefits to some fish species and life history stages. Reduced water clarity can reduce the risk of predation by visual predators, which in turn can enhance survival of juvenile fish (e.g., Sweka and Hartman 2003) and may favour planktivorous fish…"	The Proponent discusses effects of TSS specific to the individual VEC fish species. However, much of the Proponent's impact assessment appears to rely primarily on general and lethal TSS concentration effects. Can the Proponent provide an expanded discussion of sub-lethal or chronic impact severity of effect risk assessment for anticipated TSS changes?	In the absence of specific lethal and sub-lethal data for various species and life-stages, would the proponent provide some hypothetical modelling for evaluation of sub-lethal risks?	**see TAC Rd 2 DFO-0085**

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	Proponent Response
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?	**see TAC Rd 2 DFO-0086**
87	DFO	R-EIS Gdlines	Section 8.0	N/A	Physical Environment	Previous daily TSS sediment monitoring at the Wuskwatim GS construction site had frequent problems with bio-fouling of sensors.	Can the Proponent provide additional information on its anticipated TSS monitoring showing that problems with previous monitoring, e.g., bio-fouling of sensors, has been anticipated and solved?	Can the proponent provide additional information on its anticipated TSS monitoring showing that problems with previous monitoring , e.g., bio-fouling of sensors, has been anticipated and solved? Proponent notes that the SMP to be provided "in the first quarter of 2013…" provides details. DFO notes that a draft, referred to as an informal draft was received on October 17, 2012 noting that a formal version would follow after discussion with regulators. Would the proponent provide details, specific to the biofouling risk, from the proposed SMP to answer the EIS question? Awaiting receipt of In-stream Construction Sediment Management Plan (SMP).	**see TAC Rd 2 DFO-0087**

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	Proponent Response
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?	**see TAC Rd 2 DFO-0093**
94	DFO	AE SV	Appendix 1A, Part 2	N/A	Aquatic Environment	Appendix 1A - Part2	The recruitment model/unexploited scenario mimics the Wisconsin guideline. There is acknowledgement that these numbers may be too low given the guideline was developed based on rivers smaller that the Nelson. How will final numbers be derived?	This contradicts statements in proponent response provided in DF0-0052, "CPUE was not used to estimate population size" and DFO-0017 "CPUE was not used in statistical analysis"	**see TAC Rd 2 DFO-0094**
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.	**see TAC Rd 2 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?	**see TAC Rd 2 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.	**see TAC Rd 2 DFO-0103**

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	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.	**see TAC Rd 2 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)?	**see TAC Rd 2 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).	**see TAC Rd 2 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	**see TAC Rd 2 DFO-0107**

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	Proponent Response
Environment Canada									
7	EC	AE SV 2	Section 2.0, Table 2-11	2-135	Aquatic Environment	Table 2-11 outlines that water treatment plant backwash will be treated if required, such that TSS will be less then 25 mg/L prior to discharge to the receiving environment.	EC requests the Proponent provide a full characterization of discharges to ensure they are not deleterious; noting that TSS should not be the only discharge parameter to be assessed against water quality objectives.	The Proponent does not clarify which other discharge parameter will be considered as part of the treated back wash water quality objectives. EC requests that the Proponent provide a detailed characterisation of the anticipated backwash water quality, including other parameters of potential concern, aside from TSS.	**see TAC Rd 2 EC-0007**
18	EC	R-EIS Guidelines	Section 6.5	6-362	Terrestrial Environment	The Proponent has not included a discussion or impact assessment regarding these risks associated with lighting and collision; could find no reference to these in the EIS.	EC requests that the Proponent provide information regarding any design and mitigation measures that have been incorporated to minimize the adverse effects of lighting. EC also requests further information regarding the communication tower, and any other features planned for the project site that may create a specific collision hazard for migratory birds, as well as on the proponent's proposed mitigation measures to minimize the risk of collisions.	EC requests that the Proponent clarify what lighting will be used for the powerhouse building and communication tower. EC also has a particular interest in project effects on migratory birds and requests the opportunity to review the monitoring reports. In order to minimize the risk of avian collisions and fatalities, EC recommends that any lighting used on the communications tower at night be limited to white (preferable) or red flashing LED or strobe lights, and be the minimum in number, intensity, and frequency of flashes required for aircraft safety. EC also recommends that Manitoba Hydro avoid the use of floodlights and other intense light sources at the base of the tower, or on the powerhouse building, especially those left on all night. With respect to any necessary security lighting on ground facilities (including buildings) and equipment, EC recommends that this lighting is as minimal as possible, and be down-shielded to keep light within the boundaries of the site. Consideration could also be given to turning these lights off at night during migration, and during bad weather. Finally, EC recommends that the proponent regularly monitor and document the level of avian mortality that occurs near the communications tower.	**see TAC Rd 2 EC-0018**

KEEYASK Hydropower Limited Partnership

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	Proponent Response
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.	**see TAC Rd 2 EC-0019**

KEEYASK Hydropower Limited Partnership

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	Proponent Response
26	EC	R-EIS Guidelines	6.5 Effects and Mitigation Terrestrial Environment and 6.5.7 Birds	6-343, 6-349 and 6-351	Terrestrial Environment	In this section the proponent indicates that clearing will be undertaken outside of "the sensitive breeding period (April 1-July 31)" to the extent practicable to minimize disturbance to breeding birds. The proponent also proposes to retain 100m vegetated buffers "wherever practicable" around lakes, wetlands and creeks located adjacent to infrastructure sites to minimize loss of nesting habitat and limit noise-related disturbance to migratory birds (p. 6-341, 6-343). EC's mandate includes the protection of migratory birds and their habitat. EC reminds the proponent of the federal Migratory Birds Convention Act (MBCA) which protects migratory birds and their eggs and nests. Section 5(1) of the Regulations prohibits the hunting of a migratory bird except under authority of a permit. "Hunt" means chase, pursue, worry, follow after or on the trail of, lie in wait for, or attempt in any manner to capture, kill, injure or harass a migratory bird, whether or not the migratory bird is captured, killed or injured. Section 6 of the regulations prohibits the disturbance, destruction, or taking of a nest, egg or nest shelter of a migratory bird. Possession of a migratory bird, nest or egg without lawful excuse is also prohibited. Section 5.1 of the MBCA prohibits the deposition of substances harmful to migratory birds in waters or areas frequented by migratory birds, or in a place from which the substance may enter such waters or such an area. EC's website on Incidental Take (http://www.ecgc.ca/paom-itmb/default.asp?lang=En&n=FA4AC736-1) contains additional information as well as a link to the MBCA and Regulations. EC provides the following recommendations as general guidelines for industry to protect the great majority of migratory birds while realizing the practicalities of development activities on the landscape. However the onus remains with the proponent to comply with the legislation. •To minimize disturbance to breeding migratory birds in the Boreal ecozones of Manitoba, in areas where migratory birds may be nesting, EC recommends that habitat destruction activities (e.g. vegetation clearing and management, initial flooding, reclamation, etc.) for project areas greater than 50 hectares (such as this project) avoid at minimum the period between April 1 and August 31, to minimize population level effects to breeding birds. •If limited habitat destruction (e.g. vegetation clearing and management, reclamation, etc.) must proceed during the migratory bird breeding season (despite EC's recommendations for avoidance), the area to be cleared/destroyed should not exceed one hectare in size, as the effectiveness of finding nests is compromised in forested habitats. The lands to be cleared/destroyed should be surveyed for active nests by an avian biologist or naturalist with experience with migratory birds and migratory bird behaviours indicative of nesting (e.g. carrying fecal sacs, nesting material or food, aggressive territorial behaviour, or distraction behaviour, etc.) within 7 days of destruction/clearing. Nest surveys should follow widely-accepted protocols and be thorough and defensible. Some nest search protocols may require a permit, therefore the proponent is advised to contact the regional permitting officer John Dunlop, at john.dunlop@ec.gc.ca or at (306) 975-4090). Any nests found should be protected with a species appropriate buffer until the young have fledged and left the area. •If an individual has a priori knowledge of an active nest, at any time during the year, it must be protected with a suitable species-appropriate buffer until the young have fledged. •Wetlands attractive to breeding migratory birds (e.g. those containing water) should not be cleared/destroyed at minimum between April 1 and August 31. Canada geese and Mallards may nest early and broods of waterfowl and waterbird species are dependent upon wetlands throughout August and beyond.		EC requests that the Proponent confirm that they will include the month of August in the habitat and wetland clearing/destruction avoidance period and to confirm that no greater than one hectare in size will be cleared/destroyed if limited habitat destruction must proceed during the migratory bird breeding season. EC also requests that the Proponent discuss their plans in regards to active nest surveys should limited habitat destruction proceed and their plans should an active nest be found in the habitat destruction area.	**TO BE FILED AT A LATER DATE**

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	Proponent Response
27	EC	R-EIS Guidelines	6.5 Effects and Mitigation Terrestrial Environment and 6.5.7 Birds	6-361	Terrestrial Environment	With respect to blasting, the proponent indicates that "over the course of construction, if there is overlap of scheduled construction activities that could affect the breeding colonies at Gull Rapids with the bird breeding period (April 1-July 31), measures will also be taken to avoid or minimize disturbance to active nesting colonies to the extent possible" (p. 6-361). Regarding blasting, EC recommends that the Proponent implement an appropriate blasting guideline for the protection of migratory birds (e.g., buffer zone, scheduling) and design a monitoring program that allows for detection of potential adverse effects and implementation of timely adaptive management actions. EC recommends that the proponent avoid commencing blasting between April 1 and August 31, and within 1600m of active nesting colonies at any time during the year. Where local landscape features lessen blasting impacts, this distance may be reduced, to a minimum of 1000m.		EC requests that the Proponent: • confirm that blasting will be avoided between April 1st and August 31st and will not be within 1600m of active nesting colonies, or within 1000m where local landscape features will lessen blasting effects, at any time during the year; • discuss any blasting guidelines that will be developed to protect migratory birds; and • confirm if a monitoring program will be in place that allows for the detection of potential adverse effects on migratory birds.	**TO BE FILED AT A LATER DATE**
28	EC	R-EIS Guidelines	6.2.3 Existing Environment and Future Trends, 6.2.3.4 Terrestrial Environment and 6.2.3.4.3 Terrestrial Plants	6-102	Terrestrial Environment	Invasive species spread readily along disturbance corridors and once established are virtually impossible to eradicate. This section mentions that "field studies detected all of the 19 invasive plants known to occur in the Regional Study Area". The construction and operation of the project may provide additional opportunities for invasive species to establish and spread (through dispersal of weed seeds on equipment and vehicles, or in reclamation materials brought to the site, etc.), disrupting native plant communities. EC acknowledges the proponent's commitment on page 3-34 of TE SV to 1) clean construction equipment and machinery recently used more than 150km from the project area prior to transport to the project area regularly; 2) use seed mixtures containing only native species and/or non-invasive introduced plant species; 3) implement containment, eradication and/or control programs if monitoring identifies problems with invasive plants; and 4) educate contractors about the importance of cleaning their vehicles, equipment and footwear before traveling to the area. In addition to the proponent's commitments above, EC recommends that all vehicles and equipment are cleaned prior to entering the project areas. EC also recommends that any areas containing noxious weeds be clearly marked, so that equipment operators can easily recognize when passing through weed infested areas, and so that the spread of species from these areas can be monitored. EC further recommends that equipment and vehicles are thoroughly cleaned after passing through any such area in order to avoid transporting seed to other areas.		EC requests that the Proponent discuss: • if all vehicles and equipment will be cleaned prior to entering the project areas; • if areas containing noxious weeds will be clearly marked, so that equipment operators can easily recognize when passing through weed infested areas; • if vehicles and equipment will be cleaned after passing through areas containing noxious weeds; and • if seed mixtures to be used contain only native species and/or non-invasive introduced plant species.	**see TAC Rd 2 EC-0028**

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	Proponent Response
29	EC	R-EIS Guidelines	6.5.3 Terrestrial Ecosystems and Habitat, and 6.5.3.2 Ecosystem Diversity	6-318 to 6-320	Terrestrial Environment	This section notes on page 6-318 that a "rehabilitation plan will be developed that gives preference to rehabilitating the most affected priority habitat types using approaches that "go with nature" and on page 6-319 that "the rehabilitation plan developed and initiated during construction will extend into the operation phase, and continue until all necessary rehabilitation is completed." Lastly, on page 6-320 of this section it mentions that "Monitoring will include confirming that…rehabilitation to native broad habitat types was successful at locations identified in the rehabilitation plan". EC recommends that any disturbed areas that will not be flooded are restored, and are restored as quickly as possible once they are no longer in use. EC recommends that disturbed areas are restored to mimic native vegetation communities in the surrounding area, and to provide similar habitat to pre-construction conditions. EC also recommends that the restoration materials be of local provenance, and be certified and inspected to be free of both invasive and noxious weed materials. Finally, EC recommends long-term monitoring and adaptive management to ensure restoration.		EC requests that the Proponent: • confirm that disturbed areas that are no longer in use will be restored as quickly as possible; • confirm that disturbed areas will be restored to mimic native vegetation communities in the surrounding area, and provide similar habitat to pre-construction conditions; • discuss whether the restoration materials will be of local provenance, and be certified and inspected to be free of both invasive and noxious weed materials; and • discuss any long-term monitoring and adaptive management plans to ensure restoration.	**see TAC Rd 2 EC-0029**

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	Proponent Response
30	EC	R-EIS Guidelines	6.5.3 Terrestrial Ecosystems and Habitat, and 6.5.3.4 Wetland Function	6-325 to 6-327	Terrestrial Environment	These sections outline the following: 1) project construction is predicted to affect up to 7765 ha of wetlands, including 9-12 ha of off-system marsh (p. 6-325); 2) mitigation to replace Nelson river wetlands is not proposed (p. 6-325); and 3) "globally, nationally and/or provincially significant wetlands are not affected" (p. 6-327). Proposed mitigation includes: 1) "measures to protect against erosion, siltation and hydrological alteration will be implemented in utilized construction areas that are within 50 m of any off-system marsh that is outside of the Project Footprint" (p. 6-325) ; and 2) "12 ha of the off-system marsh wetland type will be developed within or near the local Study Area" (p. 6-326; p. 6-327). Wetlands provide important habitat for both migratory birds and Species at Risk. EC promotes the maintenance of the functions and values derived from wetlands throughout Canada, enhancement and rehabilitation of wetlands in areas where continuing loss or degradation of wetlands have reached critical levels, no net loss of wetland functions for federal lands and waters, recognition of wetland functions in resource planning and economic decisions, and utilization of wetlands in a manner that enhances prospects for their sustained and productive use by future generations. EC recommends that the proponent take all reasonable measures to avoid wetlands, where feasible, irrespective of whether they are wet or dry, and that buffers or setbacks originate from the one in one hundred year high water mark. One hundred metre setbacks should be utilized from the edge of the proposed development or associated feature (e.g., access route) where feasible. EC acknowledges that the proponent will develop 12 ha of off-system marsh habitat within or near the study area to compensate for the loss of 9-12 ha of off-system marsh. EC refers the Proponent to 'The Federal Policy on Wetland Conservation' which promotes the wise use of wetlands and elevates concerns for wetland conservation to a national level. EC recommends that the Proponent review this document to provide further guidance on reducing impacts to wetlands.		EC requests that the Proponent confirm the use of appropriate setbacks from wetlands and discuss, for those wetlands where avoidance is not possible, what mitigation and compensation measures will be implemented. I79+I79	**see TAC Rd 2 EC-0030**

KEEYASK Hydropower Limited Partnership

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	Proponent Response
31	EC	R-EIS Guidelines	Table 6-10 SARA and MESA-Listed Species at Risk That May Occur within the Bird Regional Study Area	6-117	Terrestrial Environment	The EIS lists the Common Nighthawk, Olive-sided Flycatcher, Rusty Blackbird, Short-eared Owl, Peregrine Falcon, and Wolverine as species that have been identified in the project area. In addition Northern Leopard Frog, Yellow Rail, Red Knot, Horned Grebe, and Little Brown Myotis also have the potential to occur within the project area. The federal Species at Risk Act (SARA) is directed towards preventing wildlife species from becoming extinct or lost from the wild, helping in the recovery of species that are at risk as a result of human activities, and promoting stewardship. The Act prohibits the killing, harming or harassing of listed species; the damage and destruction of their residences; and the destruction of critical habitat. EC recommends that an Environmental Monitor, knowledgeable in the identification of all species at risk that may occur in the project area, is present on site during project construction activities. In the event that species at risk are expected or encountered, the primary mitigation measure should be avoidance. EC refers the proponent to the Petroleum Industry Activity Guidelines for Wildlife Species at Risk in the Prairie and Northern Region (attached). This document includes species-specific timing restrictions, setback distances and best management practices. Please note the following amendments not reflected in the document: •Common nighthawk May 1 to August 31 200m •Horned Grebe April 1 to August 31 100m from the high water mark of the wetland or waterbody containing the nest •Olive-sided flycatcher May 1 to August 31 300m •Rusty Blackbird May 1 to July 31 300m		EC requests that the Proponent confirm whether they intend to have an environmental monitor on site during construction activities and the setbacks and timing restrictions that will be used to avoid the nests of species at risk in the project area.	**TO BE FILED AT A LATER DATE**

KEEYASK Hydropower Limited Partnership

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	Proponent Response
32a	EC	R-EIS Guidelines	6.2.3 Existing Environment and Future Trends, 6.2.3.4 Terrestrial Environment and 6.2.3.4.7 Mammals	6-127 and 6-130	Terrestrial Environment	The EIS describes three groupings of caribou for the Regional Study area: 1) barren-ground caribou from the Qamanirjuaq herd; 2) coastal caribou from the Cape-Churchill and Pen Islands herds; and 3) "summer resident caribou" (which "could be coastal caribou, [boreal] woodland caribou, or a mixture of both"; p. 6-130). There are 6 geographically distinct populations of the forest-dwelling Woodland Caribou in Canada: Northern Mountain population, Southern Mountain population, Boreal population, Forest-Tundra population, Atlantic Gaspesie population, and the insular Newfoundland population. With the exception of the barren-ground caribou, EC considers the caribou in the project area to be part of the "forest-tundra" population, which are not SARA-listed and have not been assessed. EC notes that the project will result in the permanent loss of some primary calving and rearing complexes ("clusters of islands in lakes or islands of black spruce surrounded by expansive wetlands or treeless areas (peatland complexes)" (p. 6-131)) for the summer resident caribou (p. 6-367, 6-372), as well as 6825 ha of physical winter habitat for the Qamanirjuaq, Cape-Churchill and Pen Island herds (p. 6-366). Additionally, sensory disturbances associated with construction and operation are expected to result in additional loss of effective habitat (p. 6-367, p. 6-372), and increased access to the project area could increase mortality due to predation (p. 6-368, 6-372). EC encourages the proponent to consult with Manitoba Conservation to identify any plans to manage undisturbed caribou habitat in the project area. EC acknowledges the proponent plans to implement mitigation measures including; •minimizing blasting from May 15 to June 30 (p. 6-370); •implementing an access management plan, including locked gates at the north and south dykes from May 15 to June 30, as well as during other sensitive times determined through monitoring (p.6-371); •rehabilitating temporarily cleared and excavated materials placement areas to native habitat; •blocking and revegetating project-related cutlines and trails within 100m of the project footprint (p. 6-374); and •long term monitoring of caribou and predators in the project area (p. 8-23, 8-26). In addition to these measures, EC recommends the reduction of sight lines along the access trails, and the continual restoration of project-related cleared areas, cutlines, trails, etc. as they are no longer in use. EC also recommends that the proponent consider additional mitigation measures (e.g., mitigation of noise, light, smells, vibrations; reduction of vehicle speeds, etc.) to minimize harassment of caribou in the project area, particularly from late winter to late spring and early summer, as this will be a stressful period for all of the caribou in the project area.		EC requests that the Proponent discuss any plans to implement additional mitigation measures (e.g. mitigation of noise, light, smells, vibrations, reduction of vehicle speeds, etc.) to minimize harassment of caribou in the project area, particularly from late winter to late spring and early summer. EC requests that the Proponent discuss any plans to reduce sight lines along access trails and discuss restoration plans for project-related cleared areas, temporary transmission right of ways, trails, etc. EC also requests the Proponent discuss their plans to consult with the province.	**see TAC Rd 2 EC-0032a**

Keeyask Hydropower Limited Partnership

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	Proponent Response
32b	EC	R-EIS Guidelines	6.2.3 Existing Environment and Future Trends, 6.2.3.4 Terrestrial Environment and 6.2.3.4.7 Mammals		Terrestrial Environment	In addition to the previous comments provided by EC regarding caribou in the project area, EC notes that the southwest corner of the Regional Study Area overlaps with parts of two ranges of boreal woodland caribou as delineated in the Final Recovery Strategy: Wapisu (MB8) and Manitoba North (MB9). While it does not appear that the project will have any direct effects on these herds, there is potential for indirect effects on these SARA-listed species. The effects analysis in the EIS appears to focus on project effects on the non-SARA-listed caribou (the migratory ecotype of woodland caribou and the barren ground caribou), and predominantly on caribou in the local study area. The EIS report states the following regarding the potential impact on boreal caribou: "Because changes to intactness will be negligible, effects on caribou will likely be negligible. The Project will not contribute to measurable changes in caribou intactness of the RSA." (p. 6-370) It is not clear from the information provided however, what indirect effects on boreal woodland caribou may occur (e.g., sensory disturbances, loss of habitat, habitat degradation, increased access, indirect mortality, etc.), or the nature of cumulative impacts on boreal woodland caribou when considered with all other foreseeable projects in the area. Additionally it is unclear how the proponent has determined effects for boreal woodland caribou specifically, to be "negligible".		EC suggests that the proponent provide clarification on the above points. EC also encourages the Canadian Environmental Assessment Agency to discuss the potential for indirect effects on boreal woodland caribou with both the proponent and provincial caribou experts.	**see TAC Rd 2 EC-0032b**
33	EC	R-EIS Guidelines	Chapter 8.0 Monitoring and Follow-up	N/A	Monitoring and Follow-Up	EC notes the proponent's plans to implement monitoring and follow-up plans regarding the effects of the project on colonial waterbirds, species at risk, caribou, wetlands, invasive plants, and ecosystem diversity, and the success of planned mitigation measures for each. EC has a particular interest in project effects on migratory birds and species at risk, the development of wetlands, the progress of reclamation with native species in the project area, and the success in preventing the incursion of invasive species.		EC requests confirmation from the Proponent that the monitoring reports collected will be shared with EC.	**see TAC Rd 2 EC-0033**

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	Proponent Response
Health Canada									
2	HC	SE SV and TE SV	Appendix 5C Section 5.4.2.3 Table 7-1	5C-1 5-214 7-53	Socio-Economy	Mercury and human health – proposed mitigation measures: Based on the results of the HHRA, fish consumption recommendations were developed. HC agrees with the need for such recommendations and in general, would also concur with the recommendations themselves. However, HC notes that with respect to recommendations of "unrestricted eating" for all fish with less than 0.2 ppm mercury, the current edition of the Guidelines for the Consumption of Recreationally Angled Fish in Manitoba (2007) recommends that women of childbearing age and children under 12 years, limit their consumption of fish with less than 0.2 ppm mercury to 8 meals per month. The HHRA recommends that fish consumption advisories be communicated to local First Nations and communities. Also, based on fish monitoring data, additional human health risk assessments will be undertaken every 5 years after peak mercury levels have been reached to determine if consumption advisories need to be changed.	HC advises adopting Manitoba's guidelines recommendation limiting consumption for women of childbearing age and children under 12 years with respect to fish with less than 0.2 ppm mercury to provide added protection of health for these sensitive receptors. HC would consider this approach reasonable but would advise that if monitoring results show that mercury levels in fish are higher than the predicted maximum levels in the HHRA, prior to reaching their actual maximum levels, fish consumption advisories should be re-visited to ensure that they remain protective of human health.	HC has previously submitted a response to the CEA Agency in its letter of December 28, 2012. HC disagrees with the HHRA conclusion of supporting unrestricted eating of fish with elevated Hazard Quotients (eg. HQ of 14 for whitefish from Gull and Stephens Lakes). HC welcomes further discussions on mercury levels in fish and the use of provisional Tolerable Daily Intakes (pTDI) of 0.47 micrograms (µg) methyl mercury (MeHg) per kilogram of body weight per day (kg-bw/day) for adults, and 0.2 µg MeHg per kg-bw/day 0.2 ug/kg bw/day for women of childbearing age in human health risk assessments. HC advises the risk communication plan be separate from the HHRA and included within a risk management plan as mitigation for this project. HC welcomes further discussion and is available to review the risk management plan upon request.	**see TAC Rd 2 HC-0002**
3	HC	SE SV	Section 5.3.3	5-104 to 5-120	Socio-Economy	Mercury and human health: The EIS indicates that communication products to address adverse health impacts will be developed.	It should be noted that the determination and implementation of risk management strategies for country foods in the project area fall under the responsibilities of provincial and/or municipal authorities. However, HC considers accurate communication strategies a very important tool in the reduction of risk to Aboriginal health with regards to country foods. HC would be willing to review proposed risk management approaches and communication products to provide its opinion.	HC has reviewed the communication products provided, and some preliminary comments are provided in the attached table (Formative Review of Risk Comm Products). HC would be pleased to meet with the proponent to undertake a more thorough discussion of the communication products, upon request. HC advises that the focus of the communication products be on the protection of the most sensitive receptors first (i.e. pregnant women and women of child-bearing age, and children). HC is available to review communication products that are developed for the post-impoundment scenario, upon request.	**see TAC Rd 2 HC-0003**

KEEYASK Hydropower Limited Partnership

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	Proponent Response
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.	**see TAC Rd 2 HC-0007**

KEEYASK
Hydropower Limited Partnership

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	Proponent Response
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.	**see TAC Rd 2 NRCan-0005**

KEEYASK
Hydropower Limited Partnership

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	Proponent Response
16	NRCan	PE SV	Section 5.3.2.1	5-6	Physical Environment	The nature of underlying bedrock (and overlying materials) is an important component, even in projects such as Keeyask where it provides not only the solid ground on which the Generating Station rests but also it may contain trace elements that may affect groundwater and surface water quality.		The proponent has not provided the information requested in relation to a detailed description of the regional and local bedrock that includes information such as: local fracture/joint density, orientation, etc. NRCan requests that this information be provided.	**see TAC Rd 2 NRCan-0016**
17	NRCan	R-EIS Gdlines	Section 4.3.3.1 Section 4.6.3	4-15 4-34	Reservoir Preparation	The proponent indicates that standing woody material, including dead and living trees and shrubs 1.5 m tall or taller, as well as fallen trees will be removed from the areas to be flooded. Reservoir clearing addresses boating safety issues and aesthetic issues and is also intended to reduce the production of methylmercury in the future reservoir.	The reduction of methylmercury production would be more effective if reservoir clearing included the removal of labile organic materials such as shrub foliage. Labile organic matter from flooded foliage is one of the main factors favouring the algal bloom that occurs in the first years after impoundment, and this in turn favours the methylation of mercury and its uptake in the reservoir foodweb. NRCan recommends consider whether this strategy could be applied for the Keeyask project.	The proponent states that the production of MeHg is predominantly associated with the decomposition of peat and other organic soils and that the decomposition of shrub foliage is not expected to reduce significantly the mobilization of MeHg in the reservoir foodweb. The EIS however, contains no information on the nature (labile/non labile) of organic matter in soils (including peat) or vegetation of the region. The terrains that will be flooded consist of a mosaic of vegetation and soil cover that have not been characterized with respect to their MeHg mobilization potential. Characterize the variable nature and concentration of C and Hg in vegetation and soils.	**see TAC Rd 2 NRCan-0017**

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	Proponent Response
18	NRCan	R-EIS Gdlines	Section 6.4.7	6-288 to 6-291	Mercury mitigation in aquatic environments	The proponent expects a significant increase of mercury concentrations in large piscivorous species, such as walleye and northern pike and to a lesser extent in lake whitefish. This increase is expected to peak within 3 to 5 years after flooding and to decrease gradually in the following 25 to 30 years. Peak concentrations on the order of 0.8 to 1.4 ppm (Table 6-18), well above the 0.5 ppm guideline for commercial marketing, are expected for walleye and northern pike. Given the amplitude of the mercury residual effect, monitoring of Hg concentrations in fish muscle tissue will take place until concentrations return to long-term stable levels.	The main measures proposed to mitigate the mercury issue in reservoir biota are (1) the clearing of trees and large shrubs prior to flooding and (2) the monitoring of Hg concentrations in large fish and (3) the ensuing publication of consumption advisories. In an effort to reduce as much as possible the increase of mercury concentrations, NRCan recommends that the proponent consider extending the reservoir clearing activities to areas expected to be affected by peatland disintegration (cf. section 6.3.7), one possible effect of which may be is to stretch beyond 30 years the period of strong mercury contamination in the Keeyask reservoir. This consideration should be discussed with relevant federal departments (e.g. Environment Canada) and provincial ministries.	In the proponent's view the model has the ability to fully integrate all the factors that lead to MeHg contamination and that there is no need to characterize the organic C and Hg burden of the vegetation and soils in terrains that will be flooded by the reservoir. It is NRCan's view that fish MeHg concentrations in some boreal reservoirs, such as Gouin or Baskatong, have yet to return to acceptable levels after more than 80 years of impoundment. The proponent should consider all measures that may help to mitigate the expected Hg increase in the reservoir foodweb, especially in view of the continued 'breakdown of shorelines' some 30 years after impoundment.	**see TAC Rd 2 NRCan-0018**

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	Proponent Response
19	NRCan	AE SV	Section 7.0	7-1 to 7-75	Mercury in fish	This section presents a well documented and fairly comprehensive account of the mercury issue in boreal hydroelectric reservoirs, and more specifically in the Keeyask reservoir and nearby water bodies. It presents in a single document much of the information which is otherwise scattered in various other EIS documents.	However, this document presents no information on the variability of Hg concentrations in soils (particularly in organic horizons) that will be affected by reservoir flooding, whether immediately following impoundment or much later as a result of peatland disintegration. In NRCan's view this information, and its links with vegetation cover and wildfire history, are critical in the development of strategies to reduce the remobilization of mercury and to reduce methylation rates in flooded terrain. Moreover, the EIS documents contain no information on forest fire history, as had been requested in the Guidelines (section 8.1.3). NRCan recommends that this information be included in the EIS.	As stated by the proponent, the magnitude and timing of the Hg responses are not only related to mercury concentrations in soils and vegetation but also to factors such as controls on methylation, availability of MeHg to the food web or trophic transfer to the food web. For these reasons, NRCan proposes that the proponent characterize the variable nature and concentration of C and Hg in vegetation and soils. As the proponent recognizes, the algal bloom that follows flooding plays a key, perhaps determining, role in transferring MeHg to the reservoir food web and thus must be attenuated as much as possible by the removal of labile organic matter prior to flooding. It is NRCan's understanding that the proponent has not utilized information on soil mercury content, as this data was not included in the EIS. Without quality information on both Hg and C characteristics in flooded terrains, there are no grounds to compare or assess MeHg predictions in the future reservoir. The region that will be flooded has combined terrain characteristics (thick peaty soils, permafrost) that have yet to be fully assessed in the context of potential Hg contamination. NRCan suggests that the proponent carry out a characterization study in this rather unique terrain and discuss results and mitigation measures (as appropriate) with federal departments and provincial ministries.	**see TAC Rd 2 NRCan-0019a and NRCan-0019b**
Aboriginal and/or Public Comments									
1	Aboriginal and/or public comments	R-EIS Guidelines	Section 4.8 Decommissioning	4-54	Decomissioning of permanent facilities	Although the EIS notes that any future decomissioning will be conducted according to the legislation, standards, and agreements in place at the time, it does not provide a conceptual discussion of decommissioning of permanent facilities as required by the *EIS Guidelines.*		Provide a conceptual discussion on how decommissioning may occur for permanent facilities.	**see TAC Rd 2 Aboriginal and/or Public Comments-0001**

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	Proponent Response
2a	Aboriginal and/or public comments	R-EIS Guidelines	6.2 Existing Environment; 6.4 Effects and mitigation Aquatic Environment	6-238	Reservoir comparisons	The EIS notes that the proposed Keeyask reservoir is compared to other reservoirs for predicting and assessing effects. In particular, the EIS refers to Stephens Lake reservoir and to the "lower Churchill reservoir in Newfoundland and Labrador."		(a) Since Stephens Lake reservoir fluctuates within a 3 m range, whereas Keeyask reservoir fluctuates within a 1 m range and according to a peaking operation pattern, explain how the resulting differences in physical factors would influence future riparian habitat development in the Keeyask reservoir.	**see TAC Rd 2 Aboriginal and/or Public Comments-0002a**
2b	Aboriginal and/or public comments	R-EIS Guidelines	6.2 Existing Environment; 6.4 Effects and mitigation Aquatic Environment	6-238	Reservoir comparisons			(b) Since the lower Churchill projects are not yet developed, and existing reservoirs in the Churchill Falls projects have widely-varying characteristics, clarify what data from the Churchill River System reservoirs were used to assess proposed effects for the Keeyask project.	**see TAC Rd 2 Aboriginal and/or Public Comments-0002b**
3a	Aboriginal and/or public comments	R-EIS Guidelines	7.0 Cumulative Effects Assessment		Sturgeon mitigation	Given the long-term decline of Lake Sturgeon populations, the further fragmentation of the river system, and the importance of the success of stocking and/or habitat enhancement as mitigation for the predicted effects of another hydroelectric dam on the Nelson River to lake Sturgeon, the uncertainties related to the effectiveness of the strategy should be clearly represented and evaluated. Uncertainties include success of spawining habitat enhancement measures (e.g. to be implemented at Brithday Rapids "if practicable and feasible." (p.1A-11)), and long-term effectiveness of trap/catch & transport upstream passage. There are also uncertainties related to predicted effects (e.g. effects to fish of downstream passage through turbines). Given the importance that the EIS places on the stocking strategy (while acknowledging the KCN's reduced confidence in its adequacy to mitigate for disturbance to, and loss of, habitat), results from any existing or experimental programs should be described. Further, other measures that may be required should the proposed mitigation measures fail or prove inadequate should be described and analysed with respect to feasibility and practicality.		(a) Describe the design, implementation and results of experimental habitat enhancement that has occurred in Stephens Lake reservoir.	**see TAC Rd 2 Aboriginal and/or Public Comments-0003a**
3b	Aboriginal and/or public comments	AE SV 1	Section 1A.3.1.6	p. 1A-11	Sturgeon mitigation			(b) Provide information about the implementation and results of stocking programs in the upper Nelson River, including any trial programs (as recommended by the draft Keeyask Lake Sturgeon Stocking Strategy) or existing programs implemented by the Nelson River Sturgeon Co-Management Board.	**see TAC Rd 2 Aboriginal and/or Public Comments-0003b**
3c	Aboriginal and/or public comments	R-EIS Guidelines	Section 1A.3.1.6	p. 1A-11	Sturgeon mitigation			(c) To assist in understanding how stocking programs recommended as mitigation might be implemented within existing management frameworks, describe the functioning of the Nelson River Sturgeon Co-Management Board.	**see TAC Rd 2 Aboriginal and/or Public Comments-0003c**
3d	Aboriginal and/or public comments	R-EIS Guidelines	Section 1A.3.1.6	p. 1A-11	Sturgeon mitigation			(d) Describe other mitigation measures that could be considered as part of an adaptive management regime if the proposed mitigation measures are inadequate.	**see TAC Rd 2 Aboriginal and/or Public Comments-0003d**

Requests for Additional Information - Provincial & Public Reviewers

Comment Number	Department	Volume / Document	Section	Page	Topic	Context / Preamble (e.g. provide applicable background/rationale for providing the comment)	Specific Department Comment / Request for Additional Information:	Proponent Response
Manitoba Conservation and Water Stewardship - Environmental Approvals Branch								
1	MCWS-EAB	R-EIS Gdlines	Section 7.0	N/A	Cumulative Effects Assessment		Please provide the map required pursuant to Section 9.8 of the federal EIS guidelines showing all the past, present and future projects that were considered in the cumulative effects assessment.	**see MCWS-EAB-0001**
Manitoba Conservation and Water Stewardship - Fisheries Branch								
1	MCWS-FB	AE SV	N/A	N/A	Aquatic Environment		Please provide additional information regarding aquatic invasive species (AIS), with specific reference to Spiny Waterflea, Zebra Mussels and Rainbow Smelt. In particular, demonstrate how the proponent will: 1) identify the impact of AIS on the native fish community given that these specific AIS are better adapted to lacustrine and reservoir habitats and 2) distinguish the potential impact of these AIS on both the existing and post project aquatic environment apart from the impact of the Project itself. The the impacts may be synergistic, but if that is expected to be the case, then the proponent is requested to explain how the project and the effects of AIS are expected to interact. Finally, please include a discussion of best management practices to be implemented both during project construction and, during ongoing operation to negate the spread and / or mitigate the impact of aquatic invasive species.	**see MCWS-FB-0001**
2	MCWS-FB	R-EIS Gdlines	N/A	N/A			Please provide additional information on how the Partnership will monitor and mitigate impacts resulting from the offset lake fishing program.	**see MCWS-FB-0002**
Manitoba Health								
1	MB-Health	R-EIS Gdlines	N/A	N/A			Please provide additional information on how the offset lake fishing program will be evaluated to ensure that it is working as it is intended.	**see MB-Health-0001**
2	MB-Health	R-EIS Gdlines	N/A	N/A			Flooding due to extreme weather has been a concern in Manitoba and has caused damage to homes in some locations. Are there any risks of ice jams or extreme flooding as a result of unusual weather patterns as it relates to the Development?	**see MB-Health-0002**

Requests for Additional Information - Provincial & Public Reviewers

Comment Number	Department	Volume / Document	Section	Page	Topic	Context / Preamble (e.g. provide applicable background / rationale for providing the comment)	Specific Department Comment / Request for Additional Information:	Proponent Response
Manitoba Conservation and Water Stewardship - Lands Branch								
12	MCWS-LB	R-EIS Gdlines	N/A	N/A			The NE Wildlife Branch was not aware that a caribou access program was going to be implemented with TCN. If this is happening, will the branch have any input or say on this? Initially it doesn't make sense as the Caribou aren't always in the area of the Keeyask access road or Generation Station. How is there enough of a disturbance that would require an annual fly out hunting program? Locals aren't guaranteed caribou every year if they haven't migrated through the area, why would guaranteed hunting via an access program be allowed? Please provide additional comment.	**see MCWS-LB-0012**
13	MCWS-LB	R-EIS Gdlines	N/A	N/A			MCWS-LB-0004: Lines 55-60. This paragraph seems to refer to an offsetting program specifically for caribou domestic harvest. Is this what it means or is it referencing offsetting programs in general	**see MCWS-LB-0013**
Pimicikamak Cree Nation								
1	PCN		N/A	N/A			The Stephens Lake reservoir is used as a comparison with the proposed Keeyask reservoir in terms of factors such as the development of new riparian habitats in future. This reservoir fluctuates within a 3m range, whereas the Keeyask reservoir would fluctuate within a 1m range and according to a peaking operation pattern. Please explain the differences in these reservoirs and how these physical factors would be expected to influence future habitat development.	**see PCN-0001**
2	PCN	R-EIS Gdlines	N/A	6-238			Reservoir Comparisons: This section describes approaches used in the technical assessment. It mentions that magnitude and spatial and temporal extent of effects were determined through several methods, one of which is comparing data from other reservoirs. It mentions the "lower Churchill River reservoir in Newfoundland and Labrador". There are no reservoirs on the lower Churchill River in Labrador. In the Churchill River system there are the Smallwood and Ossokmanuan reservoirs and two forebays associated with the Churchill Falls project in the upper reaches of the basin. These reservoirs all have widely differing characteristics. The lower Churchill projects are not yet developed. What data were used in this assessment?	**see PCN-0002**

KEEYASK Hydropower Limited Partnership

ACRONYMS

Submitter Name	Full Name
Aboriginal and/or Public Comments	
CEAA	Canadian Environmental Assessment Agency
DFO	Department of Fisheries and Oceans
EC	Environment Canada
HC	Health Canada
MB Health	Manitoba Health
MCWS-EAB	Manitoba Conservation and Water Stewardship - Environmental Approvals Branch
MCWS-FB	Manitoba Conservation and Water Stewardship - Fisheries Branch
MCWS-LB	Manitoba Conservation and Water Stewardship - Lands Branch
MCWS-WB	Manitoba Conservation and Water Stewardship - Wildlife Branch
NRCan	Natural Resources Canada
PCN	Pimicikamak Cree Nation

REFERENCE: Volume: Response to EIS Guidelines; Section: 4.8 Decommissioning; p. 4-54

TAC Public Rd 2 Aboriginal and/or public comments-0001

PREAMBLE:

Although the EIS notes that any future decommissioning will be conducted according to the legislation, standards, and agreements in place at the time, it does not provide a conceptual discussion of decommissioning of permanent facilities as required by the EIS Guidelines.

QUESTION:

Provide a conceptual discussion on how decommissioning may occur for permanent facilities.

RESPONSE:

Should there ever be a decision to discontinue production of electricity at the Project, the *TCN 1992 NFA Implementation Agreement*, signed by Canada, Manitoba, Manitoba Hydro and TCN, establishes the fundamental parameters for future water regimes. According to article 2.9 (the Maintenance of the Water Regime):

> *"If, in the future, the Project is no longer utilized for the production of hydro-electric power, then Hydro covenants and agrees to continue to operate and maintain all such works, structures and improvements, within its legal authority and control, as may be necessary to avoid, to the extent reasonably possible, deviations from the Post Project Water Regime."*

In this context, the word Project "…means and includes all Existing Development and all past, present and future hydroelectric development or redevelopment on the Churchill, Burntwood, and Nelson River Systems, and shall include all development or redevelopment of the Lake Winnipeg Regulation System north of the 53rd parallel, and shall also include the operation thereof by Hydro."

Post Project Water Regime means "…the levels and flows, including the fluctuation and timing thereof, with respect to the Project Influenced Waterways (excepting the Aiken River) as such levels and flows occur within the Resource Area and have been observed since September 1, 1977 to the Date of this Agreement, or based thereon are reasonably anticipated to occur in the future…"

As such, in order to meet the requirements of the *TCN 1992 NFA Implementation Agreement*, the permanent facilities would need to be maintained to avoid deviations in the post project water regime. Even if electric production were discontinued, effects to the environment would be very limited, if any were to occur at all.

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.2 Existing Environment; 6.4 Effects and Mitigation Aquatic Environment; p. 6-238

TAC Public Rd 2 Aboriginal and/or public comments-0002a

PREAMBLE:

The EIS notes that the proposed Keeyask reservoir is compared to other reservoirs for predicting and assessing effects. In particular, the EIS refers to Stephens Lake reservoir and to the "lower Churchill reservoir in Newfoundland and Labrador."

QUESTION:

Since Stephens Lake reservoir fluctuates within a 3 m range, whereas Keeyask reservoir fluctuates within a 1 m range and according to a peaking operation pattern, explain how the resulting differences in physical factors would influence future riparian habitat development in the Keeyask reservoir.

RESPONSE:

This same question was also raised by Pimicikimak Cree Nation (PCN) and a response is provided as TAC Public Rd 2 PCN-0001. For convenience, this response is also provided below.

PCN-0001 RESPONSE:

Generalizations about the relative importance of physical factors and how they are expected to influence future Keeyask reservoir shore zone habitat development are based on six northern Manitoba proxy areas for flooding and/or water regulation, some northern Quebec reservoirs and the scientific literature. More than one northern Manitoba proxy area is used because no single one represents ecological conditions identical to Keeyask and to provide replication for any findings.

The six proxy areas used for the shore zone habitat effects assessment are the Kelsey reservoir, Stephens Lake (i.e., Kettle reservoir), Long Spruce reservoir, Wuskwatim Lake (post-CRD and prior to Wuskwatim GS), Notigi reservoir (TE SV Map 2-2) and the Keeyask reach of the Nelson River (post CRD and prior to Keeyask Generating Station development). The Stephens Lake proxy area is immediately downstream of the proposed Keeyask reservoir, is the most ecologically comparable proxy area and has the best historical time series of large scale aerial photography.

The Keeyask reservoir and four of the proxy areas are located in peatland dominated areas. Relief ranges from low to high (Keeyask is low). The normal water level range (i.e., the difference between the 5th and 95th percentiles for daily water elevations) during the open water season at the proxy areas is as follows: 0.8 m at Kelsey, 1.2 m at Wuskwatim, 1.5 m at Notigi, 0.8 m at Long Spruce, 2.0 m at Stephens and 2.3 m at Keeyask. Three of the proxy areas have normal water level ranges similar to the Keeyask project, which is 1.0 m, while the remaining three proxy areas have increasingly higher ranges.

The proxy areas indicate that relief and the proportion of reservoir area that is peatland are expected to be the most important physical factors for shore zone habitat development in the Keeyask reservoir. Reservoir flooding in peatland dominated areas essentially converts existing riparian peatlands and a high proportion of inland peatlands to reservoir riparian peatlands because the new shoreline forms in these peatlands. These peatlands already have established wetland vegetation that is adapted to the new conditions and can persist over the long-term. Relief is important because flooded areas that are generally flatter tend to have more of the wetter peatland types, which already have vegetation that is similar to what develops along reservoir shorelines.

Water regime is another important factor for shore zone habitat development because it influences the proportion of the shore zone that can support wetland vegetation. The length of time that various water depths persist determines the width of the shoreline wetland band that can potentially support vegetation. That is, the normal range of growing season water depths rather than the entire water level fluctuation range determines the potential width of the shore zone. For ease of relating this to information in the Physical Environment Supporting Volume, the normal range of growing season water depths is approximated by the difference between the 5th and 95th percentiles for daily water elevations during the open water season (for Stephens Lake the normal water level range is 2 m rather than 3 m; see the Terrestrial Environment Supporting Volume Section 2.3.2.2 for details on how the normal range of growing season water depths are calculated for shore zone habitat). The proportion of this shoreline wetland zone that is actually vegetated is influenced by water level variability, the seasonality of extended high and low water levels, wave energy, current, substrate type, water chemistry, turbidity, substrate freezing during winter drawdowns, ice scouring and ice-related substrate compression.

Prior to 2005 there was a relatively small amount of shoreline wetland vegetation in the Keeyask reach, and the vegetation that was there was less diverse than that found in off-system waterbodies and in the Stephens proxy area (the proxy area with a comparable number of ground transects). Of the total available shoreline wetland area determined for the Keeyask reach based on water depth durations, only approximately 10% to 15% of the area with suitable water depths actually supported wetland vegetation. Emergent vegetation on the littoral to middle beach sub-zones (i.e., what people generally think of as marsh) accounted for very little of that 10% to 15%. That is, most of the area that could be vegetated based on water depth is not vegetated. This was attributed to the high degree of water level variability and the effects of winter drawdowns.

The Project would affect a small amount of existing shoreline wetland vegetation relative to what is expected to develop during Project operation. Very high water levels and river flows from 2005 to 2011 have virtually eliminated beach and littoral vegetation, and also removed some shoreline tall shrub habitat in the Keeyask reach. Even using pre-2005 conditions as the baseline, the total area removed by the Project is small relative to the total available area there in 2005 based on suitable depths.

The six proxy areas support the overall EIS prediction that shoreline wetlands removed or altered by the Project will be replaced by wetlands that develop along the reservoir shoreline during the operation phase. Most of the shoreline wetland vegetation in the existing Nelson River reservoir proxy areas was shrub and/or low vegetation on sunken peat that predominantly originated from riparian and inland peatlands that became reservoir shoreline after flooding and reservoir expansion. Because the Keeyask reservoir occurs in similar conditions to the other Nelson River reservoirs (the majority of the flooded area is peatlands), the Keeyask reservoir shoreline is expected to support more shoreline wetland per kilometer of shoreline than the Keeyask reach presently does. The overall EIS prediction may be met on this basis alone even before considering that the reservoir shoreline at Year 30 is predicted to be almost 20% longer than the existing shoreline.

Incremental to the above factors, reduced water level variability in winter should reduce exposed substrate freezing, ice scouring and ice-related bottom compression, which is expected to facilitate more widespread emergent vegetation development. Reduced water level variability during the growing season is expected to provide emergent plants sufficient time to establish over a larger percentage of the area where water depths are suitable.

An additional important contributor to total vegetated shoreline wetland area will be the peat islands that are now virtually absent in the Keeyask reach but are expected to be common in the Keeyask reservoir (peat islands are still present in the reservoir proxy areas after more than 35 years). Floating peat islands will develop through peatland disintegration processes. The proxy areas have shown that emergent vegetation develops on the sunken fringes of the peat islands much like it does on the fringes of off-system riparian peatlands.

In summary, when comparing post-Project with existing conditions, at least an equivalent amount of vegetated shoreline wetland is expected to develop because:

- the total area to replace is relatively small (especially the emergent vegetation component of this total);
- vegetated riparian peatland will already be established along much of the shoreline;
- a higher percentage of the shore zone area with water depths suitable for emergent vegetation will become vegetated because the water level fluctuation regime will be more favorable than it is currently and winter drawdowns will be eliminated;
- the reservoir will contain peat islands, a feature not presently found in the Keeyask reach of the Nelson River, which are expected to be a substantial long-term contributor to emergent vegetation; and,
- a longer shoreline will be available for shoreline wetland development.

Additionally, the proxy areas indicate that it is likely that the Keeyask reservoir will have higher vegetation diversity than currently exists in the Keeyask reach.

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.2 Existing Environment; 6.4 Effects and mitigation Aquatic Environment; P. 6-238

TAC Public Rd 2 Aboriginal and_or public comments-0002b

PREAMBLE:

The EIS notes that the proposed Keeyask reservoir is compared to other reservoirs for predicting and assessing effects. In particular, the EIS refers to Stephens Lake reservoir and to the "lower Churchill reservoir in Newfoundland and Labrador."

QUESTION:

Since the lower Churchill projects are not yet developed, and existing reservoirs in the Churchill Falls projects have widely-varying characteristics, clarify what data from the Churchill River System reservoirs were used to assess proposed effects for the Keeyask project.

RESPONSE:

This same question was also raised by Pimicikamak Cree Nation (PCN) and a response is provided as TAC Public Rd 2 PCN-0002. For convenience, this response is also provided below.

PCN-0002 RESPONSE:

The reviewer is correct that there is currently no reservoir on the lower Churchill River in Labrador. In amalgamating text from several sections of the Aquatic Environment Supporting Volume, references to data and models used to predict effects to the lower Churchill River were inadvertently included in the list of existing reservoirs. We apologize for any confusion this may have caused.

The data sources to describe the existing environment and the methods used to conduct the effects assessment are described in detail in the Aquatic Environment Supporting Volume. The effects assessment was based on a combination of comparison of pre- and post-Project conditions, models, and comparison to other similar systems. It is assumed that the above-stated question is referring specifically to reservoirs or similar systems that were used to assist in determining effects of the Keeyask Project. These are as follows:

- Manitoba: Stephens Lake, Long Spruce Forebay, Limestone Forebay, impounded river upstream of the Kelsey Generating Station, Southern Indian Lake, Notigi Lake, other lakes along the Churchill River Diversion route, the impoundment upstream of the lower Churchill River weir, Winnipeg River below the Slave Falls generating station and between the Slave Falls and the Pointe du Bois generating stations.

- Québec : Opinaca Reservoir, Robert-Bourassa Reservoir, Desaulniers Reservoir, Caniapiscau Reservoir, and La Grande Complex, among others.

In addition, the assessment referenced general information obtained from studies of impoundments in Scandinavia and other areas of Canada and the United States.

REFERENCE: Volume: Response to EIS Guidelines; Section: 7.0 Cumulative Effects Assessment; p. N/A

TAC Public Rd 2 Aboriginal and/or public comments-0003a

PREAMBLE:

Given the long-term decline of Lake Sturgeon populations, the further fragmentation of the river system, and the importance of the success of stocking and/or habitat enhancement as mitigation for the predicted effects of another hydroelectric dam on the Nelson River to Lake Sturgeon, the uncertainties related to the effectiveness of the strategy should be clearly represented and evaluated. Uncertainties include success of spawining habitat enhancement measures (e.g. to be implemented at Brithday Rapids "if practicable and feasible." (p.1A-11)), and long-term effectiveness of trap/catch & transport upstream passage. There are also uncertainties related to predicted effects (e.g. effects to fish of downstream passage through turbines). Given the importance that the EIS places on the stocking strategy (while acknowledging the KCN's reduced confidence in its adequacy to mitigate for disturbance to, and loss of, habitat), results from any existing or experimental programs should be described. Further, other measures that may be required should the proposed mitigation measures fail or prove inadequate should be described and analysed with respect to feasibility and practicality.

QUESTION:

(a) Describe the design, implementation and results of experimental habitat enhancement that has occurred in Stephens Lake reservoir.

RESPONSE:

No experimental habitat enhancement has occurred to date in Stephens Lake because Gull Rapids currently provides habitat for any spawning sturgeon that may be present in Stephens Lake.

TAC Public Rd 2 DFO-0045 provides a description of spawning habitat creation in other reservoirs, and has been copied below for convenience. Similarly, TAC Public Rd 2 DFO-0098 provides a discussion of successful lake sturgeon stocking programs and is also copied below.

DFO-0098 RESPONSE:

The reviewers comments appear to comprise four questions:

1. Will the reservoir be suitable for Lake Sturgeon given predictions of accumulated sedimentation/peat accumulation and subsequent influences on water chemistry (including decreasing oxygen)?
2. Will mercury levels (presumably in fish) affect the suitability of the reservoir for Lake Sturgeon?
3. Will the Proponent provide more detail about changes in the reservoir (pre- versus post-Project comparison)?
4. Will the proponent provide publications that support stocking in the reservoir given mercury in fish tissue significantly elevate post-Project?

Each of these is answered in turn.

1. Will the reservoir be suitable for Lake Sturgeon given predictions of accumulated sedimentation/peat accumulation and subsequent influences on water chemistry (including decreasing oxygen)?

Most effects to water quality (e.g., dissolved oxygen depletion) will be restricted to the newly flooded terrestrial habitat that is currently not aquatic habitat. Over time, flooded terrestrial habitat will evolve to become suitable for subadult and adult Lake Sturgeon. Sediment deposition will affect flooded terrestrial habitat and much of existing aquatic habitat in Gull Lake. However, habitat will be available for spawning and for foraging by subadult and adult sturgeon in riverine sections of the river, even in the first years post-impoundment. Monitoring and mitigation measures have been identified to address uncertainties with respect to the availability of rearing habit for young-of-the-year sturgeon. The following are quoted from the AE SV Section 6.4.2.2.2:

> *Changes to water quality are not expected to affect the suitability of spawning habitat in the riverine portion of the reservoir where lake sturgeon spawn as the analysis of sediment transport indicates that total suspended solids levels will decline post-impoundment and no consequential effects to other water quality parameters are expected (Section 2).*

> *The existing environment HSI model for lake sturgeon rearing habitat show the reach between Clark Lake and Gull Rapids as having a WUA of between 199 and 220 ha (Section 6.3.2.3.1). However, almost all high quality habitat (HSI greater than or equal to 0.5; 54–64 ha) is located in the downstream portion of Gull Lake on the north side of Caribou Island, where YOY lake sturgeon were captured during environmental studies. The post-Project HSI model predicts a total rearing habitat WUA of between 445 and 637 ha. However, the amount of high quality rearing habitat for the reservoir is predicted to be lower (WUA=16–19 ha; Map*

6-47 to Map 6-49; Appendix 6D). Furthermore, YOY access to the high quality habitat also is expected to be reduced given the increased area of the reservoir and the loss of moderate currents on which larvae currently rely to transport them to favourable rearing habitat in the lower end of Gull Lake. Because of this, it is uncertain whether the post-Project rearing habitat will be accessible to drifting larval sturgeon.

During the initial years post-impoundment, conditions over the newly flooded terrestrial habitat would not be optimal for lake sturgeon, which appear to favour deeper, more riverine, mineral substrate environments in the Nelson River (Section 6.3.2.3.1)…. Lake sturgeon will continue to be able to use habitat in the former mainstem and Gull Lake that are not expected to experience the changes in water quality (Section 2.5.2.2) that are predicted for flooded shallow water lentic habitats (decreased dissolved oxygen, flooded terrestrial organics and episodic increases in suspended sediments). Over time, as the substratum evolves, lake sturgeon could begin to use flooded portions of the reservoir as conditions become suitable.

2. Will mercury levels (presumably in fish) affect the suitability of the reservoir for Lake Sturgeon?

Current (2002-2006) mean mercury concentrations in the body musculature of Lake Sturgeon captured from Gull Lake have been measured at approximately 0.2 ppm in adult fish (i.e., exceeding 1000 mm fork length) and, based on a single fish captured in 2006, may be considerably lower in juveniles (Table 1; also see AE SV 2012, Appendix 7A). Data on sturgeon mercury content are limited for Manitoba. Two recent samples of relatively small fish from the Winnipeg River and for a large range of fish sizes from the Churchill River indicate that mercury concentrations in juvenile (<700 mm fork length) Lake Sturgeon are less than 0.1 ppm, approximately 0.2 ppm for fish of up to 1000 mm length, and some of the larger individuals may reach concentrations of up to 0.7 ppm (Table 1). A similar relationship between mercury concentration and fish length has been shown for Lake Sturgeon from the Ottawa River (Haxton and Findlay 2008). Therefore, current mercury concentrations in Lake Sturgeon from Gull Lake seem to be quite typical for Manitoba and the species in general.

The models applied in the Keeyask EIS to estimate maximum mean mercury concentrations in Lake Whitefish, Northern Pike, and Walleye for the future Keeyask forebay (and for Stephens Lake) do not include Lake Sturgeon and quantitative predictions were not attempted for this species. In trying to attempt such predictions, several factors have to be considered, particularly:

- The trophic position of sturgeon from the time of stocking as 0+ or 1+ fish until reaching approximately 1000 mm fork length (a mean [i.e., "standard"] length at which meaningful comparisons of mercury levels between locations and among years for the same location can be made) will be similar to that of adult (i.e., benthivorous) whitefish and certainly lower than that of adult (i.e., piscivorous) pike and Walleye. The same applies to wild sturgeon in the Keeyask reservoir.
- Based on the preferred habitat of juvenile Lake Sturgeon, deeper water over mainly mineral sediments, the general conditions for mercury methylation and the availability of methylmercury (MeHg) and its bioaccumulation up the food chain will be less so than in most other areas of the reservoir. Spatial variation in fish mercury concentrations due to heterogeneity in MeHg availability are well documented (Chumchal et al. 2008; Schetagne et al. 2003; Cizdziel et al. 2002).

Based on the predicted increases in mercury concentrations for the Keeyask forebay (0.2 ppm in whitefish, approximately 1.0 ppm in pike and Walleye, AE SV 2012) and taking into account the ecological parameters that will affect the dynamics of mercury bioaccumulation in Lake Sturgeon after the impoundment of the Keeyask forebay, a maximum mean concentration of 0.30 ppm for fish of approximately 1000 mm fork length seems realistic. This estimate applies to fish that use Gull Lake as a habitat and will continue to forage in the area during and after impoundment. Fish stocked in year 2 or later after the start of operations will grow in an environment of successively declining efficiency of MeHg bioaccumulation and likely will not reach the maximum mean concentration of 0.3 ppm. Also because of the relative long time it will take stocked sturgeon to attain a length of 1000 mm, maximum mercury concentrations may not be measured in the population after 4-8 years as for the other three large-bodied fish species (see above), but a few years later. Similar to the other three species, the maximum concentrations may last no longer than 1-2 years and a period of up to 30 years may be expected for mercury levels to return to pre-Project concentrations.

Mean muscle mercury concentrations of 0.3 ppm, particularly if transient, will in all likelihood not affect the success of sturgeon stocking. To our knowledge no studies exist on the effects of mercury on Lake Sturgeon. However, there have been many recent publications of the effects of dietary MeHg and mercury tissue concentration on the physiology and behavior of fish, including other sturgeon species (Lee et al. 2011; Gharaei et al. 2011, 2008, Webb et al. 2008). These studies indicate lowest observed adverse effect levels of dietary MeHg for growth and mortality of juvenile Beluga (*Huso huso*) of 1.97 and 4.05 ppm, respectively (Gharaei et al. 2011, 2008) and of juvenile Green Sturgeon (*Acipenser medirostris*) and White Sturgeon (*A. transmontanus*) of 9.73 and 24.3 ppm, respectively (Lee et al. 2011; also see summary in Depew et al. 2012). Reviews by Sandheinrich and Wiener (2011) and Depew et al. (2012) have summarized recent advances in our knowledge regarding toxicological effects of environmentally relevant concentrations of mercury in freshwater fish. In trying to establish a 'tissue residue guideline' concentration above which there is the potential for mercury induced effects to fish, Sandheinrich and Wiener (2011) reported that impairment of biochemical processes, damage to cells and tissues, and reduced reproduction have been observed at MeHg concentrations of about 0.5-1.2 ppm mercury in axial muscle. Such concentrations are well above the predicted mean maximum concentration for Lake Sturgeon in the future Keeyask forebay, although some of the largest, oldest individuals may reach the lower range of these mercury levels, as has been observed for existing populations in Gull Lake, the mouth of the Nelson River, and the Churchill River (Table 1).

To assess the health risk of elevated muscle mercury concentrations on sturgeon populations in the future Keeyask forebay (and the Keeyask Study Area in general) it must also be considered that many adult fish inhabiting natural freshwaters in the midwestern and eastern United States and the eastern half of Canada exceed muscle concentrations of 1.0 ppm wet weight (Kamman et al. 2005; Schetagne and Verdon 1999a). Moreover, mean muscle mercury concentrations of adult Northern Pike (*Esox lucius*) and Walleye (*Sander vitreus*), but also Lake Trout (*Salvelinus namaycush*) and burbot (*Lota lota*) are known to exceed 2.0 ppm in newly created reservoirs in Québec and Manitoba (Therrien and Schetagne 2008; Bodaly et al. 2007; Schetagne and Verdon 1999b), and may reach 4.0 ppm in pike (Schetagne and Verdon 1999b). Despite the obvious potential (based on the threshold concentrations proposed by Sandheinrich and Wiener 2011) for compromised health of these fish populations due to elevated body mercury concentrations, clear evidence for associated population level effects on wild fish is lacking. For example, based on catch-per-unit-effort data, which provide approximate estimates of fish abundance, pike and Walleye populations have not been substantially reduced in any of the well-studied lakes/reservoirs on the CRD route and the lower Nelson River in Manitoba (e.g., AE SV 2012) or reservoirs on the La Grande Rivière in Québec (Schetagne et al. 2003; Roger Schetagene, Hydro Québec, pers. comm., July 2011). These findings do not necessarily indicate an absence of mercury effects on fish populations, but if such effects exist they have not been severe enough to be detected by the sampling and analytical methods applied in these studies. Mercury effects may also be confounded by the multitude of ecological variables that structure fish populations, such as the abundance of prey and predators, parasite loads, fishing pressure, and habitat alterations, and that are likely affected by the physical, chemical, and biological changes in the course of reservoir creation and succession.

For all these reason, the expected relatively minor increase in muscle mercury concentrations of Lake Sturgeon in the future Keeyask forebay does not pose a threat to the health of individuals and is not expected to affect the potential benefits of a stocking program to the recovery and long-term viability of the population in the Keeyask Study Area.

Table 1. Mean arithmetic (± standard error, SE, range) mercury concentration (ppm) and mean fork length (range) of Lake Sturgeon sampled from Manitoba waterbodies in 1970-2012. R= River; Lt CR= Little Churchill River; GrF= Great Falls reservoir; PdB= Pointe du Bois; TP= near The Pas. Mean concentrations with superscripted letters are from commercial samples and raw data are not available.

Waterbody	Year	n	Arithmetic	SE	Range	Length (mm)	n
Gull Lake	2006	1	0.039	-	-	646	1
	2004	10	0.207	0.060	0.04 - 0.67	1158.8[1] (1035 - 1286)	10
	2002	3	0.166	0.033	0.10 - 0.20	1162.5 (1050 - 1275)	2
Nelson R, lower	2011	3	0.141	0.016	0.14 - 0.21	693.7 (654 - 715)	3
	2010	1	0.178	-	-	690	1
	2008	5	0.125	0.019	0.08 - 0.19	621.2 (537 - 736)	5
	2003	7	0.185	0.028	0.13 - 0.34	841.4 (725 - 1200)	7
	1970[a]	4	0.11	-	0.09 - 0.13	-	-
Nelson R, mouth	1982	5	0.220	0.096	0.10 - 0.60	-	0
Fox River	1979	3	0.263	0.050	0.19 - 0.36	- [2]	0
Hayes River	2011	1	0.213	-	-	771	1
	2010	1	0.194	-	-	6649	1
	2009	2	0.098	0.033	0.07 - 0.13	550.5 (543 - 558)	2
Stephens Lake	2008	1	0.099	-	-	587	1
Split Lake	1970[b]	1	0.014	-	-	-	-
Churchill R, at Lt CR	2010	32	0.156	0.023	0.03 - 0.65	797.6 (221 - 1334)	32
Playgreen Lake	1970[c]	7	0.18	0.07	0.49	-	0
Duck to Sipiwesk lakes	1970[d]	1	0.08	-	-	-	0
Cross L (Eves Falls)	1970[e]	1	0.11	-	-	-	0
Mud Lake	1972[f]	1	0.12	-	-	-	0
Burntwood R,	2011	1	0.041	-	-	562	1
Winnipeg R, GrF	2011	3	0.058	0.010	0.08 - 0.11	561.3 (442 - 770)	3
Winnipeg R, PdB	2008	21	0.081	0.005	0.03 - 0.14	582.8 (443 - 682)	21
	2007	4	0.064	0.009	0.04 - 0.08	511.5 (270 - 613)	4
Saskatchewan R, TP	1990	1	0.08	-	-	884	1
	1970[g]	2	0.29	-	0.21 - 0.37	-	0

[1] Calculated based on relationship between fork length and total length for 68 Lake Sturgeon from Manitoba waters
[2] range of weights: 1022 - 2247 g
[a] Derksen 1978a (p.25), b (p.52), 1979 (p.30); undesignated location
[b] Derksen 1978b (p.51), 1979 (p.30)
[c] Derksen 1978a (p.24), b (p.49), 1979 (p.29)
[d] Derksen 1979 (p.30)
[e] Derksen 1978a (p.24), b (p.50), 1979 (p.29)
[f] Derksen 1978b (p.51)
[g] Derksen 1978b (p.42), 1979 (p.24)

3. Will the Proponent provide more detail about changes in the reservoir (pre- versus post-Project comparison)?

The following provides a description of habitat available to Lake Sturgeon pre- and post-Project (AE SV Section 6.4.2.2.2 p. 6-35 to 6-36).

> *6.4.2.2.2 Habitat*
>
> *Spawning Habitat*
>
> *Environmental studies indicate that Birthday Rapids is an important spawning location for lake sturgeon in the reach of the Nelson River between Clark Lake and Gull Rapids. Alternative spawning habitat may be available in Long Rapids immediately downstream of Clark Lake (Section 6.3.2.3). Physical conditions in the Long Rapids area appear to meet depth, velocity, and substrate criteria for sturgeon spawning habitat. Evidence of sturgeon spawning activity at Long Rapids was documented during two of the four environmental studies conducted between Clark Lake and Birthday Rapids from 2001–2010. In some cases, lake sturgeon may only move upstream as far as the first set of rapids that provides suitable conditions for spawning, even if suitable habitat is also available further upstream (Section 6.3.2.3.1). Lake sturgeon in the Nelson River between Clark Lake and Gull Rapids do not appear to use Gull Rapids for spawning; therefore, the loss of Gull Rapids is not expected to affect spawning sturgeon between Clark Lake and the Keeyask GS.*
>
> *The existing environment HSI model for lake sturgeon spawning habitat indicates that there is a WUA of between 9 and 12 ha from Clark Lake to Gull Rapids (Section 6.3.2.3.1). Birthday Rapids and Long Rapids and areas immediately downstream of them account for all of this area. Existing spawning habitat between Clark Lake and Birthday Rapids is not expected to be affected by the Project as flooding is not expected to extend that far upstream. However, increased water levels at Birthday Rapids due to impoundment may reduce the suitability of habitat in the rapids for spawning lake sturgeon; the post-Project*

HSI model suggests that these rapids will no longer be suitable for spawning due to the associated loss of white water (Map 6-44 to Map 6-46; Appendix 6D). Loss of spawning habitat due to flooding has been observed at the rapids on the Nelson River above the Kettle GS (FLCN 2008 Draft). However, some locations where increased water depth has resulted in the loss of white water but maintained appropriate velocity and substrate conditions have continued to support spawning lake sturgeon. For example, sturgeon appear to have continued to spawn in the Nelson River above the Kelsey GS following impoundment (Macdonald pers. comm. 2009). Therefore, it is possible that lake sturgeon will continue to use Birthday Rapids as a spawning area. Post-impoundment monitoring of spawning activity in this reach will be conducted to determine spawning success and, should monitoring indicate poor or no spawning success, contingency works to create suitable spawning habitat will be implemented. Contingency measures for the loss of Birthday Rapids as a spawning site are discussed further in Appendix 1A.

Changes to water quality are not expected to affect the suitability of spawning habitat in the riverine portion of the reservoir where lake sturgeon spawn as the analysis of sediment transport indicates that total suspended solids levels will decline post-impoundment and no consequential effects to other water quality parameters are expected (Section 2).

The current extent of predation on lake sturgeon eggs at their spawning grounds in the study area is not known. Predation by both lake sturgeon and other species is a source of mortality for lake sturgeon eggs in other systems (Appendix 6A). While the Project is predicted to change the composition of the fish community between Clark Lake and the Keeyask GS (Section 5), this change (increase in piscivorous fish species) is not expected to result in an increase in predation on lake sturgeon eggs.

Rearing Habitat (YOY)

Different life history stages of sturgeon appear to have different requirements for foraging habitat, with younger fish having more specific habitat needs than older fish (Appendix 6A). In the Nelson River between Clark Lake and Gull Rapids, YOY lake sturgeon were captured in deep, low velocity water over a mostly sand substrate in the downstream portion of Gull Lake on the north side of Caribou Island during environmental studies (Section 6.3.2.3.1). The existing environment HSI model for lake sturgeon rearing habitat show the reach between Clark Lake and Gull Rapids as having a WUA of between 199 and 220 ha (Section 6.3.2.3.1). However, almost all high quality habitat (HSI greater than or equal to 0.5; 54–64 ha) is located in the downstream portion of Gull Lake on the north side of

Caribou Island, where YOY lake sturgeon were captured during environmental studies. The post-Project HSI model predicts a total rearing habitat WUA of between 445 and 637 ha. However, the amount of high quality rearing habitat for the reservoir is predicted to be lower (WUA=16–19 ha; Map 6-47 to Map 6-49; Appendix 6D). Furthermore, YOY access to the high quality habitat also is expected to be reduced given the increased area of the reservoir and the loss of moderate currents on which larvae currently rely to transport them to favourable rearing habitat in the lower end of Gull Lake. Because of this, it is uncertain whether the post-Project rearing habitat will be accessible to drifting larval sturgeon. Post-Project monitoring will be conducted to determine YOY distribution and abundance and, if necessary, contingency works to create sandy habitat suitable for YOY rearing in the reservoir would be implemented; contingency measures are discussed further in Appendix 1A.

Foraging Habitat (Sub-adult and Adult)

During the initial years post-impoundment, conditions over the newly flooded terrestrial habitat would not be optimal for lake sturgeon, which appear to favour deeper, more riverine, mineral substrate environments in the Nelson River (Section 6.3.2.3.1). Both sub-adult and adult lake sturgeon were captured or relocated via telemetry between Birthday Rapids and Gull Rapids, but were mainly found in Gull Lake (Section 6.3.2.3.1). In Gull Lake, sub-adults occupied a narrower range of conditions, favouring deep, low to moderate velocity areas. Adult sturgeon were also observed in the reach between Clark Lake and Birthday Rapids.

Lake sturgeon will continue to be able to use habitat in the former mainstem and Gull Lake that are not expected to experience the changes in water quality (Section 2.5.2.2) that are predicted for flooded shallow water lentic habitats (decreased dissolved oxygen, flooded terrestrial organics and episodic increases in suspended sediments). Over time, as the substratum evolves, lake sturgeon could begin to use flooded portions of the reservoir as conditions become suitable.

The long-term use of the reservoir by sub-adult and adult sturgeon was modeled separately. The post-Project HSI models predict a net gain of approximately 600–750 ha (WUA) of foraging habitat for sub-adults and a net gain of approximately 3,000–3,150 ha for adults (Map 6-50 to Map 6-55; Appendix 6D).

Currently, there appears to be a sufficient food supply for lake sturgeon between the outlet of Clark Lake and Gull Rapids (Section 6.3.2.3.1). Overall, benthic invertebrate abundance is expected to increase between Clark Lake and the

Keeyask GS in both the short-term and long-term (Table 4-34), suggesting there will be an adequate food supply for both sub-adult and adult lake sturgeon post-Project.

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.

Overwintering Habitat

Localized reductions in dissolved oxygen in nearshore zones may reduce the quality of habitat in off-current areas during winter, particularly in the first year post-impoundment (Section 2.5.2.2). However, these reductions are expected to have a limited effect on lake sturgeon overwintering habitat as ample well-oxygenated deep-water habitat will be available during winter.

4. Will the Proponent provide publications that support stocking in the reservoir given mercury in fish tissue significantly elevate post-Project?

As discussed above, mercury concentrations in Lake Sturgeon are not expected to increase significantly post-Project.

Stocking Lake Sturgeon into the Keeyask Reservoir is the only realistic option to recover populations as stocks are already at very low levels. Lake Sturgeon stocking has been attempted in several North American rivers, especially in tributaries of the Great Lakes; however, monitoring or evaluation of the stocking programs are often not published in the primary literature. Below is a short summary of selected relevant Lake Sturgeon stocking initiatives that have occurred in North America. Additional examples of Lake Sturgeon stocking plans can be found in Smith 2009 and in the Keeyask Lake Sturgeon stocking strategy.

In the past 30 years, stocking has commonly been used to rehabilitate Lake Sturgeon populations. Culture and rearing can now be conducted with relative certainty in both hatchery and stream-side rearing facilities, and many programs have successfully released young fish into the wild. Survival and growth of stocked Lake Sturgeon has been demonstrated in many locations. However, it has been noted that stocking initiatives “have not been adequately evaluated and many programs rely on intermittent, short-term, or anecdotal indicators of program success” (Smith 2009). Until recently, due at least in part to lengthy generation times, stocking initiatives have been conducted based on the assumption that stocked Lake Sturgeon which survive to maturity will successfully reproduce and contribute to subsequent generations. However, in 2011, Lake Sturgeon stocked into the St. Louis River successfully spawned approximately 30 years following their initial reintroduction (R. Bruch, Wisconsin DNR, pers. comm.) This finding is significant, since re-establishment of self-sustaining populations (as opposed to put-and-take fisheries) is the ultimate goal of most Lake Sturgeon recovery strategies.

While the vast majority of Lake Sturgeon stocking initiatives have occurred in Great Lakes systems which are markedly different environments from the Nelson River, there are some relevant proximal examples. In Western Canada, Lake Sturgeon stocking has been conducted in the Assiniboine, Nelson, Winnipeg, and Saskatchewan rivers. Lake Sturgeon stocking has also been conducted in the Minnesota portion of the Red River, which subsequently flows through Manitoba.

The Assiniboine River was stocked with over 12,000 fingerlings and 4,000 fry between 1996 to 2008. Although a formal study has never been conducted to assess the success of the stocking effort, Lake Sturgeon captures are frequently reported by anglers (B. Bruederlin, Manitoba Fisheries Branch, pers. comm.). At present, most of the Lake Sturgeon being captured are larger than 43 inches, with the largest measuring 60 inches. A study is now required to determine if stocked fish will begin to reproduce naturally.

The Minnesota Department of Natural Resources started a 20 year plan to restore Lake Sturgeon populations and has been releasing Lake Sturgeon from the Rainy River into the Red River drainage (Minnesota DNR 2002; Aadland et al. 2005). The 2002-2022 plan is to release 600,000 fry and 34,000 fingerlings per year at various locations throughout the Red River drainage in Minnesota. Anecdotal evidence (angler recaptures) suggests that Lake Sturgeon encounters in the Red River in Canada are increasing (Cleator et al. 2010).

Lake Sturgeon stocking in the Nelson River was conducted intermittently from 1994 to 2011 by the Nelson River Sturgeon Board and Manitoba Fisheries Branch. Spawn collection typically occurred at the Landing River tributary, located 30 km upstream of the Kelsey GS. Prior to 2011, male and female Lake Sturgeon were held in streamside tanks until they were ripe and running (water temperature influenced). Attempts were then made to collect eggs and milt from these fish. Because success was sporadic using these methods, Ovaprim was adopted for spawn taking operations in 2011. Fertilized eggs were transported to the Grand Rapids Hatchery for rearing during each year in which spawn collection was successful. Lake Sturgeon fingerlings (age 0) and some yearlings (age 1) were stocked back into various locations of the upper Nelson River. Until recently, success of Nelson River stocking efforts has remained largely unknown. In fall 2012, a Lake Sturgeon inventory was conducted in the Sea Falls – Sugar Falls reach, which had been stocked with large quantities of both fingerling (age 0, n = 20,885) and yearling (age 1, n = 1,107) Lake Sturgeon from 1994 – 2011. A total of 91 individual Lake Sturgeon (90 juvenile, 1 adult) were captured and 67 (74%) of these had Passive Integrated Transponder (PIT) tags, signifying that they were stocked as age 1 (McDougall and Pisiak 2012). Given the relative proportions of PIT tagged fish in the catch and considering only those fish from the 2006 – 2011 cohorts reasoned to be susceptible to the gillnets deployed, relative recruitment success was conservatively estimated to be 17.4 times greater for Lake Sturgeon stocked as age 1 versus those stocked as age 0 (which were stocked in far greater numbers). Furthermore, based on atypical growth chronologies observed when examining ageing structures of the captured fish (missing or weak first annuli, attributed to unnatural overwinter hatchery thermal regimes), the authors suggested that as many as 95.5% of the fish aged may actually have been stocked as age 1 (and perhaps that PIT tag loss or malfunction occurred, or that tags were somehow missed during field scanning). Based on this observation, relative recruitment success might actually have been 128 times as great for age 1 compared to age 0 stocked fish. In addition to survival, it was noted that age 1 stocked fish from the 2007 cohort were considerably larger than those identified as age 0 stocked fish from the same cohort based on growth chronologies, and therefore the head-start afforded by overwinter hatchery growth might well translate into age 1 stocked fish reaching maturity faster or being more fecund upon reaching maturity (since they are larger for a given age) than their age 0 stocked counterparts. It was concluded that stocking initiatives should strongly consider rearing Lake Sturgeon to age 1 prior to release in order to increase survival.

Lake Sturgeon (primarily fingerlings) were stocked in the Winnipeg River most years from 1996 – 2010. In 2008 and 2009, Ovaprim was used to induce ripe Lake Sturgeon to release gametes. Research investigating the physiological effects (as well as survival and post-release movement patterns) of Ovaprim injected adults began in 2011, and it is expected that results will be available shortly. Research also suggests that survival of stocked yearlings (age 1) may far exceed survival of fingerlings (age 0) in the Slave Falls to Seven Sisters reach of the river, although data analysis is ongoing (C. Klassen, University of Manitoba, pers. comm.). With those exceptions, Winnipeg River stocking was conducted to supplement recruitment. As natural recruitment has now been ascertained in all impoundments on the Manitoba side of the Winnipeg River, stocking Winnipeg River populations does not appear to be necessary to rehabilitate these populations. However, stocking is still being considered for the Lamprey Falls – Manitoba/Ontario border stretch of river conditional on the presence of quality habitat and very few fish, both of which have not been adequately assessed (K. Kansas, Manitoba Fisheries Branch, pers. comm.).

Lake Sturgeon were stocked into the Saskatchewan River during 1999 and 2000, as well as from 2003 – 2007. Spawning adults were captured from downstream of the EB

Campbell or Nipawin dams by Saskatchewan Environment staff. Ovaprim was used during each year. Fertilized eggs were reared in the Grand Rapids Hatchery or Fort Qu'Appelle hatchery. While considerable numbers of Lake Sturgeon have been stocked into the Saskatchewan River as either fry or fingerlings, the success of the Lake Sturgeon program remains unknown.

DFO-0045 RESPONSE:

The proposed spawning shoal at Keeyask was designed based on characteristics of successful structures. Constructed spawning shoals that have been reported in the primary literature include two locations in Quebec, one below the Des Prairie GS (Dumont et al. 2011) and the other in the St. Lawrence River (Johnson et al. 2006) and one in the Detroit River (Roseman et al. 2011). All three are reported to have been successful at improving Lake Sturgeon spawning success.

The results of Manitoba Hydro's tests of constructed spawning shoals at the Pointe du Bois Generating Station on the Winnipeg River are summarized below. It should be noted that the shoals at Pointe due Bois are not a test of the proposed design for the Keeyask Generating Station because the velocity, depth and substrate conditions in the tailraces of the two generating stations are very different. The tests of the constructed shoals at Pointe du Bois were designed to provide an understanding of factors that attract sturgeon to spawn on specific micro-habitats. However, as discussed in the conclusion of this response, some of the information obtained from these tests has been applied to improve the design of the Keeyask spawning shoal.

Pointe du Bois Generating Station Lake Sturgeon Spawning Shoals

Lake Sturgeon spawning shoals were constructed at four areas below the Pointe du Bois Generating Station, one in 2009 and three in 2010 (Murray and MacDonell 2010, 2012; North/South Consultants Inc., 2011). The intent was to test shoals in various locations to obtain a better understanding the factors influencing selection of spawning locations by Lake Sturgeon.

The Pointe du Bois Generating Station is a 100-year-old facility, spanning 150 m of the Winnipeg River with 16 turbine units and a spillway over a natural rock shelf with 97 spillway/sluiceway bays. Due to the age of the station, turbines are often off for maintenance and therefore operation cannot be predicted in advance. In 2009, an area downstream of Unit 16 was selected to test construction of a spawning shoal because velocities and depths were within the known ranges used by sturgeon but the existing substrate lacked flow diversity and the interstitial spaces needed for egg incubation.

Three additional shoals were constructed in 2010 based on the results of the previous year's monitoring program. The locations selected for construction were spread out across the face of the generating station to test a variety of flow conditions. The location below Unit 13 was adjacent to Unit 12 where there was some evidence of spawning in 2007 and 2008. The location below Unit 5 was in proximity to units 2-4 where there was evidence of spawning from 2007 to 2009. The location below Unit 1 was selected because it was immediately downstream of the highest water velocities recorded in the vicinity of the Pointe du Bois powerhouse (~1.8-2.6 m/s).

Shoals were constructed by lowering boulders and cobble from a barge and divers then positioned the material on the bottom according to predetermined specifications. The shoals were constructed of coarse cobbles with four large boulders 1-1.5 m in diameter placed in a v-formation at the upstream end. The shoals were expected to provide the necessary cover, turbulence and flow diversity for spawning, and interstitial spaces for egg incubation.

Shoals have been monitored via two methods each subsequent spring to determine if: (i) adult sturgeon are orienting to the shoals; and and (ii) spawning is occurring on or near the shoals. A Dual-frequency Identification Sonar (DIDSON) acoustic camera (manufactured by Sound Metrics Corporation, WA) was used during the peak spawning period each spring to observe the abundance and behaviour of fish on the constructed shoals. Egg collection mats were deployed throughout the tailrace and spillway areas with some specifically targeting the experimental shoals to determine where egg deposition was occurring.

The Unit 16 spawning shoal was the only shoal present during the 2009 spring spawning season. Very few Lake Sturgeon were observed on or near the shoal and no eggs were collected in its vicinity. Monitoring in 2010, 2011 and 2012 also showed no Lake Sturgeon utilization of the Unit 16 shoal. However, it should be noted that in 2012 the entire west side of the Pointe du Bois GS from Unit 11 on to Unit 16 was not in operation; therefore, Lake Sturgeon were not expected to spawn in the vicinity as they do not spawn in the absence of direct flow.

The Unit 13 spawning shoal has been subject to unit outages and has not had direct flow across it during the spawning season since construction. As may be expected, no Lake Sturgeon spawning has been detected on the shoal to 2012.

Monitoring of the spawning shoal constructed below Unit 5 was hampered in 2010 and 2011 due to difficulties associated with operating the DIDSON camera in the turbulent flow and accurately placing egg mats. However, egg mats located within 10 m of the shoal in both years had the highest frequency of egg captures of any of the shoals. In total, 1285 eggs were collected in 2010 and 1863 eggs were collected in 2011, 600 of which were on egg mats within 5 m of the shoal. In 2012 Unit 5 was not in operation, which allowed the monitoring crews to more safely access the Unit 5 spawning shoal. The DIDSON camera recorded large congregations of adult Lake Sturgeon both on and adjacent to the spawning shoal with the greatest numbers being observed downstream of units 4 and 5. Up to 50 individuals were observed congregating in the area at a time and multiple instances of small groups forming around larger individuals, presumably females, were observed. Potential spawning behavior was noted among these groups, including smaller Lake Sturgeon holding until a larger sturgeon arrived, which was then followed by tails being thrashed against the larger individuals for several seconds. A total of six egg mats were located on the Unit 5 shoal in 2012 resulting in 88 eggs collected with an additional 222 eggs collected within 5 m and 827 within 10 m of the shoal.

Monitoring at the Unit 1 spawning shoal was limited throughout the monitoring period due to its location along the edge of the highest velocity areas within the tailrace. The shoal was also placed slightly further away from the dam than the other shoals due to a larger channel present immediately below the station at Unit 1 to accommodate the larger turbine at this location. No egg mats were located directly on the shoal in either 2010 or 2011, and only one was located on the shoal in 2012, which resulted in no eggs. Despite this, egg mats located within 10 m of the shoal each year have indicated that spawning is occurring in close proximity to the shoal. In 2010, 1128 eggs were collected from 37 egg mat stations, in 2011, 112 eggs were collected from 16 stations, and in 2012 35 eggs were collected from 13 stations. No evidence of Lake Sturgeon spawning was observed using the DIDSON camera on the Unit 1 shoal from 2010 to 2012; however, Lake Sturgeon were observed in both 2010 and 2011 lined up on and near the spawning shoal prior to the peak spawning period. When peak spawning occurred, the Lake Sturgeon appeared to vacate the area below Unit 1 and move further into the tailrace area as increases in Lake Sturgeon numbers were noted at several other locations in the tailrace at this time. In 2012 this movement was not observed; however, this may be due to monitoring commencing closer to the peak spawning time when the Lake Sturgeon may have already moved further into the tailrace area.

In summary, the egg mat and DIDSON monitoring data suggests that successful spawning occurred on and near the Unit 5 spawning shoal from 2010 to 2012. The egg mat data also suggests that some spawning likely occurred near the Unit 1 shoal. There is no evidence that either the Unit 13 or Unit 16 spawning shoals have had any success to date. The lack of flow due to unit outages has undoubtedly affected the success of these areas for attracting spawning Lake Sturgeon.

<u>Conclusion</u>

Overall, the data suggest that constructed shoals should be built close to the origin of flow and near maximum available water velocities, but still within the sustainable swimming speeds for Lake Sturgeon. The shoals also need to provide flow diversity and nearby staging areas that allow sturgeon to congregate before moving into optimal habitats for egg deposition. These features have been incorporated into the design of the spawning structure proposed for downstream of the Keeyask generating station.

Data reports listed below are provided on the enclosed CD entitled "Technical Reports Referenced in TAC and Public Review, Round 2."

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Section 1A.3.1.6; p. 1A-11

TAC Public Rd 2 Aboriginal and/or public comments-0003b

PREAMBLE:

Given the long-term decline of Lake Sturgeon populations, the further fragmentation of the river system, and the importance of the success of stocking and/or habitat enhancement as mitigation for the predicted effects of another hydroelectric dam on the Nelson River to lake Sturgeon, the uncertainties related to the effectiveness of the strategy should be clearly represented and evaluated. Uncertainties include success of spawining habitat enhancement measures (e.g. to be implemented at Brithday Rapids "if practicable and feasible." (p.1A-11)), and long-term effectiveness of trap/catch & transport upstream passage. There are also uncertainties related to predicted effects (e.g. effects to fish of downstream passage through turbines). Given the importance that the EIS places on the stocking strategy (while acknowledging the KCN's reduced confidence in its adequacy to mitigate for disturbance to, and loss of, habitat), results from any existing or experimental programs should be described. Further, other measures that may be required should the proposed mitigation measures fail or prove inadequate should be described and analysed with respect to feasibility and practicality.

QUESTION:

Provide information about the implementation and results of stocking programs in the upper Nelson River, including any trial programs (as recommended by the draft Keeyask Lake Sturgeon Stocking Strategy) or existing programs implemented by the Nelson River Sturgeon Co-Management Board.

RESPONSE:

The Nelson River Sturgeon Board initiated a lake sturgeon stocking program in the upper Nelson River in 1994. Since that time they have operated a spawn camp each spring to collect eggs from wild adults at the Landing River and transported them to Grand Rapids Hatchery for rearing. Between 1994 and 2012, over 80,000 sturgeon fingerlings (3-4 months old) and yearlings have been stocked in a total of five (5) different locations in the upper Nelson River (Sea Falls, Jenpeg, Cross Lake, Duck Rapids, Landing River). Since that time, anecdotal reports of small sturgeon being caught by local fishers in some of these areas have been increasing. To begin to formally investigate the success of stocking, the Nelson River Sturgeon Board and Manitoba Hydro conducted a sturgeon inventory study between Sea Falls and Sugar Falls in 2012. The majority of nets set for small sturgeon were successful and captured a total of 90 juvenile-size sturgeon.

Seventy-four percent of the juvenile sturgeon that were captured contained tags that confirmed they had been stocked as yearlings from Grand Rapids Hatchery. Only sturgeon stocked as yearlings were tagged on release since fingerlings were too small. A full report of the 2012 sturgeon inventory at Sea Falls is included on the enclosed CD "Technical Reports Referenced in TAC and Public Reviews, Round 2".

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Section 1A.3.1.6; p. 1A-11

TAC Public Rd 2 Aboriginal and/or public comments-0003c

PREAMBLE:

Given the long-term decline of Lake Sturgeon populations, the further fragmentation of the river system, and the importance of the success of stocking and/or habitat enhancement as mitigation for the predicted effects of another hydroelectric dam on the Nelson River to lake Sturgeon, the uncertainties related to the effectiveness of the strategy should be clearly represented and evaluated. Uncertainties include success of spawining habitat enhancement measures (e.g. to be implemented at Brithday Rapids "if practicable and feasible." (p.1A-11)), and long-term effectiveness of trap/catch & transport upstream passage. There are also uncertainties related to predicted effects (e.g. effects to fish of downstream passage through turbines). Given the importance that the EIS places on the stocking strategy (while acknowledging the KCN's reduced confidence in its adequacy to mitigate for disturbance to, and loss of, habitat), results from any existing or experimental programs should be described. Further, other measures that may be required should the proposed mitigation measures fail or prove inadequate should be described and analysed with respect to feasibility and practicality.

QUESTION:

To assist in understanding how stocking programs recommended as mitigation might be implemented within existing management frameworks, describe the functioning of the Nelson River Sturgeon Co-Management Board.

RESPONSE:

The Nelson River Sturgeon Board is a multi-stakeholder board consisting of communities, First Nations, regulators and industry. It operates with a small amount of base funding from Manitoba and Manitoba Hydro which it uses to leverage additional funding from sources such as federal stewardship programs. It conducts basic field studies to assess stock status and habitat condition on which management decisions can be based. Conservation efforts include educational programs and specific recommendations for voluntary harvest reduction. Stock enhancement measures consist of annual collection of sturgeon eggs from the spawning run of fish in the Nelson River near the confluence with the Landing River. Eggs are shipped to Grand Rapids Hatchery for incubation and rearing. Summer and fall incubation also occurs at the NRSB seasonal rearing facility at Jenpeg. Fingerlings or yearlings are stocked in fall to areas of the Nelson River, such as Sea Falls, Jenpeg and Duck Rapids, where stocks are severely depleted.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Section 1A.3.1.6; p. p. 1A-11

TAC Public Rd 2 Aboriginal and/or public comments-0003d

PREAMBLE:

Given the long-term decline of Lake Sturgeon populations, the further fragmentation of the river system, and the importance of the success of stocking and/or habitat enhancement as mitigation for the predicted effects of another hydroelectric dam on the Nelson River to lake Sturgeon, the uncertainties related to the effectiveness of the strategy should be clearly represented and evaluated. Uncertainties include success of spawning habitat enhancement measures (e.g. to be implemented at Birthday Rapids "if practicable and feasible." (p.1A-11)), and long-term effectiveness of trap/catch & transport upstream passage. There are also uncertainties related to predicted effects (e.g. effects to fish of downstream passage through turbines). Given the importance that the EIS places on the stocking strategy (while acknowledging the KCN's reduced confidence in its adequacy to mitigate for disturbance to, and loss of, habitat), results from any existing or experimental programs should be described. Further, other measures that may be required should the proposed mitigation measures fail or prove inadequate should be described and analysed with respect to feasibility and practicality.

QUESTION:

Describe other mitigation measures that could be considered as part of an adaptive management regime if the proposed mitigation measures are inadequate.

RESPONSE:

Adaptive management can be defined as a process used to continually improve management policies and practices through learning from the outcomes of previously employed policies and practices. One element of adaptive management is consideration of the success and failure for management practices at other locations with similar mitigation needs. Responses to TAC Public Rd 2 Aboriginal and/or public comments 0003a and 0003b provide information related to the successful application of planned mitigation and compensation measures elsewhere. Additional discussion is provided in conjunction with plans for mitigation measures in the AE SV Appendix 1A.

Two essential elements required for the successful implementation of adaptive management are: (i) an effective monitoring program to identify the response of the environmental component of interest to the established management practices; and, (ii) required expertise and commitment to identify changes to existing management practices, if required.

With respect to lake sturgeon and the Keeyask Project, post-Project monitoring will be used to identify factors limiting the lake sturgeon population, and to provide information on the effectiveness of compensation works and mitigation measures designed to address effects of the Project. The monitoring program is being developed in consultation with and will be reviewed by biologists from Manitoba Conservation and Water Stewardship and Fisheries and Oceans Canada. A draft of the Aquatic Effects Monitoring Plan will be formally filed with regulators and available to the public in the second quarter of 2013. The plan will provide reference to baseline conditions and identify action points at which a review of, and potential modifications to, mitigation and compensation measures will be required. If monitoring indicates that mitigation is not working as planned, or that other unanticipated factors related to the Project are adversely affecting the population, then existing mitigation measures will be modified, or alternative measures will be implemented, until the long-term goal of self-sustaining lake sturgeon populations is reached (this is discussed in the AE SV Section 6.4.4).

In order to "describe other mitigation measures that could be considered under an adaptive management regime" for lake sturgeon, it is important to first identify the potential limiting factor in each specific circumstance. While all potential adaptive mitigation measures cannot be described at this time, two scenarios are provided as examples below: (1) lake sturgeon do not spawn in the vicinity of Birthday Rapids; and (2) lake sturgeon stocked into Stephens Lake do not survive.

Spawning Habitat at Birthday Rapids

The following text is quoted from the AE SV Section 6.4.2.2.2, p. 6-35 to 6-36.

> *"Environmental studies indicate that Birthday Rapids is an important spawning location for lake sturgeon in the reach of the Nelson River between Clark Lake and Gull Rapids. Alternative spawning habitat may be available in Long Rapids immediately downstream of Clark Lake (Section 6.3.2.3)…*
>
> *The existing environment HSI model for lake sturgeon spawning habitat indicates that there is a WUA of between 9 and 12 ha from Clark Lake to Gull Rapids (Section 6.3.2.3.1)… However, increased water levels at Birthday Rapids due to impoundment may reduce the suitability of habitat in the rapids for spawning lake sturgeon; the post-Project HSI model suggests that these rapids will no longer be suitable for spawning due to the associated loss of white water(Map 6-44 to Map 6-46; Appendix 6D). Loss of spawning habitat due to flooding has been observed at the rapids on the Nelson River above the Kettle GS (FLCN 2008 Draft). However, some locations where increased water depth has resulted in the loss of white water but maintained appropriate velocity and substrate conditions have continued to support spawning lake sturgeon. For example, sturgeon appear to have continued to spawn in the Nelson River above*

> *the Kelsey GS following impoundment (Macdonald pers. comm. 2009). Therefore, it is possible that lake sturgeon will continue to use Birthday Rapids as a spawning area. Post-impoundment monitoring of spawning activity in this reach will be conducted to determine spawning success and, should monitoring indicate poor or no spawning success, contingency works to create suitable spawning habitat will be implemented. Contingency measures for the loss of Birthday Rapids as a spawning site are discussed further in Appendix 1A."*

If monitoring indicates that sturgeon are not observed at Birthday Rapids, then detailed plans will be developed to construct spawning habitat as described in AE SV Appendix 1A p. 1A-10 to 1A-11:

> *"Monitoring will be implemented to determine the success of lake sturgeon spawning in the reach of the Nelson River between Long Rapids and Birthday Rapids. Should monitoring indicate poor or no spawning success, contingency works to create suitable spawning habitat for the maintenance of lake sturgeon in the reservoir would be implemented. One option currently being considered is the addition of large boulders/structures at locations slightly upstream of the current spawning site at Birthday Rapids to create white water to attract spawning fish. Placement of large boulders in this area would be difficult during the construction phase due to lack of access. However, access would be improved during the operation period. The design would be such that the structures could not be removed by ice.*
>
> *Sturgeon behavior in response to these structures would be monitored and modifications implemented if and as required."*

In terms of the lake sturgeon stocking program, the stocking strategy outlined in AE SV Appendix 1A Part 2 describes a variety of contingency measures that could be applied if required, including the following scenarios:

1. Insufficient spawn is collected at initial target locations due to inadequate numbers of adult fish. Other locations would be assessed as potential sites of spawn collection, in consultation with MCWS and DFO. Considerations would include genetic similarities and differences among the donor and recipient populations; the number of sturgeon available for span collection at the target locations; and the suitability of the site for spawn collection (e.g., access, ease of capture of lake sturgeon).

2. Monitoring indicates that survival of stocked fish released as fingerlings is very low. If survival of stocked fingerling lake sturgeon is poor, then potential adaptive management measures include:

   a. review rearing and handling procedures to determine if fish are in good condition when released and modify procedures as appropriate;
   b. stock out a higher proportion of fish as yearlings rather than fingerlings, if the issue appears related to age of fish stocked;
   c. select other locations/microhabitats to stock the fish if poor survival appears linked to a particular area; and
   d. investigate site-specific conditions to determine if habitat modification is warranted.

3. Monitoring indicates that though numbers of young sturgeon are high, the condition is poor. The potential for overstocking would be investigated and, if this is an issue, the number of sturgeon stocked would be reduced.

The above examples illustrate that in adaptive management, the appropriate response is closely linked to an analysis of monitoring results to determine the exact nature of the problem. In each case, an iterative response may be required, with additional monitoring indicating whether further modifications to a mitigation measure may be necessary.

REFERENCE: Volume: Map & Figure Folio; Section: 4.0 Project Description; Map 4-10

TAC Public Rd 2 CEAA-0005

ORIGINAL PREAMBLE AND QUESTION:

Biophysical Environmental Mitigation Areas Map - A potential high quality wetland area identified on the map will be fragmented by the south access road development. The road location has the potential to impact the wetland mitigation.

Please provide a rationale for developing the wetland mitigation in an area that is also identified for the development of proposed south access road corridor.

FOLLOW-UP QUESTION:

Given that the road will be located through the wetland area, what measures will be in put place to create a suitable buffer area between the road and the wetlands? Please describe the mitigation measures that will be employed to protect the new 'potential high quality wetland' from impacts due to the presence of or operation and maintenance of the proposed road and water control structures, including erosion and sedimentation from the road surface.

RESPONSE:

Construction of the South Access Road (SAR) will take place prior to construction of the new wetland mitigation measure and will be used to facilitate construction of the wetland mitigation area.

One of the primary concerns raised in the question was potential effects to the wetland mitigation area from erosion and sedimentation. Construction of the SAR will follow procedures described in the *Keeyask Generation Project South Access Road Construction Environmental Protection Plan (EnvPP).* This is currently in draft form, but will include a sediment and erosion control plan to be implemented in conjunction with road construction.

Much of the area traversed by the SAR is comprised of peat and, as such, construction techniques for the SAR will be the same as those used in other areas where there is peat. Figure 1 illustrates the typical road construction to be undertaken at this location. It will involve placing geotextile over top of the existing peat and constructing an earthfill berm (i.e., a flat pad) comprised of composite material (sand/gravel) on top of the geotextile. The final road will be constructed on top of a berm, which will extend approximately two meters wider on either side of the final road. The road will be constructed using the same composite materials as used in the berm. The berm will trap gravel or other suspended material that falls off the road surface. Ditching along the side of the road will be designed with erosion and sediment control works, where appropriate, to divert the water away from the constructed wetland as much as feasible to minimize sediment inputs.

In addition to the above measures Figure 2 illustrates that the design of the wetland area will include a buffer adjacent to the road right of way, consisting of existing peatland, so that the 12 ha of constructed off-system marsh mitigation will not be within 100 m of the SAR. This 100 m buffer will only be modified to the extent needed for road construction and to improve water flows for downstream aquatic mitigation. Measurable water flow passing underneath the road at this location will be monitored during construction and operation of the road to measure the effectiveness of the erosion and sediment control measures implemented. Should water quality monitoring results indicate potential deficiencies in the erosion and sediment control mitigation measures, additional measures will be implemented, where practicable. These design and construction measures at the wetland crossing site are expected to minimize and largely avoid erosion and sedimentation effects on the new wetland.

After construction the road will become part of the provincial road network. As indicated, it is assumed that the considerations incorporated into the road design and in the mitigation implementation will largely address effects.

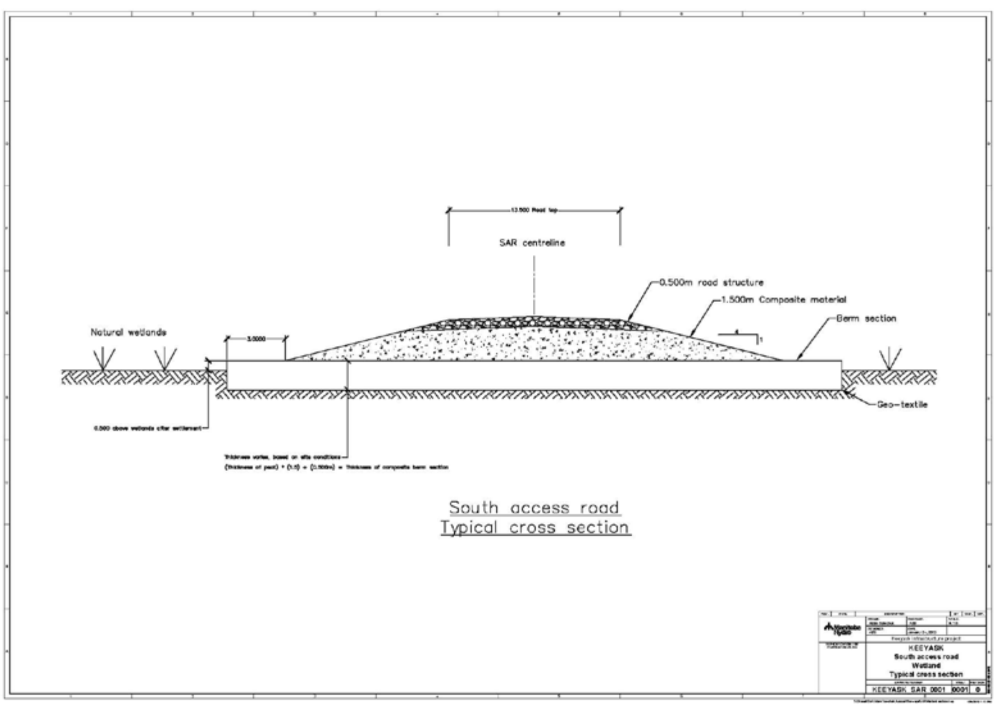


Figure 1 – Typical road cross section - SAR

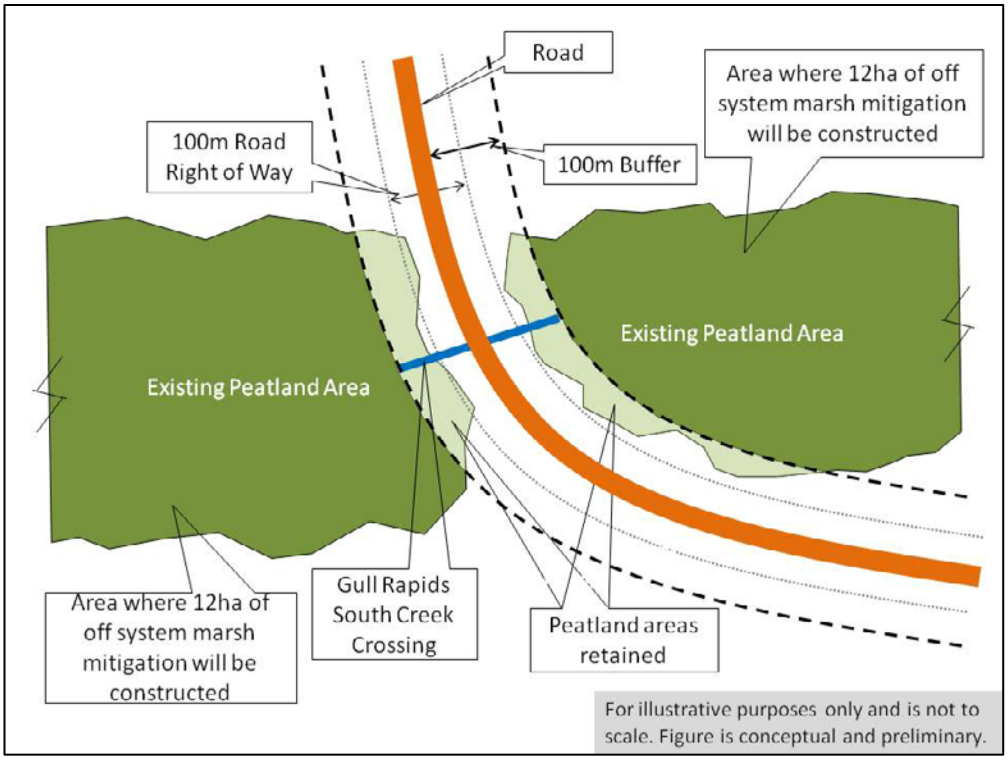


Figure 2 – Conceptual and Preliminary Design of Wetland Area

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.2.3.2.5 Physiography and 6.2.3.4.8 Mercury in Wildlife; p. N/A

TAC Public Rd 2 CEAA-0010

ORIGINAL PREAMBLE AND QUESTION:

EIS Guidelines required the proponent to provide the present mercury and methylmercury data and analysis in soil. There is very little detail provided.

Please provide this information.

FOLLOW-UP QUESTION:

Proponent indicated that total mercury, along with other metals and nutrients, were analysed in soil samples from the flooded area; however, the EIS indicates that the report documenting this work has not been completed. Please provide the data and analysis to support the assessment.

RESPONSE:

Peat samples were collected at 49 representative locations during 2003 in the Keeyask project area, predominantly in the proposed reservoir area (Map 1) to characterize the chemical properties of flooded peat. Two volumetric peat samples were collected at each location, one at the surface and the second starting at 20 cm below the surface. Peat samples were air-dried in the field camp to the extent feasible and then shipped to the office laboratory where they were dried at approximately 35° C.

Samples were sent to an accredited lab for chemical analysis, where they were oven-dried at 60°C prior to analysis to ensure consistent moisture content. Element concentrations except for mercury were determined using inductively coupled atomic emission spectroscopy following EPA Method 6010B. Mercury was determined using by cold-vapor atomic absorption following APHA Method 3112B. Quality control during analyses was monitored by the use of duplicate samples, blanks, and standard reference materials.

Samples were sent in two batches. The 35 samples in the first batch (or approximately 22% of the total number analyzed) were retested to determine arsenic and selenium concentrations using graphite furnace atomic absorption spectrophotometry, a more costly technique with much lower detection limits for these elements. Retesting evaluated whether using the optical ICP and EPA 3052 digestion method created a serious limitation. The graphite furnace detection limits for arsenic and selenium were 0.3 μg/g and 0.2 μg/g, respectively. All retested samples had arsenic concentrations less than 2.1 μg/g (including 13 below the lower detection limit) and selenium concentrations less than 0.6 μg/g (including 25 below the lower detection limit). On this basis it was decided that the additional cost of analyzing all samples using a method with a lower detection limit was not justified.

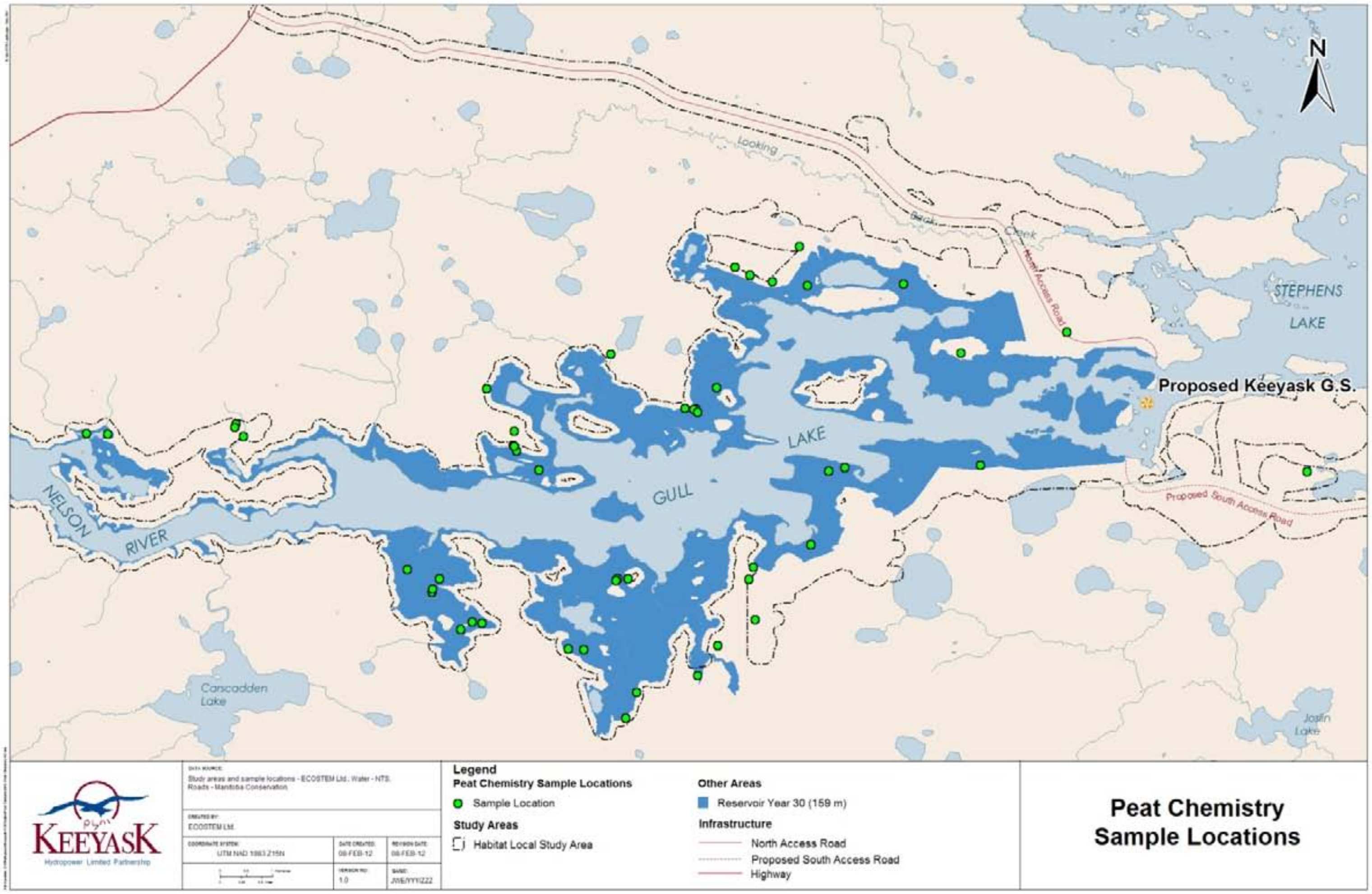
Table 1 below provides element detection limits (μg/g), percentage of samples with non-detects, and mean concentrations and standard errors of the mean for each element by soil layer (the DL/2 substitution method was used for non-detect values). Of the 22 elements, 20 had less than 10% non-detects. Mean concentrations by soil layer differed significantly (α=1%) for at least one soil layer when compared with the others for 22 of the 27 elements that had less than 50% non-detects. Elements whose concentrations did not vary significantly with soil layer and had less than 50% non-detects included manganese, phosphorus, potassium, tin and zinc.

Table 1: Element detection limits (μg/g), percentage of samples with non-detects, mean and standard error of element concentrations (μg/g) measured in peat samples (DL/2 substituted for non-detects)

Element	DL	% Non-detects	Surface		Of		Om		Oh	
			Mean	S.E of Mean	Mean	S.E of Mean	Mean	S.E of Mean	Mean	S.E of Mean
Aluminum	1	0	2,769	716	757	181	7,014	2,607	11,787	4,299
Antimony	2	94	1.08	0.08	1.09	0.09	1.21	0.21	1.58	0.40
Arsenic	4	87	2.43	0.24	2.52	0.29	2.57	0.33	2.63	0.46
Barium	0.05	0	33.4	6.2	22.7	2.9	87.8	18.9	143.8	20.8
Beryllium	0.05	57	0.07	0.02	0.03	0.00	0.25	0.08	0.41	0.10
Bismuth	2	94	1.00	0.00	1.00	0.00	1.53	0.25	1.25	0.25
Cadmium	0.05	7	0.41	0.05	0.15	0.02	0.32	0.03	0.53	0.07
Calcium	1	0	8,642	2,678	9,131	1,678	21,408	4,187	23,823	4,683
Chromium	0.1	1	2.32	0.72	1.20	0.21	11.45	3.84	17.33	5.10
Cobalt	0.1	15	0.49	0.13	0.85	0.35	2.66	0.63	4.29	0.82
Copper	0.1	0	3.82	0.50	2.42	0.34	9.65	1.64	16.40	2.02
Iron	0.2	0	1,340	406	937	178	5,171	1,485	8,987	2,740
Lead	1	43	8.02	0.80	2.69	0.68	1.88	0.74	2.00	0.95
Lithium	0.6	63	1.00	0.44	0.44	0.08	5.42	2.08	9.12	3.45
Magnesium	1	0	1,046	149	1,679	210	2,725	511	4,297	983
Manganese	0.05	0	83.0	11.7	181.8	61.8	165.9	46.7	151.4	39.2
Mercury	0.01	1	0.15	0.01	0.09	0.01	0.09	0.01	0.11	0.01
Molybdenum	1	84	0.50	0.00	0.57	0.07	1.27	0.19	0.67	0.13
Nickel	0.2	1	3.14	0.52	1.73	0.20	5.94	1.43	11.69	2.37
Phosphorus	5	0	548	42	471	41	510	54	531	67
Potassium	100	9	1,563	471	917	107	895	332	2,434	1,533
Selenium	10	100	5.00	0.00	5.00	0.00	5.00	0.00	5.00	0.00
Silicon	5	9	1,430	907	805	655	890	421	2,609	1,324
Silver	0.2	66	0.15	0.02	0.11	0.01	0.54	0.14	0.91	0.18

Element	DL	% Non-detects	Surface		Of		Om		Oh	
			Mean	S.E of Mean	Mean	S.E of Mean	Mean	S.E of Mean	Mean	S.E of Mean
Sodium	5	0	329	57	329	36	1,028	321	1,481	360
Strontium	0.5	0	14	2	22	3	63	8	80	9
Sulfur	100	0	893	56	887	143	2,314	287	2,213	292
Thorium	0.5	3	0.50	0.08	0.45	0.09	2.13	0.51	3.81	0.85
Tin	1	0	1.23	0.22	1.32	0.25	1.44	0.29	1.34	0.34
Titanium	0.4	0	60.35	16.02	24.01	5.26	260.35	83.45	422.47	109.50
Uranium	6	1	4.55	0.33	5.00	0.45	12.22	1.89	24.11	4.94
Vanadium	0.1	0	3.00	0.84	1.26	0.25	13.28	4.10	21.47	5.58
Zinc	0.1	0	18.39	1.76	16.07	1.63	16.48	4.40	25.26	11.38
Zirconium	0.5	0	2.31	0.66	1.55	0.29	13.05	3.37	22.46	3.84
N			26		23		19		12	

Notes: DL=detection limit; Of=fibric organic layer; Om=mesic organic layer; Oh=humic organic layer; S.E.=standard error.



Map 1: Peat chemistry sample locations [DRAFT

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

TAC Public Rd 2 DFO-0001

ORIGINAL PREAMBLE AND QUESTION:

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

Detailed background reports have not been provided in the EIS. These should be made available for review.

QUESTION:

Requested reports not provided.

RESPONSE:

By “biological components of aquatic habitat” it is understood that the reviewer is referring to aquatic macrophytes. A description of changes in macrophyte distribution in relation to inter-annual variations in flow is provided in Aquatic Environment Supporting Volume Section 3.3.2.3.1 and is reproduced below. Also see data reports 01-06, 02-10, 03-16, 04-17, 17 06-08. These reports are included on the enclosed CD “Technical Reports Referenced in TAC and Public Reviews, Round 2.”

AE SV Section 3.3.2.3.1 p. 3-15 to 3-20

“Immediately below Clark Lake, is Long Rapids which is about 3 km long, and is relatively shallow, fast flowing and turbulent, with some areas of white water habitat. Between Clark Lake and Birthday Rapids there is an approximate 4 m drop in water level, velocities are typically more than 1.5 m/s within this reach, and standing waves are common (PE SV, Section 4.3.1). Depths range from less than 4 m in the Long Rapids area to more than 15 m just upstream of Birthday Rapids. The substrate and shoreline features of this section of the river are largely bedrock and boulder/cobble. Downstream of Long Rapids the river widens to about 600 m, deepens, and velocity decreases.

Birthday Rapids, situated approximately 10 km downstream of Clark Lake, is a 300 m wide constriction in the Nelson River that is characterized by a fairly steep gradient (drop of approximately 1.8–2.0 m) with high velocities (greater than 1.5 m/s), (PE SV, Section 4.3.1) white water habitat, and boulder/cobble/bedrock substrate. Below

Birthday Rapids the next 15 km of the Nelson River is a relatively uniform approximately 600 m wide channel with medium to high water velocities and relatively consistent depths of less than 8.0 m (PE SV, Section 4.3.1). River substrates here are primarily bedrock in shallow water, boulder and cobble in the thalweg, with some fine sediment in areas with reduced velocity in shallow water. There are a few large bays with reduced water velocity, which in some years will support aquatic macrophytes.

Gull Lake features a diversity of aquatic habitats, including **lotic** and **lentic** environments. Gull Lake is generally a very wide channel with several islands and bays (PE SV, Section 4.3.1). Depths along the main body of the lake are more than 7 m, with some areas approaching 20 m in depth. Depths around the islands and in the bays are substantially shallower (less than 3 m). Due to the width and depth of Gull Lake, velocities are typically less than 0.5 m/s. Under 50^{th} and 95^{th} percentile flows, velocities in the 0.5–1.5 m/s range become increasingly more abundant in Gull Lake, particularly in the main river channel(s) (PE SV, Map 4.3-5). At the downstream end of Gull Lake, the Nelson River splits around Caribou Island. The north channel is generally wider, shallower, and longer than the south channel. As a result, approximately 75% of the river discharge is conveyed by the south channel (PE SV, Section 4.3.1). Both channels are characterized by moderate velocities (0.5–1.5 m/s). Lake substrates are predominantly cobble and boulder in on-current areas, with soft substrates in off-current areas. Aquatic vegetation is primarily restricted to lower velocity areas that are off the major river channel. The presence of macrophytes and their location may vary from year to year depending on water levels.

Gull Rapids is the largest set of rapids in the Keeyask area with a drop of approximately 11 m across its approximately 2 km length (PE SV, Section 4.3.1). There are several islands and channels located in Gull Rapids. Gull Rapids is a dynamic environment, with new channels being cut periodically due to the erosive forces of the existing ice and water processes occurring in the area (PE SV, Section 4.3.1). Most of the flow (75% to 85%) passes through the south channel of Gull Rapids, with little to no flow being conveyed by the north channel during low Nelson River discharge (PE SV, Section 4.3.1). All channels include rapid and turbulent flows featuring the highest velocities (greater than 1.5 m/s) found within the Keeyask area. The substrate and shoreline of Gull Rapids are composed of bedrock and boulders.

Just below Gull Rapids, the Nelson River enters Stephens Lake. Stephens Lake was formed in 1971 by the creation of the Kettle GS. Between Gull Rapids and Stephens Lake, there is an approximately 6.0 km- long reach of the Nelson River that, although affected by the Kettle reservoir, remains a lotic environment with moderate water velocity. A breach in the north and south bank of the Nelson River below Gull Rapids occurred during winter 2000/2001, when the ice dam that forms each year in the area was particularly massive (PE SV, Appendix 4A). The north breach has since developed into a well-formed channel that connects via “Pond 13” to O’Neil Bay in Stephens Lake.

A detailed description of habitat in the Keeyask area based on specific variables is provided below.

Habitat Variables

Habitat variables discussed in the following sections are characterized under 95th percentile flow open water conditions. Effects under variable flows and ice conditions are discussed under “Environmental Variation”.

Water depth in the Keeyask area is deepest in the primary thalweg and tends to become deeper in the downstream direction. Depths as shallow as 2.5 m occur between Clark Lake and Birthday Rapids. Depth attains a maximum of 16 m in Gull Lake (Map 3-6). Most of the main channel of the river has depths in the range of 8–12 m.

Most of the Nelson River habitat within the Keeyask area is deep (*i.e.*, more than 3 m), with shallow habitat in the main channel being limited to two areas: 1) the reach of river between Clark Lake and Birthday Rapids; and 2) Gull Rapids (Map 3-7). Shallow habitat is abundant in bays in the Gull Lake area. Areas that are backwatered during high flow events are limited to inlets or the upper extent of shallow bays fed by tributaries. The IEZ of the Nelson River is described later in this section.

Lotic water masses are defined as having a depth average velocity of 0.2 m/s or greater. A lotic water mass is continuous throughout the thalweg of the Keeyask area, despite having apparent riverine and lacustrine sections. Lentic water masses are limited to narrow bays or areas where the river is notably wider than the thalweg.

Velocities in the riverine portion upstream of Gull Lake are predominantly moderate or high (Map 3-8). Velocities are lower in Gull Lake but moderate velocity habitat (0.5−1.5 m/s) is found throughout the lake (Map 3-8).

White water habitat exists in several riverine locations upstream of Gull Lake. White water habitat is formed in a rapid, when a river's gradient increases enough to disturb its laminar flow and create turbulence. Sites with white water may have sudden drops in riverbed level and may be associated with eddies where reverse flows occur. The presence of white water suggests the diversity of hydraulic habitat over a small area is relatively high and so provides important fish habitat during spawning or for refugia or feeding.

The location of rapids with white water habitat does not change with different inflows, although at some locations white water occurs only under lower flow conditions. Under an inflow of 3,102 m^3/s (just above the 50^{th} percentile condition), white water was observed at various locations in the Keeyask area (Map 3-9 to Map 3-13). White water habitat is well developed mainly in two localized areas occupying part of the river channel between Clark Lake and Birthday Rapids. This area is known as Long Rapids (Map 3-9). Within Reach 4, white water at Birthday Rapids spans the full width of the Nelson River (about 275 m) (Map 3-10). White water is present on both sides of the island downstream of Birthday Rapids, but is better developed under lower flows. In the north channel, white water habitat is localized in two areas: 1) the north side of the island; and 2) just downstream along the north bank of the Nelson River. The white water on the south side of the island spans most of the width of the south channel (~200 m wide). Water movements in reaches 5–8 are turbulent in several areas but no white water is developed. White water in Reach 9A and 9B, Gull Rapids, is frequent in the north channel (Map 3-11), middle channel (Map 3-12), and south channel (Map 3-13).

The substrate distribution upstream of Gull Rapids corresponds closely to the pattern of flows and water depth. This is most notable when lentic and lotic areas are compared; habitats along the edge of the river in lentic habitat typically are depositional (*i.e.*, soft bottomed; silt/clay), whereas the areas of lotic habitat are erosion or transport environments (*i.e.*, hard bottomed; boulder to gravel).

Areas that are deep and lotic are found within the thalweg and are dominated by hard bottomed materials (i.e., mainly boulder/cobble/gravel) (Map 3-14). Generally, the largest materials line the riverbed in reaches 2A–5. In Reach 6, the flows disperse enough to enable cobble to form a stable bottom. Some lotic habitat in this reach has a stable bottom formed of gravel, as shown downstream of Seebeesis Creek along the south shore (Map 3-14), providing evidence of dampened velocity gradient in the lower part of Reach 6. Decreases in thalweg velocity are evident again farther downstream where the secondary channel that flows around the north side of Caribou Island allows sand to form a stable bottom. Sand is not abundant in Deep habitat, and has only been located in this channel. Velocity in this area is not fast enough to create a net movement of sand away from the area but is sufficient to transport silt/clay downstream. Observations of near bottom velocity in these two areas averaged 0.26 m/s, with a corresponding depth averaged velocity of 0.48 m/s with water depths in the range of 8–11 m (Appendix 3A).

Areas of shallow and lentic habitat are present along the edge of the river in the form of depositional bays (*i.e.*, mostly silt/clay). Organic materials are found mostly in the lower reaches of the tributaries where backwater effects from the Nelson River occur during times of higher flows (Map 3-14).

Below Gull Rapids, the riverbed shows that a size gradient of materials occurs in the first 6 km as velocity drops. Flows are sufficient to maintain the bed processes of erosion and transport for more than 5 km, as evident by substrates of sand or greater material size (Map 3-15). A small eroded channel exists about 2 km downstream of Gull Rapids on the south bank. The substrate of the channel was mainly clay but it should be noted that changes in flow among seasons over time may create changing hydraulic conditions and the long term character of the substrate may change. About 3.5 km downstream of Gull Rapids, gravel starts to dominate the flooded thalweg which then grades to gravel/sand and then to sand over the next two kilometres. The zone of homogenous silt deposition in the flooded thalweg starts about 5.5 km below Gull Rapids at depths of about 17–20 m.

The position of the silt boundary in the flooded thalweg of the river as it enters Stephens Lake appears to be formed by relatively high magnitude flows. Low inflows, *i.e.*, 5th or 50th percentile, form lentic habitat about 1.2–2.2 km up river of the depositional boundary and this standing water overlies erosion and transport substrate habitat. In comparison, flows above the 50th percentile maintain lotic habitat over the gravel and sand substrates that extend to depths of 17–20 m, where the onset of silt deposition begins. Homogeneous silt deposition dominates the bottom of the flooded thalweg down river of the silt boundary even in lotic habitat during relatively high inflows, due to increased water depth/lack of channel confinement.

The lentic habitat in the river channel downstream of Gull Rapids on the north bank of Reach 11 is not depositional as was observed consistently in lentic habitat up river of Gull Rapids. This is an apparent response to the winter hydrodynamics resulting from the hanging ice dams (PE SV 4.3.2.5), which may create a seasonal shift in the position of the lentic/lotic boundary.

The distribution of macrophytes (Map 3-16) above Gull Rapids corresponds closely with the distribution of standing or low water velocity, shallow water, and silt/clay substrate. Most of these habitat variables co-occur in low slope areas, including the relatively large bays in the Gull Lake area, but small plant beds are also found in portions of the Nelson River mainstem. In the first 4 km below Gull Rapids, the availability of potential habitat is limited and macrophytes are sparse.

Environmental Variation

Variation in flows, within and among years, determines the amount and type of aquatic habitat available to biota. A comparison of annual and seasonal flows is provided in the PE SV, Section 4.3.1.

Open water season inflows during the period when the majority of environmental assessment studies were conducted (2000−2006) varied to near the full range expected in the Nelson River (Figure 3-2, further described in PE SV, Section 4). The maximum hourly discharge during this period was observed in the fall of 2005, when flow was about 6,590 m^3/s, or about 1.2 times the 95^{th} percentile flow of 5,266 m^3/s. The lowest discharge occurred in the fall of 2003 when flow was 1,372 m^3/s, or about 0.73 times lower than the 5^{th} percentile of 1,882 m^3/s. Most years had flows for extended periods in the range of 3,000–4,000 m^3/s; *i.e.*, higher than the 50^{th} percentile (2,866 m^3/s). The following discussion compares aquatic habitat at 95^{th} and 5^{th} percentile inflows, and also describes other changes that have occurred as a result of variation in open water flows.

Upstream of Gull Rapids, difference in average water depth for the reaches ranged from 0.6 to 1.7 m at 5^{th} and 95^{th} percentile flows. The average depth of the IEZ in reaches 2–8 (upstream of Gull Rapids) ranges from 1.2–2.1 m. Water depth in many areas of Gull Rapids is uncertain (PE SV, Appendix 4A) preventing calculation of the IEZ. Water level variation in reaches downstream of Gull Rapids is primarily controlled by operation of the Kettle GS.

During the open water season, changes in depth over short time periods are small: for example, the typical 1-day water level variation on Gull Lake is 0.01 m, while the 7-day variation was 0.07 m (PE SV, Section 4.3.1).

Variations in flow result in changes in velocity magnitude and pattern in the river. Differences in velocity between the 5th (Map 3-17) and 95th percentile inflows above Gull Rapids are smallest in the riverine reaches, in particular at rapids, and are largest in the lacustrine reaches (Map 3-18). Maximum velocities within each reach are typically found in rapids or narrows; the 5th percentile maxima are 87% (4.4 m/s) of the 95th percentile flows (5.1 m/s), and are very similar. Away from the rapids, the average riverine velocity also remains similar between low and high flows; the average 5^{th}

percentile flow rate is 1.0 m/s, and this is 75% of the 1.36 m/s average of the 95th percentile. In the lacustrine reaches, the average 5th percentile velocity is 0.21 m/s; this is 65% of the 0.33 m/s modelled for the 95th percentile flow. These data show that the riverine sections do not slow notably over a wide range in flows, but the area of faster water near each narrows does decrease. In the lacustrine reaches, the decrease in velocity between the 95th and the 5th percentile inflows is largest suggesting that changes of flow are more likely to have an effect on the type and distribution of substrate in Gull Lake, for example.

The discussion of aquatic habitat above was based on open water conditions, which is an important period to determine the distribution of aquatic biota and includes most biologically significant periods, such as spawning. However, ice scour in shallow areas can disrupt littoral biota and formation of ice dams or thick ice cover can make areas unsuitable for overwintering fish. As described in PE SV, Section 4.3.1.4, the formation of ice is complex and varies considerably between years. Constrictions in the river due to formation of ice results in higher overall water elevation in some sections than during the open water season and the distribution of velocity may be substantially different from the open water season. In particular, nearshore velocity can be high in riverine reaches.

Macrophytes

The presence or absence of rooted macrophytes depends on the availability of suitable wetted habitat, and the ability of plants to occupy that habitat. Changes in water level for a prolonged period during the growing season result in shifts in the location of macrophyte beds as plants respond to the changes in the availability of suitable habitat. When river levels remain low, some of the potential habitat higher on the bank is not wetted (*i.e.*, not suitable) and the elevation to which light can penetrate will also be lower (Figure 3-3). In the Nelson River, the zone of suitable habitat fluctuates up and down the bank within the zone of potential habitat as water levels change; as such, the suitable habitat will always be smaller than the potential habitat, and more closely linked to the recent water regime.

Constraint criteria were used to define the area of habitat with potential for macrophyte growth, and calculate the proportion of occupied habitat. The constraint criteria were limited to observations made during 2001, 2003, and 2006 in reaches 5–8. The constraint criteria were: 1) 95th percentile inflow water surface; 2) silt/clay substrata; 3) standing or low water velocity (depth averaged) (*i.e.*, less than0.5 m/s); and 4) water depths less than 3 m at a 5th percentile inflow (to account for light penetration at low water). The constraint criteria accounted for 94–99.7% of the macrophyte data observed each year.

Macrophyte stands observed in any one year tended to occupy the same general areas in the other years (Map 3-16), but notable differences in the depth of plant beds, their size, and number was evident between years. Water levels varied within and among years but in general they were high in 2001 and 2006 and were low in 2003 (Figure 3-2). The average depth of the plant beds in 2003 (1.9 m), when compared using depths relative to the 95th percentile, was notably greater than that of 2001 and 2006 (1.2 m, 0.72 m) (Figure 3-4A). After the 2003 depths were adjusted to account for low water using the 5th percentile inflow instead, the average depth (0.95 m) appears similar to the other years (Figure 3-4B) with a grand mean depth of 1.09 m and a standard deviation of 0.68 m. These data show that plants in the Keeyask area have adapted to considerable interannual variation of water levels.

Low water years appear to have fewer but larger macrophyte stands when compared to high water years (Table 3-3). Although 2001 and 2006 were both years of high water and both had relatively small average stand sizes, the total area occupied by plants in 2001 was about 2.5 times that observed in 2006 (Table 3-3). In 2005, water levels in the Keeyask area were also high for most of the open water season (Figure 3-2) and this may have also contributed to the distribution observed at higher elevations in 2006. Review of the water regime data for the early part of the growing season suggests that the relatively lower water levels in 2001, *i.e.*, nearer to the 50th percentile inflow, may have provided better conditions (*i.e.*, somewhat similar to 2003) than in 2006 when water levels remained relatively high throughout the growing season.

The total area that macrophytes occupied in reaches 5–8 during the three years of study was 788 hectares (ha) (164 ha of overlapping plants was surveyed among years). Therefore, over the years of study, rooted macrophytes occupied 624 ha of the 1,168 ha (*i.e.*, 53.4%) of the total potential habitat available (Table 3-4). In any one year, plants occupied 13.6–37.7% of the suitable habitat, or 12.5% to 30.7% of the potential habitat, that was available over the years. On average, the area of plants found in reaches 2B-9A is 208 ha.

In summary, low water levels provide better overall conditions for plant growth in the Keeyask area as the soft textured substrate in the extensive flats of the bays becomes sufficiently shallow to be suitable; this appears to result in fewer but much larger macrophyte beds. At high water, many of these areas do not to support plant growth. Instead, the plant beds are visible at higher elevations (which correspond with sloped parts of the channel) as relatively narrow bands that are oriented parallel to shore. The effect of intra and inter-annual variation of the water regime on macrophyte distribution is large. The ability of plants to occupy suitable habitat ranged from 13.6–37.7%; the range was slightly smaller when potential habitat was considered. "

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.3.1 Pre-1997 Conditions and 3.3.2 Current Conditions (Post-1996); p. 3-11 and 3-12

TAC Public Rd 2 DFO-0002

ORIGINAL 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 analysis.

FOLLOW-UP QUESTION:

No additional information provided.

RESPONSE:

As discussed in the response to TAC Public Rd 1 DFO 002 and further at a TAC Review meeting on February 14, 2013, among KHLP, DFO and MCWS, there is little historic habitat information for the reach of the Nelson River that will become the future Keeyask reservoir. Available aquatic habitat information is summarized in AE SV Section 3.3.1 and 3.3.2 and reproduced below. Relevant information is also found in Section 4.3 of the Physical Environment Supporting Volume

> _Aquatic Environment Supporting Volume, 3.3.1.2 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".*

3.3.1.3 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 km2 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 discernable 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."

3.3.3 Current Trends/Future Conditions

"Apart from the effect of inter-annual variations in flow, aquatic habitat has been relatively stable over the recent past, given that analyses of the water regime and sedimentation (Section 6.2.3.2.6 and Section 6.2.3.2.8) do not identify any pronounced trends. However, the formation of large ice dams at Gull Rapids has created and would continue to create new channels, due to water level staging and redirection of flows, and may cause changes to the river bottom such as the movement of substrate (e.g., boulders) (Section 6.2.3.2.8). The potential effects of climate change were considered separately as described in Section 6.4.9."

With respect to the statement by the reviewer "habitat changes were not assessed to support this claim", as noted above, habitat changes would arise from changes to water flows and/or erosion/sedimentation. As discussed in the Physical Environment Supporting Volume and quoted below, these have varied but not displayed a consistent trend (upwards or downwards) since 1977.

> <u>*PE SV Section 4.3*</u>
>
> *"The environmental setting has been influenced by past hydroelectric development in northern Manitoba. In 1970, Manitoba Hydro was granted a license to regulate Lake Winnipeg. As described in the Project Description Supporting Volume, the license stipulates conditions under which Manitoba Hydro is allowed to adjust the outflows as required for power production purposes along the Nelson River. This allows Manitoba Hydro to store water in Lake Winnipeg during periods of high water supply, typically during spring and summer, and release this water during higher power demand periods such as fall and winter. LWR has resulted in a shift in seasonal patterns of lake outflows, which results in a winter flow increase on the Lower Nelson River and an associated summer flow decrease.*
>
> *In 1977, the CRD was constructed, diverting water from the Churchill River into the Burntwood River and eventually into Split Lake. The amount of water diverted into Split Lake fluctuates monthly and annually between 400 m^3/s and 1,000 m^3/s. This augmented flow has increased the level of Split Lake by up to 0.8 m. The exact magnitude of the water level depends on the outflow at the Notigi control structure and varies throughout the year.*
>
> *The estimated Post-project flow conditions are within the range of flows experienced on the study area portion of the Nelson River prior to LWR and CRD.*
>
> *The combined effects of CRD and LWR somewhat offset each other with respect to Split Lake outflows and the flows in the reach of the Nelson River affected by the Keeyask Project. In the unregulated state, the highest lower Nelson River flows typically occurred in mid-summer and reduced to the lowest flows in mid-winter. With LWR and CRD, the lower Nelson River flows are still typically highest in mid-summer, lower in late summer and then rising in winter, due to increased power demand but the Post-project flows during the winter and open water periods are much closer together. Historical water levels on Split Lake were higher in summer than winter, whereas post-CRD and LWR, the winter levels are an average of about 0.6 m higher than summer. Water levels at the downstream end of Gull Rapids were affected by the backwater effects of the Kettle GS reservoir (Stephens Lake) and the water levels throughout the reach*

were also affected by the increased flows resulting from LWR and CRD. It is important to note that the net combined effect of LWR and CRD can vary as the net effect is largely a function of the inflow conditions and the values above were estimated from limited data available for pre-CRD and pre-LWR conditions.

Little information is available to estimate the exact change in water levels throughout the Clark Lake to Gull Rapids reach."

In addition to the flows, the following discussion on trends within the water regime highlights that many parameters are relatively insensitive to changes in inflow.

PE SV Section 4.3.2 Open Water Conditions/Trends

"It is expected that without the development of the Project, and assuming that climatic and watershed conditions remain as they currently are, that the open water regime for the study reach of the Nelson River would continue to be the same in the future as that described earlier for the environmental setting.

As indicated in the Approach and Methodology Section (Section 4.2), the river flows for the historical period of 1977 to 2006 are very similar to the river flows that are used to represent the future long term flow record. Based on this characteristic of the inflows and the relatively low sensitivity of water regime characteristics to flow variations, it is reasonable to assume that the water regime characteristics presented in the environmental setting would represent the water regime characteristics for the future environment without the Project in place.

While the general hydraulic conditions in the study area are expected to be the same in the future, the magnitude and duration of water levels, variations, and other water regime characteristics are dictated by the frequency and duration of different river flows. Also, the hydrologic characteristics of the study area and the distribution of river flows are expected to vary from year to year and the resulting 5^{th}, 50^{th}, and 95^{th} percentile water regime parameters may be slightly different, but the general hydraulic characteristics of the study area would remain the same without the Project in place. For example, the 50^{th} percentile water level on Gull Lake for the environmental setting would be the same as the 50^{th} percentile water level on Gull Lake for the future environment without the Project in place."

The same constancy was recorded for the other key physical parameter affecting aquatic habitat, erosion and resulting sedimentation.

PE SV Section 6.3

"The environmental setting has been influenced by past hydroelectric development in northern Manitoba, particularly the LWR and CRD. The Water Regime section of the PE SV describes the nature of the changes. Of particular note to shoreline erosion, it is estimated that Post-project flows and water levels in the study area portion of the Nelson River are within the range of conditions experienced prior to LWR and CRD. Due to LWR and CRD, mean water levels in the study area portion of the Nelson River during the winter and open water seasons have generally increased and mean winter water levels have become higher than mean open water levels. The net combined effect of LWR and CRD can vary as the net effect is largely a function of the inflow conditions to the reach and limited data exist for pre-LWR and pre-CRD conditions.

Existing information regarding shoreline peatlands and peatland disintegration in the Gull reach was not previously available. Photo-interpretation of historical air photos indicated that measureable peat bank recession did not occur between 1962 and 2005 except at one localized area where an ice dam diverted river flow and carved a channel through an island in the river. The high degree of water level variability prior to and after water regulation may have maintained peat bank position in shore segments where peatland disintegration was the dominant bank formation and recession process.

Little information is available regarding mineral erosion rates in the Keeyask Project study area prior to LWR and CRD and, as a result, little is known about changes in mineral shoreline erosion rates following implementation of those projects.

Kellerhals (1987) and the Federal Ecological Monitoring Program Summary Report (1992) report that erosion to date in the post-LWR and CRD environment has been much lower than originally predicted. Moreover, the focus of those studies was on shoreline reaches upstream of Split Lake where changes to flow and water levels were likely greater than in reaches downstream of Split Lake. Therefore, it seems probable that effects on erosion rates downstream of Split Lake would have been less than in upstream reaches.

As discussed later in this section, studies conducted for Keeyask (i.e., Shoreline Erosion section of the PE SV) indicate that shore zone materials and slope geometry in the Keeyask study area are such that one would not expect large changes in erosion rates to have resulted from water level and flow changes caused by LWR and CRD. Much of the riverine reach between Clark Lake and Birthday Rapids is bedrock controlled, while the remaining river reach and gently sloping shores in Gull Lake have experienced low erosion rates in the existing environment, with the exception of a few localized shoreline segments.

Therefore, even if LWR and CRD had an effect on erosion rates, the magnitude of that effect must have been small, at most, judging by erosion rates in the existing environment.

In order to incorporate whatever effect LWR and CRD may have had on erosion rates in the study area, the existing mineral erosion environment has been based on post-1986 erosion rates as determined from historical air photos and surveyed transects."

6.3.1.1.2 Mineral Shorelines

"Mineral banks on the existing Nelson River shoreline consist mainly of low to moderately high (0 m to 3 m) steep banks that have formed in coarse-textured clay till and glaciofluvial (sand and gravel) sediments and, in places, fine-textured clay and silt sediment which were deposited in glacial Lake Agassiz. Gently sloping beaches and nearshore slopes extend out into the lake from the toe of steep shoreline banks. In places mineral shorelines consist of non-erodible river-washed bedrock, and in other places very gently sloping non-eroding mineral slopes that are overlain by thin peat and vegetated to just above the normal high-water elevation. Many of the banks along the Nelson River are ice scoured for a short distance above the normal open water elevation, and in places ice has shoved coarse gravel, cobbles and boulders onto the shore, effectively protecting these shorelines from erosion. Overall, mineral erosion rates in the study area are relatively low under existing conditions as compared to other lakes and rivers in northern Manitoba."

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Map 3A-3 Substratum Data Collection Index Map; p. N/A

TAC Public Rd 2 DFO-0003

ORIGINAL PREAMBLE AND QUESTION:

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

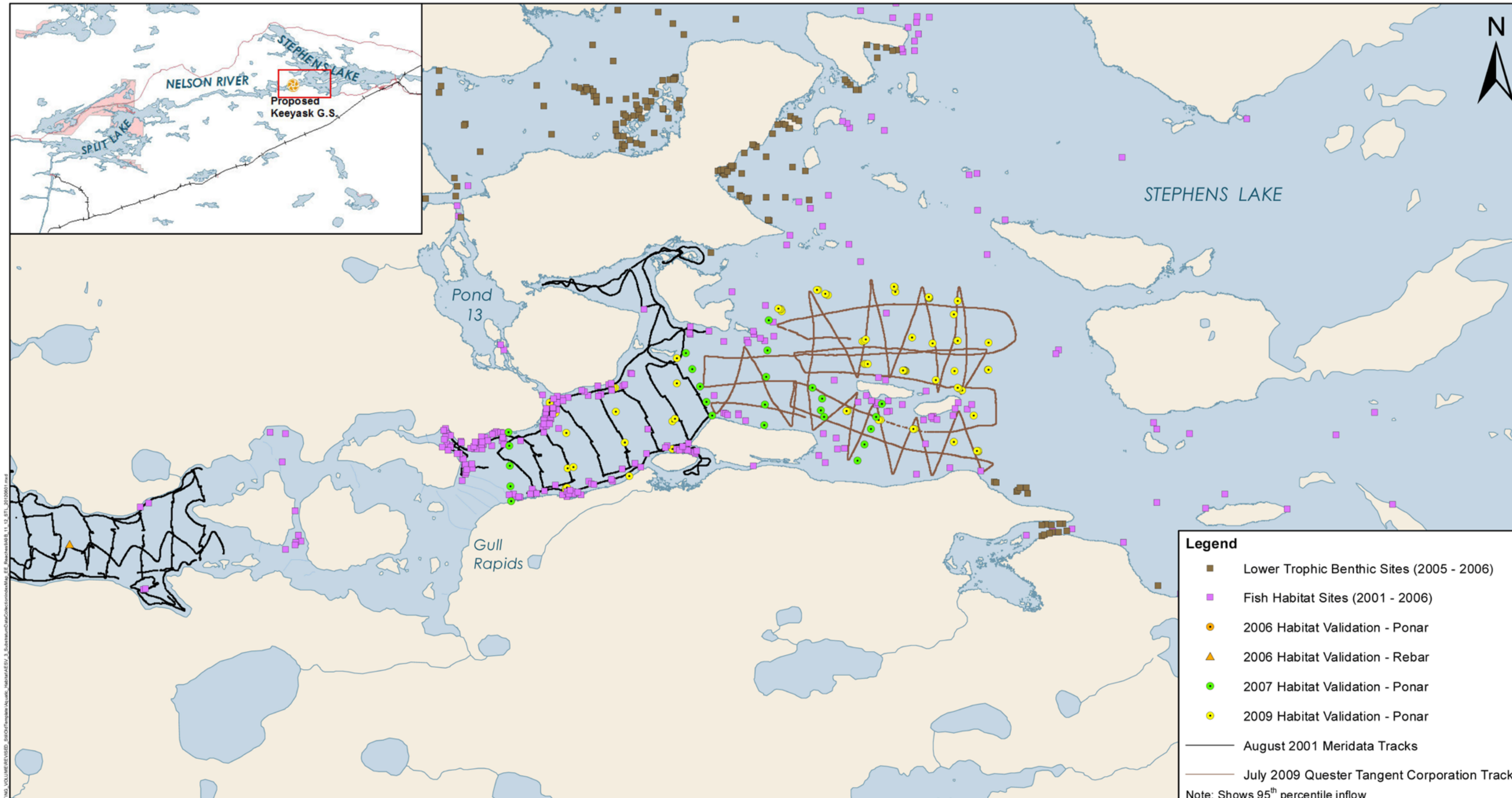
Please define "immediately". Substrate composition be should be confirmed in the dewatered areas in Gull Rapids prior to any construction. Resolution should be similar to that already conducted in the vicinity of Gull Rapids. This information is crucial for proper accounting of habitat destruction in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

FOLLOW-UP QUESTION:

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

RESPONSE:

The November 2012 response noted, “Mapping of bottom types extended to approximately 330 m upstream of Gull Rapids and 330 m downstream of Gull Rapids”; i.e., 330 m downstream of Gull Rapids is considered “immediately” downstream of Gull Rapids. Map 3A-3 in the Aquatic Environment Supporting Volume shows the location of transects and other methods of data collection. A copy of this map is attached.



Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000,
Stephens Lake Shoreline-Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro

Substratum Data Collection Index Map

Existing Environment - Reaches 9A, 9B, 11,12 and Stephens Lake

KEEYASK Hydropower Limited Partnership

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.3.2.3.1 Description of Mainstream; p. 3-15

TAC Public Rd 2 DFO-0004

ORIGINAL 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.

FOLLOW-UP QUESTION:

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

RESPONSE:

During a technical meeting held on February 14, 2013, among KHLP, CEAA, DFO and MCWS, DFO clarified that modelling results would be required for the full range of flows if the model was to be used to calculate the Harmful Alteration, Disruption, and Destruction (HADD) of habitat for Authorization under the *Fisheries Act*. DFO indicated a concern that not determining model results at the full range of flows could under-estimate the effects to habitat and consequently, the fish community. The proponent clarified that the model was one of several approaches used to assess the net effect to fish of the changes in habitat as a result of impoundment; other approaches included assessment of changes to specific habitats used in the existing environment and their condition post-impoundment, and effects to the fish community observed in similar systems. Taken together, this three-pronged approach provides additional certainty in conclusions presented in the Aquatic Environment Supporting Volume.

With respect to the use of a fish model based on habitat availability calculated at 95th percentile flows, the proponent clarified at the technical meeting that the intent of the model was to determine the relative amount of foraging habitat in the post versus pre-Project environments and as the 95th percentile provides the most available habitat in the pre-Project environment, this is an appropriate basis for comparison in a "worst case" scenario. In addition, the amount of habitat available in the reservoir only varies slightly between flows, since the water level in the majority of the reservoir is regulated to be between 158 to 159 m Above Sea Level (ASL). Finally, as described in the response to Round 1 DFO-0004 and repeated below, for the reader's convenience, the range of flows (5th, 50th and 95th) were described for depth and velocity and for other aquatic habitat parameters that are affected by flow (e.g., aquatic plants).

The response to Round 1 is repeated below.

RESPONSE:

The 95th percentile approach describes the total area of habitat that is available except under very high magnitude but low frequency events. The median condition would leave about half of the habitat undescribed, which is undesirable when assessing the loss/alteration of habitat. Post-project, water levels on the reservoir will be constrained within a one metre range. Inflows will affect water levels in the upper, riverine section of the reservoir where there is relatively little change in wetted area with changes in flow. Therefore, 95th percentile inflows provide a realistic description of habitat available Post-project. The appropriate basis of comparison in the existing environment would then also be the 95th percentile inflow.

It is recognized that the availability of certain types of habitat vary with inflow in both the existing and Post-project environments. Variation with flow in the existing environment is described in Aquatic Environment Supporting Volume, Section 3.3.2.3.1. The existing environment habitat data demonstrate that small changes in lentic and lotic habitat occur over wide ranges of inflow. River stage affects habitat availability most in lentic habitat where bed slope is low. This effect was covered in the section on macrophyte habitat availability which addressed river stage directly using observational data collected over nearly the full range of inflow (see Aquatic Environment Supporting Volume, Section 3.3.2.3.1.

In the Post-project environment, effects of inflow on habitat were described where relevant (see for example discussion of substrate composition in the reservoir, Aquatic Environment Supporting Volume 3.4.2.2.3). In general, inflows have the greatest effect on habitat downstream of the generating station as it affects operation of the generating station (e.g., spilling vs. not spilling). This is discussed in Aquatic Environment Supporting Volume Section 3.4.2.3.1. With respect to the statement, "The 50th percentile would represent a more normal flow condition", there is typically a wide range of inflow in the system and flows are not normally distributed (see Physical Environment Supporting Volume Figure 4.3.3), so the 50th percentile is not likely to repeat as often as may be expected. Further, and as shown in Aquatic Environment Supporting Volume Figure 3-2, the 50th percentile occurred only during three years during 2000 - 2006. Even when it did occur, this state occurred for short a duration (week) amidst a longer trend of change.

Sampling programs for habitat and biota were distributed over a wide range in flow. In the Aquatic Environment Supporting Volume, the variation in specific aspects of habitat with flow was described in order to set the context for the 95th percentile comparisons. Fifth percentile inflows were described in addition to 95th for the IEZ/depth (Aquatic Environment Supporting Volume Table 3-8) before and after the project. Other descriptions of variations due to inflow included: the change in area of flooded creek habitat due to the range of IEZ (i.e. 5th – 95th variation) (Aquatic Environment Supporting Volume Table 3-9); velocity (Aquatic Environment Supporting Volume Map 3-18); and effect of IEZ on plants (Aquatic Environment Supporting Volume Figure 3-4). Models of deposition were built over a wide range of discharge (Aquatic Environment Supporting Volume Table 3B-2) and tested for relative importance of variables at 5th and 95th percentile flows (Aquatic Environment Supporting Volume able 3B-3, 3B-4, and 3B-5). The differences between the predicted depositional boundaries at 5th and 95th percentiles are shown for lotic habitat in Aquatic Environment Supporting Volume Map 3B-3. These analyses provide information on habitat availability under different flow conditions in both the existing and post-Project environments; however, as discussed at the beginning of this response, it is felt that comparisons of habitat areas at the 95th percentile inflows provide an appropriate overall summary of changes in habitat area.

At the technical meeting on February 14, DFO indicated that in order to calculate the HADD there is currently uncertainty regarding the amount of habitat lost versus the amount in the existing environment, and the current outputs of the fish habitat model used in the EIS do not appear to fully address this issue given that modeling is limited to 95th percentile flows. In addition, DFO noted uncertainty with the use of catch-per-unit-effort results in establishing the relative use by fish of different types of habitat for foraging. DFO indicated that further analyses may be required for the HADD calculations and the current model may not be sufficient. Further discussions will be undertaken as part of the *Fisheries Act* approvals but additional analysis for the range of flow conditions using the model has not been undertaken pending the results of these discussions.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.4.2.3.1 Aquatic Habitat at Impoundment; p. N/A

TAC Public Rd 2 DFO-0005

ORIGINAL PREAMBLE AND QUESTION:

"intermittently-exposed zone" . Uncertain as to whether the "intermittently-exposed zone" is in the forebay, below the GS or both. There is no mention or study of the effects of water control on dewatering and re-watering areas below the GS and whether habitat losses and fish kills will occur as a result of this.

Please confirm whether the "intermittently-exposed zone" is in the forebay, below the GS or both. Please also provide an analysis of the effects of water control on dewatering and re-watering areas below the GS and whether habitat losses and fish kills will occur as a result of this.

FOLLOW-UP QUESTION:

Requested information not provided.

RESPONSE:

The round 1 response was clarified by discussions at a February 14, 2013, technical review meeting with regulators and no further information is required. Specifically, it was re-iterated that the intermittently exposed zone refers to the area wetted at high flows (95^{th} percentile) and exposed at low flows (5^{th} percentile). Downstream of the generating station, the area where water levels are affected by cycling of the turbines at the generating station is backwatered by Stephens Lake, and the small changes in water levels caused by operation of the station lie within the larger range of water level variations on Stephens Lake. Fish stranding is not expected as a result of water level fluctuations in the tailrace due to cycling at the station. Potential fish stranding after spillway operation is being mitigated through the provision of channels to connect isolated pools to Stephens Lake.

The round 1 response is provided below.

> The “intermittently exposed zone” (IEZ) is both in the forebay (reservoir) and below the generating station. It is the area that is wetted at high flows (95^{th} percentile) and dewatered at low flows (5^{th} percentile). The effects of water controls on dewatering and re-watering areas below the generating station are discussed in Aquatic Environment Supporting Volume Section 3.4.2.3.1. As discussed in this section, the tailrace is backwatered by Stephens Lake and small water level fluctuations caused by cycling of turbines at the generating station

occur within the larger range of water level variations caused by regulation of Stephens Lake by the Kettle Generating Station. The area downstream of the spillway would be watered and dewatered depending on spillway operation.

Effects of water level fluctuations on fish downstream of the generating station are discussed in Aquatic Environment Supporting Volume Section 5.4.2.3. Fish stranding is not expected as a result of water level fluctuations in the tailrace due to cycling at the station. Potential fish stranding after spillway operation is being mitigated through the provision of channels to connect isolated pools to Stephens Lake.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 3A Aquatic Habitat Methods; p. N/A

TAC Public Rd 2 DFO-0007

ORIGINAL 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)?

FOLLOW-UP 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)?

RESPONSE:

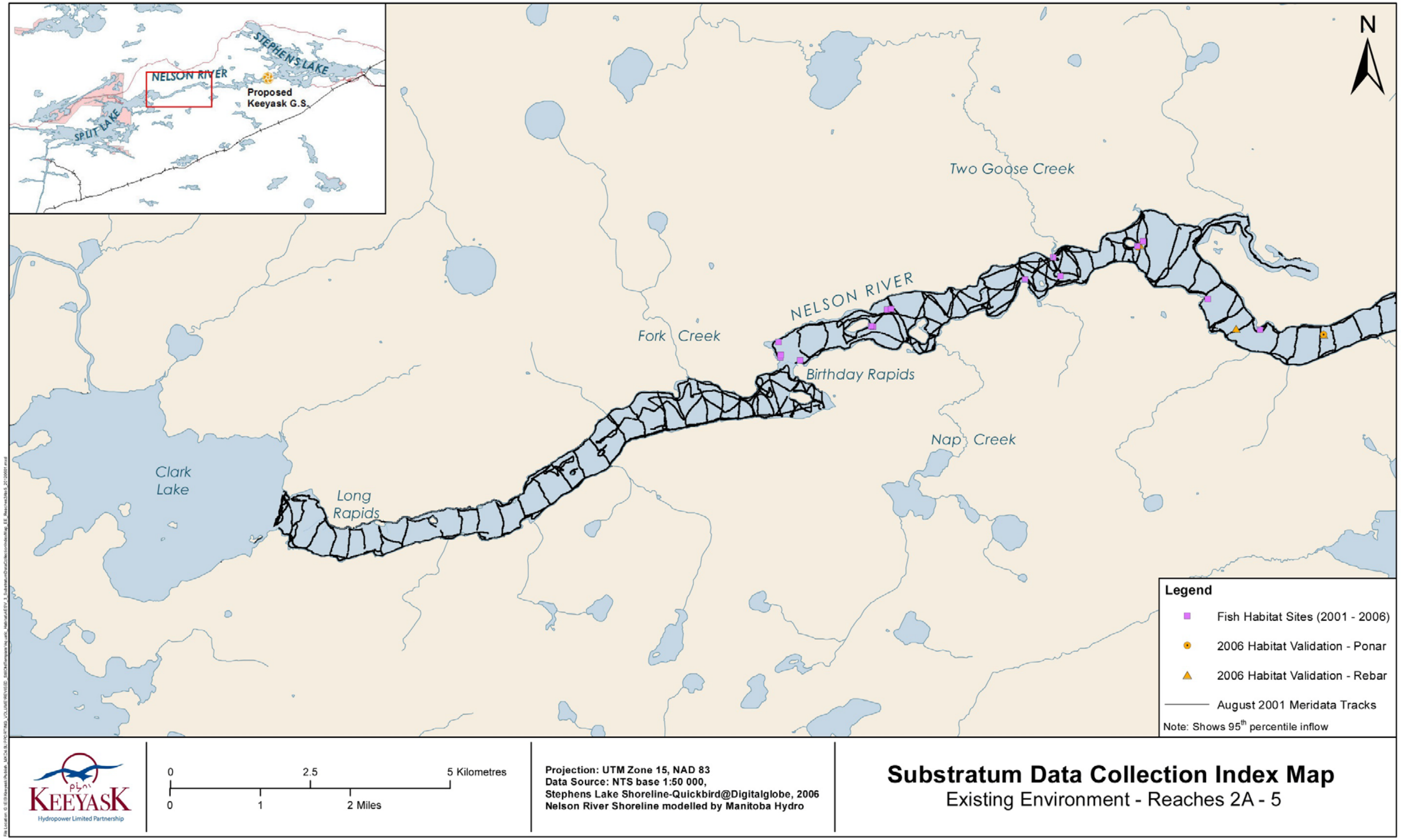
At a technical review meeting on February 14, 2013, among KHLP, DFO and MCWS, reviewers indicated an interest in maps showing the location of sonar transects and points where physical samples to verify bottom type were collected. These maps are provided in the AE SV maps 3A-1 to 3A-4 and copies are attached to this response.

The following information is provided to clarify the approach to sampling and determination of bottom substrate type.

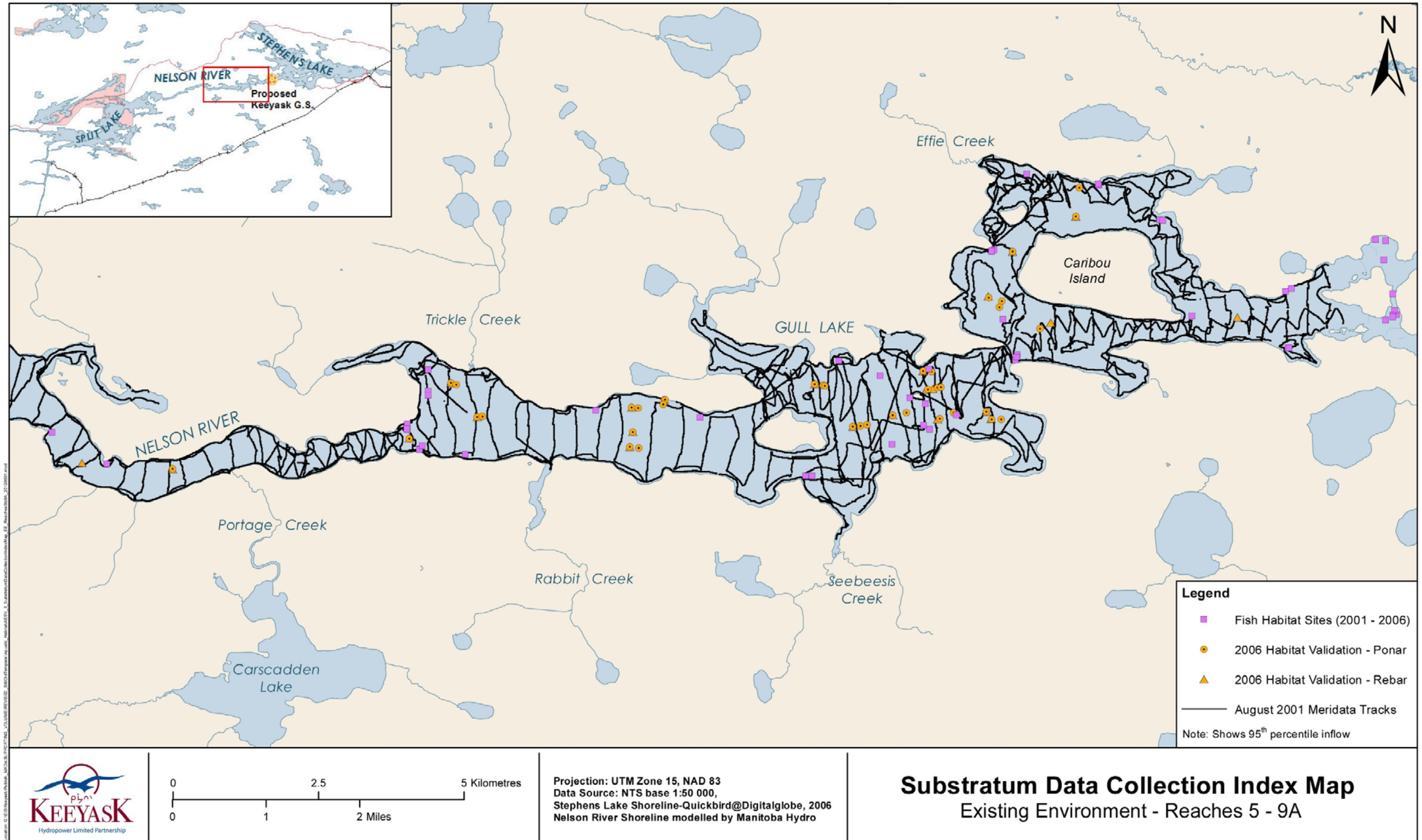
The primary means for riverbed classification was direct sampling of the bottom and sonar was used as a secondary means. Surveys were iterative such that the results of previous surveys directed additional efforts to locations where more precision was needed (e.g., where substrate type changed).

Synoptic or preliminary surveys sometimes use a small amount of validation data to classify the associated sonar data, suggesting that extrapolation is large and analysis such as described by the reviewer is needed to confirm that the predicted bottom type is the same as observed. In the surveys conducted for the Keeyask project, sonar transects were used to confirm that heterogeneity between locations where the bottom was directly sampled was limited. If heterogeneity in acoustic returns was observed in areas of particular interest, direct sampling of the bottom type was used to improve certainty of the specific bottom type.

Areas of very fast flows, like that upstream of Gull Lake and immediately below Gull Rapids have fewer sampling sites but the bottom type in such areas still are fairly well known; only relatively large material, like boulder/cobble or bedrock, can remain stable under such high water velocities. Transitions to materials more fine than cobble, such as gravel or sand, were identified in more detail with samples retrieved from the bottom.



Map 3A-1 of AE SV



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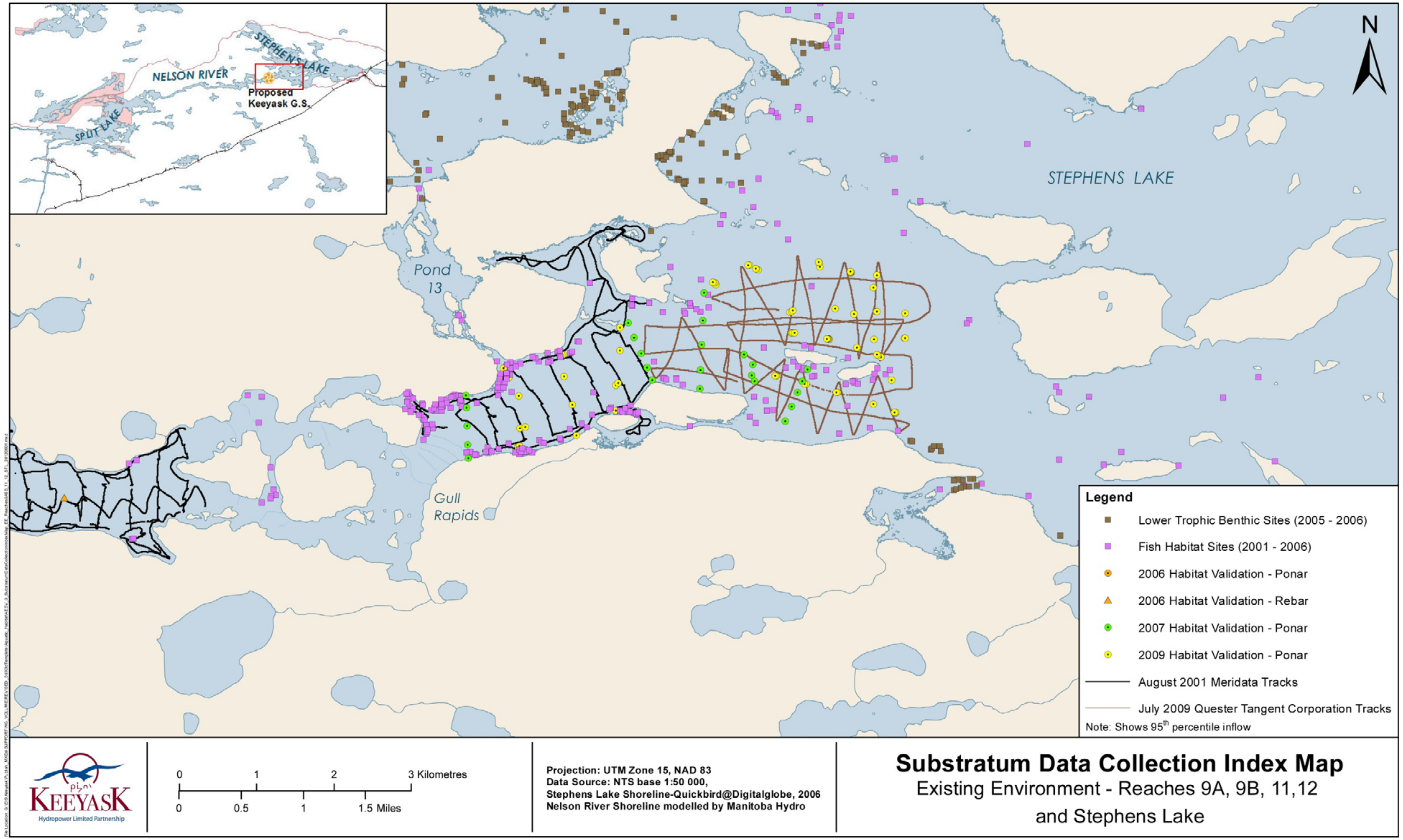
4 Map 3A-2 of AE SV



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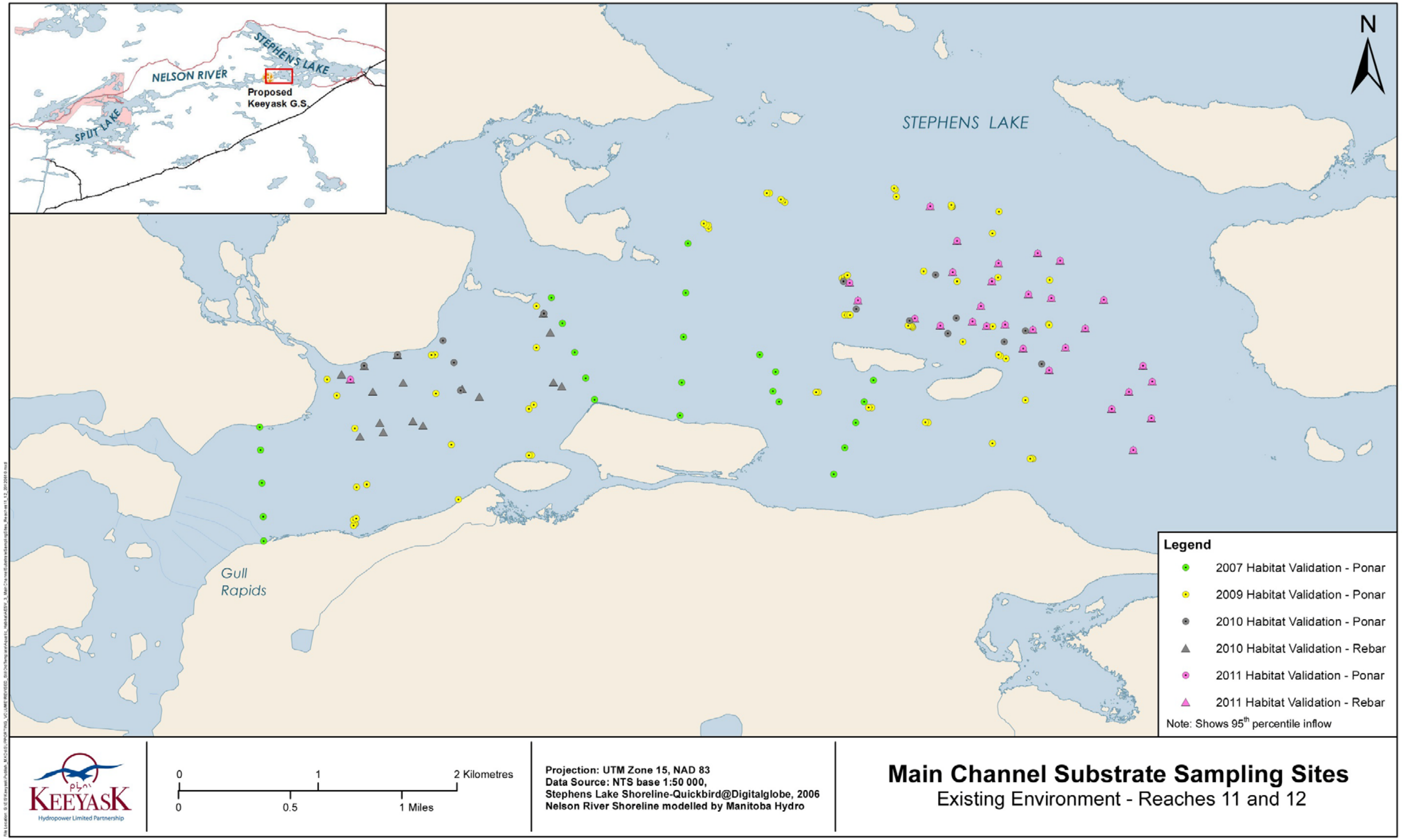
6 Map 3A-3 of AE SV



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8 Map 3A-4 of AE SV

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.4.2.2.3 Aquatic Habitat at Year 30; p. 3-34 to 3-36

TAC Public Rd 2 DFO-0014

ORIGINAL QUESTION AND PREAMBLE:

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.

FOLLOW-UP QUESTION:

HADD description and accounting as requested was not provided.

RESPONSE:

TAC Public Rd 1 DFO-0014 initially requested information on how deposition would change fish habitats and how this impact would be monitored. The response provided a brief summary of changes as a result of deposition and referenced sections of the Aquatic Environment Supporting Volume where effects of this habitat change to specific fish life history functions were assessed. In this second round of Requests for Additional Information, the reviewer indicates, “HADD description and accounting as requested not provided”.

During discussions at a technical review meeting on February 14, 2013, among KHLP, CEAA, DFO and MCWS, the following points were raised:

1. An accounting of the area of pre and post-Project habitat types (which include substrate) are provided in Appendix 3D of the Aquatic Environment Supporting Volume. This appendix includes the flooded terrestrial area as part of the post-Project habitat.

2. A description of substrate changes from pre- to post-Project is provided in Aquatic Environment Supporting Volume, Section 3.4.2.2.3. This description includes the flooded terrestrial areas. Text, tables and figures illustrating changes in substrate considering the pre-existing aquatic habitat alone are provided below.

3. Existing aquatic habitat in the Nelson River mainstem is not expected to be subject to peat deposition. The Physical Environment Supporting Volume (PE SV) Section 7.4.2.3, p. 7-35 provides an analysis of peat sedimentation upstream of the Project. Specifically with respect to organic sediment deposition:

7.4.2.3.3 Organic Sediment Deposition

"Most of the organic sediments are expected to accumulate in the bays of origin. The process of accumulation will occur in different forms including deposition. The magnitude of deposition will vary depending upon the amount of peat disintegrated from the shoreline and the location of the bays. The bays in the south side of the reservoir will experience relatively higher deposition than those in the north side. It is unlikely that there will be any appreciable amount of organic sediment deposition in the mainstem waterbody outside of the bays."

Aquatic Substrate Change due to the Keeyask Project

Substrate changes expected due to the Keeyask Project at Year 30 are described in Section 3.4.2.2.3 of the Aquatic Environment Supporting Volume, relative to the Existing Environment 95th percentile inflow. This text complements that section and extends the detail of description of substrate changes.

Changes to specific substrate types for the full reservoir area are summarized, and then again for each of three areas within the hydraulic zone of influence where the type and magnitude of change are notably different: 1) the riverine reach extending to Gull Lake; 2) lower reservoir (including Gull Lake), and 3) the area downstream of Gull Rapids/Principal Structures. The effect of classification precision on change is also considered given that prediction (post-project) is seldom possible at the same resolution as observation (existing environment).

Changes of substrate by area are provided for the entire reservoir (Table 1), the riverine reaches (Table 2), and the lower reservoir (including Gull Lake) (Table 3). Changes downstream of the proposed Keeyask dam are discussed in the text.

<u>Overview of Substrate Changes in the Keeyask Reservoir at Year 30 Post-impoundment</u>

At Year 30, the Keeyask reservoir will have an estimated area of 9973.5 ha, or an increase of about 5149.4 relative to the existing environment at a 95th percentile inflow (PE SV). Silt is expected to be present as a relatively homogenous surficial layer over an area of about 5280.5 ha, or 52.9% of the total reservoir (Table 1) (Aquatic Environment Supporting Volume, Map 3.34 and Map 1, attached). Most of the silt deposition upstream of the dam will be found in Reaches 6 – 9a. Silt deposition is expected to change slightly more than half of the substrate area present today (54.3% of 2806.7 ha). Silt deposits will notably decrease the area of several existing substrate types that are relatively abundant in the existing environment: 1) silt/clay located mainly in large lentic bays (92.5% of 1268 ha); 2) gravel/cobble/boulder found in the main channel of present day Gull Lake (75.4% of 1198.9 ha); 3) cobble/boulder, which forms most of the main channel except at Gull Lake and Gull Rapids (18.3% of 1782.3 ha); and 4) cobble/boulder/bedrock, which composes most of the substrate in Gull Rapids (74.6% of 256.5 ha).

Other lotic bottom types, such as gravel and sand, are relatively fine and are not common in the existing environment. When present, sand and gravel was found most often in shallow water along the banks, except for a few relatively large patches that are found in the lower reservoir where water velocities in lotic areas are relatively slow. Sand habitat totals about 177.5 ha with the single largest patch of about 1 ha in size found in the secondary channel north of Caribou Island (Map 1). After the Project, 78.4% of the total area of sand will change to silt over time. Most of the homogenous gravel substrate (92.6% of 19.6 ha) will be covered by silt after the Project, including the largest known patch (0.16 ha) located on the bottom of the main channel in deep water of Gull Lake.

In the flooded area, about 442.4 ha of fine organic deposition will become the main substrate type at the ends of bays over flooded peatlands fed by tributaries (Aquatic Environment Supporting Volume, Map 3.34 and Map 1). This will be a new habitat but will total only about 5.4% of the total reservoir area. There is expected to be about 273.8 ha of peat nearshore area (i.e., at depths less than that of silt sediment in shallow water). Peat substrates are expected occupy about 297.2 ha (2.9 %) of the reservoir area. When found in the main reservoir they will be mainly where deep peat deposits are found today. Peat nearshore substrates will be composed of inundated fibrous peat, as well as areas of partially decomposed peat after the fibrous surface layer has resurfaced (PE SV Section 6.4.2.1). In most other exposed areas of the reservoir, the processes of wave action and water level variation will remove the thin organic overburden. Most shorelines of the lower reservoir (reaches 6 – 9a) that erode into the sloped topography of today will erode through the thin peat and/or mineral soils, and create a clay nearshore area (1427 ha; 14.3%), with some localized deposits of aggregate lag when available. The clay-based nearshore areas in the main reservoir and the deposits of fine organic deposition at the ends of bays will form most of the rooted macrophyte habitat in the reservoir (Aquatic Environment Supporting Volume Section 3, 3.4.2.2.3). Areas of inundated peat, either at exposed or sheltered sites, will not contribute to potential macrophyte habitat. Some of the islands flooded in Gull Rapids may not be depositional sites due to sufficient water velocity and/or slope, and so will likely have the character of inundated mineral soils (137 ha or 1.38% of reservoir area).

Substrate Changes in the Riverine Reaches of the Keeyask Reservoir at Year 30

In Year 30, most of the substrate in the main channel of the riverine reaches (Long Rapids to entrance to Gull Lake) is expected to remain similar to today (Map 2, attached). About 132.7 ha (97.4% of reaches 2b – 5) of the channel bottom will remain as cobble/boulder substrate (Table 2). Changes in substrate type in the riverine reaches are expected to be more apparent in shallow water along the banks. In the existing environment sand was seldom observed in the riverine reach (15.5 ha; about 1% of the riverine area). Sand was present only in shallow water along shorelines in the intermittently exposed zone in areas not subject to marked river flows, or near Fork Creek in Reach 3 (upstream of Birthday Rapids on the north bank), or on banks of the island Near Nap Creek (downstream of Birthday Rapids on the south bank). By year 30 most if not all of the sand areas will change to other substrate types due to shore erosion or movement of lotic habitat towards the shore as the bank recedes. The riverine reach currently has more glacio-fluvial deposits than does the lower reservoir where glacio-lacustrine deposits are more common. The banks of the riverine area may therefore be slightly more coarse and form a sandy clay. Although sandy clay only accounts for about 6.1% of the areal changes in substrate (117.1 ha) in the Post-Project riverine reach, it will be a notably visible, but relatively narrow, band of substrate that comprises most of the riverine bank where erosion would or could continue to occur. Small backwater inlets found along both banks of the riverine reach today will tend to increase in number and area after the Project. This creates more lentic habitat that will become depositional substrate. The riverine area today has about 152.0 ha of silt/clay substrate found entirely in backwater inlets (9.9 % of riverine EE). By Year 30, silt will cover 86.9 ha of the silt/clay substrate (57.1 % of riverine EE). An additional 75.1 ha of new silt substrate will develop in the flooded lentic bays and total about 162.1 ha, or 8.5% of the total Year 30 riverine area.

Substrate Changes in the Lower Reservoir Area

Changes of substrates in the lower reservoir are similar to that described above for the entire reservoir given that changes in area in the riverine reach are relatively small. At Year 30, silt is expected to cover about 908 ha (75.7%) of the existing gravel/cobble/boulder substrate, which is found only in the lower reservoir area today (Table 3). Nearly all silt/clay habitat associated with lentic bays in Gull Lake today will be inundated and will change to silt substrate (1087.2 ha or 97.3% of EE). More than half of the cobble/boulder substrate currently found south of Caribou Island in the main channel downstream to the entrance of Gull Rapids will change to silt in some of the deepest water of the reservoir (294.3 ha; 60.8%; Aquatic Environment Supporting Volume, Map 3 - 28). The output from a lotic substrate model (Aquatic Environment Supporting Volume, Appendix 3B, Map 3.34) suggests that this main channel habitat near Caribou Island will alternate between the existing substrate (where velocities remain higher within a constrained channel) to depositional where it is more open, deep, and velocity is slower. About 191.6 ha, or nearly three quarters (74.6%) of the cobble/boulder/bedrock substrate unique to Gull Rapids, will change to silt. A small amount of the remaining cobble/boulder/bedrock habitat in this area will be excavated bedrock at the powerhouse intake channel. Silt will cover all (17.9 ha.) of the known large gravel bed area in reach 6 of Gull Lake, and about 81.9% (132.7 ha) of the existing sand substrate in reaches 6 – 9a.

As described above for the entire reservoir area, the substrates that are either new or that increase in area markedly within the flooded area due to the Project, are: 1) clay; 2) flooded terrestrial soil; 3) peat; and 4) fine organic deposition. Clay, which will be common sloped substrate in the nearshore zone after removal of thin peat and/or mineral soil erosion, will increase in area by about 110 times (1376.2 ha increase, or 17.1% of lower reservoir). The flooded terrestrial soils that persist in some of the flooded islands will be only total about 1.7% of the lower reservoir area. Peat nearshore substrate will occupy about 3.4% of the lower reservoir area. The deposition of fine organic material that will develop at the end of bays, where peatlands were abundant before the Project, will be a notable and new habitat in the reservoir, but will only occupy about 5.4% of the Year 30 lower reservoir area.

Downstream of the Keeyask Generating Station

Sediment deposition may occur along the north bank within 3 km downstream of the GS (Map 3). Deposition is expected in this area due to: 1) a shift in the path of flow which will increase the area of lentic habitat over that which occurs in the open water season today (Aquatic Environment Supporting Volume Map 3.31); and 2) this lentic habitat will persist all year due to the loss of the ice dam and associated flow dynamics in winter (PE SV Section 4). The area of anticipated sedimentation is approximately 55.1 ha, all of which covers cobble/boulder habitat in the existing environment.

Modelling Precision

Changes of substrate type apparent in Tables 1 – 3 include those that are expected to occur and be readily observable, as described above, as well as those that result due to comparisons made between observation and prediction. For the latter, Table 1 shows that about 290.9 ha of gravel/cobble/boulder bottom type present in Gull Lake today will change to cobble/boulder after the Project. This is an apparent change that shows the difference of detail between observation and prediction. After the Project the areas of non-depositional bottom type will continue to exhibit the substrate type present today (i.e., hard bottom). These non-depositional areas after the Project are expected to be in relatively fast flowing areas, as they are today. Such sites do not have a lot of gravel today and therefore would not be expected to have this substrate in the future with the Project. For example, Gull Lake was sampled most often as a cobble/boulder substrate, but gravel was sometimes present downstream of bottom undulation, or was more available where current slowed over large areas. After the Project, these gravel areas are expected to become depositional substrate due to the fact that these areas are relatively slow lotic habitat today. Although there is the potential that some small areas of gravel present now could remain after the Project (e.g., Table 1; 1.45 ha), this is not likely. These gravel sites tend to be small and found along shorelines where lotic habitat will form, or velocity will notably increase as the channel widens in the future with the Project. Consequently, it is expected that most often a cobble/boulder bottom type will form where gravel is present today and deposition is not predicted.

Cobble/boulder is the dominant bottom type of the main channel today in most flowing water areas (i.e., where the parent bedrock geology does not control material availability). This is expected to continue to be the case after the Project.

Table 1. Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the entire reservoir area.

Existing Substrate (ha.)	Year 30 Substrate (ha.)												
	Bedrock	Boulder	Clay	Cobble	Cobble/Boulder	Cobble/Boulder/Bedrock	Flooded Terrestrial Soils	Organic	Peat	Sand	Sandy Clay	Silt	Grand Total EE
Bedrock	18.16		0.73		33.04	0.00					0.64	14.83	**67.42**
Boulder		0.36			3.27							1.93	**5.57**
Cobble			0.00	0.50	12.81						0.68	7.61	**21.60**
Cobble/Boulder					1454.38					0.00	1.07	326.88	**1782.33**
Cobble/Boulder/Bedrock	5.49		4.31			55.15				0.00		191.61	**256.56**
Gravel					1.45						0.00	18.16	**19.61**
Gravel/Cobble/Boulder					290.90							908.05	**1198.95**
Organic					0.35			0.76			0.00	24.27	**25.39**
Sand					17.36					20.40	0.52	139.27	**177.55**
Silt/Clay	0.17		8.82		59.01	0.02		22.63	0.00		3.82	1174.19	**1268.67**
Aquatic within EE 95)	**23.82**	**0.36**	**13.87**	**0.50**	**1872.59**	**55.17**	**0.00**	**23.40**	**0.00**	**20.40**	**6.73**	**2806.80**	**4823.65**
Flooded Only	20.65	0.01	1413.63		127.35	43.87	137.72	521.87	297.27	3.15	110.42	2473.45	5149.40
Grand Total (Year 30)	**44.47**	**0.37**	**1427.50**	**0.50**	**1999.94**	**99.04**	**137.72**	**545.27**	**297.27**	**23.56**	**117.15**	**5280.25**	**9973.05**

191

KEEYASK Hydropower Limited Partnership

Table 2.Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the riverine reservoir area.

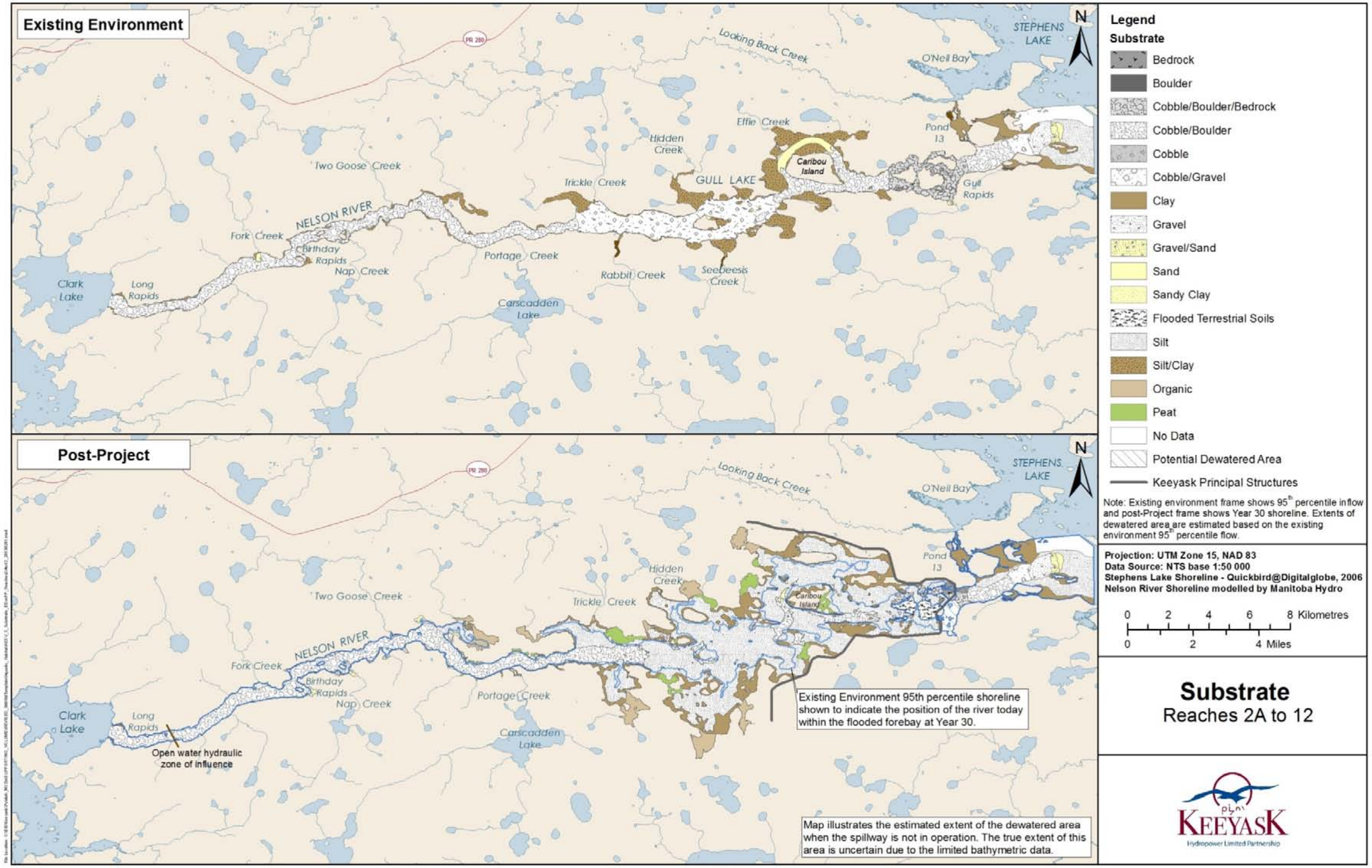
Existing Substrate (ha.)	Year 30 Substrate (ha.)							
	Clay	Bedrock	Cobble/Boulder	Organic	Peat	Sandy Clay	Silt	Grand Total EE
Bedrock		33.03				0.64	2.66	**36.33**
Boulder			2.44				0.60	**3.04**
Cobble	0.00		12.41			0.68	2.97	**16.06**
Cobble/Boulder			1265.15			1.07	32.55	**1298.76**
Gravel			1.45			0.00	0.19	**1.63**
Organic			0.32			0.00	0.23	**0.55**
Sand			8.45			0.52	6.58	**15.55**
Silt/Clay	1.28		37.35	22.63	0.00	3.82	86.98	**152.06**
Aquatic within EE 95)	**1.28**	**33.03**	**1360.59**	**22.63**	**0.00**	**6.73**	**132.76**	**1524.00**
Flooded Only	37.40		48.08	79.47	23.42	110.42	75.13	**373.93**
Grand Total (Year 30)	**38.69**	**33.03**	**1375.64**	**102.11**	**23.42**	**117.15**	**207.89**	**1897.92**

192

Table 3. Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the reaches of the lower reservoir area.

Existing Substrate (ha.)	Year 30 Substrate (ha.)											
	Bedrock	**Boulder**	**Clay**	**Cobble**	**Cobble/Boulder**	**Cobble/Boulder/Bedrock**	**Flooded Terrestrial Soil**	**Organic**	**Peat**	**Sand**	**Silt**	**Grand Total EE**
Bedrock	18.16		0.73		0.02	0.00					12.17	**31.08**
Boulder		0.36			0.84						1.33	**2.53**
Cobble				0.50	0.40						4.63	**5.54**
Cobble/Boulder					189.24					0.00	294.33	**483.57**
Cobble/Boulder/Bedrock	5.49		4.31			55.15				0.00	191.61	**256.56**
Gravel											17.97	**17.97**
Gravel/Cobble/Boulder					290.90						908.05	**1198.95**
Organic					0.03			0.76			24.04	**24.84**
Sand					8.91					20.40	132.69	**162.00**
Silt/Clay	0.17		7.54		21.67	0.02					1087.21	**1116.61**
Aquatic within EE 95)	**23.82**	**0.36**	**12.58**	**0.50**	**511.99**	**55.17**		**0.76**		**20.40**	**2674.05**	**3299.66**
Flooded Only	20.65	0.01	1376.23	79.27	43.87		137.72	442.40	273.86	3.15	2398.31	**4775.47**
Grand Total (Year 30)	**44.47**	**0.37**	**1388.82**	**79.77**	**555.86**	**55.17**	**137.72**	**443.17**	**273.86**	**23.56**	**5072.36**	**8075.13**

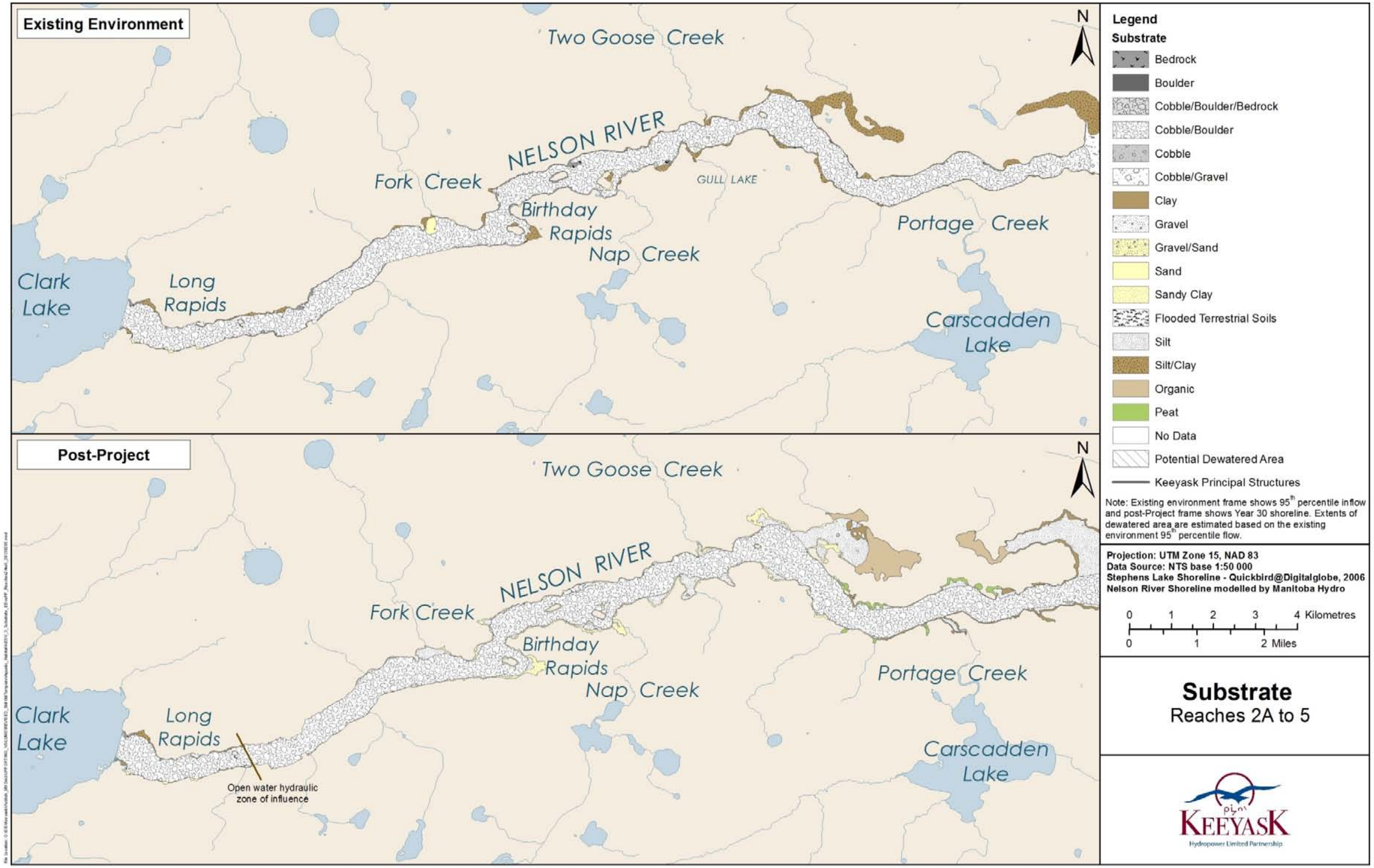
193



194

195 **Map 1. Change of substrate type for the Existing Environment (upper panel) and Year 30 Post-Project. The extent of the existing environment 95th percentile shoreline is shown in blue for comparison to the Post-Project Year 30 shoreline.**

196



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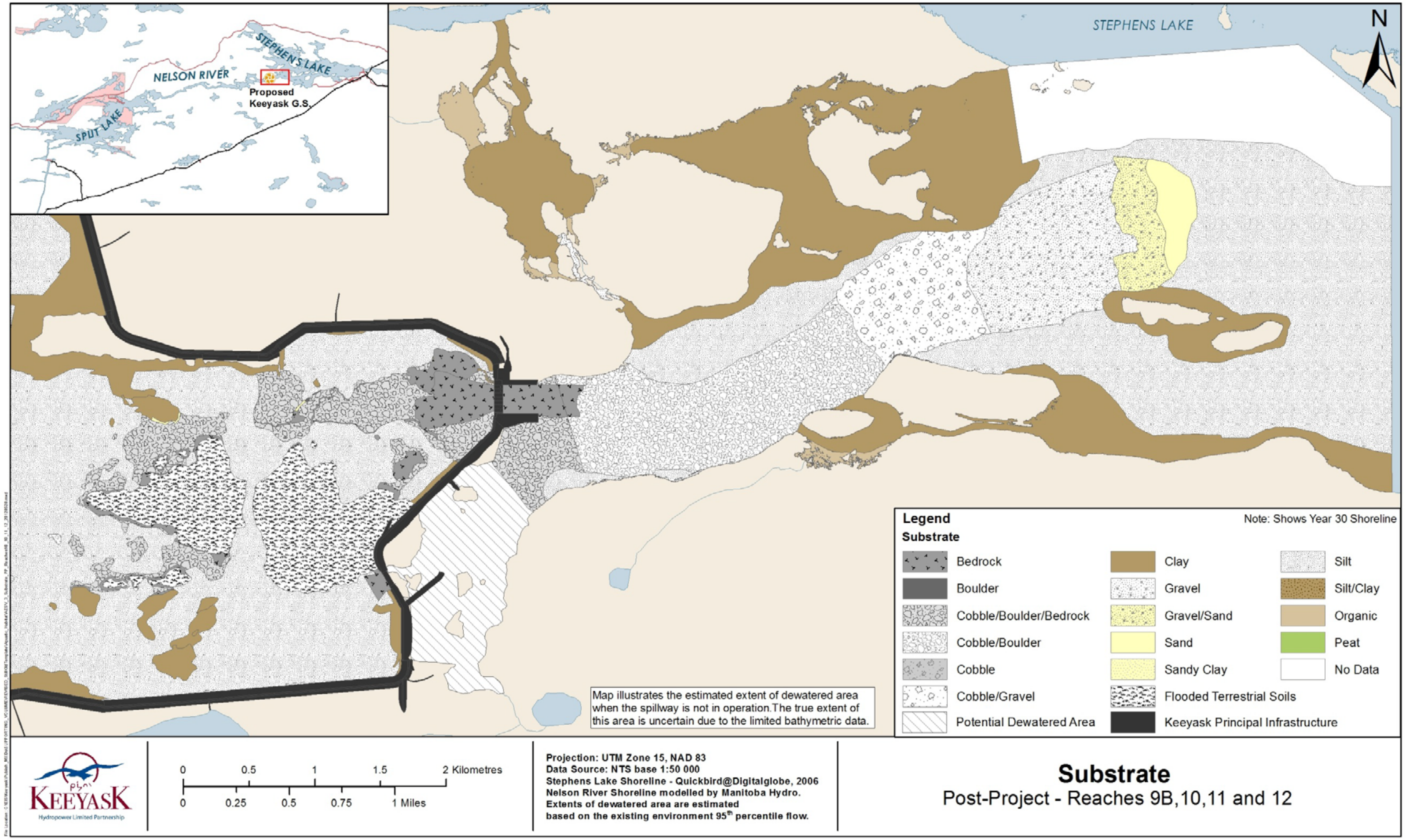
198 **Map 2. Change of substrate type for the Existing Environment (upper panel) and Year 30 Post- Project for the riverine reaches. The hydraulic zone of influence is shown in the lower panel for the Post-Project.**

199



200

201 **Map 3. Post-Project substrate immediately downstream of the generating station.**

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 6D Lake Sturgeon Habitat Suitability Index Modelling Results; p. N/A

TAC Public Rd 2 DFO-0024

ORIGINAL PREAMBLE AND QUESTION:

Appendix 6D

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

FOLLOW-UP QUESTION:

Requested HU's not provided.

RESPONSE:

As discussed at a technical review meeting among KHLP, DFO and MCWS on February 14, 2013, and in the response TAC Public Rd 1 DFO-0024, habitat units and weighted useable area are computationally the same measure.

Weighted Usable Areas (WUA) of Lake Sturgeon habitat are presented as follows:

- Lake Sturgeon spawning habitat in Tables 1-3 (Tables 6D-4, 6D-6 and 6D-8 in the AE SV)
- Young-of-the-year habitat in Tables 4-6 (Tables 6D-10, 6D-12 and 6D-14 in the AE SV)
- Sub-adult Lake Sturgeon habitat in Tables 7-9 (Tables 6D-16, 6D-18 and 6D-20 in the AE SV)
- Adult Lake Sturgeon foraging habitat in Tables 10-12 (Tables 6D-22, 6D-24 and 6D-26 in the AE SV).

The following tables come from Appendix 6D of the Aquatic Environment Supporting Volume (AE SV) of the Keeyask Generation Project Environmental Impact Statement.

Table 1: Lake Sturgeon 5th percentile spawning weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to downstream of Gull Rapids and the proposed Keeyask Generating Station (GS)

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	2.5	1.1	0.0	2.5	0.0	0.0	0.0	0.0	**6.1**	3.0	5.9	0.0	0.0	**8.9**	**15.0**
WUA 0.25 – <0.5	Moderate	1.2	0.4	0.0	1.2	0.0	0.0	0.0	0.0	**2.8**	0.9	4.4	0.0	0.0	**5.3**	**8.0**
WUA 0.5 – <0.75	High	0.9	0.2	0.0	0.9	0.0	0.0	0.0	0.0	**1.9**	0.9	2.7	0.0	0.0	**3.5**	**5.4**
WUA 0.75 – 1	Very High	0.4	0.1	0.0	0.4	0.0	0.0	0.0	0.0	**1.0**	0.1	0.2	0.0	0.0	**0.3**	**1.3**
Total WUA (0.001–1)		**5.0**	**1.7**	**0.0**	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**11.8**	**4.8**	**13.2**	**0.0**	**0.0**	**18.0**	**29.8**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	2.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.7**	2.0	0.0	0.0	**2.0**	**5.7**
WUA 0.25 – <0.5	Moderate	1.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.0**	0.4	0.0	0.0	**0.4**	**2.4**
WUA 0.5 – <0.75	High	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.2**	0.1	0.0	0.0	**0.1**	**1.3**
WUA 0.75 – 1	Very High	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.7**	0.0	0.0	0.0	**0.0**	**0.7**
Total WUA (0.001–1)		**5.1**	**2.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**7.6**	**2.5**	**0.0**	**0.0**	**2.5**	**10.1**

1. Location of reaches outlined in Map 6D-1.

Table 2: **Lake Sturgeon 50th percentile spawning weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to downstream of Gull Rapids and the proposed Keeyask Generating Station (GS)**

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake				Gull Rapids		Downstream of Gull Rapids			
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Upstream Total	Reach 9A	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	2.0	1.0	0.0	3.4	0.0	0.0	0.0	0.0	**6.3**	3.0	5.9	0.0	0.0	**8.9**	**15.1**
WUA 0.25 – <0.5	Moderate	0.9	0.4	0.0	1.0	0.0	0.0	0.0	0.0	**2.3**	1.0	3.0	0.0	0.0	**4.0**	**6.3**
WUA 0.5 – <0.75	High	0.6	0.3	0.0	0.3	0.0	0.0	0.0	0.0	**1.2**	0.6	1.1	0.0	0.0	**1.7**	**2.9**
WUA 0.75 – 1	Very High	0.4	0.1	0.0	0.1	0.0	0.0	0.0	0.0	**0.6**	0.0	0.0	0.0	0.0	**0.1**	**0.7**
Total WUA (0.001–1)		**3.8**	**1.8**	**0.0**	**4.8**	**0.0**	**0.0**	**0.0**	**0.0**	**10.4**	**4.7**	**10.0**	**0.0**	**0.0**	**14.7**	**25.1**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir					Downstream of Keeyask GS				
		Reac 2A	Reac 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A	Upstream Total	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	1.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.0**	1.2	0.0	0.0	**1.2**	**4.3**
WUA 0.25 – <0.5	Moderate	0.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.6**	0.2	0.0	0.0	**0.2**	**1.8**
WUA 0.5 – <0.75	High	0.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.0**	0.1	0.0	0.0	**0.1**	**1.1**
WUA 0.75 – 1	Very High	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.7**	0.0	0.0	0.0	**0.0**	**0.7**
Total WUA (0.001–1)		**3.9**	**2.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6.3**	**1.5**	**0.0**	**0.0**	**1.5**	**7.8**

1. Location of reaches outlined in Map 6D-1.

Keeyask Hydropower Limited Partnership

Table 3: **Lake Sturgeon 95th percentile spawning weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to downstream of Gull Rapids and the proposed Keeyask Generating Station (GS)**

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake				Gull Rapids		Downstream of Gull Rapids			
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Upstream Total	Reach 9A	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	1.3	0.8	0.0	3.2	0.0	0.0	0.0	0.0	**5.3**	3.6	4.6	0.0	0.0	**8.2**	**13.4**
WUA 0.25 – <0.5	Moderate	0.7	0.6	0.0	1.0	0.0	0.0	0.0	0.0	**2.3**	1.1	3.0	0.0	0.0	**4.1**	**6.4**
WUA 0.5 – <0.75	High	0.5	0.3	0.0	0.4	0.0	0.0	0.0	0.0	**1.2**	0.4	0.7	0.0	0.0	**1.1**	**2.3**
WUA 0.75 – 1	Very High	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	**0.4**	0.0	0.0	0.0	0.0	**0.0**	**0.5**
Total WUA (0.001–1)		**2.7**	**1.8**	**0.0**	**4.7**	**0.0**	**0.0**	**0.0**	**0.0**	**9.2**	**5.1**	**8.3**	**0.0**	**0.0**	**13.4**	**22.6**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir					Downstream of Keeyask GS				
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A	Upstream Total	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	1.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.1**	2.6	0.0	0.0	**2.6**	**4.7**
WUA 0.25 – <0.5	Moderate	0.7	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.5**	2.0	0.0	0.0	**2.0**	**3.4**
WUA 0.5 – <0.75	High	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.1**	1.0	0.0	0.0	**1.0**	**2.1**
WUA 0.75 – 1	Very High	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.7**	0.1	0.0	0.0	**0.1**	**0.7**
Total WUA (0.001–1)		**2.8**	**2.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**5.3**	**5.6**	**0.0**	**0.0**	**5.6**	**11.0**

1. Location of reaches outlined in Map 6D-1.

Table 4: **Young-of-the-year Lake sturgeon 5th percentile foraging (rearing) weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project Senvironments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)**

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Gull Lake				Gull Rapids		Downstream of Gull Rapids			
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Upstream Total	Reach 9A	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	0.5	0.4	5.0	1.3	6.8	90.7	26.9	5.4	**137.0**	0.0	1.5	30.4	28.4	**60.3**	**197.4**
WUA 0.25 – <0.5	Moderate	0.0	0.0	0.6	0.0	0.0	3.4	0.5	9.1	**13.6**	0.0	0.0	4.7	5.3	**9.9**	**23.5**
WUA 0.5 – <0.75	High	0.0	0.0	0.3	0.0	0.0	0.1	0.2	24.3	**24.9**	0.0	0.0	0.0	12.8	**12.8**	**37.7**
WUA 0.75 – 1	Very High	0.0	0.0	1.1	0.0	0.0	0.0	0.0	30.8	**31.9**	0.0	0.0	0.0	1.2	**1.2**	**33.2**
Total WUA (0.001–1)		**0.5**	**0.4**	**7.0**	**1.3**	**6.8**	**94.3**	**27.7**	**69.6**	**207.5**	**0.0**	**1.5**	**35.0**	**47.7**	**84.3**	**291.8**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Keeyask GS Reservoir					Downstream of Keeyask GS				
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A	Upstream Total	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	0.5	0.7	9.2	12.6	62.0	182.8	86.0	31.1	32.3	**417.3**	1.5	31.2	30.7	**63.4**	**480.8**
WUA 0.25 – <0.5	Moderate	0.0	0.0	0.0	0.0	0.2	2.2	8.3	0.3	0.7	**11.8**	0.0	6.5	8.4	**14.8**	**26.6**
WUA 0.5 – <0.75	High	0.0	0.0	0.0	0.0	0.0	0.0	2.3	1.9	0.1	**4.3**	0.0	0.0	10.7	**10.7**	**15.0**
WUA 0.75 – 1	Very High	0.0	0.0	0.0	0.0	0.0	0.0	1.6	9.6	0.5	**11.7**	0.0	0.0	5.7	**5.7**	**17.3**
Total WUA (0.001–1)		**0.5**	**0.7**	**9.2**	**12.6**	**62.3**	**185.0**	**98.2**	**42.9**	**33.6**	**445.0**	**1.5**	**37.6**	**55.5**	**94.7**	**539.7**

1. Location of reaches outlined in Map 6D-1.

Table 5: Young-of-the-year Lake Sturgeon 50th percentile foraging (rearing) weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake				Gull Rapids		Downstream of Gull Rapids			
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Upstream Total	Reach 9A	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	0.5	0.5	4.4	2.0	7.0	93.9	25.2	9.5	**142.8**	0.1	1.3	29.6	33.5	**64.5**	**207.3**
WUA 0.25 – <0.5	Moderate	0.0	0.0	0.7	0.0	0.0	3.8	0.5	8.4	**13.4**	0.0	0.0	8.8	14.5	**23.2**	**36.6**
WUA 0.5 – <0.75	High	0.0	0.0	0.5	0.0	0.0	0.2	0.3	22.2	**23.1**	0.0	0.0	0.0	5.2	**5.2**	**28.4**
WUA 0.75 – 1	Very High	0.0	0.0	0.5	0.0	0.0	0.1	0.1	40.3	**40.9**	0.0	0.0	0.0	37.5	**37.5**	**78.4**
Total WUA (0.001–1)		**0.6**	**0.5**	**5.9**	**2.0**	**7.0**	**97.9**	**26.1**	**80.3**	**220.3**	**0.1**	**1.3**	**38.4**	**90.7**	**130.4**	**350.7**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir					Downstream of Keeyask GS				
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A	Upstream Total	Reach 9B	Reach 11	Reach 12	Downstream Total	Overall Total
WUA 0.001 – <0.25	Low	0.5	0.6	5.9	8.5	41.4	163.0	84.7	45.1	24.6	**374.3**	1.3	28.9	35.8	**66.0**	**440.3**
WUA 0.25 – <0.5	Moderate	0.0	0.0	0.0	0.0	0.4	90.8	37.9	3.9	22.2	**155.2**	0.0	9.0	16.3	**25.2**	**180.5**
WUA 0.5 – <0.75	High	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.3	0.0	**2.8**	0.0	0.0	5.1	**5.1**	**7.8**
WUA 0.75 – 1	Very High	0.0	0.0	0.0	0.0	0.0	0.0	2.4	12.9	0.6	**15.9**	0.0	0.0	36.7	**36.7**	**52.6**
Total WUA (0.001–1)		**0.5**	**0.6**	**5.9**	**8.5**	**41.8**	**253.9**	**127.4**	**62.2**	**47.4**	**548.2**	**1.3**	**37.8**	**93.8**	**133.0**	**681.2**

1. Location of reaches outlined in Map 6D-1.

Table 6: **Young-of-the-year Lake Sturgeon 95th percentile foraging (rearing) weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)**

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	0.5	0.5	3.1	2.5	8.1	77.0	21.5	17.6	**130.9**	0.2	1.2	26.8	32.3	**60.5**	**191.4**
WUA 0.25 – <0.5	Moderate	0.1	0.0	1.9	0.0	0.0	2.2	0.5	9.2	**13.8**	0.0	0.0	6.8	39.7	**46.5**	**60.3**
WUA 0.5 – <0.75	High	0.0	0.0	0.7	0.0	0.0	0.5	0.0	11.9	**13.1**	0.0	0.0	0.0	0.0	**0.0**	**13.2**
WUA 0.75 – 1	Very High	0.0	0.0	0.0	0.0	0.0	0.1	0.0	40.8	**40.9**	0.0	0.0	0.0	50.1	**50.1**	**91.0**
Total WUA (0.001–1)		**0.6**	**0.5**	**5.7**	**2.5**	**8.1**	**79.8**	**22.0**	**79.5**	**198.8**	**0.2**	**1.2**	**33.6**	**122.1**	**157.1**	**355.9**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	0.5	0.6	4.5	6.6	25.3	132.8	87.2	48.3	22.7	**328.3**	1.2	27.9	39.3	**68.4**	**396.6**
WUA 0.25 – <0.5	Moderate	0.1	0.0	0.0	0.0	0.7	172.5	56.4	24.6	35.5	**289.8**	0.0	8.8	34.1	**42.9**	**332.7**
WUA 0.5 – <0.75	High	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.3	0.0	**2.7**	0.0	0.0	0.3	**0.3**	**2.9**
WUA 0.75 – 1	Very High	0.0	0.0	0.0	0.0	0.0	0.0	2.5	13.1	0.6	**16.2**	0.0	0.0	49.6	**49.6**	**65.8**
Total WUA (0.001–1)		**0.6**	**0.6**	**4.5**	**6.6**	**26.0**	**305.3**	**148.5**	**86.2**	**58.8**	**636.9**	**1.2**	**36.7**	**123.3**	**161.2**	**798.1**

1. Location of reaches outlined in Map 6D-1.

Table 7: Sub-adult Lake Sturgeon 5th percentile foraging weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	3.2	6.6	13.6	15.2	45.5	58.8	29.1	10.0	**181.9**	5.9	8.5	24.9	4.8	**44.2**	**226.1**
WUA 0.25 – <0.5	Moderate	0.0	0.6	20.1	0.9	16.9	77.4	57.2	9.0	**182.2**	0.0	5.9	46.2	127.7	**179.8**	**362.0**
WUA 0.5 – <0.75	High	0.0	0.0	0.2	0.0	0.1	46.6	1.4	10.9	**59.3**	0.0	0.0	53.5	34.9	**88.4**	**147.6**
WUA 0.75 – 1	Very High	0.0	0.0	1.8	0.0	0.1	517.7	0.1	46.2	**565.9**	0.0	0.0	32.9	61.0	**93.9**	**659.8**
Total WUA (0.001–1)		**3.2**	**7.2**	**35.7**	**16.1**	**62.7**	**700.6**	**87.7**	**76.1**	**989.3**	**5.9**	**14.5**	**157.5**	**228.4**	**406.3**	**1395.6**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	3.1	9.4	14.2	19.6	32.0	125.7	54.0	38.7	94.7	**391.5**	6.4	18.3	4.8	**29.5**	**421.0**
WUA 0.25 – <0.5	Moderate	0.0	2.3	29.6	44.5	165.0	587.2	240.7	139.6	94.7	**1303.6**	5.2	69.5	134.2	**208.9**	**1512.5**
WUA 0.5 – <0.75	High	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.1	0.1	**2.0**	0.0	47.4	23.1	**70.5**	**72.6**
WUA 0.75 – 1	Very High	0.0	0.0	0.0	0.0	0.0	0.0	4.3	12.3	0.6	**17.2**	0.0	35.8	70.9	**106.7**	**123.9**
Total WUA (0.001–1)		**3.1**	**11.7**	**43.8**	**64.1**	**197.0**	**712.9**	**300.8**	**190.8**	**190.1**	**1714.4**	**11.6**	**171.0**	**233.0**	**415.6**	**2130.0**

1. Location of reaches outlined in Map 6D-1.

Table 8: Sub-adult Lake Sturgeon 50th percentile foraging weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	3.0	8.2	15.0	19.4	53.2	55.2	31.2	14.7	**199.9**	7.2	8.9	23.7	4.8	**44.7**	**244.6**
WUA 0.25 – <0.5	Moderate	0.0	0.7	23.9	0.7	17.8	81.7	65.7	7.9	**198.5**	0.0	3.7	46.6	139.7	**189.9**	**388.4**
WUA 0.5 – <0.75	High	0.0	0.0	0.1	0.0	0.1	73.5	1.7	9.7	**85.1**	0.0	0.0	58.6	10.8	**69.4**	**154.6**
WUA 0.75 – 1	Very High	0.0	0.0	2.1	0.0	0.1	590.0	0.2	59.2	**651.5**	0.0	0.0	39.7	105.0	**144.7**	**796.2**
Total WUA (0.001–1)		**3.0**	**8.9**	**41.1**	**20.2**	**71.2**	**800.5**	**98.8**	**91.4**	**1135.0**	**7.2**	**12.6**	**168.6**	**260.3**	**448.7**	**1583.8**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	2.7	12.5	20.4	38.4	45.5	132.0	55.8	38.5	46.3	**392.0**	6.7	16.9	4.8	**28.4**	**420.4**
WUA 0.25 – <0.5	Moderate	0.0	0.3	25.8	19.5	148.3	370.8	167.2	132.6	47.1	**911.6**	3.6	71.6	146.8	**222.0**	**1133.5**
WUA 0.5 – <0.75	High	0.0	0.0	0.0	0.0	0.4	329.8	121.9	43.8	68.0	**563.9**	0.0	50.2	4.2	**54.4**	**618.3**
WUA 0.75 – 1	Very High	0.0	0.0	0.0	0.0	0.0	0.0	5.4	13.7	0.6	**19.8**	0.0	40.5	105.3	**145.8**	**165.6**
Total WUA (0.001–1)		**2.7**	**12.8**	**46.1**	**57.9**	**194.2**	**832.6**	**350.2**	**228.7**	**162.0**	**1887.2**	**10.3**	**179.3**	**261.0**	**450.6**	**2337.8**

1. Location of reaches outlined in Map 6D-1.

Table 9: Sub-adult Lake Sturgeon 95th percentile foraging weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	2.6	9.8	20.4	21.0	57.1	53.1	42.9	19.5	**226.5**	8.3	6.9	23.9	4.9	**44.0**	**270.5**
WUA 0.25 – <0.5	Moderate	0.0	0.1	20.0	1.6	17.1	78.6	64.1	8.3	**189.8**	0.0	2.6	41.2	141.9	**185.6**	**375.4**
WUA 0.5 – <0.75	High	0.0	0.0	0.8	0.0	0.2	81.4	1.7	8.2	**92.2**	0.0	0.0	63.1	21.2	**84.3**	**176.5**
WUA 0.75 – 1	Very High	0.0	0.0	2.0	0.0	0.1	699.8	0.3	72.4	**774.7**	0.0	0.0	46.1	118.4	**164.5**	**939.2**
Total WUA (0.001–1)		**2.6**	**9.9**	**43.2**	**22.6**	**74.4**	**912.9**	**109.0**	**108.5**	**1283.1**	**8.3**	**9.5**	**174.3**	**286.4**	**478.4**	**1761.5**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	2.7	12.5	20.4	38.4	45.5	132.0	55.8	38.5	47.1	**392.8**	6.3	17.1	4.8	**28.3**	**421.1**
WUA 0.25 – <0.5	Moderate	0.0	0.3	25.8	19.5	148.3	370.8	167.2	132.6	47.1	**911.6**	3.3	72.6	150.2	**226.1**	**1137.7**
WUA 0.5 – <0.75	High	0.0	0.0	0.0	0.0	0.4	329.8	121.9	43.8	68.0	**563.9**	0.0	54.0	13.7	**67.7**	**631.5**
WUA 0.75 – 1	Very High	0.0	0.0	0.0	0.0	0.0	0.0	5.4	13.7	0.6	**19.8**	0.0	42.1	115.2	**157.3**	**177.1**
Total WUA (0.001–1)		**2.7**	**12.8**	**46.1**	**57.9**	**194.2**	**832.6**	**350.2**	**228.7**	**162.8**	**1888.0**	**9.7**	**185.9**	**283.9**	**479.4**	**2367.4**

1. Location of reaches outlined in Map 6D-1.

KEEYASK Hydropower Limited Partnership

Table 10: Adult Lake Sturgeon 5th percentile foraging weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	5.5	3.5	1.1	3.7	4.1	10.7	3.5	6.8	**38.9**	5.6	2.2	0.5	0.3	**8.6**	**47.6**
WUA 0.25 – <0.5	Moderate	15.2	15.9	8.3	17.1	27.5	60.2	29.6	27.2	**201.0**	16.5	7.9	26.2	7.1	**57.6**	**258.6**
WUA 0.5 – <0.75	High	18.2	34.1	26.0	57.6	109.3	84.0	28.6	23.2	**381.1**	24.8	18.9	164.8	409.4	**617.9**	**999.0**
WUA 0.75 – 1	Very High	15.7	35.1	165.1	74.8	317.9	1049.2	432.1	131.0	**2220.8**	59.4	83.3	199.9	75.2	**417.9**	**2638.7**
Total WUA (0.001–1)		**54.6**	**88.6**	**200.5**	**153.2**	**458.8**	**1204.1**	**493.8**	**188.2**	**2841.9**	**106.3**	**112.3**	**391.4**	**492.0**	**1102.0**	**3943.8**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	5.1	2.5	0.7	0.6	4.1	31.0	3.2	10.4	24.0	**81.6**	0.1	0.7	0.3	**1.1**	**82.7**
WUA 0.25 – <0.5	Moderate	15.1	9.9	4.2	2.7	24.0	323.1	61.9	123.1	24.0	**588.0**	1.9	25.2	6.9	**34.1**	**622.1**
WUA 0.5 – <0.75	High	17.6	27.9	16.7	19.1	95.6	1057.7	376.7	341.8	155.0	**2108.1**	15.4	158.0	415.2	**588.6**	**2696.7**
WUA 0.75 – 1	Very High	16.1	76.9	208.5	267.4	617.0	901.1	520.8	108.7	390.6	**3107.2**	49.0	212.1	86.3	**347.4**	**3454.5**
Total WUA (0.001–1)		**53.9**	**117.2**	**230.2**	**289.8**	**740.7**	**2312.9**	**962.6**	**584.0**	**593.6**	**5884.9**	**66.4**	**395.9**	**508.8**	**971.1**	**6856.0**

1. Location of reaches outlined in Map 6D-1.

Table 11: **Adult Lake Sturgeon 50th percentile foraging weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)**

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	4.8	3.8	1.0	3.7	6.8	20.9	7.5	8.0	**56.6**	4.0	2.7	0.5	0.2	**7.5**	**64.0**
WUA 0.25 – <0.5	Moderate	12.7	14.0	8.1	22.6	45.1	84.8	21.0	30.1	**238.4**	15.1	8.4	23.2	6.2	**52.9**	**291.3**
WUA 0.5 – <0.75	High	14.1	30.4	25.6	58.4	115.3	90.4	50.9	60.2	**445.2**	27.9	23.0	151.2	332.3	**534.4**	**979.6**
WUA 0.75 – 1	Very High	14.9	39.8	175.8	82.7	283.9	1164.6	465.0	160.4	**2387.0**	72.5	61.2	240.2	213.4	**587.4**	**2974.4**
Total WUA (0.001–1)		**46.6**	**88.1**	**210.5**	**167.4**	**451.0**	**1360.7**	**544.3**	**258.7**	**3127.2**	**119.5**	**95.4**	**415.1**	**552.2**	**1182.1**	**4309.3**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids			Downstream Birthday Rapids		Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	4.9	2.3	0.7	0.7	4.3	30.3	3.0	10.3	22.2	**78.6**	0.1	0.6	0.2	**1.0**	**79.6**
WUA 0.25 – <0.5	Moderate	12.5	10.0	4.3	4.2	25.2	309.6	49.9	122.4	22.2	**560.4**	5.2	23.5	5.8	**34.5**	**594.9**
WUA 0.5 – <0.75	High	14.4	35.0	24.8	23.6	82.0	925.5	312.2	260.7	114.8	**1793.1**	20.0	152.1	335.0	**507.1**	**2300.2**
WUA 0.75 – 1	Very High	15.6	59.6	200.1	253.2	640.3	1206.8	675.2	225.7	479.4	**3755.7**	33.5	236.2	219.0	**488.6**	**4244.3**
Total WUA (0.001–1)		**47.3**	**106.9**	**229.9**	**281.8**	**751.8**	**2472.2**	**1040.3**	**619.1**	**638.6**	**6187.8**	**58.8**	**412.3**	**560.0**	**1031.1**	**7219.0**

1. Location of reaches outlined in Map 6D-1.

Keeyask Hydropower Limited Partnership

Table 12: Adult Lake Sturgeon 95th percentile foraging habitat areas and weighted usable areas (WUAs; in hectares), by habitat suitability index (HSI) and reach in the existing and Year 30 post-Project environments from Clark Lake to Gull Rapids and the proposed Keeyask Generating Station (GS)

Existing Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Gull Lake			Upstream Total	Gull Rapids		Downstream of Gull Rapids		Downstream Total	Overall Total
		Reach[1] 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8		Reach 9A	Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	3.8	3.6	1.3	5.5	15.1	10.9	2.0	2.1	**44.3**	3.8	3.6	0.6	0.2	**8.2**	**52.5**
WUA 0.25 – <0.5	Moderate	8.4	16.4	11.0	30.1	61.7	96.2	26.4	23.9	**274.1**	15.5	8.7	22.3	5.3	**51.8**	**325.9**
WUA 0.5 – <0.75	High	9.7	27.9	25.1	36.9	93.0	124.1	62.2	51.3	**430.3**	33.4	14.1	137.4	230.5	**415.4**	**845.7**
WUA 0.75 – 1	Very High	13.9	30.5	168.1	89.8	245.2	1258.6	489.5	247.5	**2543.1**	72.2	50.0	267.3	381.1	**770.6**	**3313.7**
Total WUA (0.001–1)		**35.8**	**78.4**	**205.5**	**162.3**	**415.0**	**1489.8**	**580.0**	**324.8**	**3291.7**	**124.9**	**76.4**	**427.6**	**617.1**	**1246.0**	**4537.7**

Year 30 Post-Project Environment

HSI	Suitability Classification	Upstream Birthday Rapids		Downstream Birthday Rapids			Keeyask GS Reservoir				Upstream Total	Downstream of Keeyask GS			Downstream Total	Overall Total
		Reach 2A	Reach 2B	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9A		Reach 9B	Reach 11	Reach 12		
WUA 0.001 – <0.25	Low	3.7	2.4	1.2	1.7	8.4	29.0	2.7	9.9	20.2	**79.3**	1.8	0.6	0.2	**2.6**	**81.9**
WUA 0.25 – <0.5	Moderate	8.9	16.1	9.2	10.6	31.5	292.6	40.6	120.8	20.2	**550.6**	5.5	21.9	5.0	**32.3**	**582.9**
WUA 0.5 – <0.75	High	10.0	31.0	26.2	48.4	102.5	851.4	243.7	209.6	79.3	**1602.1**	8.9	136.4	242.0	**387.2**	**1989.4**
WUA 0.75 – 1	Very High	14.6	40.7	183.2	186.3	586.1	1469.0	832.0	333.4	551.3	**4196.5**	42.1	266.8	368.8	**677.7**	**4874.2**
Total WUA (0.001–1)		**37.1**	**90.2**	**219.7**	**247.1**	**728.6**	**2642.0**	**1119.0**	**673.8**	**671.0**	**6428.6**	**58.3**	**425.6**	**616.0**	**1099.9**	**7528.5**

1. Location of reaches outlined in Map 6D-1.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.0 Lake Sturgeon; p. N/A

TAC Public Rd 2 DFO-0025

ORIGINAL QUESTION AND PREAMBLE:

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.

FOLLOW-UP QUESTION:

Revised maps not provided.

RESPONSE:

The original Partnership response to TAC Public Rd 1 DFO-0025 indicated that the HSI analysis is based on long-term (30 year) habitat conditions in the reservoir. At that time, flooded habitat with suitable substrate, depth and velocity is expected to provide foraging habitat to sub-adult and adult Lake Sturgeon based on the suitability criteria used for the HSI analysis.

DFO indicated in this second round of Requests for Additional Information that the requested maps were not provided. Subsequent discussions at a technical review meeting on February 14, 2013 among KHLP, CEAA, DFO and MCWS indicated that the issue was the determination of the Harmful Alteration, Disruption and Destruction (HADD) of habitat and that this determination needed to include the initial years post-impoundment when the flooded habitat is still evolving. It is understood that habitat for certain life history stages (i.e., spawning and young-of-the-year rearing) is negatively affected. The effect of habitat changes associated with reservoir creation on sub-adult and adult Lake Sturgeon is more complex since habitat in certain areas will become more productive (e.g., based on the suitability indices provided in AE SV Appendix 6D, where velocities decrease to the 0.2-1.0 m/s range from greater than 1 m/s suitability increases, but deposition of silt may decrease the suitability of existing sand or gravel areas for sub-adult Lake Sturgeon). Based on the suitability indices for these life stages provided in AE SV, p. 6-Appendix 6D, the overall amount of suitable habitat for these life stages will increase post-Project. The degree to which Lake Sturgeon will use flooded terrestrial habitat immediately after flooding is unknown so a conservative approach was taken in the AE SV Section 6.4.2.2.2, p. 6-36):

> *During the initial years post-impoundment, conditions over the newly flooded terrestrial habitat would not be optimal for lake sturgeon, which appear to favour deeper, more riverine, mineral substrate environments in the Nelson River (Section 6.3.2.3.1). Both sub-adult and adult lake sturgeon were captured or relocated via telemetry between Birthday Rapids and Gull Rapids, but were mainly found in Gull Lake (Section 6.3.2.3.1). In Gull Lake, sub-adults occupied a narrower range of conditions, favouring deep, low to moderate velocity areas. Adult sturgeon were also observed in the reach between Clark Lake and Birthday Rapids.*

> *Lake sturgeon will continue to be able to use habitat in the former mainstem and Gull Lake that are not expected to experience the changes in water quality (Section 2.5.2.2) that are predicted for flooded shallow water lentic habitats (decreased dissolved oxygen, flooded terrestrial organics and episodic increases in suspended sediments). Over time, as the substratum evolves, lake sturgeon could begin to use flooded portions of the reservoir as conditions become suitable.*

> *The long-term use of the reservoir by sub-adult and adult sturgeon was modeled separately. The post-Project HSI models predict a net gain of approximately 600–750 ha (WUA) of foraging habitat for sub-adults and a net gain of approximately 3,000–3,150 ha for adults (Map 6-50 to Map 6-55; Appendix 6D).*

The AE SV Section 6.4.2.2.3, p. 6-37 also considered potential effects of emigration of Lake Sturgeon in response to rapids habitat changes at impoundment:

> *Studies conducted to date have recorded incidental movements of lake sturgeon through Birthday Rapids and Gull Rapids (Section 6.3.2.7). Lower velocities and increased depth at Birthday Rapids may facilitate passage of lake sturgeon upstream through the rapids. It is possible that sturgeon will emigrate upstream or downstream away from the reservoir in response to habitat changes resulting from impoundment. Upstream emigration of other fish species was observed in the Desaulniers River, Québec (Boucher 1982), and downstream emigration was documented for lake sturgeon moving out of the Limestone reservoir within the first five years after impoundment (NSC 2012). Over time, some lake sturgeon that move upstream may return downstream to the reservoir. Although fish that permanently leave Gull Lake will not be replaced with the same age classes, conservation stocking will be used to maintain the total number of lake sturgeon in the reservoir. Details of the stocking program are provided in Appendix 1A.*

At the technical meeting on February 14, 2013, the Proponent was asked to develop a brief summary of Lake Sturgeon habitat changes for DFO's consideration. This summary is provided below.

Summary of Lake Sturgeon Habitat Changes from Keeyask Generation Project Development

The Keeyask Generation Project will result in the destruction of 128 ha of habitat used by lake sturgeon due to construction and operation of the Keeyask Generating Station and the effects on reservoir and downstream flow regime modification as detailed below:

- Destruction of 128 ha of habitat in Gull Rapids that will be permanently lost due to the footprint of the principle structures of the generating station, construction of intake and tailrace channels, and dewatering of the south channel of Gull Rapids. Areas within Gull Rapids provide spawning habitat for Lake Sturgeon resident in Stephens Lake.
- Reduction in the suitability of habitat along the north bank of the Nelson River for sub-adult Lake Sturgeon due to velocity reduction and siltation.
- Alteration of fish habitat in the Nelson River between Long Rapids and Stephens Lake, an area of approximately 4,500 ha of river and lake habitat. Negative effects of this habitat alteration include:
  - A potential short term emigration of sub-adult and adult Lake Sturgeon in response to the rapid habitat change. Sturgeon are expected to return to the area over time.
  - A potential decrease in the suitability of spawning habitat at Birthday Rapids.
  - A loss of access to young-of-the-year rearing habitat north of Caribou Island in Gull Lake.
  - A decrease in suitability of some currently preferred areas of habitat for sub-adult Lake Sturgeon due to reduction in velocity to less than 0.2 m/s and siltation.

Positive or neutral effects of this alteration include:

- Conversion of high velocity (>1 m/s) habitat to habitat with a velocity of 0.2-1.0 m/s.
- Creation, in the long term, of an additional 4,800 ha of habitat from the flooded terrestrial area. Given that velocity is mainly less than 0.2 m/s, it is not high value habitat but has some value as foraging habitat for adult Lake Sturgeon.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 1A Aquatic Mitigation and Compensation Measures: Evaluation of Alternatives and Rationale for Selected Measures; p. N/A

TAC Public Rd 2 DFO-0026

ORIGINAL 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.

FOLLOW-UP QUESTION:

Requested details on sand habitat creation not provided.

RESPONSE:

Impoundment of the Gull Lake area to create the forebay of the Keeyask Generating Station will flood a diverse variety of aquatic habitats. An existing area where Young-Of-Year Habitat (YOYH) sturgeon have been located has been identified north of Caribou Island, as shown in Figure 1. This document describes a phased approach for the development of the YOYH.

Sand Blanket Criteria

Using the information provided by North/South and a preliminary estimate of where the velocity drops below 0.5 m/s in the central channel, the approximate area that would be suitable for sand blanket deposition is shown on Figure 2. It should be noted that the selection of the preferred location for the construction of the sand blanket was not based on an area where young-of-year sturgeon have been located under current conditions, but rather on conditions that will exist once the Keeyask Generating station is operational. The preferred location was instead based on the most likely area in the post-impoundment setting where YOY lake sturgeon that emerge from upstream spawning locations in the reach from Birthday Rapids to Long Rapids would settle to the bottom of the river channel. The area was selected based on water velocity characteristics following impoundment.

The preferred location for the sand blanket is an approximately 400 m wide by 2 km long section (total area of 800,000 m^2) in the central channel, as shown in Figure 2. The sand blanket would consist of dirty sand, ideally containing some silt, covering the existing cobbles by 5 cm.

An average cobble size of 7.5 inches, or 19 cm, would require a blanket depth of approximately 24 cm. Since the presence of cobbles and boulders will not require a continuous sand thickness of 24 cm, an approximate thickness of 20 cm has been used to estimate a volume of sand required for 160,000 m^3. Some boulders and cobbles may not be covered by this thickness of sand and will provide cover for the fish. The outline of the proposed sand blanket is shown in Figure 2.

Phased Approach for Sand Blanket Development

Phase I Sand Placement

If monitoring indicates that sand placement is necessary, then the placement of a sand blanket as a Phase I pilot program would provide an area of sand habitat covering a 200,000 m^2 area. This area represents approximately one-half of the existing high suitability area. The preliminary location of the Phase I sand blanket that is shown in Figure 2 may be refined based on observations made during the initial monitoring program prior to Phase I sand placement.

Intermediate Monitoring Program

The success of the Phase I pilot placement will be monitored over one or more years to assess the need for and location of the next phase of sand placement.

Phase II Sand Placement

Based on the observations made during the intermediate monitoring program, the Phase II sand placement would be implemented. The preliminary location of the Phase II sand blanket is shown on Figure 2; however, the location of the sand blanket would be refined based on observations made during the intermediate monitoring program. The Phase II sand blanket may be an extension of the Phase I sand blanket or a separate site, depending on the observations made during the intermediate monitoring program.

Construction Methodology

Sand Blanket Material Sources

The two material sources were reviewed to ensure that each could provide a sufficient quantity of clean sand for this project. Two locations have been identified as potential source of sand:

- Option 1 sources material from Deposit G-1.
- Option 2 sources material from Deposit B-1.

Options 1 and 2 can be seen on Figure 1. Deposit B-1 can be seen in detail in Figure 3.

Sand Placement Methods

Sand placement on river bottoms and lakebeds has been used to cover contaminated material deposited in the water bodies. The sand placement methods used for these projects can also be used for the placement of sand blanket material in the Nelson River. The appendix at the end of this document provides figures that illustrate some of these placement methods.

Surface release from a barge, dredge or pipeline would result in more TSS generation than the placement of material from a barge using a sand spreader or tremie equipment. The sand spreader and tremie placement methods are described below.

A sand spreader system can be used to place material on the bottom of a river. Sand is transported to the placement area on a barge. Water is added to the sand to create a slurry, which is pumped through a submerged pipe to the river bottom. A winch and anchor system is used to move the submerged pipe to direct the placement of the sand slurry. This gives a more accurate sand placement and less TSS generation than dumping material from the surface of the river. In the same way, tremie equipment mounted on a barge can be used to place material on the bottom of a river. When the barge is in the placement area, the sand is moved to a hopper using a small front-end loader or conveyor belt. The hopper feeds the sand into a large-diameter pipe mounted on the side of the barge. The pipe extends vertically from the hopper to just above the river bottom, isolating the sand from the upper water column. An anchor and winch system, tugboat guidance or cable and winch system can be used to move the barge over the sand blanket area. This method also results in more accurate sand placement and less TSS generation than dumping material from the surface of the river. A conceptual drawing of a tremie composed of a retractable nested plastic chute attached to the side of a barge is shown in the appendix. Photos of a retractable plastic chute with a hopper loading system are also shown in the appendix. Either the sand spreader or tremie methods would be suitable for the placement of sand blanket material.

Excavation and Transportation of Sand Material

This is a significant construction operation in which 80,000 m^3 of sand is to be placed on the river bottom over two areas of 200,000 m^2 each. It is assumed that approximately one metre of clay would be stripped from Deposit B-1 to access the poorly graded gravelly sand. Stripping of clay and overburden would not be required at Deposit G-1, as the sand would have already been exposed during the development of the Keeyask GS. Some processing is required to isolate the material between 1.0 mm and 2.0 mm in diameter. The material would be transported by truck from the deposit areas to the river, and then transported to the sand blanket placement area by a tug towing a barge. Depending on the source of material for this project a barge loading area would be constructed at the North Dyke or near Deposit B-1 if Deposit B-1 was selected as the source for the material.

These loading areas would be removed at the end of the project.

The proposed barge loading areas and barge routes are shown in Figures 1 and 2. Use of Deposit B-1 would require construction of a winter road prior to the Phase I sand blanket placement in order to allow access for equipment to clear and prepare the deposit sites. This will ensure that the full summer construction season can be utilized for the construction of YOYH.

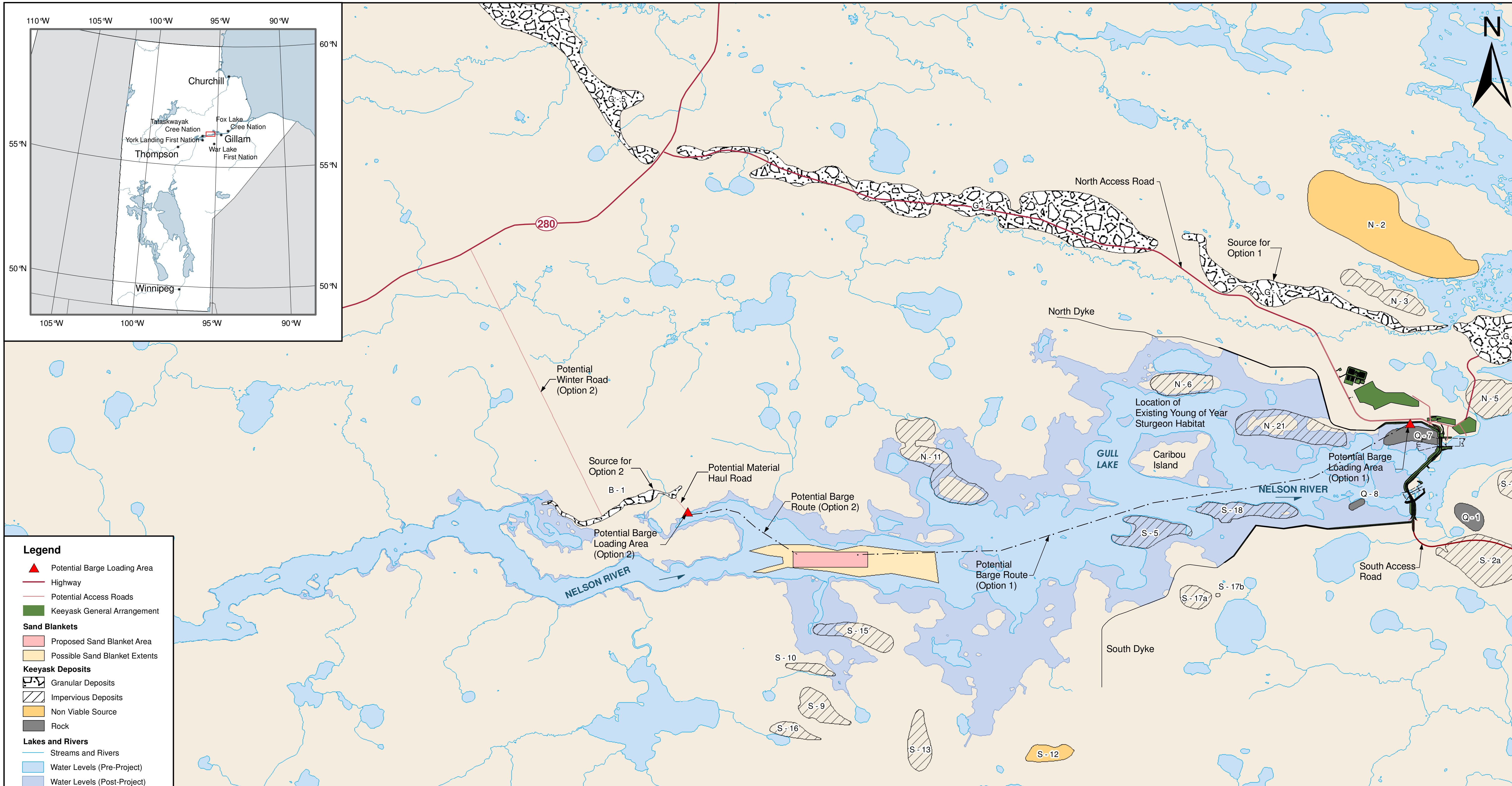
Five barge sections would be connected to be used for transportation of the sand blanket material. An example of interconnected barge segments and a tug is shown in the Appendix. One tug will be able to move the interconnected barge.

The sand blanket areas shown in Figure 2 would be revised based on observations from the initial monitoring program. GPS technology would be used during sand placement, and placement would be verified using a dive team. The marine staff would consist of one tug operator and one small front-end loader operator to move the material into the hopper. Three truck operators and two loader operators with one foreman comprise a total staff of eight. Two divers would also be required for the diving program.

A fuel depot would be included at the site of the granular source.

Scheduling Of Work

This operation would require about 5 weeks each for Phase I and Phase II, with 60 hour work weeks using Deposit B-1 as a source. Alternatively, the operation would require about 10 weeks each for Phase I and Phase II using Deposit G-1 as a source. Placement of the Phase I sand blanket would begin following a three-year initial monitoring program after impoundment. An intermediate monitoring program would monitor the success of the Phase I sand blanket for a minimum of one year. The Phase II sand blanket placement would begin following this monitoring program.



KEEYASK
Hydropower Limited Partnership

0 2.5 5 Kilometers
0 7,500 15,000 Feet

Projection: Universal Transverse Mercator (UTM) Zone 15N, North American Datum 1983 (NAD 83)

Data Sources:
1. Post-project and pre-project shorelines provided by Manitoba Hydro, 2010
2. Lakes, rivers, roads and toponyms provided by Geogratis, 2007.
3. Infrastructure data and deposits provided by KGS Acres, 2010.
4. Potential barge loading area, potential barge route, proposed sand blanket area, possible sand blanket extents and potential access roads provided by KGS Acres, 2009

FOR GENERAL REFERENCE ONLY

STAGE IV STUDIES AXIS GR-4 LOCATION OF DEPOSITS, SAND BLANKET AND ACCESS ROUTES - PART 1

Figure 2

Figure 1

Created By: KGS ACRES

File Location: P:\P\10008\16\shared\deliver\GR4\GN_9_8\GN_9_8_11\rev_1\CAD\GIS

Date Created: May 24, 2011

KEEYASK Hydropower Limited Partnership

0 500 1,000 Meters

0 1,500 3,000 Feet

Projection: Universal Transverse Mercator (UTM) Zone 15N, North American Datum 1983 (NAD 83)

Data Sources:
1. Lakes, rivers, roads and toponyms provided by Geogratis, 2007.
2. Infrastructure data and deposits provided by KGS Acres, 2010.
3. Minimum permissible material data, potential barge route and proposed sand blanket area provided by KGS Acres, 2011
4. Water levels (pre-project) and water levels (post-project) provided by MB Hydro 2010
5. Habitat suitability index areas provided by North South Consultants, 2011

FOR GENERAL REFERENCE ONLY

STAGE IV STUDIES AXIS GR-4 LOCATION OF SAND BLANKETS AND ACCESS ROUTES - PART 2

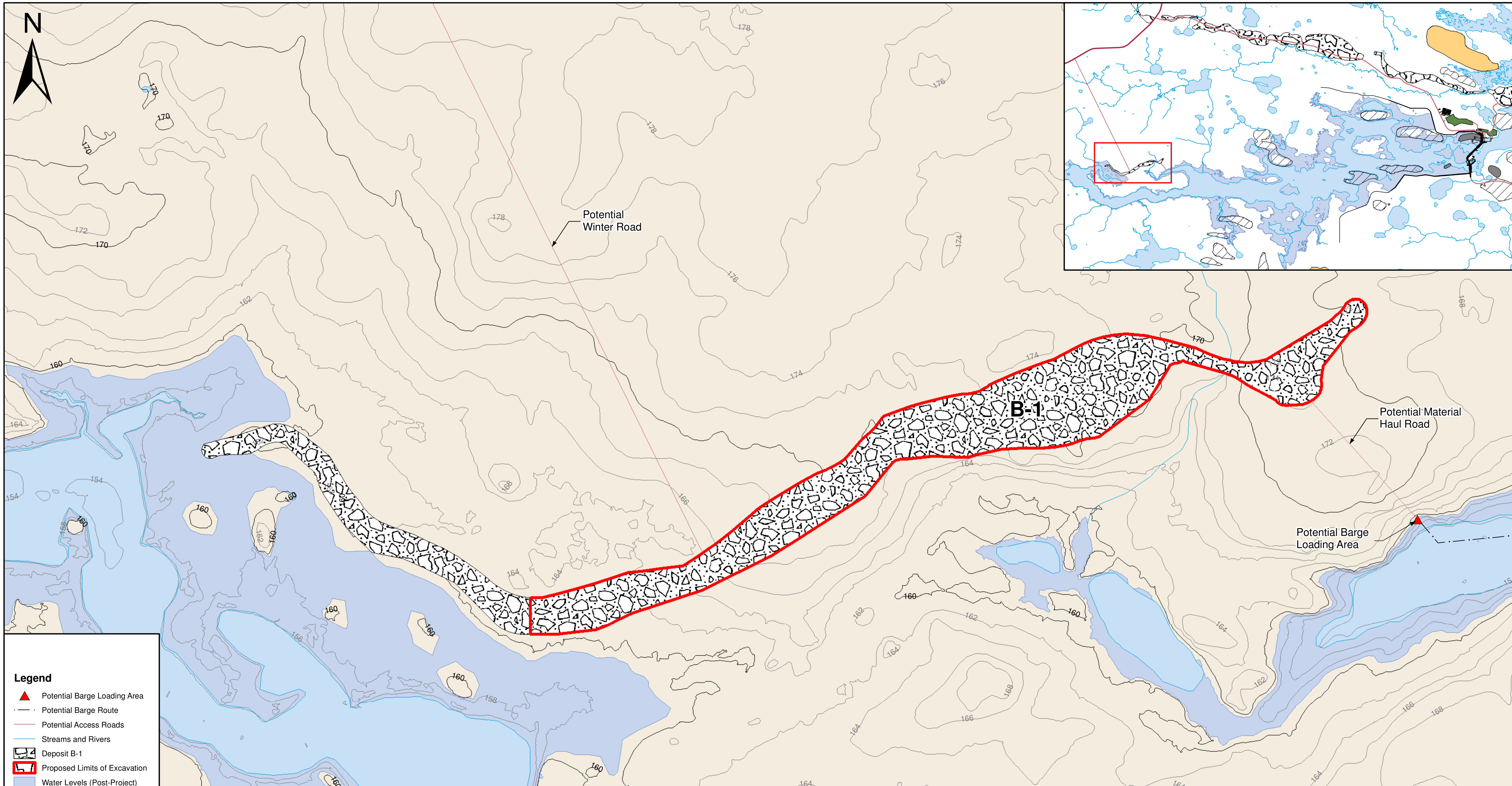
Figure 4

Figure 2

Created By: KGS ACRES

File Location: P:\P\10008\16\shared\deliver\GR4\GN_9_8\GN_9_8_11\rev_1\CAD\GIS

Date Created: May 17, 2011



KEEYASK Hydropower Limited Partnership

0 500 1,000 Meters
0 1,500 3,000 Feet

Projection: Universal Transverse Mercator (UTM) Zone 15N, North American Datum 1983 (NAD 83)

Data Sources:
1. 1. Post-project and pre-project shorelines provided by Manitoba Hydro, 2010
2. Lakes, rivers, roads and toponyms provided by Geogratis, 2007.
3. Deposits provided by KGS Acres, 2010.
4. Potential barge loading area, potential barge route and potential access roads provided by KGS Acres, 2009

FOR GENERAL REFERENCE ONLY

STAGE IV STUDIES AXIS GR-4 PROPOSED LIMITS OF EXCAVATION FOR DEPOSIT B-1 (OPTION 2) - PART 1

Figure 3

Figure 3

Created By: KGS ACRES

File Location: P:\P\10008\16\shared\deliver\GR4\GN_9_8\GN_9_8_11\rev_1\CAD\GIS

Date Created: May 09, 2011

Appendix

Photo 1: Typical Dump Scow Barge

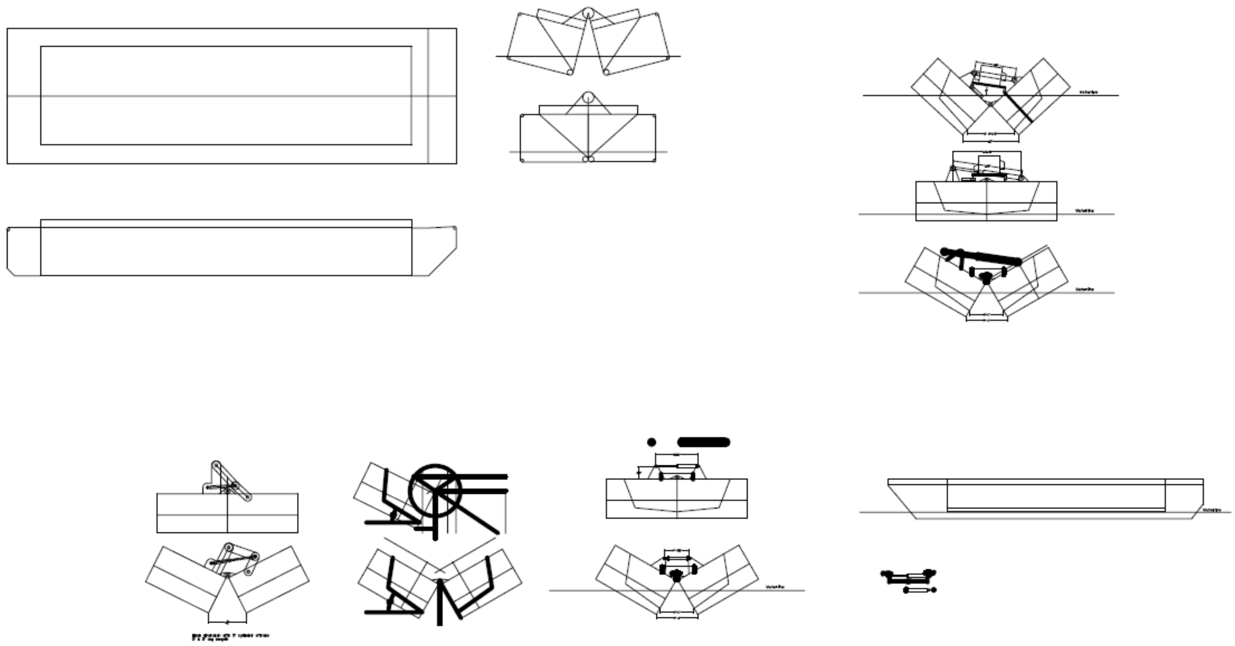


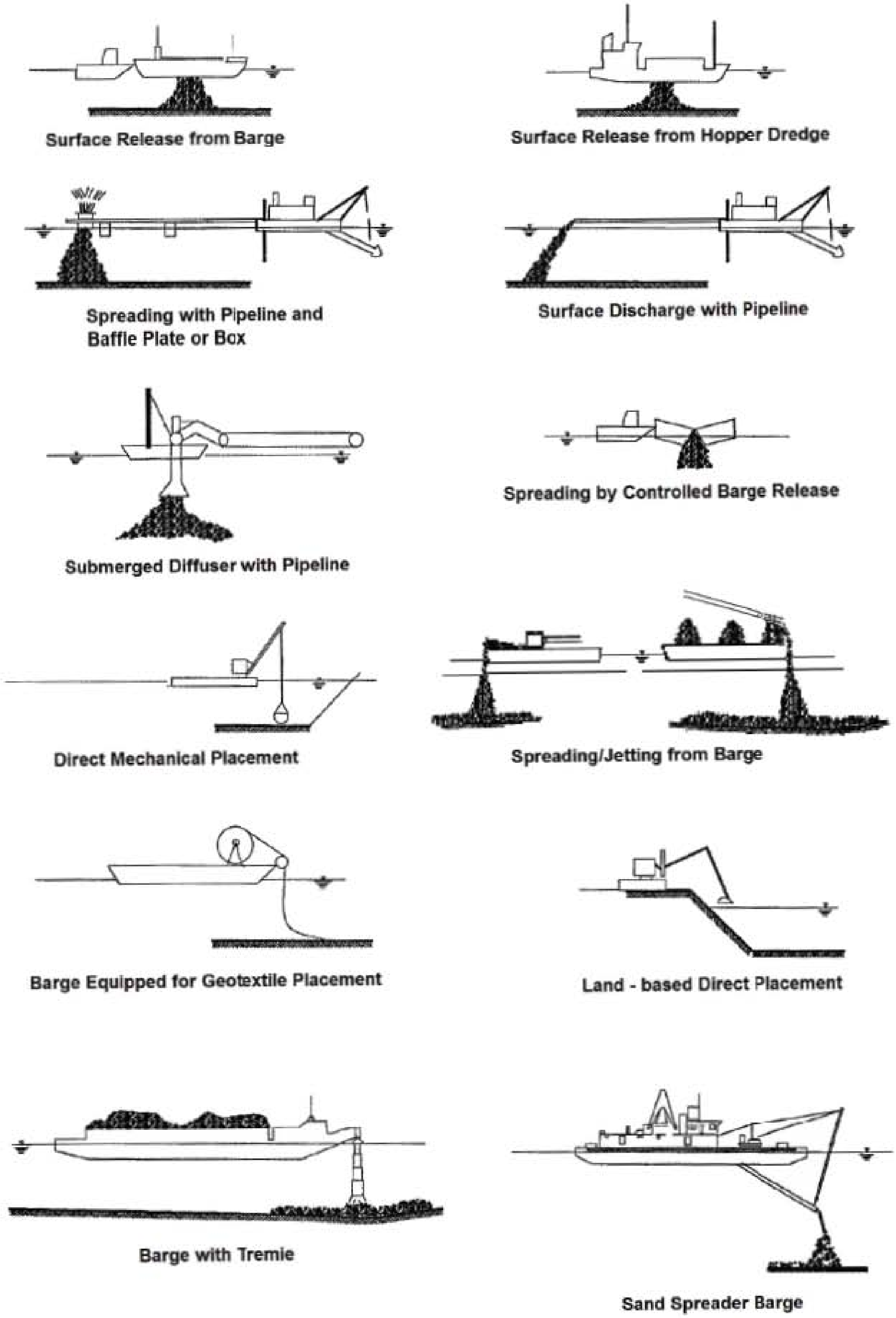
Photo 2: Transportation of Barge by Truck

Source:

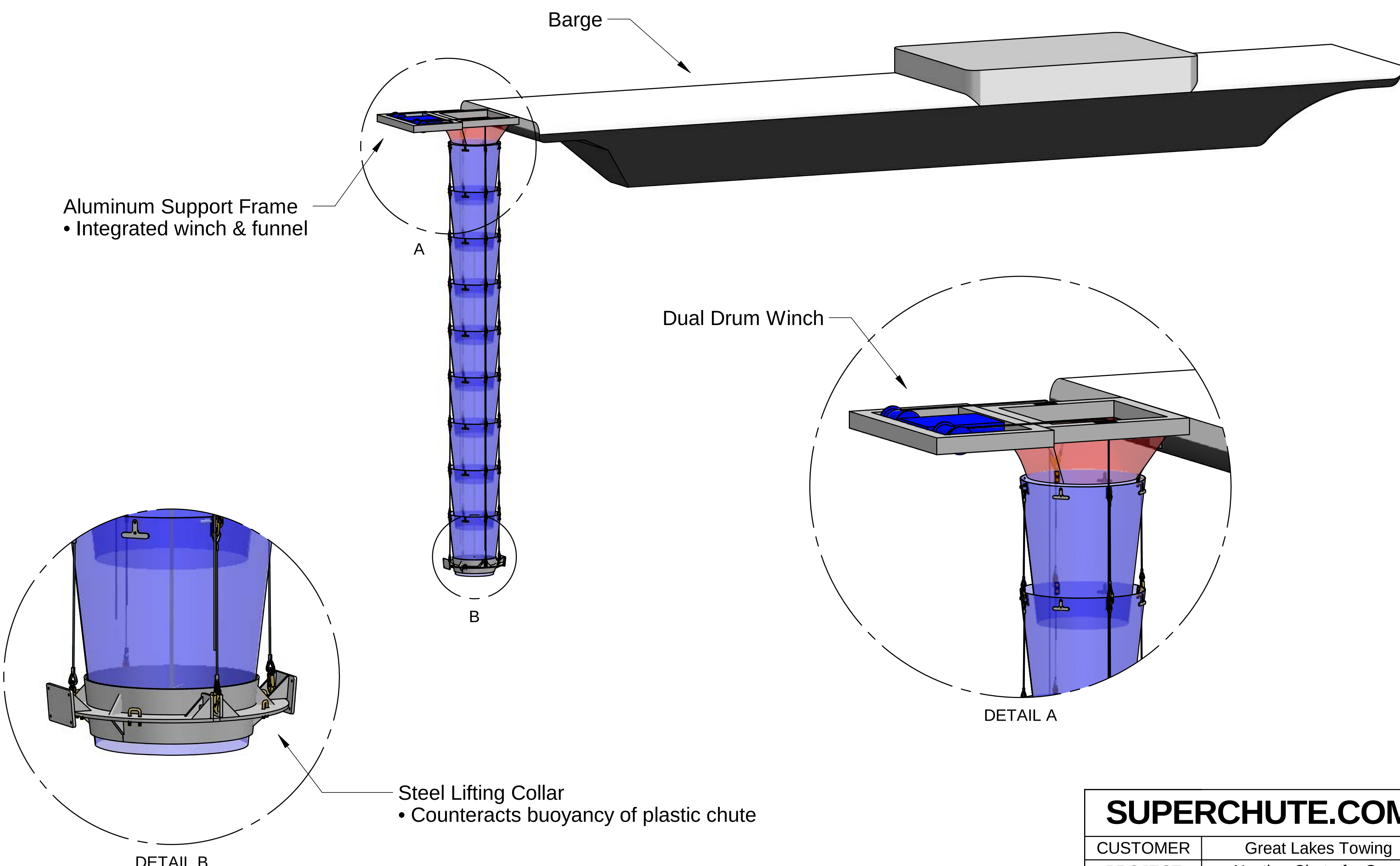
Stark, Joseph P. (Great Lakes Shipyard). Message to David Ranta (KGS ACRES) [Email]. “Truckable Workboat and Barges”. November 19, 2009 2:28 PM.

Photo 3: Typical Tugboat

Plate 1
Keeyask GS, Stage IV Studies – Axis GR-4
Sand Placement Methods



Nesting Chute for Sand



SUPERCHUTE.COM	
CUSTOMER	Great Lakes Towing
PROJECT	Nesting Chute for Sand
DRAWN BY	Lorin Spevack, B.Eng.
REV A	March 17, 2011

Photo 1
Keeyask GS, Stage IV Studies – Axis GR-4
Example of Retractable Plastic Chute with Hopper

Photo 2
Keeyask GS, Stage IV Studies – Axis GR-4
Example of Hopper on Retractable Plastic Chute

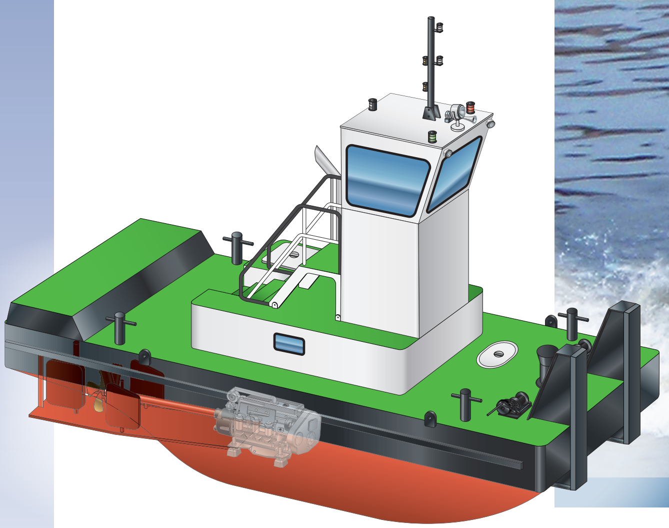
Workboats and Barges Built for a Lifetime. Not Just a Job.

If you want a quality workboat or barge that will withstand the test of time, in a tough working environment, put your trust in Great Lakes Shipyard. Whether it's a simple or a complex design, our experienced engineers, construction team and ABS welders will deliver your vessel on time – at a competitive price.

HandySize Workboatz™

Truckable workboats that pay for themselves. Again. Again. And again.

We will work closely with you to design the perfect workboat solution to match your specific application. Or, maybe one of our standard models will meet your needs. These tough workboats can be delivered in single or twin-screw models, on time anywhere you need them.



Models
251 - Single Screw Truckable Work Boat
252 - Twin Screw Truckable Work Boat

Dimensions
25'11" x 10'0" x 4'6" single screw, Up to 300HP, approximately 20,000lbs
25'6" x 13'2" x 5'6" twin screw, Up to 600HP, approximately 25,000lbs

WORKBOAT SPECIFICATIONS

Construction Deck and hull all 1/4" A36 throughout. All seams welded continuously. Bottom, sides and deck framed with 3" x 3" x 1/4" angle on 20" centers. 2 transverse frames of 4" x 5.4" channel installed 7'6" from bow and stern.

Pilot house House is 4'0" x 4'0" x 7'0" and is constructed of 3/16" plate. All windows are of high quality aluminum construction, horizontal sliding type.

Power Train Workboat engines, gears, and shafting to be selected by buyer from multiple manufacturers.

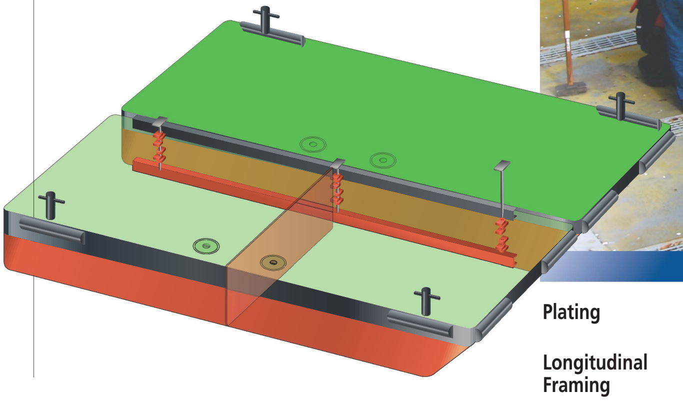
Custom Equipped Buyer to select multiple available options such as generators, electronics, custom pilot houses, coatings, deck equipment and much more.

HandySize Bargez™

Naval Work Platform

Truckable barges built for tough working environments.

We can design and build your floating equipment at a competitive price. And, we will deliver it anywhere, on time. Whether you require a deck barge, hopper barge, or a custom designed work platform, our design engineers and experienced construction crews will build the highest quality equipment you can buy, that will stand the test of time.



Standard Sizes Widths 8', 10', or 12'.

Lengths 30', 40', or 50'.

Available as single rake, double rake or box-end units. Custom sizes and designs to meet special requirements are also available.

BARGE SPECIFICATIONS

Plating 1/4" A36 plate throughout

Longitudinal Framing Bottom and sides 3" x 3" x 1/4" angle, 20" maximum spacing

Deck 3" x 4" x 1/4" angle, 20" maximum spacing. Transcers frames are 5" x 8# channels box framed with 3" x 3" x 1/4" angle verticals, frames on 5'0" centers.

Pin Connections 3 – 2-1/2" 1045 steel pins with 3/4" x 6" retainer plates, which mate to pocketed pin bosses of 1-1/2" steel plate. The pin bosses are nested inside notched 8" x 20.0# ship channel and welded continuous inside and out.

Lifting Eyes 4 balanced lifting lugs or D-rings per barge, welded continuous and integral to the frames and pinning system.

High-quality marine fabrication, delivered on time, at a competitive price.

Breakwall


Deck Barge

Naval Work Platform


Rail Barge

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REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.3.2.7.2 Movements Through Large Rapids; p. 6-27

TAC Public Rd 2 DFO-0033

ORIGINAL QUESTION AND PREAMBLE:

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.

FOLLOW-UP QUESTION:

Detailed reports not provided.

RESPONSE:

Results of lake sturgeon movement studies reported in the EIS are discussed in data reports 01-14; 02-19; 03-08; 04-05. These reports are provided on the enclosed CD "Technical Reports Referenced in TAC and Public Review, Round 2." The Aquatic Effects Monitoring Plan (AEMP) describes additional fish movement studies that are being undertaken prior to construction (studies initiated in 2011). A preliminary version of the AEMP was informally provided to DFO and MCWS in fall 2012 for review and consideration; a draft of the AEMP will be formally submitted to regulators during the second quarter of 2013.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.4.2.2.2. Habitat; p. 6-37

TAC Public Rd 2 DFO-0043

ORIGINAL PREAMBLE AND QUESTION:

"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.

FOLLOW-UP QUESTION:

WUA, in practice, is the combination of suitabilities.

RESPONSE:

The original response to TAC Public Rd 1 DFO-0043 was discussed and at a technical review meeting on February 14, 2013, among KHLP, CEAA, DFO and MCWS.

It was clarified that in referring to the combination of "suitabilities” that DFO was referring to the product of the suitability values for each of the parameters considered in the HSI (i.e., depth, velocity, and substrate). This method of calculation was used in the HSI analysis.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.4.2.3.1 Habitat; p. 6-40

TAC Public Rd 2 DFO-0044

ORIGINAL PREAMBLE AND QUESTION:

"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.

FOLLOW-UP QUESTION:

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).

RESPONSE:

The Partnership recognizes that DFO and the Partnership are continuing to discuss the approach to determination of the HADD. The Partnership confirms that methods/analysis for delineation of the HADD will be commensurate with the proposed compensation.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.4.2.3.1 Habitat; p. 6-41

TAC Public Rd 2 DFO-0045

ORIGINAL PREAMBLE AND QUESTION:

"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.

FOLLOW-UP QUESTION:

Experimental spawning habitat has been developed at Pointe du Bois generating station. Please provide the results.

RESPONSE:

The proposed spawning shoal at Keeyask was designed based on characteristics of successful structures. Constructed spawning shoals that have been reported in the primary literature include two locations in Quebec, one below the Des Prairie GS (Dumont et al. 2011) and the other in the St. Lawrence River (Johnson et al. 2006) and one in the Detroit River (Roseman et al. 2011). All three are reported to have been successful at improving Lake Sturgeon spawning success.

The results of Manitoba Hydro's tests of constructed spawning shoals at the Pointe du Bois Generating Station on the Winnipeg River are summarized below. It should be noted that the shoals at Pointe due Bois are not a test of the proposed design for the Keeyask Generating Station because the velocity, depth and substrate conditions in the tailraces of the two generating stations are very different. The tests of the constructed shoals at Pointe du Bois were designed to provide an understanding of factors that attract sturgeon to spawn on specific micro-habitats. However, as discussed in the conclusion of this response, some of the information obtained from these tests has been applied to improve the design of the Keeyask spawning shoal.

<u>Pointe du Bois Generating Station Lake Sturgeon Spawning Shoals</u>

Lake Sturgeon spawning shoals were constructed at four areas below the Pointe du Bois Generating Station, one in 2009 and three in 2010 (Murray and MacDonell 2010, 2012; North/South Consultants Inc., 2011). The intent was to test shoals in various locations to obtain a better understanding the factors influencing selection of spawning locations by Lake Sturgeon.

The Pointe du Bois Generating Station is a 100-year-old facility, spanning 150 m of the Winnipeg River with 16 turbine units and a spillway over a natural rock shelf with 97 spillway/sluiceway bays. Due to the age of the station, turbines are often off for maintenance and therefore operation cannot be predicted in advance. In 2009, an area downstream of Unit 16 was selected to test construction of a spawning shoal because velocities and depths were within the known ranges used by sturgeon but the existing substrate lacked flow diversity and the interstitial spaces needed for egg incubation.

Three additional shoals were constructed in 2010 based on the results of the previous year's monitoring program. The locations selected for construction were spread out across the face of the generating station to test a variety of flow conditions. The location below Unit 13 was adjacent to Unit 12 where there was some evidence of spawning in 2007 and 2008. The location below Unit 5 was in proximity to units 2-4 where there was evidence of spawning from 2007 to 2009. The location below Unit 1 was selected because it was immediately downstream of the highest water velocities recorded in the vicinity of the Pointe du Bois powerhouse (~1.8-2.6 m/s).

Shoals were constructed by lowering boulders and cobble from a barge and divers then positioned the material on the bottom according to predetermined specifications. The shoals were constructed of coarse cobbles with four large boulders 1-1.5 m in diameter placed in a v-formation at the upstream end. The shoals were expected to provide the necessary cover, turbulence and flow diversity for spawning, and interstitial spaces for egg incubation.

Shoals have been monitored via two methods each subsequent spring to determine if: (i) adult sturgeon are orienting to the shoals; and and (ii) spawning is occurring on or near the shoals. A Dual-frequency Identification Sonar (DIDSON) acoustic camera (manufactured by Sound Metrics Corporation, WA) was used during the peak spawning period each spring to observe the abundance and behaviour of fish on the constructed shoals. Egg collection mats were deployed throughout the tailrace and spillway areas with some specifically targeting the experimental shoals to determine where egg deposition was occurring.

The Unit 16 spawning shoal was the only shoal present during the 2009 spring spawning season. Very few Lake Sturgeon were observed on or near the shoal and no eggs were collected in its vicinity. Monitoring in 2010, 2011 and 2012 also showed no Lake Sturgeon utilization of the Unit 16 shoal. However, it should be noted that in 2012 the entire west side of the Pointe du Bois GS from Unit 11 on to Unit 16 was not in operation; therefore, Lake Sturgeon were not expected to spawn in the vicinity as they do not spawn in the absence of direct flow.

The Unit 13 spawning shoal has been subject to unit outages and has not had direct flow across it during the spawning season since construction. As may be expected, no Lake Sturgeon spawning has been detected on the shoal to 2012.

Monitoring of the spawning shoal constructed below Unit 5 was hampered in 2010 and 2011 due to difficulties associated with operating the DIDSON camera in the turbulent flow and accurately placing egg mats. However, egg mats located within 10 m of the shoal in both years had the highest frequency of egg captures of any of the shoals. In total, 1285 eggs were collected in 2010 and 1863 eggs were collected in 2011, 600 of which were on egg mats within 5 m of the shoal. In 2012 Unit 5 was not in operation, which allowed the monitoring crews to more safely access the Unit 5 spawning shoal. The DIDSON camera recorded large congregations of adult Lake Sturgeon both on and adjacent to the spawning shoal with the greatest numbers being observed downstream of units 4 and 5. Up to 50 individuals were observed congregating in the area at a time and multiple instances of small groups forming around larger individuals, presumably females, were observed. Potential spawning behavior was noted among these groups, including smaller Lake Sturgeon holding until a larger sturgeon arrived, which was then followed by tails being thrashed against the larger individuals for several seconds. A total of six egg mats were located on the Unit 5 shoal in 2012 resulting in 88 eggs collected with an additional 222 eggs collected within 5 m and 827 within 10 m of the shoal.

Monitoring at the Unit 1 spawning shoal was limited throughout the monitoring period due to its location along the edge of the highest velocity areas within the tailrace. The shoal was also placed slightly further away from the dam than the other shoals due to a larger channel present immediately below the station at Unit 1 to accommodate the larger turbine at this location. No egg mats were located directly on the shoal in either 2010 or 2011, and only one was located on the shoal in 2012, which resulted in no eggs. Despite this, egg mats located within 10 m of the shoal each year have indicated that spawning is occurring in close proximity to the shoal. In 2010, 1128 eggs were collected from 37 egg mat stations, in 2011, 112 eggs were collected from 16 stations, and in 2012 35 eggs were collected from 13 stations. No evidence of Lake Sturgeon spawning was observed using the DIDSON camera on the Unit 1 shoal from 2010 to 2012; however, Lake Sturgeon were observed in both 2010 and 2011 lined up on and near the spawning shoal prior to the peak spawning period. When peak spawning occurred, the Lake Sturgeon appeared to vacate the area below Unit 1 and move further into the tailrace area as increases in Lake Sturgeon numbers were noted at several other locations in the tailrace at this time. In 2012 this movement was not observed; however, this may be due to monitoring commencing closer to the peak spawning time when the Lake Sturgeon may have already moved further into the tailrace area.

In summary, the egg mat and DIDSON monitoring data suggests that successful spawning occurred on and near the Unit 5 spawning shoal from 2010 to 2012. The egg mat data also suggests that some spawning likely occurred near the Unit 1 shoal. There is no evidence that either the Unit 13 or Unit 16 spawning shoals have had any success to date. The lack of flow due to unit outages has undoubtedly affected the success of these areas for attracting spawning Lake Sturgeon.

Conclusion

Overall, the data suggest that constructed shoals should be built close to the origin of flow and near maximum available water velocities, but still within the sustainable swimming speeds for Lake Sturgeon. The shoals also need to provide flow diversity and nearby staging areas that allow sturgeon to congregate before moving into optimal habitats for egg deposition. These features have been incorporated into the design of the spawning structure proposed for downstream of the Keeyask generating station.

Data reports listed below are provided on the enclosed CD entitled “Technical Reports Referenced in TAC and Public Review, Round 2.”

REFERENCES

Murray, L., and D.S. MacDonell. 2010. Lake Sturgeon Spawning Habitat Enhancement Project. A report prepared for Manitoba Hydro by North/South Consultants Inc. #5900.01 09-01. 11 pp.

North/South Consultants Inc. 2011. Construction of Shoals to Enhance Lake Sturgeon Spawning Habitat in the Winnipeg River at Pointe du Bois: 2010 Monitoring Program. A report prepared for Manitoba Hydro by North/South Consultants Inc. #5900 10-01. 33 pp.

Murray, L., and D. MacDonell. 2012. Construction of Shoals to Enhance Lake Sturgeon Spawning Habitat in the Winnipeg River at Pointe du Bois: 2011 Monitoring Program. A report prepared for Manitoba Hydro by North/South Consultants Inc. #5914 11-05. 24 pp.

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Roseman, E.F., B. Manny, J. Boase, M. Child, G. Kennedy, J. Craig, K. Soper, and R. Drouin. 2011. Lake sturgeon response to a spawning reef constructed in the Detroit River. Journal of Applied Ichthyology 27 (Suppl. 2): 66-76.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.4.2.3.1 Habitat; p. 6-41

TAC Public Rd 2 DFO-0047

ORIGINAL PREAMBLE AND QUESTION:

"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?

FOLLOW-UP QUESTION:

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.

RESPONSE:

In response to the original question, the Partnership noted, “Based on the sedimentation analysis, there will be no long-term change in substrate composition of the YOY habitat downstream of Gull Rapids. Monitoring will determine whether this prediction is correct.”

At the technical review meeting among KHLP, CEAA, DFO and MCWS on February 15, 2013, the Partnership provided clarification as to the basis for concluding that the sand habitat downstream of the generating station at the entrance to Stephens Lake would not be lost. Key points included:

- A map showing the post-Project minus existing environment velocities demonstrates virtually no change in velocity in the area of sand habitat in Stephens Lake downstream of the generating station. Since the pre and post Project changes in hydraulic conditions for a given rate of flow are expected to be minimal in the area of the sand habitat, the change in deposition regime is also expected to be minimal in the area of the sand habitat.

- Similar to existing conditions, silts are expected to deposit in this area during lower flow conditions and are expected to remobilize and wash away downstream during higher flows. There would be insufficient time for the silts to consolidate thus allowing the silts to remobilize.

- There may be slight shifts in the boundary of the sand area in Stephens Lake as flows change, which is also expected under existing conditions.
- Mitigation measures during construction are designed to minimize the addition of sediment to the river.
- During operation, when the station is operating in a peaking mode, there will be high flows during the day and lower flows at night. Potential silt accumulation that would occur during the night is expected to be washed away during day.

During discussion at the February 15, 2013, technical review meeting, DFO asked that the proponent consider adaptive management measures in the case of unanticipated loss of the sand habitat. The creation of YOY habitat through the placement of sand, as has been described for the reservoir in the response to TAC Public Rd 2 DFO-0026, could be conducted in Stephens Lake. If the results of monitoring indicate that the sand habitat downstream of Gull Rapids is lost as a result of the Project, more sand could be put into Stephens Lake in an area with suitable velocities to provide habitat for YOY sturgeon. While this contingency plan is in place, the proponent expects that this measure will not be required.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.4.2.3.2 Movements; p. 6-43

TAC Public Rd 2 DFO-0048

ORIGINAL PREAMBLE AND QUESTION:

"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.

FOLLOW-UP QUESTION:

A detailed report on options and/or an agreement on post-project fish movement/behaviour have not been provided and/or concluded.

RESPONSE:

Note that the following response to DFO-0048 is the same as the response to DFO-0049.

As clarified at a technical review meeting among KHLP, CEAA, DFO and MCWS on February 14, 2013, all relevant information on fish passage options has been provided to DFO and MCWS in the report entitled "Keeyask Fish Passage Identification of Design Concepts Report, November 29th, 2012"; this report is provided on the enclosed CD entitled "Technical Reports Referenced in TAC and Public Review, Round 2."

The scope of this report is based on a number of meetings and discussions that have occurred with DFO and MCWS since March 2012. Part of these discussions involved an understanding not to select a single fish passage option until the results of post-construction monitoring on fish movements and behavior in the immediate vicinity of the Project are available.

Like the fish passage report, a preliminary Aquatic Effects Monitoring Plan (AEMP) was provided to DFO and MCWS in fall 2012. This document provides a description of planned fish movement studies, including studies that are being initiated during the pre-construction phase of monitoring. A draft of the AEMP will be submitted to regulators in the second quarter of 2013.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.4.2.3.2 Movements; p. 6-43

TAC Public Rd 2 DFO-0049

ORIGINAL PREAMBLE AND QUESTION:

"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 rationale for the selection of this option is required. What criteria will be used to determine if and when trap and truck should be implemented?

FOLLOW-UP QUESTION:

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.

RESPONSE:

Note that the following response to DFO-0049 is the same as the response for DFO-0048.

As clarified at a technical review meeting among KHLP, CEAA, DFO and MCWS on February 14, 2013, all relevant information on fish passage options has been provided to DFO and MCWS in the report entitled “Keeyask Fish Passage Identification of Design Concepts Report, November 29th, 2012“; this report is provided on the enclosed CD entitled “Technical Reports Referenced in TAC and Public Review, Round 2.”

The scope of this report is based on a number of meetings and discussions that have occurred with DFO and MCWS since March 2012. Part of these discussions involved an understanding not to select a single fish passage option until the results of post-construction monitoring on fish movements and behavior in the immediate vicinity of the Project are available. Like the fish passage report, a preliminary Aquatic Effects Monitoring Plan (AEMP) was provided to DFO and MCWS in fall 2012. This document provides a description of planned fish movement studies, including studies that are being initiated during the pre-construction phase of monitoring. A draft of the AEMP will be submitted to regulators in the second quarter of 2013.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 6.4.2.3.2 Movements; p. 6-43

TAC Public Rd 2 DFO-0051

ORIGINAL PREAMBLE AND QUESTION:

"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. Please provide detailed reports which describe this.

FOLLOW-UP QUESTION:

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?

RESPONSE:

By way clarification, the November 2012 response to TAC Public Rd 1 DFO-0051 did not indicate that turbine mortality rates for large Northern Pike could not be used as a surrogate for Lake Sturgeon. Rather, it was stated that mortality rates for large Northern Pike measured at the Kelsey Generating Station cannot be directly used to predict mortality rates at the proposed Keeyask Generating Station as the turbines planned for the Keeyask Generating Station incorporate several features that would reduce mortality. The text from TAC Public Rd 1 DFO-051 (November 2012) stated:

> *"While using a species of similar size is one approach in the absence of other data, the turbines at Kelsey are not similar to the turbines that will be used at Keeyask; the Keeyask turbines incorporate several features that are expected to improve survival over the kind tested at Kelsey (see DFO -0102). Therefore, using results from the turbine mortality studies at the Kelsey Generation Station to directly predict lake sturgeon mortality through turbines at Keeyask, is not advisable."*

The response to TAC Public Rd 1 DFO-0051 then provided a table summarizing mortality rates for a variety of turbines for larger fish (including the Northern Pike at the Kelsey Generating Station). As noted in this response, *"Survival estimates range from 65-93% and tend to be greater for turbines with a larger diameter and slower rotational speed. As described in DFO-0102, the turbines at the Keeyask Generating Station will have a larger diameter (8.35 m) and slower rotational speed (75 rpm) than any of the* *generating stations listed in the attached table; these properties are expected to reduce the incidence of fish injury and mortality."*

DFO requested any information available for turbine effects to White Sturgeon. To our knowledge no field study on White Sturgeon (or any other sturgeon species) turbine mortality exist for a full-sized hydroelectric generating station (literature search and discussions with specialists in the field of turbine effects on January 28, 2013). The only data that address the topic come from a recent Alden Research Laboratories laboratory study using a pilot scale size Alden/Concepts NREC turbine (approximate diameter of 1 m; Amaral and Sullivan, unpublished). These authors experimentally passed several hundred juvenile (mean length of 103 mm) White Sturgeon through the turbine and compared outcomes to results from Alewife (*Alosa pseudoharengus*; 75.5 mm) and Coho Salmon (*Oncorhynchus kisutch*; 102 mm). White Sturgeon had higher "immediate" (98.3%) and "total" (97.0%) survival than Alewife and Coho Salmon (~95.5% immediate, ~93.5% total survival). Also, (non-lethal) injury rates of White Sturgeon (~7%) were lower than those of the two other species (15% and 10%, respectively).

As discussed at a technical review meeting among KHLP, DFO and MCWS on February 15, 2013, and further at a similar meeting on February 22, 2013, an analysis of the potential effect of increased mortality rates on the Lake Sturgeon population based on a population model is provided in TAC Public Rd 2 DFO-0106 (for ease of reference, this response is also copied below). Although precise measures of turbine mortality are not available for adult Lake Sturgeon, this analysis provides insight into potential effects of increased losses from the population.

DFO-0106 RESPONSE:

The initial question posed by TAC Public Rd 1 DFO-0106 requested acceptable mortality rates for turbine passage based on the fish community and population in the Keeyask study area. The proponent noted, with reference to specific sections of the AE SV, that mortality of fish during passage past the turbines and spillway would reduce the number of fish entering Stephens Lake. Given the relative size of Gull and Stephens lakes, emigration of juvenile and adult fish from Gull Lake to Stephens Lake is not thought to provide a major input to the Stephens Lake population and no material impact of turbine/spillway mortality to the fish community is expected. Construction of the Keeyask Generating Station will also reduce the drift of larval fish from Gull to Stephens lakes. The input of larval Lake Sturgeon from upstream of Gull Rapids may be the source of young Lake Sturgeon in Stephens Lake, given the extremely low numbers of spawning fish observed in the last decade; however, this reduction in larval drift is due to the presence of the reservoir and would not be affected by the turbines.

The follow-up question by DFO notes that information on acceptable mortality rates was not provided. In subsequent discussions (technical review meeting on 15 February, 2013 among KHLP, CEAA, DFO and MCWS), the Partnership noted that no literature values of "acceptable" turbine mortality rates could be located, though considerations of effects to fish were included in the turbine design at Keeyask. It was noted that, even at stations that do not use modern turbines with features to reduce effects to fish, there is no clear evidence that fish numbers are declining through a series of reservoirs (e.g., Winnipeg River system has eight generating stations; lower Nelson River has three generating stations). DFO noted that a particular concern is with a rare species such as Lake Sturgeon, where the mortality of even a few individuals is of concern. At the 15 February, 2013 meeting, it was suggested that examining the effect of increasing mortality rates on Lake Sturgeon using a population model could assist in assessing the potential effects of increased turbine mortality. This analysis was presented at a follow-up meeting on February 22, 2013 meeting and is documented below.

MORTALITY ANALYSIS USING POPULATION MODEL FOR LAKE STURGEON

It should be noted that although this assessment does not deal specifically with turbine mortality or decreased immigration, it does address the permanent loss of individual Lake Sturgeon from the population through decreased survival. The following assumptions are made:

1. The current Jolly-Seber model for the Gull Lake population is definitive for other exploited populations (i.e., Stephens Lake) (Nelson and Barth 2012); and
2. That the parameters as modeled from Program MARK (White and Burnham 1999) are normally and independently distributed.

The Burnham Jolly-Seber model estimates new entrants into the population indirectly by modeling the rate of population growth (λ) between each interval where population growth is the net effect of survival and recruitment (White and Burnham 1999) .

$$\lambda i = N_{i+1}/N_i$$

The formulations for these versions of the Jolly-Seber were developed by Burnham (1991) and Pradel (1996). The key difference between the two parameterizations is that the Pradel-λ approach is conditional upon animals being seen during the study, while the Burnham Jolly-Seber formulation is not. Therefore, the Burnham Jolly-Seber formulation also includes a parameter for the population size at the start of the experiment. This enables the estimation of the population size at each subsequent time point.

Table 1.Model output for the best model based on Akaike's Information Criterion selection in Program MARK (Akaike 1973).

Parameter	*Mean*	*SE*	*95% Confidence Interval*	
			Lower	Upper
Survival	0.84	0.04	0.75	0.90
$P_{capture}$ 2001	0.22	0.03	0.16	0.29
$P_{capture}$ 2002	0.15	0.02	0.11	0.19
$P_{capture}$ 2003	0.25	0.03	0.19	0.32
$P_{capture}$ 2004	0.13	0.02	0.10	0.18
$P_{capture}$ 2006	0.34	0.05	0.24	0.45
$P_{capture}$ 2006	0.09	0.02	0.05	0.14
$P_{capture}$ 2010	0.12	0.04	0.07	0.22
Population Growth	1.02	0.04	0.95	1.10
Population Estimate	464.80	63.99	359.39	613.21

The best model was determined using Akaike's Information Criterion (AIC) and is defined by constant survival, time varying recapture, and constant lambda (Table 1). This model was used as the basis to model the effects of decreased survival on population growth (a surrogate for permanent emigration through entrainment in this case). This was accomplished by decreasing the survival from the current level 0.84 by fixing it at sequentially lower levels 0.83, 0.82, 0.81… 0.73. The population growth estimates were tabulated for each of the decreased survival estimates from 0.84 to 0.73. The mean and standard error of the estimated population growth was used to generate a distribution assuming a normal and independent distribution. These distributions were then used to calculate percentiles for 95% confidence intervals, 50% likelihood, and medians. The results are provided in Figure 1.

The basic interpretation of these results is as follows. The population growth estimate is the ratio of successive population estimates, and therefore if it is greater than 1 the population is growing and if it is less than 1 the population is declining.

At the present level of survival (with harvest) there is about a 23% likelihood that the current population is actually in decline. If survival decreases by an additional 6% the likelihood of decline becomes approximately 75% (Figure 1). There would need to be a decrease of 11% to say with 95% confidence that the population is in decline (Figure 1). Moving the other direction if survival increases by 4% or more the Gull Lake population is growing with 95% confidence.

It should be noted that decline in this sense means only that successive population estimates are lower; there is no implication of significance statistical or otherwise. This should be considered a preliminary assessment of effects. Based on the literature minimum viable population size estimates vary between 80-1800 (Schueller and Hayes 2011) and between 413 and 2500 for adult spawning females (Velez-Espino and Koops 2008). The current estimate for Gull Lake is 465 (this particular model) which is in the range for what the Schueller and Hayes (2011) model determines as a minimum viable population size (see paper for model specifics). The best way to foster increases in population survival and ultimately growth, is to increase the survival for critical life stages which are most sensitive to elasticity (Gross et al. 2002). For Lake Sturgeon this means increasing the survival from egg to yearly; in other words, if population growth is a goal then stocking of yearlings is the fastest and most efficient way to overcome the low population levels for Lake Sturgeon.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 6B.1 Field Data Collection and Analysis; p. 6B-1

TAC Public Rd 2 DFO-0054

ORIGINAL PREAMBLE AND QUESTION:

Appendix 6B Field Data Collection and Analysis

Details on mark recapture information are lacking in terms of annual movements. Raw data used for population estimates should be made available.

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

The report is provided on the enclosed CD entitled “Technical Reports Referenced in TAC and Public Review, Round 2.”

Nelson, P.A., and C.C. Barth. 2012. Lake Sturgeon population estimates in the Keeyask Study Area: 1995-2011. Keeyask Project Environmental Studies Program Report # 11-02.

REFERENCE: Volume: Project Description Supporting Volume; Section: 3.10.2 Management Plans to be Developed; p. 3-32

TAC Public Rd 2 DFO-0055

ORIGINAL PREAMBLE AND QUESTION:

Management Plans to be Developed.

All cited management plans should be provided as part of the EIS submission.

FOLLOW-UP QUESTION:

Proponent plans still in production and not available for review.

RESPONSE:

The original response to TAC Public Rd 1 DFO-0055 noted that, while the EIS Guidelines do not require the management plans, the Partnership will provide preliminary versions of the management plans to regulators in the first quarter of 2013. Preliminary versions of the monitoring plans will be provided in the second quarter of 2013.

Preliminary drafts of the Aquatic Effects Monitoring Plan, the In-stream Construction Sediment Management Plan and the Fish Habitat Compensation Plan were provided to DFO in the fall of 2012 for their review and comment before these preliminary versions are formally filed.

REFERENCE: Volume: Response to EIS Guidelines; Section: Section: 4.3.3 Environmental Mitigation/Compensation; p. 4-14

TAC Public Rd 2 DFO-0057

ORIGINAL PREAMBLE AND QUESTION:

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.

FOLLOW-UP QUESTION:

Pre-emptive planning and design required for exemption to time restrictions.

RESPONSE:

This question is addressed in the response to TAC Public Rd 2 DFO-0086. For ease of review, this response is copied below.

DFO-0086 RESPONSE:

This response is similar to the response to TAC Public Rd 2 DFO-0057 and DFO-75.

The primary tool in reducing the environmental effects of construction is mitigation through construction methods, timing and/or locations, all of which has been integrated into project planning. The secondary tool has been compensation and follow-up, through replacement of predicted losses or harmful alterations and a commitment to monitor effectiveness of compensation measures and modify, if necessary. The question recognizes that there is uncertainty in the planning of construction activities, and unavoidable changes that can occur must be efficiently managed – ideally in a proactive manner, so that contingency options are developed and agreed to prior to the need to apply them.

In developing detailed construction schedules, considerable effort has been made to mitigate effects as much as possible by avoiding sensitive timing windows. However, it is recognized that there is potential for the need to undertake in-stream construction during restricted periods (i.e., fall/winter to protect lake whitefish and spring/early summer to protect species such as lake sturgeon/walleye/northern pike) in spawning habitat (Gull Rapids). This has the potential to introduce sediments to these areas during sensitive times. It is also recognized that adaptive management measures need to be in place to deal with this potential.

The Keeyask Generation Project In-stream Construction Sediment Management Plan (SMP) documents the adaptive management measures to be taken during construction should sediment monitoring trigger a need for them. A draft of this plan was provided to DFO in October 2012, and will be filed with regulators in the second quarter of 2013. A key tool in the plan is monitoring and communication. Section 4.0 of the SMP outlines the communication protocol for construction site staff and environmental regulators.

Once the general civil contractor is retained and throughout the construction process, construction schedules will be monitored on a regular basis and any potential changes that may encroach upon sensitive timing windows or predetermined and/or agreed to timing restrictions will be communicated to the appropriate regulatory authorities to discuss proposed changes and to confirm acceptance prior to implementation where practicable.

The SMP also describes the actions planned and potential measures to manage the release of sediments during in-stream construction activities. Considerable effort has already gone into developing in-stream construction methods to minimize impacts as much as practical. Substantial changes in construction techniques and mitigation measures to reduce sediment inputs as a result of changes to the schedule are therefore not anticipated. One caveat to this may involve innovative construction techniques that the general civil contractor may bring once they are selected

Section 4.0 of the SMP outlines the adaptive action plans for increases in suspended sediment levels above thresholds set out in the plan. Section 4.3 outlines the management plan for commissioning the spillway and powerhouse.

Section 2.4 of the SMP lists the primary mitigation measures for each of the potential sources of sediment for the anticipated in-stream construction activities. Section 2.5 lists the secondary mitigation techniques that have been established to address the uncertainty in the predictions of shoreline erosion and impacts to TSS due to in-stream construction activities. It is noted that the estimated impacts to TSS due to construction activities are conservative, which minimizes the likelihood of exceeding the thresholds set out in the SMP for TSS increases above background levels.

Appendix A of the SMP lists the various mitigation techniques that could be implemented to address potential sediment problems for the following in-stream construction activities:

- Placement of rock fill and rip rap;
- Placement of transition fill;

- Placement of impervious fill;
- Dewatering cofferdams;
- Rock excavation and removal of rock fill;
- Removal of transition and impervious fill;
- First flow through spillway;
- First flow through powerhouse; and
- Shoreline erosion upstream of cofferdams.

Figure 5 in the SMP shows the predicted concentration of TSS for each in-stream activity. It should be noted that these predicted concentrations should not increase if the activity is shifted to other times of the year. The same action plans and mitigation techniques described in the SMP and summarized in the previous response to this question would be applied to protect fish, fisheries and fish habitat. As indicated above, this includes timely communication with DFO and MCWS, applying one or more of the secondary measures described in Section 2.5 and Appendix A of the SMP, and discussing results and the need for follow up with the regulators, as described in the previous response.

REFERENCE: Volume: Response to EIS Guidelines; Section: 8.0 Monitoring & Follow-up; p. N/A

TAC Public Rd 2 DFO-0058

ORIGINAL PREAMBLE AND QUESTION:

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

FOLLOW-UP QUESTION:

See DFO-0055

RESPONSE:

The original response to TAC Public Rd DFO-0055 noted that, while the EIS Guidelines do not require the management plans, the Partnership will provide preliminary versions of the management plans to regulators in the first quarter of 2013. Preliminary versions of the monitoring plans will be provided in the second quarter of 2013.

Preliminary drafts of the Aquatic Effects Monitoring Plan, the In-stream Construction Sediment Management Plan and the Fish Habitat Compensation Plan were provided to DFO in the fall of 2012 for their review and comment before these preliminary versions are formally filed.

REFERENCE: Volume: Response to EIS Guidelines; Section: 8.0 Monitoring & Follow-up; p. N/A

TAC Public Rd 2 DFO-0059

ORIGINAL PREAMBLE AND QUESTION:

Monitoring

How will peat deposition be monitored? And assumptions in the EIS verified? (ex. Estimate only 1% of peat will be transported downstream)

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

A description of proposed monitoring and follow-up activities, as required by the Guidelines, is provided in Chapter 8 of the Response to the EIS Guidelines. Table 8-1 indicates that monitoring will be performed with respect to: water and ice regimes; shoreline erosion and peat breakdown; sedimentation; and greenhouse gas. Table 8-2 indicates that physical environment monitoring will be performed in support of other monitoring programs for the following: woody debris; dissolved oxygen and water temperature; and total dissolved gas.

The preliminary Physical Environment Monitoring Plan will contain additional details. As noted in original response to TAC Public Rd 1 CEAA-0011, while the Guidelines do not require the Physical Environment Monitoring Plan, the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: Appendix 7C Field Maps (Open Water) and 7D Monitoring Locations (Winter); p. N/A

TAC Public Rd 2 DFO-0060

ORIGINAL PREAMBLE AND QUESTION:

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.

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

A description of proposed monitoring and follow-up activities, as required by the Guidelines, is provided in Chapter 8 of the Response to the EIS Guidelines. Table 8-1 indicates that monitoring will be performed with respect to: water and ice regimes; shoreline erosion and peat breakdown; sedimentation; and greenhouse gas. Table 8-2 indicates that physical environment monitoring will be performed in support of other monitoring programs for the following: woody debris; dissolved oxygen and water temperature; and total dissolved gas.

The preliminary Physical Environment Monitoring Plan will contain additional details. As noted in original response to TAC Public Rd 1 CEAA-0011, while the Guidelines do not require the Physical Environment Monitoring Plan, the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: Appendix 7B Detailed Description of the Environmental Setting for Mineral Sedimentation; p. N/A

TAC Public Rd 2 DFO-0061

ORIGINAL PREAMBLE AND QUESTION:

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?

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

A description of proposed monitoring and follow-up activities, as required by the Guidelines, is provided in Chapter 8 of the Response to the EIS Guidelines. Table 8-1 indicates that monitoring will be performed with respect to: water and ice regimes; shoreline erosion and peat breakdown; sedimentation; and greenhouse gas. Table 8-2 indicates that physical environment monitoring will be performed in support of other monitoring programs for the following: woody debris; dissolved oxygen and water temperature; and total dissolved gas.

The preliminary Physical Environment Monitoring Plan will contain additional details. As noted in original response to TAC Public Rd 1 CEAA-0011, while the Guidelines do not require the Physical Environment Monitoring Plan, the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: 7.2.5.1 Mineral Sedimentation and Appendix 7A.2.2 Stephens Lake Sedimentation During Construction Model; p. 7-11 and 7A-25

TAC Public Rd 2 DFO-0065

ORIGINAL PREAMBLE AND QUESTION:

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?

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

A description of proposed monitoring and follow-up activities, as required by the Guidelines, is provided in Chapter 8 of the Response to the EIS Guidelines. Table 8-1 indicates that monitoring will be performed with respect to: water and ice regimes; shoreline erosion and peat breakdown; sedimentation; and greenhouse gas. Table 8-2 indicates that physical environment monitoring will be performed in support of other monitoring programs for the following: woody debris; dissolved oxygen and water temperature; and total dissolved gas.

The preliminary Physical Environment Monitoring Plan will contain additional details. As noted in original response to TAC Public Rd 1 CEAA-0011, while the Guidelines do not require the Physical Environment Monitoring Plan, the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

REFERENCE: Volume: Response to EIS Guidelines; Section: 8.0 Monitoring & Follow-up; p. N/A

TAC Public Rd 2 DFO-0066

ORIGINAL PREAMBLE AND QUESTION:

Sedimentation – TSS

Suggest that discrete data loggers (TSS) are better than continuous collection data loggers. Discrete loggers should be verified using point sampling to verify data loggers especially in the first year. The use of discrete data loggers for existing environment and post project post project environment. The continuous data loggers are too variable and subject to error due to bio-fouling.

FOLLOW-UP QUESTION:

Would the proponent please extract those parts of any sediment management plan (their answer states that it will be provide in the first quarter of 2013) that provides additional information pertinent to the question? Proponent plan still in production and not available for review.

RESPONSE:

The Partnership provided a preliminary draft of the Sediment Management Plan for In-stream Construction to regulators on October 17, 2012 and a revised draft will be provided during the 2nd quarter of 2013.

With respect to the issue of biofouling, Section 3.4.1 of the draft SMP states:

> *"The YSI turbidity loggers that will be used for the Project are equipped with self-cleaning sensors with integrated wipers to remove biofouling and maintain high data accuracy. However, the loggers will be visited every two weeks to maintain and clean the monitoring system (and free them of algae and vegetation debris) to avoid erratic spikes in data."*

At the request of the regulators, Section 3.4.1 will be revised to include additional maintenance and manual sampling to determine if there are problems with loggers such as biofouling.

Further, with regards to discrete sampling, Section 3.4 of the draft SMP states:

> *"In-situ turbidity logger data will be supplemented through manual monitoring of turbidity using handheld loggers and collecting water samples. At each*

> *location, water samples will also be collected for analysis of TSS to confirm or improve the Tu-TSS relationship. Manual sampling will consist of the collection of turbidity measurements and water sampling at near surface, mid-depth, and near-bottom depths in the water column along a river cross section in the vicinity of the turbidity loggers (SMP sites)."*

The draft SMP thus provides for maintenance and data checks to ensure that the in-situ loggers are accurately measuring and reporting in-stream turbidity.

REFERENCE: Volume: Response to EIS Guidelines; Section: 8.0 Monitoring & Follow-up; p. N/A

TAC Public Rd 2 DFO-0067

ORIGINAL PREAMBLE AND QUESTION:

Sedimentation – TSS

EIS proposes to have the first post project monitoring station 1km downstream of the construction site in the "fully mixed zone". The location of the first monitoring station downstream of Keeyask construction site is too far away to assess impacts and effectiveness of mitigation. It is recommended that a turbidity/TSS monitoring site be placed at the construction site.

FOLLOW-UP QUESTION:

Would the proponent please extract those parts of any sediment management plan (their answer states that it will be provide in the first quarter of 2013) that provides additional information pertinent to the question? Proponent plan still in production and not available for review.

RESPONSE:

The Partnership provided a preliminary draft of the Sediment Management Plan for In-stream Construction to regulators on October 17, 2012 and a revised draft will be provided during the 2nd quarter of 2013.

Section 3.3 of the SMP notes the following with respect to the location of the first downstream monitoring site (SMP-2):

> *"SMP-2 will be located approximately 1.5 km downstream of all in-stream sediment sources from the Project and is a near-field location within the mixing zone prior to fully mixed conditions. Loggers will be installed at two sites (SMP-2L and SMP-2R) located evenly across the channel width to monitor for sediment plumes that may be located closer to one shoreline. [Drafting Note: Based on discussions with regulators, the text describing the location of SMP-2 will be revised to more accurately indicate that the distance between in-stream construction activity and SMP-2 depends upon the structure being constructed. The following revision is proposed: 'SMP-2 will be located approximately 1.5 km downstream of the powerhouse structure, or approximately 0.7 km to 3 km downstream of sediment sources from the Project due to in-stream construction depending on which structure is being constructed. This is a near-field location*

> *within the mixing zone prior to fully mixed conditions. Loggers will be installed at two sites (SMP-2L and SMP-2R) located evenly across the channel width to monitor for sediment plumes that may be located closer to one shoreline.']"*

As noted in the response to the original information request, based on the experience of field staff who conducted baseline monitoring studies, moving the SMP-2 monitoring site further upstream is problematic due to potentially high water velocities, possible presence of large standing waves and large waves that can develop due to high winds on Stephens Lake. While it may be possible to navigate further upstream, conditions can present unacceptable safety hazards for equipment and people that need to work in a stationary position for lengthy periods of time.

REFERENCE: Volume: Response to EIS Guidelines; Section: 8.0 Monitoring & Follow-Up; p. N/A

TAC Public Rd 2 DFO-0068

ORIGINAL PREAMBLE AND QUESTION:

Sedimentation – TSS

Can the Proponent provide an analysis showing that its monitoring will have a high degree of confidence, or the power, to detect TSS above the action threshold?

FOLLOW-UP QUESTION:

Would the proponent please re-state their answer to the question rather than refer to another response? Proponent plan still in production and not available for review.

RESPONSE:

The original response to DFO-0068 pointed the reader to the response for DFO-0084, which reads:

> *"The In-stream Construction Sediment Management Plan (SMP) will utilize continuous, real time turbidity measurements as a proxy for total suspended solids (TSS) concentrations, which cannot be measured in real time. Turbidity readings will be converted to TSS concentration based on a regression equation relating turbidity to TSS. The regression equation was developed based on turbidity and TSS data collected in the study area between Clark Lake and the entrance to Stephens Lake in open water periods from 2007-2009. The regional regression equation was tested on an independent data set not used to develop the relationship and calculated average TSS was within 1.2 mg/L of measured average TSS. The SMP will be used to measure change in TSS between a monitoring site upstream and a site downstream. It will, therefore, be an assessment of relative difference between the TSS at monitoring sites upstream and downstream of the in-stream construction activities. Note that the relationship will be revised if necessary during construction. Revision would be based on TSS test results for water quality samples obtained during routine maintenance of the SMP loggers. Maintenance will occur approximately every 2 weeks. Overall, it is expected that the regional turbidity-TSS relationship will be able to reliably indicate if TSS increases due to construction exceed SMP action thresholds.*

> *CEAA-0011 provides information about the Partnership's environmental protection program, including the In-stream Construction Sediment Management Plan. The Partnership intends to provide a preliminary version of that report to regulators in the first quarter of 2013."*

The Partnership provided a preliminary draft of the Sediment Management Plan for In-stream Construction (SMP) to regulators on October 17, 2012 and a revised draft is being filed with regulators at the end of April 2013.

The response to TAC Public Rd 2 DFO-0078 provides additional discussion pertaining to the detection of TSS increases above action thresholds specified in the SMP. The response to that question is copied below.

DFO-0078 RESPONSE:

The proponent understands that the question is asking for a statistical characterization of the historic total suspended solids (TSS) data to be used as a background criterion against which observed TSS during construction would be compared. Based on this understanding, the question suggests that TSS levels obtained from monitoring for the Sediment Management Plan for In-Stream Construction (SMP) would be compared with baseline data to determine if TSS increases due to in-stream construction exceed action levels specified in the SMP. The proponent notes that the SMP uses real time monitoring of ambient in-stream conditions to measure changes in TSS in the river as in-stream work is taking place. The monitoring is not based upon the measurement of changes relative to conditions observed in the pre-Project baseline studies.

Implementation of the SMP will involve identifying changes in TSS between a reference monitoring site (SMP-1) just upstream of in-stream construction, a site (SMP-2) in the mixing zone just downstream of in-stream construction, and a site (SMP-3) in a fully mixed zone further downstream. The monitoring is designed to detect if an in-stream construction activity causes an increase in ambient TSS between SMP-1 and SMP-2 that exceeds specified action levels. The SMP (Sec. 4) describes actions to be taken to reduce the effects of in-stream construction if it causes TSS to increase by 200 mg/L or more in a 15-minute averaging period or 25 mg/L or more in four consecutive 15-minute averaging periods. The action levels at SMP-2 are set so that increases due to construction can be addressed in sufficient time to take action to attempt to maintain the 24-hour average increases at SMP-3 (relative to SMP-1) below 25 mg/L as well as the areas downstream of SMP-3.

The SMP will use automated probes to continuously measure ambient turbidity levels in the river in real time as in-stream work is occurring, and will continuously transmit the data to an on-site environmental office. Turbidity values will be converted to TSS concentrations using a linear regression relationship between turbidity and TSS based on data collected during baseline environmental monitoring studies. During in-stream work, samples of water at the monitoring stations will be periodically collected and analyzed for TSS to confirm or adjust the turbidity-TSS relationship, as required. It is anticipated that each probe will measure and transmit several dozen turbidity measurements every hour and hundreds of measurements per day.

Because the SMP is based on real-time monitoring, the background TSS at SMP-1 and the TSS at SMP-2 and SMP-3 will vary in real-time as ambient conditions change. Thus the calculation of TSS changes and determination of whether or not action levels are exceeded is based on ambient conditions while in-stream work is taking place. The SMP monitoring does not measure TSS changes relative to fixed background criteria (e.g., seasonal or annual) based on data from pre-Project environmental studies.

Although the SMP is based on ambient TSS conditions rather than a comparison with pre-Project monitoring data, an a-priori power analysis was performed to determine the number of samples required to detect changes equal to the specified action levels (i.e., the effect size to be detected). The analysis assumes that the standard deviation of TSS from the baseline data used to develop the turbidity-TSS relationship (see Figure 1 below) are representative of the standard deviations of the SMP measurements over the 15-minute and 1-hour averaging periods at SMP-2 and the 24-hour averaging period at SMP-3. The power analysis employed methods described in the documents Metal Mining Technical Guidance for Environmental Effects Monitoring (Environment Canada, 2012, Ottawa) and Guidance Document on Collection and Preparation of Sediments for Physicochemical Characterization and Biological Testing (Environment Canada, Environmental Protection Series Report, EPS 1/RM/29, 1994, Ottawa). Assuming 5% significance coefficients ($\alpha = \beta = 0.05$; power=1- β=95%), approximately four measurements are required to detect effect sizes of 25 mg/L and 200 mg/L, while approximately 40 samples would be required for an effect size of 5 mg/L. Based on the anticipated sampling frequency, a sufficient number of measurements will be obtained to detect TSS changes equal to the action levels over the specified averaging periods with a high level of power.

As noted above, TSS at the SMP monitoring sites will be calculated using a linear regression relationship between turbidity and TSS (SMP, Sec. 3.2). In order for calculated TSS differences between the upstream reference site (SMP-1) and the downstream sites (SMP-2, SMP-3) to be considered statistically significant, the sum of the confidence intervals for the TSS estimates at SMP-1 and SMP-2 or SMP-3 must be less than the effect sizes to be measured. Based on the 95th percentile confidence intervals for the linear regression (Figure 1) and assuming typical TSS concentrations of about 5 mg/L to 30 mg/L at the reference site (SMP-1), TSS differences of 200 mg/L between SMP-1 and SMP-2 or 25 mg/L between SMP-1 and SMP-2 or SMP-3 would be considered statistically significant.

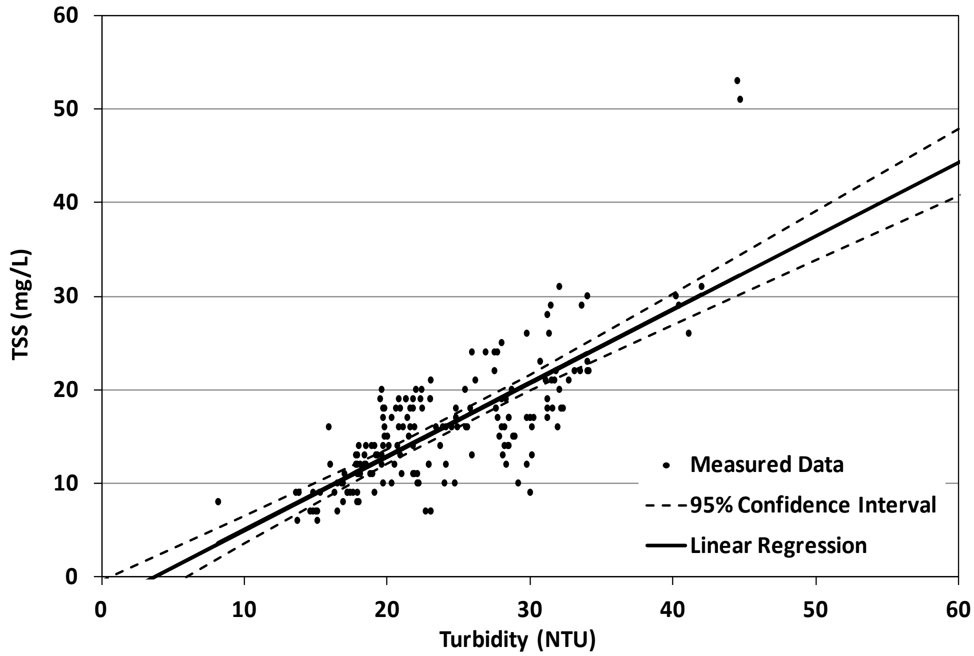


Figure 1: TSS-Turbidity Relationship for the Nelson River at Keeyask

Two locations will be monitored at each SMP monitoring site, with the locations spaced evenly across the river (i.e., left and right side of channel). Pre-project TSS monitoring across transects at sampling sites K-S-06 (location of SMP-1) and K-S-07 (just upstream of SMP-2) found that TSS typically had a small variation across the river width. From eight sets of TSS transect data at K-S-06 (five sample points across the river) from 2005-2007, the average standard deviation of TSS across the river was 1.4 mg/L. At K-S-07 the average standard deviation from seven sets of transect data was 1.2 mg/L. On average, the standard deviations were less than 10% of the average TSS concentration across the transects. Due to the low variation in TSS across the river width, sampling at two locations at each SMP site is expected to reasonably represent average conditions at each site for the purposes of the SMP monitoring program. Because site SMP-2 is in the mixing zone downstream of in-stream construction, the variability in TSS across the river will likely be greater than observed in the existing environment if in-stream work causes an increase in TSS at SMP-2. Based on discussions with regulators (March 25, 2013; Canadian Environmental Assessment Agency; Fisheries and Oceans; Environment Canada), methods are being developed to confirm that site SMP-2 is able to detect changes in TSS concentrations due to in-stream construction activities. A potential method that is being explored is to augment the ambient measurements from the in-situ data loggers with additional manual readings. Potential revisions to the proposed SMP monitoring will be the subject of additional discussions with the regulators.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 2.5.2.2.5 Total Suspended Solids/Turbidity; p. 2-66 to 2-68

TAC Public Rd 2 DFO-0069

ORIGINAL PREAMBLE AND QUESTION:

Sedimentation – TSS

The Proponent appears not to discuss effects of TSS specific to the individual VEC fish species. The Proponent's impact assessment appears to rely primarily on lethal TSS concentration effects. Can the Proponent provide an expanded discussion of sub-lethal or chronic impact risk assessment for anticipated TSS changes?

FOLLOW-UP QUESTION:

Would the proponent please extract those parts of the EIS referred to and re-phrase them in a manner that provides a more detailed answer to the question?

RESPONSE:

The following text has been taken from the AESV in response to this request. To highlight the sections of text that provide a more detailed answer to the question as per the reviewer's request, some sections have been bolded:

> "Changes in TSS may affect primary producers (through changes in the characteristics and penetration of light), fish, and invertebrates. Fish and invertebrates may be directly or indirectly affected by changes in TSS. Direct effects to fish and invertebrates are generally considered in terms of increases in TSS and may include behavioural alterations, reduced growth or condition, physiological stress, and in the most severe instances mortality. Indirect effects include changes in the food web (*e.g.*, reductions in primary production due to reduced water clarity, reduced abundance of benthic invertebrates due to increased TSS and/or sedimentation causing reductions in the abundance of fish diet items), which are considered in Section 4. Potential effects of changes in TSS on water clarity are discussed in the "Water Clarity" section below.
>
> Increases in TSS within the order of tens to hundreds of mg/L are generally associated with sub-lethal effects to fish such as behavioural alterations, reduced growth or condition, and physiological stress (*e.g.*, DFO 2000). Acute toxicities are generally reported for concentrations ranging from the hundreds to hundreds of thousands of mg/L (DFO 2000; Robertson *et al.* 2006). **Therefore,**

the predicted maximum increases in organic TSS in the flooded, lentic areas of the reservoir in Year 1 could result in sub-lethal effects to fish, but estimated concentrations are well below acute toxicity levels. Sub-lethal effects may include alterations in behaviour, such as feeding and predation, growth, and condition.

Increases in organic TSS are predicted to decrease rapidly after initial full impoundment. As described in the PE SV, Section 7, maximum concentrations of organic TSS in the peat transport zones are predicted to range from less than 1 to 4 mg/L in Year 2 and by less than 1 to 1 mg/L by Year 5. Therefore, it is expected that increases in TSS would remain within the chronic Manitoba PAL water quality objective and CCME PAL guideline (5 mg/L change from background) by Year 2 of operation.

There are few studies that have reported the acute or chronic toxicity of TSS to fish species represented in the Aquatic Environment Study Area. Lawrence and Scherer (1974) reported that the 96-hour lethal concentration (LC50) for lake whitefish (*Coregonus clupeaformis*) was 16,613 mg/L. McKinnon and Hnytka (1988) found relatively high increases in TSS (instantaneous maximum = 3,524 mg/L and 1-day average concentration = 524 mg/L) caused by winter pipeline construction did not have any direct effect (no downstream emigration and no mortalities) on the fish community of Hodgson Creek, NT. This study is notable as four of the fish species found in Hodgson Creek - northern pike (*Esox lucius*), lake chub (*Couesius plumbeus*), longnose sucker (*Catostomus catostomus*), and burbot (*Lota lota*) - are also found in the Aquatic Environment Study Area.

As indicated in Section 5.4.2, northern pike may spawn in the nearshore areas of the Keeyask reservoir, even during the initial years of operation. Therefore, early life history stages of northern pike may be exposed to elevated concentrations of TSS for several years post-impoundment. No information on the acute or chronic toxicity of TSS to northern pike eggs or larvae could be located. Information for early life history stages of other species represented in the Aquatic Environment Study Area is also sparse and many of the available studies do not differentiate between the effects of suspended particulate materials and sediment deposition. However, the available scientific literature indicates a potential for reduced hatching success in salmonids exposed to elevated TSS concentrations on the order of two months or more, at concentrations ranging from 6.6–157 mg/L (Table 2-17). In addition, northern pike eggs would also be exposed to the combined effects of sedimentation and elevated TSS. Therefore, should northern pike spawn in the

> **nearshore, flooded areas of the reservoir in the initial years of operation where organic TSS will be notably elevated, reduced hatching success of northern pike eggs is likely.**
>
> Conversely, elevated TSS and turbidity can provide benefits to some fish species and life history stages. Reduced water clarity can reduce the risk of predation by visual predators, which in turn can enhance survival of juvenile fish (*e.g.*, Sweka and Hartman 2003) and may favour planktivorous fish (De Robertis *et al.* 2003). Alternatively, increased TSS and turbidity may be detrimental to visual predators (De Robertis *et al.* 2003). Therefore, nearshore areas may favour some fish species and/or life history stages during the initial years of operation when TSS is notably elevated."

As per discussions during a February 15, 2013, technical review meeting among KHLP, DFO and MCWS, a model was used to analyze the severity of effects of predicted low level increases in TSS and is discussed in the response to TAC Public Rd 2 DFO-0085. The effects of sediment deposition on fish habitat are discussed in TAC Public Rd 2 DFO-0073. For convenience, they are copied below.

DFO-0073 RESPONSE:

A description of proposed monitoring and follow-up activities, as required by the Guidelines, is provided in Chapter 8 of the Response to the EIS Guidelines. The preliminary Physical Environment Monitoring Plan will contain additional details. As noted in original response to TAC Public Rd 1 CEAA-0011, while the Guidelines do not require the Physical Environment Monitoring Plan, the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

With respect to information on thresholds for risk of sediment deposition, the aquatic habitat assessment assumed that all areas in the reservoir where fine sediment (i.e., silt) would be deposited over sand, gravel, or coarser substrate would, in the long term, be classified as fine sediment. Therefore, there is no "threshold for risk of sediment deposition"; it was recognized that even very small amounts of annual deposition (e.g., 0.5 cm) over several decades would result in the accumulation of substantial amounts of silt.

Effects of sediment (i.e., silt) deposition on aquatic habitat in the reservoir in the long term (i.e., after 30 years of impoundment) were assessed based on whether or not sediment (i.e., silt) deposition was predicted(AESV Appendix 3B). The presence or absence of sediment deposition was used to determine whether a qualitative change of substrate type would occur. Studies of Stephens Lake showed that sites of net deposition, despite varying sediment deposition rates, develop a homogenous silt surficial layer within 30 years of impoundment. This silt layer completely covered the underlying materials, although the depth of silt varied depending on location (see AESV Appendix 3B, photo 3B-2). Therefore, the rate of sediment deposition is not the primary determinant of substrate availability three decades after impoundment. Instead, the approach to determine the long term type of substrate was to identify the boundaries of sites of net deposition (for methods see AE SV Appendix 3B).

Downstream of the generating station, the change in flow distribution in the river within 3 km of the generating station will create shoreline areas with minimal flow, where silt is expected to accumulate over rock in the long term (see AE SV Map 3-34). Further downriver (including at the area of the present day sand lens in Stephens Lake), the velocity post-Project will essentially be the same as today so deposited materials would be redistributed over time as they are today (PE SV Section 7.4.2.2.4). Superimposition of like materials would not change the habitat type (e.g., sand deposited on the sand lens will not change the habitat classification). It should be noted that sediment deposition and re- suspension occurs in the existing environment and will continue post-Project.

The description of sedimentation downstream of the generating station in PE SV Section 7.4.2.2.4 is reproduced below:

> *"7.4.2.2.4 Mineral Sediment Deposition*
>
> *As discussed earlier in this section, some of the relatively coarser sediment material would be deposited in the Keeyask reservoir. Absence of relatively coarser material in the flow in the Post-project environment downstream of Keeyask GS would likely cause reduction in deposition currently observed in the existing environment in Stephens Lake, particularly near the upstream end of the lake. It is expected that Project impact on the mineral deposition would be limited to a reach of approximately 10 km to 12 km from the Gull Rapids.*
>
> *As discussed earlier in Section 7.4.1.1, a young of year habitat area for Lake Sturgeon currently exists downstream of Gull Rapids near a sand and gravel/sand bed. Two-dimensional modelling was used to assess the spatial distribution of the potential for suspended material to be deposited near the young of yeah habitat area under Post-project conditions. The modelling results indicate that it is unlikely that silt will deposit near the young of year habitat under on-peak flows, such as all seven powerhouse units.*
>
> *Under off-peak flows, such as one Powerhouse unit, there is a higher potential for silt deposition near the young of year habitat area compared to the existing environment. However, due to the relatively short duration of off-peak flows, the amount of silt deposition would be very small and will likely be eroded from the*

> *bed under on-peak flows. Map 7.4-26 illustrates the potential for sediment deposition as well as the existing substrate immediately downstream of the Keeyask GS under all seven Powerhouse units operating at best gate flow. A detailed description of this two-dimensional modeling can be found in Appendix 7A."*

Maps and tables providing the areas of different types of substrate in the existing and post-Project environment are provided in the response to TAC Public Rd 2 DFO-0014. These are reproduced below for your convenience.

DFO-0085 RESPONSE:

Predicted effects of altered total suspended solids (TSS) on aquatic life in the Keeyask area are discussed in the Aquatic Environment Supporting Volume (AE SV) and provided in the response to TAC Public Rd 2 DFO-0069. As noted in the AE SV, we are not aware of studies assessing the effect of low level increases of TSS on fish species in the Keeyask area. In the absence of data, the reviewer requested hypothetical modeling for evaluation of sub-lethal risks; we are only aware of the Severity of Ill Effects model (SEV) developed by Newcombe and Jensen (1996) for this purpose. However, as discussed below, this model is not able to accurately predict the effects of low levels of TSS on aquatic life. Nevertheless, the requested assessment was conducted and is provided below.

Manitoba water quality objectives (MWS 2011) and CCME water quality guidelines (1999; updated to 2013) for TSS for the protection of aquatic life are based on the British Columbia Ministry of the Environment Lands and Parks (BCMELP) guidelines, derived using the severity of ill effects model originally developed by Newcombe and Jensen (1996) and modified by Caux et al. (1997). Specifically, the BCMELP criteria were developed based on the Newcombe and Jensen (1996) SEV Model for adult salmonids (Model 2); this group was determined to elicit the largest response to a given increase in TSS concentration over a set duration (i.e., this group was identified as the most sensitive based on the various models developed). Consideration of exposure duration as well as background conditions in the natural environment were incorporated into the criteria.

As noted in the AESV, the MWQSOG/CCME PAL guideline is predicted to be exceeded in the fully mixed Lower Nelson River during three events:

- Exposure Scenario 1: maximum predicted increase of 7 mg/L for approximately six days during placement of the Spillway and Central Dam cofferdams in July 2015;
- Exposure Scenario 2: an increase in TSS of 7 mg/L for a period of one month during removal of the Tailrace Summer Level Cofferdam in September 2019; and

- Exposure Scenario 3: maximum predicted increase of 15 mg/L for 10 days (actual concentrations are predicted to peak at 15 mg/L above background and to decrease over this 10 day period) during placement of the South Dam Rock Fill Groin in early September 2017.

TSS currently ranges between 5 and 30 mg/L, averaging 14 mg/L in the Gull Lake area. Using the existing background TSS conditions, effects of increases in TSS identified above on fish were examined using the Newcombe and Jensen (1996), as modified by Caux et al. (1997), Severity of Ill Effects Model for adult salmonids (Model 2) and non-salmonid freshwater fish (Model 6).

<u>Effects on Salmonids</u>

SEV scores for adult salmonids are presented in Figure 1 and Table 1 for a range of scenarios applicable to the Keeyask Project. As the SEV models generate scores based on absolute TSS concentrations rather than effects related to relative increases, it is relevant to compare scores for the exposure scenarios indicated above to the scores based on background TSS concentrations. All three exposure scenarios cause an increase in the SEV scores of one or less, and most scenarios cause changes of less than 0.5. The largest change in SEV score is predicted to occur under the minimum TSS background condition (5 mg/L); as discussed below, the SEV model is limited in its ability to predict effects of low concentrations of TSS, in particular due to the lack of empirical data on which the model was constructed. All SEV scores are below the paralethal/lethal threshold (SEV = 9) and the highest SEV rankings are unchanged from background conditions under each of the three scenarios (Table 1).

<u>Effects on Adult Freshwater Non-Salmonids</u>

SEV scores for adult freshwater non-salmonids are presented in Figure 2 and Table 2 for a range of scenarios applicable to the Keeyask Project. SEV scores for exposure scenarios 1 and 3 are below the paralethal/lethal threshold (SEV = 9; Table 2). However, SEV scores exceed 9 for scenario 2 – including purely background TSS conditions (i.e., without Project-induced increases in TSS). It is also worth noting that this model predicts that concentrations of TSS of 5 mg/L (the minimum measured in the Keeyask area), would prove lethal to non-salmonids in less than one month (Figure 3). A concentration of near zero (0.1 mg/L) is predicted to be lethal by the SEV model in less than 2 months. This observation illustrates one of the key limitations of this model; the model is not reliable for predicting effects associated with low concentrations of TSS. For the purposes of assessing potential effects associated with the Keeyask Project, it is the relative difference between the SEV scores with and without the Project that is of relevance. All three exposure scenarios cause an increase in the SEV scores of less than 0.5, and most scenarios cause changes of less than 0.2.

Context

For additional context, Figure 3 presents SEV model results for a TSS concentration of 120 mg/L – the mean concentration measured in the Assiniboine River at Headingley. Mean concentrations in the Red River are of a similar magnitude (132 mg/L at the south gate of the floodway and 124 mg/L at Selkirk). These averages are an order of magnitude higher than the predicted TSS concentrations for the Keeyask Project. Over a 365 day period, this average concentration (120 mg/L) is predicted to cause SEV rankings of 10 and 12 for salmonids and non-salmonids, respectively. These scores fall into the categories of “0-20% mortality, increased predation, moderate to severe habitat degradation” and “40-60% mortality”, respectively.

Conclusions

The SEV model developed by Newcombe and Jensen (1996) has been criticized for its inherent inability to accurately predict effects of low levels of TSS to aquatic life, as these conditions were not captured within the database used to construct the model (e.g., Birtwell et al. 2003, Anderson et al. 1996). Therefore, the utility or accuracy of the model to predict risks to fish associated with small increases in TSS is limited.

Notwithstanding the limitations of the SEV model to predict effects of small increases in TSS on fish, the SEV model indicated that scores increased by less than one, and generally less than 0.2, for the various potential exposure scenarios examined.

Collectively, these results indicate effects of the predicted increases in TSS on salmonids and non-salmonids during construction would be small and potentially indistinguishable from existing conditions.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: 4.0 Surface Water and Ice Regimes; p. N/A

TAC Public Rd 2 DFO-0070

ORIGINAL PREAMBLE AND QUESTION:

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?

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

A description of proposed monitoring and follow-up activities, as required by the Guidelines, is provided in Chapter 8 of the Response to the EIS Guidelines. Table 8-1 indicates that monitoring will be performed with respect to: water and ice regimes; shoreline erosion and peat breakdown; sedimentation; and greenhouse gas. Table 8-2 indicates that physical environment monitoring will be performed in support of other monitoring programs for the following: woody debris; dissolved oxygen and water temperature; and total dissolved gas.

The preliminary Physical Environment Monitoring Plan will contain additional details. As noted in original response to TAC Public Rd 1 CEAA-0011, while the Guidelines do not require the Physical Environment Monitoring Plan, the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: Appendix 7A, Model Descriptions; p. N/A

TAC Public Rd 2 DFO-0071

ORIGINAL PREAMBLE AND QUESTION:

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?

FOLLOW-UP QUESTION:

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?

RESPONSE:

AE SV 2.5.2.3.5 notes: "Changes in organic carbon are not expected to be detectable along the mainstem of the river upstream of Stephens Lake and concentrations flowing into Stephens Lake would therefore remain similar to existing conditions." The effects of increased organic TSS concentrations on fish and fish habitat in Stephens Lake were not assessed based on the assessment results that there would be no measureable increases in organic TSS leaving the reservoir. The following text is quoted for the assessment of effects to mineral and organic totals suspended sediments in the reservoir (AE SV Section 2.5.2.2.5). Sections pertaining directly to organic TSS in the main flow of the river are provided in **bold**.

> "Total suspended sediments (TSS) and turbidity may be affected by erosion of mineral or organic shoreline materials in combination with changes in the hydraulic regime that affect sediment transport and deposition. TSS is defined here as organic and inorganic materials that are retained on a standard-sized filter (typically 1.5 micrometre [μm]). Predicted changes in TSS during the Project operation period were generated separately for mineral bank erosion (i.e., "mineral TSS") and disintegration of peat (i.e., "organic TSS") and are presented in the PE SV, Section 7. The following is intended to provide a brief summary and integration of these predictions and describe how these changes may affect water quality and aquatic biota. Mineral TSS predictions were based on the modeling reaches and shallow/deep areas indicated in Map 2 23 and organic TSS predictions were based on peat transport zones as shown in Map 2

22. Peat transport zones 4, 5 and 7–13 (note: there is no zone 6) are composed entirely of lentic habitat, whereas peat transport zones 1–3 contain both lotic and lentic habitat and are deeper (i.e., composed largely of deep habitat; see Section 3.4.2.2). Additionally, peat transport zones 7–13 are composed mostly of flooded habitat (see Section 3.4.2.2).

Predicted effects of the Project on the spatial distribution of mineral and organic TSS are somewhat different. **In general, effects of the Project on organic TSS are expected to dominate in the flooded, nearshore areas**, whereas Project-related effects on mineral TSS would be greatest in the lotic areas (i.e., mainstem). The following provides a brief overview of these predicted changes. Detailed descriptions of the effects of the Project on organic and mineral TSS are presented in the PE SV, Section 7.

As described in the PE SV, Section 7, mineral TSS is generally predicted to decrease in the shallow and deep areas of the reservoir with the Project, most notably under high flows (95th percentile), although small increases (1–4 mg/L) are projected in some areas under some conditions (i.e., different flows and years of operation). The predicted changes in mineral TSS are also relatively similar for the peaking and base loaded modes of operation for median and high flows. In general, the predicted decreases (or occasionally increases) in mineral TSS are less than 5 mg/L under low, median, and high flows in shallow and deep areas for Years 1 and 5 of operation. The major exception would occur under high flows in reaches 7 and 8 (at the downstream end of present day Gull Lake) and most notably reach 9 (the reservoir immediately upstream of the GS) where larger decreases (up to 14 mg/L below background) are expected.

Mineral TSS would generally remain within the chronic Manitoba PAL water quality objective and the CCME PAL guideline (a change of less than or equal to 5 mg/L relative to background, where background TSS is less than or equal to 25 mg/L). The exceptions would occur in the immediate reservoir (reach 9) and reach 8 (the area north of Caribou Island) under high flow conditions, where decreases may be larger than the Manitoba water quality objective.

As described in the PE SV, Section 7, although mineral TSS will generally decline in nearshore areas with the Project despite the increase in mineral erosion, episodic resuspension of fine particles may occur in the nearshore areas of the reservoir. Therefore, mineral TSS concentrations may increase during high wind events. Similarly, episodic erosion events may lead to episodic increases in TSS in the nearshore environment.

Changes in mineral TSS beyond Year 5 were predicted for the base loaded operation scenario under median flows only. Mineral TSS is predicted to be similar to or lower in Years 15 and 30 relative to earlier years of operation, under median flows in the deeper, lotic areas of reaches 6–9 (i.e., the central areas of the reservoir). An equilibrium is predicted by Year 15. . Although modelling was not conducted for time frames beyond Year 5 for the high flow condition, it is expected that the magnitude of changes in TSS for the long-term period would be similar to those predicted for Year 5 (i.e., up to 7-14 mg/L near the GS). Therefore, the long-term effects on TSS (i.e., decreases) are expected to be within the Manitoba PAL objective more than 50% of the time and the largest decreases predicted under high flow conditions would occur in the areas closest to the GS.

As described in the PE SV, Section 7, effects of the Project on organic TSS are not expected to be detectable along the main flow of the reservoir (i.e., in lotic areas) but would result in detectable increases in the nearshore, lentic areas in Year 1 of operation. In addition, organic TSS concentrations will vary across the lentic areas of the reservoir due to spatial differences regarding peatland disintegration, local bathymetry, and the water regime. For the purposes of quantitatively estimating the effects of this pathway on TSS, it was assumed that organic TSS would be introduced evenly over the open water period and that some accumulation (i.e., TSS carry-over between days) may occur due to longer water residence times in the peat transport zones (i.e., “average conditions”). Modeling predictions presented in the PE SV (Section 7.4.2.3) represent the maximum predicted increases within each peat transport zone. Overall, the largest increases in organic TSS would occur in peat transport zones 7–9, 11, and 12, which are flooded, lentic areas.

Organic TSS is predicted to remain within the Manitoba PAL water quality objective and the CCME PAL guideline (i.e., less than or equal to 5 mg/L change from background) in peat transport zones 1–3 (which includes the main flow of the Nelson River, including the area immediately adjacent to the GS) in Year 1 where flow and mixing are high. In addition, the predicted decreases in mineral TSS in these areas will likely offset any increases in organic TSS.

The upper range of predicted increases are above the Manitoba PAL water quality objective and the CCME PAL guideline in peat transport zones 7–9, 11, and 12 (i.e., maximum predicted increases ranging from 8–21 mg/L). Increases in organic TSS are predicted to remain within the Manitoba PAL objective and

> the CCME PAL guideline in the remaining areas (peat transport zones 5, 10, and 13).
>
> As peatland disintegration will decrease notably after Year 1, increases in organic TSS will decline rapidly thereafter. The increases in organic TSS in the flooded bay areas would also be somewhat offset by predicted decreases in mineral TSS. However, changes in mineral TSS are expected to be small (less than 5 mg/L) relative to the predicted increases in organic TSS for some of the flooded backbays.
>
> It should be noted that like mineral erosion, peatland disintegration will likely not occur in a uniform manner over the open water season and statistically rare events could occur in which larger quantities of peat and mineral soils are introduced to the water column. In addition, resuspension of settled organic TSS may also occur in the nearshore areas during high wind events. On that basis, it is likely that short-term increases in organic TSS that exceed the short-term Manitoba PAL water quality objective and CCME PAL guideline (increase of 25 mg/L above background) may periodically occur in some nearshore areas."

At a February 15, 2013, technical review meeting among KHLP, DFO and MCWS, DFO indicated concerns with the effect of sediment deposition on substrate type. The response to TAC Public Rd 2 DFO-0014 provides substrate conditions in the existing and post-Project environments. For ease of reference, this response is copied below.

DFO-0014 RESPONSE:

TAC Public Rd 1 DFO-0014 initially requested information on how deposition would change fish habitats and how this impact would be monitored. The response provided a brief summary of changes as a result of deposition and referenced sections of the Aquatic Environment Supporting Volume where effects of this habitat change to specific fish life history functions were assessed. In this second round of Requests for Additional Information, the reviewer indicates, "HADD description and accounting as requested not provided".

During discussions at a technical review meeting on February 14, 2013, among KHLP, CEAA, DFO and MCWS, the following points were raised:

1. An accounting of the area of pre and post-Project habitat types (which include substrate) are provided in Appendix 3D of the Aquatic Environment Supporting Volume. This appendix includes the flooded terrestrial area as part of the post-Project habitat.

2. A description of substrate changes from pre- to post-Project is provided in Aquatic Environment Supporting Volume, Section 3.4.2.2.3. This description includes the flooded terrestrial areas. Text, tables and figures illustrating changes in substrate considering the pre-existing aquatic habitat alone are provided below.

3. Existing aquatic habitat in the Nelson River mainstem is not expected to be subject to peat deposition. The Physical Environment Supporting Volume (PE SV) Section 7.4.2.3, p. 7-35 provides an analysis of peat sedimentation upstream of the Project. Specifically with respect to organic sediment deposition:

   7.4.2.3.3 Organic Sediment Deposition

   "Most of the organic sediments are expected to accumulate in the bays of origin. The process of accumulation will occur in different forms including deposition. The magnitude of deposition will vary depending upon the amount of peat disintegrated from the shoreline and the location of the bays. The bays in the south side of the reservoir will experience relatively higher deposition than those in the north side. It is unlikely that there will be any appreciable amount of organic sediment deposition in the mainstem waterbody outside of the bays."

Aquatic Substrate Change due to the Keeyask Project

Substrate changes expected due to the Keeyask Project at Year 30 are described in Section 3.4.2.2.3 of the Aquatic Environment Supporting Volume, relative to the Existing Environment 95^{th} percentile inflow. This text complements that section and extends the detail of description of substrate changes.

Changes to specific substrate types for the full reservoir area are summarized, and then again for each of three areas within the hydraulic zone of influence where the type and magnitude of change are notably different: 1) the riverine reach extending to Gull Lake; 2) lower reservoir (including Gull Lake), and 3) the area downstream of Gull Rapids/Principal Structures. The effect of classification precision on change is also considered given that prediction (post-project) is seldom possible at the same resolution as observation (existing environment).

Changes of substrate by area are provided for the entire reservoir (Table 1), the riverine reaches (Table 2), and the lower reservoir (including Gull Lake) (Table 3). Changes downstream of the proposed Keeyask dam are discussed in the text.

Overview of Substrate Changes in the Keeyask Reservoir at Year 30 Post-impoundment

At Year 30, the Keeyask reservoir will have an estimated area of 9973.5 ha, or an increase of about 5149.4 relative to the existing environment at a 95th percentile inflow (PE SV). Silt is expected to be present as a relatively homogenous surficial layer over an area of about 5280.5 ha, or 52.9% of the total reservoir (Table 1) (Aquatic Environment Supporting Volume, Map 3.34 and Map 1, attached). Most of the silt deposition upstream of the dam will be found in Reaches 6 – 9a. Silt deposition is expected to change slightly more than half of the substrate area present today (54.3% of 2806.7 ha). Silt deposits will notably decrease the area of several existing substrate types that are relatively abundant in the existing environment: 1) silt/clay located mainly in large lentic bays (92.5% of 1268 ha); 2) gravel/cobble/boulder found in the main channel of present day Gull Lake (75.4% of 1198.9 ha); 3) cobble/boulder, which forms most of the main channel except at Gull Lake and Gull Rapids (18.3% of 1782.3 ha); and 4) cobble/boulder/bedrock, which composes most of the substrate in Gull Rapids (74.6% of 256.5 ha).

Other lotic bottom types, such as gravel and sand, are relatively fine and are not common in the existing environment. When present, sand and gravel was found most often in shallow water along the banks, except for a few relatively large patches that are found in the lower reservoir where water velocities in lotic areas are relatively slow. Sand habitat totals about 177.5 ha with the single largest patch of about 1 ha in size found in the secondary channel north of Caribou Island (Map 1). After the Project, 78.4% of the total area of sand will change to silt over time. Most of the homogenous gravel substrate (92.6% of 19.6 ha) will be covered by silt after the Project, including the largest known patch (0.16 ha) located on the bottom of the main channel in deep water of Gull Lake.

In the flooded area, about 442.4 ha of fine organic deposition will become the main substrate type at the ends of bays over flooded peatlands fed by tributaries (Aquatic Environment Supporting Volume, Map 3.34 and Map 1). This will be a new habitat but will total only about 5.4% of the total reservoir area. There is expected to be about 273.8 ha of peat nearshore area (i.e., at depths less than that of silt sediment in shallow water). Peat substrates are expected occupy about 297.2 ha (2.9 %) of the reservoir area. When found in the main reservoir they will be mainly where deep peat deposits are found today. Peat nearshore substrates will be composed of inundated fibrous peat, as well as areas of partially decomposed peat after the fibrous surface layer has resurfaced (PE SV Section 6.4.2.1). In most other exposed areas of the reservoir, the processes of wave action and water level variation will remove the thin organic overburden. Most shorelines of the lower reservoir (reaches 6 – 9a) that erode into the sloped topography of today will erode through the thin peat and/or mineral soils, and create a clay nearshore area (1427 ha; 14.3%), with some localized deposits of aggregate lag when available. The clay-based nearshore areas in the main reservoir and the deposits of fine organic deposition at the ends of bays will form most of the rooted macrophyte habitat in the reservoir (Aquatic Environment Supporting Volume Section 3, 3.4.2.2.3). Areas of inundated peat, either at exposed or sheltered sites, will not contribute to potential macrophyte habitat. Some of the islands flooded in Gull Rapids may not be depositional sites due to sufficient water velocity and/or slope, and so will likely have the character of inundated mineral soils (137 ha or 1.38% of reservoir area).

Substrate Changes in the Riverine Reaches of the Keeyask Reservoir at Year 30

In Year 30, most of the substrate in the main channel of the riverine reaches (Long Rapids to entrance to Gull Lake) is expected to remain similar to today (Map 2, attached). About 132.7 ha (97.4% of reaches 2b – 5) of the channel bottom will remain as cobble/boulder substrate (Table 2). Changes in substrate type in the riverine reaches are expected to be more apparent in shallow water along the banks. In the existing environment sand was seldom observed in the riverine reach (15.5 ha; about 1% of the riverine area). Sand was present only in shallow water along shorelines in the intermittently exposed zone in areas not subject to marked river flows, or near Fork Creek in Reach 3 (upstream of Birthday Rapids on the north bank), or on banks of the island Near Nap Creek (downstream of Birthday Rapids on the south bank). By year 30 most if not all of the sand areas will change to other substrate types due to shore erosion or movement of lotic habitat towards the shore as the bank recedes. The riverine reach currently has more glacio-fluvial deposits than does the lower reservoir where glacio-lacustrine deposits are more common. The banks of the riverine area may therefore be slightly more coarse and form a sandy clay. Although sandy clay only accounts for about 6.1% of the areal changes in substrate (117.1 ha) in the Post-Project riverine reach, it will be a notably visible, but relatively narrow, band of substrate that comprises most of the riverine bank where erosion would or could continue to occur. Small backwater inlets found along both banks of the riverine reach today will tend to increase in number and area after the Project. This creates more lentic habitat that will become depositional substrate. The riverine area today has about 152.0 ha of silt/clay substrate found entirely in backwater inlets (9.9 % of riverine EE). By Year 30, silt will cover 86.9 ha of the silt/clay substrate (57.1 % of riverine EE). An additional 75.1 ha of new silt substrate will develop in the flooded lentic bays and total about 162.1 ha, or 8.5% of the total Year 30 riverine area.

Substrate Changes in the Lower Reservoir Area

Changes of substrates in the lower reservoir are similar to that described above for the entire reservoir given that changes in area in the riverine reach are relatively small. At

Year 30, silt is expected to cover about 908 ha (75.7%) of the existing gravel/cobble/boulder substrate, which is found only in the lower reservoir area today (Table 3). Nearly all silt/clay habitat associated with lentic bays in Gull Lake today will be inundated and will change to silt substrate (1087.2 ha or 97.3% of EE). More than half of the cobble/boulder substrate currently found south of Caribou Island in the main channel downstream to the entrance of Gull Rapids will change to silt in some of the deepest water of the reservoir (294.3 ha; 60.8%; Aquatic Environment Supporting Volume, Map 3 - 28). The output from a lotic substrate model (Aquatic Environment Supporting Volume, Appendix 3B, Map 3.34) suggests that this main channel habitat near Caribou Island will alternate between the existing substrate (where velocities remain higher within a constrained channel) to depositional where it is more open, deep, and velocity is slower. About 191.6 ha, or nearly three quarters (74.6%) of the cobble/boulder/bedrock substrate unique to Gull Rapids, will change to silt. A small amount of the remaining cobble/boulder/bedrock habitat in this area will be excavated bedrock at the powerhouse intake channel. Silt will cover all (17.9 ha.) of the known large gravel bed area in reach 6 of Gull Lake, and about 81.9% (132.7 ha) of the existing sand substrate in reaches 6 – 9a.

As described above for the entire reservoir area, the substrates that are either new or that increase in area markedly within the flooded area due to the Project, are: 1) clay; 2) flooded terrestrial soil; 3) peat; and 4) fine organic deposition. Clay, which will be common sloped substrate in the nearshore zone after removal of thin peat and/or mineral soil erosion, will increase in area by about 110 times (1376.2 ha increase, or 17.1% of lower reservoir). The flooded terrestrial soils that persist in some of the flooded islands will be only total about 1.7% of the lower reservoir area. Peat nearshore substrate will occupy about 3.4% of the lower reservoir area. The deposition of fine organic material that will develop at the end of bays, where peatlands were abundant before the Project, will be a notable and new habitat in the reservoir, but will only occupy about 5.4% of the Year 30 lower reservoir area.

<u>Downstream of the Keeyask Generating Station</u>

Sediment deposition may occur along the north bank within 3 km downstream of the GS (Map 3). Deposition is expected in this area due to: 1) a shift in the path of flow which will increase the area of lentic habitat over that which occurs in the open water season today (Aquatic Environment Supporting Volume Map 3.31); and 2) this lentic habitat will persist all year due to the loss of the ice dam and associated flow dynamics in winter (PE SV Section 4). The area of anticipated sedimentation is approximately 55.1 ha, all of which covers cobble/boulder habitat in the existing environment.

Modelling Precision

Changes of substrate type apparent in Tables 1 – 3 include those that are expected to occur and be readily observable, as described above, as well as those that result due to comparisons made between observation and prediction. For the latter, Table 1 shows that about 290.9 ha of gravel/cobble/boulder bottom type present in Gull Lake today will change to cobble/boulder after the Project. This is an apparent change that shows the difference of detail between observation and prediction. After the Project the areas of non-depositional bottom type will continue to exhibit the substrate type present today (i.e., hard bottom). These non-depositional areas after the Project are expected to be in relatively fast flowing areas, as they are today. Such sites do not have a lot of gravel today and therefore would not be expected to have this substrate in the future with the Project. For example, Gull Lake was sampled most often as a cobble/boulder substrate, but gravel was sometimes present downstream of bottom undulation, or was more available where current slowed over large areas. After the Project, these gravel areas are expected to become depositional substrate due to the fact that these areas are relatively slow lotic habitat today. Although there is the potential that some small areas of gravel present now could remain after the Project (e.g., Table 1; 1.45 ha), this is not likely. These gravel sites tend to be small and found along shorelines where lotic habitat will form, or velocity will notably increase as the channel widens in the future with the Project. Consequently, it is expected that most often a cobble/boulder bottom type will form where gravel is present today and deposition is not predicted.
Cobble/boulder is the dominant bottom type of the main channel today in most flowing water areas (i.e., where the parent bedrock geology does not control material availability). This is expected to continue to be the case after the Project.

Table 1. Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the entire reservoir area.

Existing Substrate (ha.)	Year 30 Substrate (ha.)												
	Bedrock	**Boulder**	**Clay**	**Cobble**	**Cobble/Boulder**	**Cobble/Boulder/Bedrock**	**Flooded Terrestrial Soils**	**Organic**	**Peat**	**Sand**	**Sandy Clay**	**Silt**	**Grand Total EE**
Bedrock	18.16		0.73		33.04	0.00					0.64	14.83	**67.42**
Boulder		0.36			3.27							1.93	**5.57**
Cobble			0.00	0.50	12.81						0.68	7.61	**21.60**
Cobble/Boulder					1454.38					0.00	1.07	326.88	**1782.33**
Cobble/Boulder/Bedrock	5.49		4.31			55.15				0.00		191.61	**256.56**
Gravel					1.45						0.00	18.16	**19.61**
Gravel/Cobble/Boulder					290.90							908.05	**1198.95**
Organic					0.35			0.76			0.00	24.27	**25.39**
Sand					17.36					20.40	0.52	139.27	**177.55**
Silt/Clay	0.17		8.82		59.01	0.02		22.63	0.00		3.82	1174.19	**1268.67**
Aquatic within EE 95)	**23.82**	**0.36**	**13.87**	**0.50**	**1872.59**	**55.17**	**0.00**	**23.40**	**0.00**	**20.40**	**6.73**	**2806.80**	**4823.65**
Flooded Only	20.65	0.01	1413.63		127.35	43.87	137.72	521.87	297.27	3.15	110.42	2473.45	5149.40
Grand Total (Year 30)	**44.47**	**0.37**	**1427.50**	**0.50**	**1999.94**	**99.04**	**137.72**	**545.27**	**297.27**	**23.56**	**117.15**	**5280.25**	**9973.05**

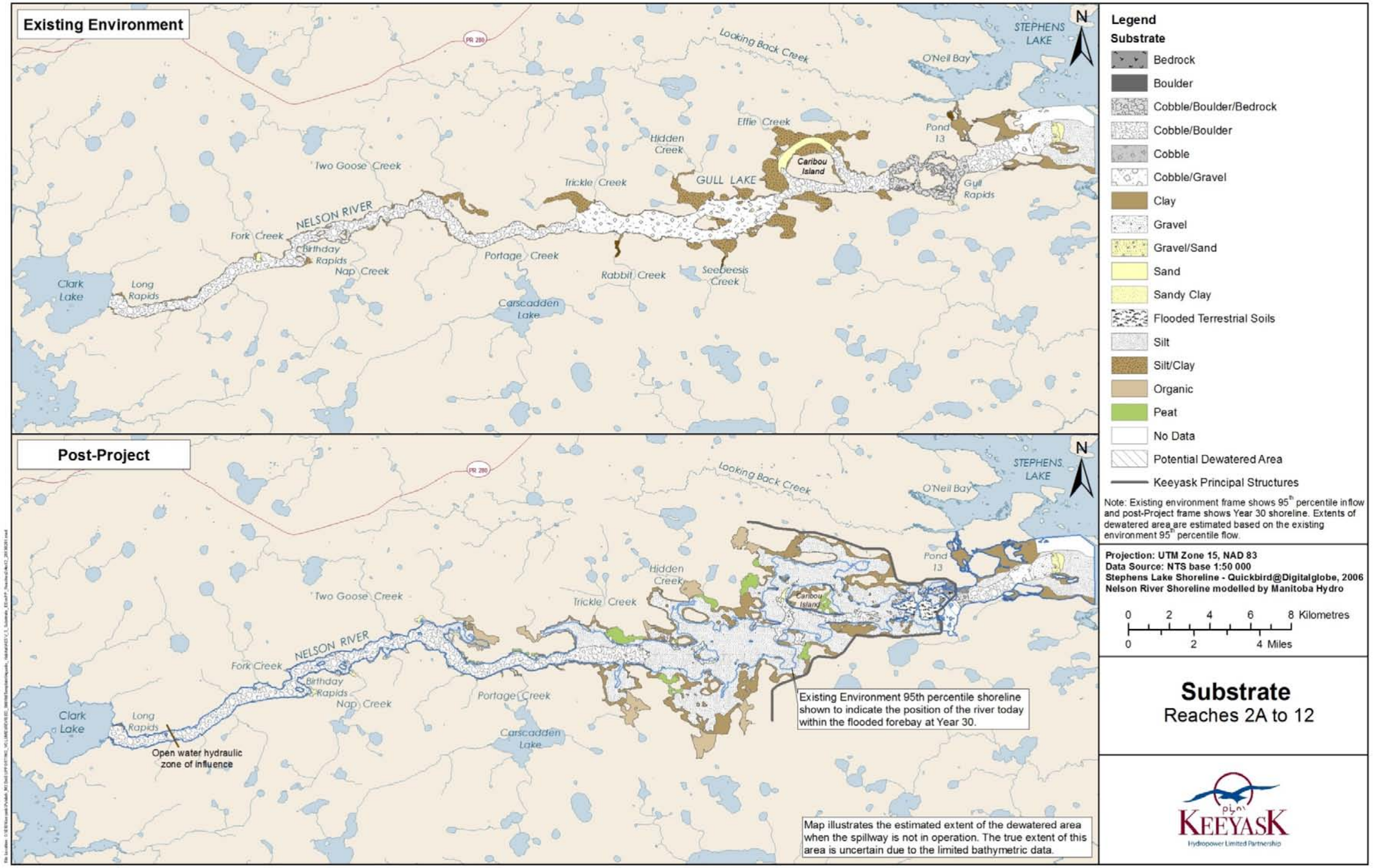
Table 2.Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the riverine reservoir area.

Existing Substrate (ha.)	Year 30 Substrate (ha.)							
	Clay	**Bedrock**	**Cobble/Boulder**	**Organic**	**Peat**	**Sandy Clay**	**Silt**	**Grand Total EE**
Bedrock		33.03				0.64	2.66	**36.33**
Boulder			2.44				0.60	**3.04**
Cobble	0.00		12.41			0.68	2.97	**16.06**
Cobble/Boulder			1265.15			1.07	32.55	**1298.76**
Gravel			1.45			0.00	0.19	**1.63**
Organic			0.32			0.00	0.23	**0.55**
Sand			8.45			0.52	6.58	**15.55**
Silt/Clay	1.28		37.35	22.63	0.00	3.82	86.98	**152.06**
Aquatic within EE 95)	**1.28**	**33.03**	**1360.59**	**22.63**	**0.00**	**6.73**	**132.76**	**1524.00**
Flooded Only	37.40		48.08	79.47	23.42	110.42	75.13	**373.93**
Grand Total (Year 30)	**38.69**	**33.03**	**1375.64**	**102.11**	**23.42**	**117.15**	**207.89**	**1897.92**

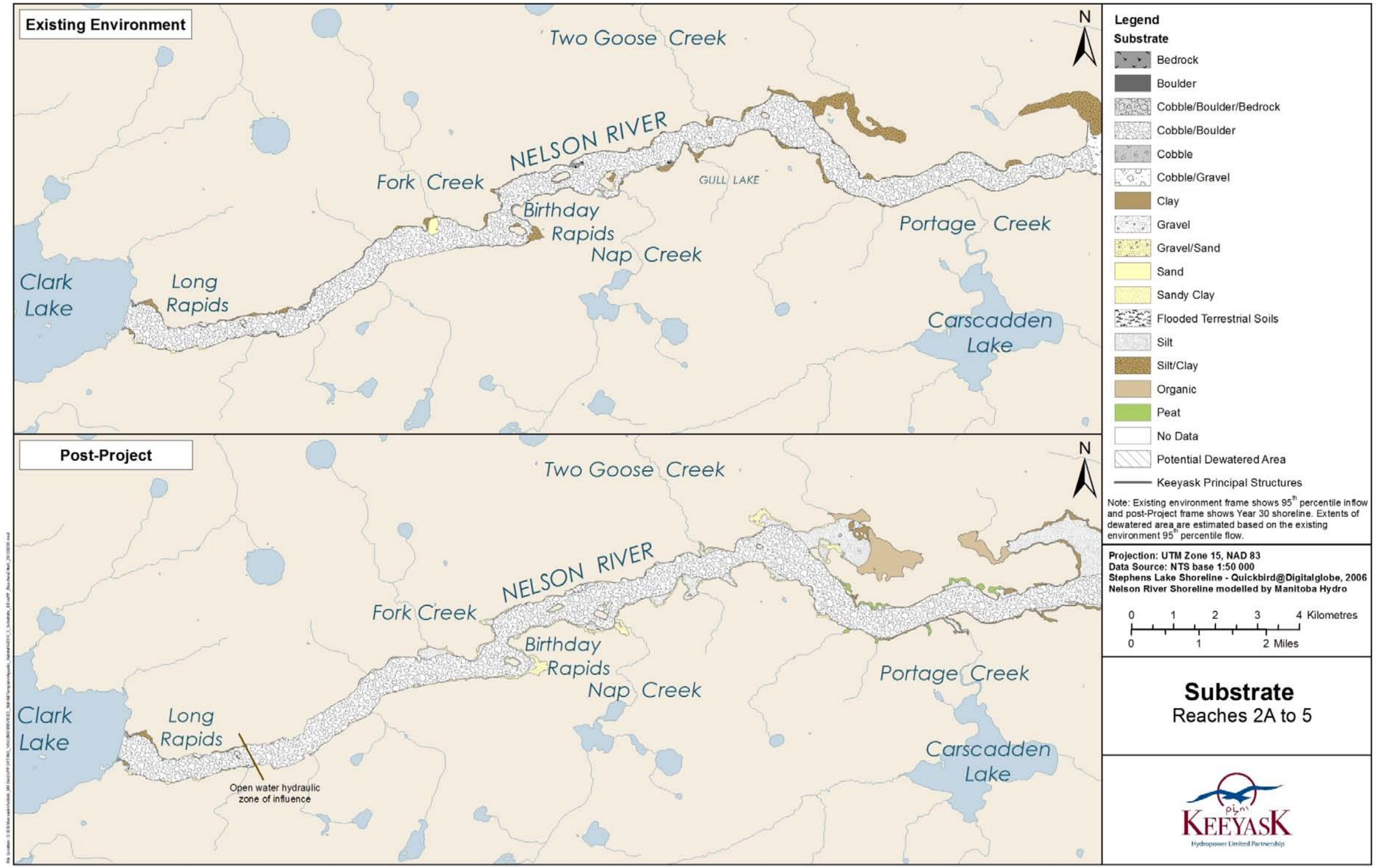
Table 3. Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the reaches of the lower reservoir area.

Existing Substrate (ha.)	Year 30 Substrate (ha.)											
	Bedrock	Boulder	Clay	Cobble	Cobble/Boulder	Cobble/Boulder/Bedrock	Flooded Terrestrial Soil	Organic	Peat	Sand	Silt	Grand Total EE
Bedrock	18.16		0.73		0.02	0.00					12.17	**31.08**
Boulder		0.36			0.84						1.33	**2.53**
Cobble				0.50	0.40						4.63	**5.54**
Cobble/Boulder					189.24					0.00	294.33	**483.57**
Cobble/Boulder/Bedrock	5.49		4.31			55.15				0.00	191.61	**256.56**
Gravel											17.97	**17.97**
Gravel/Cobble/Boulder					290.90						908.05	**1198.95**
Organic					0.03			0.76			24.04	**24.84**
Sand					8.91					20.40	132.69	**162.00**
Silt/Clay	0.17		7.54		21.67	0.02					1087.21	**1116.61**
Aquatic within EE 95)	**23.82**	**0.36**	**12.58**	**0.50**	**511.99**	**55.17**		**0.76**		**20.40**	**2674.05**	**3299.66**
Flooded Only	20.65	0.01	1376.23	79.27	43.87		137.72	442.40	273.86	3.15	2398.31	**4775.47**
Grand Total (Year 30)	**44.47**	**0.37**	**1388.82**	**79.77**	**555.86**		**55.17**	**137.72**	**443.17**	**273.86**	**23.56**	**5072.36**	**8075.13**

312

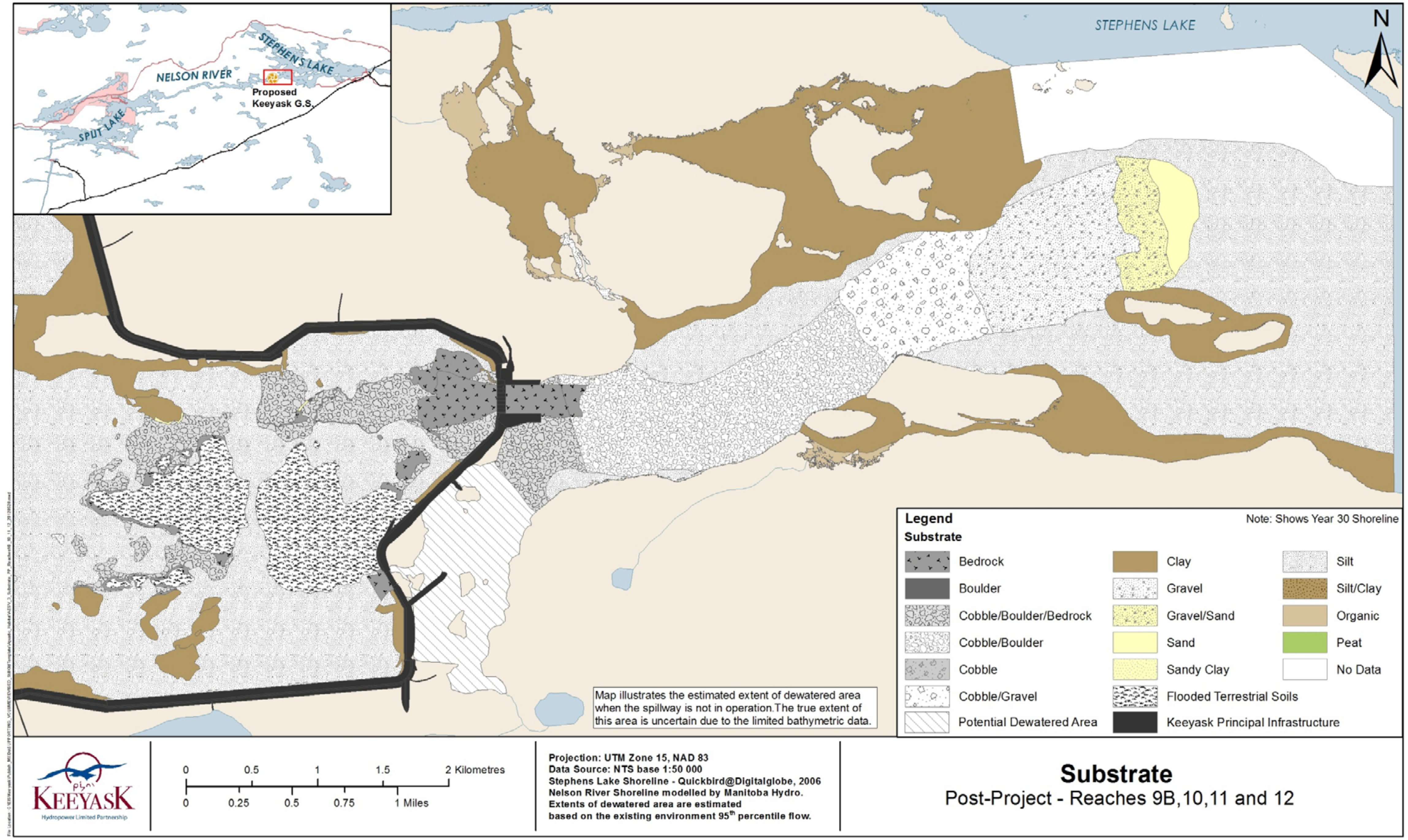


Map 1. Change of substrate type for the Existing Environment (upper panel) and Year 30 Post-Project. The extent of the existing environment 95th percentile shoreline is shown in blue for comparison to the Post-Project Year 30 shoreline.



Map 2. Change of substrate type for the Existing Environment (upper panel) and Year 30 Post- Project for the riverine reaches. The hydraulic zone of influence is shown in the lower panel for the Post-Project.

KEEYASK Hydropower Limited Partnership



320

321 **Map 3. Post-Project substrate immediately downstream of the generating station.**

REFERENCE: Volume: Physical Environment Supporting Volume; Section: 7.4.2.3 Peat Sedimentation - Upstream of Projects; p. 7-35 Volume: Aquatic Environment Supporting Volume; Section: 3.4.2.2 Outlet of Clark Lake to the Keeyask Generating Station; p. N/A

TAC Public Rd 2 DFO-0072

ORIGINAL PREAMBLE AND QUESTION:

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?

FOLLOW-UP QUESTION:

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?

RESPONSE:

Deposition of fine organic material is not expected to impact existing aquatic habitat because, as discussed in TAC Round 1 DFO-0072, the majority of peat released from flooded terrestrial areas will settle in the bay of origin (i.e., over flooded terrestrial habitat). The substrate in the flooded terrestrial area will initially consist largely of organic matter; however, in the long term silt is expected to deposit over the peat (see TAC Round 1 DFO-0072). Organic material is expected to be present in the long term in certain areas of flooded terrestrial habitat, as discussed below.

Sites for the deposition of fine organic material are shown in AE SV Map 3 – 34. The model used to predict deposition of this fine organic material is provided in AE SV Map 3B - 4. Deposits of fine organic material are only expected to occur in the long term (more than 30 years) in flooded areas at the terminal ends of small and flooded peatland bays. This is consistent with observed conditions in Stephens Lake, where 30 years or more after impoundment, there is no evidence of fine organic deposition in areas of the reservoir other than at the terminal ends of small tributaries.

The formation of organic deposits has been described in the AESV for Year 30 (i.e., 30 years post-impoundment) on page 3-35, Year 1 on page 3 – 37, Year 5 on page 3-38, and Year 15 on page 3-39. (The relevant sections of the AE SV are provided below for convenience.) TAC Public Rd 2 DFO-0014 provides maps and areas of pre- and post-Project substrate type.

AE SV Pages 3-34 to 3-39

Section 3.4.2.2.3 Aquatic Habitat at Year 30

At Year 30, reservoir expansion will have increased the reservoir area to about 99.8 km^2, an increase of 7–8 km^2 due to mineral bank erosion and shore peat breakdown (PE SV, Section 6.4.2.1, see Map 6.4-6 and Map 6.4-7). Shoreline erosion, peatland resurfacing and transport, and sedimentation processes will remain active in some areas, but are at rates that are much slower than in the first 15 years of the reservoirs history (PE SV, Section 6.4.2.1). The physical environment modelling studies and the aquatic environment observations on Stephens Lake collectively suggest that the exposed nearshore areas of a reservoir in the study area at Year 30 will be mostly mineral, whereas sheltered bays retain more of their pre-flood peatland characteristics. Less wave energy is available in flooded bays, and when compared to the main basin of the reservoir, the slope of bays is minimal and the peat deposits tend to be larger and deeper. The inherent character of peatland bays infers that they are less able to shift to a mineral nearshore area over time. For the Keeyask reservoir, the physical environment studies estimate that mineral-based shorelines are expected to increase from 28% to 69% of the total shoreline length over 30 years. This transition from mainly peat-based substrates, which do not support rooted plants, to nearshore slopes that develop from mineral soils due to erosion and resurfacing of peat is important as it helps develop potential macrophyte habitat over time. Water velocities and water depths at Year 30 will essentially be the same as following the initial FSL, with the exception of changes in very shallow water due to shoreline recession, peatland resurfacing, and development of nearshore slopes that will slightly increase the amount of lentic habitat around the perimeter of the reservoir.

The results of substrate modelling for the Keeyask reservoir at Year 30 are provided in Appendix 3B. The pattern of substrate deposition in the reservoir is similar when 95th and 5th percentile inflow scenarios are compared, although some differences are apparent. The 95th percentile inflow model results suggest that the silt sediment boundary would occur up to about 1 km farther downstream in Reach 6, at the entrance to present day Gull Lake, when compared to the 5th percentile inflows. A few small areas that are depositional under 95th percentile inflows will not be under 5th percentile flows. These non-depositional sites under low flows tend to be shallow where flows would be constrained, such as near the boundary of reaches 6 and 7 at narrows found between islands, and in shallow areas within present day Gull Rapids.

Soil erosion studies indicate the river banks will erode (PE SV, Section 6.3.1.2.2), including the riverine reaches 4 and 5 below Birthday Rapids. The altered state of the banks is expected to be sandy/clay given the deposits are mainly glacial till, with local occurrences of **glaciofluvial** or glaciolacustrine sediments. Nearshore sedimentation studies suggest however that the mineral sediments eroded from these banks will not be transported downriver, so deposition of gravel and sand at the entrance to Gull Lake is not expected (PE SV, Section 7). The PE studies of the existing environment demonstrated limited bed load movement from upstream (PE SV 7.3.1.2); this is expected to continue in the future with the Project;

The combined results of the terrestrial soil studies (TE SV, Section 2.3.4.2), peatland and mineral erosion studies (PE SV, Section 5 and Section 6), sedimentation studies (PE SV, Section 7) and the reservoir habitat models (Map 3-34 and Appendices 3B and 3C) suggest:

- The bottom of the thalweg in the riverine section (reaches 2B–5) of the reservoir is expected to remain free of silt. The thalweg of reaches 2B–5 expected to maintain a bed composition similar to that of the existing environment;
- Most of the lower reservoir (reaches 6–9A) will become depositional with silt sediments, except for some of the main thalweg areas where velocity, depth, exposure, and slope are sufficient to keep the substrate silt-free with a substrate composition similar to today;
- Shallow water substrate type depends strongly on the pre-flood soils (Appendix 3C). In open areas of the reservoir, clay substrata forms from pre-flood mineral soils or from thin peat veneers overlying mineral deposits, often in glaciolacustrine deposits. The substrate in other shallow habitat is inundated fibrous or humic peat where pre-flood peatlands are large and relatively deep;
- Deposits of fine organic material will accumulate in lentic habitat at the ends of bays fed by local peatland streams in reaches 5–7(Appendix 3C); and
- Potential macrophyte habitat may develop in many nearshore areas of the reservoir. Areas of thin peat, which is a common soil type within the bounds of the future reservoir (PE SV 5.3.3.2), will resurface or erode and expose mineral-based soils (Appendix 3C). Once relatively stable, nearshore processes (*i.e.*, waves and water level variation) will wash the clay and aggregate lag and keep some or the entire photic zone on the nearshore slope silt free. Potential macrophyte habitat may even develop at the ends of sheltered bays where peat accumulation was relatively thick, after peat has floated away and local water masses prevent silt from the main reservoir to deposit (Appendix 3C).

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.

1.1.1.1.1 Evolution of the Reservoir - Year 1 to Year 15

The physical processes responsible for the development and maintenance of aquatic habitat in the Keeyask area after the Project are expected to slow to levels at or near those expected without the Project before or by Year 15 (PE SV, Section 6.4.2, Section 6.4.4, and Section 7.4.2). These studies suggest: 1) that rates of shoreline erosion are expected to stabilize at rates similar to those of the existing environment by about Year 15; 2) like the rate of shoreline erosion, the rates of mineral deposition will be greatest at Year 1 and generally decrease thereafter; and 3) the peatland disintegration models suggest that most of the flooded peatland dynamics, which are unique to the post-Project, have occurred by Year 15.

When compared to the Peaking Mode of operation, the Base loaded scenario generates a slightly higher rate of mineral erosion, and rate of mineral deposition (PE SV, Section 6.4.2.1 and Section 7.4.2.1). The mode of operation is not expected to change the amount of peat resurfacing or rate of disintegration, or movement of floating peat (PE SV, Section 6.4.2.1).

The results of total suspended solids, dissolved oxygen, and organic sediment models by the physical environment studies are described in Section 2 of this volume and in the PE SV, Section 7 and Section 9. A detailed examination of the differences between Base loaded and Peaking operations is provided in the PE SV, Section 4.4.2.2.

1.1.1.1.2 Development of Reservoir Habitat

The Keeyask environmental studies suggest that the reservoir habitat may begin to approach a more stable state by Year 15 given that the physical processes that force the composition and distribution of habitat (including water depth and velocity regimes established at initial FSL) have slowed appreciably. Accordingly, the main habitat patterns that are well established at Year 30 are expected to be evident by Year 15. Although erosion, transport, and deposition are expected to continue in the reservoir after Year 15, the rates of change within the habitats established are expected to be relatively low and/or episodic over smaller areas. In all but the highly exposed areas such small increments of change are not expected to alter the type of reservoir habitat developed by Year 15 but more heterogeneity would be evident (*i.e.*, arising from remnants of flooded terrestrial and shore erosion) than in Year 30. Further, the ability of the reservoir to form habitat boundaries (*i.e.*, those that define the edges of habitat types like rock, sand, or silt) is in part dependent on the available hydraulic energy. As such, substrate habitat boundaries that form in Deep Water due to the pattern of lentic/lotic habitat are more likely to be evident earlier in the reservoir than shallow habitat, which, due to erosion, is relatively unstable for longer periods of time. Deep Water habitat boundaries, such as the superimposition of silt on the existing riverbed, could probably be observed by Year 5. In Shallow and Lentic habitat, the habitat boundaries that form in back bays would be at a slower rate than those that form in the main body of the reservoir where wave energy is higher, but could stabilize earlier than highly exposed sites.

Year 1

As described in detail in the PE SV, the physical changes from the state at initial FSL are mainly: 1) the ongoing peat resurfacing and transport, 2) mineral and peat erosion, 3) mineral sediment deposition in shallow water and silt sediment begins to deposit in many areas of the lower reservoir.

One year after flooding the reservoir substrate is expected to be heterogeneous and composed of flooded terrestrial habitat, flooded aquatic habitat, and early signs of newly formed substrate that will eventually be predominant at Year 30. The area of flooded terrestrial habitat (*i.e.*, where substrate is still the same as at initial FSL) is expected to decrease relative to initial FSL; many areas of the lower reservoir will be heterogeneous and composed of pre-flood and post-flood materials. The distribution of post-flood materials is expected to be discontinuous and under-developed due to the limited time the reservoir has had to segregate water masses, move materials that have been mobilized since flooding, and the available bottom types. Floating peat islands will be readily apparent and mobile on the surface of the reservoir (PE SV, Appendix 6D). Differences in the rate of peatland and mineral shore erosion around the perimeter of the reservoir (PE SV, Section 6.4.2.1) suggest differences in the rate of reservoir habitat evolution may be apparent. The shallow flooded terrestrial areas in the south Shallow Water area of Reach 6 are expected to have the highest rates of shore erosion and deposition at Year 1 (PE SV, Section 7.4.2.1).

The post-Project distribution of aquatic habitat types within each water elevation zone (MOL=158 m ASL, FSL=159 m ASL, and the IEZ) that are expected to develop by Year 1 are shown in Appendix 3D (Table 3D-1). These predicted habitat distributions were used in the lower trophic level and fish community assessments (Section 4 to Section 6).

Local tributaries that enter at the ends of bays will have pooled tea-colour peatland water at the end of the bays; the visible contrast to that of the turbid water of the main reservoir will remain a long-term characteristic of the reservoir (Appendix 3B). The location where the peatland water mass meets the more turbid water of the reservoir will influence the long-term position of organic and silt habitat boundaries evident at Year 30 (Appendix 3B). The flooded terrestrial bays will have markedly different water quality characteristics and are expected to show large seasonal changes in oxygen (Section 2).

Year 5

At Year 5, the area of substrate comprised of post-flood materials is expected to increase while the area of flooded terrestrial habitat will decrease. Sedimentation analyses indicate erosion and sedimentation processes in the reservoir remain active at five years post-flooding (PE SV, Section 6.4.2.1 and Section 7.4.2.1). Sedimentation analysis indicates rates of sediment deposition of 0−1 cm/year in offshore areas (PE SV, Section 7.4.4). Mineral sediment, primarily in the form of silt, is expected to cover much of the flooded aquatic habitat and flooded terrestrial habitat, except where water velocity, surface wave energy, or slope of the substrate is sufficient to prevent deposition (Appendix 3B).

Erosion of thin peatlands in exposed areas of shallow water of the lower reservoir is expected to expose the underlying mineral soils (PE SV, Section 6.4.2.1). Aquatic studies of Stephens Lake also show that, over time, a clay-based substrate will form from pre-flood topography that is mineral or thin peat from which potential macrophyte habitat will begin to develop (Appendix 3B). Occupation of the potential plant habitat by rooted macrophytes could occur but would probably be infrequent and, in general, not a widely visible aspect of the reservoir. According to the results of erosion and sedimentation studies (PE SV, Section 6.4.2.1), the habitat adjacent to the southern shoreline area of Reach 7 and in Reach 9 would likely be the most unstable Shallow habitat in the reservoir.

Ends of back bays fed by peatland streams will lack silt sediment originating from the turbid waters of the main reservoir (Appendix 3B) and will resemble flooded terrestrial habitat. Peat resurfacing and transport away from the bays appears to be slower when compared to the main body of the reservoir (Larter 2010). At Year 5 peat is likely to be a readily visible characteristic of back bays in the reservoir; floating and mobile peat is estimated to be greatest at Year 5 (PE SV, Appendix 6D). The greatest accumulation of floating peat is expected in the southern bays of the lower reservoir (PE SV, Section 7.4.4). Some of this mobile peat could anchor on shores and superimpose existing reservoir habitat. This would constitute a small and short-term loss of habitat that is not expected to influence biota.

The boundaries of post-flood substrate materials in deep water, (*i.e.*, substrates of silt and other harder bottom types) could evident by Year 5 in lentic habitat given that silt sedimentation is the dominant open-water process but, as described in later time steps, is discontinuous in the Lotic areas of the lower reservoir.

The post-Project distribution of aquatic habitat types within each water elevation zone (MOL=158 m ASL, FSL=159 m ASL, and the IEZ) that are expected to develop by Year 5 are shown in Appendix 3D (Table 3D-1). These predicted habitat distributions were used in the lower trophic level and fish community assessments (Section 4 to Section 6).

Year 15

The main habitat patterns that are evident and well established at Year 30 (described in previous section) are expected to be present at Year 15. When compared to the reservoir habitat at Years 1 and 5, relatively stable shallow water habitats will have developed given that peatland disintegration, mineral erosion and mineral sedimentation processes are expected to have slowed markedly (PE SV, Section 6.4.2.1 and Section 7.4.2.1). It is anticipated that the areas of post-flood substrate materials at Year 15 would be somewhat less than at Year 30 as some heterogeneity would persist given that some remnant flooded terrestrial habitat would remain but the segregation of distinct reservoir habitats (Appendix 3B) would be recognizable.

Some of the potential macrophyte habitat available at Year 30 would be present at Year 15 but heterogeneity would be expected due to remnants of flooded terrestrial habitat and occasional changes in quality of some of that habitat due to ongoing erosion. A predominantly clay-based substrate with some aggregate lag will begin to be widely available in the lower reservoir in Shallow Water within the zone of wave action (Appendix 3B); this is expected to form the primary habitat for the rooted macrophyte *Potamogeton richardsonii*. Some of the potential macrophyte habitat found at the ends of back bays also will have developed. By Year 15, much of the fibrous surface layers of the resurfaced peat will have resurfaced and transported away (PE SV, Section 7) which creates and enables fine organic deposition to form (Appendix 3B). The ends of sheltered bays with fine organic deposition are expected to form some of the habitat for the rooted macrophyte *Myriophyllum sibiricum*.

The Deep Water habitat patterns of silt deposition are expected to be quite similar to modelled estimates of Year 30 (described in previous section). Unlike the development of Shallow Habitat, which in most areas of the reservoir responds mainly to the intermittent effects wave action and water level cycling, the Deep Water habitat will arise from water depth and velocity regimes that will have acted continuously since initial FSL. Silt deposits, which will sediment at rates from 0–1 cm/year (PE SV 7.4.2.1) will form a continuous surface where deposition is expected at Year 30 (described in previous section), but at Year 15 the deposits will be thinner (PE SV 7.4.2.1). In reaches 2A–5 the velocity of the thalweg will be sufficient to maintain the bottom type observed in the studies of the existing environment. A substrate material size gradient is not expected where riverine flows leave Reach 5 and enter Reach 6 upstream of the zone of deep water silt deposition based on sediment transport analysis that suggest negligible amounts of sand and gravel material will be transported from the flooded banks upstream in the flooded riverine reaches (PE SV, Section 7). This is unlike the material size gradient that appears to have formed 4–5 km below Gull Rapids after Kettle GS was built (see Map 3-14). The area of the confluence of reaches 5 and 6 will be monitored after the Project to determine if sand and gravel transport and deposit in this area.

The post-Project distribution of aquatic habitat types within each water elevation zone (MOL=158 m ASL, FSL=159 m ASL, and the IEZ) that are expected to develop by Year 15 are shown in Appendix 3D (Table 3D-1). These predicted habitat distributions were used in the lower trophic level and fish community assessments (Section 4 to Section 6).

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.3.8 Sedimentation; p. 6-215

TAC Public Rd 2 DFO-0073

ORIGINAL PREAMBLE AND QUESTION:

Deposition - EIS states deposition loads will not change post project – about 3cm/year, based on about 30 cm 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?

FOLLOW-UP QUESTION:

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.

RESPONSE:

A description of proposed monitoring and follow-up activities, as required by the Guidelines, is provided in Chapter 8 of the Response to the EIS Guidelines. The preliminary Physical Environment Monitoring Plan will contain additional details. As noted in original response to TAC Public Rd 1 CEAA-0011, while the Guidelines do not require the Physical Environment Monitoring Plan, the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

With respect to information on thresholds for risk of sediment deposition, the aquatic habitat assessment assumed that all areas in the reservoir where fine sediment (i.e., silt) would be deposited over sand, gravel, or coarser substrate would, in the long term, be classified as fine sediment. Therefore, there is no “threshold for risk of sediment deposition”; it was recognized that even very small amounts of annual deposition (e.g., 0.5 cm) over several decades would result in the accumulation of substantial amounts of silt.

Effects of sediment (i.e., silt) deposition on aquatic habitat in the reservoir in the long term (i.e., after 30 years of impoundment) were assessed based on whether or not sediment (i.e., silt) deposition was predicted(AESV Appendix 3B). The presence or absence of sediment deposition was used to determine whether a qualitative change of substrate type would occur. Studies of Stephens Lake showed that sites of net deposition, despite varying sediment deposition rates, develop a homogenous silt surficial layer within 30 years of impoundment. This silt layer completely covered the underlying materials, although the depth of silt varied depending on location (see AESV Appendix 3B, photo 3B-2). Therefore, the rate of sediment deposition is not the primary determinant of substrate availability three decades after impoundment. Instead, the approach to determine the long term type of substrate was to identify the boundaries of sites of net deposition (for methods see AE SV Appendix 3B).

Downstream of the generating station, the change in flow distribution in the river within 3 km of the generating station will create shoreline areas with minimal flow, where silt is expected to accumulate over rock in the long term (see AE SV Map 3-34). Further downriver (including at the area of the present day sand lens in Stephens Lake), the velocity post-Project will essentially be the same as today so deposited materials would be redistributed over time as they are today (PE SV Section 7.4.2.2.4). Superimposition of like materials would not change the habitat type (e.g., sand deposited on the sand lens will not change the habitat classification). It should be noted that sediment deposition and re- suspension occurs in the existing environment and will continue post-Project.

The description of sedimentation downstream of the generating station in PE SV Section 7.4.2.2.4 is reproduced below:

> *“7.4.2.2.4 Mineral Sediment Deposition*
>
> *As discussed earlier in this section, some of the relatively coarser sediment material would be deposited in the Keeyask reservoir. Absence of relatively coarser material in the flow in the Post-project environment downstream of*

> *Keeyask GS would likely cause reduction in deposition currently observed in the existing environment in Stephens Lake, particularly near the upstream end of the lake. It is expected that Project impact on the mineral deposition would be limited to a reach of approximately 10 km to 12 km from the Gull Rapids.*
>
> *As discussed earlier in Section 7.4.1.1, a young of year habitat area for Lake Sturgeon currently exists downstream of Gull Rapids near a sand and gravel/sand bed. Two-dimensional modelling was used to assess the spatial distribution of the potential for suspended material to be deposited near the young of yeah habitat area under Post-project conditions. The modelling results indicate that it is unlikely that silt will deposit near the young of year habitat under on-peak flows, such as all seven powerhouse units.*
>
> *Under off-peak flows, such as one Powerhouse unit, there is a higher potential for silt deposition near the young of year habitat area compared to the existing environment. However, due to the relatively short duration of off-peak flows, the amount of silt deposition would be very small and will likely be eroded from the bed under on-peak flows. Map 7.4-26 illustrates the potential for sediment deposition as well as the existing substrate immediately downstream of the Keeyask GS under all seven Powerhouse units operating at best gate flow. A detailed description of this two-dimensional modeling can be found in Appendix 7A.”*

Maps and tables providing the areas of different types of substrate in the existing and post-Project environment are provided in the response to TAC Public Rd 2 DFO-0014. These are reproduced below for your convenience.

Table 1. Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the entire reservoir area.

Existing Substrate (ha.)	Year 30 Substrate (ha.)												
	Bedrock	Boulder	Clay	Cobble	Cobble/Boulder	Cobble/Boulder/Bedrock	Flooded Terrestrial Soils	Organic	Peat	Sand	Sandy Clay	Silt	Grand Total EE
Bedrock	18.16		0.73		33.04	0.00					0.64	14.83	**67.42**
Boulder		0.36			3.27							1.93	**5.57**
Cobble			0.00	0.50	12.81						0.68	7.61	**21.60**
Cobble/Boulder					1454.38					0.00	1.07	326.88	**1782.33**
Cobble/Boulder/Bedrock	5.49		4.31			55.15				0.00		191.61	**256.56**
Gravel					1.45						0.00	18.16	**19.61**
Gravel/Cobble/Boulder					290.90							908.05	**1198.95**
Organic					0.35			0.76			0.00	24.27	**25.39**
Sand					17.36					20.40	0.52	139.27	**177.55**
Silt/Clay	0.17		8.82		59.01	0.02		22.63	0.00		3.82	1174.19	**1268.67**
Aquatic within EE 95)	**23.82**	**0.36**	**13.87**	**0.50**	**1872.59**	**55.17**	**0.00**	**23.40**	**0.00**	**20.40**	**6.73**	**2806.80**	**4823.65**
Flooded Only	20.65	0.01	1413.63		127.35	43.87	137.72	521.87	297.27	3.15	110.42	2473.45	5149.40
Grand Total (Year 30)	**44.47**	**0.37**	**1427.50**	**0.50**	**1999.94**	**99.04**	**137.72**	**545.27**	**297.27**	**23.56**	**117.15**	**5280.25**	**9973.05**

91

KEEYASK Hydropower Limited Partnership

Table 2.Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the riverine reservoir area.

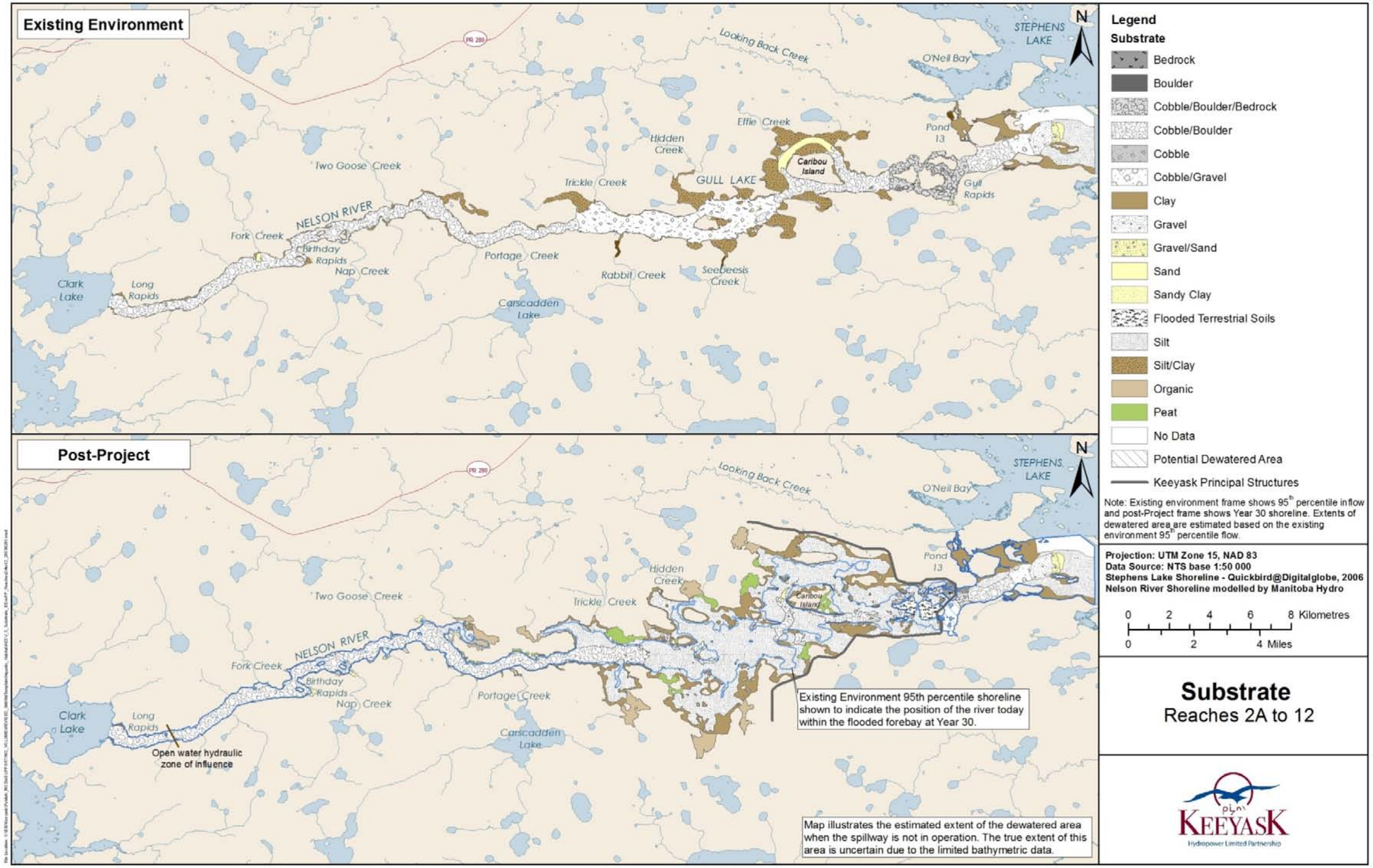
Existing Substrate (ha.)	Year 30 Substrate (ha.)							
	Clay	**Bedrock**	**Cobble/Boulder**	**Organic**	**Peat**	**Sandy Clay**	**Silt**	**Grand Total EE**
Bedrock		33.03				0.64	2.66	**36.33**
Boulder			2.44				0.60	**3.04**
Cobble	0.00		12.41			0.68	2.97	**16.06**
Cobble/Boulder			1265.15			1.07	32.55	**1298.76**
Gravel			1.45			0.00	0.19	**1.63**
Organic			0.32			0.00	0.23	**0.55**
Sand			8.45			0.52	6.58	**15.55**
Silt/Clay	1.28		37.35	22.63	0.00	3.82	86.98	**152.06**
Aquatic within EE 95)	**1.28**	**33.03**	**1360.59**	**22.63**	**0.00**	**6.73**	**132.76**	**1524.00**
Flooded Only	37.40		48.08	79.47	23.42	110.42	75.13	**373.93**
Grand Total (Year 30)	**38.69**	**33.03**	**1375.64**	**102.11**	**23.42**	**117.15**	**207.89**	**1897.92**

92

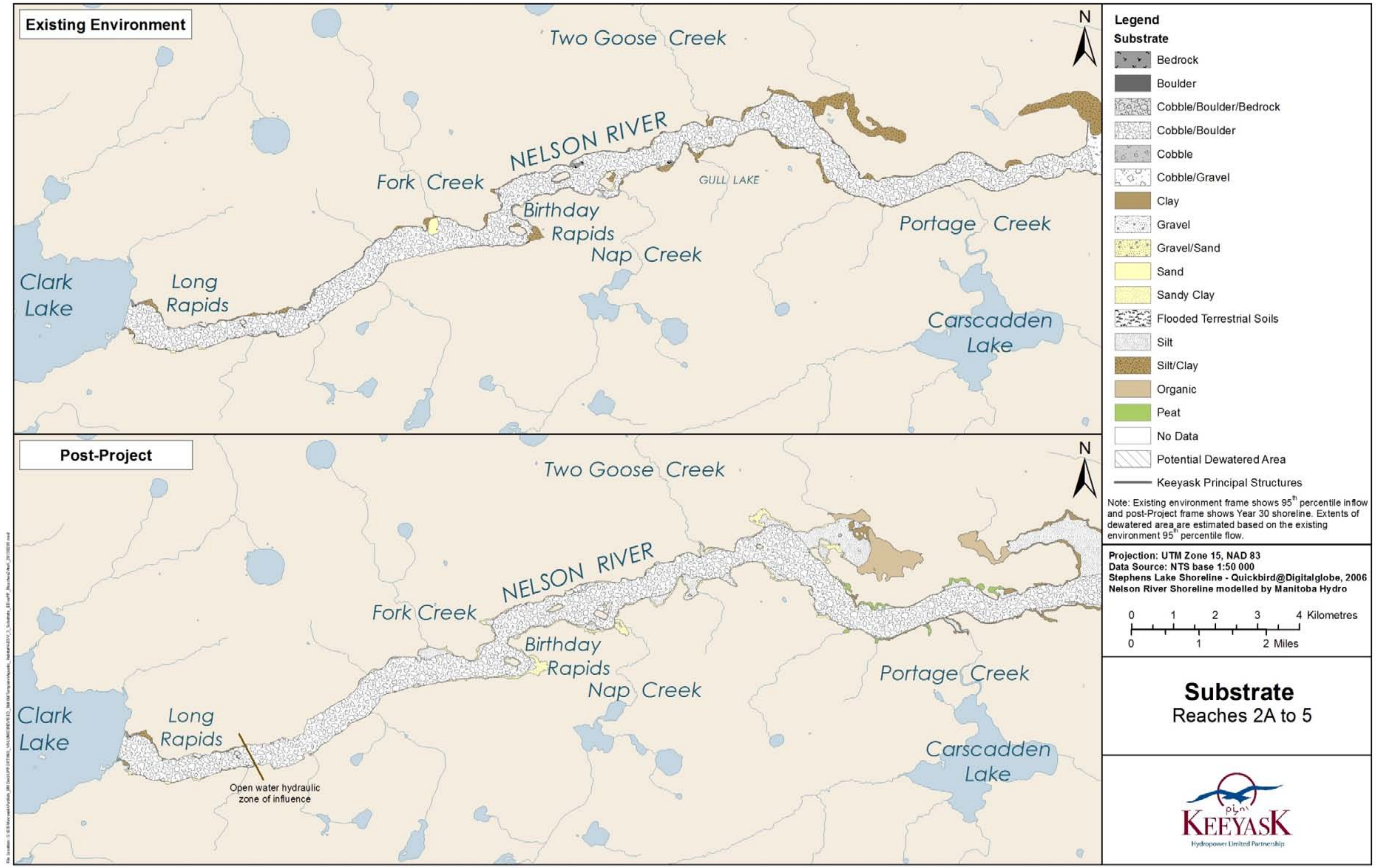
Table 3. Change of area in hectares (ha) of the substrate classes present in the Existing Environment according to a 95th percentile inflow (rows) and the Year 30 Post-Project (columns) for the reaches of the lower reservoir area.

Existing Substrate (ha.)	Year 30 Substrate (ha.)											
	Bedrock	**Boulder**	**Clay**	**Cobble**	**Cobble/Boulder**	**Cobble/Boulder/Bedrock**	**Flooded Terrestrial Soil**	**Organic**	**Peat**	**Sand**	**Silt**	**Grand Total EE**
Bedrock	18.16		0.73		0.02	0.00					12.17	**31.08**
Boulder		0.36			0.84						1.33	**2.53**
Cobble				0.50	0.40						4.63	**5.54**
Cobble/Boulder					189.24					0.00	294.33	**483.57**
Cobble/Boulder/Bedrock	5.49		4.31			55.15				0.00	191.61	**256.56**
Gravel											17.97	**17.97**
Gravel/Cobble/Boulder					290.90						908.05	**1198.95**
Organic					0.03			0.76			24.04	**24.84**
Sand					8.91					20.40	132.69	**162.00**
Silt/Clay	0.17		7.54		21.67	0.02					1087.21	**1116.61**
Aquatic within EE 95)	**23.82**	**0.36**	**12.58**	**0.50**	**511.99**	**55.17**		**0.76**		**20.40**	**2674.05**	**3299.66**
Flooded Only	20.65	0.01	1376.23	79.27	43.87		137.72	442.40	273.86	3.15	2398.31	**4775.47**
Grand Total (Year 30)	**44.47**	**0.37**	**1388.82**	**79.77**	**555.86**	**55.17**	**137.72**	**443.17**	**273.86**	**23.56**	**5072.36**	**8075.13**

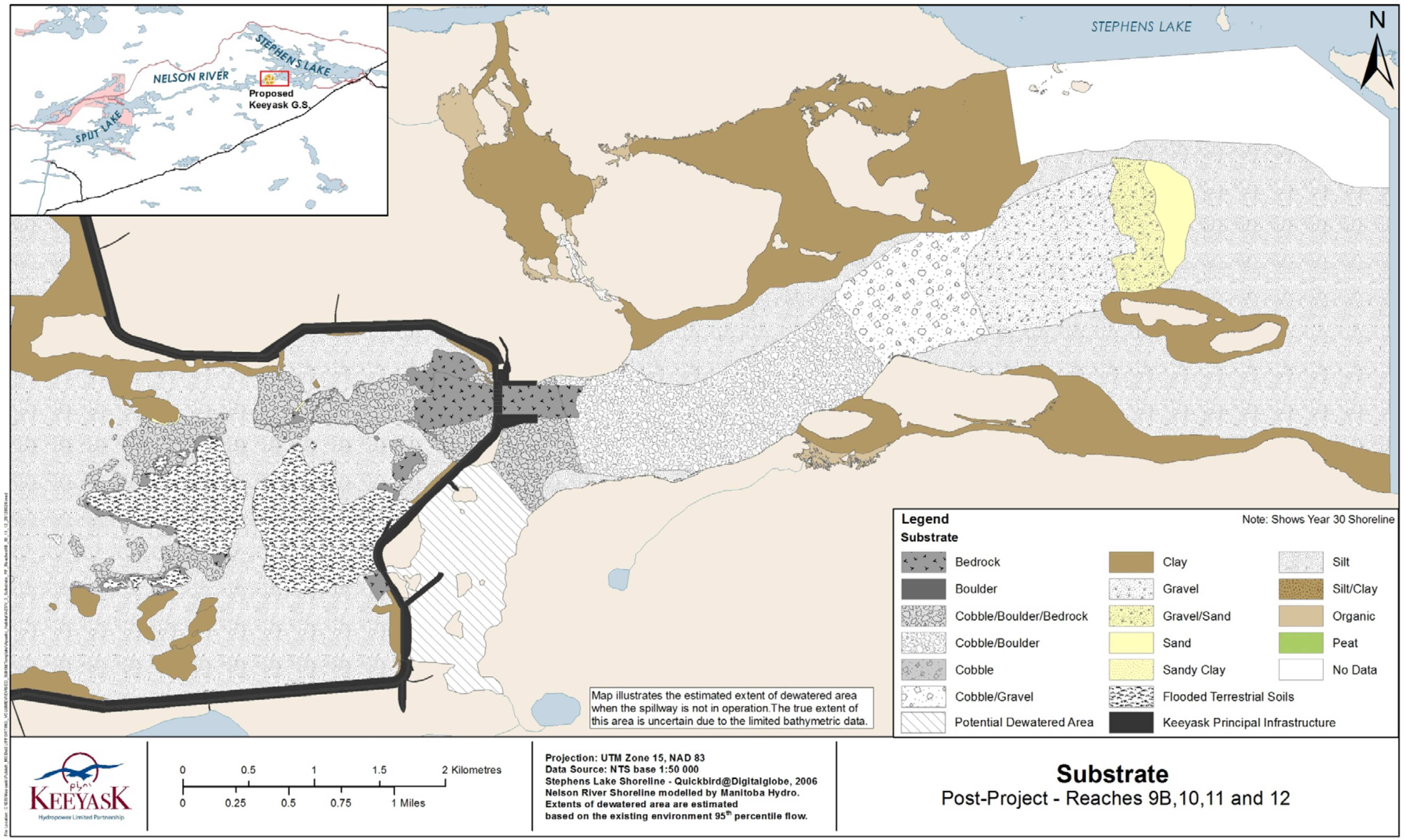
93



Map 1. Change of substrate type for the Existing Environment (upper panel) and Year 30 Post-Project. The extent of the existing environment 95th percentile shoreline is shown in blue for comparison to the Post-Project Year 30 shoreline.



Map 2. Change of substrate type for the Existing Environment (upper panel) and Year 30 Post- Project for the riverine reaches. The hydraulic zone of influence is shown in the lower panel for the Post-Project.



Map 3. Post-Project substrate immediately downstream of the generating station.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: Appendix 7A.1.1.3 Post-Project Nearshore Sedimentation Model; p. 7A-6

TAC Public Rd 2 DFO-0074

ORIGINAL PREAMBLE AND QUESTION:

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?

FOLLOW-UP QUESTION:

Sensitivity analysis not provided.

RESPONSE:

Analysis of nearshore mineral sedimentation upstream of the Keeyask Generating Station produced estimates of sediment deposition rates based on different loading conditions:

- Sediment loadings due to shoreline erosion were those resulting from operating 100% of the time in either a base loaded or a peaking mode of operation over the prediction periods (PE SV Sec. 6.4.2.1.3). The Keeyask Response to EIS Guidelines (Section 4.7.1 [appended to end of response]) describes the modes of operation. A peaking mode of operation produces less erosion, and thus less sediment than a base loaded mode of operation (Response to EIS Guidelines, Sec. 6.3.7.2). It is expected that the generating station will not operate 100% of the time in one mode or the other. Based on historic flow records, it could operate in peaking mode up to 88% of the time, although it could operate 27% of the time or more in a base loaded mode (PE SV Sec. 4.4.2.2.1, 4.4.2.2.2). Assuming erosion volumes due to 100% operation in one mode or the other gives a wider range of sediment input than would actually be expected since actual operation will be a mix of peaking and base loaded modes of operation.

- Using the estimated sediment loadings, the Post-project sedimentation environment was simulated under low, medium and high (5th, 50th, 95th percentile) open water flow conditions for different time frames of 1 year, 5 years, 15 years and 30 years after impoundment.

- Nearshore sedimentation modeling tested different cases where 50% to 80% of the eroded material was deposited within the nearshore area. The range of material deposited in the nearshore was based on a conceptual model of nearshore sedimentation, which tested the sensitivity of deposition based on injecting a sediment load at distances of 10 m to 50 m offshore (PE SV, Sec. 7A.1.1.3).

Sedimentation rates reported as ranges in the Response to EIS Guidelines (e.g., 1-2 cm/yr) encompass the likely range of sedimentation rates during operation, particularly because the predictions of sediment loads assume either 100% peaking or 100% base loaded operation when in fact the operation (and thus the loading) will be somewhere in between these two extremes. Deposition rates are not sensitive to flow because nearshore water velocities in the post-Project environment would be low and of similar magnitude regardless of flow.

Potential downstream sedimentation was also considered in the physical environment studies. Analyses that were performed to estimate sediment loads and downstream deposition during construction included the following (see Appendix 7A of the Physical Environment Supporting Volume (PE SV) for model descriptions):

- Estimation of potential changes in suspended sediment transported downstream for low, median and high flow conditions (i.e., 5th, 50th and 95th percentile flows) due to in-stream construction and removal of dams and cofferdams. Results reported in the Keeyask response to EIS Guidelines (Sec. 7.4.1; Figure 7.4-1) are for a low flow condition, which results in the largest potential increase in suspended sediment due to in-stream placement and removal of construction materials.

- Erosion of upstream shorelines resulting from water level increases along shorelines in the Gull Rapids area due to cofferdam construction in the river. The analysis considered erosion potential using four different sediment transport equations for two high flow conditions (i.e., 95th percentile and 1:20 year flood flows). Lower flows were not assessed because high flows produce the largest effects. Additionally, the analysis assumed an infinite amount of shoreline material would be available to be eroded from the shorelines, even though the actual amount of material available may be limited. The assessment of shoreline erosion during construction is therefore considered to produce estimates of potential Project effects that are higher than what is expected to occur.

- A sediment transport model was developed to analyse the transport of eroded materials through Stephens Lake, from just downstream of the Project to the Kettle Generating Station. Various model scenarios were assessed using input that considered multiple sediment gradations, several different flow conditions and two different sediment transport equations. The analyses found that the resulting deposition within Stephens Lake is not very sensitive to the variables. The amount of downstream sedimentation resulting from construction was estimated and reported in PE SV (Map 7.4-1).

- Additional modeling was completed to identify sediment deposition potential in the area downstream of the Project (i.e., about 5-6 km downstream) to assess sediment deposition potential near a known fish habitat area. Sediment deposition potential was analyzed for both the construction and operation periods for a range of flow and operating conditions. The modeling only assessed the potential for sediment deposition and did not include predictions of sediment deposition rates.

The downstream sedimentation analyses considered the sensitivity of estimated Project effects by considering a range of flow and sediment input conditions using several different erosion and sediment transport formulations. Results presented in the PE SV (Sec. 7.4.1) likely overestimate Project effects because the values reported are based on the high estimates of the Project effects rather than average effects.

The follow-up question for DFO-0073 also enquired about the risks of sedimentation with respect to fish and fish habitat. The relevant portion of the response to the follow-up question for DFO-0073 is copied below.

DFO-0073 RESPONSE:

Effects of sediment (i.e., silt) deposition on aquatic habitat in the reservoir in the long term (i.e., after 30 years of impoundment) were assessed based on whether or not sediment (i.e., silt) deposition was predicted(AESV Appendix 3B). The presence or absence of sediment deposition was used to determine whether a qualitative change of substrate type would occur. Studies of Stephens Lake showed that sites of net deposition, despite varying sediment deposition rates, develop a homogenous silt surficial layer within 30 years of impoundment. This silt layer completely covered the underlying materials, although the depth of silt varied depending on location (see AESV Appendix 3B, photo 3B-2). Therefore, the rate of sediment deposition is not the primary determinant of substrate availability three decades after impoundment. Instead, the approach to determine the long term type of substrate was to identify the boundaries of sites of net deposition (for methods see AE SV Appendix 3B).

Downstream of the generating station, the change in flow distribution in the river within 3 km of the generating station will create shoreline areas with minimal flow, where silt is expected to accumulate over rock in the long term (see AE SV Map 3-34). Further downriver (including at the area of the present day sand lens in Stephens Lake), the velocity post-Project will essentially be the same as today so deposited materials would be redistributed over time as they are today (PE SV Section 7.4.2.2.4). Superimposition of like materials would not change the habitat type (e.g., sand deposited on the sand lens will not change the habitat classification). It should be noted that sediment deposition and re- suspension occurs in the existing environment and will continue post-Project.

The description of sedimentation downstream of the generating station in PE SV Section 7.4.2.2.4 is reproduced below:

> *"7.4.2.2.4 Mineral Sediment Deposition*
>
> *As discussed earlier in this section, some of the relatively coarser sediment material would be deposited in the Keeyask reservoir. Absence of relatively coarser material in the flow in the Post-project environment downstream of Keeyask GS would likely cause reduction in deposition currently observed in the existing environment in Stephens Lake, particularly near the upstream end of the lake. It is expected that Project impact on the mineral deposition would be limited to a reach of approximately 10 km to 12 km from the Gull Rapids.*
>
> *As discussed earlier in Section 7.4.1.1, a young of year habitat area for Lake Sturgeon currently exists downstream of Gull Rapids near a sand and gravel/sand bed. Two-dimensional modelling was used to assess the spatial distribution of the potential for suspended material to be deposited near the young of yeah habitat area under Post-project conditions. The modelling results indicate that it is unlikely that silt will deposit near the young of year habitat under on-peak flows, such as all seven powerhouse units.*
>
> *Under off-peak flows, such as one Powerhouse unit, there is a higher potential for silt deposition near the young of year habitat area compared to the existing environment. However, due to the relatively short duration of off-peak flows, the amount of silt deposition would be very small and will likely be eroded from the bed under on-peak flows. Map 7.4-26 illustrates the potential for sediment deposition as well as the existing substrate immediately downstream of the Keeyask GS under all seven Powerhouse units operating at best gate flow. A detailed description of this two-dimensional modeling can be found in Appendix 7A."*

Copy of Text from Keeyask Response to EIS Guidelines, Section 4.7.1:

4.7.1 MODES OF OPERATION

The Project will operate as a modified peaking plant, meaning that it will operate either in a peaking mode or a base-loaded mode. The extent by which the Project will be operated in a base-loaded mode or a peaking mode will be determined by the flows in the Nelson River and the requirements of the Manitoba Hydro integrated power system to meet the power demands at that time.

There may be occasions when the Project will be required to operate in a special or emergency mode of operation. Special conditions include load rejection (units tripping off due to mechanical, transmission or other problems), flood management, or meteorological events. Emergency conditions include a risk of imminent failure of one of the dams or dykes or when the flow passing through the station needs to be halted temporarily.

When the Project operates in a peaking mode, water stored in the reservoir will be used to augment Nelson River inflows so that maximum power can be generated during the weekday on-peak periods to coincide with peak power demand. At night, when demand for power is lower, flow through the station will be reduced to store water in the reservoir for use the following day, resulting in an overnight increase in the reservoir level. During weekends, flows through the station will be reduced to fill the reservoir to the FSL by the following Monday morning. The reservoir may fluctuate up to 1.0 m in one day between the FSL and the MOL during a peaking mode of operation. When the Project operates in a base-loaded mode, the reservoir will remain relatively stable at or near the FSL and the outflow from the station will be approximately equal to the inflow. The volume of water available in the reservoir for a peak mode of operation is 81.4 million m3 when the reservoir is at its full supply level. During the first 30 years of operation the reservoir is predicted to expand by 7-8 km2 due to the erosion of mineral shoreline and peatland disintegration. Reservoir storage would increase to 84.9 – 85.4 million m3. Based on historic flow records since the LWR and CRD have been in operation, the Project could operate in a peaking mode up to about 88% of the time.

There will be two potential constraints on the mode of operation to mitigate environmental effects. The first potential constraint would be a minimum plant discharge equal to two units at best gate setting and five units closed during the lake sturgeon spring-spawning period to ensure sufficient water velocities exist in the sturgeon spawning areas to be constructed downstream of the powerhouse. The results of monitoring will be used to assess if this constraint is required or if the spawning shoal requires modification. The second constraint would be applied if monitoring shows that lake sturgeon eggs are deposited downstream of the spillway during its operation and requires that the spillway discharge be maintained at levels sufficient to permit egg hatch and survival of larval fish until they emerge and drift from the site (see Section 6.4.6.2.2).

The surface water and ice regimes during operation are described in Section 6.3. The existing environment and post-Project environment shorelines (at FSL) and water surface profiles for open water conditions are shown in Map 4-3.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: 7.4.1 Construction Period; p. N/A

TAC Public Rd 2 DFO-0075

ORIGINAL PREAMBLE AND QUESTION:

The EIS notes "Placement and removal of cofferdams/groins during Stage II Diversion will occur over three years (2017, 2018, and 2019) during the open water seasons. Most of these activities are predicted to result in increases in TSS of less than 5 mg/L above background, which would be within the…CCME guidelines for the protection of aquatic life. The exceptions include placement of the South Dam Rock Fill Groin, which is predicted to result in TSS increases of up to 15 mg/L above background, with increases of greater than 5 mg/L for a period of approximately 10 days in early September 2017. An increase in TSS of 7 mg/L for a period one month is also predicted during removal of the Tailrace Summer Level Cofferdam in September/October 2019.

The Proponent predicts several instances of average TSS increases greater than the CCME guideline for longer term impacts (e.g., inputs lasting between 24 h and 30 d should not exceed 5 mg/L above background). Are there additional opportunities, both reasonable and practical, to further prevent and mitigate sediment releases such that the guidelines can be met? For example, if a given TSS exceedance is in part due to shoreline erosion, would pre-emptive shoreline stabilization be an option?

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

While it is recognized that it is not possible to prevent sediment releases so that TSS concentrations meet the CCME guidelines at all times and at all locations, reasonable and practical methods to reduce sediment inputs are described in the In-stream Construction Sediment Management Plan (SMP). Monitoring conducted as part of the Physical Environment Monitoring Plan (PEMP) and the Aquatic Effects Monitoring Plan (AEMP) will be used to confirm the predicted effects of sediment releases on the environment.

The Partnership provided a preliminary draft of the Keeyask Generation Project Sediment Management Plan for In-Stream Construction to regulators on October 17, 2012 and a revised draft will be provided during the 2nd quarter of 2013. Preliminary drafts of the PEMP and AEMP will be provided during the 2nd quarter of 2013.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: 7.2.1.

TAC Public Rd 2 DFO-0076

ORIGINAL PREAMBLE AND QUESTION:

The EIS notes "Prediction of the post-impoundment…environment upstream…was carried out by…numerical modeling…Depth-average mineral suspended sediment concentrations were estimated for average (50th percentile) flow for prediction periods of 1 year, 5 years, 15 years and 30 years after impoundment. Sediment concentrations were also predicted for low (5th percentile) and high (95th percentile flow conditions for…1 year and 5 years after…impoundment. While outside the zone of hydraulic influence, a qualitative assessment was carried out for…sedimentation…in Stephens Lake…"

Can the Proponent provide some explanation, or direct reviewers to its location, of why TSS modeling at selected flow percentiles, e.g., 50th percentile or 5th and 95th percentile, or other model settings, provide good estimates of likely effects on the aquatic environment?

FOLLOW-UP QUESTION:

Can the proponent clarify why a median is used for the first, fifth, fifteenth, and thirtieth years while 5th, 50th, and 95th percentiles are only estimated for one and five years after impoundment? Proponent plan still in production and not available for review.

RESPONSE:

This follow -up question is similar to the original question asked in TAC Public Rd 1 DFO-0070. The second paragraph of the response to TAC Public Rd 1 DFO-0070 addresses why total suspended sediment concentrations were not modelled at 5^{th} and 95^{th} percentile flows beyond year 5:

> *"Based on the 50th percentile results, most of the changes in total suspended solids concentrations are predicted to occur between years 1 and 5. Similar trends were predicted for the 5th and 95th percentile flow scenarios. No modeling was carried out for 15 and 30 years for the low and high flow conditions because the results are expected to be similar to the 50th percentile."*

It should be noted that 50 percentile and median flows refer to the same flow.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 2.5.2.2.5 Total Suspended Solids/Turbidity; p. 2-66 to 2-68

TAC Public Rd 2 DFO-0077

ORIGINAL PREAMBLE AND QUESTION:

The EIS notes “Placement and removal of cofferdams/groins during Stage II Diversion will occur over three years (2017, 2018, and 2019) during the open water seasons. Most of these activities are predicted to result in increases in TSS of less than 5 mg/L above background, which would be within the…CCME guidelines for the protection of aquatic life. The exceptions include placement of the South Dam Rock Fill Groin, which is predicted to result in TSS increases of up to 15 mg/L above background, with increases of greater than 5 mg/L for a period of approximately 10 days in early September 2017. An increase in TSS of 7 mg/L for a period one month is also predicted during removal of the Tailrace Summer Level Cofferdam in September/October 2019…”

If increases in TSS exceeding the CCME guidelines appear to be unavoidable, can the Proponent provide additional discussion and rationale (or direct reviewers to the location of that information in the EIS) for why the exceedences, in the Nelson River at Keeyask case, are not likely significant adverse environmental effects. For example, can the Proponent indicate that an exceedance of 7 mg/L TSS above background for 30 days in September/October is not likely to be in the sub-lethal or lethal severity of effect range for fish, fish eggs or larvae, benthic macroinvertebrates, or other aquatic organisms. In addition, can the Proponent say that the exceedance when added to the expected background range for that time of year is within the anticipated natural range of TSS in the Nelson River at the Project site, and in one case downstream to the estuary, at that time of year?

FOLLOW-UP QUESTION:

Would the proponent please provide an expanded discussion of the type and extent of expected sub-lethal effects, extracting information as necessary from the EIS sections referred to?

RESPONSE:

As described in AE SV Section 2.5.2.2.5, p. 2-66 to 2-68, increases in TSS within the order of tens to hundreds of mg/L are generally associated with sub-lethal effects to fish such as behavioural alterations, reduced growth or condition, and physiological stress (e.g., DFO 2000). Acute toxicities are generally reported for concentrations ranging from the hundreds to hundreds of thousands of mg/L (DFO 2000; Robertson et al. 2006). The available scientific literature indicates a potential for reduced hatching success in salmonids exposed to elevated TSS concentrations on the order of two months or more, at concentrations ranging from 6.6–157 mg/L (Table 2-17).

Based on the available scientific literature, the predicted increases in TSS may result in sublethal effects to fish, but would not be in the lethal severity of effect range. Sublethal effects of increases in TSS on fish may include behavioural alterations (e.g. avoidance of sediment plumes), reduced growth or condition, and physiological stress. Indirect effects include changes in the food web (e.g., reductions in primary production due to reduced water clarity, reduced abundance of benthic invertebrates due to increased TSS and/or sedimentation causing reductions in the abundance of fish diet items), which are considered in Section 4.

As noted in the response provided to the original information request, the predicted increases in TSS during Project construction are expected to remain within the existing range of TSS in the area (i.e., 5-30 mg/L). Notably higher concentrations of TSS occur in other river systems which support similar or even more diverse fish species assemblages. For example, the mean TSS concentrations measured by Manitoba Conservation and Water Stewardship over the period of 1997-2006 in the Assiniboine River at Headingley (120 mg/l), the Red River at the south gate of the floodway (132mg/L), and the Red River at Selkirk (124 mg/L) are an order of magnitude higher than the predicted TSS concentrations for the Keeyask Project.

Based on discussions at a technical review meeting on February 15, 2013, among KHLP, DFO and MCWS, sublethal effects were examined using the model described in the response to TAC Public Rd 2 DFO-0085. For ease of reference, this response is copied below.

DFO-0085 RESPONSE:

Predicted effects of altered total suspended solids (TSS) on aquatic life in the Keeyask area are discussed in the Aquatic Environment Supporting Volume (AE SV) and provided in the response to TAC Public Rd 2 DFO-0069. As noted in the AE SV, we are not aware of studies assessing the effect of low level increases of TSS on fish species in the Keeyask area. In the absence of data, the reviewer requested hypothetical modeling for evaluation of sub-lethal risks; we are only aware of the Severity of Ill Effects model (SEV) developed by Newcombe and Jensen (1996) for this purpose. However, as discussed below, this model is not able to accurately predict the effects of low levels of TSS on aquatic life. Nevertheless, the requested assessment was conducted and is provided below.

Manitoba water quality objectives (MWS 2011) and CCME water quality guidelines (1999; updated to 2013) for TSS for the protection of aquatic life are based on the British Columbia Ministry of the Environment Lands and Parks (BCMELP) guidelines, derived using the severity of ill effects model originally developed by Newcombe and Jensen (1996) and modified by Caux et al. (1997). Specifically, the BCMELP criteria were developed based on the Newcombe and Jensen (1996) SEV Model for adult salmonids (Model 2); this group was determined to elicit the largest response to a given increase in TSS concentration over a set duration (i.e., this group was identified as the most sensitive based on the various models developed). Consideration of exposure duration as well as background conditions in the natural environment were incorporated into the criteria.

As noted in the AESV, the MWQSOG/CCME PAL guideline is predicted to be exceeded in the fully mixed Lower Nelson River during three events:

- Exposure Scenario 1: maximum predicted increase of 7 mg/L for approximately six days during placement of the Spillway and Central Dam cofferdams in July 2015;
- Exposure Scenario 2: an increase in TSS of 7 mg/L for a period of one month during removal of the Tailrace Summer Level Cofferdam in September 2019; and
- Exposure Scenario 3: maximum predicted increase of 15 mg/L for 10 days (actual concentrations are predicted to peak at 15 mg/L above background and to decrease over this 10 day period) during placement of the South Dam Rock Fill Groin in early September 2017.

TSS currently ranges between 5 and 30 mg/L, averaging 14 mg/L in the Gull Lake area. Using the existing background TSS conditions, effects of increases in TSS identified above on fish were examined using the Newcombe and Jensen (1996), as modified by Caux et al. (1997), Severity of Ill Effects Model for adult salmonids (Model 2) and non-salmonid freshwater fish (Model 6).

<u>Effects on Salmonids</u>

SEV scores for adult salmonids are presented in Figure 1 and Table 1 for a range of scenarios applicable to the Keeyask Project. As the SEV models generate scores based on absolute TSS concentrations rather than effects related to relative increases, it is relevant to compare scores for the exposure scenarios indicated above to the scores based on background TSS concentrations. All three exposure scenarios cause an increase in the SEV scores of one or less, and most scenarios cause changes of less than 0.5. The largest change in SEV score is predicted to occur under the minimum TSS background condition (5 mg/L); as discussed below, the SEV model is limited in its ability to predict effects of low concentrations of TSS, in particular due to the lack of empirical data on which the model was constructed. All SEV scores are below the paralethal/lethal threshold (SEV = 9) and the highest SEV rankings are unchanged from background conditions under each of the three scenarios (Table 1).

Effects on Adult Freshwater Non-Salmonids

SEV scores for adult freshwater non-salmonids are presented in Figure 2 and Table 2 for a range of scenarios applicable to the Keeyask Project. SEV scores for exposure scenarios 1 and 3 are below the paralethal/lethal threshold (SEV = 9; Table 2). However, SEV scores exceed 9 for scenario 2 – including purely background TSS conditions (i.e., without Project-induced increases in TSS). It is also worth noting that this model predicts that concentrations of TSS of 5 mg/L (the minimum measured in the Keeyask area), would prove lethal to non-salmonids in less than one month (Figure 3). A concentration of near zero (0.1 mg/L) is predicted to be lethal by the SEV model in less than 2 months. This observation illustrates one of the key limitations of this model; the model is not reliable for predicting effects associated with low concentrations of TSS. For the purposes of assessing potential effects associated with the Keeyask Project, it is the relative difference between the SEV scores with and without the Project that is of relevance. All three exposure scenarios cause an increase in the SEV scores of less than 0.5, and most scenarios cause changes of less than 0.2.

Context

For additional context, Figure 3 presents SEV model results for a TSS concentration of 120 mg/L – the mean concentration measured in the Assiniboine River at Headingley. Mean concentrations in the Red River are of a similar magnitude (132 mg/L at the south gate of the floodway and 124 mg/L at Selkirk). These averages are an order of magnitude higher than the predicted TSS concentrations for the Keeyask Project. Over a 365 day period, this average concentration (120 mg/L) is predicted to cause SEV rankings of 10 and 12 for salmonids and non-salmonids, respectively. These scores fall into the categories of “0-20% mortality, increased predation, moderate to severe habitat degradation” and “40-60% mortality”, respectively.

Conclusions

The SEV model developed by Newcombe and Jensen (1996) has been criticized for its inherent inability to accurately predict effects of low levels of TSS to aquatic life, as these conditions were not captured within the database used to construct the model (e.g., Birtwell et al. 2003, Anderson et al. 1996). Therefore, the utility or accuracy of the model to predict risks to fish associated with small increases in TSS is limited.

Notwithstanding the limitations of the SEV model to predict effects of small increases in TSS on fish, the SEV model indicated that scores increased by less than one, and generally less than 0.2, for the various potential exposure scenarios examined.

Collectively, these results indicate effects of the predicted increases in TSS on salmonids and non-salmonids during construction would be small and potentially indistinguishable from existing conditions.

REFERENCE: Volume: Physical Environment Supporting Volume; Section: Appendix 7E Sedimentation Field Data 2004 to 2007; p. N/A

TAC Public Rd 2 DFO-0078

ORIGINAL PREAMBLE AND QUESTION:

The EIS notes “data collected in the open water periods of 2005 to 2007 indicates…suspended sediment concentration generally lies within the range of 5 mg/L to 30 mg/L…from Clark Lake to Gull Rapids…sediment concentrations can vary within their normal range at a given location in a given day…variations…over a short period…can be due to many reasons, including local turbulences in the waterbody, changes in the meteorological environment, and local bank erosion processes…suspended sediment concentrations…in the open water period…2001 to 2004…show similar ranges (2 mg/L to 30 mg/L with an average of 12 mg/L)…A report prepared by Lake Winnipeg, Churchill and Nelson Rivers Study Board in 1975…documents a suspended sediment concentration range of 6 mg/L to 25 mg/L with an average of 15 mg/L based on…measurements in 1972 and 1973. Field studies…on the Burntwood and…Lower Nelson River reach also show a concentration range of 5 mg/L to30 mg/L (Acres…2004…2007b, KGS Acres 2008b…KGS Acres 2008c)…Suspended sediment concentration measurements during…winter…(January to April), of 2008 and 2009 reveal that sediment concentration variations in the winter period are larger than the open water period. A limited data set collected at monitoring locations in Gull Lake show a concentration range of 3 mg/L to 84 mg/L, with an average of 14.6 mg/L…”

The Proponent provides some ranges, point estimates, and expected durations of TSS changes. Would it be possible to provide, or direct reviewers to where this information is in the EIS, sample sizes and standard deviations for estimates? Where intervals that are not ranges, would it be possible to specify the level of confidence? E.g., are they 95% confidence intervals for a mean?

FOLLOW-UP QUESTION:

Would the proponent please provide a description of the extent to which the historic TSS information can be expected to represent seasonal and year-to-year variation in TSS? Would the proponent please propose one or more composite sample sizes, averages and standard deviations as background criteria for expected TSS during construction for determining the power of its proposed monitoring program?

RESPONSE:

The proponent understands that the question is asking for a statistical characterization of the historic total suspended solids (TSS) data to be used as a background criterion against which observed TSS during construction would be compared. Based on this understanding, the question suggests that TSS levels obtained from monitoring for the Sediment Management Plan for In-Stream Construction (SMP) would be compared with baseline data to determine if TSS increases due to in-stream construction exceed action levels specified in the SMP. The proponent notes that the SMP uses real time monitoring of ambient in-stream conditions to measure changes in TSS in the river as in-stream work is taking place. The monitoring is not based upon the measurement of changes relative to conditions observed in the pre-Project baseline studies.

Implementation of the SMP will involve identifying changes in TSS between a reference monitoring site (SMP-1) just upstream of in-stream construction, a site (SMP-2) in the mixing zone just downstream of in-stream construction, and a site (SMP-3) in a fully mixed zone further downstream. The monitoring is designed to detect if an in-stream construction activity causes an increase in ambient TSS between SMP-1 and SMP-2 that exceeds specified action levels. The SMP (Sec. 4) describes actions to be taken to reduce the effects of in-stream construction if it causes TSS to increase by 200 mg/L or more in a 15-minute averaging period or 25 mg/L or more in four consecutive 15-minute averaging periods. The action levels at SMP-2 are set so that increases due to construction can be addressed in sufficient time to take action to attempt to maintain the 24-hour average increases at SMP-3 (relative to SMP-1) below 25 mg/L as well as the areas downstream of SMP-3.

The SMP will use automated probes to continuously measure ambient turbidity levels in the river in real time as in-stream work is occurring, and will continuously transmit the data to an on-site environmental office. Turbidity values will be converted to TSS concentrations using a linear regression relationship between turbidity and TSS based on data collected during baseline environmental monitoring studies. During in-stream work, samples of water at the monitoring stations will be periodically collected and analyzed for TSS to confirm or adjust the turbidity-TSS relationship, as required. It is anticipated that each probe will measure and transmit several dozen turbidity measurements every hour and hundreds of measurements per day.

Because the SMP is based on real-time monitoring, the background TSS at SMP-1 and the TSS at SMP-2 and SMP-3 will vary in real-time as ambient conditions change. Thus the calculation of TSS changes and determination of whether or not action levels are exceeded is based on ambient conditions while in-stream work is taking place. The SMP monitoring does not measure TSS changes relative to fixed background criteria (e.g., seasonal or annual) based on data from pre-Project environmental studies.

Although the SMP is based on ambient TSS conditions rather than a comparison with pre-Project monitoring data, an a-priori power analysis was performed to determine the number of samples required to detect changes equal to the specified action levels (i.e., the effect size to be detected). The analysis assumes that the standard deviation of TSS from the baseline data used to develop the turbidity-TSS relationship (see Figure 1 below) are representative of the standard deviations of the SMP measurements over the 15-minute and 1-hour averaging periods at SMP-2 and the 24-hour averaging period at SMP-3. The power analysis employed methods described in the documents Metal Mining Technical Guidance for Environmental Effects Monitoring (Environment Canada, 2012, Ottawa) and Guidance Document on Collection and Preparation of Sediments for Physicochemical Characterization and Biological Testing (Environment Canada, Environmental Protection Series Report, EPS 1/RM/29, 1994, Ottawa). Assuming 5% significance coefficients ($\alpha = \beta = 0.05$; power=1- β=95%), approximately four measurements are required to detect effect sizes of 25 mg/L and 200 mg/L, while approximately 40 samples would be required for an effect size of 5 mg/L. Based on the anticipated sampling frequency, a sufficient number of measurements will be obtained to detect TSS changes equal to the action levels over the specified averaging periods with a high level of power.

As noted above, TSS at the SMP monitoring sites will be calculated using a linear regression relationship between turbidity and TSS (SMP, Sec. 3.2). In order for calculated TSS differences between the upstream reference site (SMP-1) and the downstream sites (SMP-2, SMP-3) to be considered statistically significant, the sum of the confidence intervals for the TSS estimates at SMP-1 and SMP-2 or SMP-3 must be less than the effect sizes to be measured. Based on the 95th percentile confidence intervals for the linear regression (Figure 1) and assuming typical TSS concentrations of about 5 mg/L to 30 mg/L at the reference site (SMP-1), TSS differences of 200 mg/L between SMP-1 and SMP-2 or 25 mg/L between SMP-1 and SMP-3 would be considered statistically significant.

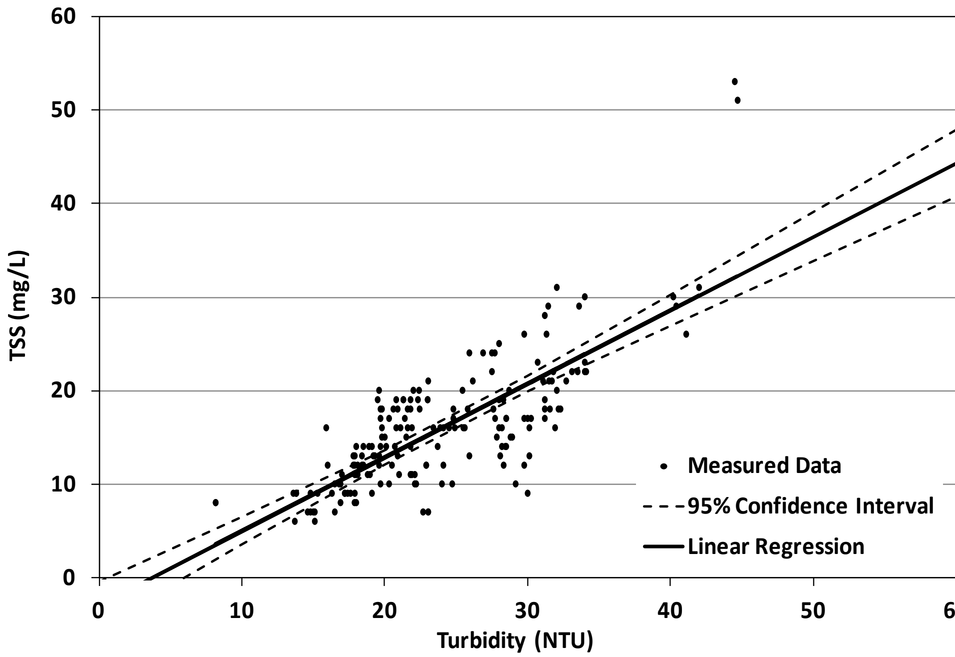


Figure 1: TSS-Turbidity Relationship for the Nelson River at Keeyask

Two locations will be monitored at each SMP monitoring site, with the locations spaced evenly across the river (i.e., left and right side of channel). Pre-project TSS monitoring across transects at sampling sites K-S-06 (location of SMP-1) and K-S-07 (just upstream of SMP-2) found that TSS typically had a small variation across the river width. From eight sets of TSS transect data at K-S-06 (five sample points across the river) from 2005-2007, the average standard deviation of TSS across the river was 1.4 mg/L. At K-S-07 the average standard deviation from seven sets of transect data was 1.2 mg/L. On average, the standard deviations were less than 10% of the average TSS concentration across the transects. Due to the low variation in TSS across the river width, sampling at two locations at each SMP site is expected to reasonably represent average conditions at each site for the purposes of the SMP monitoring program. Because site SMP-2 is in the mixing zone downstream of in-stream construction, the variability in TSS across the river will likely be greater than observed in the existing environment if in-stream work causes an increase in TSS at SMP-2. Based on discussions with regulators (March 25, 2013; Canadian Environmental Assessment Agency; Fisheries and Oceans; Environment Canada), methods are being developed to confirm that site SMP-2 is able to detect changes in TSS concentrations due to in-stream construction activities. A potential method that is being explored is to augment the ambient measurements from the in-situ data loggers with additional manual readings. Potential revisions to the proposed SMP monitoring will be the subject of additional discussions with the regulators.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 2A Background Information on Selected Water Quality Parameters, 2.5.2.2.5 Total Suspended Solids/Turbidity, and 4.2.4.2 Operation Period; p. N/A

TAC Public Rd 2 DFO-0080

ORIGINAL PREAMBLE AND QUESTION:

The EIS says "Mineral TSS would generally remain within the chronic Manitoba PAL water quality objective and the CCME PAL guideline (a change of less than or equal to 5 mg/L relative to background, where background TSS is less than or equal to 25 mg/L). The exceptions would occur in the immediate reservoir (reach 9) and reach 8 (the area north of Caribou Island) under high flow conditions, where decreases may be larger than the Manitoba water quality objective…"

When discussing TSS decreases the Proponent refers to TSS guidelines as being for changes. In fact, the guidelines talk about increases only – not changes in general – so that they do not really apply to decreases in TSS. Can the Proponent explain in more detail its criteria for discussing changes?

FOLLOW-UP QUESTION:

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?

RESPONSE:

The Manitoba water quality objective (MWQSOG) for TSS for the protection of aquatic life (PAL) refers to a change in TSS and therefore applies to both increases and decreases in TSS. The AESV compared predicted changes (both increases and decreases in TSS) to the MWQSOG. This comparison indicated that under high flows in reaches 7 and 8 (at the downstream end of present day Gull Lake) and most notably reach 9 (the reservoir immediately upstream of the GS) TSS may decrease by more than the MWQSOG for PAL. It is also noted in the AESV (p. 2-70), that these decreases in TSS will in turn increase water clarity.

As discussed in Section 4.2.4.2.2, the increase in clarity and other changes in the mainstem of the Nelson River within the Keeyask reservoir are not expected to affect phytoplankton growth due to the extremely short residence time:

> *"However, detectable changes in mean phytoplankton biomass along the mainstem are not expected as increased water residence time will remain too*

> *short to permit a measureable increase in phytoplankton biomass… The lack of detectable effects may be attributed to high water flushing rates through the mainstem portion of the reservoir (i.e., post-Project water residence time will be in the order of 15-30 hours, depending on flows, Section 3.4.2.2)."*

There is a potential for increased clarity in Stephens Lake to have a small effect on phytoplankton, as described in Section 4.2.4.2.3:

> *"Downstream effects on water quality are not expected to be substantive as the conditions of the reservoir outflow will not be considerably different from current conditions (Section 2.5.2.3). The major exception is a predicted decrease in TSS at the outflow of the GS. Furthermore, TSS is expected to decrease further as water moves through Stephens Lake and this area of reduced TSS would likely extend approximately 10–12 km downstream of the GS. This improvement in water clarity is expected to result in a long-term, small increase in phytoplankton biomass in the affected portion of Stephens Lake (Figure 4-6). The absence of a marked increase in phytoplankton biomass is likely due to the relatively short water residence time within the portion of Stephens Lake along the main flow of the Nelson River, which, although longer than the unimpounded river, is still too short to allow substantial growth of phytoplankton."*

REFERENCE: Volume: Physical Environment Supporting Volume; Section: 7.4.1 Project Effects, Mitigation & Monitoring, Construction Period; p. 7-22

TAC Public Rd 2 DFO-0083

ORIGINAL PREAMBLE AND QUESTION:

"Water Quality: Project Effects, Mitigation, and Monitoring…Construction Period…Total Suspended Solids, Turbidity, and Water Clarity…" p 2-40 "Cofferdam Placement and Removal…during Stage I and II Diversions have the potential to increase TSS in the Nelson River…results…presented in detail in the PE SV, section 7.4.1…Predicted increases in TSS refer to the fully mixed condition, approximately 1 km downstream of Gull Rapids…"

The Proponent notes that it has modeled TSS downstream at 1km from the construction area in the fully mixed zone. Will the Proponent be able to monitor TSS closer to the construction areas? What sort of area might be affected by construction TSS increases greater than those predicted upstream of the fully mixed zone. What are the, at source, sediment loading TSS concentrations likely to be, how extensive might they be in area, and what might their durations be?

FOLLOW-UP QUESTION:

Would the proponent please re-iterate information provided for a previous question so that the reader does not have to refer to another response? The answer refers to information not provided with the EIS. Please use information from documents developed after the EIS to provide an answer to the question. Would the proponent please describe the extent and nature of plumes exceeding effect thresholds and evaluate them for potential lethal and sub-lethal risks?

RESPONSE:

The response to TAC Public Rd 1 DFO-0083 pointed to the response for TAC Public Rd 1 DFO-0067, which states:

> *"During the construction phase of Project, the first downstream monitoring site (SMP-2) for the Sediment Management Plan for In-stream Construction (SMP) is proposed to be located approximately 1.5 km downstream of all in-stream sediment sources from the Project. Moving this location closer to the construction site is problematic due to high water velocities and turbulent flow conditions in the area just downstream of Gull Rapids. Based on experience from baseline monitoring programs, these conditions can result in significant safety hazards for people and equipment."*

The Partnership provided a preliminary draft of the Sediment Management Plan for In-stream Construction to regulators on October 17, 2012 and a revised draft will be provided during the 2nd quarter of 2013.

Areas where total suspended solids (TSS) will be higher than in the fully mixed zone will be localized and will depend upon where the sediment originates and how the plume disperses between the source and the fully mixed zone. Sediments entering the Nelson River during in-stream work will primarily come from two sources: shoreline erosion and in-stream placement/removal of construction materials. As the plumes generated at the source disperse downstream and across the river, the TSS concentration will reduce. Passage of flow through the spillway and powerhouse for the first time will also result in downstream TSS increases.

During Stage I river diversion, the river’s flow will be diverted through the south channel of Gull Rapids, resulting in the erosion of susceptible shorelines because of increased flow velocities. Shorelines along the south channel that are most likely to erode extend over a distance of about 1.5 km (shown in Map 6.4-1 of the PE SV which is attached to this response). Due to the high flow velocity in the south channel and shoreline geometry (relatively mild sloped banks), the transverse spread of the plume across the river would not be large: likely remaining within tens of metres of shore, but mixing completely with the main flow once it passes through Gull Rapids. Such plumes moving along the shoreline have been observed in the existing environment (as shown in Photo 7.3-1 below of the PE SV).

PE SV Photo 7.3-1: An Example of High Suspended Sediment Concentration in Nearshore Areas (Photo Taken by Lynden Penner in 2004)

During Stage II river diversion shoreline erosion would occur mainly because of water level increases and flooding of shorelines in the Gull Rapids area upstream of the cofferdams. The erosion of shorelines are expected to be gradual during this stage, but the length of eroding shoreline would be larger that Stage I river diversion. Erosion and dispersion of sediment would be similar to that predicted for the reservoir after impoundment. The conceptual model for nearshore sediment transport in the reservoir predicted most of the eroded material remains within 100 m of the shoreline and TSS concentration drops to a level of 5 mg/L above the ambient TSS concentration about 300 m downstream from its source. Sediment plumes generated during this stage of construction will be completely mixed with mainstem flow as it passes through the partially completed spillway.

A local increase in TSS concentration up to the levels observed in the existing environment is expected in nearshore areas due to shoreline erosion during Stage I and Stage II river diversion. During baseline monitoring of the existing environment from 2005-2007, high TSS concentrations of between 60 and 125 mg/L were observed in the nearshore area (PE SV Sec. 7.3.1.1.1). TSS increases during Stage I and II are expected to be at peak levels over a period of several days and taper off gradually over a few weeks as material susceptible to erosion is eroded and material less susceptible to erosion is exposed (as shown in PE SV, Sec. 7, Figure 7.4-1 – an updated version of the figure was provided in the SMP and is provided at the end of this response).

At-source daily average TSS increases were estimated for in-stream construction and removal of dams and cofferdams. The analysis estimated suspended sediment concentrations at the source and for fully mixed conditions, and did not provide estimates of spatial dispersion downstream of the source. Therefore, the spatial extent of plumes was estimated based on an assumption of linear dispersion over a mixing distance of about 1.5 km. At source increases of more than 5 mg/L ranged from about 6 mg/L to 19 mg/L for durations of 2 to 33 days for all construction activities except for the Tailrace Summer Level Cofferdam. For even the highest value in this range, dispersion is estimated to reduce the TSS increase to less than 5 mg/L above background within about 50 m downstream, and about half the source concentration over approximately half that distance. The affected areas are less than 0.1 ha. During construction of the Tailrace Summer Level Cofferdam, a daily average sediment concentration up to 43 mg/L is expected for 20 days at the source. This is estimated to disperse to less than a 5 mg/L increase within about 100 m of the tailrace summer level cofferdam over an area of less than about 0.4 ha. However, the increase is expected to be localized between two rock groins forming the cofferdam and would not be exposed to the main river flow.

The removal of the Tailrace Summer Level cofferdam is expected to locally increase daily average sediment concentration between 35 and 70 mg/L above background, with the highest concentrations in an area within 50 m from the cofferdam. This results from removal of the impervious material sealing the outside of the cofferdam. The sediment would be predominantly clay and silt and, based on linear dispersion as noted above, it is estimated to disperse to less than a daily average 25 mg/L increase within about 300 m downstream of the cofferdam over an area of less than about 4 ha. In the fully mixed zone, the increase in sediment concentration would be up to 7 mg/L because of this activity. The duration of the removal activity was conservatively assumed as 25 days in the construction schedule but the actual number of days with a TSS increase of 7 mg/L is expected to be between 5 and 10 days depending on the flow conditions and removal methods. The sedimentation analysis conservatively assumed an increase of 7 mg/L over the 25-day duration of the removal activity (see PE SV, Fig. 7.4-1; also see copy of revised figure (Fig. 5) from the draft SMP at end of this response). This conservative increase was used in the aquatic assessment (e.g., see AE SV: Sec. 2.5.1.1.3 on water quality; Sec 4.2.4.1.2 for phytoplankton and corresponding sections for other lower trophic topics; Sec. 5.4.1.2.6 for fish community).

The estimated TSS increases noted above are for low flow conditions (i.e., 5^{th} percentile flows). At median (50^{th} percentile) and high (95^{th} percentile) flows the estimated concentrations are about 40% to 60% lower, respectively. Overall, the sediment plumes are expected to affect relatively small areas over short distances downstream for durations of several days to several weeks.

In addition to the sources noted above, sediment will enter the river when flow is first passed through the spillway and powerhouse. This results from erosion of cofferdam remnants and suspension of fine materials that generally cannot be completely removed from the excavated approach and discharge channels (e.g., in cracks and crevices of rock surface). The following description of potential effects due to first flows through these structures was provided in the draft SMP (Sec. 2.3.2):

> *"Based on the TSS assessments and Manitoba Hydro's recent experience during the construction of the Wuskwatim GS, the maximum increases in TSS are expected to occur when water is first passed through the Spillway and the Powerhouse which activities do not occur at the same time. The maximum increases in TSS are predicted to occur when water is first passed through the Spillway. For a scenario with all seven Spillway bays each open 1 m (worst case scenario), the downstream instantaneous TSS in the proximity of site SMP-2 is predicted to increase sharply to a maximum peak of up to 250 mg/L and then drop rapidly, with elevated TSS persisting for about 25 minutes. Subsequent increases in flow through the Spillway bays (with gates open more than 1 m) would result in sharp peaks that rapidly attenuate. It is predicted that each subsequent peak will be progressively lower in magnitude. The increase in daily average TSS is predicted to range between 1 and 25 mg/L (Figure 5 [ed. note, provided on following page]) for scenarios with one Spillway bay open 1 m and seven Spillway bays each open 1 m, respectively. It should be noted that the opening seven Spillway bays was modeled to gain an understanding of the potential sediment load for the worst case scenario, but it does not represent how the Spillway will be commissioned. During the first flow through the Spillway, the Spillway gates will be actively managed to control and maintain the TSS level within the limits described in Section 4.*
>
> *During the testing of the Powerhouse units, the TSS level is predicted to increase by 41 mg/L at the initial start-up of Unit 1 (5-minute average TSS level). The TSS concentrations are predicted to decrease with each subsequent incremental increase of flow through this unit. Less effect on TSS level is expected when testing the subsequent Powerhouse units. The predicted increase in daily average TSS is predicted to be less than 1 mg/L (Figure 5) during the testing of the Powerhouse units."*

The follow up request regarding information on potential lethal or sub-lethal effects is similar to the follow up questions for DFO—0069, DFO-0077 and DFO-0085. The response to the follow up question for DFO-0077 states:

DFO-0077 RESPONSE:

As described in AE SV Section 2.5.2.2.5, p. 2-66 to 2-68, increases in TSS within the order of tens to hundreds of mg/L are generally associated with sub-lethal effects to fish such as behavioural alterations, reduced growth or condition, and physiological stress (e.g., DFO 2000). Acute toxicities are generally reported for concentrations ranging from the hundreds to hundreds of thousands of mg/L (DFO 2000; Robertson et al. 2006). The available scientific literature indicates a potential for reduced hatching success in salmonids exposed to elevated TSS concentrations on the order of two months or more, at concentrations ranging from 6.6–157 mg/L (Table 2-17).

Based on the available scientific literature, the predicted increases in TSS may result in sublethal effects to fish, but would not be in the lethal severity of effect range. Sublethal effects of increases in TSS on fish may include behavioural alterations (e.g. avoidance of sediment plumes), reduced growth or condition, and physiological stress. Indirect effects include changes in the food web (e.g., reductions in primary production due to reduced water clarity, reduced abundance of benthic invertebrates due to increased TSS and/or sedimentation causing reductions in the abundance of fish diet items), which are considered in Section 4.

As noted in the response provided to the original information request, the predicted increases in TSS during Project construction are expected to remain within the existing range of TSS in the area (i.e., 5-30 mg/L). Notably higher concentrations of TSS occur in other river systems which support similar or even more diverse fish species assemblages. For example, the mean TSS concentrations measured by Manitoba Conservation and Water Stewardship over the period of 1997-2006 in the Assiniboine River at Headingley (120 mg/l), the Red River at the south gate of the floodway (132mg/L), and the Red River at Selkirk (124 mg/L) are an order of magnitude higher than the predicted TSS concentrations for the Keeyask Project.

Based on discussions at a technical review meeting on February 15, 2013, among KHLP, DFO and MCWS, sublethal effects were examined using the model described in the response to TAC Public Rd 2 DFO-0085. For ease of reference, this response is copied below.

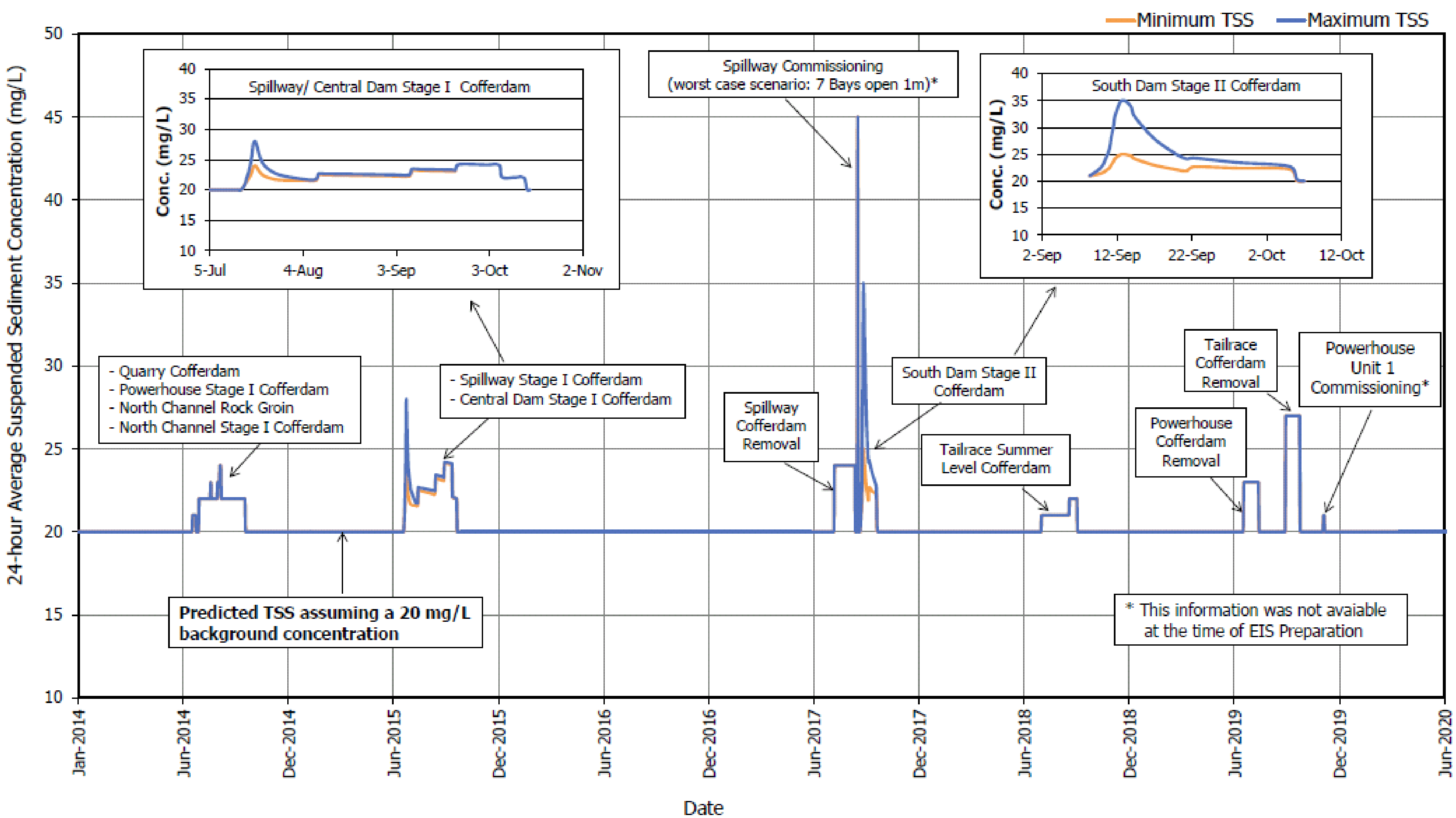
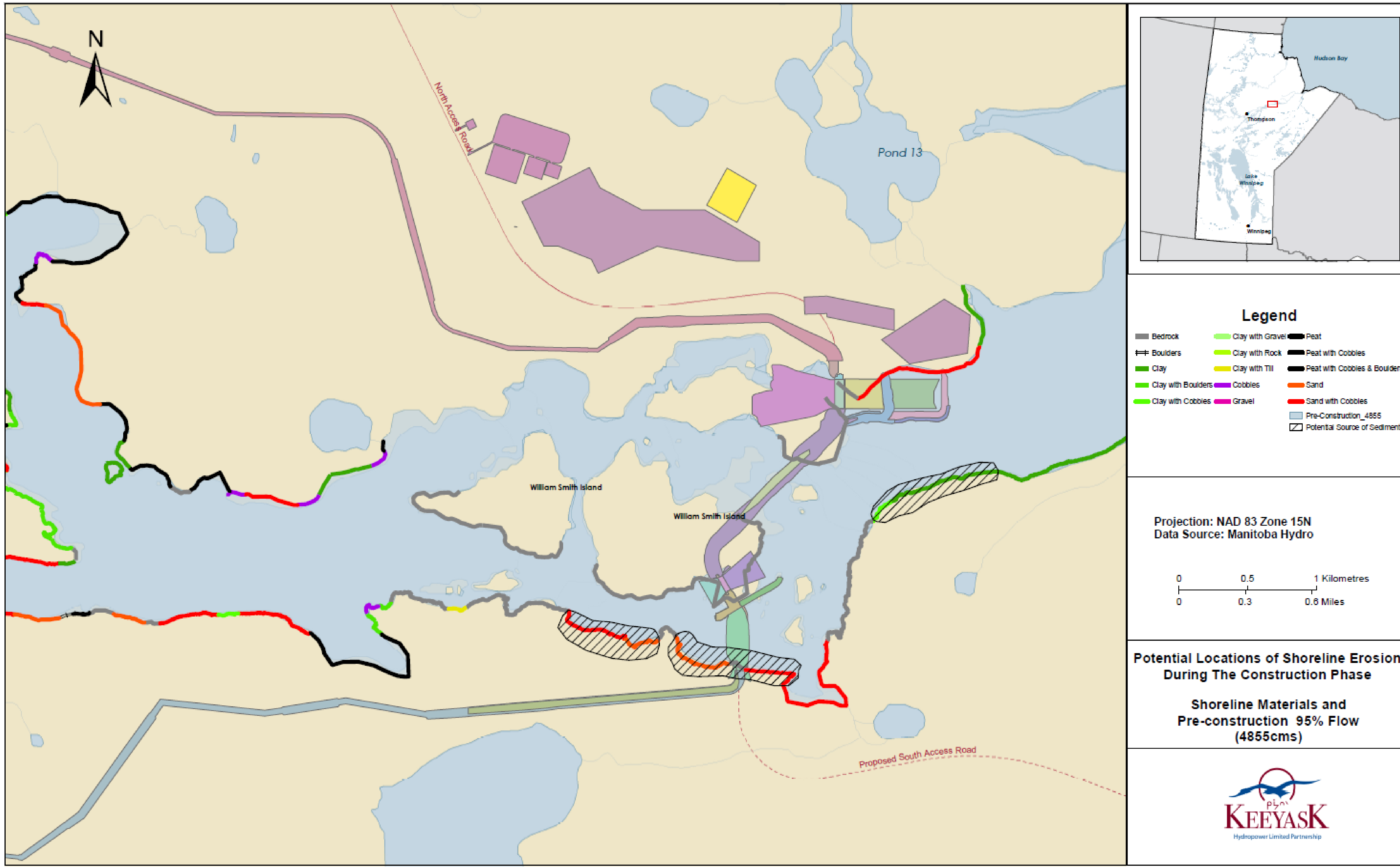


Figure 5 from the Sediment Management Plan for In-stream Construction - 24-hour average TSS concentration predicted in the proximity of site SMP-2 (mixing zone) during construction of Keeyask GS



1 Map 6.4-1 from the Physical Environment Supporting Volume.

REFERENCE: Volume: Response to EIS Guidelines; Section: 8.0 Monitoring & Follow-up; p. N/A

TAC Public Rd 2 DFO-0084

ORIGINAL PREAMBLE AND QUESTION:

Information does not appear to be present in the EIS but is required to determine if monitoring can adequately determine potential problems and appropriate actions taken to mitigate unexpected events.

Can the Proponent provide an analysis showing that its monitoring will have sufficient power with high confidence, to detect TSS above the action threshold (regulatory guideline)? For example, how likely is it that the Proponent can detect environmental changes that result in elevated TSS that exceed critical effect sizes such as 5 mg/L above background? Will the number of samples collected during monitoring be sufficient to correctly conclude, with a confidence of say 95% [i.e., a high confidence], that there is a difference of, say, 5 mg/L or more above background?

FOLLOW-UP QUESTION:

Proponent plan still in production and not available for review.

RESPONSE:

The Partnership provided a preliminary draft of the Sediment Management Plan for In-stream Construction to regulators on October 17 2012, through the TAC review process. As noted in the original response to TAC Public Rd 1 DFO-0084, preliminary monitoring plans, although not required as part of the EIS Guidelines, will be filed with regulators in the second quarter of 2013.

The response to DFO-0078 provides discussion pertaining to the detection on of specified effect thresholds (i.e., changes in TSS due to in-stream construction) through the monitoring proposed in the SMP. For ease of reference the response to DFO-0078 is copied below.

DFO-0078 RESPONSE:

The proponent understands that the question is asking for a statistical characterization of the historic total suspended solids (TSS) data to be used as a background criterion against which observed TSS during construction would be compared. Based on this understanding, the question suggests that TSS levels obtained from monitoring for the Sediment Management Plan for In-Stream Construction (SMP) would be compared with baseline data to determine if TSS increases due to in-stream construction exceed action levels specified in the SMP. The proponent notes that the SMP uses real time monitoring of ambient in-stream conditions to measure changes in TSS in the river as in-stream work is taking place. The monitoring is not based upon the measurement of changes relative to conditions observed in the pre-Project baseline studies.

Implementation of the SMP will involve identifying changes in TSS between a reference monitoring site (SMP-1) just upstream of in-stream construction, a site (SMP-2) in the mixing zone just downstream of in-stream construction, and a site (SMP-3) in a fully mixed zone further downstream. The monitoring is designed to detect if an in-stream construction activity causes an increase in ambient TSS between SMP-1 and SMP-2 that exceeds specified action levels. The SMP (Sec. 4) describes actions to be taken to reduce the effects of in-stream construction if it causes TSS to increase by 200 mg/L or more in a 15-minute averaging period or 25 mg/L or more in four consecutive 15-minute averaging periods. The action levels at SMP-2 are set so that increases due to construction can be addressed in sufficient time to take action to attempt to maintain the 24-hour average increases at SMP-3 (relative to SMP-1) below 25 mg/L as well as the areas downstream of SMP-3.

The SMP will use automated probes to continuously measure ambient turbidity levels in the river in real time as in-stream work is occurring, and will continuously transmit the data to an on-site environmental office. Turbidity values will be converted to TSS concentrations using a linear regression relationship between turbidity and TSS based on data collected during baseline environmental monitoring studies. During in-stream work, samples of water at the monitoring stations will be periodically collected and analyzed for TSS to confirm or adjust the turbidity-TSS relationship, as required. It is anticipated that each probe will measure and transmit several dozen turbidity measurements every hour and hundreds of measurements per day.

Because the SMP is based on real-time monitoring, the background TSS at SMP-1 and the TSS at SMP-2 and SMP-3 will vary in real-time as ambient conditions change. Thus the calculation of TSS changes and determination of whether or not action levels are exceeded is based on ambient conditions while in-stream work is taking place. The SMP monitoring does not measure TSS changes relative to fixed background criteria (e.g., seasonal or annual) based on data from pre-Project environmental studies.

Although the SMP is based on ambient TSS conditions rather than a comparison with pre-Project monitoring data, an a-priori power analysis was performed to determine the number of samples required to detect changes equal to the specified action levels (i.e., the effect size to be detected). The analysis assumes that the standard deviation of TSS from the baseline data used to develop the turbidity-TSS relationship (see Figure 1 below) are representative of the standard deviations of the SMP measurements over the 15-minute and 1-hour averaging periods at SMP-2 and the 24-hour averaging period at SMP-3. The power analysis employed methods described in the documents Metal

Mining Technical Guidance for Environmental Effects Monitoring (Environment Canada, 2012, Ottawa) and Guidance Document on Collection and Preparation of Sediments for Physicochemical Characterization and Biological Testing (Environment Canada, Environmental Protection Series Report, EPS 1/RM/29, 1994, Ottawa). Assuming 5% significance coefficients ($\alpha = \beta = 0.05$; power=1- β=95%), approximately four measurements are required to detect effect sizes of 25 mg/L and 200 mg/L, while approximately 40 samples would be required for an effect size of 5 mg/L. Based on the anticipated sampling frequency, a sufficient number of measurements will be obtained to detect TSS changes equal to the action levels over the specified averaging periods with a high level of power.

As noted above, TSS at the SMP monitoring sites will be calculated using a linear regression relationship between turbidity and TSS (SMP, Sec. 3.2). In order for calculated TSS differences between the upstream reference site (SMP-1) and the downstream sites (SMP-2, SMP-3) to be considered statistically significant, the sum of the confidence intervals for the TSS estimates at SMP-1 and SMP-2 or SMP-3 must be less than the effect sizes to be measured. Based on the 95th percentile confidence intervals for the linear regression (Figure 1) and assuming typical TSS concentrations of about 5 mg/L to 30 mg/L at the reference site (SMP-1), TSS differences of 200 mg/L between SMP-1 and SMP-2 or 25 mg/L between SMP-1 and SMP-2 or SMP-3 would be considered statistically significant.

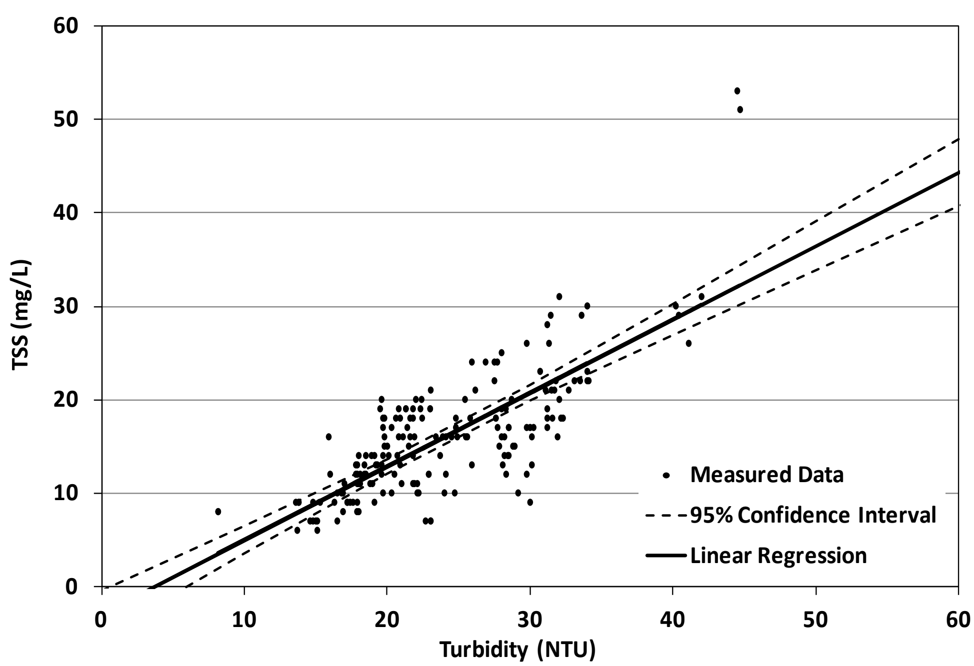


Figure 1: TSS-Turbidity Relationship for the Nelson River at Keeyask

Two locations will be monitored at each SMP monitoring site, with the locations spaced evenly across the river (i.e., left and right side of channel). Pre-project TSS monitoring across transects at sampling sites K-S-06 (location of SMP-1) and K-S-07 (just upstream of SMP-2) found that TSS typically had a small variation across the river width. From eight sets of TSS transect data at K-S-06 (five sample points across the river) from 2005-2007, the average standard deviation of TSS across the river was 1.4 mg/L. At K-S-07 the average standard deviation from seven sets of transect data was 1.2 mg/L. On average, the standard deviations were less than 10% of the average TSS concentration across the transects. Due to the low variation in TSS across the river width, sampling at two locations at each SMP site is expected to reasonably represent average conditions at each site for the purposes of the SMP monitoring program. Because site SMP-2 is in the mixing zone downstream of in-stream construction, the variability in TSS across the river will likely be greater than observed in the existing environment if in-stream work causes an increase in TSS at SMP-2. Based on discussions with regulators (March 25, 2013; Canadian Environmental Assessment Agency; Fisheries and Oceans; Environment Canada), methods are being developed to confirm that site SMP-2 is able to detect changes in TSS concentrations due to in-stream construction activities. A potential method that is being explored is to augment the ambient measurements from the in-situ data loggers with additional manual readings. Potential revisions to the proposed SMP monitoring will be the subject of additional discussions with the regulators.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 2.5.2.2.5 Total Suspended Solids/Turbidity; p. 2-64

TAC Public Rd 2 DFO-0085

ORIGINAL PREAMBLE AND QUESTION:

The EIS, in the aquatic effects supporting document section 2 on water and sediment quality, notes: “There are few studies that have reported the acute or chronic toxicity of TSS to fish species represented in the Aquatic Environment Study Area. Lawrence and Scherer (1974) reported that the 96-hour lethal concentration (LC50) for lake whitefish (Coregonus clupeaformis) was 16,613 mg/L. McKinnon and Hnytka (1988) found relatively high increases in TSS (instantaneous maximum = 3,524 mg/L and 1-day average concentration = 524 mg/L) caused by winter pipeline construction did not have any direct effect (no downstream emigration and no mortalities) on the fish community of Hodgson Creek, NT. This study is notable as four of the fish species found in Hodgson Creek - northern pike (Esox lucius), lake chub (Couesius plumbeus), longnose sucker (Catostomus catostomus), and burbot (Lota lota) - are also found in the Aquatic Environment Study Area. As indicated in Section 5.4.2, northern pike may spawn in the nearshore areas of the Keeyask reservoir, even during the initial years of operation. Therefore, early life history stages of northern pike may be exposed to elevated concentrations of TSS for several years post-impoundment. No information on the acute or chronic toxicity of TSS to northern pike eggs or larvae could be located. Information for early life history stages of other species represented in the Aquatic Environment Study Area is also sparse and many of the available studies do not differentiate between the effects of suspended particulate materials and sediment deposition. However, the available scientific literature indicates a potential for reduced hatching success in salmonids exposed to elevated TSS concentrations on the order of two months or more, at concentrations ranging from 6.6–157 mg/L (Table 2-17). In addition, northern pike eggs would also be exposed to the combined effects of sedimentation and elevated TSS. Therefore, should northern pike spawn in the nearshore, flooded areas of the reservoir in the initial years of operation where organic TSS will be notably elevated, reduced hatching success of northern pike eggs is likely. Conversely, elevated TSS and turbidity can provide benefits to some fish species and life history stages. Reduced water clarity can reduce the risk of predation by visual predators, which in turn can enhance survival of juvenile fish (e.g., Sweka and Hartman 2003) and may favour planktivorous fish…”

The Proponent discusses effects of TSS specific to the individual VEC fish species. However, much of the Proponent's impact assessment appears to rely primarily on general and lethal TSS concentration effects. Can the Proponent provide an expanded discussion of sub-lethal or chronic impact severity of effect risk assessment for anticipated TSS changes?

FOLLOW-UP QUESTION:

In the absence of specific lethal and sub-lethal data for various species and life-stages, would the proponent provide some hypothetical modelling for evaluation of sub-lethal risks?

RESPONSE:

Predicted effects of altered total suspended solids (TSS) on aquatic life in the Keeyask area are discussed in the Aquatic Environment Supporting Volume (AE SV) and provided in the response to TAC Public Rd 2 DFO-0069. As noted in the AE SV, we are not aware of studies assessing the effect of low level increases of TSS on fish species in the Keeyask area. In the absence of data, the reviewer requested hypothetical modeling for evaluation of sub-lethal risks; we are only aware of the Severity of Ill Effects model (SEV) developed by Newcombe and Jensen (1996) for this purpose. However, as discussed below, this model is not able to accurately predict the effects of low levels of TSS on aquatic life. Nevertheless, the requested assessment was conducted and is provided below.

Manitoba water quality objectives (MWS 2011) and CCME water quality guidelines (1999; updated to 2013) for TSS for the protection of aquatic life are based on the British Columbia Ministry of the Environment Lands and Parks (BCMELP) guidelines, derived using the severity of ill effects model originally developed by Newcombe and Jensen (1996) and modified by Caux et al. (1997). Specifically, the BCMELP criteria were developed based on the Newcombe and Jensen (1996) SEV Model for adult salmonids (Model 2); this group was determined to elicit the largest response to a given increase in TSS concentration over a set duration (i.e., this group was identified as the most sensitive based on the various models developed). Consideration of exposure duration as well as background conditions in the natural environment were incorporated into the criteria.

As noted in the AESV, the MWQSOG/CCME PAL guideline is predicted to be exceeded in the fully mixed Lower Nelson River during three events:

- Exposure Scenario 1: maximum predicted increase of 7 mg/L for approximately six days during placement of the Spillway and Central Dam cofferdams in July 2015;
- Exposure Scenario 2: an increase in TSS of 7 mg/L for a period of one month during removal of the Tailrace Summer Level Cofferdam in September 2019; and
- Exposure Scenario 3: maximum predicted increase of 15 mg/L for 10 days (actual concentrations are predicted to peak at 15 mg/L above background and to decrease over this 10 day period) during placement of the South Dam Rock Fill Groin in early September 2017.

TSS currently ranges between 5 and 30 mg/L, averaging 14 mg/L in the Gull Lake area. Using the existing background TSS conditions, effects of increases in TSS identified above on fish were examined using the Newcombe and Jensen (1996), as modified by Caux et al. (1997), Severity of Ill Effects Model for adult salmonids (Model 2) and non-salmonid freshwater fish (Model 6).

<u>Effects on Salmonids</u>

SEV scores for adult salmonids are presented in Figure 1 and Table 1 for a range of scenarios applicable to the Keeyask Project. As the SEV models generate scores based on absolute TSS concentrations rather than effects related to relative increases, it is relevant to compare scores for the exposure scenarios indicated above to the scores based on background TSS concentrations. All three exposure scenarios cause an increase in the SEV scores of one or less, and most scenarios cause changes of less than 0.5. The largest change in SEV score is predicted to occur under the minimum TSS background condition (5 mg/L); as discussed below, the SEV model is limited in its ability to predict effects of low concentrations of TSS, in particular due to the lack of empirical data on which the model was constructed. All SEV scores are below the paralethal/lethal threshold (SEV = 9) and the highest SEV rankings are unchanged from background conditions under each of the three scenarios (Table 1).

<u>Effects on Adult Freshwater Non-Salmonids</u>

SEV scores for adult freshwater non-salmonids are presented in Figure 2 and Table 2 for a range of scenarios applicable to the Keeyask Project. SEV scores for exposure scenarios 1 and 3 are below the paralethal/lethal threshold (SEV = 9; Table 2). However, SEV scores exceed 9 for scenario 2 – including purely background TSS conditions (i.e., without Project-induced increases in TSS). It is also worth noting that this model predicts that concentrations of TSS of 5 mg/L (the minimum measured in the Keeyask area), would prove lethal to non-salmonids in less than one month (Figure 3). A concentration of near zero (0.1 mg/L) is predicted to be lethal by the SEV model in less than 2 months.

This observation illustrates one of the key limitations of this model; the model is not reliable for predicting effects associated with low concentrations of TSS. For the purposes of assessing potential effects associated with the Keeyask Project, it is the relative difference between the SEV scores with and without the Project that is of relevance. All three exposure scenarios cause an increase in the SEV scores of less than 0.5, and most scenarios cause changes of less than 0.2.

Context

For additional context, Figure 3 presents SEV model results for a TSS concentration of 120 mg/L – the mean concentration measured in the Assiniboine River at Headingley. Mean concentrations in the Red River are of a similar magnitude (132 mg/L at the south gate of the floodway and 124 mg/L at Selkirk). These averages are an order of magnitude higher than the predicted TSS concentrations for the Keeyask Project. Over a 365 day period, this average concentration (120 mg/L) is predicted to cause SEV rankings of 10 and 12 for salmonids and non-salmonids, respectively. These scores fall into the categories of “0-20% mortality, increased predation, moderate to severe habitat degradation” and “40-60% mortality”, respectively.

Conclusions

The SEV model developed by Newcombe and Jensen (1996) has been criticized for its inherent inability to accurately predict effects of low levels of TSS to aquatic life, as these conditions were not captured within the database used to construct the model (e.g., Birtwell et al. 2003, Anderson et al. 1996). Therefore, the utility or accuracy of the model to predict risks to fish associated with small increases in TSS is limited.

Notwithstanding the limitations of the SEV model to predict effects of small increases in TSS on fish, the SEV model indicated that scores increased by less than one, and generally less than 0.2, for the various potential exposure scenarios examined.

Collectively, these results indicate effects of the predicted increases in TSS on salmonids and non-salmonids during construction would be small and potentially indistinguishable from existing conditions.

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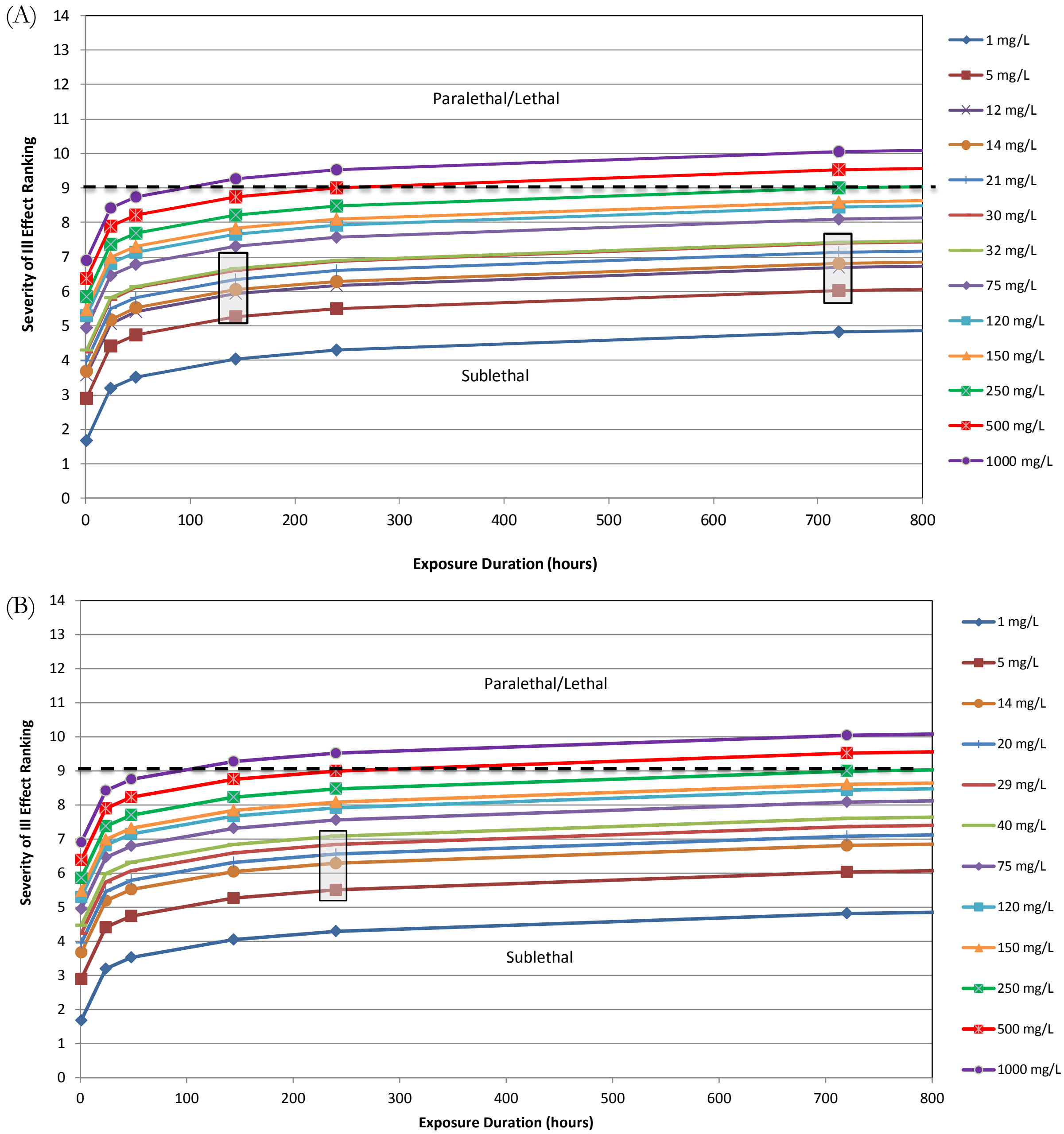

Figure 1. Severity of Ill Effects scores for adult salmonids (Model 2) for a range of TSS concentrations and exposure durations. Shaded boxes represent scores derived for increases of: (A) 7 mg/L above background for 6 and 30 days; and (B) 15 mg/L above background for 10 days, where background ranges from 5 to 30 mg/L.

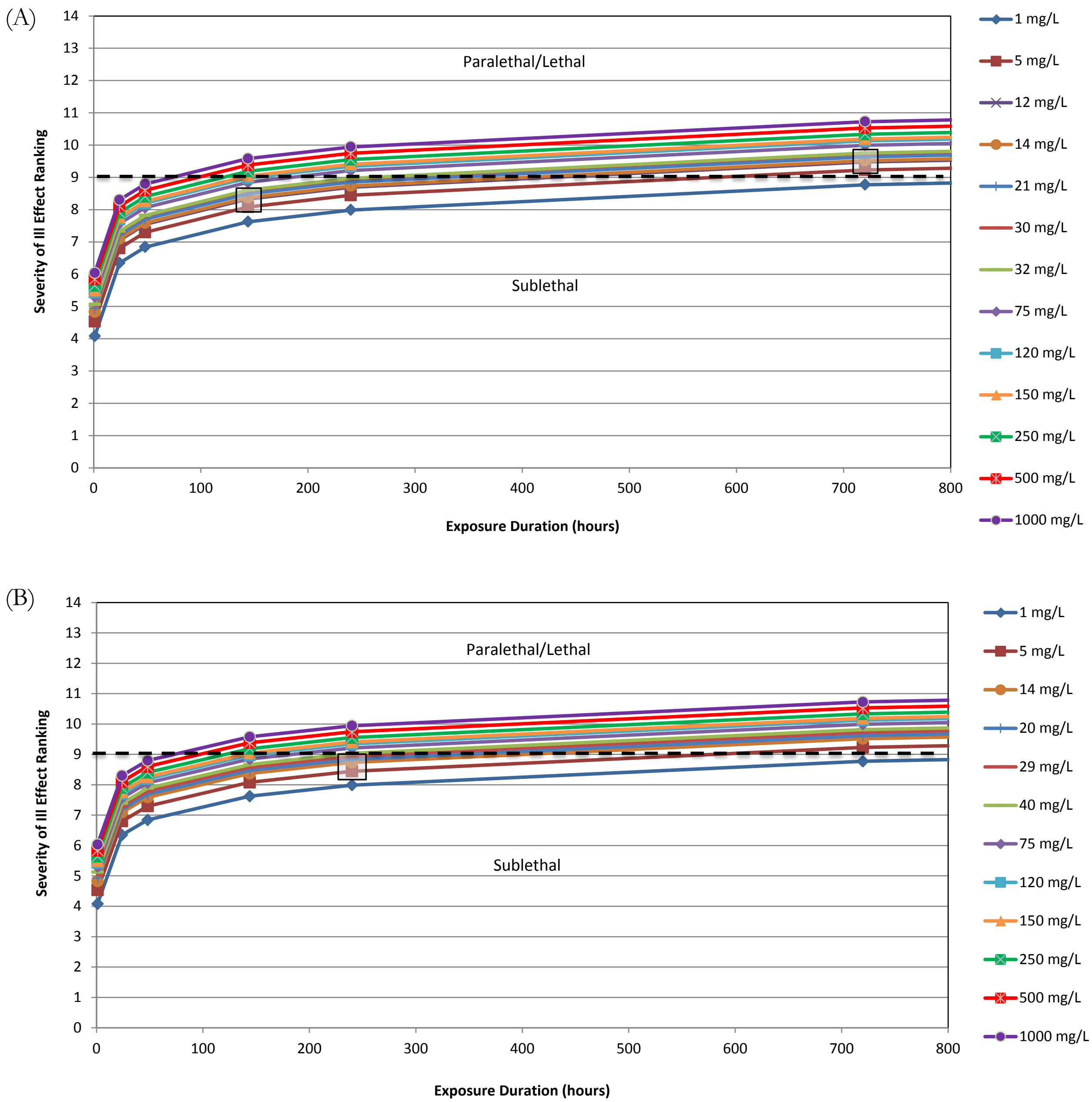

Figure 2. Severity of Ill Effects scores for adult freshwater non-salmonids (Model 6) for a range of TSS concentrations and exposure durations. Shaded boxes represent scores derived for increases of: (A) 7 mg/L above background for 6 and 30 days; and (B) 15 mg/L above background for 10 days, where background ranges from 5 to 30 mg/L.

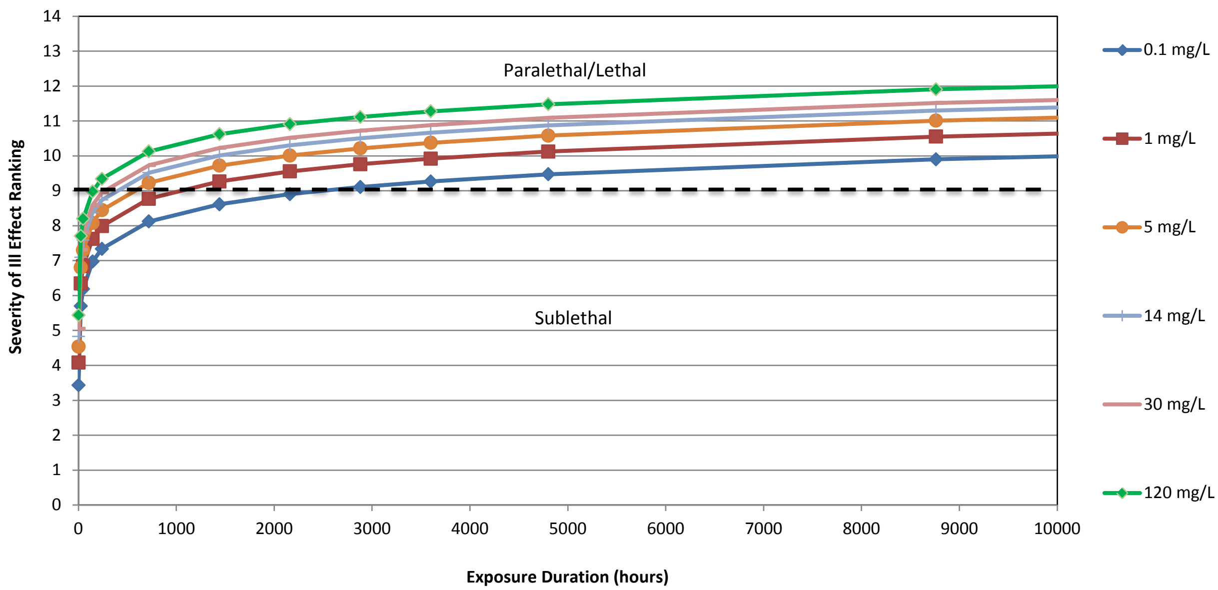

Figure 3. Severity of Ill Effects scores for adult freshwater non-salmonids (Model 6) for a range of TSS concentrations and exposure durations, including the range for the Keeyask Area (5-30 mg/L), the mean for the Assiniboine River (120 mg/L), and a concentration near to 0 mg/L.

Table 1. SEV scores for adult salmonids based on a background TSS range of 5-30 mg/L and an average TSS concentration 14 mg/L. Shaded rows represent the background TSS for the Keeyask area and unshaded rows below indicate predicted TSS concentrations.

Group	Scenario	TSS (mg/L)	Duration (days)	Duration (hours)	SEV Score	Score Category
7 mg/L increase for 6 days	Minimum Background	5	6	144	5.3	Minor physiological stress; increase in rate of coughing; increase respiration rate
	Minimum Background + 7 mg/L	12	6	144	5.9	Moderate physiological stress
	Mean Background	14	6	144	6.0	Moderate physiological stress
	Mean Background + 7 mg/L	21	6	144	6.4	Moderate physiological stress
	Maximum Background (for which MWQSOGs apply)	25	6	144	6.5	Moderate habitat degradation; impaired homing
	Maximum Background + 7 mg/L	32	6	144	6.7	Moderate habitat degradation; impaired homing
7 mg/L increase for 30 days	Minimum Background	5	30	720	6.0	Moderate physiological stress
	Minimum Background + 7 mg/L	12	30	720	6.7	Moderate habitat degradation; impaired homing
	Mean Background	14	30	720	6.8	Moderate habitat degradation; impaired homing
	Mean Background + 7 mg/L	21	30	720	7.1	Moderate habitat degradation; impaired homing

Group	Scenario	TSS (mg/L)	Duration (days)	Duration (hours)	SEV Score	Score Category
	Maximum Background (for which MWQSOGs apply)	25	30	720	7.3	Moderate habitat degradation; impaired homing
	Maximum Background + 7 mg/L	32	30	720	7.4	Moderate habitat degradation; impaired homing
15 mg/L Increase for 10 days	Minimum Background	5	10	240	5.5	Moderate physiological stress
	Minimum Background + 15 mg/L	20	10	240	6.6	Moderate habitat degradation; impaired homing
	Mean Background	14	10	240	6.3	Moderate physiological stress
	Mean Background + 15 mg/L	29	10	240	6.8	Moderate habitat degradation; impaired homing
	Maximum Background (for which MWQSOGs apply)	25	10	240	6.7	Moderate habitat degradation; impaired homing
	Maximum Background + 15 mg/L	40	10	240	7.1	Moderate habitat degradation; impaired homing

67

Table 2. SEV scores for adult freshwater non-salmonids based on a background TSS range of 5-30 mg/L and an average TSS concentration 14 mg/L. Shaded rows represent the background TSS for the Keeyask area and unshaded rows below indicate predicted TSS concentrations.

Group	Scenario	TSS (mg/L)	Duration (days)	Duration (hours)	SEV Score	Score Category
7 mg/L increase for 6 days	Minimum Background	5	6	144	8.1	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Minimum Background + 7 mg/L	12	6	144	8.3	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Mean Background	14	6	144	8.4	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Mean Background + 7 mg/L	21	6	144	8.5	Reduced growth rate; delayed hatching; reduced fish density
	Maximum Background (for which MWQSOGs apply)	25	6	144	8.5	Reduced growth rate; delayed hatching; reduced fish density
	Maximum Background + 7 mg/L	32	6	144	8.6	Reduced growth rate; delayed hatching; reduced fish density
7 mg/L increase for 30 days	Minimum Background	5	30	720	9.2	Reduced growth rate; delayed hatching; reduced fish density
	Minimum Background + 7 mg/L	12	30	720	9.5	Moderate habitat degradation; impaired homing
	Mean Background	14	30	720	9.5	Moderate habitat degradation; impaired homing
	Mean Background	21	30	720	9.6	Moderate habitat degradation; impaired homing

Group	Scenario	TSS (mg/L)	Duration (days)	Duration (hours)	SEV Score	Score Category
	+ 7 mg/L					
	Maximum Background (for which MWQSOGs apply)	25	30	720	9.7	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction feeding success; poor condition
	Maximum Background + 7 mg/L	32	30	720	9.8	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
15 mg/L Increase for 10 days	Minimum Background	5	10	240	8.4	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Minimum Background + 15 mg/L	20	10	240	8.8	Reduced growth rate; delayed hatching; reduced fish density
	Mean Background	14	10	240	8.7	Reduced growth rate; delayed hatching; reduced fish density
	Mean Background + 15 mg/L	29	10	240	8.9	Reduced growth rate; delayed hatching; reduced fish density
	Maximum Background (for which MWQSOGs apply)	25	10	240	8.9	Reduced growth rate; delayed hatching; reduced fish density
	Maximum Background + 15 mg/L	40	10	240	9.0	Reduced growth rate; delayed hatching; reduced fish density

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 1A.2.1 Structures in Water - Construction Scheduling; p. N/A

TAC Public Rd 2 DFO-0086

ORIGINAL PREAMBLE AND QUESTION:

"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? b) What sort of information would be available to rapidly assess the potential risk of a schedule change? c) What criteria would the Proponent use to trade-off costs to the project and costs to a Valued Environmental Component (VEC) fish species?

FOLLOW-UP QUESTION:

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?

RESPONSE:

This response is similar to the response to TAC Public Rd 2 DFO-0057 and DFO-75.

The primary tool in reducing the environmental effects of construction is mitigation through construction methods, timing and/or locations, all of which has been integrated into project planning. The secondary tool has been compensation and follow-up, through replacement of predicted losses or harmful alterations and a commitment to monitor effectiveness of compensation measures and modify, if necessary. The question recognizes that there is uncertainty in the planning of construction activities, and unavoidable changes that can occur must be efficiently managed – ideally in a proactive manner, so that contingency options are developed and agreed to prior to the need to apply them.

In developing detailed construction schedules, considerable effort has been made to mitigate effects as much as possible by avoiding sensitive timing windows. However, it is recognized that there is potential for the need to undertake in-stream construction during restricted periods (i.e., fall/winter to protect lake whitefish and spring/early summer to protect species such as lake sturgeon/walleye/northern pike) in spawning habitat (Gull Rapids). This has the potential to introduce sediments to these areas during sensitive times. It is also recognized that adaptive management measures need to be in place to deal with this potential.

The Keeyask Generation Project In-stream Construction Sediment Management Plan (SMP) documents the adaptive management measures to be taken during construction should sediment monitoring trigger a need for them. A draft of this plan was provided to DFO in October 2012, and will be filed with regulators in the second quarter of 2013. A key tool in the plan is monitoring and communication. Section 4.0 of the SMP outlines the communication protocol for construction site staff and environmental regulators.

Once the general civil contractor is retained and throughout the construction process, construction schedules will be monitored on a regular basis and any potential changes that may encroach upon sensitive timing windows or predetermined and/or agreed to timing restrictions will be communicated to the appropriate regulatory authorities to discuss proposed changes and to confirm acceptance prior to implementation where practicable.

The SMP also describes the actions planned and potential measures to manage the release of sediments during in-stream construction activities. Considerable effort has already gone into developing in-stream construction methods to minimize impacts as much as practical. Substantial changes in construction techniques and mitigation measures to reduce sediment inputs as a result of changes to the schedule are therefore not anticipated. One caveat to this may involve innovative construction techniques that the general civil contractor may bring once they are selected

Section 4.0 of the SMP outlines the adaptive action plans for increases in suspended sediment levels above thresholds set out in the plan. Section 4.3 outlines the management plan for commissioning the spillway and powerhouse.

Section 2.4 of the SMP lists the primary mitigation measures for each of the potential sources of sediment for the anticipated in-stream construction activities. Section 2.5 lists the secondary mitigation techniques that have been established to address the uncertainty in the predictions of shoreline erosion and impacts to TSS due to in-stream construction activities. It is noted that the estimated impacts to TSS due to construction activities are conservative, which minimizes the likelihood of exceeding the thresholds set out in the SMP for TSS increases above background levels.

Appendix A of the SMP lists the various mitigation techniques that could be implemented to address potential sediment problems for the following in-stream construction activities:

- Placement of rock fill and rip rap;
- Placement of transition fill;
- Placement of impervious fill;
- Dewatering cofferdams;
- Rock excavation and removal of rock fill;
- Removal of transition and impervious fill;
- First flow through spillway;
- First flow through powerhouse; and
- Shoreline erosion upstream of cofferdams.

Figure 5 in the SMP shows the predicted concentration of TSS for each in-stream activity. It should be noted that these predicted concentrations should not increase if the activity is shifted to other times of the year. The same action plans and mitigation techniques described in the SMP and summarized in the previous response to this question would be applied to protect fish, fisheries and fish habitat. As indicated above, this includes timely communication with DFO and MCWS, applying one or more of the secondary measures described in Section 2.5 and Appendix A of the SMP, and discussing results and the need for follow up with the regulators, as described in the previous response.

REFERENCE: Volume: Response to EIS Guidelines; Section: 8.0 Monitoring & Follow-up; p. N/A

TAC Public Rd 2 DFO-0087

ORIGINAL PREAMBLE AND QUESTION:

Previous daily TSS sediment monitoring at the Wuskwatim GS construction site had frequent problems with bio-fouling of sensors.

Can the Proponent provide additional information on its anticipated TSS monitoring showing that problems with previous monitoring, e.g., bio-fouling of sensors, has been anticipated and solved?

FOLLOW-UP QUESTION:

Can the proponent provide additional information on its anticipated TSS monitoring showing that problems with previous monitoring , e.g., bio-fouling of sensors, has been anticipated and solved? Proponent notes that the SMP to be provided "in the first quarter of 2013…" provides details. DFO notes that a draft, referred to as an informal draft was received on October 17, 2012 noting that a formal version would follow after discussion with regulators. Would the proponent provide details, specific to the biofouling risk, from the proposed SMP to answer the EIS question? Awaiting receipt of In-stream Construction Sediment Management Plan (SMP).

RESPONSE:

Section 3.4.1 of the September 2012 draft In-Stream Construction Sediment Management Plan (provided to DFO, as noted, on October 17, 2012) indicates that biofouling will be addressed as follows:

> *"The YSI turbidity loggers that will be used for the Project are equipped with self-cleaning sensors with integrated wipers to remove biofouling and maintain high data accuracty. However, the loggers will be visited every two weeks to maintain and clean the monitoring system (and free them of algae and vegetation debris) to avoid erratic spikes in data."*

In addition to the routine maintenance visits, the on-site environmental officers will be routinely checking the monitoring data. At the request of the regulators, Section 3.4.1 of the SMP will be revised to include additional maintenance and manual sampling to determine if there are problems with loggers such as biofouling.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 1A, Part 2 Keeyask Lake Sturgeon Stocking Strategy; p. N/A

TAC Public Rd 2 DFO-0093

ORIGINAL PREAMBLE AND QUESTION:

Appendix 1A - Part 2

Should the original population be decimated, how will the population within the Gull Reach be maintained?

FOLLOW-UP QUESTION:

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?

RESPONSE:

The Aquatic Environment Supporting Volume describes a two-pronged approach to maintaining a Lake Sturgeon population in the Keeyask (Gull) reach of the Nelson River, firstly by addressing habitat losses through the creation of habitat in the reservoir, and secondly, by supplementing the existing population and replacing potential losses through emigration at impoundment, by a long term stocking program. Within the reservoir, the two primary habitat measures are:

- Monitoring to determine whether Lake Sturgeon continue to spawn at Birthday Rapids and, if not, placement of large structures along the shorelines to create turbulent flow to attract spawning fish; and
- Monitoring of potential YOY habitat in the Keeyask reservoir and, if monitoring shows that juvenile recruitment is not successful, implementation of a program to create suitable habitat.

Stocking of Lake Sturgeon is a key point and is described as follows (AE SV Section 6.4.2.4, pages 6-46 to 6-47):

“Finally, implementation of a stocking program in the Kelsey to Kettle GS reach of the Nelson River. As discussed in Section 6.3.1, lake sturgeon were historically abundant in much of the lower Nelson River, but numbers have declined to the extent that they are currently assessed as endangered by COSEWIC and are being considered for listing under SARA. Given that construction of the Project will alter existing lake sturgeon habitat, and the uncertainties with respect to their use of constructed or altered habitats, it is

proposed that stocking be used to support and enhance lake sturgeon populations within the Clark Lake to Stephens Lake reach of the Nelson River. Stocking would commence with the start of construction to compensate for the loss of natural recruitment that is expected to occur until compensatory spawning habitat has been provided. The stocking plan would include the introduction of fall fingerlings (three to four months old) and spring yearlings.

In addition, lake sturgeon will be stocked at off-site locations that currently provide habitat to support all life history functions where the current small populations are limiting the potential for recovery. To date, candidate sites have been identified in the upper Split Lake area, in the Nelson River below the Kelsey GS, the Grass River, and the Burntwood River below First Rapids (Map 1 1). A detailed description of the stocking program is provided in Appendix 1A. Principal points are provided below:

- *The stocking program will address effects of the Project, but be conducted in coordination with other regional recovery plans;*
- *The plan will be long-term, with a commitment by the Partnership to construct a hatchery and/or other facilities in northern Manitoba to provide the necessary infrastructure;*
- *Brood stock from the Nelson River will be selected based on genetic considerations, including numbers of individuals and genetic similarity to the target area;*
- *The program will be conducted in consideration of the need to maintain genetic diversity; and*
- *Target numbers and ages of fish stocked at each location will be determined based on the size and age structure of the existing population, the ability of the habitat to support additional fish, and recommended stocking rates and population targets developed elsewhere (e.g., DFO 2010; Wisconsin stocking guidelines).*

Stocking of lake sturgeon is one of the most effective means of recovering this species where adequate habitat is available (see Appendix 1A for details). Examples of successful conservation stocking programs include:

- *The St. Louis River, a tributary of Lake Superior, where sturgeon were stocked from 1983 to 2000. Populations have increased in western Lake Superior and recently stocked sturgeon have been observed using historical spawning grounds on the St. Louis River;*
- *Red River of the North, a tributary of Lake Winnipeg, where a 20-year stocking plan has released fingerlings and fry across tributaries in Minnesota and lake sturgeon have been observed in the Red River to Lake Winnipeg; and*
- *Oneida Lake, New York, where lake sturgeon exhibited very high growth rates.*

Lake sturgeon have also been stocked into the Saskatchewan, Assiniboine and upper Nelson rivers in Manitoba."

If in referring to the depleted state of the Lake Sturgeon population, the reviewer was concerned that insufficient sturgeon would be available to support a stocking program, the Lake Sturgeon Stocking Strategy identified (AE SV Appendix 1A Part 2 – Page 17) states:

> “With respect to the third consideration listed above, the collection of spawn is feasible (see Section 3.1) from each subpopulation. Therefore, given the uncertainties surrounding genetic mixing of stocks, the initial stocking plan would likely attempt to maintain the existing genetic structure and collect spawn from the same subpopulations as will be stocked. However, given uncertainties and difficulties associated with spawn collection, a second contingency strategy may be required. If the number of spawning fish is too small to support the above approach, then spawn will be collected at sites that are genetically the most similar to proposed stocking locations”.

As discussed at a February 15, 2013 technical review meeting among KHLP, DFO and MCWS and during follow-up discussions on February 22, genetic analyses currently being conducted will provide the basis for more effectively assessing differences in genetic structure among areas. These results will be provided to MCWS and DFO when available and be used to assist in identifying alternate sources of spawn, if required.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 1A, Part 2 Keeyask Lake Sturgeon Stocking Strategy; p. N/A

TAC Public Rd 2 DFO-0094

ORIGINAL PREAMBLE AND QUESTION:

Appendix 1A - Part 2

The recruitment model/unexploited scenario mimics the Wisconsin guideline. There is acknowledgement that these numbers may be too low given the guideline was developed based on rivers smaller than the Nelson. How will final numbers be derived?

FOLLOW-UP QUESTION:

This contradicts statements in proponent response provided in DF0-0052, "CPUE was not used to estimate population size" and DFO-0017 "CPUE was not used in statistical analysis"

RESPONSE:

At the technical meeting on February 15, 2013, held among DFO, MCWS, and KHLP, DFO reviewed the follow-up question and indicated that it was a misunderstanding and should be disregarded. No further information was required for DFO-0094.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 1A, Part 2 Keeyask Lake Sturgeon Stocking Strategy; p. N/A

TAC Public Rd 2 DFO-0098

ORIGINAL PREAMBLE AND QUESTION:

Appendix 1A - Part 2

Given predictions 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?

FOLLOW-UP QUESTION:

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.

RESPONSE:

The reviewers comments appear to comprise four questions:

5. Will the reservoir be suitable for Lake Sturgeon given predictions of accumulated sedimentation/peat accumulation and subsequent influences on water chemistry (including decreasing oxygen)?
6. Will mercury levels (presumably in fish) affect the suitability of the reservoir for Lake Sturgeon?
7. Will the Proponent provide more detail about changes in the reservoir (pre- versus post-Project comparison)?
8. Will the proponent provide publications that support stocking in the reservoir given mercury in fish tissue significantly elevate post-Project?

Each of these is answered in turn.

1. Will the reservoir be suitable for Lake Sturgeon given predictions of accumulated sedimentation/peat accumulation and subsequent influences on water chemistry (including decreasing oxygen)?

Most effects to water quality (e.g., dissolved oxygen depletion) will be restricted to the newly flooded terrestrial habitat that is currently not aquatic habitat. Over time, flooded terrestrial habitat will evolve to become suitable for subadult and adult Lake Sturgeon. Sediment deposition will affect flooded terrestrial habitat and much of existing aquatic habitat in Gull Lake. However, habitat will be available for spawning and for foraging by subadult and adult sturgeon in riverine sections of the river, even in the first years post-impoundment. Monitoring and mitigation measures have been identified to address uncertainties with respect to the availability of rearing habit for young-of-the-year sturgeon. The following are quoted from the AE SV Section 6.4.2.2.2:

> *Changes to water quality are not expected to affect the suitability of spawning habitat in the riverine portion of the reservoir where lake sturgeon spawn as the analysis of sediment transport indicates that total suspended solids levels will decline post-impoundment and no consequential effects to other water quality parameters are expected (Section 2).*

> *The existing environment HSI model for lake sturgeon rearing habitat show the reach between Clark Lake and Gull Rapids as having a WUA of between 199 and 220 ha (Section 6.3.2.3.1). However, almost all high quality habitat (HSI greater than or equal to 0.5; 54–64 ha) is located in the downstream portion of Gull Lake on the north side of Caribou Island, where YOY lake sturgeon were captured during environmental studies. The post-Project HSI model predicts a total rearing habitat WUA of between 445 and 637 ha. However, the amount of high quality rearing habitat for the reservoir is predicted to be lower (WUA=16–19 ha; Map 6-47 to Map 6-49; Appendix 6D). Furthermore, YOY access to the high quality habitat also is expected to be reduced given the increased area of the reservoir and the loss of moderate currents on which larvae currently rely to transport them to favourable rearing habitat in the lower end of Gull Lake. Because of this, it is uncertain whether the post-Project rearing habitat will be accessible to drifting larval sturgeon.*

> *During the initial years post-impoundment, conditions over the newly flooded terrestrial habitat would not be optimal for lake sturgeon, which appear to favour deeper, more riverine, mineral substrate environments in the Nelson River (Section 6.3.2.3.1)…. Lake sturgeon will continue to be able to use habitat in the former mainstem and Gull Lake that are not expected to experience the changes in water quality (Section 2.5.2.2) that are predicted for flooded shallow water lentic habitats (decreased dissolved oxygen, flooded terrestrial organics and*

episodic increases in suspended sediments). Over time, as the substratum evolves, lake sturgeon could begin to use flooded portions of the reservoir as conditions become suitable.

2. Will mercury levels (presumably in fish) affect the suitability of the reservoir for Lake Sturgeon?

Current (2002-2006) mean mercury concentrations in the body musculature of Lake Sturgeon captured from Gull Lake have been measured at approximately 0.2 ppm in adult fish (i.e., exceeding 1000 mm fork length) and, based on a single fish captured in 2006, may be considerably lower in juveniles (Table 1; also see AE SV 2012, Appendix 7A). Data on sturgeon mercury content are limited for Manitoba. Two recent samples of relatively small fish from the Winnipeg River and for a large range of fish sizes from the Churchill River indicate that mercury concentrations in juvenile (<700 mm fork length) Lake Sturgeon are less than 0.1 ppm, approximately 0.2 ppm for fish of up to 1000 mm length, and some of the larger individuals may reach concentrations of up to 0.7 ppm (Table 1). A similar relationship between mercury concentration and fish length has been shown for Lake Sturgeon from the Ottawa River (Haxton and Findlay 2008). Therefore, current mercury concentrations in Lake Sturgeon from Gull Lake seem to be quite typical for Manitoba and the species in general.

The models applied in the Keeyask EIS to estimate maximum mean mercury concentrations in Lake Whitefish, Northern Pike, and Walleye for the future Keeyask forebay (and for Stephens Lake) do not include Lake Sturgeon and quantitative predictions were not attempted for this species. In trying to attempt such predictions, several factors have to be considered, particularly:

- The trophic position of sturgeon from the time of stocking as 0+ or 1+ fish until reaching approximately 1000 mm fork length (a mean [i.e., "standard"] length at which meaningful comparisons of mercury levels between locations and among years for the same location can be made) will be similar to that of adult (i.e., benthivorous) whitefish and certainly lower than that of adult (i.e., piscivorous) pike and Walleye. The same applies to wild sturgeon in the Keeyask reservoir.
- Based on the preferred habitat of juvenile Lake Sturgeon, deeper water over mainly mineral sediments, the general conditions for mercury methylation and the availability of methylmercury (MeHg) and its bioaccumulation up the food chain will be less so than in most other areas of the reservoir. Spatial variation in fish mercury concentrations due to heterogeneity in MeHg availability are well documented (Chumchal et al. 2008; Schetagne et al. 2003; Cizdziel et al. 2002).

Based on the predicted increases in mercury concentrations for the Keeyask forebay (0.2 ppm in whitefish, approximately 1.0 ppm in pike and Walleye, AE SV 2012) and taking into account the ecological parameters that will affect the dynamics of mercury bioaccumulation in Lake Sturgeon after the impoundment of the Keeyask forebay, a maximum mean concentration of 0.30 ppm for fish of approximately 1000 mm fork length seems realistic. This estimate applies to fish that use Gull Lake as a habitat and will continue to forage in the area during and after impoundment. Fish stocked in year 2 or later after the start of operations will grow in an environment of successively declining efficiency of MeHg bioaccumulation and likely will not reach the maximum mean concentration of 0.3 ppm. Also because of the relative long time it will take stocked sturgeon to attain a length of 1000 mm, maximum mercury concentrations may not be measured in the population after 4-8 years as for the other three large-bodied fish species (see above), but a few years later. Similar to the other three species, the maximum concentrations may last no longer than 1-2 years and a period of up to 30 years may be expected for mercury levels to return to pre-Project concentrations.

Mean muscle mercury concentrations of 0.3 ppm, particularly if transient, will in all likelihood not affect the success of sturgeon stocking. To our knowledge no studies exist on the effects of mercury on Lake Sturgeon. However, there have been many recent publications of the effects of dietary MeHg and mercury tissue concentration on the physiology and behavior of fish, including other sturgeon species (Lee et al. 2011; Gharaei et al. 2011, 2008, Webb et al. 2008). These studies indicate lowest observed adverse effect levels of dietary MeHg for growth and mortality of juvenile Beluga (*Huso huso*) of 1.97 and 4.05 ppm, respectively (Gharaei et al. 2011, 2008) and of juvenile Green Sturgeon (*Acipenser medirostris*) and White Sturgeon (*A. transmontanus*) of 9.73 and 24.3 ppm, respectively (Lee et al. 2011; also see summary in Depew et al. 2012). Reviews by Sandheinrich and Wiener (2011) and Depew et al. (2012) have summarized recent advances in our knowledge regarding toxicological effects of environmentally relevant concentrations of mercury in freshwater fish. In trying to establish a 'tissue residue guideline' concentration above which there is the potential for mercury induced effects to fish, Sandheinrich and Wiener (2011) reported that impairment of biochemical processes, damage to cells and tissues, and reduced reproduction have been observed at MeHg concentrations of about 0.5-1.2 ppm mercury in axial muscle. Such concentrations are well above the predicted mean maximum concentration for Lake Sturgeon in the future Keeyask forebay, although some of the largest, oldest individuals may reach the lower range of these mercury levels, as has been observed for existing populations in Gull Lake, the mouth of the Nelson River, and the Churchill River (Table 1).

To assess the health risk of elevated muscle mercury concentrations on sturgeon populations in the future Keeyask forebay (and the Keeyask Study Area in general) it must also be considered that many adult fish inhabiting natural freshwaters in the midwestern and eastern United States and the eastern half of Canada exceed muscle concentrations of 1.0 ppm wet weight (Kamman et al. 2005; Schetagne and Verdon 1999a). Moreover, mean muscle mercury concentrations of adult Northern Pike (*Esox lucius*) and Walleye (*Sander vitreus*), but also Lake Trout (*Salvelinus namaycush*) and burbot (*Lota lota*) are known to exceed 2.0 ppm in newly created reservoirs in Québec and Manitoba (Therrien and Schetagne 2008; Bodaly et al. 2007; Schetagne and Verdon 1999b), and may reach 4.0 ppm in pike (Schetagne and Verdon 1999b). Despite the obvious potential (based on the threshold concentrations proposed by Sandheinrich and Wiener 2011) for compromised health of these fish populations due to elevated body mercury concentrations, clear evidence for associated population level effects on wild fish is lacking. For example, based on catch-per-unit-effort data, which provide approximate estimates of fish abundance, pike and Walleye populations have not been substantially reduced in any of the well-studied lakes/reservoirs on the CRD route and the lower Nelson River in Manitoba (e.g., AE SV 2012) or reservoirs on the La Grande Rivière in Québec (Schetagne et al. 2003; Roger Schetagene, Hydro Québec, pers. comm., July 2011). These findings do not necessarily indicate an absence of mercury effects on fish populations, but if such effects exist they have not been severe enough to be detected by the sampling and analytical methods applied in these studies. Mercury effects may also be confounded by the multitude of ecological variables that structure fish populations, such as the abundance of prey and predators, parasite loads, fishing pressure, and habitat alterations, and that are likely affected by the physical, chemical, and biological changes in the course of reservoir creation and succession.

For all these reason, the expected relatively minor increase in muscle mercury concentrations of Lake Sturgeon in the future Keeyask forebay does not pose a threat to the health of individuals and is not expected to affect the potential benefits of a stocking program to the recovery and long-term viability of the population in the Keeyask Study Area.

Table 1. Mean arithmetic (± standard error, SE, range) mercury concentration (ppm) and mean fork length (range) of Lake Sturgeon sampled from Manitoba waterbodies in 1970-2012. R= River; Lt CR= Little Churchill River; GrF= Great Falls reservoir; PdB= Pointe du Bois; TP= near The Pas. Mean concentrations with superscripted letters are from commercial samples and raw data are not available.

Waterbody	Year	n	Arithmetic	SE	Range	Length (mm)	n
Gull Lake	2006	1	0.039	-	-	646	1
	2004	10	0.207	0.060	0.04 - 0.67	1158.8[1] (1035 - 1286)	10
	2002	3	0.166	0.033	0.10 - 0.20	1162.5 (1050 - 1275)	2
Nelson R, lower	2011	3	0.141	0.016	0.14 - 0.21	693.7 (654 - 715)	3
	2010	1	0.178	-	-	690	1
	2008	5	0.125	0.019	0.08 - 0.19	621.2 (537 - 736)	5
	2003	7	0.185	0.028	0.13 - 0.34	841.4 (725 - 1200)	7
	1970[a]	4	0.11	-	0.09 - 0.13	-	-
Nelson R, mouth	1982	5	0.220	0.096	0.10 - 0.60	-	0
Fox River	1979	3	0.263	0.050	0.19 - 0.36	-[2]	0
Hayes River	2011	1	0.213	-	-	771	1
	2010	1	0.194	-	-	6649	1
	2009	2	0.098	0.033	0.07 - 0.13	550.5 (543 - 558)	2
Stephens Lake	2008	1	0.099	-	-	587	1
Split Lake	1970[b]	1	0.014	-	-	-	-
Churchill R, at Lt CR	2010	32	0.156	0.023	0.03 - 0.65	797.6 (221 - 1334)	32
Playgreen Lake	1970[c]	7	0.18	0.07	0.49	-	0
Duck to Sipiwesk lakes	1970[d]	1	0.08	-	-	-	0
Cross L (Eves Falls)	1970[e]	1	0.11	-	-	-	0
Mud Lake	1972[f]	1	0.12	-	-	-	0
Burntwood R,	2011	1	0.041	-	-	562	1
Winnipeg R, GrF	2011	3	0.058	0.010	0.08 - 0.11	561.3 (442 - 770)	3
Winnipeg R, PdB	2008	21	0.081	0.005	0.03 - 0.14	582.8 (443 - 682)	21
	2007	4	0.064	0.009	0.04 - 0.08	511.5 (270 - 613)	4
Saskatchewan R, TP	1990	1	0.08	-	-	884	1
	1970[g]	2	0.29	-	0.21 - 0.37	-	0

[1] Calculated based on relationship between fork length and total length for 68 Lake Sturgeon from Manitoba waters

[2] range of weights: 1022 - 2247 g

[a] Derksen 1978a (p.25), b (p.52), 1979 (p.30); undesignated location

[b] Derksen 1978b (p.51), 1979 (p.30)

[c] Derksen 1978a (p.24), b (p.49), 1979 (p.29)

[d] Derksen 1979 (p.30)

[e] Derksen 1978a (p.24), b (p.50), 1979 (p.29)

[f] Derksen 1978b (p.51)

[g] Derksen 1978b (p.42), 1979 (p.24)

3. Will the Proponent provide more detail about changes in the reservoir (pre- versus post-Project comparison)?

The following provides a description of habitat available to Lake Sturgeon pre- and post-Project (AE SV Section 6.4.2.2.2 p. 6-35 to 6-36).

6.4.2.2.2 Habitat

Spawning Habitat

Environmental studies indicate that Birthday Rapids is an important spawning location for lake sturgeon in the reach of the Nelson River between Clark Lake and Gull Rapids. Alternative spawning habitat may be available in Long Rapids immediately downstream of Clark Lake (Section 6.3.2.3). Physical conditions in the Long Rapids area appear to meet depth, velocity, and substrate criteria for sturgeon spawning habitat. Evidence of sturgeon spawning activity at Long Rapids was documented during two of the four environmental studies conducted between Clark Lake and Birthday Rapids from 2001–2010. In some cases, lake sturgeon may only move upstream as far as the first set of rapids that provides suitable conditions for spawning, even if suitable habitat is also available further upstream (Section 6.3.2.3.1). Lake sturgeon in the Nelson River between Clark Lake and Gull Rapids do not appear to use Gull Rapids for spawning; therefore, the loss of Gull Rapids is not expected to affect spawning sturgeon between Clark Lake and the Keeyask GS.

The existing environment HSI model for lake sturgeon spawning habitat indicates that there is a WUA of between 9 and 12 ha from Clark Lake to Gull Rapids (Section 6.3.2.3.1). Birthday Rapids and Long Rapids and areas immediately downstream of them account for all of this area. Existing spawning habitat between Clark Lake and Birthday Rapids is not expected to be affected by the Project as flooding is not expected to extend that far upstream. However, increased water levels at Birthday Rapids due to impoundment may reduce the suitability of habitat in the rapids for spawning lake sturgeon; the post-Project HSI model suggests that these rapids will no longer be suitable for spawning due to the associated loss of white water (Map 6-44 to Map 6-46; Appendix 6D). Loss of spawning habitat due to flooding has been observed at the rapids on the Nelson River above the Kettle GS (FLCN 2008 Draft). However, some locations where increased water depth has resulted in the loss of white water but maintained appropriate velocity and substrate conditions have continued to support spawning lake sturgeon. For example, sturgeon appear to have continued to spawn in the Nelson River above the Kelsey GS following impoundment (Macdonald pers. comm. 2009). Therefore, it is possible that lake *sturgeon will continue to use Birthday Rapids as a spawning area. Post-impoundment monitoring of spawning activity in this reach will be conducted to determine spawning success and, should monitoring indicate poor or no spawning success, contingency works to create suitable spawning habitat will be implemented. Contingency measures for the loss of Birthday Rapids as a spawning site are discussed further in Appendix 1A.*

Changes to water quality are not expected to affect the suitability of spawning habitat in the riverine portion of the reservoir where lake sturgeon spawn as the analysis of sediment transport indicates that total suspended solids levels will decline post-impoundment and no consequential effects to other water quality parameters are expected (Section 2).

The current extent of predation on lake sturgeon eggs at their spawning grounds in the study area is not known. Predation by both lake sturgeon and other species is a source of mortality for lake sturgeon eggs in other systems (Appendix 6A). While the Project is predicted to change the composition of the fish community between Clark Lake and the Keeyask GS (Section 5), this change (increase in piscivorous fish species) is not expected to result in an increase in predation on lake sturgeon eggs.

Rearing Habitat (YOY)

Different life history stages of sturgeon appear to have different requirements for foraging habitat, with younger fish having more specific habitat needs than older fish (Appendix 6A). In the Nelson River between Clark Lake and Gull Rapids, YOY lake sturgeon were captured in deep, low velocity water over a mostly sand substrate in the downstream portion of Gull Lake on the north side of Caribou Island during environmental studies (Section 6.3.2.3.1). The existing environment HSI model for lake sturgeon rearing habitat show the reach between Clark Lake and Gull Rapids as having a WUA of between 199 and 220 ha (Section 6.3.2.3.1). However, almost all high quality habitat (HSI greater than or equal to 0.5; 54–64 ha) is located in the downstream portion of Gull Lake on the north side of Caribou Island, where YOY lake sturgeon were captured during environmental studies. The post-Project HSI model predicts a total rearing habitat WUA of between 445 and 637 ha. However, the amount of high quality rearing habitat for the reservoir is predicted to be lower (WUA=16–19 ha; Map 6-47 to Map 6-49; Appendix 6D). Furthermore, YOY access to the high quality habitat also is expected to be reduced given the increased area of the reservoir and the loss of moderate currents on which larvae currently rely to transport them to favourable rearing habitat in the lower end of Gull Lake. Because of this, it is uncertain whether the post-Project rearing habitat will be accessible to drifting *larval sturgeon. Post-Project monitoring will be conducted to determine YOY distribution and abundance and, if necessary, contingency works to create sandy habitat suitable for YOY rearing in the reservoir would be implemented; contingency measures are discussed further in Appendix 1A.*

Foraging Habitat (Sub-adult and Adult)

During the initial years post-impoundment, conditions over the newly flooded terrestrial habitat would not be optimal for lake sturgeon, which appear to favour deeper, more riverine, mineral substrate environments in the Nelson River (Section 6.3.2.3.1). Both sub-adult and adult lake sturgeon were captured or relocated via telemetry between Birthday Rapids and Gull Rapids, but were mainly found in Gull Lake (Section 6.3.2.3.1). In Gull Lake, sub-adults occupied a narrower range of conditions, favouring deep, low to moderate velocity areas. Adult sturgeon were also observed in the reach between Clark Lake and Birthday Rapids.

Lake sturgeon will continue to be able to use habitat in the former mainstem and Gull Lake that are not expected to experience the changes in water quality (Section 2.5.2.2) that are predicted for flooded shallow water lentic habitats (decreased dissolved oxygen, flooded terrestrial organics and episodic increases in suspended sediments). Over time, as the substratum evolves, lake sturgeon could begin to use flooded portions of the reservoir as conditions become suitable.

The long-term use of the reservoir by sub-adult and adult sturgeon was modeled separately. The post-Project HSI models predict a net gain of approximately 600–750 ha (WUA) of foraging habitat for sub-adults and a net gain of approximately 3,000–3,150 ha for adults (Map 6-50 to Map 6-55; Appendix 6D).

Currently, there appears to be a sufficient food supply for lake sturgeon between the outlet of Clark Lake and Gull Rapids (Section 6.3.2.3.1). Overall, benthic invertebrate abundance is expected to increase between Clark Lake and the Keeyask GS in both the short-term and long-term (Table 4-34), suggesting there will be an adequate food supply for both sub-adult and adult lake sturgeon post-Project.

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.

Overwintering Habitat

Localized reductions in dissolved oxygen in nearshore zones may reduce the quality of habitat in off-current areas during winter, particularly in the first year post-impoundment (Section 2.5.2.2). However, these reductions are expected to have a limited effect on lake sturgeon overwintering habitat as ample well-oxygenated deep-water habitat will be available during winter.

4. Will the Proponent provide publications that support stocking in the reservoir given mercury in fish tissue significantly elevate post-Project?

As discussed above, mercury concentrations in Lake Sturgeon are not expected to increase significantly post-Project.

Stocking Lake Sturgeon into the Keeyask Reservoir is the only realistic option to recover populations as stocks are already at very low levels. Lake Sturgeon stocking has been attempted in several North American rivers, especially in tributaries of the Great Lakes; however, monitoring or evaluation of the stocking programs are often not published in the primary literature. Below is a short summary of selected relevant Lake Sturgeon stocking initiatives that have occurred in North America. Additional examples of Lake Sturgeon stocking plans can be found in Smith 2009 and in the Keeyask Lake Sturgeon stocking strategy.

In the past 30 years, stocking has commonly been used to rehabilitate Lake Sturgeon populations. Culture and rearing can now be conducted with relative certainty in both hatchery and stream-side rearing facilities, and many programs have successfully released young fish into the wild. Survival and growth of stocked Lake Sturgeon has been demonstrated in many locations. However, it has been noted that stocking initiatives “have not been adequately evaluated and many programs rely on intermittent, short-term, or anecdotal indicators of program success” (Smith 2009). Until recently, due at least in part to lengthy generation times, stocking initiatives have been conducted based on the assumption that stocked Lake Sturgeon which survive to maturity will successfully reproduce and contribute to subsequent generations. However, in 2011, Lake Sturgeon stocked into the St. Louis River successfully spawned approximately 30 years following their initial reintroduction (R. Bruch, Wisconsin DNR, pers. comm.) This finding is significant, since re-establishment of self-sustaining populations (as opposed to put-and-take fisheries) is the ultimate goal of most Lake Sturgeon recovery strategies.

While the vast majority of Lake Sturgeon stocking initiatives have occurred in Great Lakes systems which are markedly different environments from the Nelson River, there are some relevant proximal examples. In Western Canada, Lake Sturgeon stocking has been conducted in the Assiniboine, Nelson, Winnipeg, and Saskatchewan rivers. Lake Sturgeon stocking has also been conducted in the Minnesota portion of the Red River, which subsequently flows through Manitoba.

The Assiniboine River was stocked with over 12,000 fingerlings and 4,000 fry between 1996 to 2008. Although a formal study has never been conducted to assess the success of the stocking effort, Lake Sturgeon captures are frequently reported by anglers (B. Bruederlin, Manitoba Fisheries Branch, pers. comm.). At present, most of the Lake Sturgeon being captured are larger than 43 inches, with the largest measuring 60 inches. A study is now required to determine if stocked fish will begin to reproduce naturally.

The Minnesota Department of Natural Resources started a 20 year plan to restore Lake Sturgeon populations and has been releasing Lake Sturgeon from the Rainy River into the Red River drainage (Minnesota DNR 2002; Aadland et al. 2005). The 2002-2022 plan is to release 600,000 fry and 34,000 fingerlings per year at various locations throughout the Red River drainage in Minnesota. Anecdotal evidence (angler recaptures) suggests that Lake Sturgeon encounters in the Red River in Canada are increasing (Cleator et al. 2010).

Lake Sturgeon stocking in the Nelson River was conducted intermittently from 1994 to 2011 by the Nelson River Sturgeon Board and Manitoba Fisheries Branch. Spawn collection typically occurred at the Landing River tributary, located 30 km upstream of the Kelsey GS. Prior to 2011, male and female Lake Sturgeon were held in streamside tanks until they were ripe and running (water temperature influenced). Attempts were then made to collect eggs and milt from these fish. Because success was sporadic using these methods, Ovaprim was adopted for spawn taking operations in 2011. Fertilized eggs were transported to the Grand Rapids Hatchery for rearing during each year in which spawn collection was successful. Lake Sturgeon fingerlings (age 0) and some yearlings (age 1) were stocked back into various locations of the upper Nelson River. Until recently, success of Nelson River stocking efforts has remained largely unknown. In fall 2012, a Lake Sturgeon inventory was conducted in the Sea Falls – Sugar Falls reach, which had been stocked with large quantities of both fingerling (age 0, n = 20,885) and yearling (age 1, n = 1,107) Lake Sturgeon from 1994 – 2011. A total of 91 individual Lake Sturgeon (90 juvenile, 1 adult) were captured and 67 (74%) of these had Passive Integrated Transponder (PIT) tags, signifying that they were stocked as age 1 (McDougall and Pisiak 2012). Given the relative proportions of PIT tagged fish in the catch and considering only those fish from the 2006 – 2011 cohorts reasoned to be susceptible to the gillnets deployed, relative recruitment success was conservatively estimated to be

17.4 times greater for Lake Sturgeon stocked as age 1 versus those stocked as age 0 (which were stocked in far greater numbers). Furthermore, based on atypical growth chronologies observed when examining ageing structures of the captured fish (missing or weak first annuli, attributed to unnatural overwinter hatchery thermal regimes), the authors suggested that as many as 95.5% of the fish aged may actually have been stocked as age 1 (and perhaps that PIT tag loss or malfunction occurred, or that tags were somehow missed during field scanning). Based on this observation, relative recruitment success might actually have been 128 times as great for age 1 compared to age 0 stocked fish. In addition to survival, it was noted that age 1 stocked fish from the 2007 cohort were considerably larger than those identified as age 0 stocked fish from the same cohort based on growth chronologies, and therefore the head-start afforded by overwinter hatchery growth might well translate into age 1 stocked fish reaching maturity faster or being more fecund upon reaching maturity (since they are larger for a given age) than their age 0 stocked counterparts. It was concluded that stocking initiatives should strongly consider rearing Lake Sturgeon to age 1 prior to release in order to increase survival.

Lake Sturgeon (primarily fingerlings) were stocked in the Winnipeg River most years from 1996 – 2010. In 2008 and 2009, Ovaprim was used to induce ripe Lake Sturgeon to release gametes. Research investigating the physiological effects (as well as survival and post-release movement patterns) of Ovaprim injected adults began in 2011, and it is expected that results will be available shortly. Research also suggests that survival of stocked yearlings (age 1) may far exceed survival of fingerlings (age 0) in the Slave Falls to Seven Sisters reach of the river, although data analysis is ongoing (C. Klassen, University of Manitoba, pers. comm.). With those exceptions, Winnipeg River stocking was conducted to supplement recruitment. As natural recruitment has now been ascertained in all impoundments on the Manitoba side of the Winnipeg River, stocking Winnipeg River populations does not appear to be necessary to rehabilitate these populations. However, stocking is still being considered for the Lamprey Falls – Manitoba/Ontario border stretch of river conditional on the presence of quality habitat and very few fish, both of which have not been adequately assessed (K. Kansas, Manitoba Fisheries Branch, pers. comm.).

Lake Sturgeon were stocked into the Saskatchewan River during 1999 and 2000, as well as from 2003 – 2007. Spawning adults were captured from downstream of the EB Campbell or Nipawin dams by Saskatchewan Environment staff. Ovaprim was used during each year. Fertilized eggs were reared in the Grand Rapids Hatchery or Fort Qu'Appelle hatchery. While considerable numbers of Lake Sturgeon have been stocked into the Saskatchewan River as either fry or fingerlings, the success of the Lake Sturgeon program remains unknown.

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Webb, M.A.H., G.W. Feist, M.S. Fitzpatrick, E.P. Foster, C.B. Schreck, M. Plumlee, C. Wong, and D.T. Gundersen 2006. Mercury concentrations in gonad, liver, and muscle of White Sturgeon *Acipenser transmontanus* in the lower Columbia River. Arch. Environ. Contam. Toxicol. 50: 443-451.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Appendix 1A, Part 2 Keeyask Lake Sturgeon Stocking Strategy; p. N/A

TAC Public Rd 2 DFO-0100

ORIGINAL PREAMBLE AND QUESTION:

Appendix 1A - Part 2

Given the challenges of detecting changes in sturgeon (growth, age, etc.) over the short term, how will success/failure be determined?

FOLLOW-UP QUESTION:

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?

RESPONSE:

Detecting change in life history parameters such as fecundity, interbreeding intervals (for females), and life expectancy post-Project will be difficult because information on these life history parameters does not exist pre-Project.

Detecting change in life history parameters such as growth, spawning intervals (males), size at first maturity and mortality/survival should be possible if similar data sets are collected post-Project as exist today.

Determining success/failure will be subjective. For example, it is possible that Lake Sturgeon growth in the Keeyask reservoir will be more rapid in the post-Project environment. Is this considered success?

In addition to parameters already set out in the AEMP, discussions with DFO and MCWS may identify additional metrics to include as measures of stocking program success.

REFERENCE: Volume: Project Description Supporting Volume; Section: 6.7 Powerhouse; p. 6-13

TAC Public Rd 2 DFO-0103

ORIGINAL QUESTION:

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.

FOLLOW-UP QUESTION:

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.

RESPONSE:

As discussed at a TAC review meeting among KHLP, DFO and MCWS on February 14, 2013, the Partnership is not aware of relevant information related to turbine mortality beyond what is presented in the EIS and IRs. An analysis of the potential effects of increased mortality rates on the Lake Sturgeon population based on a population model is provided in the response to TAC Public Rd 2 DFO-0106. For ease of reference, this response is also copied below. Although precise measures of turbine mortality are not available for adult Lake Sturgeon, this analysis provides insight into potential effects of increased losses from the population.

DFO-0106 RESPONSE:

The initial question posed by TAC Public Rd 1 DFO-0106 requested acceptable mortality rates for turbine passage based on the fish community and population in the Keeyask study area. The proponent noted, with reference to specific sections of the AE SV, that mortality of fish during passage past the turbines and spillway would reduce the number of fish entering Stephens Lake. Given the relative size of Gull and Stephens lakes, emigration of juvenile and adult fish from Gull Lake to Stephens Lake is not thought to provide a major input to the Stephens Lake population and no material impact of turbine/spillway mortality to the fish community is expected. Construction of the Keeyask Generating Station will also reduce the drift of larval fish from Gull to Stephens lakes. The input of larval Lake Sturgeon from upstream of Gull Rapids may be the source of young Lake Sturgeon in Stephens Lake, given the extremely low numbers of spawning fish observed in the last decade; however, this reduction in larval drift is due to the presence of the reservoir and would not be affected by the turbines.

The follow-up question by DFO notes that information on acceptable mortality rates was not provided. In subsequent discussions (technical review meeting on 15 February, 2013 among KHLP, CEAA, DFO and MCWS), the Partnership noted that no literature values of “acceptable” turbine mortality rates could be located, though considerations of effects to fish were included in the turbine design at Keeyask. It was noted that, even at stations that do not use modern turbines with features to reduce effects to fish, there is no clear evidence that fish numbers are declining through a series of reservoirs (e.g., Winnipeg River system has eight generating stations; lower Nelson River has three generating stations). DFO noted that a particular concern is with a rare species such as Lake Sturgeon, where the mortality of even a few individuals is of concern. At the 15 February, 2013 meeting, it was suggested that examining the effect of increasing mortality rates on Lake Sturgeon using a population model could assist in assessing the potential effects of increased turbine mortality. This analysis was presented at a follow-up meeting on February 22, 2013 meeting and is documented below.

MORTALITY ANALYSIS USING POPULATION MODEL FOR LAKE STURGEON

It should be noted that although this assessment does not deal specifically with turbine mortality or decreased immigration, it does address the permanent loss of individual Lake Sturgeon from the population through decreased survival. The following assumptions are made:

3. The current Jolly-Seber model for the Gull Lake population is definitive for other exploited populations (i.e., Stephens Lake) (Nelson and Barth 2012); and

4. That the parameters as modeled from Program MARK (White and Burnham 1999) are normally and independently distributed.

The Burnham Jolly-Seber model estimates new entrants into the population indirectly by modeling the rate of population growth (λ) between each interval where population growth is the net effect of survival and recruitment (White and Burnham 1999) .

$$\lambda i = N_{i+1}/N_i$$

The formulations for these versions of the Jolly-Seber were developed by Burnham (1991) and Pradel (1996). The key difference between the two parameterizations is that the Pradel-λ approach is conditional upon animals being seen during the study, while the Burnham Jolly-Seber formulation is not. Therefore, the Burnham Jolly-Seber formulation also includes a parameter for the population size at the start of the experiment. This enables the estimation of the population size at each subsequent time point.

Hydropower Limited Partnership

Table 1. Model output for the best model based on Akaike's Information Criterion selection in Program MARK (Akaike 1973).

Parameter	*Mean*	*SE*	*95% Confidence Interval*	
			Lower	Upper
Survival	0.84	0.04	0.75	0.90
$P_{capture}$ 2001	0.22	0.03	0.16	0.29
$P_{capture}$ 2002	0.15	0.02	0.11	0.19
$P_{capture}$ 2003	0.25	0.03	0.19	0.32
$P_{capture}$ 2004	0.13	0.02	0.10	0.18
$P_{capture}$ 2006	0.34	0.05	0.24	0.45
$P_{capture}$ 2006	0.09	0.02	0.05	0.14
$P_{capture}$ 2010	0.12	0.04	0.07	0.22
Population Growth	1.02	0.04	0.95	1.10
Population Estimate	464.80	63.99	359.39	613.21

The best model was determined using Akaike's Information Criterion (AIC) and is defined by constant survival, time varying recapture, and constant lambda (Table 1). This model was used as the basis to model the effects of decreased survival on population growth (a surrogate for permanent emigration through entrainment in this case). This was accomplished by decreasing the survival from the current level 0.84 by fixing it at sequentially lower levels 0.83, 0.82, 0.81… 0.73. The population growth estimates were tabulated for each of the decreased survival estimates from 0.84 to 0.73. The mean and standard error of the estimated population growth was used to generate a distribution assuming a normal and independent distribution. These distributions were then used to calculate percentiles for 95% confidence intervals, 50% likelihood, and medians. The results are provided in Figure 1.

The basic interpretation of these results is as follows. The population growth estimate is the ratio of successive population estimates, and therefore if it is greater than 1 the population is growing and if it is less than 1 the population is declining.

At the present level of survival (with harvest) there is about a 23% likelihood that the current population is actually in decline. If survival decreases by an additional 6% the likelihood of decline becomes approximately 75% (Figure 1). There would need to be a decrease of 11% to say with 95% confidence that the population is in decline (Figure 1).

Moving the other direction if survival increases by 4% or more the Gull Lake population is growing with 95% confidence.

It should be noted that decline in this sense means only that successive population estimates are lower; there is no implication of significance statistical or otherwise. This should be considered a preliminary assessment of effects. Based on the literature minimum viable population size estimates vary between 80-1800 (Schueller and Hayes 2011) and between 413 and 2500 for adult spawning females (Velez-Espino and Koops 2008). The current estimate for Gull Lake is 465 (this particular model) which is in the range for what the Schueller and Hayes (2011) model determines as a minimum viable population size (see paper for model specifics). The best way to foster increases in population survival and ultimately growth, is to increase the survival for critical life stages which are most sensitive to elasticity (Gross et al. 2002). For Lake Sturgeon this means increasing the survival from egg to yearly; in other words, if population growth is a goal then stocking of yearlings is the fastest and most efficient way to overcome the low population levels for Lake Sturgeon.

Akaike, H. 1973. Information theory and an extension of the maximum likelihood principle. In B. N. Petrov and F. Csaki (Eds.), Second international symposium on information theory (pp. 267_281). Budapest: Academiai Kiado.

Burnham, K. P. 1991. On a unified theory for release-resampling of animal populations. In Proceedings of 1990 Taipei Symposium in Statistics, M. T. Chao and P. E. Cheng (eds), 11-36. Institute of Statistical Science, Academia Sinica: Taipei, Taiwan.

Gross, M.R., J. Repka, C.T. Robertson, D.H. Secor, and W. Van Winkle. 2002. Sturgeon Conservation: Insights from elasticity analysis. American Fisherie4s Society Symposium 28: 13-30.

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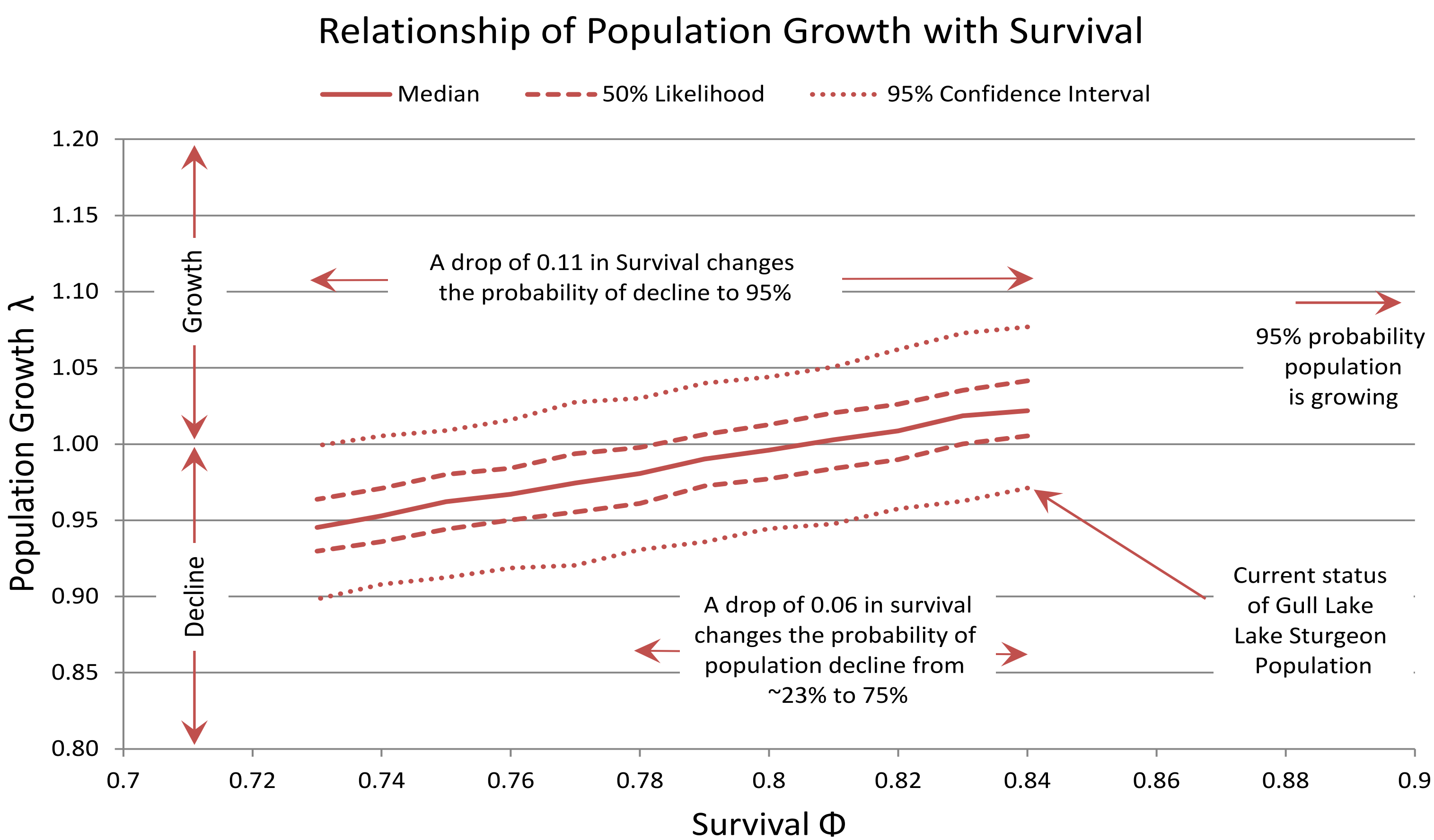

Figure 1. Relationship between survival and population growth based on the Burnham Jolly Seber model for Gull Lake Lake Sturgeon population. Data were collected between 2001 and 2010.

Keeyask Hydropower Limited Partnership

REFERENCE: Volume: Project Description Supporting Volume; Section: 6.7 Powerhouse; p. 6-13

TAC Public Rd 2 DFO-0104

ORIGINAL QUESTION:

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.

FOLLOW-UP QUESTION:

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.

RESPONSE:

As discussed at a technical review meeting among KHLP, CEAA, DFO and MCWS on February 15, 2013, limited information is available on the effects of turbine passage on fish populations, and it was agreed that additional information will be collected during post-Project monitoring as described in the Aquatic Effects Monitoring Plan (AEMP).

At DFO’s request, an analysis was conducted to assess potential effects to the population of a varying mortality rate. Please see DFO-0106.

REFERENCE: Volume: Project Description Supporting Volume; Section: 6.7 Powerhouse; p. 6-13

TAC Public Rd 2 DFO-0105

ORIGINAL QUESTION:

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?

FOLLOW-UP QUESTION:

Elaboration required. Could turbine operation mitigate impacts to fish during critical life stages (e.g. -Y-O-Y drift)?

RESPONSE:

The Partnership understand that the question relates to the effects of turbine passage on larval drift and young-of-the-year fish; in particular, that these life stages might be more sensitive to negative effects of pressure changes during passage through turbines. As discussed in the AE SV (p. 5-61), the amount of larval drift and movement of young fish is expected to be reduced due to the presence of the reservoir, which will tend to trap fish that are hatched upstream.

The Partnership notes that changes in turbine operation (with respect to maximum efficiency) only minimally affect pressure changes during passage past turbines; relevant pressure changes occur if fish are in deep water upstream of the station (i.e., entrained from deeper than 10 m) and released at the surface downstream of the station and also due to the acceleration of water within the turbine (Cada 2001; Brown et al. 2009).

REFERENCES:

Brown, R. S., T. J. Carlson, A. E. Welch, J. R. Stephenson, and C. S. Abernethy. 2009. Assessment of barotrauma from rapid decompression of depth-acclimated juvenile chinook salmon bearing radiotelemetry transmitters. Trans. Amer. Fish. Soc. 138:1285-1301.

Cada, G. F. 2001. The development of advanced hydroelectric turbines to improve fish passage survival. Fisheries 26 :14-23.

REFERENCE: Volume: Project Description Supporting Volume; Section: 6.7 Powerhouse; p. 6-13

TAC Public Rd 2 DFO-0106

ORIGINAL QUESTION:

What are acceptable mortality rates based on the fish community and population in the Keeyask study area?

FOLLOW-UP QUESTION:

Information on acceptable mortality rates not provided (e.g. literature).

RESPONSE:

The initial question posed by TAC Public Rd 1 DFO-0106 requested acceptable mortality rates for turbine passage based on the fish community and population in the Keeyask study area. The proponent noted, with reference to specific sections of the AE SV, that mortality of fish during passage past the turbines and spillway would reduce the number of fish entering Stephens Lake. Given the relative size of Gull and Stephens lakes, emigration of juvenile and adult fish from Gull Lake to Stephens Lake is not thought to provide a major input to the Stephens Lake population and no material impact of turbine/spillway mortality to the fish community is expected. Construction of the Keeyask Generating Station will also reduce the drift of larval fish from Gull to Stephens lakes. The input of larval Lake Sturgeon from upstream of Gull Rapids may be the source of young Lake Sturgeon in Stephens Lake, given the extremely low numbers of spawning fish observed in the last decade; however, this reduction in larval drift is due to the presence of the reservoir and would not be affected by the turbines.

The follow-up question by DFO notes that information on acceptable mortality rates was not provided. In subsequent discussions (technical review meeting on 15 February, 2013 among KHLP, CEAA, DFO and MCWS), the Partnership noted that no literature values of “acceptable” turbine mortality rates could be located, though considerations of effects to fish were included in the turbine design at Keeyask. It was noted that, even at stations that do not use modern turbines with features to reduce effects to fish, there is no clear evidence that fish numbers are declining through a series of reservoirs (e.g., Winnipeg River system has eight generating stations; lower Nelson River has three generating stations). DFO noted that a particular concern is with a rare species such as Lake Sturgeon, where the mortality of even a few individuals is of concern. At the 15 February, 2013 meeting, it was suggested that examining the effect of increasing mortality rates on Lake Sturgeon using a population model could assist in assessing the potential effects of increased turbine mortality. This analysis was presented at a follow-up meeting on February 22, 2013 meeting and is documented below.

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It should be noted that although this assessment does not deal specifically with turbine mortality or decreased immigration, it does address the permanent loss of individual Lake Sturgeon from the population through decreased survival. The following assumptions are made:

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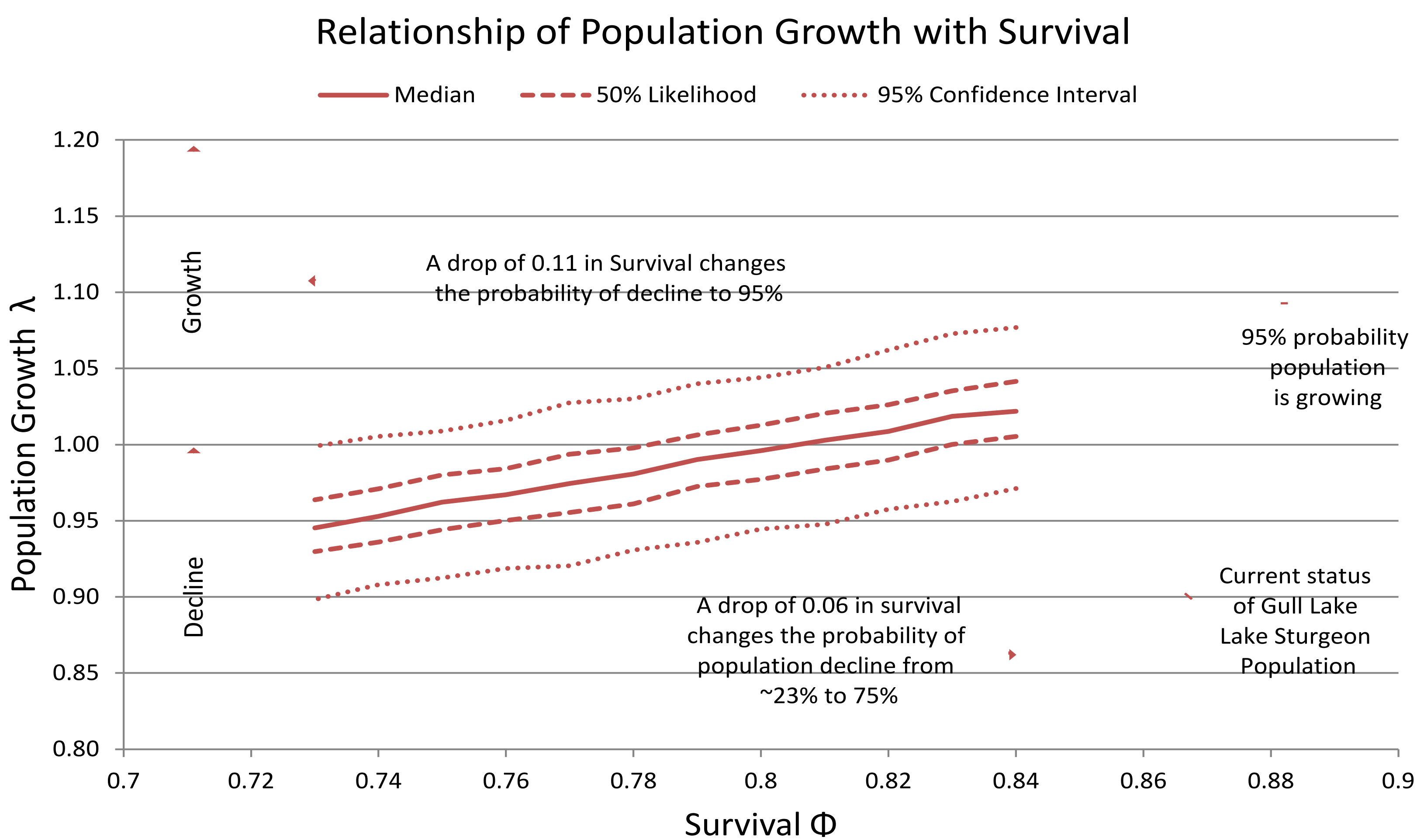


Figure 1. Relationship between survival and population growth based on the Burnham Jolly Seber model for Gull Lake Lake Sturgeon population. Data were collected between 2001 and 2010.

REFERENCE: Volume: Project Description Supporting Volume; Section: 6.7 Powerhouse; p. 6-13

TAC Public Rd 2 DFO-0107

ORIGINAL QUESTION:

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?

FOLLOW-UP QUESTION:

See DFO-0015

RESPONSE:

The Aquatic Effects Monitoring Plan (AEMP) is a detailed monitoring plan which includes assessment of mortality of fish passaing through the station and spillway. The follow-up question to this IR states, "See DFO-0015." The response to DFO-0015 states, "The Proponent response addresses the information request.". Therefore, the Partnership assumes that there is no further information required for this IR. This was confirmed during the technical review meeting among DFO, CEAA, MCWS and KHLP on February 15, 2013.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 2.0 Water and Sediment Quality, Table 2-11 Construction-related activities, potential effects to water quality, and proposed mitigation measures; p. 2-135

TAC Public Rd 2 EC-0007

ORIGINAL PREAMBLE AND QUESTION:

Table 2-11 outlines that water treatment plant backwash will be treated if required, such that TSS will be less than 25 mg/L prior to discharge to the receiving environment.

EC requests the Proponent provide a full characterization of discharges to ensure they are not deleterious; noting that TSS should not be the only discharge parameter to be assessed against water quality objectives.

FOLLOW-UP QUESTION:

The Proponent does not clarify which other discharge parameter will be considered as part of the treated back wash water quality objectives. EC requests that the Proponent provide a detailed characterisation of the anticipated backwash water quality, including other parameters of potential concern, aside from TSS.

RESPONSE:

Plans for the water treatment plant backwash have changed from that described in the Keeyask Generation Project – Project Description Supporting Volume. Based on the current Stage 5 design plan, backwash from the main camp water treatment plant will be sent to the main camp sewage treatment plant. Wastewater effluent criteria to be achieved prior to its disposal to the environment are provided in Schedule B to (Manitoba) *Environment Act* Licence No. 2952 R, which states that wastewater effluent will not be discharged from the sewage treatment plant to the receiving environment unless:

- The five day carbonaceous biochemical oxygen demand ($CBOD_5$) is less than 25 mg/L;
- The fecal coliform content, as indicated by the Most Probable Number (MPN) index, is less than 200 per 100mL of effluent;
- The total coliform content, as indicated by the MPN index, is less than 1500 per 100mL of effluent;
- The total suspended solids (TSS) concentration in the effluent is less than 25 mg/L;
- The concentration of unionized ammonia is less than 1.25 mg/L, expressed as nitrogen (N), at $15^{o}C \pm 1^{o}C$; and

- The total residual chlorine concentration of the effluent is less than 0.02 mg/L, as determined by the monthly average.

It should be noted that the sewage treatment plant effluent will be disinfected using ultraviolet light and not chlorine, so there will be no residual chlorine in the effluent.

These criteria meet those listed in the new *Wastewater Systems Effluent Regulations* under the federal *Fisheries Act.*

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.5 Effects and Mitigation Terrestrial Environment; 6.5.7 Birds; p. 6-362

TAC Public Rd 2 EC-0018

ORIGINAL PREAMBLE AND QUESTION:

The Proponent has not included a discussion or impact assessment regarding these risks associated with lighting and collision; could find no reference to these in the EIS.

EC requests that the Proponent provide information regarding any design and mitigation measures that have been incorporated to minimize the adverse effects of lighting. EC also requests further information regarding the communication tower, and any other features planned for the project site that may create a specific collision hazard for migratory birds, as well as on the proponent's proposed mitigation measures to minimize the risk of collisions.

FOLLOW-UP QUESTION:

EC requests that the Proponent clarify what lighting will be used for the powerhouse building and communication tower. EC also has a particular interest in project effects on migratory birds and requests the opportunity to review the monitoring reports. In order to minimize the risk of avian collisions and fatalities, EC recommends that any lighting used on the communications tower at night be limited to white (preferable) or red flashing LED or strobe lights, and be the minimum in number, intensity, and frequency of flashes required for aircraft safety. EC also recommends that Manitoba Hydro avoid the use of floodlights and other intense light sources at the base of the tower, or on the powerhouse building, especially those left on all night. With respect to any necessary security lighting on ground facilities (including buildings) and equipment, EC recommends that this lighting is as minimal as possible, and be down-shielded to keep light within the boundaries of the site. Consideration could also be given to turning these lights off at night during migration, and during bad weather. Finally, EC recommends that the proponent regularly monitor and document the level of avian mortality that occurs near the communications tower.

RESPONSE:

Manitoba Hydro is currently reviewing the applicable regulations regarding the lighting of the communication tower as part of the detailed design. In developing the final design, careful consideration will be given to important issues like migratory birds and public safety. A challenge will be that certain regulations developed for public safety may preclude the adoption of some of the EC recommendation regarding migratory birds. For example, Canadian Aviation Regulations (CARs) 12-1, Standard 621 – Obstruction Marking and Lighting specifically states that “two or more steady burning lights” are to be used at the top of a tower. Manitoba Hydro, on behalf of the Partnership, will provide EC with lighting design information regarding the generating station and ancillary buildings/structures as it becomes available and will commit to working with EC to protect migratory birds as much as feasible.

The EC recommendation for selection of fixtures will be adopted, where feasible. Note that lighting used on the generating station and ancillary facilities will be limited to those fixtures required for safety, security and operation requirements of the generating station. These lights cannot be turned off at night, as they are needed for performing inspections, monitoring plant equipment and, most importantly, to allow for proper egress at the plant in times of emergency. For similar safety reasons, turning these lights off for extended periods, such as during inclement weather or during migration, is not practicable.

The Partnership has committed to undertake project monitoring of bird collisions, including at the communication tower, during the project construction phase to determine whether there are any impacts on migratory birds. Based on the results of monitoring, mitigation measures may be implemented to reduce collision effects on birds. Further details will be provided in the Terrestrial Effects Monitoring Plan; the Partnership will provide a preliminary version of the plan to regulators in the second quarter of 2013.

Reports will be generated annually, documenting the monitoring programs and results. These reports will be provided to Manitoba Conservation and Water Stewardship and posted publicly on the Partnership’s Web site at www.keeyask.com.

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.5.7.7.3 Colonial Waterbirds; p. 6-362

TAC Public Rd 2 EC-0019

PREAMBLE:

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. Annually during the first three years of operation or until mitigation measures are deemed to be successful.

QUESTION:

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 that the proponent provide clarification.

RESPONSE:

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 that the proponent provide clarification.

To clarify, the monitoring activities in the first three years of operation are intended to confirm success (rather than feasibility) of the proposed mitigation measures.

The Environmental Impact Statement (EIS) currently outlines an approach to mitigate for the potential loss of habitat used by terns and gulls for nesting (see Keeyask Hydropower Limited Partnership 2012, Terrestrial Environment Supporting Volume, Section 6.4.2.3). The Partnership is currently in the process of determining the exact design specifications and site locations for the various mitigation measures, which will be documented in the Terrestrial Mitigation Implementation Plan. This Plan will include detailed design, placement, development, and implementation information for the gull and tern-nest habitat creation and /or enhancement. The Partnership agrees to share this Plan with Environment Canada.

The preliminary development of this plan has considered existing literature and information regarding the design and utilization of the various mitigation alternatives.

Artificial nesting platforms

Artificial nesting platforms are being proposed for the Keeyask Generation Project to enhance common tern nesting. The floating nesting platforms are proposed to address uncertainty regarding the formation of suitable tern nesting structures after the construction of the generating station. In most jurisdictions, the nesting platforms are left in the water year-round. It is currently anticipated that ice conditions at Keeyask will not allow this to be done in most reaches of the Nelson River. During the initial years of operation, the intent is to mobilize the platform(s) in a few key locations; if a platform is not used to the capacity expected of common terns, then alternative locations will be used in subsequent years. In most cases, these sites will be back-bay areas near shallow waters where common terns typically forage. Some of these locations may potentially be suitable sites where the floating platforms can be retained year-round. However, the current planning is to remove the platforms in the fall and replace them in the spring immediately prior to terns returning to the Keeyask reservoir area.

Key factors that will be considered with respect to the deployment of tern nesting platforms include the following:

- time of year – platforms to be placed soon before the return of common terns to breeding sites in the Keeyask area;
- location – ideally situate platforms within areas of low flow, such as back bays, that are close (within 5 km) of prime foraging areas; and
- use by other species – there may potentially be an issue if gulls out-compete terns for nesting sites on the platforms and terns are demonstrated to not have adequate alternative nesting habitat in the area during Project operation.

The timing of deployment of the tern nesting platforms is a critical step in their success for attracting and retaining breeding terns. As ring-billed gulls return to their nesting grounds earlier than common terns, gulls will potentially occupy the nesting platforms if they are available. By delaying the deployment of the platforms until immediately (within about 1 week) of the return of common terns, the intent is that majority of the local breeding gull population will have already completed their courtship rituals, selected nesting sites, and begun laying and incubating eggs. To encourage the use of nesting platforms by terns, a few tern decoys will be deployed on each platform; this will provide a social cue that would facilitate the attraction of terns to the structures during the courtship/pre-nesting period after their return to the Keeyask area in the spring. Any maintenance that is required will be done when the rafts are removed from the water in the fall.

The proposed plan for tern nesting is consistent with EC's recommendation to construct platforms, such that equivalent breeding populations might be maintained in the area. The plan to have two nesting platforms should more than compensate for any lost tern nesting areas, and from a habitat perspective, allow maintenance of the local tern population. The number of terns observed nesting in the Gull Rapids and Gull Lake reaches of the Nelson River between 2001 and 2010 ranged between 20 and 50 nesting pairs. As the nesting platforms are intended for common terns, which occur in relatively low numbers in the potentially affected areas, two platforms (which could support approximately 60 nesting pairs) will be sufficient and adequately compensate for any potential loss of nesting areas. However, another factor that may be influencing the number of nesting terns in the Gull Rapids to Gull Lake reach of the Nelson River is that ring-billed gulls may be displacing terns from the best sites on nest reefs in Gull Rapids area. Ring-billed gulls have been shown, through the field investigations, to have displaced common terns from their former nesting colony near Birthday Rapids – this is a trend that has been seen in a variety of locations in North America, e.g., the Great Lakes area.

A monitoring program outlined in the Terrestrial effects Monitoring Plan will help to determine whether the platforms are being utilized as planned and whether there are additional measures that are required to enhance their use by terns. The results of this monitoring will be considered in relation to the results of monitoring conducted along the Nelson River (from Gull Rapids to Clark Lake) to assure that an appropriate management approach is taken and sufficient nesting structures are available.

Enhancement of Areas below the Generating Station

There will be areas below the Generating Station which will not be overtopped by large spillway events. There are existing islands which will be well above the water level as well as lower rocky areas that will be more like the existing reefs. The areas to be enhanced to facilitate waterbird nesting will be identified based on potential water levels below the generating station and terrestrial areas not typically affected by high water levels during the breeding season.

The use of an island to enhance for nesting is preferable to using a peninsula and isolating it from the shore with fencing. This is partly due to the level of uncertainty regarding the size, structure and location of any suitable waterbird nesting structures that will exist in the area below the generating station after impoundment; as such, use of a peninsula is being considered as one of the alternatives. If the peninsula is utilized, the condition of the predator fencing will need to be maintained by the Partnership.

Artificial Nesting Island

The EIS and subsequent processes to define action plans have considered a suite of potential mitigation options that include the development of an artificial island in addition to enhancement of structures that would be present during the operational period of Keeyask.

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. At present, two potential sites have been identified as a possible location for constructing the artificial island prior to filling the reservoir. Both sites are in the Keeyask reservoir within 2.5 km of the generating station.

Manitoba Hydro has previously built a successful artificial nesting island to support breeding bird species in the Lower Churchill River. The development of an island was proposed as part of the Lower Churchill River Water Level Enhancement Project to compensate for the potential loss of an island used primarily by arctic terns (Manitoba Hydro 1997). Monitoring revealed that the Churchill River artificial island was utilized for nesting by gulls, common terns and waterfowl. A similar design is being considered as a starting point, although the design will need to be stronger to counter ice processes along the Nelson River; this will necessitate, for example, some stronger armoring for the sides of the island.

Literature Cited

Keeyask Hydropower Limited Partnership. 2012. Keeyask Generation Project environmental impact statement: Terrestrial environment supporting volume.

Manitoba Hydro. 1997. Lower Churchill River Water Level Enhancement Weir Project, Environmental Impact Statement, Manitoba Hydro.

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.2.3 Existing Environment and Future Trends, 6.2.3.4 Terrestrial Environment and 6.2.3.4.3 Terrestrial Plants; p. 6.102

TAC Public Rd 2 EC-0028

PREAMBLE:

Invasive species spread readily along disturbance corridors and once established are virtually impossible to eradicate. This section mentions that “field studies detected all of the 19 invasive plants known to occur in the Regional Study Area”. The construction and operation of the project may provide additional opportunities for invasive species to establish and spread (through dispersal of weed seeds on equipment and vehicles, or in reclamation materials brought to the site, etc.), disrupting native plant communities. EC acknowledges the proponent’s commitment on page 3-34 of TE SV to 1) clean construction equipment and machinery recently used more than 150km from the project area prior to transport to the project area regularly; 2) use seed mixtures containing only native species and/or non-invasive introduced plant species; 3) implement containment, eradication and/or control programs if monitoring identifies problems with invasive plants; and 4) educate contractors about the importance of cleaning their vehicles, equipment and footwear before traveling to the area. In addition to the proponent’s commitments above, EC recommends that all vehicles and equipment are cleaned prior to entering the project areas. EC also recommends that any areas containing noxious weeds be clearly marked, so that equipment operators can easily recognize when passing through weed infested areas, and so that the spread of species from these areas can be monitored. EC further recommends that equipment and vehicles are thoroughly cleaned after passing through any such area in order to avoid transporting seed to other areas.

QUESTION:

EC requests that the Proponent discuss:

- if all vehicles and equipment will be cleaned prior to entering the project areas;
- if areas containing noxious weeds will be clearly marked, so that equipment operators can easily recognize when passing through weed infested areas;
- if vehicles and equipment will be cleaned after passing through areas containing noxious weeds; and
- if seed mixtures to be used contain only native species and/or non-invasive introduced plant species.

RESPONSE:

There have been a number of previous developments and activities in the Project area that provide insight in terms of distribution of invasive plants. These include the development and operation of Kettle and Long Spruce generating stations, Radisson and Henday converter stations, the Town of Gillam, PR 280, a fiber optic line alongside PR 280, over ten years of Project-related engineering and EA studies in the proposed Project area and the activities of area residents and visitors over many years. Even with this level of activity, all of the observed invasive plant patches were confined to human disturbed areas. Field studies did not find any evidence that invasive plant species were spreading into nearby native plant communities, likely due to the harsh climate, high prevalence of surface peat, established ground cover and other factors. The risk that the Project will spread invasive plant species into native plant communities appears to be low given past trends and the Project mitigation measures. To verify this, and to be in a position to respond quickly should any unexpected outbreaks occur, invasive plant distributions in the Project area will be monitored and colonizations that could become outbreaks will be eradicated where practicable and controlled elsewhere. Additionally, areas cleared during construction but not required for operation will be rehabilitated to native habitat types, which will eliminate colonization sites for invasive plants.

If all vehicles and equipment will be cleaned prior to entering the project areas

As stated in the Response to the EIS Guidelines, construction equipment and machinery used more than 150 km away from the Project site will be cleaned prior to working on site. Other vehicles (i.e., personal cars and trucks) will not be required to be cleaned prior to arriving onsite. As part of the Environmental Protection Plans for the Project, contractors will be educated about the importance of supporting measures to limit the introduction and spreading of invasive plants.

If areas containing noxious weeds will be clearly marked, so that equipment operators can easily recognize when passing through weed infested areas

Areas where there are patches of noxious weeds will be flagged for avoidance if they are not contained in active construction areas. Concurrently, control and eradication measures will be implemented in the event that noxious weeds patches develop during construction. Monitoring and control programs will focus on the early detection of and rapid response to noxious weeds. *If vehicles and equipment will be cleaned after passing through areas containing noxious weeds*

Marking and avoiding noxious weed patches should eliminate the need to wash vehicles and equipment.

If seed mixtures to be used contain only native species and/or non-invasive introduced plant species

Seed mixtures used for revegetation will only contain native species and/or non-invasive introduced plant species.

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.5.3 Terrestrial Ecosystems and Habitat, and 6.5.3.2 Ecosystem Diversity; p. 6-318 to 6-320

TAC Public Rd 2 EC-0029

PREAMBLE:

This section notes on page 6-318 that a “rehabilitation plan will be developed that gives preference to rehabilitating the most affected priority habitat types using approaches that “go with nature” and on page 6-319 that “the rehabilitation plan developed and initiated during construction will extend into the operation phase, and continue until all necessary rehabilitation is completed.” Lastly, on page 6-320 of this section it mentions that “Monitoring will include confirming that…rehabilitation to native broad habitat types was successful at locations identified in the rehabilitation plan”. EC recommends that any disturbed areas that will not be flooded are restored, and are restored as quickly as possible once they are no longer in use. EC recommends that disturbed areas are restored to mimic native vegetation communities in the surrounding area, and to provide similar habitat to pre-construction conditions. EC also recommends that the restoration materials be of local provenance, and be certified and inspected to be free of both invasive and noxious weed materials. Finally, EC recommends long-term monitoring and adaptive management to ensure restoration.

QUESTION:

EC requests that the Proponent:

- confirm that disturbed areas that are no longer in use will be restored as quickly as possible;
- confirm that disturbed areas will be restored to mimic native vegetation communities in the surrounding area, and provide similar habitat to pre-construction conditions;
- discuss whether the restoration materials will be of local provenance, and be certified and inspected to be free of both invasive and noxious weed materials; and
- discuss any long-term monitoring and adaptive management plans to ensure restoration.

RESPONSE:

Confirm that disturbed areas that are no longer in use will be restored as quickly as possible

Cleared and disturbed areas not required for Project operation will be rehabilitated as quickly as is practicable.

Confirm that disturbed areas will be restored to mimic native vegetation communities in the surrounding area, and provide similar habitat to pre-construction conditions

The target habitat types (combinations of vegetation type and ecosite type) for areas not required for Project operation will be the native habitat types appropriate for the post-construction conditions. In some locations, the target habitat type will be the same one that was there prior to clearing or disturbance. In other locations, it will not be feasible to rehabilitate the area to the pre-construction habitat type. For example, it would be very difficult to regenerate an aspen forest in a borrow area where the clay overburden was removed leaving coarse granular material. Another example is that a jack pine woodland could not be recreated in the portion of a granular borrow area where excavation has removed material to a depth where a pond forms. A marsh or other wetland type will be the appropriate target habitat type in these locations. In locations where construction has dramatically altered site conditions, the target habitat type will be a native habitat type that is appropriate for the post-construction site conditions giving preference to the most affected priority habitat types.

Discuss whether the restoration materials will be of local provenance, and be certified and inspected to be free of both invasive and noxious weed materials

Tree and tall shrub propagules will be of local provenance. Most other propagules will also likely be of local provenance since the majority will come from stockpiled materials that are later spread. Fast-growing non-native grasses and forbs may be used in some locations to meet temporary needs such as controlling erosion on steeper banks in borrow areas. For these situations, the non-native species will eventually be displaced with native plant species appropriate for the site conditions. This staged approach maintains flexibility to use the most effective techniques to achieve the rehabilitation objectives.

Seed mixtures obtained from commercial suppliers will meet the requirements of the Canada Seeds Act for Certified Canada #1 seed for certified cultivars or Canada Common #1 for common cultivars. Commercial seed suppliers will provide seed analysis certificates verifying that the number of noxious seeds will not exceed the following limits per 25 grams for species listed by the Weed Seeds Order: 0 prohibited noxious weeds, 0 primary noxious weeds, 1 secondary noxious weeds, 25 total noxious weeds.

Commercial seed suppliers will provide seed analysis certificates verifying that the seed mixture does not contain sweet clover or alfalfa seeds.

D*iscuss any long-term monitoring and adaptive management plans to ensure restoration*

Monitoring will include confirming that rehabilitation to native broad habitat types is successful. Vegetation and soils data will be collected in the rehabilitated areas to assess degree of native habitat recovery. Additional or alternative rehabilitation will be applied to the extent practicable in areas not meeting rehabilitation targets.

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.5.3 Terrestrial Ecosystems and Habitat, and 6.5.3.4 Wetland Function; p. 6-325 to 6-327

TAC Public Rd 2 EC-0030

PREAMBLE:

These sections outline the following: 1) project construction is predicted to affect up to 7765 ha of wetlands, including 9-12 ha of off-system marsh (p. 6-325); 2) mitigation to replace Nelson river wetlands is not proposed (p. 6-325); and 3) “globally, nationally and/or provincially significant wetlands are not affected” (p. 6-327). Proposed mitigation includes: 1) “measures to protect against erosion, siltation and hydrological alteration will be implemented in utilized construction areas that are within 50 m of any off-system marsh that is outside of the Project Footprint” (p. 6-325) ; and 2) “12 ha of the off-system marsh wetland type will be developed within or near the local Study Area” (p. 6-326; p. 6-327). Wetlands provide important habitat for both migratory birds and Species at Risk. EC promotes the maintenance of the functions and values derived from wetlands throughout Canada, enhancement and rehabilitation of wetlands in areas where continuing loss or degradation of wetlands have reached critical levels, no net loss of wetland functions for federal lands and waters, recognition of wetland functions in resource planning and economic decisions, and utilization of wetlands in a manner that enhances prospects for their sustained and productive use by future generations. EC recommends that the proponent take all reasonable measures to avoid wetlands, where feasible, irrespective of whether they are wet or dry, and that buffers or setbacks originate from the one in one hundred year high water mark. One hundred metre setbacks should be utilized from the edge of the proposed development or associated feature (e.g., access route) where feasible. EC acknowledges that the proponent will develop 12 ha of off-system marsh habitat within or near the study area to compensate for the loss of 9-12 ha of off-system marsh. EC refers the Proponent to 'The Federal Policy on Wetland Conservation' which promotes the wise use of wetlands and elevates concerns for wetland conservation to a national level. EC recommends that the Proponent review this document to provide further guidance on reducing impacts to wetlands.

QUESTION:

EC requests that the Proponent confirm the use of appropriate setbacks from wetlands and discuss, for those wetlands where avoidance is not possible, what mitigation and compensation measures will be implemented.

RESPONSE:

Approximately 90% of the Regional Study Area land area is covered by wetlands (Terrestrial Environment Supporting Volume Section 2.8.3.2.1 p. 2-167), with the majority of these wetlands being naturally functioning (Nelson River shoreline wetlands being the main exception; Response to EIS Guidelines Section 6.5.3.4.1 p. 6-327; Terrestrial Environment Supporting Volume Section 2.8.3.2.1 p. 2-167). The vast majority of the potentially affected wetlands are inland bogs, which have relatively low overall ratings for their contributions to various wetland functions (Response to EIS Guidelines Section 6.5.3.4.1 p. 6-327; Terrestrial Environment Supporting Volume Section 2.8.4.1.1 p. 2-181). While some of the wetland types in the study area provide habitat suited for species at risk, such as olive-sided flycatcher and rusty blackbirds, very little of the potentially affected wetlands are productive breeding habitat for most migratory birds.

Given the very high proportion of natural wetland area, few land-based projects of any type could proceed in the Project region if the project was designed to provide a 100 m setback on all wetlands. The Project focus was on minimizing effects on wetlands to the extent practicable. It is anticipated that some degree of wetland area loss can be absorbed without adversely affecting wetland function in regions where wetlands are abundant and remain in a relatively pristine condition (Terrestrial Environment Supporting Volume 2.8.1.1). In these situations, the emphases are on reducing the total area of wetland loss and minimizing effects on the particularly important wetland types. Particularly important wetland types are those types that make relatively high contributions to many wetland functions and/or are regionally rare. Given the high prevalence of peatlands in the region and the absence of swamp in the Project zone of influence, off-system marsh was evaluated as being the only particularly important wetland type.

In this context, the Project minimized effects on wetlands using a three-stage approach consisting of avoidance, minimization and then compensation. In some cases, avoidance or minimization of wetland effects was indirectly achieved by a general objective to reduce terrestrial flooding. In other cases, minimizing effects on wetlands and avoiding specific wetland types were among the criteria used to search for the best balance between minimizing a variety of potential adverse effects and maximizing potential positive effects. The following summarizes how the Project planning process addressed wetland avoidance, minimization and compensation.

Wetlands were avoided at various stages of Project planning. During the initial planning stages, selecting the low-head option considerably reduced the amount of terrestrial flooding, which in turn considerably reduced wetland loss since bog and fen wetlands cover about 90% of the land area. Further reductions in wetland flooding were achieved when Axis GR-4 was selected (Project Description Supporting Volume p. 6-10).

Selecting a 1 m reservoir operating range further reduced shore zone wetland effects compared with a larger operating range. The high degree of water level variability associated with reservoir operation would considerably limit the amount of emergent wetland vegetation that can develop along the reservoir shoreline. A 1 m operating range is expected to reduce the width of the sparsely vegetated shoreline band when compared with a larger operating range.

Alternative dyke arrangements were evaluated with relevant considerations for wetlands including minimizing flooding and minimizing effects on creek crossings and local drainage patterns (Project Description Supporting Volume p. 6-17, 6-18).

Of the three south access road alternative routes, the south alternative was in part selected because it avoids the most sensitive wetland types, minimizes the number of waterway crossings and minimizes total affected wetland area.

Effects on wetlands were avoided and otherwise minimized in several ways during the evaluation and refinement of alternative excavated material placement areas. The initial inventory of 50 excavated material placement areas was reduced to 35 following a preliminary review and ranking by the project team, which included consideration of wetland effects. Some excavated material placement areas were located to promote marsh development in the future reservoir. Excavated material placement areas were situated in environmentally degraded areas wherever practicable.

The terrestrial, aquatic, socio-economic, engineering and construction teams worked collaboratively to refine the Project Footprint so as to find the best balance between minimizing potential adverse effects and maximizing potential positive effects. Two of the criteria were to avoid the most sensitive wetland types, and where avoidance was not practicable, minimize effects on these wetland types. As a result, some boundaries for the proposed Project Footprint were modified to further reduce adverse effects on wetlands.

By this stage of the Project design process, sufficient wetland area had been avoided and wetland effects minimized that it is expected that substantial effects will be eliminated for all wetland types except for off-system marsh (the only particularly important wetland type in the Project region).

Compensation for the predicted 9 to 12 ha of off-system marsh loss and alteration includes 100% replacement through 12 ha of wetland enhancement. Additional mitigation to avoid potential effects on off-system marshes outside of the permanent Project Footprint includes implementing measures to protect against erosion, siltation and hydrological alteration in utilized construction areas that are within 100 m of any off-system marsh that is outside of the permanent Project Footprint.

Setbacks from all wetlands are not feasible because most of the Project Footprint borders on wetlands (the vast majority of the region is bog and fen wetland). The Project planning process described above has already eliminated area effects on some wetland types and reduced residual cumulative effects on all remaining types to between 2% and 7% of the wetland area that existed prior to industrial development. Additionally, most of the potentially affected wetlands are inland wetlands that are not adjacent to a body of water. On this basis, setbacks will only be applied for off-system marsh wetlands. Setbacks for off-system marsh wetlands outside of the permanent Project Footprint will be increased to the 100 m recommended by Environment Canada except at approximately 12 locations along borrow areas, excavated material placement areas, the dykes and near two dyke drainage ditches. As noted above, measures to protect against erosion, siltation and hydrological alteration during construction will be implemented at these locations. Of the 12 locations where a 100 m buffer is not currently possible mitigation may include; use of a slightly smaller buffer, or a physical barrier such as clean fill and rock or a silt fence.

Several other mitigation measures will reduce Project effects on wetlands. Terrestrial rehabilitation will regenerate areas not required for Project operation to native habitat types, some of which are wetland types. Additionally, the rehabilitation plan may prescribe wetland creation for some excavated material placement areas in depressions (locations will not be known until construction determines which excavated material placement area locations are actually used).

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.2.3 Existing Environment and Future Trends, 6.2.3.4 Terrestrial Environment and 6.2.3.4.7 Mammals; p. 6-127 and 6-130

TAC Public Rd 2 EC-0032a

PREAMBLE:

The EIS describes three groupings of caribou for the Regional Study area: 1) barren-ground caribou from the Qamanirjuaq herd; 2) coastal caribou from the Cape-Churchill and Pen Islands herds; and 3) "summer resident caribou" (which "could be coastal caribou, [boreal] woodland caribou, or a mixture of both"; p. 6-130). There are 6 geographically distinct populations of the forest-dwelling Woodland Caribou in Canada: Northern Mountain population, Southern Mountain population, Boreal population, Forest-Tundra population, Atlantic Gaspesie population, and the insular Newfoundland population. With the exception of the barren-ground caribou, EC considers the caribou in the project area to be part of the "forest-tundra" population, which are not SARA-listed and have not been assessed. EC notes that the project will result in the permanent loss of some primary calving and rearing complexes ("clusters of islands in lakes or islands of black spruce surrounded by expansive wetlands or treeless areas (peatland complexes)" (p. 6-131)) for the summer resident caribou (p. 6-367, 6-372), as well as 6825 ha of physical winter habitat for the Qamanirjuaq, Cape-Churchill and Pen Island herds (p. 6-366). Additionally, sensory disturbances associated with construction and operation are expected to result in additional loss of effective habitat (p. 6-367, p. 6-372), and increased access to the project area could increase mortality due to predation (p. 6-368, 6-372). EC encourages the proponent to consult with Manitoba Conservation to identify any plans to manage undisturbed caribou habitat in the project area. EC acknowledges the proponent plans to implement mitigation measures including;

- minimizing blasting from May 15 to June 30 (p. 6-370);
- implementing an access management plan, including locked gates at the north and south dykes from May 15 to June 30, as well as during other sensitive times determined through monitoring (p.6-371);
- rehabilitating temporarily cleared and excavated materials placement areas to native habitat;
- blocking and revegetating project-related cutlines and trails within 100m of the project footprint (p. 6-374); and
- long term monitoring of caribou and predators in the project area (p. 8-23, 8-26).

In addition to these measures, EC recommends the reduction of sight lines along the access trails, and the continual restoration of project-related cleared areas, cutlines, trails, etc. as they are no longer in use. EC also recommends that the proponent consider additional mitigation measures (e.g., mitigation of noise, light, smells, vibrations; reduction of vehicle speeds, etc.) to minimize harassment of caribou in the project area, particularly from late winter to late spring and early summer, as this will be a stressful period for all of the caribou in the project area.

QUESTION:

EC requests that the Proponent discuss any plans to implement additional mitigation measures (e.g. mitigation of noise, light, smells, vibrations, reduction of vehicle speeds, etc.) to minimize harassment of caribou in the project area, particularly from late winter to late spring and early summer. EC requests that the Proponent discuss any plans to reduce sight lines along access trails and discuss restoration plans for project-related cleared areas, temporary transmission right of ways, trails, etc. EC also requests the Proponent discuss their plans to consult with the province.

RESPONSE:

Plans to implement additional mitigation measures (e.g. mitigation of noise, light, smells, vibrations, reduction of vehicle speeds:

Mitigation measures to minimize disturbance of caribou in the project area are discussed in the Terrestrial Environment Supporting Volume (Section 7.4.6.2) and Response to EIS Guidelines (Section 6.5.8.1). In addition to the mitigation measures stated in the preamble, caribou advisory signs will be placed on access roads to emphasize the need for safety for migrating caribou and other wildlife.

Speed limits will be based on design criteria engineered to safely operate machinery and vehicles on temporary winter trails during construction. Minimizing the use of this trail by the public during construction via an Access Management Plan is expected to reduce traffic noise and exhaust during construction. As part of the Environmental Protection Plan, workers will be educated concerning the harassment of wildlife. The Keeyask Generation Project will create sensory disturbances (e.g., noise, light, smells, and vibrations) during construction and operation that result in a loss of effective habitat for caribou. Potential disturbances are limited to areas near those lands identified for the Project. Sensory disturbance during construction will result in less than a 1% loss of winter and calving and rearing habitats in the Regional Study Area, and will not affect long-distance movments of migratory caribou (Response to EIS Guidelines ,6-366, 6-368). Sensory disturbances are anticipated to be considerably less during operation compared to construction. As a result, there are no plans to implement additional mitigation measures.

Plans to reduce sight lines along access trails:

Best management guidelines (Government of Alberta 2011) recommend that in forested areas, line-of-sight should be limited to 200 metres on non-roadway, cross-country linear features. The Project does not include any cross-country access trails (all trails are within or near other Project Footprint components). In the event that additional access trails are identified during construction, any cross-country access trails through forested areas will be designed to either be less than 200 m long or cleared in a manner such that sight lines are no greater than 200m. Access trails will be blocked when they are no longer needed for construction (see next paragraph). Additionally, it is anticipated that vegetation regeneration will generally be adequate to reduce sight lines on access trails. A study conducted in the Project region found that approximately 35% of trails and cutlines previously created for a variety of purposes had regenerated to the degree that they likely no longer functioned as travel corridors within 10 years of clearing (Terrestrial Environment Supporting Volume Section 2.4.3.2.1).

Discuss restoration plans for project-related cleared areas, temporary transmission right of ways, trails, etc.:

As described in the response to TAC Public Rd 2 EC-0029, cleared areas (including new trails) will be rehabilitated to native habitat types as quickly as is practicable after it is determined they are not required for Project operation. Except for existing resource-use trails (Response to EIS Guidelines Section 6.5.3.1.1), Project-related trails will be blocked where they intersect the Project Footprint and the portions of these features within 100 m of the Project Footprint will be revegetated. The success of the revegetation efforts will be monitored and additional efforts will be applied to areas not meeting objectives.

Plans to consult with the province:

Manitoba Hydro consults regularly with the Province concerning caribou and is an active partner participating on regional caribou committees and resource management boards. Manitoba Conservation and Water Stewardship has also participated in several meetings of the Keeyask Generation Project Mammals Working Group (Response to EIS Guidelines Section 4.5.2.2) to discuss various caribou issues.

The Partnership will be providing environmental protection plans, monitoring plans and management plans to the Province for review and approval. These plans include mitigation measures for protection of wildlife. The results of these programs will be reported on annually and provided to Manitoba Conservation and Water Stewardship and placed on the Partnership's Web site at www.keeyask.com.

LITERATURE CITED:

Government of Alberta. 2011. Best management guidelines; Enhanced approval process. Published by the Government of Alberta. 30pp.

Keeyask Hydropower Limited Partnership

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.5.8.1.1 Construction Effects and Mitigation; p. 6-370

TAC Public Rd 2 EC-0032b

PREAMBLE:

In addition to the previous comments provided by EC regarding caribou in the project area, EC notes that the southwest corner of the Regional Study Area overlaps with parts of two ranges of boreal woodland caribou as delineated in the Final Recovery Strategy: Wapisu (MB8) and Manitoba North (MB9). While it does not appear that the project will have any direct effects on these herds, there is potential for indirect effects on these SARA-listed species. The effects analysis in the EIS appears to focus on project effects on the non-SARA-listed caribou (the migratory ecotype of woodland caribou and the barren ground caribou), and predominantly on caribou in the local study area. The EIS report states the following regarding the potential impact on boreal caribou: "Because changes to intactness will be negligible, effects on caribou will likely be negligible. The Project will not contribute to measurable changes in caribou intactness of the RSA." (p. 6-370) It is not clear from the information provided however, what indirect effects on boreal woodland caribou may occur (e.g., sensory disturbances, loss of habitat, habitat degradation, increased access, indirect mortality, etc.), or the nature of cumulative impacts on boreal woodland caribou when considered with all other foreseeable projects in the area. Additionally it is unclear how the proponent has determined effects for boreal woodland caribou specifically, to be "negligible".

QUESTION:

EC suggests that the proponent provide clarification on the above points. EC also encourages the Canadian Environmental Assessment Agency to discuss the potential for indirect effects on boreal woodland caribou with both the proponent and provincial caribou experts.

RESPONSE:

The current range of boreal woodland caribou extends into the southwest corner of the Regional Study Area (Study Zone 6, Map 6-28) near Thompson, as described in Section 7.3.6.3.3 of the Terrestrial Environment Supporting Volume and Section 6.2.3.4.7 of the Response to EIS Guidelines (see Map 6-38 for caribou ranges). The range of SARA-listed boreal woodland caribou does not extend to the Local Study Area (Study Zone 4, Map 6-28), where the direct and most of the indirect Project impacts are expected to occur. No effects on boreal woodland caribou were assessed directly, as the northernmost portion of their ranges is located about 100 km from Gull Lake.

The effects assessment described potential Project effects on barren-ground caribou from the Qamanirjuaq herd, coastal caribou from the Pen Islands and Cape Churchill herds, and the small group of summer resident caribou that remain in the Keeyask region year-round. The herd association of the summer residents is unclear, and it was stated that this group could be coastal caribou, boreal woodland caribou, or a mixture of both. For the purposes of the assessment of potential Project effects, the group of summer resident caribou was treated as an independent population that uses a smaller range than the migratory groups and is more likely to use calving and rearing habitat that occurs within the Keeyask region (Section 7.3.6.3.3 of the Terrestrial Environment Supporting Volume and Section 6.2.3.4.7 of the Response to EIS Guidelines). Effects of changes to intactness on these three groups of caribou (barren-ground, coastal, and summer resident), none of which are listed by SARA, were determined to be negligible based on benchmarks established for boreal woodland caribou (Section 7.2.6.2 of the Terrestrial Environment Supporting Volume), which were based in part on recommendations by Environment Canada (2012) [1]. Other benchmarks used to describe Project effects for all caribou included predation and linear feature density.

Environment Canada (2012) indicates that the population of the Wapisu (MB8) range is estimated at 110-125 individuals, the population trend is stable, and the population is likely self-sustaining. The population estimate for the Manitoba North (MB9) range is not available, the population trend is not available, and the population is as likely as not self-sustaining (Environment Canada 2012). If the change in habitat intactness were assessed for these two ranges of boreal woodland caribou, which overlap a portion of the Regional Study Area, the measureable effect would be none or negligible for the same reasons as for other types of caribou. For example, as defined by Environment Canada, the total habitat disturbance reflecting the loss of functional habitat for the Wapisu range is currently at 24%, and the undisturbed habitat is greater than 65% of this range. For the Manitoba North range, the current total range disturbance is 28%, and the undisturbed habitat is greater than 65% of this range. Neither of these two ranges are expected to change as a result of the Project.

A small decrease in linear feature density, from 0.45 km/km² to 0.44 km/km², is anticipated in the Intactness Regional Study Area (Zone 5) as a result of the Project, of which a small portion overlaps boreal woodland caribou range (Section 6.5.3.3.1 of the Response to EIS Guidelines). Because there will be no increase in linear feature density as a result of the Project, there will be no effect on the portions of Wapisu and Manitoba North ranges that overlap the Regional Study Area. The Project will have

[1] Environment Canada. 2012. Recovery strategy for the woodland caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, ON. Xi + 138 pp.

localized core area effects for other caribou in and near the Keeyask segment of the Nelson River (Section 6.5.3.3.1 of the Response to EIS Guidelines), which is well beyond the recognized range of boreal woodland caribou.

Considering project linkage pathways, and the spatial separation between boreal woodland caribou range and the Local Study Area, reasonably foreseeable indirect effects on boreal woodland caribou could be related to increased traffic on the portions of PR 391 and PR 280 that overlap both the Regional Study Area and boreal woodland caribou range. Potential effects would be limited mainly to the construction period. Increased traffic will temporarily increase sensory disturbance and reduce effective habitat for boreal woodland caribou. However, the nearest boreal woodland caribou core use area identified in Section 3.13 of the Bipole III Transmission Project Caribou Technical Report (2011)[2] does not overlap the portion of PR 391 from Thompson to PR 280 referred to as Road Section 1 in the Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume.

Boreal woodland caribou distribution in this area is influenced by the existing roads and other development near the City of Thompson. The Project is expected to increase traffic on Road Section 1 between 1% and 6% from 2014 to 2021 (Section 5.4.1.5.2 of the Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume). Effects of increased traffic will be limited to individuals whose home ranges overlap Road Section 1. These individuals may reduce their use of habitat or may increase their movement rates near the road (Leblond *et al*. 2013)[3]. However, considering the incrementally small increase in traffic that is already located on an existing highway, any further loss of habitat effectiveness, or behavioral responses such as increased rates of movement (Leblond *et al*. 2013) are still expected to be minimal, and likely not measureable with such a small increase in traffic.

The risk of caribou-vehicle collisions could also increase with increased traffic volume; however, collisions with vehicles are not considered an important threat to boreal woodland caribou (Environment Canada 2012). Caribou-vehicle collisions are rare in Manitoba. While three or four areas on PTH 60 near The Pas have been identified as locations for caribou-vehicle collisions, most of the people interviewed for Environment Canada’s Aboriginal Traditional Knowledge report on boreal caribou had not heard of

[2] Joro Consultants Inc. 2011. Bipole III Transmission Project Caribou Technical Report. Prepared for Manitoba Hydro November 2011. 205 pp.

[3] Leblond, M., Dussault, C., and Ouellet, J.-P. 2013. Avoidance of roads by large herbivores and its relation to disturbance intensity. Journal of Zoology 289: 32-40.

such incidents (Boreal Caribou Aboriginal Traditional Knowledge Reports 2010-2011).[4] From 2007 to 2010, no caribou injured by vehicles were dispatched by Manitoba Conservation in the Gillam area (L. Meyers pers. comm.)[5]. To date, no collisions have been reported during construction of the Wuskwatim Generating Station, and of 217 reported collisions with wildlife in the Thompson area from 2008 to 2012, two were reported with caribou (Manitoba Public Insurance unpubl. data). Collision data are limited by what claimants reported (i.e., species may not have been specified in each case) and are affected by people's ability to correctly identify wildlife species..

Other indirect Project effects on boreal woodland caribou could include habitat loss, habitat degradation, and access-related mortality due to hunting and predation. These effects on caribou are discussed in Section 7.4.6.2 of the Terrestrial Environment Supporting Volume and Section 6.5.8.1 of the Response to EIS Guidelines. No Project-related habitat loss or fragmentation will affect Wapisu or Manitoba North range (Section 2.4.4.1.1 of the Terrestrial Environment Supporting Volume). Because access (i.e., new roads, trails or highway upgrades) will not increase in these two ranges as a result of the Project, neither will caribou harvest and predation.

Manitoba Hydro, on behalf of the Partnership, is willing to meet with the CEAA, EC and the provincial caribou experts to discuss the potential for indirect effects on boreal woodland caribou. As described in TAC Public Rd 2 EC-0032, Manitoba Hydro consults regularly with the Province concerning caribou, and is an active partner participating on regional caribou committees and resource management boards.

[4] Boreal Caribou Aboriginal Traditional Knowledge (ATK) Reports. 2010-2011. Compiled June 2011. Ottawa: Environment Canada.

[5] Meyers, Lisa. 2010. District Supervisor, Gillam District, Manitoba Conservation, Gillam, Manitoba. Email correspondence with Andrea Ambrose, Wildlife Resource Consulting Services MB Inc. August 26, 2010.

REFERENCE: Volume: Response to EIS Guidelines; Section: Chapter 8.0 Monitoring and Follow-up; p. N/A

TAC Public Rd 2 EC-0033

PREAMBLE:

EC notes the proponent's plans to implement monitoring and follow-up plans regarding the effects of the project on colonial waterbirds, species at risk, caribou, wetlands, invasive plants, and ecosystem diversity, and the success of planned mitigation measures for each. EC has a particular interest in project effects on migratory birds and species at risk, the development of wetlands, the progress of reclamation with native species in the project area, and the success in preventing the incursion of invasive species.

QUESTION:

EC requests confirmation from the Proponent that the monitoring reports collected will be shared with EC.

RESPONSE:

Reports will be provided annually to Manitoba Conservation and Water Stewardship, and placed on the Keeyask Hydropower Limited Partnership's website: http://keeyask.com/.

REFERENCE: Volume: Socio-Economic Supporting Volume; Section: Appendix 5C: Human Health Risk Assessment; 5.4.2.3 Mercury & Human Health; Aquatic Environment Supporting Volume; Section: Table 7-1; p. SE SV 5C-1 and 5-214 to 5-224; AE SV 7-53

TAC Public Rd 2 HC-0002

PREAMBLE:

Mercury and human health – proposed mitigation measures: Based on the results of the HHRA, fish consumption recommendations were developed. HC agrees with the need for such recommendations and in general, would also concur with the recommendations themselves. However, HC notes that with respect to recommendations of "unrestricted eating" for all fish with less than 0.2 ppm mercury, the current edition of the Guidelines for Consumption of Recreationally Angled Fish in Manitoba (2007) recommends that women of childbearing age and children under 12 years, limit their consumption of fish with less than 0.2 ppm mercury to 8 meals per month. The HHRA recommends that fish consumption advisories be communicated to local First Nations and communities. Also, based on fish monitoring data, additional human health risk assessments be undertaken every 5 years after peak mercury levels have been reached to determine if consumption advisories need to be changed. HC advises adopting Manitoba's guidelines recommendation limiting consumption for women of childbearing age and children under 12 years with respect to fish with less than 0.2 ppm mercury to provide added protection of health for these sensitive receptors. HC would consider this approach reasonable but would advise that if monitoring results show that mercury levels in fish are higher than the predicted maximum levels in the HHRA, prior to reaching their actual maximum levels, fish consumption advisories should be re-visited to ensure that they remain protective of human health.

QUESTION:

HC has previously submitted a response to the CEA Agency in its letter of December 28, 2012. HC disagrees with the HHRA conclusion of supporting unrestricted eating of fish with elevated Hazard Quotients (eg. HQ of 14 for whitefish from Gull and Stephens Lakes). HC welcomes further discussions on mercury levels in fish and the use of provisional Tolerable Daily Intakes (pTDI) of 0.47 micrograms (µg) methyl mercury (MeHg) per kilogram of body weight per day (kg-bw/day) for adults, and 0.2 µg MeHg per kg-bw/day 0.2 ug/kg bw/day for women of childbearing age in human health risk assessments. HC advises the risk communication plan be separate from the HHRA and included within a risk management plan as mitigation for this project. HC welcomes further discussion and is available to review the risk management plan upon request.

RESPONSE:

As requested by Health Canada, the Partnership has revised the HHRA as follows:

- Removed recommendations;
- Removed consumption guidance.

As requested by Health Canada, the Partnership is also preparing a separate Risk Management Plan that includes recommendations and consumption guidance. In preparing this Plan, the Partnership will continue to work with Manitoba Health and Health Canada so that the Plan is culturally appropriate, protective of human health and promotes a healthy fish diet.

We assume that the notation in the question of a Hazard Quotient of 14 for whitefish on Gull and Stephens lakes is a typographical error. The Partnership notes that the highest Hazard Quotients for whitefish from Gull and Stephens lakes, as set out in the HHRA, were for women of childbearing age; these were 1.0 and 1.4 for Gull Lake and Stephens Lake, respectively, under pre-project conditions and 2.7 and 2.1, respectively, under post-impoundment conditions.

REFERENCE: Volume: Socio-Economic Supporting Volume; Section: 5.3.3 Mercury and Human Health; p. 5-104 to 5-120

TAC Public Rd 2 HC-0003

PREAMBLE:

Mercury and human health: The EIS indicates that communication products to address adverse health impacts will be developed. It should be noted that the determination and implementation of risk management strategies for country foods in the project area fall under the responsibilities of provincial and/or municipal authorities. However, HC considers accurate communication strategies a very important tool in the reduction of risk to Aboriginal health with regards to country foods. HC would be willing to review proposed risk management approaches and communication products to provide its opinion.

QUESTION:

HC has reviewed the communication products provided, and some preliminary comments are provided in the attached table (Formative Review of Risk Comm Products). HC would be pleased to meet with the proponent to undertake a more thorough discussion of the communication products, upon request. HC advises that the focus of the communication products be on the protection of the most sensitive receptors first (i.e. pregnant women and women of child-bearing age, and children). HC is available to review communication products that are developed for the post-impoundment scenario, upon request.

RESPONSE:

The Partnership appreciates the opportunity to discuss the communication products with Health Canada, along with Manitoba Health. At a March 2013 technical meeting among Health Canada, Manitoba Health, Manitoba Conservation and Water Stewardship, Department of Fisheries and Oceans and the Partnership, there was agreement to a process in which this discussion would continue to occur.

Manitoba Health indicated a willingness to prepare initial communication materials regarding mercury and human health under present conditions. They also indicated that they would look at how best to prepare further communication materials regarding mercury and health for the Keeyask area under present conditions, including continued consultation with the Partnership (e.g., a communication working group was noted as a potential option to discuss the evolution of communication products).

The Partnership agrees that the communication products should focus on the protection of the most sensitive receptors first (i.e., women of child-bearing age and children).

The Partnership appreciates the opportunity to review communication products for the post-impoundment scenario with Health Canada, when they are developed closer to the beginning of the operations phase.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 7.2.4 Project Effects: Mitigation and Monitoring; p. 7-16

TAC Public Rd 2 HC-0007

PREAMBLE:

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.

QUESTION:

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.

RESPONSE:

As discussed in AE SV Section 2.4.2.3.4, “At present, this reach is subject to domestic fishing but the number of sturgeon taken is not known. New road construction will increase access opportunities for domestic harvesters and thereby potentially increase lake sturgeon harvest. A lake sturgeon conservation awareness program for the Project will be developed in consultation with local domestic resource users and MCWS to highlight the sensitivity of populations in the Keeyask reservoir and immediately downstream.”

Local resource users will be encouraged to not consume lake sturgeon from these waters post-Project due to conservation concerns with lake sturgeon populations during the first decades after impoundment. As such, there are no plans to measure methylmercury concentrations in lake sturgeon from the Keeyask reservoir or Stephens Lake post-impoundment.

HC also recommends that all species that will be consumed be included in the monitoring plan. The current AEMP proposes to sample mercury from three large-bodied species, two piscivors (northern pike and walleye) at the top of the aquatic food chain, and one omnivore (lake whitefish). In the relatively simple aquatic food chains of northern Manitoba waterbodies, whitefish are approximately one trophic level removed (i.e., lower) than pike and walleye and represent a levels representative of several other large-bodies fish species in the area (e.g., sucker species, freshwater drum, cisco).

In addition of being good representatives of the trophic levels (and thus, potential for mercury bioaccumulaton) occupied by most large-bodied fish species in the Study Area, Pike, Walleye, and whitefish also combine to represent the majority of the total fish intake (and thus, potential for mercury exposure) of local First Nation members. This statement is not based on exact catch statistics and formal consumption surveys (which largely do not exist) but on experience in working and living with First Nation members, including conversations about food preferences. Lake trout (a species mentioned by HC) only occurs in a few remote lakes and is not consumed by First Nation members in meaningful numbers. Rainbow smelt (another species mentioned by HC) is a recent invader in the Keeyask ecosystem. Although abundant, it has no history as a food fish in the area and is also not consumed in relevant numbers.

Worldwide, in Canada, and historically and currently in Manitoba, federal and provincial fish mercury monitoring programs have not and do not monitor every fish species, but concentrate on those species that are important in terms of human consumption and exposure, and that are suitable surrogates of species which mercury content is not directly measured.

REFERENCE: Volume: Response to EIS Guidelines; Section: N/A; p. N/A

TAC Public Rd 2 MB-Health-0001

QUESTION:

Please provide additional information on how the offset lake fishing program will be evaluated to ensure that it is working as it is intended.

RESPONSE:

The Keeyask Adverse Effects Agreements with Tataskweyak Cree Nation, War Lake First Nation and York Factory First Nation include provision for a program to address the potential for increased mercury concentrations in fish by replacing the domestic supply of fish currently taken from on-system lakes and rivers that have the potential to be affected by Keeyask. The Keeyask Adverse Effects Agreement with Fox Lake Cree Nation includes provision for an Alternative Resource Use Program, which may be used to harvest fish species in alternate resource areas within the Fox Lake Resource Management Area. These and other offsetting programs are designed to address effects on KCNs members' Treaty and Aboriginal rights resulting from the construction and operation of the Keeyask Project.

Each of the Keeyask Cree Nations is responsible for implementing the relevant programs for their community and for identifying possible off-system lakes to provide this replacement fish supply. Thus far, Tataskweyak Cree Nation and War Lake First Nation are the only communities who have outlined specific details for their respective programs. These details are included in the adverse effects agreements with these communities.

Ongoing success of these programs will be determined based on:

- Each community's ability to continue to provide a replacement fish supply from off-system lakes until such time as mercury levels return to pre-project conditions in the Keeyask forebay.
- The use of the program by community members – i.e., are community members interested in and eating the supplied fish from offsystem lakes.

As noted in the response to TAC Public Rd 2 MCWS-Fisheries-0002, to assist in selecting lakes for the programs to be operated by Tataskweyak and War Lake, the Partnership undertook fish community assessments between 2004 and 2006 on 13 lakes in the Split Lake Resource Management Area. The study documented the relative abundance of fish species in each lake, biological data (age and size) of the fish, and mercury levels. The study also estimated the maximum sustainable yield in each lake. Based on this information, TCN and War Lake selected seven and two lakes, respectively, to be harvested for their offset fishing programs. As new or different lakes are identified by the Keeyask Cree Nations for the purposes of these programs for which no fisheries data are available, additional sampling and analysis will be undertaken by the Partnership at that time.

TCN and War Lake are currently developing community-controlled Fish Harvest Sustainability Plans. These plans are being developed through a process of consultation with Members, provincial fisheries managers, the Partnership, and some members of the Split Lake Resource Management Board (SLRMB). The plans will be provided to the SLRMB to contribute to fulfilling requirements of Article 5.6.2 of the 1992 Implementation Agreement which states that the Board will develop and recommend resource management plans for the Resource Management Area. The Partnership intends to file the Plans in the second quarter of 2013.

The Fish Harvest Sustainability Plans will provide program managers in each community with the information needed to guide, regulate and monitor fishing activities on program lakes so that long-term community objectives will be met. Fishing pressure will be adjusted according to monitoring results to ensure that harvest levels remain sustainable. Monitoring details are provided in each Plan, and follow accepted fisheries management practices. Among this monitoring, it is anticipated that monitoring of mercury levels in the catch associated with these programs will be undertaken by the Partnership on an as needed basis so that the programs can be adjusted if needed. As part of ongoing program implementation, large pike and pickerel captured during fishing operations will also be released due to anticipated high mercury levels.

Overall, the Tataskweyak Cree Nation Healthy Food Fish Program is to provide annually up to one hundred thirty seven thousand (137,000) pounds (sixty two thousand one hundred forty two (62,142) kilograms) round weight of fish from identified lakes in the Split Lake Resource Management Area. The War Lake First Nation Community Fish Program is similar in nature but much smaller in magnitude. The amount of fish to be harvested through these programs was determined based on providing all on-reserve members (at the time of negotiation) with an average of one pound of fish (headless dressed) per week. As part of implementing these programs, the communities will track the program uptake by community members.

In addition to the offset fishing programs provided for in the Adverse Effects Agreements, the Partnership is also undertaking efforts to develop and distribute communication products outlining safe fish consumption. Draft versions of these communication products have been developed and will be reviewed and finalized in consultation with Manitoba Health and Health Canada.

REFERENCE: Volume: Response to EIS Guidelines; Section: Section 4.3.1.3; p. N/A

TAC Public Rd 2 MB-Health-0002

QUESTION:

Flooding due to extreme weather has been a concern in Manitoba and has caused damage to homes in some locations. Are there any risks of ice jams or extreme flooding as a result of unusual weather patterns as it relates to the Development?

RESPONSE:

The Keeyask GS will be designed to safely pass the Probable Maximum Flood (PMF). The PMF is a statistically rare event (less frequent than a 1:10,000 year event) and is considered the largest potential flood that could occur at this location in the river. The estimated PMF at this location on the Nelson River is approximately double the flow experienced during the summer of 2005, the highest daily average flow on record. Water levels on Split Lake and areas further upstream as well as water levels on Stephens Lake and areas further downstream would not be impacted by the Keeyask GS during floods on the Nelson River including the PMF.

Based on many years of observing ice formation on the Nelson River, ice jams that cause flooding do not currently occur upstream of Gull Rapids. A hanging ice dam that normally forms downstream of Gull Rapids has caused localized over land flooding and erosion during some years. The risk of ice induced effects during the construction phase will be largely mitigated by the installation of an ice boom upstream of the project site. This will facilitate the development of a stable ice cover on Gull Lake early in the winter season and will greatly reduce the size of the hanging ice dam that presently forms downstream of Gull Rapids at the inlet to Stephens Lake. Upstream of Gull Lake, the ice front is expected to progress in the upstream direction in a manner similar to the existing environment ice processes that occurs in this reach (see Response to Physical Environment Supporting Volume Section 4.3.1.3 for a detailed description). These ice formation processes are relatively insensitive to the specific weather patterns of each winter; warmer and colder winters will serve to increase or decrease the rate at which they occur but the magnitude of effects will be similar. This is true even for extreme weather patterns that may occur throughout the winter.

During the operation period, the Keeyask GS will eliminate the hanging ice dam that presently forms at the inlet to Stephens Lake. This will result in a smooth ice cover beginning about 800 m downstream of the tailrace. The Keeyask reservoir will form a smooth ice cover early in the winter season and the ice front will progress upstream in a manner similar to the existing environment ice processes that occur in this reach. Again, these ice formation processes are relatively insensitive to the specific weather patterns of each winter; warmer and colder winters will increase or decrease the rate at which they occur but the magnitude of effects will be similar. This is true even for extreme weather patterns that may occur throughout the winter.

REFERENCE: Volume: Response to EIS Guidelines; Section: 7.0; Page No.: n/a

TAC Public Rd 2 MCWS-EAB-0001

PREAMBLE:

QUESTION:

Please provide the map required pursuant to Section 9.8 of the federal EIS guidelines showing all the past, present and future projects that were considered in the cumulative effects assessment.

RESPONSE:

Please find attached a consolidated Keeyask Generation Project Cumulative Effects Map. This map includes the content of the eight maps (7A-1 to 7A-8) that were located in Appendix 7A of the Keeyask Generation Project Response to EIS Guidelines with the following updates and additions.

The most recent information available for the following projects has been used:

1. Keeyask Generation Project – updated South Access Road approach into Gillam.
2. Keeyask Infrastructure Project (KIP) – project footprint has been updated to reflect access and clearing required to drill water wells for the main camp, use of additional borrow sources along the North Access Road (NAR), use of additional borrow from G5 and use of a rock outcrop at kilometer 11, along the NAR. All of the aforementioned alterations to the KIP project footprint have been approved by Manitoba Conservation and Water Stewardship.
3. Keeyask Transmission Project – final routing of the line is now known and is shown rather than the three alternative routes considered (A, B, C, displayed in Maps 7A-7 and 7A-8).

The following information that was provided in text form in the Keeyask Generation Project Response to EIS Guidelines Appendix 7A has been converted to graphical form:

1. Mining Activities - the following information has been mapped:
   a. The location of Vale near Thompson, Manitoba (see Inset Map A);
   b. Mining claims north of Split Lake (see Inset Map A); and
   c. Exploration license on the north shore of Stephens Lake (Inset Maps A and B).

2. Commercial Fishing – the following information has been mapped:
   a. The location of active commercial fisheries (Split, Assean and Stephens lakes, Inset Map A); and
   b. Sipiwesk Lake (location of former commercial lake sturgeon fishing).

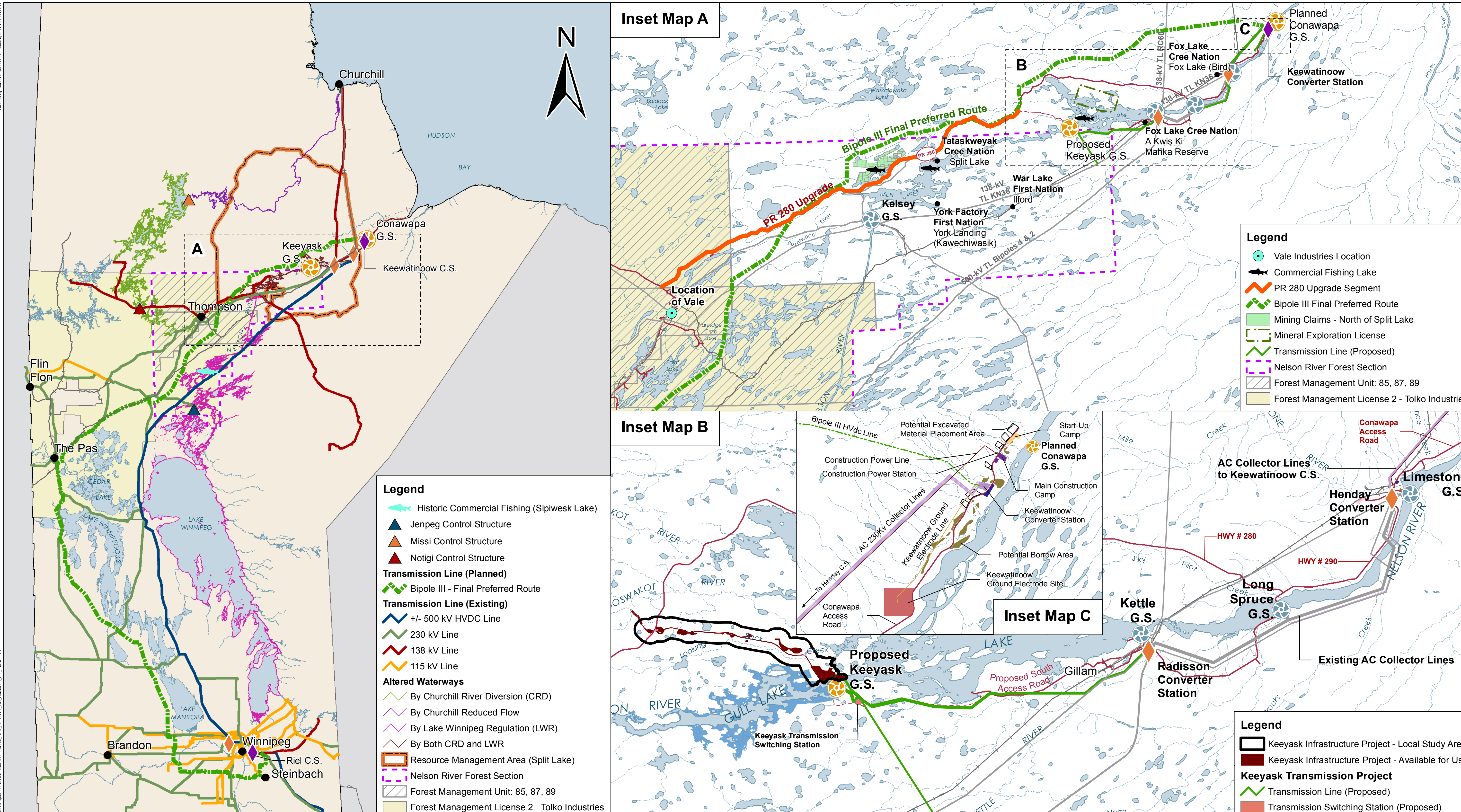
3. Commercial Forestry – the following information has been mapped:
   a. Forest Management License #2 (Provincial and Inset Map A);
   b. The Nelson River Forest Section (Provincial and Inset Map A); and
   c. Forest Management Units 85, 87 and 89 (Provincial and Inset Map A).

4. Kelsey re-runnering - The location of the Kelsey Generating Station has been mapped (Inset Map A). Further details can be found on this project in Appendix 7A of the Response to EIS Guidelines, page 7A-10.

5. Gillam Redevelopment and Expansion Program - The location of Gillam has been mapped (Inset Map B). Further details can be found on this project in Appendix 7A of the Response to EIS Guidelines, page 7A-13.

Additional information available for the Bipole III Transmission Project is displayed including the following components:

1. Keewatinoow Converter Station (Provincial and Inset Maps A and C);
2. Keewatinoow Ground Electrode Site (Inset Map C);
3. Keewatinoow Ground Electrode Line (Inset Map C);
4. AC collector line from Long Spruce Generating Station to Henday Converter Station(Inset Map B);
5. Five AC 230Kv collector lines from Henday Converter Station to the Keewatinoow Converter Station (Inset Map C);
6. Construction power line from Henday Converter Station to the construction camp site (Inset Map C);
7. Start-up and main construction camp sites (Inset Map C)); and
8. Potential borrow and excavated material placement areas (Inset Map C).



KEEYASK
Hydropower Limited Partnership

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

CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	19-MAR-13	23-APR-13
0 60 120 Kilometres / 0 50 100 Miles	VERSION NO: 1.0	QA/QC: XXX/YYY/ZZZ

Overall Legend

- Generating Station (Existing)
- Generating Station (Planned)
- Converter Station (Existing)
- Converter Station (Planned)
- Highway
- Access Road
- Proposed Access Road
- Rail (Active)
- Rail (Abandoned)
- Transmission Line (Existing)
- Transmission Line (Proposed)
- First Nation Reserve
- Existing Water Level
- Initial Flooded Area (159 m)

Keeyask Generation Project Cumulative Effects

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: 3.4.2.2, 4.4.4.2.2 & 5.3.2.7 p. N/A

TAC Public Rd 2 MCWS-Fisheries-0001

QUESTION:

Please provide additional information regarding aquatic invasive species (AIS), with specific reference to Spiny Waterflea, Zebra Mussels and Rainbow Smelt. In particular, demonstrate how the proponent will: 1) identify the impact of AIS on the native fish community given that these specific AIS are better adapted to lacustrine and reservoir habitats and 2) distinguish the potential impact of these AIS on both the existing and post project aquatic environment apart from the impact of the Project itself. The impacts may be synergistic, but if that is expected to be the case, then the proponent is requested to explain how the project and the effects of AIS are expected to interact. Finally, please include a discussion of best management practices to be implemented both during project construction and, during ongoing operation to negate the spread and / or mitigate the impact of aquatic invasive species.

RESPONSE:

The discussion below separately addresses the spiny water flea, zebra mussel and rainbow smelt in terms of their current status in Manitoba and the Project area, and potential impacts on the native fish community in the Project area under existing and post-Project conditions. Management measures are discussed at the end of this submission.

Spiny Water Flea

The spiny water flea (*Bythorephes longimanus* Leydig) is a large cladoceran that is native to northern Europe and Asia. This species has become established in all of the Great Lakes where it is thought to have been introduced from ship ballast water (Sprules et al. 1990; Berg et al. 2002). The first occurrence of the spiny water flea in Manitoba waters was recorded in a larval lake sturgeon drift trap sample collected from the Winnipeg River (Gill 2011). The spiny water flea was also recorded in 2012 at nearshore sites in Playgreen Lake (upper Nelson River) sampled under Manitoba/Manitoba Hydro's Coordinated Aquatic Monitoring Program (CAMP). To date, this species has not been documented in the Keeyask Project area; however, given its presence in the upper Nelson River it is likely that it will spread downstream, though whether it will thrive in the Nelson River is not known.

The spiny water flea is a temperate, freshwater adapted species and is typically found in large, deep clear lakes with relatively low summer bottom temperatures where it associates with other zooplankton in the upper water column (Berg and Garton 1988; MacIssac et al. 2000). The species reproduces rapidly and is not readily consumed by smaller-sized predators due to its spiny tail. As a result, it can quickly dominate the communities of waterbodies into which it is introduced. The introduction of the spiny water flea has been associated with changes in the native zooplankton community (USEPA 2008), declines in fish species abundance as a result of competition for food with planktivorous larval fish (Berg and Garton 1988; Evans 1988; Vanderploeg et al. 1993), and the fouling of fishing gear resulting from tail spines hooking on fishing lines (EC and MWS 2011).

As discussed above, the spiny water flea has not been recorded in the Project area, and the record from the upper Nelson River occurred after the Keeyask environmental impact statement (EIS) was prepared. For this reason, neither the potential effects of the Project on this species, nor potential effects of this invasive species on the native fish community were discussed in the EIS. The following outlines effects of reservoir creation on the zooplankton community, as described in the Aquatic Environment Supporting Volume (AE SV) Section 4.4.4.2.2, and it is anticipated that these would be similar for the spiny water flea.

> *"Typically, predominantly riverine environments do not support an abundant zooplankton community. In many impoundments, zooplankton density rises in response to increases in the concentration of fine, particulate organic matter, water retention time, and phytoplankton biomass (Henriques 1987). Evidence from other northern Manitoba reservoirs also indicates a small increase in zooplankton abundance because of conversion of river to reservoir habitat (NSC 2012). However, only small increases in mean zooplankton abundance along the mainstem are expected in the Keeyask reservoir as increased water residence time will remain too short to permit a measurable increase in abundance; although total abundance ('standing stock') would increase with the predicted increase in reservoir volume (approximate doubling in comparison to the existing environment) (Section 3.4.2.2). Community composition should remain comparable to the current condition, with a community dominated by small cladocerans (e.g., Bosmina spp.) and cyclopoid copepods. The lack of detectable effects may be attributed to high water flushing rates through the mainstem portion of the reservoir (i.e., post-Project water residence time will be in the order of 15 to 30 hours, depending on flow; Section 3.4.2.2), and subsequently, the low accumulation of zooplankton in the reservoir. Short retention times are often associated with high turbulence (turbidity), a mixed waterbody, and a lack of thermal stratification. Zooplankton require a minimum retention time to allow development. If rates of water movement through a reservoir exceed a few millimetres per second, little plankton will develop (Hynes 1970).*

> *Off-current areas could experience small to moderate increases in zooplankton abundance as water residence time in bays is estimated to be substantially longer than in the mainstem and could be up to one month long (Section 3.4.2.2). Post-impoundment conditions may favour bacteria over phytoplankton (Paterson et al. 1997). The addition of large amounts of newly flooded terrestrial organic matter may stimulate bacterial activity (increase the flow of carbon to higher trophic levels through the detrital pathway) and increase bacterial biomass in the medium term (5–10 years post-impoundment) instead of phytoplankton. An increase in bacterial biomass could provide a post-flooding food resource for zooplankton leading to an increase in zooplankton density and a shift in community composition to larger daphnids (more effective grazers on bacteria). Additionally, refugia for zooplankton from planktivorous fish predation (e.g., rainbow smelt) may be created over flooded peat by low oxygen conditions (Paterson et al. 1997).”*

The effect of the spiny water flea on the fish community cannot be determined since it is not known how abundant it will ultimately become in the Nelson River, nor how native species will interact with it. Distinguishing the effects of this species versus the Project on the fish community would also present a challenge; however, several sources of information will assist in this endeavor:

1. A monitoring program for *B. longimanus* has been included in the Aquatic Effects Monitoring Program (AEMP). This program will indicate whether the species is present and, if so, whether its abundance is changing. A temporal record of this species’ arrival and proliferation will assist in determining related effects to the fish community;
2. The CAMP does not sample zooplankton; however, it does collect data on the fish community in a wide range of waterbodies in northern Manitoba and both fish and benthic invertebrate collection methods provide anecdotal records of the presence of spiny water flea. As discussed in the AEMP for the Keeyask Project, CAMP waterbodies provide valuable context for interpreting changes observed in the Keeyask area, particularly to distinguish Project effects from other agents of change (e.g., climate change, invasive species).

Zebra Mussels

Zebra mussels (*Dreissena polymorpha*) are native to eastern Europe and western Asia and were first found in North America in the late 1980s. They are thought to have been introduced in discharged freshwater ballasts from ocean-going ships. Although zebra mussels are not currently in Manitoba, established colonies of zebra mussel were reported in the Lake Winnipeg watershed in 2009 (EC and MWS 2011). The distribution of zebra mussels is thought to be controlled by temperature and calcium concentration in the water. The potential detrimental effects of zebra mussels include accumulation on structures; reduction of recreation potential of beach areas due to the accumulation of sharp shells and foul odors from decaying, dead mussels; reduction in species of algae and zooplankton; and a decrease in native mussel populations.

The EIS for the Keeyask Project did not assess the effects of zebra mussel on the native fish community, or the effects of the Project on this species, given that it has not been recorded in Manitoba. Manitoba Hydro initiated a three part zebra mussel program in the 1990s that includes monitoring, mitigation, and contingency planning. If this program indicates that zebra mussel have entered Manitoba's southern rivers and subsequently the upper Nelson River, the monitoring program and mitigation measures would be reviewed to determine whether any modifications are required.

Rainbow Smelt

Rainbow smelt (*Osmerus mordax*) are a small-bodied pelagic fish with a circumpolar distribution. They first became introduced into the Great Lakes in the early 1900s and their distribution continues to expand in North American lakes, both as a result of human introductions and natural dispersal (Rooney and Paterson 2009). The potential effects of the introduction of rainbow smelt are described in Section 5.3.1 of the AE SV:

> *"Rainbow smelt were first reported in Split Lake and Stephens Lake in 1996 (Remnant et al. 1997). The colonization of waterbodies by rainbow smelt is generally considered to be an unfavourable occurrence. Rainbow smelt are an aggressive invading species that can alter the composition and abundance of native species, such as lake whitefish, cisco, and emerald shiner, residing in the waterbodies they invade. It is believed that rainbow smelt compete with these species for space and food and prey on their larvae (Franzin et al. 1994). Additionally, the consumption of rainbow smelt by predatory species such as walleye and northern pike may lead to an increase in mercury concentrations in these predators (Evans and Loftus 1987). Consumption of rainbow smelt has also been linked to a condition called "belly burn" in commercial catches of walleye. Belly burn is generally thought to occur by the release of enzymes found in rainbow smelt that break down the flesh of walleye stomachs. This condition can negatively affect a commercial fishery by decreasing the amount of time to process fish and by depreciating the value of fish stock that has not been processed fast enough (Freshwater Fish Marketing Corporation [FFMC] 2003)."*

The effects of rainbow smelt on the existing environment are described in Section 5.3.2.7 of the AE SV:

"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."

It is expected that in the absence of the Project, rainbow smelt would continue to increase in the Keeyask area and would contribute to an increase in the overall forage fish production. It will be impossible to differentiate the effects of rainbow smelt and the Project on the aquatic environment since these impacts will co-occur. The regional abundance of rainbow smelt will be monitored as part of the Comprehensive Aquatic Monitoring Program conducted by Manitoba and Manitoba Hydro. As discussed above, CAMP waterbodies provide valuable context for interpreting changes observed in the Keeyask area, particularly to distinguish Project effects from other agents of change.

<u>Management Measures for Aquatic Invasive Species</u>

The final Environmental Protection Plans for the Keeyask Project will incorporate measures that will be developed with guidance from the Province, which is currently developing a provincial Aquatic Invasive Species program to manage the spread of invasive species.

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U.S. Environmental Protection Agency (USEPA). 2008. Predicting future introductions of nonindigenous species to the Great Lakes. National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/066F.

Vanderploeg, H.A., J.R. Liebig, and M. Omair. 1993. *Bythotrephes* predation on Great Lakes zooplankton measured by an in situ method: implications for zooplankton community structure. Archiv für Hydrobiologie 127:1-8.

REFERENCE: Volume: Response to EIS Guidelines; Section: N/A; p. N/A

TAC Public Rd 2 MCWS-Fisheries-0002

QUESTION:

Please provide additional information on how the Partnership will monitor and mitigate impacts resulting from the offset lake fishing program.

RESPONSE:

The Keeyask Adverse Effects Agreements with Tataskweyak Cree Nation, War Lake First Nation and York Factory First Nation include provision for a program to address the potential for increased mercury concentrations in fish by replacing the domestic supply of fish currently taken from on-system lakes and rivers that have the potential to be affected by Keeyask. The Keeyask Adverse Effects Agreement with Fox Lake Cree Nation includes provision for an Alternative Resource Use Program, which may be used to harvest fish species in alternate resource areas within the Fox Lake Resource Management Area. These and other offsetting programs are designed to address effects on KCNs members' Treaty and Aboriginal rights resulting from the construction and operation of the Keeyask Project.

Each of the KCNs is responsible for implementing the relevant programs for their community and for identifying possible off-system lakes to provide this replacement fish supply. To assist in selecting lakes for the program, and in light of the potential for more intensive fish harvests, the Partnership undertook fish community assessments between 2004 and 2006 on 13 lakes in the Split Lake Resource Management Area. The study documented the relative abundance of fish species in each lake, biological data (age and size) of the fish, and mercury levels. The study also estimated the maximum sustainable yield in each lake. Based on this information, TCN and War Lake selected five and two lakes, respectively, to be harvested for their offset fishing programs - the only communities thus far to identify offset lakes for this purpose. As new or different lakes are identified by the Keeyask Cree Nations for the purposes of these programs for which no fisheries data are available, analysis will be undertaken in consultation with the Split Lake Resource Management Board (SLRMB).

TCN and War Lake are currently developing community-controlled Fish Harvest Sustainability Plans. These plans are being developed through a process of consultation with Members, provincial fisheries managers, the Partnership, and the SLRMB. The plans will be provided to the SLRMB to contribute to fulfilling requirements of Article

5.6.2 of the 1992 Implementation Agreement which states that the Board will develop and recommend resource management plans for the Resource Management Area.

The Fish Harvest Sustainability Plans will provide program managers in each community with information needed to implement, regulate and monitor fishing activities on program lakes so that long-term community objectives will be met. Fishing pressure will be adjusted according to monitoring results to ensure that harvest levels remain sustainable. Monitoring details are provided in each Plan, and follow accepted fisheries management practices. It is anticipated that monitoring of mercury levels in the catch associated with these programs will be undertaken.

Monitoring will be undertaken to determine whether any reductions in trophy fish are seen and to determine the need for any adaptive management measures.

The commercial lodges and outfitters operating in the Split Lake Resource Management Area operate under licences issued by the Province of Manitoba. These licences are subject to Treaty and Aboriginal rights. In the past, resolution of concerns has been mutually resolved by the responsible parties involved and it is anticipated this will continue into the future.

The KCNs' adverse effects agreements also require each KCN to coordinate its activities with its respective Resource Management Board. Each KCN is to seek input from the respective Board and to provide annual program reports respecting the management and administration of the Offsetting Programs that involve resource management, resource harvesting and resource use activities. The Boards are comprised of representatives from the respective KCNs, Manitoba and, in some cases, Manitoba Hydro.

REFERENCE: Volume: Response to EIS Guidelines; Section: N/A; p. N/A

TAC Public Rd 2 MCWS-LB-0012

QUESTION:

The NE Wildlife Branch was not aware that a caribou access program was going to be implemented with TCN. If this is happening, will the branch have any input or say on this? Initially it doesn't make sense as the Caribou aren't always in the area of the Keeyask access road or Generation Station. How is there enough of a disturbance that would require an annual fly out hunting program? Locals aren't guaranteed caribou every year if they haven't migrated through the area, why would guaranteed hunting via an access program be allowed? Please provide additional comment.

RESPONSE:

Under TCN's Adverse Effects Agreement, a number of offsetting programs are established to provide appropriate replacements, substitutions or opportunities to offset unavoidable Keeyask adverse effects on practices, customs and traditions integral to the distinctive cultural identity; i.e. to address effects of the Project on Treaty and Aboriginal rights.

For example, among its Offsetting Programs, Tataskweyak Cree Nation (TCN) has an Access Program through which Members are provided up to 52,000 miles of air charters per year and other services to enable them to travel to areas in the Split Lake Resource Management Area not affected by the Keeyask Generation Project.

The Access Program does not specifically target caribou – they are, however, hunted opportunistically. Access Program reports from 2005 to date indicate that a total of four (4) caribou have been harvested under the TCN spring and fall Access Programs. With the Access Programs occurring in the spring and fall, very few caribou are harvested because, typically, they are much more abundant and accessible during the winter season. The Spring Access program tends to target waterfowl and the fall program tends to target moose.

As part of its Adverse Effects Agreement, TCN is to coordinate its activities with the Split Lake Resource Management Board. TCN is to seek input from the board and to provide annual program reports respecting the management and administration of the offsetting programs that involve resource management, resource harvesting and resource use activities.

Community harvest levels for the CNP will be gathered as part of the reporting process outlined for the Access Program under the Adverse Effects Agreement. This information will be available to Tataskweyak and War Lake representatives on the SLRMB and will be shared as appropriate.

REFERENCE: Volume: N/A; Section: N/A; p. N/A

TAC Public Rd 2 MCWS-LB-0013

QUESTION:

MCWS-LB-0004: Lines 55-60. This paragraph seems to refer to an offsetting program specifically for caribou domestic harvest. Is this what it means or is it referencing offsetting programs in general

RESPONSE:

We apologize for the confusion. The paragraph is referring to the offsetting programs in general.

For further clarification: The TCN Access Program does not specifically target caribou – they are, however, hunted opportunistically. Access Program reports from 2005 to date indicate that a total of four (4) caribou have been harvested under the TCN spring and fall Access Programs. With the Access Programs occurring in the spring and fall, very few caribou are harvested because, typically, they are much more abundant and accessible during the winter season. The spring Access Program tends to target waterfowl and the fall program tends to target moose.

REFERENCE: Volume: Response to EIS Guidelines; Section: Section 6.2.3.2.9; p. p. 6-50

TAC Public Rd 2 NRCan-0005

ORIGINAL PREAMBLE AND QUESTION:

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)."

FOLLOW-UP QUESTION:

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.

RESPONSE:

Water quality results presented in the initial response to NRCAN-0005 were for the groundwater investigation. Groundwater well G-0556 was also tested but results from this well indicated that a solution was previously added to the well to prevent it from freezing. Based on the water quality test results the solution was likely saline. Preventing the well from freezing was necessary at this site because the well was originally drilled to install a piezometer that would function year round. Because a solution was added to prevent the well from freezing the results of the water quality test at this site could not be used to represent groundwater quality.

The camp well investigation took place in 2008 to consider potential supply rates and water quality. A test well (PW1) was drilled approximately 2.5 km due north of the proposed Keeyask camp, north of Looking Back Creek in granular deposit G1 (see Figure 1 below for approximate location). Four observation wells (OW1, OW2, OW3, OW4) were also drilled in deposit G1 near PW1 to observe drawdown and recharge during the pump test. Water samples from these wells were also tested for water quality. Two wells (OW1, OW2) were located immediately adjacent to PW1, one (OW1) was about 25 m to the west and another (OW4) was about 100 m east. All of the wells were located outside of the groundwater study area. Current plans for the Keeyask Project call for potable water to be drawn from two wells in deposit G1 for the camp water supply (PD SV, Sec. 3.3.1.1). During operation, potable water will be drawn from the reservoir (PD SV, Sec. 4.6.7). The following tables summarize the results of water quality tests from these wells. Four water samples from PW1, including a duplicate, and one sample from each from the OW wells were tested for general water quality (Table 2). Two water quality samples from PW1, including a duplicate, were tested for dissolved metals concentrations (Table 3).

Figure 1: Approximate location of camp well investigation (displayed on portion of PE SV Map 8.2-2)

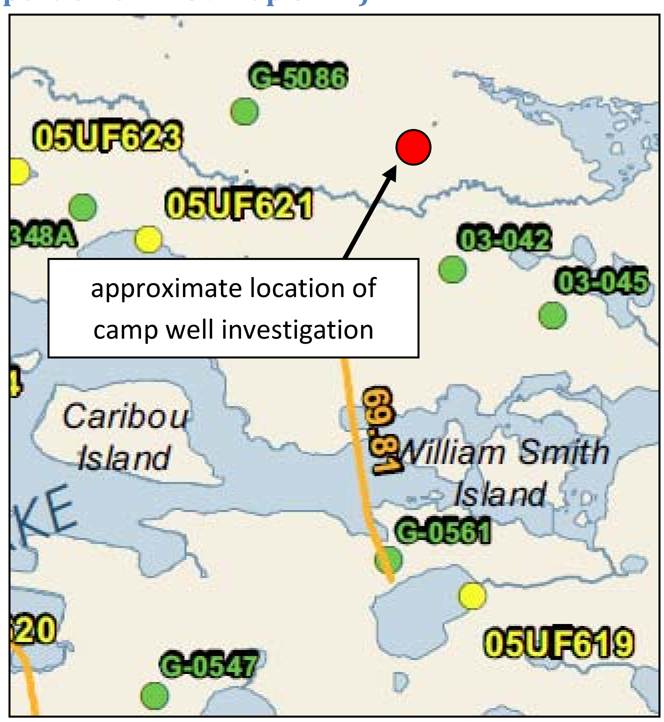

Table 2 (Page 1 of 2): 2008 Phase 1 Camp Well Installation & Pumping Well Test Program, General Water Quality.

Hole No.	Date	Time	Parameter										
			Turbidity	pH	E.C.	Total Alkalinity (as CaCO3)	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Hardness (as CaCO3)	Chloride	Fluoride	Sulphate
			NTU[5]	units	umhos/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection Limit			0.05	0.01	0.4	1	2	0.6	0.4	0.2	9	0.1	9
OW1	6-Mar-08		3	8.17	369	199	243	<0.6	<0.4	194	<9	0.3	<9
OW1[1]	5-Mar-08			7.07	430								
OW1[2]	13-Mar-08 to 15-Mar-08				351 - 353								
OW2	8-Mar-08		2.7	8.23	365	199	242	<0.6	<0.4	190	<9	0.3	<9
OW2[1]	8-Mar-08			6.97	413								
OW2[2]	13-Mar-08 to 15-Mar-08				362 - 369								
OW3	9-Mar-08		0.5	8.23	366	198	235	2.9	<0.4	190	<9	0.3	<9
OW3[1]	9-Mar-08			7.13	413								
OW3[2]	13-Mar-08 to 15-Mar-08				347 - 356								
OW4	11-Mar-08		3.6	8.26	394	212	259	<0.6	<0.4	206	<9	0.3	<9
OW4[1]	11-Mar-08			6.77	453								
OW4[2]	13-Mar-08 to 15-Mar-08				382 - 390								
PW1[1]	13-Mar-08				370								
PW1[1]	13-Mar-08	14:23			423								
PW1	13-Mar-08	14:25	5.3	8.26	369	199	239	2.1	<0.4	196	<9	0.3	<9
PW1[1]	13-Mar-08	17:00			374								
PW1[1]	14-Mar-08	10:58			380								
PW1[1]	14-Mar-08	14:40			375								
PW1	14-Mar-08	16:40	0.3	8.22	367	198	241	<0.6	<0.4	194	<9	0.3	<9
PW1[1]	14-Mar-08	18:24			377								
PW1	15-Mar-08	14:10	0.15	8.22	372	199	243	<0.6	<0.4	194	<9	0.3	<9
PW1[1]	15-Mar-08	9:15			376								
PW1[1]	15-Mar-08	14:10			381								
PW1 (Duplicate)	15-Mar-08	14:20	0.1	8.21	364	199	243	<0.6	<0.4	188	<9	0.3	<9
Health Canada [3]													
Drinking Water Guidelines			See Note 4	6.5 - 8.5 (AO)	-	-	-	-	-	See Note 6	250 (AO)	1.5 (MAC)[7]	500 (AO)

KEEYASK Hydropower Limited Partnership

Table 2 (Page 2 of 2): 2008 Phase 1 Camp Well Installation & Pumping Well Test Program, General Water Quality.

Hole No.	Date	Time	Parameter									
			Nitrate+ Nitrite-N	Calcium	Potassium	Magnesium	Sodium	Iron	Manganese	Cyanide	T.D.S (Measured)	T.D.S. (Calculated)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection Limit			0.005	0.05	0.05	0.01	0.02	0.01	0.0002		5	5
OW1	6-Mar-08		0.538	56.4	2.13	13	2.07	0.12	0.0024		230	196
OW2	8-Mar-08		0.488	54.9	1.46	12.9	1.95	0.05	0.0022		210	193
OW3	9-Mar-08		0.505	55.1	1.45	12.7	2.33	0.02	0.0008		190	192
OW4	11-Mar-08		0.104	58	2.28	14.8	2.8	0.1	0.0077		220	206
PW1	13-Mar-08	14:25	0.341	56	1.7	13.6	2.15	0.1	0.0102		210	195
PW1	14-Mar-08	16:40	0.533	55.8	1.6	13.3	1.9	<0.01	0.0006		210	194
PW1	15-Mar-08	14:10	0.556	56	1.56	13.1	1.8	0.02	0.0004	<0.002	210	194
PW1 (Duplicate)	15-Mar-08	14:20	0.577	54.2	1.51	12.8	1.73	<0.01	0.0004	<0.002	200	192
Health Canada[3]												
Drinking Water Guidelines			10 (MAC)	-	-	-	200 (AO)	0.3 (AO)	0.05 (AO)	0.2 (MAC)	500 (AO)	500 (AO)

Notes:

"-" = No Data

E.C. = Electrical Conductivity

T.D.S = Total Dissolved Solids

1. Manual reading taken in the field.
2. Range of values recorded by transducer during pumping test.
3. Guidelines for Canadian Drinking Water Quality, May 2008. Health Canada, Federal-Provincial-Territorial Committee on Drinking Water.
   MAC – Maximum Acceptable Concentration
   AO – Aesthetic Objective
4. Health Canada indicates that a treated water turbidity target of less than 0.1 NTU should be used at all times, however turbidity levels for slow sand filtration shall be less than or equal to 1.0 NTU in at least 95% of the measurements made or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
5. NTU = Nephelometric turbidity units.
6. Hardness has been identified as not requiring a guideline, however Health Canada indicates that levels greater than 200 mg/L are considered poor but can be tolerated. Values in excess of 500 mg/L are generally considered as unacceptable.
7. It is recommended, however, that the concentration of fluoride be adjusted to 0.8 to 1.0 mg/L, which is the optimum range for the control of dental caries.

Bold - Exceedance of Health Related Guidelines (MAC)
Underlined – Exceedance of Non-Health Related Guidelines (AO)

Keeyask Hydropower Limited Partnership

Table 3: 2008 Phase 1 Camp Well Installation & Pumping Well Test Program, Metals in Groundwater.

Sample No.	Date	Time	Parameter											
			Silver	Aluminum	Arsenic	Boron	Barium	Beryllium	Bismuth	Calcium	Cadmium	Cobalt	Chromium	Cesium
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L
Detection Limit			0.001	0.02	0.0005	0.03	0.0003	0.001	0.0002	0.1	0.0002	0.0002	0.001	0.0001
PW1	15-Mar-08	14:10	<0.001	<0.02	<0.0005	<0.03	0.0277	<0.001	<0.0002	54.3	<0.0002	<0.0002	<0.001	<0.0001
PW1 (Duplicate)	15-Mar-08	14:20	<0.001	<0.02	<0.0005	<0.03	0.027	<0.001	<0.0002	54.7	<0.0002	<0.0002	<0.001	<0.0001
Health Canada [1]														
Drinking Water Guidelines			-	0.1 (AO)	0.01 (MAC)	5 (MAC)	1 (MAC)	-	-	-	0.005 (MAC)	-	0.05 (MAC)	7[2], 10[3] (MAC)

Sample No.	Date	Time	Parameter											
			Copper	Iron	Potassium	Magnesium	Manganese	Molybdenum	Sodium	Nickel	Phosphorus	Lead	Rubidium	Antimony
			mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection Limit			0.001	0.05	0.1	0.01	0.0003	0.0002	0.03	0.002	0.05	0.0005	0.0002	0.001
PW1	15-Mar-08	14:10	<0.001	<0.05	1.4	11.9	0.0005	0.0007	1.76	<0.002	<0.05	<0.0005	<0.0002	<0.001
PW1 (Duplicate)	15-Mar-08	14:20	<0.001	<0.05	1.4	12	0.0005	0.0006	1.8	<0.002	<0.05	<0.0005	<0.0002	<0.001
Health Canada [1]														
Drinking Water Guidelines			1 (AO)	0.3 (AO)	-	-	0.05 (AO)	70 (MAC)[4]	200 (AO)	-	-	0.01 (MAC)	-	0.006 (MAC)

Sample No.	Date	Time			Parameter								
			Selenium	Tin	Strontium	Tellurium	Titanium	Thallium	Uranium	Vanadium	Tungsten	Zinc	Zirconium
			mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Detection Limit			0.001	0.0006	0.0001	0.001	0.0009	0.0001	0.0001	0.001	0.0002	0.01	0.0004
PW1	15-Mar-08	14:10	<0.001	<0.0006	0.0545	<0.001	<0.0009	<0.0001	0.0009	<0.001	<0.0002	<0.01	<0.0004
PW1 (Duplicate)	15-Mar-08	14:20	<0.001	<0.0006	0.0547	<0.001	<0.0009	<0.0001	0.0009	<0.001	<0.0002	<0.01	<0.0004
Health Canada [1]													
Drinking Water Guidelines			0.01 (MAC)	-	5(MAC)[5]	-	-	-	0.02 (MAC)	-	-	5 (AO)	-

Notes:
"-" = No Data
1. Guidelines for Canadian Drinking Water Quality, May 2008. Health Canada, Federal-Provincial-Territorial Committee on Drinking Water.
2. MAC – Maximum Acceptable Concentration
3. AO – Aesthetic Objective
4. Limit applies to concentration of Cesium-134
5. Limit applies to concentration of Cesium-137
6. Limit applies to concentration of Molybdenum-99
7. Limit applies to concentration of Strontium-90

Bold - Exceedance of Health Related Guidelines (MAC)
Underlined – Exceedance of Non-Health Related Guidelines (AO)

REFERENCE: Volume: Physical Environment Supporting Volume; Section: Section 5.3.2.1; p. 5-5 to 5-6

TAC Public Rd 2 NRCan-0016

PREAMBLE:

The nature of underlying bedrock (and overlying materials) is an important component, even in projects such as Keeyask where it provides not only the solid ground on which the Generating Station rests but also it may contain trace elements that may affect groundwater and surface water quality. The Precambrian bedrock is described as consisting of greywacke gneisses, granite gneisses and granites. What are greywacke gneisses? Please provide a more detailed description of regional and local bedrock that includes information such as: local fracture/joint density, orientation, etc.

QUESTION:

The proponent has not provided the information requested in relation to a detailed description of the regional and local bedrock that includes information such as: local fracture/joint density, orientation, etc. NRCan requests that this information be provided.

RESPONSE:

Addition information about the geologic conditions in the Keeyask study area is provided in the following seven reports which were provided to Natural Resources Canada on March 25, 2013.

Keeyask Stage IV Engineering Design Memoranda

- **GN-4.3.24 Rev 0 - Open File Report OF2006-32, Bedrock Geology of the Gull Rapids Area, Manitoba (part of NTS 54D6) by C.O. Bohm, M.S. Bowerman and M.W. Downey (2006)**

The document aims to:

- provide part of a new framework for the geology of the northern margin of the Superior Province in Manitoba;
- improve the understanding of an economically important but insufficiently studied area between the exposed portions of the Thompson Nickel and Fox River belts; and
- provide Manitoba Hydro with detailed geological information necessary for the bedrock assessment of the Keeyask hydroelectric dam site.

- **GN-1.5.4 Rev0 - Bedrock Geology – Review of Bedrock Conditions in the Powerhouse Area by KGS/Acres (2009)**

This memorandum discusses the preliminary results of the 2003 powerhouse investigations and the overall interpretation of the findings of all the investigations undertaken within this area. This review includes the following results:

  - general bedrock lithology
  - core losses/recovery
  - Rock Quality Designation (RQD) and rock mass characteristics
  - Water Pressure Testing (WPT)
  - dominant joint orientation trends
  - Rock Mass Rating (RMR) and Geological Strength Index (GSI).

- **GN-1.5.5 Rev0 - Bedrock Geology – Review of Bedrock Conditions in the Spillway Area by KGS/Acres (2009)**

This memorandum discusses the preliminary results of the 2003 spillway investigations and the overall interpretation of the findings of all the investigations undertaken within this area. This review includes the following results:

  - general bedrock lithology
  - core losses/recovery
  - Rock Quality Designation (RQD) and rock mass characteristics
  - Water Pressure Testing (WPT)
  - dominant joint orientation trends
    - Rock Mass Rating (RMR) and Geological Strength Index (GSI)

<u>Manitoba Geological Survey Reports</u>

- **GS-13 Bedrock mapping in the Gull Rapids area, northern Manitoba (NTS 54D6) by C.O. Böhm, M.S. Bowerman1 and M.W. Downey (2006).**

In the summer of 2003, the Manitoba Geological Survey, in collaboration with the Universities of Alberta and Waterloo, started a three-year integrated bedrock-mapping program with the aim of documenting the geology in great detail, to unravel the nature and age of the rocks and to resolve the timing and kinematics of structures at Gull Rapids. Mapping at 1:1000 scale, undertaken this summer, identified an Archean amphibolite-facies supracrustal assemblage consisting of amphibolite (metabasalt) and Fe-rich metagreywacke, with interlayered banded oxide-, sulphide- and silicate-facies iron formation

Keeyask Hydropower Limited Partnership

- **GS-15 Split Lake Block revisited: new geological constraints from the Birthday to Gull rapids corridor of the lower Nelson River (NTS 54D5 and 6) by R.P. Hartlaub, L.M. Heaman, C.O. Böhm and M.T. Corkery (2003).**

This report presents the preliminary results from a two-week field study of the Birthday to Gull rapids section of the lower Nelson River and marks the beginning of a new multiyear project to examine the age and tectonic setting of crustal domains along the northwest margin of the Superior Province.

- **GS-08 Structural geology of the Mystery-Apussigamasi lakes area, Manitoba (parts of NTS 63P13 and 14) by Y.D. Kuiper1, C.O. Böhm and S. Lin (2005)**

This report summarizes new structural data for the Mystery-Apussigamasi lakes area. A major shear zone, trending ~030°, was found along Mystery Lake. It shows east-southeast-side-up sinistral movement and it crosscuts folds in the hostrocks to the east and west. A minor northwest-side-up dextral shear/fault zone exists along the northeastern part of Apussigamasi Lake and the southwestern part of the Burntwood River

- **GS-07 Northwestern Superior craton margin, Manitoba: an overview of Archean and Proterozoic episodes of crustal growth, erosion and orogenesis (parts of NTS 54D and 64A) by R.P. Hartlaub1, C.O. Böhm, L.M. Heaman, and A. Simonetti (2005).**

This paper presents a summary of results from three years of mapping and geochronology along the northwestern Superior Boundary Zone between Paleoproterozoic rocks of the Trans-Hudson Orogen and Archean rocks of the Superior craton.

REFERENCE: Volume: Response to EIS Guidelines; Section: Section 4.3.3.1 and 4.6.3; p. 4-34

TAC Public Rd 2 NRCan-0017

ORIGINAL PREAMBLE AND QUESTION:

The proponent indicates that standing woody material, including dead and living trees and shrubs 1.5 m tall or taller, as well as fallen trees will be removed from the areas to be flooded. Reservoir clearing addresses boating safety issues and aesthetic issues and is also intended to reduce the production of methylmercury in the future reservoir.

The reduction of methylmercury production would be more effective if reservoir clearing included the removal of labile organic materials such as shrub foliage. Labile organic matter from flooded foliage is one of the main factors favouring the algal bloom that occurs in the first years after impoundment, and this in turn favours the methylation of mercury and its uptake in the reservoir foodweb. NRCan recommends consider whether this strategy could be applied for the Keeyask project."

FOLLOW-UP QUESTION:

The proponent states that the production of MeHg is predominantly associated with the decomposition of peat and other organic soils and that the decomposition of shrub foliage is not expected to reduce significantly the mobilization of MeHg in the reservoir foodweb. The EIS however, contains no information on the nature (labile/non labile) of organic matter in soils (including peat) or vegetation of the region. The terrains that will be flooded consist of a mosaic of vegetation and soil cover that have not been characterized with respect to their MeHg mobilization potential. Characterize the variable nature and concentration of C and Hg in vegetation and soils.

RESPONSE:

The predictions of future fish mercury concentrations in the Keeyask reservoir do not rely on detailed information on all environmental compartments that potentially affect the supply of methylmercury at the base of the food chain (including concentrations of organic carbon and mercury in soil and vegetation of the flooded area) and the rate of its bioaccumulation in the aquatic ecosystem. Instead, post-Project maximum fish mercury concentrations were estimated from two empirical models relating the percentage of flooded terrain to fish mercury content. One model (Johnston et al., 1991) is based on data from many reservoirs located in the same general geographical area as the future Keeyask reservoir, i.e., areas with a similar mosaic of vegetation and soil cover. The other model uses an existing reservoir (Stephens Lake) located within a few kilometers downstream of the future Keeyask reservoir as a proxy for Keeyask.

These two models integrate the physical, chemical, and biological conditions that affect the dynamics of mercury and its bioaccumulation in fish. Information on the quality (e.g., labile/non labile) of organic matter in soils or vegetation will not improve the quality of or add certainty to the model predictions and therefore, this information was not collected.

REFERENCES:

Johnston, T.A., Bodaly, R.A., and Mathias, J.A. 1991. Predicting fish mercury levels from physical characteristics of boreal reservoirs. Canadian Journal of Fisheries and Aquatic Sciences. 48: 1468–1475.

REFERENCE: Volume: KCN Evaluation Reports; Section: Section 6.4.7; p. 6-288 - 6-291

TAC Public Rd 2 NRCan-0018

ORIGINAL PREAMBLE AND QUESTION:

The proponent expects a significant increase of mercury concentrations in large piscivorous species, such as walleye and northern pike and to a lesser extent in lake whitefish. This increase is expected to peak within 3 to 5 years after flooding and to decrease gradually in the following 25 to 30 years. Peak concentrations on the order of 0.8 to 1.4 ppm (Table 6-18), well above the 0.5 ppm guideline for commercial marketing, are expected for walleye and northern pike. Given the amplitude of the mercury residual effect, monitoring of Hg concentrations in fish muscle tissue will take place until concentrations return to long-term stable levels.

The main measures proposed to mitigate the mercury issue in reservoir biota are (1) the clearing of trees and large shrubs prior to flooding and (2) the monitoring of Hg concentrations in large fish and (3) the ensuing publication of consumption advisories. In an effort to reduce as much as possible the increase of mercury concentrations, NRCan recommends that the proponent consider extending the reservoir clearing activities to areas expected to be affected by peatland disintegration (cf. section 6.3.7), one possible effect of which may be is to stretch beyond 30 years the period of strong mercury contamination in the Keeyask reservoir. This consideration should be discussed with relevant federal departments (e.g. Environment Canada) and provincial ministries.

FOLLOW-UP QUESTION:

In the proponent's view the model has the ability to fully integrate all the factors that lead to MeHg contamination and that there is no need to characterize the organic C and Hg burden of the vegetation and soils in terrains that will be flooded by the reservoir. It is NRCan's view that fish MeHg concentrations in some boreal reservoirs, such as Gouin or Baskatong, have yet to return to acceptable levels after more than 80 years of impoundment. The proponent should consider all measures that may help to mitigate the expected Hg increase in the reservoir foodweb, especially in view of the continued 'breakdown of shorelines' some 30 years after impoundment.

RESPONSE:

The overwhelming consensus in the scientific literature indicates that mercury concentrations in fish from boreal reservoirs return to pre-Project or background levels between 15 and 30 years after initial impoundment (Schetagne et al. 2003; Bodaly et al. 2007). The exact timeline of the return depends mainly on the fish species (piscivors longer) and, to a lesser degree, on the magnitude of flooding (longer with high proportion of flooded land), and the stability of the new reservoir shoreline (longer with continuous erosion of organic soils). NRCan provides two examples of Québec reservoirs, Gouin and Baskatong, for which the return times appear to be longer. However, this notion is based on a single measurement taken 59 (Baskatong) and 67 years (Gouin) after reservoir formation, when mercury concentrations in Northern Pike were at approximately 1.2 ppm (Schetagne et al. 2003 and pers. comm). Considering the uncertainty of a single measurement in the face of considerable temporal variability in mean mercury concentrations, and the fact that the range of concentrations in Pike from natural lakes in the general area is 0.33-1.8 ppm (Schetagne et al. 2003), it is questionable if Pike from the Gouin and Baskatong reservoirs represent valid examples of extended return times of fish mercury.

Based primarily on empirical evidence from a number of reservoirs in the physiographical region of the Keeyask reservoir, and taking into account the potential effects of continuous but decreasing shoreline erosion on fish mercury concentrations, the estimated 30 year return time for fish for the Keeyask reservoir must be considered conservative (i.e., an over, rather than an under,estimate). Measures that potentially shorten the time period needed for fish mercury concentrations to return to background levels, such as the removal of organic soils and vegetation in the flooded zone, may not be feasible and have little effect in an area dominated by peatlands which are partly floating and inaccessible. Importantly, such measures bear a considerable risk of actually increasing fish mercury concentrations. It has been shown that the disturbance of the soil organic layer and the removal of vegetation can dramatically increase methylmercury concentrations in runoff (Munthe and Hultberg 2004) and has been linked to elevated mercury levels in fish (Bishop et al. 2009, Porvari et al. 2009).

LITERATURE CITED:

Bishop, K. Allan,C., Bringmark, L.,Garcia, E., Johansson, K., Munthe, J., Nilsson, M., Porvari, P., and Meili, M. 2009. Forestry's contribution to Hg bioaccumulation in freshwaters: assessment of the available evidence. Abstract, 9th ICMGP. 7-12 June, 2009, Guiyang, China.

Bodaly, R.A., Jansen, W.A., Majewski, A.R., Fudge, R.J.P.,Strange, N.E., Derksen, A.J., and Green, D.J. 2007. Post-impoundment time course of increased mercury concentrations in fish in hydroelectric reservoirs of northern Manitoba, Canada. Archives of Environmental Contamination and Toxicology 53: 379-389 pp.

Munthe, J., and Hultberg, H. 2004. Mercury and methylmercury in runoff from a forested catchment concentrations, fluxes, and their response to manipulations. Water, Air, and Soil Pollution: Focus 4: 607–618 pp.

Porvari, P., Verta, M., and Linjama, J. 2009. Forestry practices cause long-term and highly elevated mercury and methylmercury output from boreal forest catchments. Abstract, 9th ICMGP, 7-12 June, 2009, Guiyang, China.

REFERENCE: Volume: Aquatic Environment Supporting Volume; Section: Section 7.0 / Fish quality p. 7-1 to 7-75

TAC Public Rd 2 NRCan-0019a and NRCan-0019b

ORIGINAL PREAMBLE AND QUESTION:

This section presents a well documented and fairly comprehensive account of the mercury issue in boreal hydroelectric reservoirs, and more specifically in the Keeyask reservoir and nearby water bodies. It presents in a single document much of the information which is otherwise scattered in various other EIS documents.

However, this document presents no information on the variability of Hg concentrations in soils (particularly in organic horizons) that will be affected by reservoir flooding, whether immediately following impoundment or much later as a result of peatland disintegration. In NRCan's view this information, and its links with vegetation cover and wildfire history, are critical in the development of strategies to reduce the remobilization of mercury and to reduce methylation rates in flooded terrain. Moreover, the EIS documents contain no information on forest fire history, as had been requested in the Guidelines (section 8.1.3). NRCan recommends that this information be included in the EIS.

FOLLOW-UP QUESTION:

As stated by the proponent, the magnitude and timing of the Hg responses are not only related to mercury concentrations in soils and vegetation but also to factors such as controls on methylation, availability of MeHg to the food web or trophic transfer to the food web. For these reasons, NRCan proposes that the proponent characterize the variable nature and concentration of C and Hg in vegetation and soils. As the proponent recognizes, the algal bloom that follows flooding plays a key, perhaps determining, role in transferring MeHg to the reservoir food web and thus must be attenuated as much as possible by the removal of labile organic matter prior to flooding. It is NRCan's understanding that the proponent has not utilized information on soil mercury content, as this data was not included in the EIS. Without quality information on both Hg and C characteristics in flooded terrains, there are no grounds to compare or assess MeHg predictions in the future reservoir. The region that will be flooded has combined terrain characteristics (thick peaty soils, permafrost) that have yet to be fully assessed in the context of potential Hg contamination. NRCan suggests that the proponent carry out a characterization study in this rather unique terrain and discuss results and mitigation measures (as appropriate) with federal departments and provincial ministries.

RESPONSE:

As outlined in the original response to NRCan-0019a and the additional response to TAC Public Rd 2, NRCan-0017, the predictions of future fish mercury concentrations in the Keeyask reservoir were not based on a detailed mechanistic model that includes all or most environmental compartments that potentially affect fish mercury concentrations in reservoirs. Instead, post-Project fish mercury concentrations were estimated from two empirical models that predict mercury content of reservoir fish based on its relationship to the percentage of flooded terrain. Both models use reservoirs located in the same general geographical area as the future Keeyask reservoir and feature similar vegetation and soil cover and generally integrate the physical, chemical and biological conditions that affect mercury bioaccumulation in fish. One of the models (Johnston et al. 1991) has been published in peer-reviewed literature. This publication included model tests by “hind casting” fish mercury concentrations from boreal reservoirs in several Canadian regions. Although considerable differences existed between predicted and observed concentrations for reservoirs from other regions, they closely agreed with the test data from other northern Manitoba reservoirs. The second model was developed based on measured mercury concentrations in Stephens Lake, a reservoir developed immediately downstream of the Keeyask Generating Station in similar terrain. Thus, detailed information on soil mercury concentrations (which are not known to be related to post-flooding concentrations in fish) and the quality of organic matter in soils or vegetation are not prerequisites for valid estimates of post-Project fish mercury concentrations.

In their request for additional Information NRCan suggests that the proponents recognize “the algal bloom that follows flooding to play a key, perhaps determining, role in transferring MeHg to the reservoir food web”. NRCan further concludes that the algal bloom “must be attenuated as much as possible by the removal of labile organic matter prior to flooding”. The partnership did not make such a claim regarding the role of algal blooms for mercury bioaccumulation at higher trophic levels. Conversely, the concentration of methylmercury per cell decreases during algal blooms (i.e., bloom dilution) and reduces mercury accumulation in zooplankton grazers (Pickhardt et al. 2002). At least for the reasons outlined by NRCan, the removal of labile organic matter does not pose a promising mitigation method for elevated fish mercury concentrations after reservoir creation.

The usefulness of mitigation measures based on the removal of soil and vegetation are discussed in the additional response to TAC Public Rd 2 NRCan-0018. For the reader’s convenience, that response is provided below.

NRCan-0018 RESPONSE:

The overwhelming consensus in the scientific literature indicates that mercury concentrations in fish from boreal reservoirs return to pre-Project or background levels between 15 and 30 years after initial impoundment (Schetagne et al. 2003; Bodaly et al. 2007). The exact timeline of the return depends mainly on the fish species (piscivors longer) and, to a lesser degree, on the magnitude of flooding (longer with high proportion of flooded land), and the stability of the new reservoir shoreline (longer with continuous erosion of organic soils). NRCan provides two examples of Québec reservoirs, Gouin and Baskatong, for which the return times appear to be longer. However, this notion is based on a single measurement taken 59 (Baskatong) and 67 years (Gouin) after reservoir formation, when mercury concentrations in Northern Pike were at approximately 1.2 ppm (Schetagne et al. 2003 and pers. comm). Considering the uncertainty of a single measurement in the face of considerable temporal variability in mean mercury concentrations, and the fact that the range of concentrations in Pike from natural lakes in the general area is 0.33-1.8 ppm (Schetagne et al. 2003), it is questionable if Pike from the Gouin and Baskatong reservoirs represent valid examples of extended return times of fish mercury.

Based primarily on empirical evidence from a number of reservoirs in the physiographical region of the Keeyask reservoir, and taking into account the potential effects of continuous but decreasing shoreline erosion on fish mercury concentrations, the estimated 30 year return time for fish for the Keeyask reservoir must be considered conservative (i.e., an over, rather than an under,estimate). Measures that potentially shorten the time period needed for fish mercury concentrations to return to background levels, such as the removal of organic soils and vegetation in the flooded zone, may not be feasible and have little effect in an area dominated by peatlands which are partly floating and inaccessible. Importantly, such measures bear a considerable risk of actually increasing fish mercury concentrations. It has been shown that the disturbance of the soil organic layer and the removal of vegetation can dramatically increase methylmercury concentrations in runoff (Munthe and Hultberg 2004) and has been linked to elevated mercury levels in fish (Bishop et al. 2009, Porvari et al. 2009).

LITERATURE CITED:

Johnston, T.A., Bodaly, R.A., and Mathias, J.A. 1991. Predicting fish mercury levels from physical characteristics of boreal reservoirs. Canadian Journal of Fisheries and Aquatic Sciences. 48: 1468–1475.

Pickhardt, P.C., C.L. Folt, C.Y. Chen, B. Klaue, and J.D. Blum. 2002. Algal blooms reduce the uptake of toxic methylmercury in freshwater food webs. PNAS 99(7): 4419-4423.

REFERENCE: Volume: N/A; Section: N/A; p. N/A

TAC Public Rd 2 PCN-0001

QUESTION:

The Stephens Lake reservoir is used as a comparison with the proposed Keeyask reservoir in terms of factors such as the development of new riparian habitats in future. This reservoir fluctuates within a 3m range, whereas the Keeyask reservoir would fluctuate within a 1m range and according to a peaking operation pattern. Please explain the differences in these reservoirs and how these physical factors would be expected to influence future habitat development.

RESPONSE:

Generalizations about the relative importance of physical factors and how they are expected to influence future Keeyask reservoir shore zone habitat development are based on six northern Manitoba proxy areas for flooding and/or water regulation, some northern Quebec reservoirs and the scientific literature. More than one northern Manitoba proxy area is used because no single one represents ecological conditions identical to Keeyask and to provide replication for any findings.

The six proxy areas used for the shore zone habitat effects assessment are the Kelsey reservoir, Stephens Lake (i.e., Kettle reservoir), Long Spruce reservoir, Wuskwatim Lake (post-CRD and prior to Wuskwatim GS), Notigi reservoir (TE SV Map 2-2) and the Keeyask reach of the Nelson River (post CRD and prior to Keeyask Generating Station development). The Stephens Lake proxy area is immediately downstream of the proposed Keeyask reservoir, is the most ecologically comparable proxy area and has the best historical time series of large scale aerial photography.

The Keeyask reservoir and four of the proxy areas are located in peatland dominated areas. Relief ranges from low to high (Keeyask is low). The normal water level range (i.e., the difference between the 5th and 95th percentiles for daily water elevations) during the open water season at the proxy areas is as follows: 0.8 m at Kelsey, 1.2 m at Wuskwatim, 1.5 m at Notigi, 0.8 m at Long Spruce, 2.0 m at Stephens and 2.3 m at Keeyask. Three of the proxy areas have normal water level ranges similar to the Keeyask project, which is 1.0 m, while the remaining three proxy areas have increasingly higher ranges.

The proxy areas indicate that relief and the proportion of reservoir area that is peatland are expected to be the most important physical factors for shore zone habitat development in the Keeyask reservoir. Reservoir flooding in peatland dominated areas essentially converts existing riparian peatlands and a high proportion of inland peatlands to reservoir riparian peatlands because the new shoreline forms in these peatlands. These peatlands already have established wetland vegetation that is adapted to the new conditions and can persist over the long-term. Relief is important because flooded areas that are generally flatter tend to have more of the wetter peatland types, which already have vegetation that is similar to what develops along reservoir shorelines.

Water regime is another important factor for shore zone habitat development because it influences the proportion of the shore zone that can support wetland vegetation. The length of time that various water depths persist determines the width of the shoreline wetland band that can potentially support vegetation. That is, the normal range of growing season water depths rather than the entire water level fluctuation range determines the potential width of the shore zone. For ease of relating this to information in the Physical Environment Supporting Volume, the normal range of growing season water depths is approximated by the difference between the 5th and 95th percentiles for daily water elevations during the open water season (for Stephens Lake the normal water level range is 2 m rather than 3 m; see the Terrestrial Environment Supporting Volume Section 2.3.2.2 for details on how the normal range of growing season water depths are calculated for shore zone habitat). The proportion of this shoreline wetland zone that is actually vegetated is influenced by water level variability, the seasonality of extended high and low water levels, wave energy, current, substrate type, water chemistry, turbidity, substrate freezing during winter drawdowns, ice scouring and ice-related substrate compression.

Prior to 2005 there was a relatively small amount of shoreline wetland vegetation in the Keeyask reach, and the vegetation that was there was less diverse than that found in off-system waterbodies and in the Stephens proxy area (the proxy area with a comparable number of ground transects). Of the total available shoreline wetland area determined for the Keeyask reach based on water depth durations, only approximately 10% to 15% of the area with suitable water depths actually supported wetland vegetation. Emergent vegetation on the littoral to middle beach sub-zones (i.e., what people generally think of as marsh) accounted for very little of that 10% to 15%. That is, most of the area that could be vegetated based on water depth is not vegetated. This was attributed to the high degree of water level variability and the effects of winter drawdowns.

The Project would affect a small amount of existing shoreline wetland vegetation relative to what is expected to develop during Project operation. Very high water levels and river flows from 2005 to 2011 have virtually eliminated beach and littoral vegetation, and also removed some shoreline tall shrub habitat in the Keeyask reach.

Even using pre-2005 conditions as the baseline, the total area removed by the Project is small relative to the total available area there in 2005 based on suitable depths.

The six proxy areas support the overall EIS prediction that shoreline wetlands removed or altered by the Project will be replaced by wetlands that develop along the reservoir shoreline during the operation phase. Most of the shoreline wetland vegetation in the existing Nelson River reservoir proxy areas was shrub and/or low vegetation on sunken peat that predominantly originated from riparian and inland peatlands that became reservoir shoreline after flooding and reservoir expansion. Because the Keeyask reservoir occurs in similar conditions to the other Nelson River reservoirs (the majority of the flooded area is peatlands), the Keeyask reservoir shoreline is expected to support more shoreline wetland per kilometer of shoreline than the Keeyask reach presently does. The overall EIS prediction may be met on this basis alone even before considering that the reservoir shoreline at Year 30 is predicted to be almost 20% longer than the existing shoreline.

Incremental to the above factors, reduced water level variability in winter should reduce exposed substrate freezing, ice scouring and ice-related bottom compression, which is expected to facilitate more widespread emergent vegetation development. Reduced water level variability during the growing season is expected to provide emergent plants sufficient time to establish over a larger percentage of the area where water depths are suitable.

An additional important contributor to total vegetated shoreline wetland area will be the peat islands that are now virtually absent in the Keeyask reach but are expected to be common in the Keeyask reservoir (peat islands are still present in the reservoir proxy areas after more than 35 years). Floating peat islands will develop through peatland disintegration processes. The proxy areas have shown that emergent vegetation develops on the sunken fringes of the peat islands much like it does on the fringes of off-system riparian peatlands.

In summary, when comparing post-Project with existing conditions, at least an equivalent amount of vegetated shoreline wetland is expected to develop because:

- the total area to replace is relatively small (especially the emergent vegetation component of this total);
- vegetated riparian peatland will already be established along much of the shoreline;
- a higher percentage of the shore zone area with water depths suitable for emergent vegetation will become vegetated because the water level fluctuation regime will be more favorable than it is currently and winter drawdowns will be eliminated;

- the reservoir will contain peat islands, a feature not presently found in the Keeyask reach of the Nelson River, which are expected to be a substantial long-term contributor to emergent vegetation; and,
- a longer shoreline will be available for shoreline wetland development.

Additionally, the proxy areas indicate that it is likely that the Keeyask reservoir will have higher vegetation diversity than currently exists in the Keeyask reach.

REFERENCE: Volume: Response to EIS Guidelines; Section: 6.4 Effects and Mitigation Aquatic Environment; p. 6-238

TAC Public Rd 2 PCN-0002

QUESTION:

Reservoir Comparisons: This section describes approaches used in the technical assessment. It mentions that magnitude and spatial and temporal extent of effects were determined through several methods, one of which is comparing data from other reservoirs. It mentions the “lower Churchill River reservoir in Newfoundland and Labrador”. There are no reservoirs on the lower Churchill River in Labrador. In the Churchill River system there are the Smallwood and Ossokmanuan reservoirs and two forebays associated with the Churchill Falls project in the upper reaches of the basin. These reservoirs all have widely differing characteristics. The lower Churchill projects are not yet developed. What data were used in this assessment?

RESPONSE:

The reviewer is correct that there is currently no reservoir on the lower Churchill River in Labrador. In amalgamating text from several sections of the Aquatic Environment Supporting Volume, references to data and models used to predict effects to the lower Churchill River were inadvertently included in the list of existing reservoirs. We apologize for any confusion this may have caused.

The data sources to describe the existing environment and the methods used to conduct the effects assessment are described in detail in the Aquatic Environment Supporting Volume. The effects assessment was based on a combination of comparison of pre- and post-Project conditions, models, and comparison to other similar systems. It is assumed that the above-stated question is referring specifically to reservoirs or similar systems that were used to assist in determining effects of the Keeyask Project. These are as follows:

- Manitoba: Stephens Lake, Long Spruce Forebay, Limestone Forebay, impounded river upstream of the Kelsey Generating Station, Southern Indian Lake, Notigi Lake, other lakes along the Churchill River Diversion route, the impoundment upstream of the lower Churchill River weir, Winnipeg River below the Slave Falls generating station and between the Slave Falls and the Pointe du Bois generating stations.
- Québec : Opinaca Reservoir, Robert-Bourassa Reservoir, Desaulniers Reservoir, Caniapiscau Reservoir, and La Grande Complex, among others.

In addition, the assessment referenced general information obtained from studies of impoundments in Scandinavia and other areas of Canada and the United States.