Keeyask Generation Project

Environmental Impact Statement

Supplemental Filing #1

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: SUPPLEMENTAL FILING #1

The Keeyask Hydropower Limited Partnership submitted the Keeyask Generation Project Environmental Impact Statement (EIS) on July 6, 2012. Since that time, supplemental information which supports or updates information in the original EIS filing has been developed and finalized by the Partnership.

The Partnership is pleased to provide the following supplemental documents, in the enclosed binder titled Supplemental Filing #1:

- Errata: Errata and related corrections from the July 2012 Keeyask Generation Project EIS submission;
- Updated Traffic Assessment: An updated traffic assessment for the Keeyask Generation Project;
- Human Health Risk Assessment: An updated and final Human Health Risk Assessment; and
- Traditional Plants Workshop: A summary of a Traditional Plants Workshop that took place among the Keeyask partners last fall.

The Partnership will also be filing a report on the third round of the Public Involvement Program once it is complete later this spring.

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/es
Enclosure

c: Ms. Shauna Sigurdson
Mr. Dan McNaughton

KEEYASK GENERATION PROJECT

ERRATA SUPPLEMENTAL FILING

Prepared by

Keeyask Hydropower Limited Partnership

Winnipeg, Manitoba

April 2013

April 2013

TABLE OF CONTENTS

1.0 Scope of Errata Supplemental Filing 2

1.1 Response to EIS Guidelines 3

1.2 Public Involvement Program Supporting Volume 30

1.3 Project Description Supporting Volume 31

1.4 Physical Environment Supporting Volume 32

1.5 Aquatic Environment Supporting Volume 33

1.6 Terrestrial Environment Supporting Volume 48

1.7 Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume 66

1.8 Responses to Requests for Additional Information from TAC and Public Reviewers, Rd 1 & 2 76

1.0 SCOPE OF ERRATA SUPPLEMENTAL FILING

The errata correct or clarify errors that were in the Keeyask Generation Project EIS filed July 6, 2012. Corrections include typographical errors as well as clarifications and corrections regarding specific information contained in the Response to EIS Guidelines and Supporting Volumes.

1.1 RESPONSE TO EIS GUIDELINES

Chapter	Page	Current Text	Corrected Text/Clarification
Chapter 1	1B-1	"Town Centre Complex Project"	"**Keeyask Generation Project**"
Chapter 6	6-84	"...inland edge and inland (Photo 6-1)."	"...inland edge and inland (Photo **6-12**)."
Chapter 6	6-84	"The TE SV Section 2.4.6 describes the fire regime."	"The TE SV Section **2.5** describes the fire regime."
Chapter 6	6-87	"...land area combined; Map 6-28)."	"...land area combined; Map **6-29**)."
Chapter 6	6-87	"(Table 6-2)"	"(Table **6-7**)"
Chapter 6	6-87	"...described in the wetland function section (Section 6.2.3.4.5)."	"...described **under the wetland function heading of this section**."
Chapter 6	6-92	"...these was very uneven (Map 6-29; TE SV Table 2.6-1, Table 2.7-2)."	"...these was very uneven (Map 6-29; TE SV **Table 2-30, Table 2-33**)."
Chapter 6	6-92	"(TE SV Table 2.7-2)"	"(TE SV Table **2-33**)"
Chapter 6	6-92	"The detailed habitat mapping (Section 6.2.3.4.1)..."	"The detailed habitat mapping (**see Terrestrial Habitat in this section**)..."
Chapter 6	6-92	"...shoreline wetland habitat types (Section 6.2.3.4.5)."	"...shoreline wetland habitat types (**see Wetland Function in this section**)."
Chapter 6	6-93	"The TE SV Section 3.2.4 provides..."	"The TE SV Section **2.4** provides..."
Chapter 6	6-96	"...between segments of the Nelson River (Section 4.3)."	"...between segments of the Nelson River (**TE SV Section 2.8.3.2**)."
Chapter 6	6-97	"(Section 6.2.3.4.1)"	"(Section **6.2.3.4.2**)"
Chapter 6	6-97	"(see Section 6.2.3.4.1 for rationale)"	"(see Section **6.2.3.4.2** for rationale)"
Chapter 6	6-97	"As noted in Section 6.2.3.4.1,..."	"As noted in Section **6.2.3.4.2**,..."
Chapter 6	6-100	"Ongoing shoreline erosion (TE SV Section 2.2.4)..."	"Ongoing shoreline erosion (TE SV Section **2.3.3**)..."
Chapter 6	6-102	"..., green alder (Alnus viridis),..."	"..., green alder (**Alnus viridis ssp. crispa**),..."

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 6	6-103	"See TE SV Section 3 Table 3.7-20 for the species list"	"See TE SV Section 3 Table **3E-2** for the species list"
Chapter 6	6-104	"...northern Labrador tea (*Ledum palustre* ssp. *decumbens*)"	"...northern Labrador tea (***Rhododendron tomentosum***)"
Chapter 6	6-104	"Exceptions are ginger root and northern Labrador tea. Ginger root was not found during field studies."	"Exceptions are **sweet flag** and northern Labrador tea. **Sweet flag** was not found during field studies."
Chapter 6	1-106	"Between 2001 and 2011, 124 different species were observed during the ground-based, boat-based and helicopter-based bird surveys (further detail on methods used to gather bird-related information is provided in the TE SV, Appendix 6.10.1)."	"Between 2001 and 2011, **129** different species were observed during the ground-based, boat-based and helicopter-based bird surveys (further detail on methods used to gather bird-related information is provided in the TE SV, **Section 6.5**)."
Chapter 6	6-107	"...as well as other priority birds (*i.e.,* species highly sensitive to human features and/or favoured for use by local people; Section 6.2.3.4)."	"...as well as other priority birds (*i.e.,* species highly sensitive to human features and/or favoured for use by local people; Section **6.2.3.4.1**)."
Chapter 6	6-107	"Twenty-six priority bird species have been identified and are discussed within their respective bird groups."	"**Twenty-nine** priority bird species have been identified and are discussed within their respective bird groups."
Chapter 6	6-107	"Seven species of colonial waterbirds occur within the Regional Study Area..."	"**Eight** species of colonial waterbirds occur within the Regional Study Area..."
Chapter 6	6-108	"Waterfowl observed in the Regional Study Area include 23 species of ducks..."	"Waterfowl observed in the Regional Study Area include **22** species of ducks..."
Chapter 6	6-111	"Approximately 178 bird species were observed in the Regional Study Area."	"Approximately 178 bird species **potentially occur within** the Regional Study Area."
Chapter 6	6-111	"Six of the 27 priority birds met the criteria to be selected as VECs..."	"Six of the **29** priority birds met the criteria to be selected as VECs..."
Chapter 6	6-308	"The TE SV Section 2.3.4 provides a detailed..."	"The TE SV Section **2.6** provides a detailed..."
Chapter 6	6-309	"(Table 6-20)"	"(Table **6-24**)"

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 6	6-309	"(Table 6-21)"	"(Table **6-25**)"
Chapter 6	6-309	"(Section 4.2.3)"	"(Section **4.3.3**)"
Chapter 6	6-310	"(Sections 6.5.3.4 and 6.5.3.5)"	"(Sections **6.5.3.2 and 6.5.3.4**)"
Chapter 6	6-311	"(Section 6.4.2)"	"(Section **6.3.7**)"
Chapter 6	6-315	"(Section 6.4.2)"	"(Section **6.3.7**)"
Chapter 6	6-315	"(Section 6.4.2)"	"(Section **6.3.7**)"
Chapter 6	6-316	"(Sections 6.5.3.4 and 6.5.3.5)"	"(Sections **6.5.3.2 and 6.5.3.4**)"
Chapter 6	6-318	"The TE SV Section 2.4.3 provides…"	"The TE SV Section **2.7.4** provides…"
Chapter 6	6-319	"…(black spruce mixture on mineral increases from 20.3% to 20.5%)."	"…(**black spruce dominant on thin peatland decreases from 32.3% to 32.1%**)."
Chapter 6	6-319	"…(see TE SV Table 2.7-5)."	"…(see TE SV Table **2-36**)."
Chapter 6	6-319	"…(see Section 4.2.3)."	"…(see Section **4.3.3**)."
Chapter 6	6-320	"(Section 6.5.3.5)"	"(Section **6.5.3.4**)"
Chapter 6	6-324	"(Section 4.2.3)"	"(Section **4.3.3**)"
Chapter 6	6-327	"…(see Section 4.2.3)."	."..(see Section **4.3.3**)."
Chapter 6	6-332	"…the Project could remove, later or indirectly affect up to 8,870 ha of terrestrial habitat…"	"…the Project could remove, later or indirectly affect up to 8,870 ha of terrestrial habitat **(after mitigation)**…"
Chapter 6	6-335	"(Sections 2.4.6 and 3.4.2 in the TE SV)"	"(Sections **2.4.4 and 3.4.2** in the TE SV)"
Chapter 6	6-342	"Of the more than 172 bird species…"	"Of the **178 bird species**…"
Chapter 6	6-358	"…and occur within the range of natural variability for rails if they occur in the Regional Study Area."	"…and occur within the range of natural variability for **populations inhabiting** the Regional Study Area."
Chapter 6	6-358	"The small residual effects of Project construction on short-eared owl are expected to be positive and occur within the range of natural variability for rails if they occur in the Regional Study Area."	"The small residual effects of Project construction on short-eared owl are expected to be positive and occur within the range of natural variability for **short-eared owls** if they occur in the Regional Study Area."

Chapter	Page	Current Text	Corrected Text/Clarification
Chapter 6	6-392	"Firearms will be prohibited in camps and at work sites, and a "no shooting" buffer zone of 300 m will be designated on either side of the access roads and around the Project work site to reduce mortality due to hunting during construction: and..."	**<u>"Firearms will be prohibited in camps and at work sites; and</u>**..."
Chapter 7	Map 7A-1		The "Hydro Development in Northern Manitoba, Map 7A-1 in appendix 7A had several rivers labeled in error as altered waterways. • Weir River not altered by both CRD and LWR • Limestone River not altered by both CRD and LWR • Belanger River not altered by LWR • Nanowin River not altered by LWR • Mukutawa River not altered by LWR
Chapter 8	8-21	Amphibians: "Annually during the first three years of operation and periodically until shoreline wetland habitat re-establishes."	• "**<u>Annually during construction.</u>** • Annually during the first three years of operation and periodically until shoreline wetland habitat re-establishes."
Chapter 8	8-22	Bald eagle: "Annually during the first three years of operation."	"Annually during **<u>construction and</u>** the first three years of operation."
Chapter 8	8-22	Colonial waterbirds: "Annually during the first three years of operation."	• "**<u>Annually during construction.</u>** • Annually during the first three years of operation"

1.1.1 Corrected Tables and Figures

Since filing the EIS, there have been revisions to how some of the aquatic study reports are characterized in the Environmental Study Report List. For reference purposes, the entire Environmental Study Report List has been reproduced below. Changes are in bold and underlined text or otherwise noted.

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
PHYSICAL ENVIRONMENT			
GN-9.1.1	Manitoba Hydro, 2009. Existing and Project Environment Flow Files. Keeyask Project Environmental Studies Program Report. 32 pp.	Completed	9/1/2012
GN-9.1.2	Manitoba Hydro, 2009. Sensitivity of Water Regime Products to Inflows. Keeyask Project Environmental Studies Program Report. 42 pp.	Completed	9/1/2012
GN-9.1.3	Manitoba Hydro, 2009. Existing and Project Environment Shoreline & Depth Effects Assessment. Keeyask Project Environmental Studies Program Report. 17 pp.	Completed	9/1/2012
GN-9.1.4	Manitoba Hydro, 2009. Existing and Project Environment Velocity Regime Effects Assessment. Keeyask Project Environmental Studies Program Report. 17 pp.	Completed	9/1/2012
GN-9.1.5	Manitoba Hydro, 2009. Existing and Project Environment Digital Terrain Models. Keeyask Project Environmental Studies Program Report. 20 pp.	Completed	9/1/2012
GN-9.1.6	KGS Acres Ltd., 2011. Existing Environment Ice Processes. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/24/2011
GN-9.1.7	KGS Acres Ltd., 2011. Project Environment Ice Processes and Effects Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/24/2011
GN-9.1.8	Manitoba Hydro, 2009. Existing Environment Water Regime - Key Sites. Keeyask Project Environmental Studies Program Report. 305 pp.	Completed	9/1/2012
GN-9.1.12	Manitoba Hydro, 2009. Project Environment - Water Level and Flow Regime at Key Sites and Effects Assessment. Keeyask Project Environmental Studies Program. 66 pp.	Completed	9/1/2012
GN-9.1.13	Manitoba Hydro, 2009. Existing and Project Environment Water Surface Profiles Effects Assessment. Keeyask Project Environmental Studies Program Report. 19 pp.	Completed	9/1/2012
GN-9.1.14	Manitoba Hydro, 2009. Existing and Project Environment Creek Hydraulics Effects Assessment. Keeyask Project Environmental Studies Program Report. 33 pp.	Completed	9/1/2012
GN-9.1.15	Manitoba Hydro, 2009. Existing and Project Environment Creek Hydrology. Keeyask Project Environmental Studies Program Report. 33 pp.	Completed	9/1/2012

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
GN-9.1.16	KGS Acres Ltd., 2011. Ice Processes and Their Potential Link to Erosion – Existing Environment, Nelson River Outlet of Split Lake to Stephens Lake. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/24/2011
GN-9.1.17	KGS Acres Ltd., 2011. Post-Impoundment Velocity and Shear Stress Distributions. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	3/21/2011
GN-9.2.1	Ecostem Ltd., 2009. Composition and Distribution of Shoreline and Inland Peatlands in the Keeyask Forebay Area and Historical Trends in Peatland Disintegration. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 99 pp.	Completed	9/18/2011
GN-9.2.2	J.D. Mollard and Associates Ltd. and KGS Acres Ltd., 2008. Existing Environment Mineral Erosion. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 72 pp.	Completed	2/16/2012
GN-9.2.3	KGS Acres Ltd., 2011. Existing Environment Sedimentation. Draft report prepared for Manitoba Hydro by KGS Acres Ltd. and the University of Ottawa. 89 pp.	Completed	6/10/2011
GN-9.2.4	Ecostem Ltd., 2009. Projected Future Peatland Disintegration in the Proposed Keeyask Reservoir Area Without the Keeyask Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp. *Draft*.	Completed	3/7/2012
GN-9.2.5	J.D. Mollard and Associates Ltd., 2008. Projected Future Mineral Erosion Without the Keeyask GS. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 19 pp.	Completed	2/16/2012
GN-9.2.6	KGS Acres Ltd., 2011. Projected Future Sedimentation Without the Keeyask Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 15 pp.	Completed	3/11/2011
GN-9.2.7	Ecostem Ltd., 2009. Peatland Disintegration in the Proposed Keeyask Reservoir Area: Model Development and Post-Project Predictions. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 195 pp.	Completed	12/29/2012
GN-9.2.8	J.D. Mollard and Associates Ltd., 2011. Project Environment Mineral Erosion and Effects Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	Completed	12/21/2011

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
GN-9.2.9	KGS Acres Ltd., 2009. Project Environment Sedimentation and Effects Assessment. Project Environmental Studies Program Report prepared for Manitoba Hydro. 99 pp.	Completed	8/17/2012
GN-9.2.10	Manitoba Hydro, 2009. Estimate of Shoreline Erosion During Construction. Keeyask Project Environmental Studies Program Report. pp. *Draft*.	Completed	3/15/2013
GN-9.2.11	KGS Acres Ltd., 2011. Estimate of Sedimentation in Stephens Lake During Construction. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 82 pp.	Completed	12/7/2012
GN-9.2.13	Ecostem Ltd., 2007. Study of Physical Properties of Peat: Lab Results – Particle Size Distribution and Specific Gravity. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	Completed	07/11/2011
GN-9.2.14	KGS Acres Ltd., 2011. Study of Erosion Potential of Disposal Material. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	10/7/2011
GN-9.2.16	KGS Acres Ltd., 2012. Relationship of Total Suspended Solids and Turbidity in the Lower Nelson River near the Proposed Keeyask Generating Station. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	Completed	10/24/2012
GN-9.2.17	KGS Acres Ltd., 2012. Cofferdam Erosion During Construction. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	4/9/2012
GN-9.2.18	KGS Acres Ltd., 2011. Peat Transport and Deposition Modelling. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	4/12/2011
GN-9.2.21	J.D. Mollard and Associates Ltd., 2010. Classification of Sediment Gradations Within Areas That Will Be Inundated During Staged Construction of the Keeyask GS. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	Completed	2/24/2012
GN-9.2.22	Ecostem Ltd., 2011. Laboratory Estimation of Organic Sediment Settling Rates. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	Completed	3/2/2011

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
GN-9.2.23	Tetr*ES* Consultants Inc., 2012. Estimation of Potential Organic Total Suspended Solids – Future With Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	Completed	11/19/2012
GN-9.3.1	Tetr*ES* Consultants Inc., 2008. Keeyask Existing Environment Groundwater Regime. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. pp.	Completed	8/9/2012
GN-9.3.2	Tetr*ES* Consultants Inc., 2008. Keeyask Predicted Future Groundwater Regime Without the Keeyask GS. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 37 pp.	Completed	8/9/2012
GN-9.3.3	Tetr*ES* Consultants Inc., 2008. Keeyask Predicted Future Groundwater Regime With the Keeyask GS. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 90 pp.	Completed	8/9/2012
GN-9.4.1	Tetr*ES* Consultants Inc., 2009. Water Temperature & Dissolved Oxygen Study – Existing Conditions. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 119 pp.	Completed	10/9/2012
GN-9.4.2	Tetr*ES* Consultants Inc., North/South Consultants Inc. and Manitoba Hydro, 2009. Water Temperature & Dissolved Oxygen Study – Future Without Project. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 10 pp.	Completed	8/21/2012
GN-9.4.3	Tetr*ES* Consultants Inc., North/South Consultants Inc. and Manitoba Hydro, 2011. Water Temperature & Dissolved Oxygen Study – Project Effects. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 100 pp.	Completed	11/19/2012
GN-9.5.1	Manitoba Hydro, 2009. Historical Climate Analysis. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 29 pp.	Completed	2/29/2012
GN-9.5.2	Manitoba Hydro, 2011. Future Climate Scenarios. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 66 pp.	Completed	2/29/2012
GN-9.5.5	The Pembina Institute, 2012. A Life Cycle Assessment of Greenhouse Gases and Select Criteria Air Contaminants. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 89 pp.	Completed	02/16/2012

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
GN-9.5.6	Environnement Illimité Inc., 2012. Keeyask Environmental Impact Statement – Reservoir Greenhyouse Gases Technical Memo. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro.	Completed	03/08/2012
GN-9.5.7	Manitoba Hydro, 2008. Historical Flow Trend Analysis. Keeyask Project Environmental Studies Program.	In preparation	
AQUATIC ENVIRONMENT			
99-01	Remnant, R.A. and C.C. Barth. 2003. Results of Experimental Gillnetting on the Nelson River between Birthday and Gull Rapids, Manitoba, Fall 1999. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 75 pp. *Draft*.	Completed	12/2003
99-02	Zrum, L. and C.L. Bezte. 2003. Water Chemistry, Phytoplankton, Benthic Invertebrate, and Sediment Data for Gull Lake and the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, Fall, 1999. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 66 pp. *Draft*.	Completed	12/2003
01-01	Zrum, L. and T.J. Kroeker. 2003. Benthic Invertebrate and Sediment Data from Split Lake and Assean Lake, Manitoba, Winter, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 78 pp. *Draft*.	Completed	12/2003
01-02	Barth, C.C., R.L. Bretecher, and J. Holm. 2004. Floy-tag Application and Recapture Information from the (Gull) Keeyask Study Area, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 88 pp. *Draft*.	Completed	11/2004
01-03	Barth, C.C., D.L. Neufeld, and R.L. Bretcher. 2003. Results of Fisheries Investigations Conducted in Tributaries of the Nelson River Between Birthday Rapids and Gull Rapids, Manitoba, Spring, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 53 pp. *Draft*.	Completed	12/2003
01-04	Juliano, K.M. and L. Zrum. 2003. Zooplankton Data from Split, Clark, Gull, Stephens, and Assean Lakes, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	12/2003
01-05	Dunmall, K.M., J. Holm, and R.L. Bretcher. 2003. Results of Index Gillnetting Studies Conducted in Assean Lake, Manitoba, Summer 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 70 pp. *Draft*.	Completed	12/2003

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
01-06	Dolce, L.T. and M.A. Sotiropoulos. 2004. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected in Gull Lake and Portions of the Nelson River Between Birthday Rapids and Gull Rapids, Manitoba, Fall 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 56 pp. *Draft*.	Completed	1/2004
01-07	Dunmall, K.M., J.E. MacDonald, and R.L. Bretecher. 2004. Results of Summer Index Gillnetting Studies Conducted in Split Lake and Clark Lake, and Spring Investigations of Adult and Larval Fish Populations in Portions of the Burntwood River, Grass River, and Nelson River flowing into Split Lake, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	2/2004
01-08	Remnant, R.A., N.J. Mochnacz, and J.E. MacDonald. 2004. Results of Fisheries Investigations Conducted in the Assean River Watershed, Manitoba, Spring and Fall, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 106 pp. *Draft*.	Completed	10/2004
01-10	Pisiak, D.J., T. Kroeker, and R.A. Remnant. 2004. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba, and Seasonal Investigations of Adult and Larval Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	10/2004
01-11	Sotiropoulos, M.A. and L.J. Neufeld. 2004. Benthic Invertebrate, Sediment, and Drifting Invertebrate Data Collected from the Gull (Keeyask) Study Area, Manitoba, Spring - Fall 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 138 pp. *Draft*.	Completed	10/2004
01-13	Remnant, R.A., C.R. Parks, and J.E. MacDonald. 2004. Results of Fisheries Investigations Conducted in the Reach of the Nelson River between Clark Lake and Gull Rapids (Including Gull Lake), 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 154 pp. *Draft*.	Completed	10/2004
01-14	Barth, C.C. and N.J. Mochnacz. 2004. Lake Sturgeon Investigations in the Gull (Keeyask) Study Area, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 146 pp. *Draft*.	Completed	10/2004

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
01-15	Badiou, P.H., and H.M. Cooley. 2004. Water Chemistry, Phytoplankton, and Sediment Chemistry Data for the Nelson and Assean River Systems, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 210 pp. *Draft*.	Completed	10/2004
02-03	Barth, C.C., L.J. Neufeld, and J.R. Olynik. 2003. Movements of Northern Pike, Walleye, and Lake Whitefish Tagged with Radio and Acoustic Transmitters in the Gull (Keeyask) Study Area, 2001/2003. Draft report prepared for Manitoba Hydro by North/South Consultants. 137 pp. *Draft*.	Completed	12/2003
02-04	Juliano, K.M. and L. Zrum. 2004. Zooplankton Data from Split, Clark, Gull, Stephens, and Assean Lakes, and the Nelson River, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 65 pp. *Draft*.	Completed	1/2004
02-05	Holm, J., V.L. Richardson, and R.L. Bretecher. 2003. Results of Index Gillnetting Studies Conducted in Assean Lake, Manitoba, Summer 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 80 pp. *Draft*.	Completed	12/2003
02-06	Hartman, E.J. and R.L. Bretecher. 2004. Results of Fisheries Investigations Conducted in the North Moswakot and South Moswakot Rivers, Manitoba, Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 69 pp. *Draft*.	Completed	1/2004
02-08	Mochnacz, N.J., C.C. Barth, and J. Holm. 2004. Results of Fisheries Investigations Conducted in the Aiken River and at the Mouth of the Ripple River, Manitoba, Spring 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 106 pp. *Draft*.	Completed	3/2004
02-09	Holm, J. and R.A. Remnant. 2004. Results of Summer Index Gillnetting Studies Conducted in Split Lake and Clark Lake, and Spring Investigations of Adult and Larval Fish Communities in Portions of the Burntwood, Grass, and Nelson Rivers Flowing into Split Lake, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 131 pp. *Draft*.	Completed	4/2004
02-10	Dolce, L.T. and M.A. Sotiropoulos. 2004. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected in Gull Lake and Portions of the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 57 pp. *Draft*.	Completed	3/2004

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
02-12	Juliano, K.M. and L.J. Neufeld. 2004. Benthic Invertebrate and Sediment Data from Split Lake and Assean Lake, Manitoba, Winter 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 67 pp. *Draft*.	Completed	12/2004
02-13	Juliano, K.M. and L.J. Neufeld. 2005. Benthic Invertebrate, Sediment, and Drifting Invertebrate Data Collected from the Gull (Keeyask) Study Area, Manitoba, Spring - Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 161 pp. *Draft*.	Completed	1/2005
02-14	Badiou, P.H. and H.M. Cooley. 2005. Water Chemistry, Phytoplankton, and Sediment Chemistry Data for the Nelson and Assean River Systems, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 255 pp. *Draft*.	Completed	2/2005
02-15	Johnson, M.W. 2005. Results of Fish Community Investigations Conducted in the Assean River Watershed, Manitoba, Spring and Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 133 pp. *Draft*.	Completed	2/2005
02-16	Pisiak, D.J. 2005. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba and Seasonal Investigations of Adult and Larval Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 179 pp. *Draft*.	Completed	1/2005
02-17	Richardson, V.L. and J. Holm. 2005. Results of Fish Community Investigations Conducted in Tributary Systems of the Nelson River between Birthday Rapids and Gull Rapids, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 98 pp. *Draft*.	Completed	1/2005
02-18	Holm, J., V.L. Richardson, and C.C. Barth. 2005. Floy-tag Application and Recapture Information from the Gull (Keeyask) Study Area, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 175 pp. *Draft*.	Completed	2/2005
02-19	Barth, C.C. 2005. Lake Sturgeon Investigations in the Keeyask Study Area, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 131 pp. *Draft*.	Completed	2/2005

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
02-20	Johnson, M.W. and C.R. Parks. 2005. Results of Fish Community Investigations Conducted in the Reach of the Nelson River between Clark Lake and Gull Rapids, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 222 pp. *Draft*.	Completed	8/2005
03-01	Ryland, D. and B. Watts. Fish Taste Studies for Tataskweyak Cree Nation. Draft report prepared for Manitoba Hydro by the University of Manitoba. 44 pp. *Draft*.	Completed	1/2004
03-02	Ryland, D. and B. Watts. Fish Taste Studies for Fox Lake Cree Nation. Draft report prepared for Manitoba Hydro by the University of Manitoba. 43 pp. *Draft*.	Completed	1/2004
03-03	Maclean, B.D. and D.J. Pisiak. 2005. Results of Fish Community Investigations Conducted at the Mouth of the Ripple River, Manitoba, Spring 2003. Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 43 pp. *Draft*.	Completed	2/2005
03-05	Badiou, P.H., H.M. Cooley, and T. Savard. 2005. Water Chemistry Data for the Lower Nelson River System, Manitoba, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 219 pp. *Draft*.	Completed	12/2005
03-06	Murray, L., C.C. Barth, and J.R. Olynik. 2005. Movements of Radio- and Acoustic- Tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2002 to April 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 125 pp. *Draft*.	Completed	8/2005
03-08	Barth, C.C. and L. Murray. 2005. Lake sturgeon Investigations in the Keeyask Study Area, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 127 pp. *Draft*.	Completed	10/2005
03-09	Pisiak, D.J. and E.J. Hartman. 2005. Results of Fish Community Investigations Conducted in the North Moswakot and South Moswakot Rivers, Manitoba, Spring and Fall 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 157 pp. *Draft*.	Completed	9/2005
03-11	Kroeker, D.S. and W. Jansen. 2005. Results of Fish Community Investigations Conducted in Tributaries of the Nelson River between Clark Lake and Gull Rapids, Manitoba, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 72 pp. *Draft*.	Completed	1/2006

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
03-12	Maclean, B.D. and J.Holm. 2005. Results of Fish Community Investigations Conducted in the Mistuska River, Manitoba, Spring 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 90 pp. *Draft*.	Completed	9/2005
03-13	Maclean, B.D. and D.J. Pisiak. 2005. Results of Fish Community Investigations Conducted in the Aiken River, Manitoba, Spring 2003, Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 108 pp. *Draft*.	Completed	12/2005
03-14	Pisiak, D. 2005. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba, and Seasonal Investigations of Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 313 pp. *Draft*.	Completed	10/2005
03-15	Holm, J. 2006. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 244 pp. *Draft*.	Completed	9/2006
03-16	Dolce, L. T. and M.J. Burt. 2008. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected from the Keeyask Study Area, Manitoba, Late Summer 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 111 pp. *Draft*.	Completed	2/2008
03-17	Gill, G. 2007. Invertebrate Drift and Plant Biomass Data from the Nelson River at Birthday Rapids, Gull Lake, Gull Rapids, and Kettle Generating Station, Manitoba, Summer and Fall 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 72 pp. *Draft*.	Completed	11/2007
03-35	Maclean, B.D. and P. Nelson. 2005. Population and Spawning Studies of Lake Sturgeon (Acipenser fulvescens) at the Confluence of the Churchill and Little Churchill Rivers, Manitoba, Spring 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 70 pp. *Draft*.	Completed	1/2006
03-36	Bretecher, R.L., G.C. Dyck, and R.A. Remnant. 2007. Results of Fish Community Investigations Conducted in the Reach of the Nelson River Between Clark Lake and Gull Rapids (Including Gull Lake), 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 275 pp. *Draft*.	Completed	2/2007

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
03-37	Cooley, H.M. and M.W. Johnson. 2008. An Evaluation of Walleye Condition from Stephens Lake. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	3/2008
04-03	Holm, J. 2005. Results of Fish Community Investigations Conducted in Clark Lake, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	10/28/2005
04-04	Badiou, P.H., T. Savard, and H.M. Cooley. 2007. Water Chemistry and Phytoplankton data for the Lower Nelson River System, Manitoba, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 247 pp. *Draft*.	Completed	1/2007
04-05	BARTH, C.C. and K. AMBROSE. 2006. Lake Sturgeon Investigations in the Keeyask Study Area, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 105 pp. *Draft*.	Completed	1/2006
04-06	Cooley, H.M. and T.G. Savard. 2008. Results of Greenhouse Gas Sampling in the Keeyask and Conawapa Study Areas: 2001-2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 76 pp. *Draft*.	Completed	2/2008
04-07	T. Savard and H.M. Cooley. 2007. Turbidity Monitoring Data for Clark and Gull Lakes, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 51 pp. *Draft*.	Completed	1/2007
04-08	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 148 pp. *Draft*.	Completed	1/2007
04-09	Johnson, M.W. 2007. Results of Fish Community Investigations Conducted in the Reach of the Nelson River Between Clark Lake and Gull Rapids (Including Gull Lake), 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 159 pp. *Draft*.	Completed	1/2007
04-10	Johnson, M.W. and C.C. Barth. 2007. Results of Fish Community Investigations in the Kettle and Butnau Rivers, Manitoba, Spring 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	1/2007
04-11	Holm, J., H.M. Cooley, and E. Shipley. 2007. Trace Elements in Fish from the Keeyask Study Area: Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 62 pp. *Draft*.	Completed	2/2007

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
04-12	Johnson, M.W. and B.D. Maclean. 2007. Results of Fish Community Investigations Conducted in the Mistuska River, Manitoba, Spring 2004. Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 87 pp. *Draft*.	Completed	6/2007
04-13	Johnson, M.W. and B.D. Maclean. 2007. Results of Fish Community Investigations Conducted in the York Landing Arm of Split Lake and Its Major Tributaries, Manitoba, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 74 pp. *Draft*.	Completed	5/2007
04-14	Pisiak, D.J. and B.D. Maclean. 2007. Population Studies of Lake Sturgeon (*Acipenser fulvescens*) in the Fox River, Manitoba, Summer 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 42 pp. *Draft*.	Completed	4/2007
04-15	Neufeld, L. 2007. Benthic Invertebrate and Sediment, Data Collected from Littoral Zones in the Keeyask Study Area, Manitoba, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 92 pp. *Draft*.	Completed	4/2007
04-16	MacDonald, J.E. 2007. Results of Fish Community Investigations in Gull Rapids and Stephens Lake, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 113 pp. *Draft*.	Completed	5/2007
04-17	Burt, M.J. and L.T. Dolce. 2008. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected from the Keeyask Study Area, Manitoba, Summer 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 130 pp. *Draft*.	Completed	2/2008
04-18	Gill, G. 2007. Invertebrate Drift and Plant Biomass Data from the Nelson River at Birthday Rapids,Gull Rapids, and Kettle Generating Station, Manitoba, Summer and Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 91 pp. *Draft*.	Completed	11/2007
05-02	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 56 pp. *Draft*.	Completed	4/2007
05-03	Murray, L. and C.C. Barth. 2007. Movements of Radio- and Acoustic- Tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2003 to August 2004 and a Summary of Findings from 2001-2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 111 pp. *Draft*.	Completed	4/2007

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
05-04	Jansen, W. and N. Strange. 2007. Mercury Concentrations in Fish From the Keeyask Project Study Area for 1999-2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 168 pp. *Draft*.	Completed	8/2007
05-05	Barth, C.C. and J.E. MacDonald. 2008. Lake Sturgeon Investigations in the Keeyask Study Area, 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 63 pp. *Draft*.	Completed	3/2008
05-06	Mazur, K.M. and T.G. Savard. 2008. Proposed Keeyask Access Road Stream Crossing Assessment, 2004 and 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 68 pp. 83 pp. *Draft*.	Completed	2/2008
06-02	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 61 pp. *Draft*.	Completed	4/2007
06-03	Savard, T. and H.M. Cooley. 2007. Dissolved Oxygen Surveys in the Keeyask Study Area: Winter 2005 and 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 54 pp. *Draft*.	Completed	4/2007
06-04	MacDonald, J.E. 2008. Lake Sturgeon Investigations in the Keeyask Study Area, 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	3/2008
06-05	Cassin, J. and R.A. Remnant. 2008. Results of Fish Spawning Investigations Conducted in Gull Rapids Creek, Pond 13, and Selected Tributaries to Stephens Lake, Spring 2005 and 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 45 pp. *Draft*.	Completed	3/2008
06-06	MacDonald, J.E. 2007. Fish community assessments of selected lakes within the Split Lake Resource Management Area, 2004-2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 145 pp. *Draft*.	Completed	11/2007
06-07	Jansen, W. 2008. Infection Rate of the Parasite *Triaenophorus crassus* in Lake Whitefish from the Keeyask Study Area for 2003-2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 35 pp. *Draft*.	Completed	3/2008

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
06-08	Cooley, P.M. and L. Dolce. 2008. Aquatic Habitat Utilization Studies in Stephens Lake: Macrophyte Distribution and Biomass, Epiphytic Invertebrates, and Fish Catch-Per- Unit-Effort in Flooded Habitat. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 75 pp. *Draft*.	Completed	3/2008
06-09	Cooley, P.M. 2008. Carbon dioxide and methane flux from peatland watersheds and divergent water masses in a sub-arctic reservoir. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 45 pp. *Draft*.	Completed	3/2008
06-10	Capar, L.N. 2008. Benthic Invertebrate Data Collected from O'Neil Bay and Ross Wright Bay in Stephens Lake, Manitoba, Fall 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 34 pp. *Draft*.	Completed	3/2008
06-11	Jansen, W. and N. Strange. 2009. Fish mercury concentrations from the Keeyask Project Study Area for 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 68 pp. *Draft*.	Completed	7/2009
06-12	Larter, J.L. and P.M. Cooley. 2010. Substratum and Depth Distribution in Flooded Habitat of Stephens Lake, Manitoba, Thirty-Five Years after Impoundment. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 57 pp. *Draft*.	Completed	12/2010
06-13	Cooley, P.M., L. Dolce Blanchard, and J. Larter. 2009. The effect of local and regional watersheds on the spectral composition and attenuation of light and water quality parameters in the surface waters of Stephens Lake, Manitoba. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 51 pp. *Draft*.	Completed	5/2009
08-01	MacDonald, J.E. 2009. Lake Sturgeon Investigations in the Keeyask Study Area, 2007-2008. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	4/2009
08-02	Holm, J. 2009. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2007 and 2008. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 63 pp. *Draft*.	Completed	4/2009
09-01	Holm, J. 2010. Results of Index Gillnetting Studies Conducted in the Keeyask Study Area, Summer 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	10/2010

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
09-02	Holm, J. 2010. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 48 pp. *Draft*.	Completed	10/2010
09-03	Michaluk, Y. and J.E. MacDonald. 2010. Lake Sturgeon Investigations in the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 83 pp. *Draft*.	Completed	12/2010
09-04	Savard, T. S. Hnatiuk-Stewart, and H.M. Cooley. 2010. Water Quality Data for the Lower Nelson River System, Manitoba, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 240 pp. *Draft*.	Completed	7/2010
09-05	Jansen, W. 2010. Fish Mercury Concentrations in the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 42 pp. *Draft*.	Completed	12/2010
10-01	**MacDonald, J.E. and C.C. Barth.** 2011. Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 78 pp. *Draft*	Completed	12/2011
10-02	**Michaluk, Y., J.E. MacDonald and C.C. Barth.** 2011. Results of Lake Whitefish Spawning Surveys in Ferris Bay and the North and South Moswakot Rivers, Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 51 pp. *Draft*	Completed	11/2011
10-03	**Henderson, L., C.C. Barth, J.E. MacDonald and S.J. Garner.** 2011. Results of a Coarse Scale Habitat Inventory in the Upper Split Lake Area, Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 75 pp. *Draft*	Completed	12/2011
10-04	**Holm, J. 2011.** Floy-tag Application and Recapture Information from the Keeyask Study Area, 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 53 pp. *Draft*	Completed	12/2011
10-05	**Ambrose, K.M. and R. Remnant.2011.** Fish Community Assessment of Armstrong Lake,2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 90 pp. *Draft*	Completed	12/2011

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
10-06	**MacDonald, J.E. and C.C. Barth.** 2011. Benthic Invertebrate Surveys in Gull Lake and Stephens Lakes, Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 78 pp. *Draft*	Completed	12/2011
10-07	**Henderson, L.M., C.C. Barth, J.E. MacDonald and M. Blanchard.** 2011. Young-of-the-Year and Sub-Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring and Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 60 pp.** *Draft*	Completed	12/2011
11-01	Hrenchuk, C.L. and C.A. McDougall. 2012. Adult Lake Sturgeon Investigations in the Keeyask Study Area, 2011. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 183 pp. *Draft*	**Completed**	**12/2012**
11-04	Henderson, L.M. and D.J. Pisiak. 2012. Results of Young-of-the-Year and Sub-Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring and Fall 2011. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 58 pp. *Draft*	**Completed**	**12/2012**
11-05	Holm, J. 2012. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2011. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 60 pp. *Draft*	**Completed**	**12/2012**
~~TBA~~	~~Ambrose, K.M. and R.A. Remnant. 2011. Results of fish community investigations in Armstrong Lake, Manitoba, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for report 10-5	
~~TBA~~	~~Capar, L.N., and F. Schneider-Vieira. 2011. Results of benthic invertebrate sampling conducted in Gull and Stephens Lakes, Fall, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-6	
~~TBA~~	~~Henderson, L. M., C. C. Bart, J.E. MacDonald, and S.J. Garner. 2011. Results of a coarse scale habitat inventory in the upper Split Lake area, fall 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-3	
~~TBA~~	~~Henderson, L.M. and C.C. Barth. 2011. Young-of-the-year and subadult lake sturgeon investigations in the Keeyask Study Area, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-7	

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
~~TBA~~	~~Holm, J. 2011. Floy-tag application and recapture information from the Keeyask Study Area, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-4	
~~TBA~~	~~MacDonald, J.E. and C.C. Barth. 2011. Lake sturgeon investigations in the Keeyask Study Area, Spring 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-1	
~~TBA~~	~~Michaluk, Y. J.E. MacDonald, and C. C. Barth. 2011. Results of lake whitefish spawning surveys in Ferris Bay and the North and South Moswakot rivers, fall, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-2	
TBA	**McDougall, C.A., C.C. Barth, and C.L. Hrenchuk. 2013. Results of Juvenile Lake Sturgeon Movement and Habitat Utilization Studies in Stephens Lake, 2011. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft***	In preparation	
TBA	**McDougall, C.A., C.C. Barth, and C.L. Hrenchuk. 2013. Results of Juvenile Lake Sturgeon Movement and Habitat Utilization Studies in Stephens Lake, October 2011 to 2012. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft***	In preparation	
Terrestrial Habitat and Ecosystems			
	Terrestrial habitats and ecosystems in the Lower Nelson River Region	In preparation	
	Responses of terrestrial habitats to reservoir flooding and water regulation in northern Manitoba	In preparation	
	Habitat relationships and wildlife habitat quality models for the Keeyask region		
FORESTRY			
01-16	Forestry Activities 2001. Draft report prepared for North/South Consultants Inc. by Plus4 Consulting Inc. and Resource Ecosystem Services. 49 pp.	Completed	12/1/2004
03-07	Forestry activities 2003. Draft report prepared for Manitoba Hydro by Plus4 Consulting Inc.	Completed	3/31/2006
TBA	Keeyask GS Forebay Clearing Plan Comparative Analysis; Hand Clearing Versus Machine Clearing (Draft). 2006 Draft report prepared for Manitoba Hydro by Plus4 Consulting Inc.	Completed	3/27/2006

Appendix 6A - Environmental Study Report List

Report Number	Report Title	Status	Date Completed
	Plus4 Consulting Inc. and Ecostem Ltd., 2006. Keeyask Forebay Clearing Plan (Draft). Draft report prepared for Manitoba Hydro by Plus4 Consulting Inc.	Completed	2/22/2006
BIRDS, AMPHIBIANS AND REPTILES			
01-09	Tetr*ES* Consultants Inc., 2004. Avian field studies report, 2001. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	Completed	12/1/2004
02-11	Tetr*ES* Consultants Inc., 2005. Avian field studies report, 2002. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 190 pp. *Draft*	Completed	3/9/2005
03-04	Tetr*ES* Consultants Inc., 2005. Avian field studies report, 2003. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	Completed	10/28/2005
04-01	Tetr*ES* Consultants Inc., 2005. Access road – Avian Field Studies report, 2004. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 33 pp. *Draft*	Completed	10/28/2005
04-02	Tetr*ES* Consultants Inc., 2005. Amphibian and reptile field studies report 2001-2004. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 27 pp. *Draft*	Completed	10/28/2005
05-01	Tetr*ES* Consultants Inc., 2006. Access road – Avian field studies report, 2005. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 52 pp. *Draft*	Completed	3/31/2006
06-01	Tetr*ES* Consultants Inc., 2007. Access road – Avian field studies report, 2006. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/28/2007
07-01	Tetr*ES* Consultants Inc., 2007. Avian field studies report, 2007. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2007
07-02	Tetr*ES* Consultants Inc., 2007. Amphibian and Reptile field studies report, 2007. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/21/2007
11-01	Stantec Consultants Ltd. Avian 2011 Field Studies Report, 2011. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	In preparation	

MAMMALS			
01-12	Patenaude, A. and R. Berger. 2004. Results of Mammal, Reptile & Amphibian Investigations in the Gull (Keeyask) Study Area, 2001. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting Services MB, Inc. 142 pp. *Draft*.	Completed	12/1/2004
02-07	Patenaude, A. and R. Berger. 2004. Results of Mammal Investigations in the Keeyask Study Area, 2002. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting Services MB, Inc. 162 pp. *Draft*.	Completed	3/15/2004
03-34	Patenaude, A., A. Kibbins, A. Walleyn and R. Berger. 2006. Results of mammal investigations in the Keeyask study area, 2003. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting Services MB, Inc. 246 pp. *Draft*.	Completed	1/23/2006
04-19	Kibbins, A. and R. Berger. 2007. Results of mammal investigations in the Keeyask study area, 2004. Draft report prepared for Manitoba Hydro by Wildlife Resource Consulting Services MB, Inc. 64 pp. *Draft*.	Completed	1/8/2007
08-XX	Wildlife Resource Consulting Services MB, Inc. Keeyask Project Generating Station Caribou of the Lower Nelson River, Workshop Discussion Report. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 21 pp. *Draft*.	Completed	12/31/2008
09-01	Knudsen, B., R. Berger, B. Kiss, S. Johnstone, J. Hopkins and J. Kelly. 2009. Split Lake Resource Management Area Moose Survey Stage 1 - March 2009. Draft report prepared for Manitoba Hydro by Knudsen Wildlife Management Systems and Wildlife Resource Consulting Services MB, Inc. 52 pp. *Draft*.	Completed	4/30/2009
10-01	Knudsen, B., R. Berger, S. Johnstone, B. Kiss, J. Paille and J. Kelly. 2010. Split Lake Resource Management Area Moose Survey 2009 and 2010. Draft report prepared for Manitoba Hydro by Knudsen Wildlife Management Systems and Wildlife Resource Consulting Services MB, Inc. 144 pp. *Draft*.	Completed	12/15/2010
HERITAGE			
N/A	Northern Lights Heritage Services Inc. Keeyask Powistick (Gull Rapids) Generating Station Cultural and Physical Heritage Area Characterization Study. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2001
A36-01	Northern Lights Heritage Services Inc. Keeyask Powistick (Gull Rapids) Heritage Resource Impact Assessment: 2001. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2001

A27-02	Northern Lights Heritage Services Inc. Gull Rapids (Keeyask) Generating Station: Heritage Resource Impact Assessment (Year I): Fox Lake Cree Nation (Interim Report). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	9/2002
02-04	Northern Lights Heritage Services Inc. Gull (Keeyask) Project Generating Station: Heritage Resource Impact Assessment Fox Lake Cree Nation. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	2002
A10-03	Northern Lights Heritage Services Inc. Keeyask Project: Generating Station: Heritage Resource Impact Assessment: Gull (Keeyask) Rapids Camp. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2003
A10-03	Northern Lights Heritage Services Inc. Keeyask Project: Generating Station: Heritage Resource Impact Assessment of Gull (Keeyask) Rapids. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2003
A10-03	Northern Lights Heritage Services Inc. Keeyask Project Heritage Resource Impact Assessment: Archaeological Survey of Stephen's and Fox (Atikinson) Lakes. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2003
A07-04	Northern Lights Heritage Services Inc. Keeyask Project Generating Station: 2004 Heritage Resource Impact Assessment Gull (Keeyask) Rapids. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2004
A07-04	Northern Lights Heritage Services Inc. Participatory Action Research, Tataskweyak Cree Nation Student Archaeological Program. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2005
A08-04	Northern Lights Heritage Services Inc. Keeyask Projects: Heritage Resource Impact Assessment: Archaeological Investigation at the Paradise Beach Site on Fox (Atkinson) Lake. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2005
A30-05	Northern Lights Heritage Services Inc. Gull (Keeyask) Project: Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2005

A31-05	Northern Lights Heritage Services Inc. Gull (Keeyask) Generating Station: Kettle Lake Comparison Study. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	1/2006
A33-05	Northern Lights Heritage Services Inc. War Lake Archaeological Research Project (WARP) Archaeological Field Survey Report. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	4/2006
A31-06	Northern Lights Heritage Services Inc. Keeyask (Gull) Generating Station: Bryant's Point: Archaeological Field Investigation Component Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	9/2006
A28-06	Northern Lights Heritage Services Inc. Archaeological Survey of the Northwest Arm of Stephens Lake, Manitoba. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	12/2006
A31-06	Northern Lights Heritage Services Inc. Keeyask Projects: Archaeological Survey of Kettle Lake, Manitoba: Comparative Study for the Heritage Resource Impact Assessment (HRIA). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	1/2007
A30-06	Northern Lights Heritage Services Inc. Keeyask (Gull) Project: 2006 Fox Lake Comparative Study Component. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2007
A32-06	Northern Lights Heritage Services Inc. Keeyask Generating Station: Archaeological Field Investigation Component Clark Lake Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2007
A25-07	Northern Lights Heritage Services Inc. Keeyask Generating Station 2007 Archaeological Field Investigation Component Clark Lake Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	2/2008
A25-07	Northern Lights Heritage Services Inc. Keeyask Generating Station 2007 Archaeological Field Investigation Component Carscadden Lake and Portage (Pisitif) Creek Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	2/2008

A38-08	Northern Lights Heritage Services Inc. Archaeological Investigation of the Lower Odei & Burntwood Rivers Related to the Aboriginal Sturgeon Fishery. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	10/2008
A34-08	Northern Lights Heritage Services Inc. Keeyask Generating Station 2008 Archaeological Field Investigation Component: Carscadden Lake Archaeological Survey Heritage Resource Impact Assessment (HRIA). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	1/2009
A30-08	Northern Lights Heritage Services Inc. 2008 Split Lake Archaeological Shoreline Survey. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2009
A35-08	Northern Lights Heritage Services Inc. Keeyask Generating Station 2008 Archaeological Field Investigation Component Clark Lake Archaeological Survey Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2009
A29-08	Northern Lights Heritage Services Inc. Keeyask Generating Station 2008 Archaeological Field Investigation Component Pointe West Site (HfKe-2) Formal Excavation. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	4/2009
N/A	Northern Lights Heritage Services Inc. Keeyask Construction Power Transmission Line Cultural and Physical Heritage Area Characterization Study & Route Selection. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	5/2009
A40-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009: HRIA of Impervious and Granular Deposit Borrow Areas. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2009
A37-09	Northern Lights Heritage Services Inc. Keeyask Infrastructure Project 2009 HRIA Startup and Main Camp (Phase 1). Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	8/2009
A18-09 & A5109	Northern Lights Heritage Services Inc. Keeyask Transmission Project 2009 Heritage Resource Impact Assessment. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	10/2009

A41-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009 Heritage Resource Impact Assessment: Monitoring of Drill Testing on Caribou Island. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2009
A42-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009 HRIA of North and South Retaining Dykes. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2009
A32-09	Northern Lights Heritage Services Inc. Keeyask Generation Project 2009 Archaeological Field Investigations: Excavation of the Pointe West Site (HbKx-02), a Proxy Site Investigated for the Keeyask Generation Project HRIA. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	3/2010
A21-10	Northern Lights Heritage Services Inc. Keeyask Generation Project 2010 Archaeological Survey of Cache Lake as part of the HRIA Process. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2011
A40-10	Northern Lights Heritage Services Inc. Keeyask Generation Project 2010: HRIA of William Smith Island & Selected Borrow Areas. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2011
A25-10	Northern Lights Heritage Services Inc. Keeyask Generation Project 2010 Archaeological Field Investigations: Excavation of the Pointe West Site (HbKx-02), a Proxy Site Investigated for the Keeyask Generation Project HRIA. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	6/2011
A56-11	Northern Lights Heritage Services Inc. Keeyask Generation Project 2011 South Access Road Butnau River Crossing HRIA. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	Completed	11/2011
A17-11	Northern Lights Heritage Services Inc. Keeyask Generation Project 2011 HRIA North Shore Gull Lake and Selected Borrow Area Investigations. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	MB Hydro Review	
A16-11	Northern Lights Heritage Services Inc. Keeyask Generation Project 2011 HRIA of Potential Burial Locations on Gull Lake and Caribou Island. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*.	MB HYDRO Review	

1.2 PUBLIC INVOLVEMENT PROGRAM SUPPORTING VOLUME

As of this filing there are no errata to report for the Public Involvement Program Supporting Volume.

1.3 PROJECT DESCRIPTION SUPPORTING VOLUME

Chapter	Page	Current Text	Corrected Text/Clarification
Chapter 2	2-24	“The south access road includes a 13.5 km section of new road between Gull Rapids and Butnau Dam and a 21.5 km section of existing road that will be upgraded to Provincial Road standards (Table 3-1).”	“The south access road includes a **19 km** section of new road between Gull Rapids and Butnau Dam and a **16 km** section of existing road that will be upgraded to Provincial Road standards (Table 3-1)”

1.4 PHYSICAL ENVIRONMENT SUPPORTING VOLUME

As of this filing there are no errata to report for the Physical Environment Supporting Volume.

1.5 AQUATIC ENVIRONMENT SUPPORTING VOLUME

Chapter	Page	Current Text	Corrected Text/Clarification
Acknowledgements	i	"Jarod Larter, B. Sc."	"Jarod Larter, B. Sc., **Adv. Dip. GIS, M. Sc.**"
Acknowledgements	i	"Paul Cooley, B. Sc., M. Sc., Ph. D."	"Paul Cooley, B. Sc., **M. A.,** Ph. D."
Acknowledgements	i	"Laura Henderson, B. Sc., M. Sc."	"**Laura Henderson, B. Sc.**"
Acknowledgements	i	"Laurel Neufeld, B. Sc., M. Sc."	"**Laurel Neufeld, B. Sc.**"
List of Tables	xxvii, 5-v	Table 5-1 is listed as starting on p. 5-73	Table 5-1 starts on p. **5-75**
List of Tables	xxx, 7-v	Table 7-1 is listed as starting on p. 7-51	Table 7-1 starts on p. **7-53**
List of Figures	xxxiv, 2-x	"Figure 2-11: Open water season (± standard error) concentrations of (A) magnesium, (B) potassium, (C) sodium, and (D) calcium measured at sites in the Keeyask Study Area: 2001-2004"	"Figure 2-11: Open water season (± standard error) concentrations of (A) magnesium, (B) potassium, (C) sodium, and (D) calcium measured at sites **in the Aquatic Environment Study Area**: 2001-2004"
List of Maps	xl, 2-xiii	"Map 2-8: Water quality sampling sites 2001-2004 – Downstream area"	"Map 2-8: Water quality sampling sites 2001-2004 – **Stephens Lake** area"
Appendix 1A Part 1	Map 1A-8B on p. 1A-68	The purple "North Shore bench" area is missing from the map image (but included in the map legend)	A map showing the location of the purple "North Shore bench" area during Phase 2 and Phase 3 of habitat construction can be found in the Fish Habitat Compensation Plan
Appendix 1A Part 2	II	Appendix I is listed as starting on p. 23	Appendix I starts on p. **24**
Appendix 1B	Table 1B-1 (p.1B-1 to 1B-14)	Two different, incomplete references were included for each 2010 data report	A table with one correct reference for each 2010 data report is provided as an attachment
Chapter 2	Map 2-1 p. 191	Areas within the larger Water Quality Study Area are not labeled with their names	A map with labeled areas is provided as an attachment

Chapter 3	3-30	"As discussed in Section 6.2.3.3.2, the total area of large river and lake habitat…"	"As discussed in Section **3.3.2.1**, the total area of large river and lake habitat…"
Chapter 4	4-133	"Table 4-20A: Residual effects on the zooplankton community: operation period"	"Table **4-20B**: Residual effects on the zooplankton community: operation period"
Chapter 5	Figure 5-1	The 2002-2003 date range in panel A (Split Lake fish abundance) is incorrect	The date range should be 1997-1998, 2001-2002. A figure with the correct date range is provided as an attachment
Appendix 6B	6D-6	The final paragraph in Section 6D.3 is a drafting note	The drafting note should be omitted

A few formatting errors present in the initial electronic version of the AE SV (distributed on CD on 06 July 2012) were identified before binders were printed. These formatting errors were corrected in the web and print versions, as well as in the electronic version on all subsequently distributed CDs. These corrections included such things as: the addition of missing section prefixes to page numbers (e.g., in Section 2, p. 147 became p. 2-147); the movement of section headings stranded at the bottom of pages, or related tabular data/literature cited/table of contents entries split across two pages, to the top of the following page; updating map names in the List of Maps to match titles on maps included in the document; correcting the page number(s) on p. 2I-6 and the list of Attachments on p. 1A-ix; and fixing the incorrect location of a "Tables, Maps and Figures" title page. Apart from formatting, document content between the two versions was not altered.

1.5.1 Corrected Tables and Figures

The changes notes for Table 1B-1 below are comparable to those notes for Table 6A-1 of the Response to EIS Guidelines.

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
99-01	Remnant, R.A. and C.C. Barth. 2003. Results of Experimental Gillnetting on the Nelson River between Birthday and Gull Rapids, Manitoba, Fall 1999. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 75 pp. *Draft*.	Completed	Dec-03
99-02	Zrum, L. and C.L. Bezte. 2003. Water Chemistry, Phytoplankton, Benthic Invertebrate, and Sediment Data for Gull Lake and the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, Fall, 1999. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 66 pp. *Draft*.	Completed	Dec-03

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
01-01	Zrum, L. and T.J. Kroeker. 2003. Benthic Invertebrate and Sediment Data from Split Lake and Assean Lake, Manitoba, Winter, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 78 pp. *Draft*.	Completed	Dec-03
01-02	Barth, C.C., R.L. Bretecher, and J. Holm. 2004. Floy-tag Application and Recapture Information from the (Gull) Keeyask Study Area, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 88 pp. *Draft*.	Completed	Nov-04
01-03	Barth, C.C., D.L. Neufeld, and R.L. Bretcher. 2003. Results of Fisheries Investigations Conducted in Tributaries of the Nelson River Between Birthday Rapids and Gull Rapids, Manitoba, Spring, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 53 pp. *Draft*.	Completed	Dec-03
01-04	Juliano, K.M. and L. Zrum. 2003. Zooplankton Data from Split, Clark, Gull, Stephens, and Assean Lakes, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	Dec-03
01-05	Dunmall, K.M., J. Holm, and R.L. Bretcher. 2003. Results of Index Gillnetting Studies Conducted in Assean Lake, Manitoba, Summer 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 70 pp. *Draft*.	Completed	Dec-03
01-06	Dolce, L.T. and M.A. Sotiropoulos. 2004. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected in Gull Lake and Portions of the Nelson River Between Birthday Rapids and Gull Rapids, Manitoba, Fall 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 56 pp. *Draft*.	Completed	Jan-04
01-07	Dunmall, K.M., J.E. MacDonald, and R.L. Bretecher. 2004. Results of Summer Index Gillnetting Studies Conducted in Split Lake and Clark Lake, and Spring Investigations of Adult and Larval Fish Populations in Portions of the Burntwood River, Grass River, and Nelson River flowing into Split Lake, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	Feb-04
01-08	Remnant, R.A., N.J. Mochnacz, and J.E. MacDonald. 2004. Results of Fisheries Investigations Conducted in the Assean River Watershed, Manitoba, Spring and Fall, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 106 pp. *Draft*.	Completed	Oct-04

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
01-10	Pisiak, D.J., T. Kroeker, and R.A. Remnant. 2004. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba, and Seasonal Investigations of Adult and Larval Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	Oct-04
01-11	Sotiropoulos, M.A. and L.J. Neufeld. 2004. Benthic Invertebrate, Sediment, and Drifting Invertebrate Data Collected from the Gull (Keeyask) Study Area, Manitoba, Spring - Fall 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 138 pp. *Draft*.	Completed	Oct-04
01-13	Remnant, R.A., C.R. Parks, and J.E. MacDonald. 2004. Results of Fisheries Investigations Conducted in the Reach of the Nelson River between Clark Lake and Gull Rapids (Including Gull Lake), 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 154 pp. *Draft*.	Completed	Oct-04
01-14	Barth, C.C. and N.J. Mochnacz. 2004. Lake Sturgeon Investigations in the Gull (Keeyask) Study Area, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 146 pp. *Draft*.	Completed	Oct-04
01-15	Badiou, P.H., and H.M. Cooley. 2004. Water Chemistry, Phytoplankton, and Sediment Chemistry Data for the Nelson and Assean River Systems, Manitoba, 2001. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 210 pp. *Draft*.	Completed	Oct-04
02-03	Barth, C.C., L.J. Neufeld, and J.R. Olynik. 2003. Movements of Northern Pike, Walleye, and Lake Whitefish Tagged with Radio and Acoustic Transmitters in the Gull (Keeyask) Study Area, 2001/2003. Draft report prepared for Manitoba Hydro by North/South Consultants. 137 pp. *Draft*.	Completed	Dec-03
02-04	Juliano, K.M. and L. Zrum. 2004. Zooplankton Data from Split, Clark, Gull, Stephens, and Assean Lakes, and the Nelson River, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 65 pp. *Draft*.	Completed	Jan-04
02-05	Holm, J., V.L. Richardson, and R.L. Bretecher. 2003. Results of Index Gillnetting Studies Conducted in Assean Lake, Manitoba, Summer 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 80 pp. *Draft*.	Completed	Dec-03

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
02-06	Hartman, E.J. and R.L. Bretecher. 2004. Results of Fisheries Investigations Conducted in the North Moswakot and South Moswakot Rivers, Manitoba, Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 69 pp. *Draft*.	Completed	Jan-04
02-08	Mochnacz, N.J., C.C. Barth, and J. Holm. 2004. Results of Fisheries Investigations Conducted in the Aiken River and at the Mouth of the Ripple River, Manitoba, Spring 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 106 pp. *Draft*.	Completed	Mar-04
02-09	Holm, J. and R.A. Remnant. 2004. Results of Summer Index Gillnetting Studies Conducted in Split Lake and Clark Lake, and Spring Investigations of Adult and Larval Fish Communities in Portions of the Burntwood, Grass, and Nelson Rivers Flowing into Split Lake, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 131 pp. *Draft*.	Completed	Apr-04
02-10	Dolce, L.T. and M.A. Sotiropoulos. 2004. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected in Gull Lake and Portions of the Nelson River between Birthday Rapids and Gull Rapids, Manitoba, Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 57 pp. *Draft*.	Completed	Mar-04
02-12	Juliano, K.M. and L.J. Neufeld. 2004. Benthic Invertebrate and Sediment Data from Split Lake and Assean Lake, Manitoba, Winter 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 67 pp. *Draft*.	Completed	Dec-04
02-13	Juliano, K.M. and L.J. Neufeld. 2005. Benthic Invertebrate, Sediment, and Drifting Invertebrate Data Collected from the Gull (Keeyask) Study Area, Manitoba, Spring - Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 161 pp. *Draft*.	Completed	Jan-05
02-14	Badiou, P.H. and H.M. Cooley. 2005. Water Chemistry, Phytoplankton, and Sediment Chemistry Data for the Nelson and Assean River Systems, Manitoba, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 255 pp. *Draft*.	Completed	Feb-05
02-15	Johnson, M.W. 2005. Results of Fish Community Investigations Conducted in the Assean River Watershed, Manitoba, Spring and Fall 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 133 pp. *Draft*.	Completed	Feb-05

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
02-16	Pisiak, D.J. 2005. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba and Seasonal Investigations of Adult and Larval Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 179 pp. *Draft*.	Completed	Jan-05
02-17	Richardson, V.L. and J. Holm. 2005. Results of Fish Community Investigations Conducted in Tributary Systems of the Nelson River between Birthday Rapids and Gull Rapids, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 98 pp. *Draft*.	Completed	Jan-05
02-18	Holm, J., V.L. Richardson, and C.C. Barth. 2005. Floy-tag Application and Recapture Information from the Gull (Keeyask) Study Area, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 175 pp. *Draft*.	Completed	Feb-05
02-19	Barth, C.C. 2005. Lake Sturgeon Investigations in the Keeyask Study Area, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 131 pp. *Draft*.	Completed	Feb-05
02-20	Johnson, M.W. and C.R. Parks. 2005. Results of Fish Community Investigations Conducted in the Reach of the Nelson River between Clark Lake and Gull Rapids, 2002. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 222 pp. *Draft*.	Completed	Aug-05
03-01	Ryland, D. and B. Watts. Fish Taste Studies for Tataskweyak Cree Nation. Draft report prepared for Manitoba Hydro by the University of Manitoba. 44 pp. *Draft*.	Completed	Jan-04
03-02	Ryland, D. and B. Watts. Fish Taste Studies for Fox Lake Cree Nation. Draft report prepared for Manitoba Hydro by the University of Manitoba. 43 pp. *Draft*.	Completed	Jan-04
03-03	Maclean, B.D. and D.J. Pisiak. 2005. Results of Fish Community Investigations Conducted at the Mouth of the Ripple River, Manitoba, Spring 2003. Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 43 pp. *Draft*.	Completed	Feb-05
03-05	Badiou, P.H., H.M. Cooley, and T. Savard. 2005. Water Chemistry Data for the Lower Nelson River System, Manitoba, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 219 pp. *Draft*.	Completed	Dec-05

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
03-06	Murray, L., C.C. Barth, and J.R. Olynik. 2005. Movements of Radio- and Acoustic- Tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2002 to April 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 125 pp. *Draft*.	Completed	Aug-05
03-08	Barth, C.C. and L. Murray. 2005. Lake sturgeon Investigations in the Keeyask Study Area, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 127 pp. *Draft*.	Completed	Oct-05
03-09	Pisiak, D.J. and E.J. Hartman. 2005. Results of Fish Community Investigations Conducted in the North Moswakot and South Moswakot Rivers, Manitoba, Spring and Fall 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 157 pp. *Draft*.	Completed	Sep-05
03-11	Kroeker, D.S. and W. Jansen. 2005. Results of Fish Community Investigations Conducted in Tributaries of the Nelson River between Clark Lake and Gull Rapids, Manitoba, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 72 pp. *Draft*.	Completed	Jan-06
03-12	Maclean, B.D. and J.Holm. 2005. Results of Fish Community Investigations Conducted in the Mistuska River, Manitoba, Spring 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 90 pp. *Draft*.	Completed	Sep-05
03-13	Maclean, B.D. and D.J. Pisiak. 2005. Results of Fish Community Investigations Conducted in the Aiken River, Manitoba, Spring 2003, Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 108 pp. *Draft*.	Completed	Dec-05
03-14	Pisiak, D. 2005. Results of Summer Index Gillnetting Studies in Stephens Lake, Manitoba, and Seasonal Investigations of Fish Communities in the Reach of the Nelson River between Gull Rapids and Stephens Lake, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 313 pp. *Draft*.	Completed	Oct-05
03-15	Holm, J. 2006. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 244 pp. *Draft*.	Completed	Sep-06

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
03-16	Dolce, L. T. and M.J. Burt. 2008. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected from the Keeyask Study Area, Manitoba, Late Summer 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 111 pp. *Draft*.	Completed	Feb-08
03-17	Gill, G. 2007. Invertebrate Drift and Plant Biomass Data from the Nelson River at Birthday Rapids, Gull Lake, Gull Rapids, and Kettle Generating Station, Manitoba, Summer and Fall 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 72 pp. *Draft*.	Completed	Nov-07
03-35	Maclean, B.D. and P. Nelson. 2005. Population and Spawning Studies of Lake Sturgeon (Acipenser fulvescens) at the Confluence of the Churchill and Little Churchill Rivers, Manitoba, Spring 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 70 pp. *Draft*.	Completed	Jan-06
03-36	Bretecher, R.L., G.C. Dyck, and R.A. Remnant. 2007. Results of Fish Community Investigations Conducted in the Reach of the Nelson River Between Clark Lake and Gull Rapids (Including Gull Lake), 2003. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 275 pp. *Draft*.	Completed	Feb-07
03-37	Cooley, H.M. and M.W. Johnson. 2008. An Evaluation of Walleye Condition from Stephens Lake. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	Mar-08
04-03	Holm, J. 2005. Results of Fish Community Investigations Conducted in Clark Lake, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	28-Oct-05
04-04	Badiou, P.H., T. Savard, and H.M. Cooley. 2007. Water Chemistry and Phytoplankton data for the Lower Nelson River System, Manitoba, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 247 pp. *Draft*.	Completed	Jan-07
04-05	BARTH, C.C. and K. AMBROSE. 2006. Lake Sturgeon Investigations in the Keeyask Study Area, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 105 pp. *Draft*.	Completed	Jan-06
04-06	Cooley, H.M. and T.G. Savard. 2008. Results of Greenhouse Gas Sampling in the Keeyask and Conawapa Study Areas: 2001-2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 76 pp. *Draft*.	Completed	Feb-08

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
04-07	T. Savard and H.M. Cooley. 2007. Turbidity Monitoring Data for Clark and Gull Lakes, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 51 pp. *Draft*.	Completed	Jan-07
04-08	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 148 pp. *Draft*.	Completed	Jan-07
04-09	Johnson, M.W. 2007. Results of Fish Community Investigations Conducted in the Reach of the Nelson River Between Clark Lake and Gull Rapids (Including Gull Lake), 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 159 pp. *Draft*.	Completed	Jan-07
04-10	Johnson, M.W. and C.C. Barth. 2007. Results of Fish Community Investigations in the Kettle and Butnau Rivers, Manitoba, Spring 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 59 pp. *Draft*.	Completed	Jan-07
04-11	Holm, J., H.M. Cooley, and E. Shipley. 2007. Trace Elements in Fish from the Keeyask Study Area: Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 62 pp. *Draft*.	Completed	Feb-07
04-12	Johnson, M.W. and B.D. Maclean. 2007. Results of Fish Community Investigations Conducted in the Mistuska River, Manitoba, Spring 2004. Year II. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 87 pp. *Draft*.	Completed	Jun-07
04-13	Johnson, M.W. and B.D. Maclean. 2007. Results of Fish Community Investigations Conducted in the York Landing Arm of Split Lake and Its Major Tributaries, Manitoba, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 74 pp. *Draft*.	Completed	May-07
04-14	Pisiak, D.J. and B.D. Maclean. 2007. Population Studies of Lake Sturgeon (*Acipenser fulvescens*) in the Fox River, Manitoba, Summer 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 42 pp. *Draft*.	Completed	Apr-07
04-15	Neufeld, L. 2007. Benthic Invertebrate and Sediment, Data Collected from Littoral Zones in the Keeyask Study Area, Manitoba, Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 92 pp. *Draft*.	Completed	Apr-07
04-16	MacDonald, J.E. 2007. Results of Fish Community Investigations in Gull Rapids and Stephens Lake, 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 113 pp. *Draft*.	Completed	May-07

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
04-17	Burt, M.J. and L.T. Dolce. 2008. Aquatic Macrophyte and Associated Epiphytic Invertebrate Data Collected from the Keeyask Study Area, Manitoba, Summer 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 130 pp. *Draft*.	Completed	Feb-08
04-18	Gill, G. 2007. Invertebrate Drift and Plant Biomass Data from the Nelson River at Birthday Rapids,Gull Rapids, and Kettle Generating Station, Manitoba, Summer and Fall 2004. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 91 pp. *Draft*.	Completed	Nov-07
05-02	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 56 pp. *Draft*.	Completed	Apr-07
05-03	Murray, L. and C.C. Barth. 2007. Movements of Radio- and Acoustic-Tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2003 to August 2004 and a Summary of Findings from 2001-2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 111 pp. *Draft*.	Completed	Apr-07
05-04	Jansen, W. and N. Strange. 2007. Mercury Concentrations in Fish From the Keeyask Project Study Area for 1999-2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 168 pp. *Draft*.	Completed	Aug-07
05-05	Barth, C.C. and J.E. MacDonald. 2008. Lake Sturgeon Investigations in the Keeyask Study Area, 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 63 pp. *Draft*.	Completed	Mar-08
05-06	Mazur, K.M. and T.G. Savard. 2008. Proposed Keeyask Access Road Stream Crossing Assessment, 2004 and 2005. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 68 pp. 83 pp. *Draft*.	Completed	Feb-08
06-02	Holm, J. 2007. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 61 pp. *Draft*.	Completed	Apr-07
06-03	Savard, T. and H.M. Cooley. 2007. Dissolved Oxygen Surveys in the Keeyask Study Area: Winter 2005 and 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 54 pp. *Draft*.	Completed	Apr-07
06-04	MacDonald, J.E. 2008. Lake Sturgeon Investigations in the Keeyask Study Area, 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	Mar-08

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
06-05	Cassin, J. and R.A. Remnant. 2008. Results of Fish Spawning Investigations Conducted in Gull Rapids Creek, Pond 13, and Selected Tributaries to Stephens Lake, Spring 2005 and 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 45 pp. *Draft*.	Completed	Mar-08
06-06	MacDonald, J.E. 2007. Fish community assessments of selected lakes within the Split Lake Resource Management Area, 2004-2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 145 pp. *Draft*.	Completed	Nov-07
06-07	Jansen, W. 2008. Infection Rate of the Parasite *Triaenophorus crassus* in Lake Whitefish from the Keeyask Study Area for 2003-2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 35 pp. *Draft*.	Completed	Mar-08
06-08	Cooley, P.M. and L. Dolce. 2008. Aquatic Habitat Utilization Studies in Stephens Lake: Macrophyte Distribution and Biomass, Epiphytic Invertebrates, and Fish Catch-Per- Unit-Effort in Flooded Habitat. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 75 pp. *Draft*.	Completed	Mar-08
06-09	Cooley, P.M. 2008. Carbon dioxide and methane flux from peatland watersheds and divergent water masses in a sub-arctic reservoir. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 45 pp. *Draft*.	Completed	Mar-08
06-10	Capar, L.N. 2008. Benthic Invertebrate Data Collected from O'Neil Bay and Ross Wright Bay in Stephens Lake, Manitoba, Fall 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 34 pp. *Draft*.	Completed	Mar-08
06-11	Jansen, W. and N. Strange. 2009. Fish mercury concentrations from the Keeyask Project Study Area for 2006. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 68 pp. *Draft*.	Completed	Jul-09
06-12	Larter, J.L. and P.M. Cooley. 2010. Substratum and Depth Distribution in Flooded Habitat of Stephens Lake, Manitoba, Thirty-Five Years after Impoundment. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 57 pp. *Draft*.	Completed	Dec-10

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
06-13	Cooley, P.M., L. Dolce Blanchard, and J. Larter. 2009. The effect of local and regional watersheds on the spectral composition and attenuation of light and water quality parameters in the surface waters of Stephens Lake, Manitoba. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 51 pp. *Draft*.	Completed	May-09
08-01	MacDonald, J.E. 2009. Lake Sturgeon Investigations in the Keeyask Study Area, 2007-2008. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 116 pp. *Draft*.	Completed	Apr-09
08-02	Holm, J. 2009. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2007 and 2008. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 63 pp. *Draft*.	Completed	Apr-09
09-01	Holm, J. 2010. Results of Index Gillnetting Studies Conducted in the Keeyask Study Area, Summer 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 110 pp. *Draft*.	Completed	Oct-10
09-02	Holm, J. 2010. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 48 pp. *Draft*.	Completed	Oct-10
09-03	Michaluk, Y. and J.E. MacDonald. 2010. Lake Sturgeon Investigations in the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 83 pp. *Draft*.	Completed	Dec-10
09-04	Savard, T. S. Hnatiuk-Stewart, and H.M. Cooley. 2010. Water Quality Data for the Lower Nelson River System, Manitoba, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 240 pp. *Draft*.	Completed	Jul-10
09-05	Jansen, W. 2010. Fish Mercury Concentrations in the Keeyask Study Area, 2009. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 42 pp. *Draft*.	Completed	Dec-10
10-01	**MacDonald, J.E. and C.C. Barth.** 2011. Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 78 pp. *Draft*	Completed	Dec-10
10-02	**Michaluk, Y., J.E. MacDonald and C.C. Barth.** 2011. Results of Lake Whitefish Spawning Surveys in Ferris Bay and the North and South Moswakot Rivers, Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 51 pp. *Draft*		

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
10-03	**Henderson, L., C.C. Barth, J.E. MacDonald and S.J. Garner.** 2011. Results of a Coarse Scale Habitat Inventory in the Upper Split Lake Area, Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 75 pp. *Draft*		
10-04	**Holm, J. 2011.** Floy-tag Application and Recapture Information from the Keeyask Study Area, 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 53 pp. *Draft*		
10-05	**Ambrose, K.M. and R. Remnant.2011.** Fish Community Assessment of Armstrong Lake,2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 90 pp. *Draft*		
10-06	**MacDonald, J.E. and C.C. Barth.** 2011. Benthic Invertebrate Surveys in Gull Lake and Stephens Lakes, Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc.** 78 pp. *Draft*		
10-07	**Henderson, L.M., C.C. Barth, J.E. MacDonald and M. Blanchard.** 2011. Young-of-the-Year and Sub-Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring and Fall 2010. **Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 60 pp**. *Draft*	Completed	12/2011
11-01	Hrenchuk, C.L. and C.A. McDougall. 2012. Adult Lake Sturgeon Investigations in the Keeyask Study Area, 2011. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. 167 pp. *Draft*	**Completed**	**Dec-12**
11-04	Henderson, L.M. and D.J. Pisiak, 2012. Results of Young-of-the-Year and Sub-Adult Lake Sturgeon Investigations in the Keeyask Study Area, Spring and Fall 2011. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	**Completed**	**Dec-12**
11-05	Holm, J., 2012. Floy-tag Application and Recapture Information from the Keeyask Study Area, 2011. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. *Draft*	**Completed**	**Dec-12**
~~TBA~~	~~Ambrose, K.M. and R.A. Remnant. 2011. Results of fish community investigations in Armstrong Lake, Manitoba, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for report 10-5	

Table 1B-1: Keeyask Generation Project aquatic environment study reports

Report Number	Report Title	Status	Date Completed
~~TBA~~	~~Capar, L.N., and F. Schneider-Vieira. 2011. Results of benthic invertebrate sampling conducted in Gull and Stephens Lakes, Fall, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-6	
~~TBA~~	~~Henderson, L. M., C. C. Bart, J.E. MacDonald, and S.J. Garner. 2011. Results of a coarse scale habitat inventory in the upper Split Lake area, fall 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-3	
~~TBA~~	~~Henderson, L.M. and C.C. Barth. 2011. Young-of-the-year and subadult lake sturgeon investigations in the Keeyask Study Area, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-7	
~~TBA~~	~~Holm, J. 2011. Floy-tag application and recapture information from the Keeyask Study Area, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-4	
~~TBA~~	~~MacDonald, J.E. and C.C. Barth. 2011. Lake sturgeon investigations in the Keeyask Study Area, Spring 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-1	
~~TBA~~	~~Michaluk, Y. J.E. MacDonald, and C. C. Barth. 2011. Results of lake whitefish spawning surveys in Ferris Bay and the North and South Moswakot rivers, fall, 2010. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft*~~	Duplicate report reference for 10-2	
TBA	**McDougall, C.A., C.C. Barth, and C.L. Hrenchuk. 2013. Results of Juvenile Lake Sturgeon Movement and Habitat Utilization Studies in Stephens Lake, 2011. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft***	In preparation	
TBA	**McDougall, C.A., C.C. Barth, and C.L. Hrenchuk. 2013. Results of Juvenile Lake Sturgeon Movement and Habitat Utilization Studies in Stephens Lake, October 2011 to 2012. Draft report prepared for Manitoba Hydro by North/South Consultants Inc. *Draft***	In preparation	

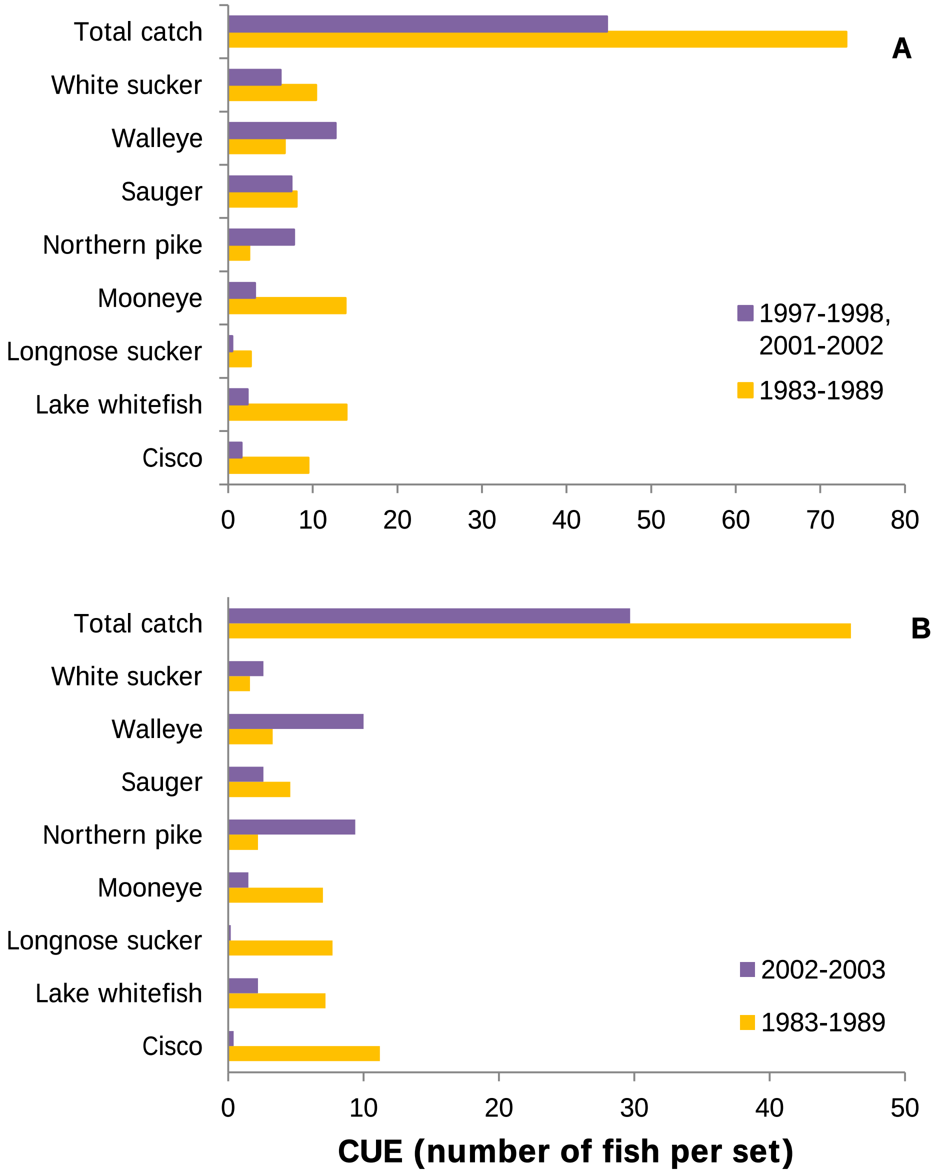


Figure 5-1: Comparison of historic (pre-1997; Ecological Monitoring Program) and recent (post-1997; Keeyask environmental studies) fish abundance in Split Lake (A) and Stephens Lake (B), as indicated by catch-per-unit-effort (CUE; number of fish/standard gang set)

1.6 TERRESTRIAL ENVIRONMENT SUPPORTING VOLUME

Chapter	Page	Current Text	Corrected Text/Clarification
Chapter 1	1-II	"Error! Bookmark not defined."	Remove this entry from the list of tables. Duplicate table number, caption does not appear in text
Chapter 1	1-7	"Figure 1.8-1"	"**Figure 1-6**"
Chapter 1	1-13	"Figure 1.8-1"	"**Figure 1-6**"
Chapter 1	1-16	"Figure 1-3 illustrates the conceptual approach... on moose."	"Figure **1-5** illustrates the conceptual approach... on moose."
Chapter 1	1-17	"Table 1.3-2"	"**Table 1-2**"
Chapter 1	1-21	"...Project operation since most Project-related changes are expected to be decline in magnitude with time."	"...Project operation since most Project-related changes are expected **to decline in magnitude** with time."
Chapter 1	1-23	"...has the key topic already experienced major stress ordeclines from events that occurred in the past?"	"...has the key topic already experienced major stress **or declines from events** that occurred in the past?"
Chapter 1	1-28	"(Map 1.7-1)"	"(**Map 1.1**)"
Chapter 2	2-5	"...defined in Table 1.4-1."	"...defined in Table **1-4**."
Chapter 2	2-6	"(*e.g.*, Figure 1.1-1),.." "...(*e.g.*, Figure 1.3-2)..." "...(*e.g.*, Figure 1.3-3)."	"(*e.g.*, Figure **1-2**),.." "...(*e.g.*, Figure **1-3**)..." "...(*e.g.*, Figure **1-4**)."
Chapter 2	2-6	"(Table 1.3-1)"	"(Table **1-1**)"
Chapter 2	2-8	"(Map 1.7-1)"	"(Map **2-1**)"
Chapter 2	2-11	"...photography from 1962, 1975, 1986,..."	"...photography from 1962, **1971**, 1986,..."
Chapter 2	2-18	"(Section 2.2.5.2)"	"(Section **2.6.2.2**)"
Chapter 2	2-19	"Land accounted for 91% of Study Zone 6..."	"Land accounted for **89%** of Study Zone 6..."
Chapter 2	2-20	"(PE SV Section 5)"	"(PE SV Section **2**)"
Chapter 2	2-34	"...see the PD SV Section 1.3)."	"...see the PD SV Section **1.4**)."
Chapter 2	2-36	"Over the 50-year period from 1967 to 2006,..."	"Over the **40-year** period from 1967 to **2008**,..."

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 2	2-36	"...were the highest in winter (3.11°C increase) and in September (1.54°C increase)."	"...were the highest in **January (0.46°C increase per decade) and in April-June (0.32-0.43°C increase per decade)**."
Chapter 2	2-36	"...with October mean precipitation decreasing 33.88 mm."	"...with **annual precipitation decreasing 3.13 mm per year**."
Chapter 2	2-40	"...Figure 2-7 to Figure 2-14."	"...Figure 2-7 to **Figure 2-15**."
Chapter 2	2-54	"Approximately 7% of Study Zone 4 burned recently (between the beginning of 2002 and end of 2011), ..."	"Approximately **8.5%** of Study Zone 4 burned recently (between the beginning of 2002 and end of 2011), ..."
Chapter 2	2-84	"(PD SV Section 2.2)"	"(PD SV Section **2.4**)"
Chapter 2	2-88	"(Table 2-12; Map 2-25)"	"(Table 2-12; Map **2-26**)"
Chapter 2	2-88	"(Map 2-25 to Map 2.13-3)"	"(**Map 2-26 to Map 2-27**)"
Chapter 2	2-89	"(Map 2-25 to Map 2.13-3)"	"(Map 2-25 to **Map 2-27**)"
Chapter 2	2-90	"(Table 2-12; Map 2-25 to Map 2-28)"	"(Table 2-12; Map 2-25 to Map **2-27**)"
Chapter 2	2-94	"As described in section 2.3.6, Project-related fire regime effects are not expected."	"As described in section **2.5.4**, Project-related fire regime effects are not expected."
Chapter 2	2-104	"(Table 2-18)"	"(Table **2-17**)"
Chapter 2	2-111	"(see Section 3.3)"	"(see Section **3.4**)"
Chapter 2	2-117	"Table Total: Overall Study area land area = 12,385 Rest of the Regional Study Area = 10,677"	"Overall Study area land area = **12,374** Rest of the Regional Study Area = **10,666**"
Chapter 2	2-121	"(Section 4.2.3)"	"(**PD SV Section 6**)"
Chapter 2	2-124	"(see Section 2.12, Table 2.12-1..."	"(see Section 2.12, Table **2-52**..."
Chapter 2	2-125 to 2-151	Page numbering set to value of "1" for all pages.	Set page numbering to run from 2-125 to 2-151
Chapter 2	2-147	"(black spruce mixture on mineral increases from 20.3% to 20.5%)"	"(black spruce **dominant on thin peatland decreases from 32.3% to 32.1%**)"
Chapter 2	2-151	"(see Section 4.2.3)"	"(see **PD SV Section 6**)"
Chapter 2	2-155	"(Section 2.3.4)"	"(Section **2.5.4**)"

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 2	2-155	"As described in Section 2.2.4.3,…"	"As described in Section **2.3.6.3**,…"
Chapter 2	2-162	"(Section 4.3)"	"(Section **2.8.3.2**)"
Chapter 2	2-165	"…Appendix 2F, Table 2 83)"	"…Appendix 2F, Table **2F-1**)"
Chapter 2	2-167	"A tall shrub band was present at upper elevations along approximately 59% of the classified shoreline, becoming wide along about 21% of the shoreline."	"A tall shrub band was present at upper elevations along approximately **69%** of the classified shoreline, becoming wide along about **24%** of the shoreline."
Chapter 2	2-167	"Marsh wetland forms included lacustrine marsh, stream marsh, riparian fen, riparian bog and shallow water (shallow water was only mapped for the Keeyask reach of the Nelson River where bathymetry data were available to separate shallow from deep water)."	"Marsh wetland forms included **lacustrine marsh and stream marsh. Other shore zone wetland forms included riparian fen, riparian bog and shallow water** (shallow water was only mapped for the Keeyask reach of the Nelson River where bathymetry data were available to separate shallow from deep water)."
Chapter 2	2-167	"(Map 2-29 to Map 2-40)"	"(**Appendix 2F, Map 2F-1 to Map 2F-13**)"
Chapter 2	2-167	"(Map 2-28 to Map 2-40)"	"(**Appendix 2F, Map 2F-1 to Map 2F-13**)"
2.8.4.1.1	p.2-181/ paragraph 4, Line 6	(EnvPPs; Section 8.3.2)	(EnvPPs; Response to EIS Guidelines Section 8.3.2)
Chapter 2	2-181	"An additional 1,604 ha could be indirectly affected in the wetland zone of influence, which could increase the total Project effects to 0.7% of wetland habitat in the Regional Study Area."	"An additional 1,604 ha could be indirectly affected in the wetland zone of influence, which could increase the total Project effects to **7,765 ha, or 0.7%**, of wetland habitat in the Regional Study Area."
Chapter 2	2-181	"Table 2-46"	"Table **2-47**"
Chapter 2	2-182	This table should have been the analogue to Table 2-36 in the Ecosystem Diversity section (Section 2.7).	Replace with the Table 2-46 provided below.
Chapter 2	2-183	"1.7"	"**0.0**"

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 2	2-183	Last row of table is missing.	Replace with the Table 2-47 provided below.
Chapter 2	2-185	"(Response to EIS Guidelines Chapter 4 Section 4.2.3)"	"(Response to EIS Guidelines Chapter 4 Section **4.3.3**)"
Chapter 2	2-187	This table should have been the analogue to Table 2-37 in the Ecosystem Diversity section (Section 2.7).	Replace with the Table 2-48 provided below.
Chapter 2	2-185	"...between 0.2% and 2.4% of estimated historical area for the remaining wetland types."	"...between 0.2% and **1.3%** of estimated historical area for the remaining wetland types **(Table 2 46)**."
Chapter 2	2-185	"...to between 3.0% and 6.2% of estimated historical area."	"...to between 3.0% and 6.2% of estimated historical area **(Table 2 48).**"
Chapter 2	2-186	"The decrease in length over the expansion period would be due to decreased shoreline shape complexity."	"The decrease in length over the expansion period would be due to **peninsulas and islands disappearing and** decreased shoreline shape complexity."
Chapter 2	2-186	"...wetland quality scores lower than 20."	"...wetland quality scores lower than 20 **(Table 2-47)**."
Chapter 2	2-186 / paragraph 3, line 2	"Table 2-48"	"Table **2-46**"
Chapter 2	2-186	"...wetland quality scores lower than 20."	"...wetland quality scores lower than 20 **(Table 2-47)**."
Chapter 2	2-186 / paragraph 6, line 4	"Table 2-48"	"Table **2-46**"
Chapter 2	2-186 / paragraph 7, line 2	"Table 2-47"	"Table **2-46**"
Chapter 2	2-187 / Table 2-48	This table should have been the analogue to Table 2-37 in the Ecosystem Diversity section (Section 2.7).	Replace with the Table 2-48 provided below.

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 2	2-188	"...between 0.2% and 1.6% of estimated historical area for the remaining wetland types."	"...between 0.2% and 1.6% of estimated historical area for the remaining wetland types **(Table 2-46)**."
Chapter 2	2-188	"...to between 1.7% and 6.5% of estimated historical area."	"...to between 1.7% and 6.5% of estimated historical area **(Table 2-48)**."
Chapter 2	2-194	"(Section 2.2.4)"	"(**TE SV Section 2.3.3**)"
Chapter 2	2-233	"Nelson River Marsh"	This legend item groups three coarse habitat types that should be shown as separate colors on the map: "**Nelson River shrub and / or low vegetation on upper beach"; "Nelson River shrub and / or low vegetation on sunken peat"; and "Nelson River marsh"**
Chapter 2 Appendices 2D to G	Page footer	"Section 3: Plants"	"**Section 2: Habitat and Ecosystems**"
Chapter 3	3-6	"The 55 km^2 Local Study Area..."	"The **187 km^2** Local Study Area..."
Chapter 3	3-15	"Based on the species distribution and abundance classes (Table 3-2), no species were very widespread and very abundant in the inland plots while 168 species were localized and scarce (**Error! Reference source not found.**). No species were widespread or very widespread in the shoreline wetland transects while 17 species were scattered."	"Based on the species distribution and abundance classes (Table 3-2), no species were very widespread and very abundant in the inland plots while **158** species were localized and scarce (Table 3-3). No species were widespread or very widespread in the shoreline wetland transects while **11 species** were scattered."
Chapter 3	Table 3-3	"Shoreline Wetland Transects: Scattered=17, Localized = 236"	"Shoreline Wetland Transects: Scattered=**11**, Localized=**169**"
Chapter 3	3-16	"Drafting note under table caption."	***Remove this drafting note.***

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 3	3-18	"No taxa were widespread or very widespread in the shoreline wetland transects."	"**The shoreline wetland descriptive results were estimated using the species that were present in at least one quadrat in both transects. No taxa were widespread or very widespread in the shoreline wetland transects**."
Chapter 3	3-19		Add following sentence to the end of last paragraph: "**Table 3-4 identifies the plant species typically found in each of the water duration zones, as well as variations related to substrate type and water regime zone."**
Chapter 6	6B-1	"Table 6B-4: Bird Species Potentially Using the Bird Regional Study Area"	"Table 6B-**1**: Bird Species Potentially Using the Bird Regional Study Area"
Chapter 7	7-4	Table 7-1: "Zone 5**: 14,160** km²"	"Zone 5: **14,200** km²"
Chapter 7	7-9	"The total amount of physical habitat lost (area of physical habitat falling within Zone 1) was calculated…"	"The total amount of physical habitat lost (area of physical habitat falling within Zone **2**) was calculated…"
Chapter 7	7-61	"Winter range tends to be smaller, a fraction of that occupied in summer (Brown *et al*. 2000)"	"**Summer** range tends to be smaller, a fraction of that occupied in **winter** (Brown *et al*. 2000)."
Chapter 7	7-69	"Summer Resident Caribou Habitat Models"	"**Caribou Habitat Models**"
Chapter 7	7-69	"...or peatland complexes greater than 2,000 ha"	"... or peatland complexes greater than **200** ha."

1.6.1.1 Corrected Tables and Figures

Table 2-46. Wetlands Affected During Construction and Operation by Wetland Type as a Percentage of Regional Study Area

Wetland Type	Regional Study Area		Construction Period			Operation Period	
	Total Estimated Area[1] (ha)	Total Estimated Percentage[1] (%)	Project Footprint (%)	Habitat Zone of Influence (%)	After Mitigation (%)	Project Footprint at Year 30 (%)	Net Habitat Affected at Year 30[2] (%)
Non-regulated Types							
Bay Lacustrine Marsh	*426*	*0*	*1.5*	*1.6*	*0*	*1.4*	*0*
Stream Riparian Marsh	*108*	*0*	*1.9*	*2.4*	*0*	*1.9*	*0*
Flat Swamp	*4*	*0*	-	-	-	-	-
Shore and floating Riparian Fen	*32,033*	*2.9*	*0.6*	*0.7*	*0.7*	*0.6*	*0.8*
Northern ribbed, ladder or net String Fen	*155*	*0*	-	-	-	-	-
Basin Fen	*12*	*0*	-	-	-	-	-
Collapse scar Fen	*76*	*0*	-	-	-	-	-
Horizontal Fen	*48,260*	*4.4*	*0.3*	*0.4*	*0.4*	*0.3*	*0.4*
Slope Fen	*2,106*	*0.2*	*0.5*	*0.6*	*0.6*	*0.6*	*0.8*
Horizontal and blank Fen/ Bog mixture	*2,549*	*0.2*	-	-	-	-	-
Shore and floating Riparian Bog	*2,073*	*0.2*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*
Peat plateau Bog	*60,951*	*5.6*	*0.6*	*0.7*	*0.7*	*0.6*	*0.7*
Slope Bog	*18,041*	*1.6*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*
Collapse scar (CS) Bog	*1,806*	*0.2*	*1.2*	*1.3*	*1.3*	*1.3*	*1.6*
Flat Bog	*7,526*	*0.7*	*0.6*	*0.6*	*0.6*	*0.6*	*0.6*
Blanket Bog/ CS mixture Bog	*17,188*	*1.6*	-	-	-	-	-
Peat plateau/CS mixture Bog	*122,256*	*11.1*	*0.5*	*0.6*	*0.6*	*0.5*	*0.7*
Veneer Bog	*31,596*	*2.9*	*0.3*	*0.4*	*0.4*	*0.3*	*0.4*

Table 2-46. Wetlands Affected During Construction and Operation by Wetland Type as a Percentage of Regional Study Area

Wetland Type	Regional Study Area		Construction Period			Operation Period	
	Total Estimated Area[1] (ha)	Total Estimated Percentage[1] (%)	Project Footprint (%)	Habitat Zone of Influence (%)	After Mitigation (%)	Project Footprint at Year 30 (%)	Net Habitat Affected at Year 30[2] (%)
Blanket Bog	*258,612*	*23.6*	*0.5*	*0.7*	*0.7*	*0.5*	*0.7*
Strongly sloped Veneer Bog	*485,117*	*44.2*	*0.6*	*0.7*	*0.7*	*0.5*	*0.8*
Regulated Types[3]							
Nelson River shore zone wetland	*6,156*	*n/a*	*388*	*441*	*441*	*0*	*0*
Total mapped wetland area	*1,097,026*	100	6,161	7,765	7,765	6,164	8,276

Notes: [1] Net wetland area affected at Year 30 is after predicted reservoir expansion, Project-related indirect effects (*e.g.*, edge and groundwater effects) and habitat recovery from habitat rehabilitation and natural regeneration. [2] Extrapolated from Study Zone 4 values using method described in Section 2.2.4.4. Nelson River shoreline wetland habitat composition was not extrapolated from Study Zone 4 to the Regional Study Area due to the large differences in the Nelson River water regimes along the river reaches. . [3] Areas provided because percentages were not calculated for Nelson River wetlands since these areas were not extrapolated from Study Zone 4 to the Regional Study Area as per previous footnote.

Table 2-47: Wetland Quality Types Affected During Construction and Operation as a Percentage of Area in Regional Study Area

Wetland Quality Score Class	*Total Estimated Regional Study Area (ha)*	Existing Percentage of Regional Study Area (%)	Construction Period			Operation Period	
			Project Footprint (%)	Habitat Local Study Area (%)	After Mitigation	Year 30 After Construction Mitigation, Reservoir Expansion and Habitat Recovery	Habitat Local Study Area, Reservoir Expansion and Habitat Recovery
60	*534*	0.0	1.6	1.7	0.0	1.5	0.0
50	*32,033*	2.9	1.2	1.3	1.3	1.2	1.4
40	*1,268*	0.1	0.6	0.6	0.6	0.6	0.6
30	*55,434*	5.1	0.7	0.7	0.7	0.7	0.8
20	*259,412*	23.6	0.7	0.8	0.8	0.7	0.9
10	*748,345*	68.2	0.9	1.0	1.0	0.9	1.1
All	***1,097,026***	**100.0**	***6,161***	***7,765***	***7,756***	***6,155***	***8,276***

Note: Reported areas are land area only.

Table 2-48: Wetland Habitat Affected During Construction and Operation Including Cumulative Historical Effects as a Percentage of Historical Area in Regional Study Area

Non-regulated wetland type	Total Estimated Historical Regional Study Area (ha)	Estimated Percentage of Historical Regional Study Area Wetlands (%)	Construction Period			Operation Period	
			Project Footprint (%)	Habitat Zone of Influence (%)	After Mitigation (%)	Project Footprint at Year 30 (%)	Net Habitat Affected at Year 30[1] (%)
Bay Lacustrine Marsh	*426*	0.0	3.2	3.3	3.3	3.1	1.7
Stream Riparian Marsh	*108*	0.0	3.6	4.1	4.1	3.6	1.7
Flat Swamp	*4*	0.0	n/a	n/a	n/a	n/a	n/a
Shore and floating Riparian Fen	*33,017*	2.9	5.3	5.4	5.4	5.3	5.5
Slope Fen	*2,175*	0.2	5.4	5.5	5.5	5.5	5.7
Northern ribbed, ladder or net String Fen	*160*	0.0	n/a	n/a	n/a	n/a	n/a
Basin Fen	*12*	0.0	n/a	n/a	n/a	n/a	n/a
Collapse scar Fen	*79*	0.0	n/a	n/a	n/a	n/a	n/a
Horizontal Fen	*49,648*	4.4	4.8	4.9	4.9	4.8	4.9
Horizontal and blank Fen/ Bog mixture	*2,571*	0.2	n/a	n/a	n/a	n/a	n/a
Shore and floating Riparian Bog	*2,139*	0.2	5.3	5.3	5.3	5.3	5.3
Peat plateau Bog	*62,949*	5.6	5.4	5.5	5.5	5.4	5.6

Table 2-48: Wetland Habitat Affected During Construction and Operation Including Cumulative Historical Effects as a Percentage of Historical Area in Regional Study Area

Non-regulated wetland type	Total Estimated Historical Regional Study Area (ha)	Estimated Percentage of Historical Regional Study Area Wetlands (%)	Construction Period			Operation Period	
			Project Footprint (%)	Habitat Zone of Influence (%)	After Mitigation (%)	Project Footprint at Year 30 (%)	Net Habitat Affected at Year 30[1] (%)
Slope Bog	*18,533*	1.6	4.5	4.6	4.6	4.5	4.6
Collapse scar (CS) Bog	*1,866*	0.2	6.1	6.2	6.2	6.3	6.5
Flat Bog	*7,770*	0.7	5.4	5.5	5.5	5.5	5.5
Blanket Bog/ CS Mixture Bog	*17,428*	1.5	n/a	n/a	n/a	n/a	n/a
Peat plateau bog/CS mixture Bog	*125,986*	11.2	5.2	5.3	5.3	5.2	5.4
Veneer Bog	*31,871*	2.8	2.9	3.0	3.0	2.9	3.0
Blanket Bog	*266,368*	23.6	5.1	5.3	5.3	5.2	5.3
Strongly sloped Veneer Bog	*497,669*	44.2	4.8	5.0	5.0	4.8	5.0

Notes: [1] Net habitat affected at Year 30 is after predicted reservoir expansion, Project-related indirect effects (*e.g.*, edge and groundwater effects) and habitat recovery from habitat rehabilitation and natural regeneration. Habitat types with values of "n/a" are types with no expected project effects, and are not considered in the cumulative effects analysis.

Table 6B-1: Bird Species[1] Potentially Using the Bird Regional Study Area

Scientific Name	Common Name	Status[2]	Observed Using the Study Area
Loons			
Gavia pacifica	Pacific Loon	M	✓
Gavia immer	Common Loon	B	✓
Grebes			
Podilymbus podiceps	Pied-billed Grebe	B	
Podiceps auritus	Horned Grebe	B?	✓
Podiceps grisegena	Red-necked Grebe	B	✓
Pelicans and Cormorants			
Pelecanus erythrorhynchos	American White Pelican	B?,N	✓
Phalacrocorax auritus	Double-crested Cormorant	B,N	✓
Herons and Bitterns			
Botaurus lentiginosus	American Bittern	B	
Ardea herodias	Great Blue Heron	B	✓
Swans			
Cygnus columbianus	Tundra Swan	M	✓
Geese			
Anser albifrons	Greater White-fronted Goose	M	
Anser caerulescens	Snow Goose	M	✓
Anser rossii	Ross's Goose	M	
Branta canadensis	Canada Goose	B	✓
Ducks			
Anas crecca	Green-winged Teal	B	✓
Anas rubripes	American Black Duck	B	✓
Anas platyrhynchos	Mallard	B	✓
Anas acuta	Northern Pintail	B	✓
Anas discors	Blue-winged Teal	B	✓
Anas clypeata	Northern Shoveller	B	✓
Anas strepera	Gadwall	B,N	✓
Anas americana	American Wigeon	B	✓
Aythya valisinerina	Canvasback	B?,N	
Aythya americana	Redhead	B?,N	
Aythya collaris	Ring-necked Duck	B	✓

Table 6B-1: Bird Species[1] Potentially Using the Bird Regional Study Area

Scientific Name	Common Name	Status[2]	Observed Using the Study Area
Aythya marila	Greater Scaup	M	✓
Aythya affinis	Lesser Scaup	B	✓
Somateria mollissima	Common Eider	M	
Melanitta nigra	Black Scoter	M	✓
Melanitta perspicillata	Surf Scoter	M	✓
Melanitta fusca	White-winged Scoter	B	✓
Bucephala clangula	Common Goldeneye	B	✓
Bucephala albeola	Bufflehead	B	✓
Lophodytes cucullatus	Hooded Merganser	B	✓
Mergus merganser	Common Merganser	B	✓
Mergus serrator	Red-breasted Merganser	B	✓
Gulls and Terns			
Stercorarius parasiticus	Parasitic Jaeger	B?	
Larus philadelphis	Bonaparte's Gull	B	✓
Larus delawarensis	Ring-billed Gull	B	✓
Larus argentatus	Herring Gull	B	✓
Sterna caspia	Caspian Tern	B	✓
Sterna hirundo	CommonTern	B	✓
Sterna paradisaea	Arctic Tern	M	✓
Chlidonias niger	Black Tern	B?	✓
Accipters (Hawks and Eagles)			
Pandion haliaetus	Osprey	B	✓
Haliaeetus leucocephalus	Bald Eagle	B	✓
Circus cyaneus	Northern Harrier	B	✓
Accipiter striatus	Sharp-shinned Hawk	B	✓
Accipiter gentilis	Northern Goshawk	P	✓
Buteo jamaicensis	Red-tailed Hawk	B	✓
Buteo lagopus	Rough-legged Hawk	M	
Aquila chrysaetos	Golden Eagle	B,M	✓
Falcons			
Falco sparverius	American Kestrel	B	
Falco columbarius	Merlin	B	✓
Falco peregrinus anatum	Peregrine Falcon	M	

Table 6B-1: Bird Species[1] Potentially Using the Bird Regional Study Area

Scientific Name	Common Name	Status[2]	Observed Using the Study Area
Falco rusticolus	Gyrfalcon	W?	
Owls			
Bubo virginianus	Great Horned Owl	P	✓
Nyctea scandiaca	Snowy Owl	M,W	✓
Surnia ulula	Northern Hawk-Owl	P	✓
Strix nebulosa	Great Gray Owl	P	✓
Asio otus	Long-eared Owl	B	✓
Asio flammeus	Short-eared Owl	B	✓
Aegolius funerus	Boreal Owl	P	✓
Upland Gamebirds			
Dendragapus canadensis	Spruce Grouse	P	✓
Lagopus lagopus	Willow Ptarmigan	W	✓
Bonasa umbellus	Ruffed Grouse	P	✓
Tympanuchus phasianellus	Sharp-tailed Grouse	P	✓
Rails and Cranes			
Coturnicops noveboracensis	Yellow Rail	B	
Porzana carolina	Sora	B	✓
Fulica americana	American Coot	B	
Grus canadensis	Sandhill Crane	B	✓
Shorebirds			
Pluvialis squatarola	Black-bellied plover	M	
Pluvialis dominica	Lesser golden-Plover	M	
Charadrius semipalmatus	Semipalmated Plover	M	
Charadrius vociferus	Killdeer	B	✓
Tringa melanoleuca	Greater Yellowlegs	B	✓
Tringa flavipes	Lesser Yellowlegs	B	✓
Tringa solitaria	Solitary Sandpiper	B	✓
Actitis macularia	Spotted Sandpiper	B	✓
Limosa haemastica	Hudsonian Godwit	M	
Arenaria interpres	RuddyTurnstone	M	
Calidris conutus	Red Knot	M	
Calidris alba	Sanderling	M	

Table 6B-1: Bird Species[1] Potentially Using the Bird Regional Study Area

Scientific Name	Common Name	Status[2]	Observed Using the Study Area
Calidris pusilla	Semipalmated Sandpiper	M	
Calidris minutilla	Least Sandpiper	M	
Calidris fuscicollis	White-rumped Sandpiper	M	
Calidris bairdii	Baird's Sandpiper	M	
Calidris melanotos	Pectoral Sandpiper	M	
Calidris alpina	Dunlin	M?	
Limnodromus griseus	Short-billed Dowitcher	B?	
Gallinago gallinago	Wilson's Snipe*	B	✓
Phalaropus lobatus	Red-necked Phalarope	M	
Nighthawks			
Chordeiles minor	Common Nighthawk	B	✓
Hummingbirds			
Archilochus colubris	Ruby-throated Hummingbird	B,N	
Kingfishers			
Cerlye alcyon	Belted Kingfisher	B	✓
Woodpeckers			
Sphyrapicus varius	Yellow-bellied Sapsucker	B	✓
Picoides pubescens	Downy Woodpecker	P	✓
Picoides villosus	Hairy Woodpecker	P	✓
Picoides tridactylus	Three-toed Woodpecker	P	✓
Picoides arcticus	Black-backed Woodpecker	P	✓
Colaptes auratus	Northern Flicker	B	✓
Dryocopus pileatus	Pileated Woodpecker	P	
Passerines			
Contopus borealis	Olive-sided Flycatcher	B	✓
Empidonax flaviventris	Yellow-bellied Flycatcher	B	✓
Empidonax alnorum	Alder Flycatcher	B	✓
Empidonax minimus	Least Flycatcher	B	✓
Sayornis phoebe	Eastern Phoebe	B	
Tyrannus tyrannus	Eastern Kingbird	B	
Eremophila alpestris	Horned Lark	B?,W	
Tachycineta bicolor	Tree Swallow	B	✓

Table 6B-1: Bird Species[1] Potentially Using the Bird Regional Study Area

Scientific Name	Common Name	Status[2]	Observed Using the Study Area
Riparia riparia	Bank Swallow	B	✓
Hirundo pyrrhonota	Cliff Swallow	B	✓
Hirundo rustica	Barn Swallow	B	
Perisoreus canadensis	Gray Jay	P	✓
Pica pica	Black-billed Magpie	P	
Corvus brachyrhynchos	American Crow	P	✓
Corvus corax	Common Raven	P	✓
Parus hudsonicus	Boreal Chickadee	P	✓
Sitta canadensis	Red-breasted Nuthatch	P	✓
Troglodytes troglodytes	Winter Wren	B	✓
Regulus satrapa	Golden-crowned Kinglet	B	✓
Regulus calendula	Ruby-crowned Kinglet	B	✓
Catharus minimus	Gray-cheeked Thrush	M	✓
Catharus ustulatus	Swainson's Thrush	B	✓
Catharus guttatus	Hermit Thrush	B	✓
Turdus migratorius	American Robin	B	✓
Anthus spinoletta	Water Pipit	M	✓
Bombycilla garrulus	Bohemian Waxwing	B	
Bombycilla cedrorum	Cedar Waxwing	B	✓
Lanius excubitor	Northern Shrike	M	
Moqueur roux	Brown Thrasher	B?	
Certhia americana	Brown Creeper	B	✓
Sturnus vulgaris	European Starling	B, I	
Vireo solitarius	Blue-headed Vireo	B	✓
Vireo philadelphicus	Philadelphia Vireo	B	
Vireo olivaceus	Red-eyed Vireo	B	✓
Vermivora peregrina	Tennessee Warbler	B	✓
Vermivora celata	Orange-crowned Warbler	B	✓
Dendroica petechia	Yellow Warbler	B	✓
Dendroica magnolia	Magnolia Warbler	B	✓
Dendroica tigrina	Cape May Warbler	B	✓
Dendroica coronata	Yellow-rumped Warbler	B	✓
Dendroica fusca	Blackburnian Warbler	B	✓

Table 6B-1: Bird Species[1] Potentially Using the Bird Regional Study Area

Scientific Name	Common Name	Status[2]	Observed Using the Study Area
Dendroica palmarum	Palm Warbler	B	✓
Dendroica castanea	Bay-breasted Warbler	B	✓
Dendroica striata	Blackpoll Warbler	B	✓
Mniotilta varia	Black-and-white Warbler	B	✓
Seiurus aurocapillus	Ovenbird	B	✓
Seiurus noveboracensis	Northern Waterthrush	B	✓
Wilsonia pusilla	Wilson's Warbler	B	✓
Pheucticus ludovicianus	Rose-breasted Grosbeak	B	✓
Spizella arborea	American Tree Sparrow	B	✓
Spizella passerina	Chipping Sparrow	B	✓
Spizella pallida	Clay-colored Sparrow	B?,N	✓
Pooecetes gramineus	Vesper Sparrow	B	
Passerculus sandwichensis	Savannah Sparrow	B	✓
Ammodramus leconteii	Le conte's Sparrow	B	✓
Passerella iliaca	Fox Sparrow	B	✓
Melospiza melodia	Song Sparrow	B	✓
Melospiza lincolnii	Lincoln's Sparrow	B	✓
Melospiza georgiana	Swamp Sparrow	B	✓
Zonotrichia albicollis	White-throated Sparrow	B	✓
Zonotrichia leucophrys	White-crowned Sparrow	B	✓
Zonotrichia querula	Harris's Sparrow	M	
Junco hyemalis	Dark-eyed Junco	B	✓
Calcarius lapponicus	Lapland Longspur	M	
Calcarius pictus	Smith's Longspur	M	
Plectophenax nivalis	Snow Bunting	M	✓
Agelaius phoeniceus	Red-Winged Blackbird	B	✓
Euphagus carolinus	Rusty Blackbird	B	✓
Quiscalus quiscula	Common Grackle	B	✓
Pinicola enucleator	Pine Grosbeak	P	✓
Loxia curvirostra	Red Crossbill	P	✓
Loxia leucoptera	White-winged Crossbill	P	✓
Carduelis flammea	Common Redpoll	P	✓
Carduelis hornemanni	Hoary Redpoll	M,W	

Table 6B-1: Bird Species[1] Potentially Using the Bird Regional Study Area

Scientific Name	Common Name	Status[2]	Observed Using the Study Area
Carduelis pinus	Pine Siskin	B?,N	
Passer domesticus	House Sparrow	B,I	
TOTAL SPECIES OBSERVED IN REGIONAL STUDY AREA			129

[1]Birds known or likely to occur within the study area

[2]Note: B = breeding, M = migrant, P = permanent resident, N = northern extent of range, W = winter range, I = introduced, ? = unknown; appropriate habitat uncertain

[3]Bird Surveys from 2001 to 2010

Source: Godfrey 1986; Manitoba Naturalists Society 2003

1.7 SOCIO-ECONOMIC ENVIRONMENT, RESOURCE USE AND HERITAGE RESOURCES SUPPORTING VOLUME

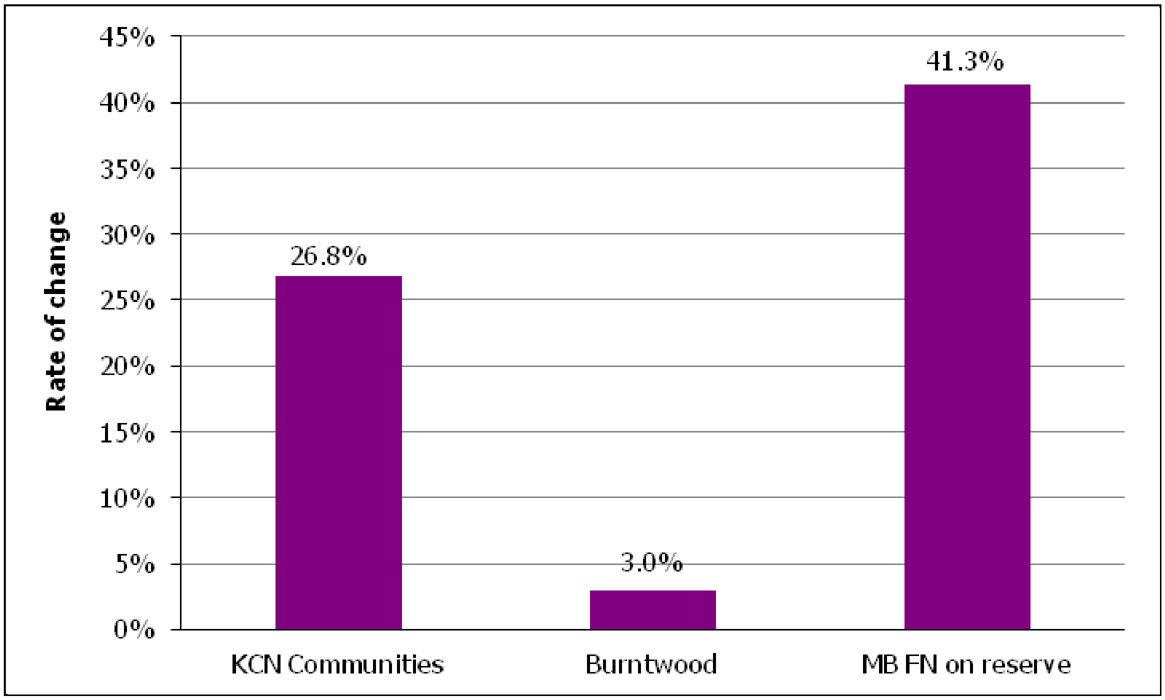
1.7.1 Part 1 – Socio-Economic Environment

Chapter	Page	Current Text	Corrected Text/Clarification
Chapter 5	5-viii	Table 5-30 is listed twice	Delete second reference; there is only 1 Table 5-30
Chapter 5	5-62	Figure 5-11 was the incorrect figure	See attached replacement figure below
Chapter 5	5-64	Figure 5-12 was the incorrect figure	See attached replacement figure below
Chapter 5	5-81	"While diseases of the circulatory system were the leading cause of all KCNs resident deaths, when only premature deaths (those that occurred before age 75) were reviewed, there are different trends. Injury and poisoning, which are almost totally preventable, accounted for 2,254 or 48% of all PYLL between 1980 and 2005. Diseases of the circulatory system was second accounting for 12% of PYLL and unknown causes were third accounting for 11% of PYLL. This shows that while diseases of the circulatory system account for the most deaths and are very important, many of these deaths occur at an older age and may not be preventable. Injury deaths however, impact younger residents and are preventable for the most part (see Figure 5-26 and Table 5-9) which lists all causes of death presented in the category of "other" in the pie chart)."	"**Diseases of the circulatory system was second, accounting for 12% of PYLL and unknown causes were third, accounting for 11% of PYLL (see Figure 5-26). This shows that while diseases of the circulatory system account for the most deaths and are very important, many of these deaths occur at an older age and may not preventable. Injury deaths however, tend to impact younger residents (which is why the number of PYLL are high) and are preventable for the most part (see Table 5-9 which lists all causes of death presented in the category of "other" in the pie chart) and shows that 11 classifications of disease accounted for less than half the PYLL as seen in the one category of injury and poisoning**."

Chapter 5	5-139	"Average annually daily traffic volumes for PR 280 as shown on Table 5-17 range between…."	"Average annually daily traffic volumes for PR 280 as shown on Table **<u>5-16</u>** range between…." *Note: revised traffic sections are being filed as a Supplementary Filing.*
Chapter 5	5-216	"As shown in Table 5-25, as compared to Table 5-26 (existing conditions)"	"As shown in Table 5-25, as compared to Table **<u>5-10</u>** (existing conditions)"
Chapter 5	5-217	"As shown in Table 5-26 as compared to Table 5-27 (existing conditions)"	"As shown in Table 5-26 as compared to Table **<u>5-11</u>** (existing conditions)"
Chapter 5	5-239 5-240 5-241	"Table 5-31: Summary of Operation Phase Effects on Valued Environmental Components for Personal, Family and Community Life"	"Table **<u>5-30</u>**: Summary of Operation Phase Effects on Valued Environmental Components for Personal, Family and Community Life"

1.7.1.1 Corrected Tables and Figures

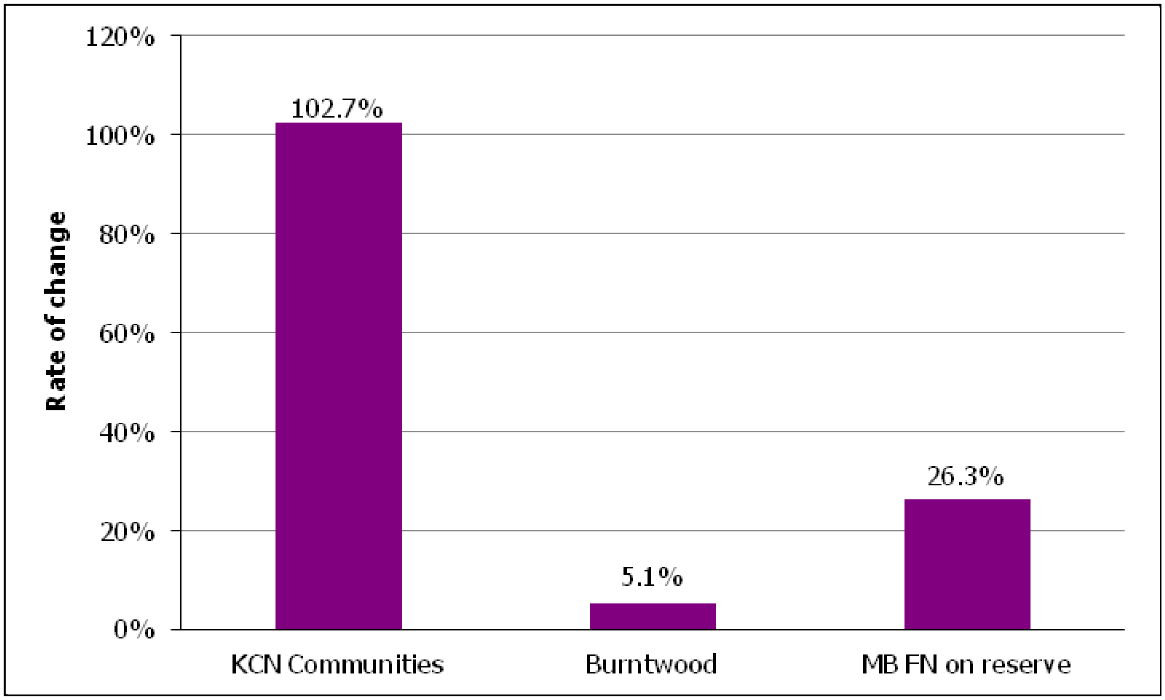
SE SV – Section 5.3.2.1.4 – Replacement Figure Pg 5-62



Manitoba Health, special data run 2011.
Note: KCN communities include Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation and Fox Lake Cree Nation

Figure 5-11: Percentage Change in Numbers of Hospitalizations for Diabetes (1984-1988 and 2002-2006)

pg. 5-64 – replacement figure



Source: Manitoba Health, special data run 2011.
Note: KCN communities include Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation and Fox Lake Cree Nation

Figure 5-12: Percentage Change in Number of Hospitalizations for Injuries (1984-1988 and 2002-2006) Averages

1.7.2 Part 2 – Resource Use

Corrections to the Keeyask Generation Project, Environmental Impact Statement, Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume, Part 2 – Resource Use are as follows. Subsequent to filing of the Keeyask Generation Project Environmental Impact Statement by the Keeyask Hydropower Limited Partnership, a calculation error in the Commercial Forestry Study was found that over estimates the amount of standing timber in the Commercial Forest Zone (FMU 86). The error in volume calculation for cutting class 1 and 2 stands was the result of an error in mid-age calculations. The mid-age reference formula erroneously used the values in the crown closure column in the spreadsheet lookup formula whereas the value in the cutting class column should have been used. This then also affected the Forest Damage Appraisal and Valuation calculations and overestimated the amount payable by Manitoba Hydro to Manitoba Conservation and Water Stewardship.

Chapter	Page	Current Text	Corrected Text / Clarification
Chapter 1	1-14	Reference to Map 1-1 is incorrect	"As noted above, previous archaeological investigations accounted for 42 sites, for a total of 162 sites within the Regional Study Area (**Table 1-1**)"
Chapter 1	1-28	"Of the 50 archaeological sites recorded within Core Study Area 28% were affiliated with Pre-European Contact culture period (n=29). Nine sites (19%) were related to the Historic Period and…."	"Of the 50 archaeological sites recorded within **the** Core Study Area **58%** were affiliated with **the** Pre-European Contact culture period (n=29). Nine sites (**18%**) were related to the Historic Period and…."
Chapter 1	1-30	Duplicate Figure	DELETE figure 1-17 on pg. 1-30 as this figure already appears on pg. 1-31

Chapter	Page	Current Text	Corrected Text/Clarification
Chapter 1	1-82	"Effects on standing timber in FMU 86 as a result of the Project Footprint are shown in Table 1-8. An estimated total of 40,859 m3 (0.63%) of softwood and 5,293 m3 (0.54%) of hardwood will be affected by the Project for a combined total of 46,152 m3 (0.62%). This is less than 1% of the total standing timber within the FMU. Some of this wood volume may be of sufficient size and concentration to make it practical to salvage."	"Effects on standing timber in FMU 86 as a result of the Project Footprint are shown in Table 1-8. An estimated total of **27,239 m^3 (0.42%)** of softwood and **3,301 m^3 (0.34%)** of hardwood will be affected by the Project for a combined total of **30,540 m^3 (0.41%)**. This is less than **0.5%** of the total standing timber within the FMU. Some of this wood volume may be of sufficient size and concentration to make it practical to salvage."
Chapter 1	1-84	"The resultant FDA&V indicates the estimated compensation payable to be $298,011.75. The calculation includes effects of construction and operation phases of the development."	"The resultant FDA&V indicates the estimated compensation payable to be **$198,590.21**. The calculation includes effects of construction and operation phases of the development."

1.7.2.1 Corrected Tables and Figures

Table 1-8: Project Effect on Standing Timber within FMU 86 (CFZ)

Pre-Project Standing Timber Gross Merchantable[1] in FMU 86 (m^3)			Project Effect on Standing Timber Gross Merchantable (m^3)			Project Effect (%)		
Soft wood	Hard wood	Total	Soft wood	Hard wood	Total	Soft wood	Hard wood	Total
6,450,518	975,391	7,425,909	27,239	3,301	30,540	0.42	0.34	0.41

[1] Gross Merchantable Volume does not consider operational constraints or cull factors. Gross Merchantable volume was used in the FDA&V.

Table 1-10: Project Forest Damage Appraisal and Valuation Summary ($)

Plantation Cost	Softwood Dues	Hardwood Dues	Forest Renewal Charge	Fire Protection Charge	Total Valuation
0.00	31,325.40	3,795.69	158,277.31	5,191.81	198,590.21

Plantation establishment cost $882.35/ha; FRC = forest renewal charge (softwood = $5.75/m^3, hardwood = $0.50/m^3); FPC = forest protection charge ($0.17/m^3); Considers Gross Merchantable Volume which does not consider operational constraints or cull factors (Manitoba, Government of 2002).

Table 1D-2: Project Footprint Gross Merchantable Volume (m^3) within the CFZ Subject to Valuation

Softwood	Hardwood	Total
27,239.5	3,300.6	30,540.1

Notes:
Project Footprint falls entirely within open Crown land (ownership code =1)

Table 1D-3: Project Footprint Gross Merchantable Volume Valuation ($)

Softwood	Hardwood	Total
31,325.40	3,795.69	35,121.09

Notes:
Based on timber dues as per Table 1C-1, Appendix 1C

Table 1D-4: Project Footprint within CFZ Forest Renewal Charge Valuation ($)

Softwood	Hardwood	Total
156,627.01	1,650.30	158,277.31

Notes:
Based on 2009 Softwood forest renewal charge of $5.75/m^3.

Table 1D-5: Project Footprint within the CFZ Fire Protection Cost Valuation ($)

Softwood	Hardwood	Total
4,824.97	366.84	5,191.81

Notes:
Based on Forest Protection Charge of $0.17/m^3.

Table 1D-6: Crown Land Forest Damage Appraisal and Valuation Summary

Total Area (ha)	Total Softwood (m^3)	Total Hardwood (m^3)	Soft-wood Dues ($)	Hard-wood Dues ($)	FRC Charge ($)	FP Charge ($)	Total Valuation ($)
783	27,239.5	3,300.6	31,325.40	3,795.69	158,277.31	5,191.81	198,590.21

Notes:
FRC- Forest Renewal Charge; FP- Forest Protection Charge

Table 1E-2: Standing Timber Volume Affected during the Construction Phase of the Project

		Cover Type			
Cutting Class	**Working Group**	**M**	**N**	**S**	**Total (m^3)**
0	Softwood	0.0	0.0	0.0	0.0
0	Hardwood	0.0	0.0	0.0	0.0
1	Softwood	1.1	41.0	2142.8	2184.8
1	Hardwood	0.1	108.8	214.0	322.9
2	Softwood	0.0	0.0	4625.7	4625.7
2	Hardwood	0.0	0.0	431.5	431.5
3	Softwood	84.1	181.5	11548.2	11813.8
3	Hardwood	45.1	481.6	938.7	1465.4
4	Softwood	162.6	267.7	6645.3	7075.5
4	Hardwood	70.9	421.8	322.0	814.6
5	Softwood	0.0	0.0	0.0	0.0
5	Hardwood	0.0	0.0	0.0	0.0
Softwood Total		247.7	490.2	24961.9	25699.9
Hardwood Total		116.1	1012.1	1906.2	3034.4
Grand Total		363.8	1502.3	26868.2	28734.2

Notes:
M= softwood mixedwood; N= hardwood mixedwood; S= softwood; Note that there are no pure hardwood stands in the study area.

Table 1E-3: Standing Timber Volume Affected during the Operations Phase of the Project

Cutting Class	Working Group	Cover Type M	Cover Type N	Cover Type S	Total (m^3)
0	Softwood	0.0	0.0	0.0	0.0
0	Hardwood	0.0	0.0	0.0	0.0
1	Softwood	0.0	0.0	258.6	258.6
1	Hardwood	0.0	0.0	28.2	28.2
2	Softwood	0.0	0.0	34.2	34.2
2	Hardwood	0.0	0.0	1.7	1.7
3	Softwood	0.0	58.3	51.7	109.9
3	Hardwood	0.0	92.9	51.7	144.5
4	Softwood	51.6	53.5	419.9	525.0
4	Hardwood	22.1	142.6	101.6	266.2
5	Softwood	0.0	0.0	0.0	0.0
5	Hardwood	0.0	0.0	0.0	0.0
Softwood Total		51.7	75.5	1412.5	1539.6
Hardwood Total		22.1	142.6	101.6	266.3
Grand Total		73.8	218.0	1514.0	1805.9

Notes:
M= softwood mixedwood; N= hardwood mixedwood; S= softwood; Note that there are no pure hardwood stands in the study area.

Table 1E-4: Standing Timber Volume Affected during the Construction and Operations Phase of the Project

		Cover Type			
Cutting Class	**Working Group**	**M**	**N**	**S**	**Total (m^3)**
0	Softwood	0.0	0.0	0.0	0.0
0	Hardwood	0.0	0.0	0.0	0.0
1	Softwood	1.1	41.0	2401.3	2443.4
1	Hardwood	0.1	108.8	242.2	351.1
2	Softwood	0.0	0.0	4660.0	4660.0
2	Hardwood	0.0	0.0	433.1	433.3
3	Softwood	84.1	203.5	12248.0	12535.6
3	Hardwood	45.1	539.8	990.4	1575.3
4	Softwood	214.2	321.2	7065.2	7600.6
4	Hardwood	93.0	506.1	341.9	941.0
5	Softwood	0.0	0.0	0.0	0.0
5	Hardwood	0.0	0.0	0.0	0.0
Softwood Total		299.4	565.7	26374.4	27239.5
Hardwood Total		138.2	1154.7	2007.8	3300.6
Grand Total		437.6	1720.3	28382.2	30540.1

Notes:
M= softwood mixedwood; N= hardwood mixedwood; S= softwood; Note that there are no pure hardwood stands in the study area.

1.8 RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION FROM TAC AND PUBLIC REVIEWERS, RD 1 & 2

Chapter	Process	Current Text in Response	Corrected Text/Clarification
NRCan-0010	TAC Public Rd 1	"The hydraulic conductivity values ranged from 1 x 10^{-4} to 1 x 10^{8} m/s."	"The hydraulic conductivity values ranged from 1 x 10^{-4} to 1 x **10^{-8}** m/s."
NRCan-0014	TAC Public Rd 1	"This sentence suggests that the earthquake reporting is complete in Manitoba for magnitude 3 and larger since 1927 based on an NRCan map that displays the known earthquakes between 1627 and 2008…"	"This sentence suggests that the earthquake reporting is complete in Manitoba for magnitude 3 and larger since **1627** based on an NRCan map that displays the known earthquakes between 1627 and 2008…"
NRCan-0015	TAC Public Rd 1	"This sentence suggests that the earthquake reporting is complete in Manitoba for magnitude 3 and larger since 1927 based on an NRCan map that displays the known earthquakes between 1627 and 2008…"	"This sentence suggests that the earthquake reporting is complete in Manitoba for magnitude 3 and larger since **1627** based on an NRCan map that displays the known earthquakes between 1627 and 2008…"
PCN-0001	TAC Public Rd 2		The reviewer is correct that there is currently no reservoir on the lower Churchill River in Labrador and that 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.

UPDATED KEEYASK TRAFFIC ASSESSMENT

Hydropower Limited Partnership

TABLE OF CONTENTS

1.0 SOCIO-ECONOMIC, RESOURCE USE AND HERITAGE RESOURCES SUPPORTING VOLUME 1-1

1.1 EXISTING ROAD CONDITIONS AND TRAFFIC 1-1

1.1.1 Local Study Area 1-1

1.1.1.1 Provincial Roadways 1-1

1.1.1.1.1 PR 391 1-2

1.1.1.1.2 PR 280 1-3

1.1.1.1.3 PR 391 and PR 280 Estimated Background Traffic Volumes (2014-2021) 1-5

2.0 EFFECTS ASSESSMENT 2-1

2.1 ROAD-BASED TRAVEL, ACCESS AND SAFETY 2-1

2.1.1 Local Study Area 2-1

2.1.1.1 Freight Traffic 2-2

2.1.1.2 Incidental Service Traffic 2-3

2.1.1.3 Construction Personnel Traffic 2-3

3.0 RESPONSE TO EIS GUIDELINES 3-1

3.1 EXISTING ENVIRONMENT 3-1

3.1.1 Road Travel 3-1

3.2 EFFECTS ASSESSMENT 3-2

3.2.1 Road Travel 3-2

APPENDIX A-1 .... A1-1

APPENDIX A-2 .... A2-1

KEEYASK

Hydropower Limited Partnership

SOCIO-ECONOMIC SUPPLEMENTAL FILING

Keeyask Hydropower Limited Partnership

The following socio-economic impact assessment supplemental filing contains updated construction traffic analysis for the Socio-Economic Supporting Volume (existing environment and effects assessment); as well as updated text in the Response to EIS Guidelines. There are no changes to operation phase traffic baseline or effects, therefore no supplemental filing is required for those sections.

This updated information relative to construction traffic should replace sections on traffic filed in July 2012; the specific section and page numbers are provided below:

Socio-Economic, Resource Use and Heritage Resources Supporting Volume:

Socio-Economic section:

- Section 5.3.5.2, pgs. 5-136 to 5-141 [existing environment]
- Section 5.4.1.5.2, pgs. 5-194 to 5-201 [effects assessment – construction phase]

Response to EIS Guidelines:

- Section 6.2.3.5.4, pg. 6-164 only [existing environment]
- Section 6.6.5.5.1, pgs. 6-483 and 6-484 only [effects assessment – construction phase]

The percentage of project-related traffic has declined in the updated analysis due to the development of a more realistic projection of background traffic flows based on more current data (i.e., 2011), and more reasonable assumptions for construction personnel travel to and from the Project site.

The updated traffic analysis examines the effects of construction traffic on public roads (PR 280 and PR 391). It does not include traffic effects on private roads or traffic experienced during the operation phase. As a result, the north and south access roads, which will be private during construction, have not been considered in this analysis.

Effects on future hydroelectric developments in the Study Area, such as the Conawapa Generation Project, are addressed in the cumulative effects assessment section included in the Response to EIS Guidelines – there are no changes in this analysis.

Projections of traffic levels during construction are presented in Section 5.4.1.5 of the Socio-Economic Supporting Volume.

SOCIO-ECONOMIC, RESOURCE USE AND HERITAGE RESOURCES SUPPORTING VOLUME

Hydropower Limited Partnership

1.0 SOCIO-ECONOMIC, RESOURCE USE AND HERITAGE RESOURCES SUPPORTING VOLUME

1.1 EXISTING ROAD CONDITIONS AND TRAFFIC

1.1.1 Local Study Area

1.1.1.1 Provincial Roadways

The Local Study Area encompasses a large geographic area, is sparsely populated and the distances between communities are quite large as shown in Map 4-1 (Travel Distances in the Local Study Area). Some communities are connected to southern parts of the province by a network of provincially maintained year-round roads. All-weather roads that are open and maintained year-round provide access to the communities of Thompson, Split Lake, Fox Lake (Bird) and Gillam. The roadways relevant to the Project in the Local Study Area include PR 391, PR 280 and PR 290. These roads, in addition to the ice roads used to access the KCNs communities, are shown in Map 4-1. PR 391 runs north and west from the city of Thompson. PR 280 runs from the junction of PR 391 northeast to the Keeyask north access road and onward to the town of Gillam. PR 280 is used to access the communities of Split Lake and Gillam. It also provides access to the ferry landing and ice roads on Split Lake that connect to York Landing and War Lake First Nation at Ilford. PR 290 provides access to Fox Lake (Bird) and the Conawapa site via PR 280.

The following section describes the present condition of roadways and ice roads including their physical attributes, traffic volume and collision statistics for PR 391 and PR 280 within the Local Study Area. In Manitoba, highways under the control of the Minister of Infrastructure and Transportation (MIT) are classified as either Research Transportation Association of Canada (RTAC) routes, Class "A1" or Class "B1" highways[1]. Each class of highway has its own specific axle loading and gross vehicle weight limits. Both highways are designated as Secondary Arterial[2] by MIT, which means that they are designed to carry up to 6,000 vehicles per day depending on their geometric features (Dillon Consulting 2003; ND Lea Engineers and Planners Inc. 2002).

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[1]Class A1 highways are any Provincial Trunk Highway numbered from 1 to 110 while Class B1 highways have number designations higher than 110 (Government of Manitoba 2010d).

[2]Primary Arterials provide intra/inter-provincial and international connections and direct service to the most important and larger population centres. Secondary Arterials connect other important population centres (Government of Manitoba 1997).

The Government of Manitoba through MIT has been making improvements to PR 391 and PR 280 for a number of years. In 2002 for example, the Minister of Transportation and Government Services announced that $700,000 would be invested to add additional gravel on various locations of PR 280 between PR 391 and PR 290 including gravel stabilization on 261 km of road (Government of Manitoba 2002; Keeyask Hydropower Limited Partnership 2009). Since then, the roads in the Local Study Area have undergone regular maintenance and improvements, including road upgrades, signage and pull-offs, which should improve travel on PR 280.

In the 2009 Manitoba Budget Address, the Minister of Finance announced that upgrades would be made to PR 280 between Thompson and Gillam as part of the 2009/2010 Highway Infrastructure Projects. MIT requested that Manitoba Hydro manage upgrades to the roads prior to future hydro development such as the Keeyask Generation Project. The project costs are being shared on a 50/50 basis between Manitoba Hydro and MIT. The detailed design, contract negotiations, and contract management during construction are managed by Manitoba Hydro while MIT is responsible for environmental licensing, land acquisition, and review and approval of designs. MIT continues to own and maintain the roadway as their asset (Government of Manitoba 2009b). The upgrades to PR 280 are being undertaken by Amisk Construction (a joint venture between CNP and Sigfusson Northern). Tasks associated with the upgrades include widening, smoothing and grading (see Section 4.3.5 for additional information).

1.1.1.1.1 PR 391

PR 391 is a two-lane undivided paved roadway with graduated posted speed limits of 50 kph, 70 kph and 90 kph. From the city of Thompson to the Thompson Airport access road, PR 391 is classified as a RTAC Class A1 highway. However, commencing December 1st in any year to the last day of February in the ensuing year, the road is approved as a Seasonal RTAC Route from the city of Thompson and gross vehicle weights (GVW) of 62.5 tonnes are allowed. From March 1 to November 30, the weight limit is reduced to approximately 55 tonnes (Government of Manitoba 2010f.).

PR 391 Traffic Volume

Table 5-14 describes PR 391 traffic volume data collected by MIT (as reported by KGS-Acres (2012)) for the years 2005, 2007, 2009 and 2011 as a count for the Average Annual Daily Traffic (AADT[1]). This updated analysis presents all data in the form of AADT volumes (the original report presented data in the form of round trips and AADT). The counts, shown in Table 5-14, represent one-way traffic at Traffic Monitoring Station 2151. The AADT on PR 391 for the years 2005 and 2007 range between 760 and 830 vehicles. There is a noticeable increase in the AADT from 2007 to 2011, which may be a result of traffic associated with projects occurring in the area, in particular the construction of the Wuskwatim, Generating Station.

[1]AADT represents the number of vehicles passing a particular point on the roadway on an average day of the year (Manitoba Infrastructure and Transportation 2009).

PR 391 Collision Statistics

The collision data presented in Table 5-15 below represents the total collisions that occurred on two control sections of PR 391 (control section 05391010 and control section 05391015), which are between Thompson and PR 280, over the period from 1990 to 2008. In total, 69 collisions were reported along these sections of the highway that would be used during construction of the Project, which works out to an average of nearly four collisions per year. Of these, 51 resulted in property damage, 18 resulted in injuries and there were no reported fatalities (Nicolas, *pers. comm.*. 2013)[1].

Table 5-1: PR 391 Traffic Volume Summary

Year	Average Annual Daily Traffic (AADT)
2005	760
2007	830
2009	1,230
2011	1,190

Source: KGS-Acres 2012.

Notes:

- Traffic volume for PR 391 is observed at Traffic Monitoring Station 2151 (West of Thompson Airport Access and East of PR 280 junction).

Table 5-2: PR 391 Collision History (combined) for Highway Control Sections 05391010 and 05391015 (1990-2008)

Highway Control Sections	Number of Collisions
05391010	1
05391015	68
Total	**69**

Source: Nicolas *pers .comm. 2013*.

1.1.1.1.2 PR 280

PR 280 is a two-lane undivided roadway constructed with a mix of gravel and asphalt (Dillon Consulting 2003). From its junction with PR 391 to the Town of Gillam, PR 280 is classified as a RTAC Class A1 highway (Government of Manitoba 2010d).

[1] Data for number of collisions is based on unaudited reported traffic collisions on record, provided to InterGroup by MIT.

PR 280 Traffic Volume

Table 5-16 describes the PR 280 traffic volume data collected by MIT from 2005 through 2011. The traffic counting stations used in this report are known as coverage count stations and are short-term traffic count stations that are surveyed on a two-year cycle. On the selected cycle year, coverage count stations are typically surveyed 2 times a year for 48 hours each time. The traffic counting stations were correlated to the appropriate highway section as described in the Methodology Section 5.2. The traffic along each highway section varies. Table 5-16 presents traffic volumes as an average for the portion of the road from the PR 391 junction with PR 280 to the junction with the Keeyask north access road. Average annual daily traffic volumes on PR 280 as shown in Table 5-16 range between 161 and 221 vehicles depending upon the year. The data show a 60 vehicle increase in AADT between 2005 and 2011, an increase of 27%.

Table 5-3: PR 280 Traffic Volume Summary

Year	Average Annual Daily Traffic (AADT)
2005	161
2007	167
2009	180
2011	221

Source: MIT and University of Manitoba. Tallied by InterGroup Consultants.

Notes:

- Data for the Average AADT comes from MIT counting stations 2293, 2376, 2377, 2437, 2438, 2441, 2442 between the PR 391 junction and the Keeyask north access road junction.

PR 280 Collision Statistics

To assist in identifying safety issues, the latest available collision data were obtained for PR 280 along the roadway control sections identified in Table 5-17. The collision data covered the period of time from 1990 to 2008. In total, 233 collisions were reported along those control sections of the highway in the Local Study Area. Of these, 147 collisions resulted in property damage and 82 resulted in injuries..

Manitoba Infrastructure and Transportation (2013) reported a total of four fatalities along this road since 1990[1].

[1] MIT indicated that this was the earliest data available for fatalities on this road.

Table 5-4: PR 280 Collision History by Highway Control Section (1990-2004)

Highway Control Section	Total Collisions
05280010	39
05280020	33
05280030	46
05280040	19
05280050	32
05280060	17
05280070	14
05280080	33
Total	**233**

Source: (Nicolas, *pers. comm.* 2013).

1.1.1.1.3 PR 391 and PR 280 Estimated Background Traffic Volumes (2014-2021)

Table 5-18 presents the projected average background traffic for the summer season and Table 5-19 presents the projected average background traffic for the winter season along four highway sections of PR 391 and PR 280 for the years 2014 to 2021. The traffic counts presented in the table are AADT estimates of the vehicles that would be using the roads assuming no future Keeyask Project.

Highway Section 1 in Table 5-18 and Table 5-19 represents the stretch of PR 391 between Thompson and PR 280. This highway section has the greatest volume of background traffic of all of the highway sections in the Local Study Area. For the summer months, the AADT background traffic is estimated to grow from 3,362 vehicles in 2014 to 4,894 vehicles in 2021. For the winter months, the AADT background traffic for this section of PR 391 is estimated to grow from 2,825 vehicles in 2014 to 4,112 vehicles in 2021.

Highway Section 2 represents the stretch of PR 280 between PR 391 and the Split Lake Junction and the AADT summer traffic for this highway section is estimated to grow from 293 vehicles in 2014 to 413 vehicles in 2021; and in winter the AADT traffic is estimated to range between 246 vehicles in 2014 to 347 vehicles in 2021.

Highway Section 3 represents the stretch of road between the Split Lake junction and the Keeyask junction (where the Keeyask north access road meets PR 280). The AADT summer traffic for this highway section is estimated to grow from 515 vehicles in 2014 to 958 vehicles in 2021, and in winter the AADT traffic is estimated to grow from 432 vehicles in 2014 to 805 vehicles in 2021.

Highway Section 4 represents the stretch of road between the Keeyask junction and PR 290 (north of Gillam). The AADT summer traffic for this highway section is estimated to grow from 103 vehicles in 2014 to 133 vehicles in 2021 and in winter the AADT traffic is estimated to grow from 86 vehicles in 2014 to 112 vehicles in 2021.

Table 5-5: Estimated Background Traffic (Summer: AADT Trips) in the Local Study Area (2014-2021)

	2014	2015	2016	2017	2018	2019	2020	2021
Highway Section 1: PR 391-Thompson to PR 280	3,362	3,580	3,812	4,059	4,253	4,457	4,670	4,894
Highway Section 2: PR280-PR 391 to Split Lake Junction	293	308	325	342	359	376	394	413
Highway Section 3: PR 280-Split Lake Junction to Keeyask Junction	515	595	688	795	833	873	915	958
Highway Section 4: PR 280-Keeyask Junction to PR 290	103	105	108	110	116	121	127	133

Source: Source: Adapted from KGS-Acres 2012 Traffic Analysis for Keeyask and Conawapa Environmental Assessments Memorandum, dated October 24, 2012.

Table 5-6: Estimated Background Traffic (Winter: AADT Trips) in the Local Study Area (2014-2021)

	2014	2015	2016	2017	2018	2019	2020	2021
Highway Section 1: PR 391-Thompson to PR 280	2,825	3,008	3,203	3,411	3,574	3,745	3,924	4,112
Highway Section 2: PR 280-PR 391 to Split Lake Junction	246	259	273	288	302	316	331	347
Highway Section 3: PR 280-Split Lake Junction to Keeyask Junction	432	500	578	668	700	733	769	805
Highway Section 4: PR 280-Keeyask Junction to PR 290	86	88	91	93	97	102	107	112

Source: Source: Adapted from KGS-Acres 2012 Traffic Analysis for Keeyask and Conawapa Environmental Assessments Memorandum, dated October 24, 2012.

EFFECTS ASSESSMENT

2.0 EFFECTS ASSESSMENT

2.1 ROAD-BASED TRAVEL, ACCESS AND SAFETY

Increases in traffic volume due to Keeyask construction activities could affect road conditions and the safety of road users. This section examines the nature, extent and effects of Project-related construction traffic.

2.1.1 Local Study Area

This section examines the effects of Keeyask Generation related traffic on publically-owned and used roads. It focuses on the construction phase, when sizeable amounts of Project-related traffic are generated[1].

During construction, effects on public road travel will stem from increased vehicular traffic associated with delivery of materials, equipment, and construction personnel and travel by construction service providers on public roads in the Local Study Area. Increased traffic volume on public roads could affect the condition of the roads and traffic safety.

Existing roads between Thompson and Gillam along PR 391 and PR 280 will be affected. These are shown on Map 1-1 Socio-Economic Local Study Area. The distance between relevant junctions and communities in the Local Study Area is shown in Table 5-22.

For purpose of assessing the effects of Project-related construction traffic, the potentially affected roadways have been divided into four road sections (see Appendix A-1):

- Road Section 1 (PR 391): Thompson to the PR 280 junction;
- Road Section 2 (PR 280): PR 391 junction to the Split Lake junction;
- Road Section 3 (PR 280): Split Lake junction to the Keeyask north access road junction; and
- Road Section 4 (PR 280): Keeyask junction to PR 290.

PR 290 is not included as Project traffic levels will be very small and will be similar to Road Section 4. No freight traffic is expected on this segment.

Average annual daily background traffic levels (under existing conditions) for these road sections are presented in Section 5.3.5. Due to the seasonal variation of background traffic flow, the estimates for Project-related traffic are shown for both summer and winter.

[1] Operation effects are addressed in Section 5.4.2.5.2 of the original SE SV – there are no changes to that analysis and therefore not included in this supplemental filing.

Effects on Project-related private roads are not included as the north and south access roads will be private roads to the Project site during construction, with traffic restricted by a security gate to those with authorization to use the roads. The north access road, which will have been built as part of the Keeyask Infrastructure Project, will be in place and ready for use from the start of Project construction. The south access road is being built as part of the Project and will be operated as a private road during the construction phase.

A Project Construction Access Management Plan will be in place prior to construction to address access to and use of the north access road and the south access road. Both access roads will remain private until the end of the construction phase, and will be gated to prevent public access..

Project-related traffic will be generated to move freight (equipment and materials), construction workers, contractors and service delivery vehicles providing incidental services. The vast majority of this traffic is expected to travel between Thompson and the Project, along PR 391 to the PR 280 junction and along PR 280 to the north access road junction. A small portion is expected to originate at Long Spruce Siding and Gillam and approach the Project site from the northeast (KGS-Acres 2012). Detailed summer and winter forecasts of Project-related traffic levels were developed to assess the effects of construction traffic on infrastructure and travel safety. The forecasts are based on the following assumptions:

- Project-related traffic would access the main Project site from the north side of the Nelson River via PR 280;
- The Project traffic would travel from Winnipeg, Thompson, Split Lake, Gillam or other communities, before turning onto the north access road;
- All traffic during construction is assumed to access the Project site via PR 280 (KGS-Acres 2012); and
- Travel between the north access road and the south access road across the Nelson River would not occur during the construction phase.

The Project-related traffic projections are organized by three categories:

- Heavy trucks hauling freight;
- Incidental support service vehicles traveling to the camp and construction work areas; and
- Vehicles transporting people to and from the Project site.

2.1.1.1 Freight Traffic

Freight traffic includes heavy transport trucks hauling bulk cement, fuel, reinforcing steel, heavy construction equipment, construction supplies and equipment for installation in the generating station and miscellaneous items associated with the Project. Projected traffic volumes are based on estimates of the amount and size of equipment and materials required for construction and shipped from manufacturers and suppliers to the Project. It does not include traffic to move aggregate materials as this will all occur on roads dedicated to Project traffic, not on public roads.

2.1.1.2 Incidental Service Traffic

Incidental service traffic is intended to cover routine traffic providing various services to the camp and construction work areas. It potentially includes removal of recyclable refuse, mail/courier/package, venders/suppliers, commercial service vehicles, catering and visitors traveling to and from the site each day. The estimated volumes of traffic for this category were based on experience and judgment. The forecast for incidental service traffic has been assumed to be constant over the duration of the construction phase of the Project, although it may be somewhat lower in years when construction activity is lower (KGS-Acres 2012).

2.1.1.3 Construction Personnel Traffic

The labour force for the Project will be made up of personnel from various local communities, including Thompson, Split Lake, York Landing, Ilford, Gillam (including FLCN), and other northern Manitoba communities. Workers from the south are expected to fly to Thompson or Gillam and then be transported to the Project site by shuttle transportation. Virtually all workers will live at the construction site while on the job. This means most will travel to and from the site at the beginning and end of their work shifts. It has been assumed that personnel will be on a 30-day turnaround (with some frequency of travel in between). It has also been assumed that approximately 75% of the workforce will use the shuttle bus service to and from the Project site. Forecasts for shuttle service and personnel vehicle usage were based on experience and judgement from previous projects; and were calculated based on 2010 manpower estimates (KGD-Acres 2012).

Table 5-22 below summarizes the sources of traffic expected in each road section, based on the assumptions presented above.

Table 5-1: Roadways Used by Project Traffic

Road Section 1: PR 391 - Thompson to PR 280 Junction	· All of the freight for the Project · Incidental service vehicles (visitors, commercial service vehicles, vendor/suppliers) traveling from Thompson and south of Thompson · Construction personnel for the Project from Thompson and any point south of Thompson
Road Section 2: PR 280 - PR 391 Junction to Split Lake Junction	· All of the freight for the Project · Incidental service vehicles for the Project traveling from Thompson and south of Thompson · All construction personnel for the Project traveling via Thompson (including any point south of Thompson)
Road Section 3: PR 280 - Split Lake Junction to Keeyask North Access Road Junction	· All of the freight for the Project · Incidental service vehicles for the Project traveling from Thompson and south of Thompson · All construction personnel for the Project traveling via Thompson and from the Split Lake area (including any point south of Thompson)
Road Section 4: PR 280 - Keeyask North Access Road Junction to PR 290	· All of the incidental service vehicles for the Project traveling from Gillam · All construction personnel for the Project traveling from Gillam

Source: KGS-Acres (2012).

Note:

- Personnel traffic attributable to the small number of workers who might fly into Gillam and be transported out to the Project site could not be predicted and is not included.
- PR 290 is not included as Project traffic levels will be very small and similar to Road Section 4. No freight traffic is expected on this segment.

Updated Project-related traffic projections based on the above considerations are presented in Table 5-23 for each road section and season during construction. This table also shows how the projected volumes compare to background volumes and what the combined projected and background volumes are estimated to be (in terms of AADT volumes). Table 5-24 illustrates the percentage increase in traffic on each road section and in each season during construction from Project-related freight traffic, which is the source of greatest concern for wear and tear and road safety (including the potential for accidents with other users of the road).

Table 5-2: Forecast of Combined Background and Project-related Average Annual Daily Traffic During Summer and Winter (2014-2021)

	Road Section 1: PR 391 - Thompson to PR 280 Junction			Road Section 2: PR 280 - PR 391 Junction to Split Lake Junction			Road Section 3: PR 280 - Split Lake Junction to Keeyask North Access Road Junction			Road Section 4: PR 280 - Keeyask North Access Road Junction to PR 290		
	BG Traffic	Project Traffic	BG and Project Traffic	BG Traffic	Project Traffic	BG and Project Traffic	BG Traffic	Project Traffic	BG and Project Traffic	BG Traffic	Project Traffic	BG and Project Traffic
2014 Summer	3,362	16.0	3,378	293	16.0	309.0	515	16.1	531.1	103	3.1	106.1
2014 Winter	2,825	14.3	2,839	246	14.3	260.3	432	14.3	446.3	86	3.1	89.1
2015 Summer	3,580	22.3	3,602	308	22.3	330.3	595	22.5	617.5	105	3.4	108.4
2015 Winter	3,008	15.1	3,023	259	15.1	274.1	500	15.3	515.3	88	3.2	91.2
2016 Summer	3,812	54.5	3,867	325	54.5	379.5	688	55.3	743.3	108	4.1	112.1
2016 Winter	3,203	21.5	3,225	273	21.5	294.5	578	21.9	599.9	91	3.4	94.4
2017 Summer	4,059	54.1	4,113	342	54.1	396.1	795	54.9	849.9	110	4.2	114.2
2017 Winter	3,411	20.4	3,431	288	20.4	308.4	668	20.6	688.6	93	3.4	96.4
2018 Summer	4,253	34.5	4,288	359	34.5	393.5	833	35.1	868.1	116	3.8	119.8
2018 Winter	3,574	20.7	3,595	302	20.7	322.7	700	21.0	721.0	97	3.4	100.4
2019 Summer	4,457	22.6	4,480	376	22.6	398.6	873	22.9	895.9	121	3.4	124.4
2019 Winter	3,745	19.0	3,764	316	19.0	335	733	19.3	752.3	102	3.4	105.4
2020 Summer	4,670	17.1	4,687	394	17.1	411.1	915	17.3	932.3	127	3.2	130.2
2020 Winter	3,924	16.5	3,941	331	16.5	347.5	769	16.6	785.6	107	3.2	110.2
2021 Summer	4,894	4.8	4,899	413	4.8	417.8	958	4.8	962.8	133	-	133.0
2021 Winter	4,112	6.0	4,118	347	6.0	353.0	805	6.0	811.0	112	0.0	112.0

Source: Adapted from KGS-Acres 2012 Traffic Analysis for Keeyask and Conawapa Environmental Assessments Memorandum, dated October 24, 2012.

Notes: BG=background. These numbers represent Average Annual Daily Traffic by road section. The analysis is based on the 85% freight by truck scenario, which was considered to be the traffic volume scenario as compared to the 15% freight by truck scenario also contained in the KGS-Acres 2012 report.

Table 5-3: Percentage Increase in Traffic Resulting from Project-related Average Annual Daily Traffic During Summer and Winter (2014-2021)

	Road Section 1: PR 391 - Thompson to PR 280 Junction		Road Section 2: PR 280 - PR 391 Junction to Split Lake Junction		Road Section 3: PR 280 - Split Lake Junction to Keeyask North Access Road Junction		Road Section 4: PR 280 - Keeyask North Access Road Junction to PR 290	
	% Increase due to Project Traffic	% Freight in Project Traffic	% Increase due to Project Traffic	% Freight in Project Traffic	% Increase due to Project Traffic	% Freight in Project Traffic	% Increase due to Project Traffic	% Freight in Project Traffic
2014 Summer	0%	19.4%	5%	19.4%	3%	19.3%	3%	0.0%
2014 Winter	1%	14.0%	6%	14.0%	3%	14.0%	4%	0.0%
2015 Summer	1%	33.6%	7%	33.6%	4%	33.3%	3%	0.0%
2015 Winter	1%	13.2%	6%	13.2%	3%	13.1%	4%	0.0%
2016 Summer	1%	61.8%	17%	61.8%	8%	60.9%	4%	0.0%
2016 Winter	1%	27.9%	8%	27.9%	4%	27.4%	4%	0.0%
2017 Summer	1%	60.4%	16%	60.4%	7%	59.6%	4%	0.0%
2017 Winter	1%	27.5%	7%	27.5%	3%	27.2%	4%	0.0%
2018 Summer	1%	46.4%	10%	46.4%	4%	45.6%	3%	0.0%
2018 Winter	1%	25.1%	7%	25.1%	3%	24.8%	4%	0.0%
2019 Summer	1%	31.9%	6%	31.9%	3%	31.4%	3%	0.0%
2019 Winter	1%	21.6%	6%	21.6%	3%	21.2%	3%	0.0%
2020 Summer	0%	22.8%	4%	22.8%	2%	22.5%	3%	0.0%
2020 Winter	0%	20.0%	5%	20.0%	2%	19.9%	3%	0.0%
2021 Summer	0%	0.0%	1%	0.0%	1%	0.0%	-	-
2021 Winter	0%	20.0%	2%	20.0%	1%	20.0%	0.0%	0.0%

Source: Adapted from KGS-Acres 2012; Tallied by InterGroup Consultants Ltd.

The largest increase in traffic is expected to occur during the summer seasons during the peak construction periods. As shown in Table 5-23 the greatest overall amount of Project-related traffic in the summer season is expected to occur in the summers of 2016 and 2017, with the former experiencing the highest volumes. The greatest amount of Project-related winter traffic is expected to occur in winter 2016 and 2018, with the highest levels reached in the winter of 2016. While traffic levels are higher in summer than winter, winter driving conditions are typically more hazardous. Overall, Road Section 2 will experience the largest percentage increase in Project-related traffic.

For Road Section 1 (PR 391 - Thompson to PR 280 Junction), the expected volume of traffic in Summer 2017 based on normal traffic growth is 4,059 vehicles/day and the number of Project-related vehicles using this road is expected to add another 54.1 vehicles for a total of 4,113 vehicles/day during the core construction period. Of those Project-related vehicles, 61% of them are expected to be freight vehicles while the remainder of traffic will come from incidental service and personnel vehicles (shown in Table 5-24). The overall increase due to Project traffic on this section is 1% or less in all periods. As, noted in the existing environment Section 5.3.5, PR 391 is designed with a capacity of up to 6,000 vehicles per day. The increase in traffic on the road as a result of the Project should be readily accommodated by the road design.

During the peak construction period (summer 2017) on Road Section 2 (PR 280 – from the junction with PR 391 to the Split Lake junction), the expected background traffic volume is estimated to be 342 vehicles/day, and the number of Project-related vehicles using this road is expected to add another 54.1 vehicles for a total of 396 vehicles/day during the core construction period. This is an increase of 16% over the expected background traffic. Of the Project-related traffic, approximately 32 vehicles (60%) are expected to be trucks transporting freight. The remainder of the vehicles will be incidental service and personnel vehicles. On Road Section 2, the Project is expected to increase the number of vehicles on the road in summer months in excess of 10% in years 2016 (17%) and 2017 (16%). During the winter months Project-related traffic will increase the number of vehicles on the road and will peak at 8% in the winter of 2016 (with 28% of that Project traffic being attributable to freight).

Road Section 3 (PR 280 - Split Lake junction to the Keeyask north access road junction) is expected to experience the greatest amount of combined Project-related traffic. Road Section 3 will have three types of Project vehicles traveling along it including: heavy trucks hauling freight, incidental support service vehicles traveling to the camp and construction work areas and personnel vehicles transporting people to and from the Project site. In Summer 2017, the expected background traffic volume is estimated to be 795 vehicles/day, and the number of Project-related vehicles using the road is expected to add another 55 vehicles for a total of 850 vehicles/day during the core construction period. As mentioned above, Road Section 3 will see the greatest total amount of Project traffic in Summer 2017 with 60% of the Project traffic made up by freight traffic and the remainder (40%) will be attributable to personnel traffic. On Road Section 3, the Project is not expected to increase the number of vehicles on the road in excess of 10% in both summer and winter seasons. As construction ramps up, the increase in Project traffic on Road Section 3 is expected to be approximately 4% in summer 2015 and is expected to reach a peak of 8% in the summer of 2016. The greatest increase in traffic due to the Project in the winter months is expected to occur in 2016 when the Project is estimated to increase traffic by 4% (with 27% of that Project traffic being attributable to freight).

On Road Section 4 (PR 280 – the Keeyask north access road junction to PR 290) during the peak construction period, the expected background traffic volume is estimated to be 110 vehicles/day, and the number of Project-related vehicles using this road is expected to add another 4 vehicles for a total of 114 vehicles/day. In Summer 2017, this is an increase of 4% over the estimated background traffic. The only Project traffic expected to travel along this road section is incidental service and personnel vehicles. Road Section 4 is not expected to have an increase in traffic volume in excess of 10%. None of the Project-related traffic is expected to be from freight vehicles.

In summary, the percentage increases in traffic due to the Project on Road Sections 1, 2, 3, and 4 is low and should be accommodated by the roadway design tolerances. Road Section 2 has percentage increases in traffic from Project-related traffic that exceed 10% at peak times although the total volume of background and Project-related traffic is well below the roadway design tolerances.

Local residents and regular haulers already travelling these routes are likely to notice the increase in the number of vehicles that they meet or have to travel behind or pass. This increases concerns about the potential for accidents to occur. As well, many of the Project-related vehicles will be large trucks. TCN interviewees have noted that large trucks travelling on PR 280 can stir up large amounts of dust reducing driving visibility and can be intimidating to drivers of smaller vehicles (CNP *pers. comm.* 2011). Other KCNs Members and residents of the Local Study Area have expressed concern about the safety and conditions of PR 280 prior to the improvements, citing numerous examples of damaged windows and vehicles, traffic accidents as well as concern about dust from trucks causing visibility hazards. Concerns have also been raised that added traffic could increase collisions with wildlife trying to cross the road. Speed restrictions and additional signage where the risk of such collisions is greatest have been identified as ways of reducing such collisions. At the time of submission, it was not known whether planned road improvements will fully address the concerns voiced by the KCNs.

RESPONSE TO EIS GUIDELINES

KEEYASK
Hydropower Limited Partnership

3.0 RESPONSE TO EIS GUIDELINES

3.1 EXISTING ENVIRONMENT

3.1.1 Road Travel

The Local Study Area encompasses a large geographic area between Thompson and north of Gillam. The main roadway and travel distances in this area are shown in Map 4.1 of the Socio-Economic Baseline of the Keeyas EIS (appended). Prior to 1979-1981 there was no KCNs road access. Today, all-weather roads that are open and maintained year-round provide access to the communities of Thompson, Split Lake, Fox Lake (Bird) and Gillam. Ilford can be accessed year-round by rail line and air (weather permitting) and in the winter by winter road. York Landing is accessible by ferry during the open water season and by winter road for several weeks in the winter, as well as by air year-round (when weather conditions enable landing and takeoff). YFFN Members rely on various transportation modes to travel to Split Lake and Thompson on a regular basis (*e.g.*, weekly and/or daily). YFFN have expressed concerns about the reliability and safety of the winter road which affects overall access to York Landing (see Transportation Infrastructure above) (YFFN KPI Program 2009-2010).

PR 391 and PR 280 are the main roadways in the Local Study Area. The Average Annual Daily Traffic on PR 391 for the years 2005, 2007, 2009 and 2011 ranges between 760 and 1,230 vehicles. Traffic volumes on PR 280 vary, but the average annual daily traffic for the years 2005, 2007, 2009 through 2011 range between 161 and 221 vehicles depending upon the year and the section of road. KCNs Members have expressed concern over the existing conditions of PR 280, noting high levels of dust and poor road conditions. In addition, vehicle damage (particularly cracked windshields) is a common issue related to PR 280. Over the past several years, the Government of Manitoba through the Department of Infrastructure and Transportation (MIT) has been making improvements to roadways, signage, and pull-offs along PR 280 (see Section 5.3.5 SE SV).

3.2 EFFECTS ASSESSMENT

3.2.1 Road Travel

During construction, the Project will generate road traffic, including delivery of materials, equipment and personnel to the Project site (including construction workers, contractors and suppliers).

Noteworthy effects on public roads will occur during constructions along PR 391from Thompson to the junction with PR 280 and along PR 280 to the junction with the north access road. PR 280 beyond the Keeyask north access road junction and PR 290 will experience minimal effects. The north and south access roads will be privately-owned during construction with restricted and controlled use.

Section 5.4.1.5 of the SE SV provides updated detailed traffic projections with and without the Project . Background or existing traffic levels are generally low for a typical provincial road, and Project-related traffic will increase these levels over most construction years by 1- 10%, with the exception of 17% and 16% increases on PR 280 to the Split Lake junction in the summers of 2016 and 2017, respectively (KGS-Acres 2012). The following focuses on the peak construction period of 2015 to 2019 between the junction of PR 391 and PR 280 and the north access road junction accessing the Project Site (see SE SV section 5.4.1.5):

- Between PR 391/280 junction near Thompson and the Split Lake junction, traffic is expected to increase 6- 17%, withthe summer months producing the largest volumes. Volumes during winter months will be lower; however, road conditions will be more difficult. Freight transport by truck is expected to produce the greatest wear and tear on the road and road safety, and accounts for 13-62% of the increased Project-related traffic.
- Between the Split Lake junction and the Keeyask north access road junction, traffic is expected to increase 3-8% (depending on the construction year and season). Freight traffic will account for 13-61% of the increased Project-related traffic.

In anticipation of increased traffic levels associated with the Project, improvements were initiated by MIT in 2011 at several locations on PR 280 prior to the Project, including widening, curve shaping and grade improvements. Road improvements will continue to be made in 2012 to complete the MIT activity prior to Project construction. KCNs Members have expressed concern about the safety and conditions of PR 280, citing numerous examples of damaged windows and vehicles, traffic accidents as well as concerns over dust from trucks creating visibility hazards (see Section 6.6.4 for information related to road infrastructure). At the time of writing, the concerns identified by the KCNs continue as not all improvements had been completed.

A Keeyask Generation Project Construction Access Management Plan has been developed for the operation of the north access road and for construction and operation of the south access road[1]. Restrictions on who is authorized to travel on the north access road is included in the KIP AMP and will

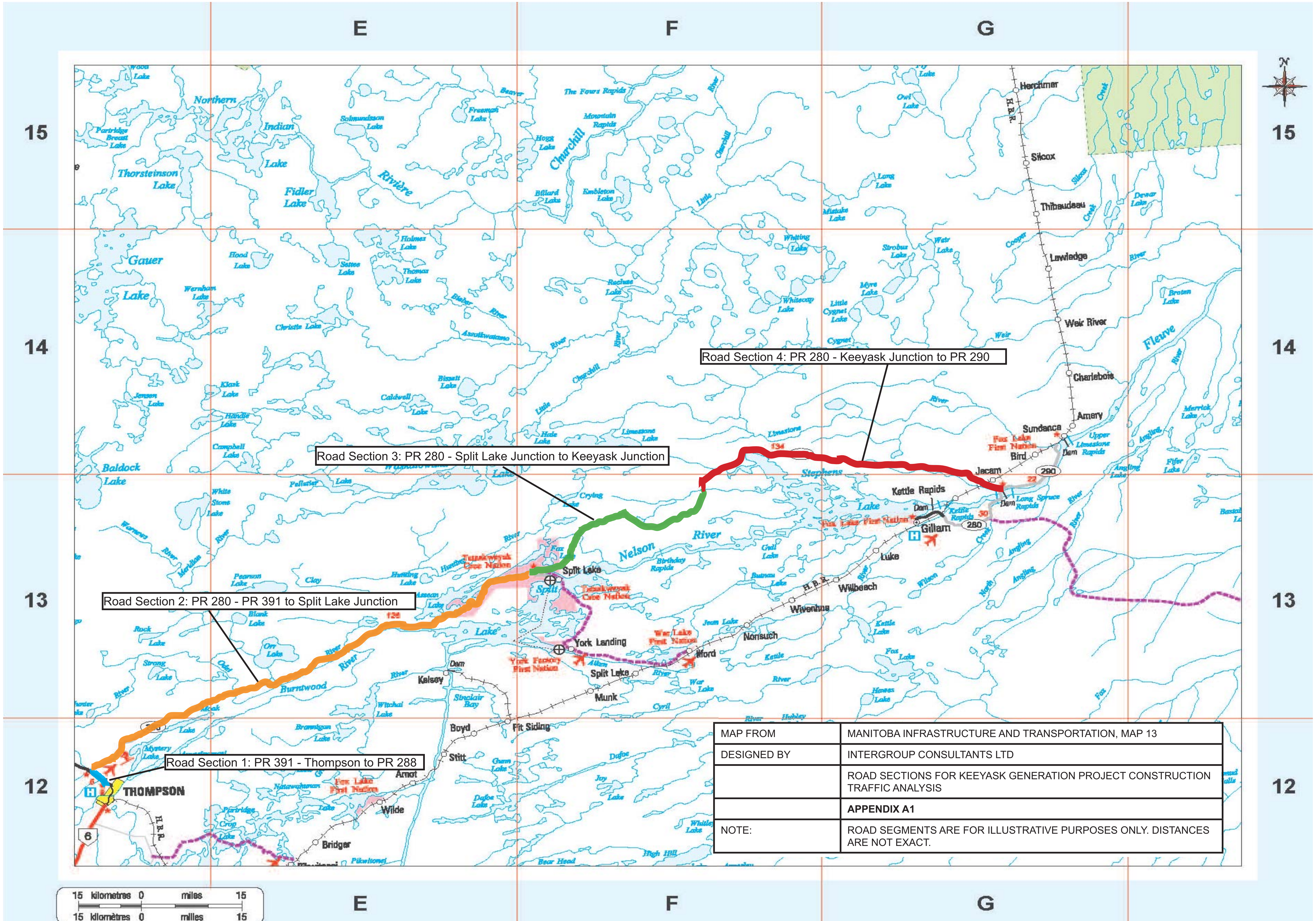
[1] The AMP is anticipated to be filed in the spring of 2013.

be included in this Project's AMP, as well as restrictions on bringing firearms, boats, ATVs and snowmobiles to site. The north and south access roads will be private access roads during the construction phase, with traffic restricted by a security gate on both access roads to restrict use of the access roads by the public. Permission to use the access roads will be granted to those with authorization to access the Project site, including workers, contractors, suppliers, representatives of the KHLP and eligible resource users (as outlined in the Construction Access Management Plan).

MIT may need to consider implementing increased signage during peak construction seasons (May through October) to advise motorists to expect increases in traffic. The Partnership will track statistics collected by MIT on traffic-related incidents and complaints on PR280. If traffic incidents and/or complaints have increased considerably, the Partnership will dialogue with MIT to determine if additional mitigation measures are appropriate (see Chapter 8).

APPENDIX A-1

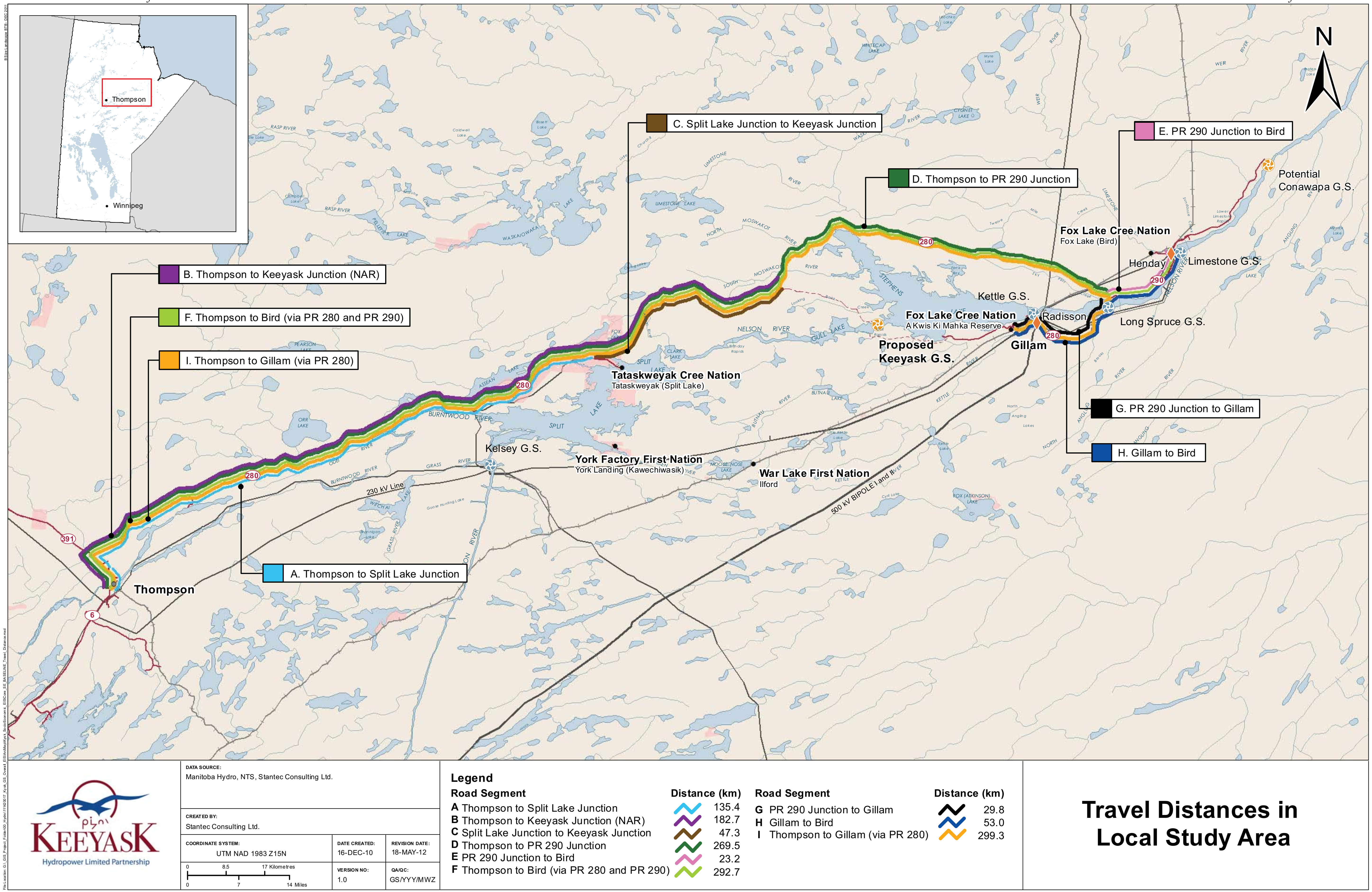
ROAD SECTIONS FOR KEEYASK GENERATION PROJECT CONSTRUCTION TRAFFIC ANALYSIS



MAP FROM	MANITOBA INFRASTRUCTURE AND TRANSPORTATION, MAP 13
DESIGNED BY	INTERGROUP CONSULTANTS LTD
	ROAD SECTIONS FOR KEEYASK GENERATION PROJECT CONSTRUCTION TRAFFIC ANALYSIS
	APPENDIX A1
NOTE:	ROAD SEGMENTS ARE FOR ILLUSTRATIVE PURPOSES ONLY. DISTANCES ARE NOT EXACT.

APPENDIX A-2

TRAVEL DISTANCES IN LOCAL STUDY AREA



Thompson
Winnipeg
N
B. Thompson to Keeyask Junction (NAR)
F. Thompson to Bird (via PR 280 and PR 290)
I. Thompson to Gillam (via PR 280)
A. Thompson to Split Lake Junction
C. Split Lake Junction to Keeyask Junction
D. Thompson to PR 290 Junction
E. PR 290 Junction to Bird
G. PR 290 Junction to Gillam
H. Gillam to Bird
Potential Conawapa G.S.
Fox Lake Cree Nation
Fox Lake (Bird)
Henday
Limestone G.S.
Kettle G.S.
Radisson
Long Spruce G.S.
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Gillam
Proposed Keeyask G.S.
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
Kelsey G.S.
York Factory First Nation
York Landing (Kawechiwasik)
War Lake First Nation
Ilford
230 kV Line
500 kV BIPOLE I and II
Thompson
280
290
391
6
DATA SOURCE:
Manitoba Hydro, NTS, Stantec Consulting Ltd.
CREATED BY:
Stantec Consulting Ltd.
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
16-DEC-10
REVISION DATE:
18-MAY-12
VERSION NO:
1.0
QA/QC:
GS/YYY/MWZ
0 8.5 17 Kilometres
0 7 14 Miles
Legend
Road Segment Distance (km)
A Thompson to Split Lake Junction 135.4
B Thompson to Keeyask Junction (NAR) 182.7
C Split Lake Junction to Keeyask Junction 47.3
D Thompson to PR 290 Junction 269.5
E PR 290 Junction to Bird 23.2
F Thompson to Bird (via PR 280 and PR 290) 292.7
G PR 290 Junction to Gillam 29.8
H Gillam to Bird 53.0
I Thompson to Gillam (via PR 280) 299.3
KEEYASK
Hydropower Limited Partnership
Travel Distances in Local Study Area

Map 4-1

KEEYASK GENERATION PROJECT
ENVIRONMENTAL IMPACT STATEMENT

SOCIO-ECONOMIC ENVIRONMENT, RESOURCE USE AND HERITAGE RESOURCES SUPPORTING VOLUME

APPENDIX 5C
HUMAN HEALTH RISK ASSESSMENT

REVISED APRIL 2013

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APPENDIX 5C

Human Health Risk Assessment of the Mercury from the Proposed Keeyask Generation Project

FINAL REPORT

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JUNE, 2012; REVISED APRIL 2013

EXECUTIVE SUMMARY

The Mercury and Human Health Technical Working Group, participating in the environmental assessment (EA) for the Keeyask Generation Project requested Wilson Scientific Consulting Inc. (Wilson Scientific) to complete a human health risk assessment (HHRA) to address current and potential increased mercury in the environment that may result if the proposed Keeyask Generation Project proceeds. The HHRA was to consider the traditional uses of the land by the various First Nation communities in the study area. In addition, the most recent scientific evidence on health effects from mercury was to be part of the assessment.

The methods used to estimate human health risks were based on risk assessment procedures cited by Health Canada, the World Health Organization (WHO) and the US Environmental Protection Agency (US EPA).

The items of main concern were:

- Consumption of country (wild) foods (*i.e.*, fish, wild game, waterfowl and wild plants); and
- Ingestion and direct contact with surface water.

The water bodies of primary interest for this assessment were Gull and Stephens lakes. The HHRA was greatly assisted by Keeyask Cree Nations' representatives who shared their knowledge regarding types and locations of country foods and food consumption patterns. In addition, it should be noted that the HHRA did not measure mercury concentrations in food or people but instead relied upon present and estimated post-impoundment concentrations in water and foods that have been provided by other experts (*i.e.*, fish and surface water mercury concentrations provided by North/South Consultants Inc.; wild game mercury concentrations by Wildlife Resource Consulting Services MB Inc.; and waterfowl concentrations of mercury estimated by TetrES Consultants Inc. [now known as Stantec]).

The key conclusions of the HHRA are as follows:

1. Hazard Quotient values greater than 1 are predicted from consumption of certain fish under both the present conditions and the predicted post-impoundment conditions. Under post-impoundment conditions, Hazard Quotient values increase since the mercury concentrations in various fish are estimated to increase. The fish with the predicted highest increase in mercury concentrations are from Gull Lake and include northern pike (0.22 µg/g to just over 1 µg) and walleye (0.23 µg/g to just over 1 µg/g) while the increase in lake whitefish would be less (0.07 µg/g to just below 0.2 µg/g). The same species from Stephens Lake would be impacted less than fish from Gull Lake. Although Hazard Quotient values greater than 1 are predicted from certain fish based on consumption frequencies, it is stressed that this does not automatically mean that the consumption of these fish needs to be restricted. Issuance of consumption advisories is a complex issue that requires evaluation of the benefits and risks. Manitoba Health and Health Canada have committed to working with the KCNs and Manitoba Hydro on consumption advisories in a separate process.
2. No Hazard Quotient values greater than 1 are predicted from consumption of wild game or waterfowl under current or post-impoundment conditions. Muskrat is the only mammal that was predicted to have increased tissue concentrations of mercury following impoundment; however, the increases are considered to be very minor (*i.e.*, 0.02 µg/g under baseline conditions versus 0.04 µg/g under post-impoundment conditions). No measurable changes in mercury tissue concentrations under post-impoundment conditions in moose, beaver and snowshoe hare were predicted by Wildlife Resource Consulting Services. In the case of waterfowl, Stantec Consultants estimate that these may mirror changes in whitefish concentrations; however, no Hazard Quotient values greater than 1 were predicted from consumption of waterfowl.
3. Mercury concentrations in surface water do not pose unacceptable risks from contact or drinking under present or post-impoundment conditions (*i.e.*, risks are considered to be negligible). Typical total mercury surface water concentrations

are predicted to remain less than the currently used analytical method detection limit (*i.e.*, less than 0.05 µg/L as compared to the Canadian Drinking Water Guideline of 1 µg/L).

4. No conclusions can be provided on consumption of wild plants or gull eggs since discipline experts have not been able to estimate mercury concentrations either presently or under post-impoundment conditions.

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Table of Contents

Page #

Executive SummaryAppendix 5C ii
1.0 Introduction 1
2.0 Mercury and human health Risk Assessment 3
2.1 What is Mercury? 3
2.2 What are Typical Sources of Mercury? 3
2.3 How are Canadians Exposed to Mercury? 4
2.4 What are the Health Effects Associated with Mercury? 5
2.5 Who is Most Sensitive to Mercury Exposures? 6
2.6 If Mercury is Toxic, How is Any Exposure Safe? 7
2.7 What are Acceptable Concentrations of Mercury in Food? 8
2.8 What is Human Health Risk Assessment? 9
3.0 Summary of Environmental concentrations used in the HHRA 15
3.1 Concentration of Mercury in Fish 16
3.2 Concentration of Mercury in Wild Game 18
3.3 Concentration of Mercury in Waterfowl 20
3.4 Concentration of Mercury in Wild Plants 22
3.5 Concentration of Mercury in Surface Water 22
4.0 HHRA Methodology 24
4.1 Introduction 24
4.2 Problem Formulation 26
4.2.1 Chemicals of Potential Concern 26
4.2.2 Receptors of Concern 26
4.2.3 Assumed Receptor Characteristics 26
4.2.4 Exposure Pathways of Concern 31
4.2.5 Conceptual Model 32
4.3 Exposure Assessment 33
4.3.1 Environmental Concentrations 33
4.3.2 Mathematical Equations Used to Estimated Exposures 37
4.4 Toxicity Assessment 38
4.5 Risk Characterization 39
5.0 Results 40
5.1 Risks from Consumption of Fish 40
5.1.1 Present Conditions 41
5.1.2 Post-Impoundment Conditions 46
5.1.3 Health Effects from Consuming Fish at Rates Greater than Hazard Quotient Values of One 47
5.2 Risks from Consumption of Wild Game 52
5.2.1 Present Conditions 53
5.2.2 Post-Impoundment Conditions 54
5.3 Risks from Consumption of Waterfowl 56
5.3.1 Present Conditions 57
5.3.2 Post-Impoundment Conditions 58
5.4 Risks from Consumption of Wild Plants 59
5.5 Risk from Contact with Surface Water 60

5.5.1 Present Conditions 60
5.5.2 Post-Impoundment Conditions 61
5.6 Chemical Interaction Assessment of Various Forms of Mercury 61
5.6.1 Present Conditions 63
5.6.2 Post-Impoundment Conditions 64
6.0 Discussion and Uncertainty Analysis 66
7.0 Conclusions 69
Statement of Limitations 72
References 73

Appendix 5C-1: Detailed Technical Information, Worked Example Risk Calculations and Detailed Risk Estimates

List of Tables

Table 3-1: Total Mercury in the Muscle Tissue of Length-Standardized* Fish from Gull and Stephens Lakes: Present (2001-2006 for Gull Lake, 2001-2005 for Stephens Lake) Concentrations 17
Table 3-2: Total Mercury in the Muscle Tissue of Length-Standardized* Fish from Gull and Stephens Lakes: Predicted Maximum Post-Impoundment Concentrations 18
Table 3-3: Total Mercury in the Muscle Tissue of Wild Game Collected from the Project Area: Present Concentrations 19
Table 3-4: Total Mercury in the Muscle Tissue of Wild Game from the Project Area: Predicted Maximum Post-Impoundment Concentrations 19
Table 3-5: Total Mercury in Waterfowl from the Project Area: Present Concentrations 21
Table 3-6: Total Mercury in Waterfowl in the Project Area: Predicted Maximum Post-Impoundment Concentrations 21
Table 3-7: Total Mercury Measured in the Surface Water from the Project Area: Present Concentrations 23
Table 3-8: Total Mercury in Surface Water from the Project Area: Predicted Mean Post-Impoundment Concentrations 23
Table 4-1: Assumed Consumption Rates of Various Country (Wild) Foods Consumed by the Keeyask Cree Nations Communities 30
Table 4-2: Conceptual Model for Traditional Land Use 33
Table 5-1: Risk Estimates from Consumption of Fish: Present Conditions 43
Table 5-2: Risk Estimates from Consumption of Fish for Various Fish Size Classes: Present Conditions 45
Table 5-3: Risk Estimates from Consumption of Fish: Post-Impoundment Conditions 47
Table 5-4: Risk Estimates from Consumption of Wild Game: Present Conditions 54
Table 5-5: Risk Estimates from Consumption of Wild Game: Post-Impoundment Conditions 56
Table 5-6: Risk Estimates from Consumption of Waterfowl: Present Conditions 58
Table 5-7: Risk Estimates from Consumption of Waterfowl: Post-Impoundment Conditions 59
Table 5-8: Risk Estimates from Contact with Surface Water: Present Conditions 60
Table 5-9: Risk Estimates from Contact with Surface Water: Post-Impoundment Conditions 61
Table 5-10: Risk Estimates from Mercury for Combined Sources: Present Conditions 64
Table 5-11: Risk Estimates from Mercury for Combined Sources: Post-Impoundment Conditions 65

HUMAN HEALTH RISK ASSESSMENT OF THE MERCURY FROM THE PROPOSED KEEYASK GENERATION PROJECT

1.0 INTRODUCTION

The Mercury and Human Health Technical Working Group (the Technical Working Group) for the Keeyask Generation Project requested that Wilson Scientific Consulting Inc. (Wilson Scientific) complete a human health risk assessment (HHRA) to address current and potential increased methylmercury (mercury) concentrations in the environment that may result if the proposed Keeyask Generation Project is approved. The specific questions that the HHRA needed to address were:

1. What are the risks from consumption of fish under present conditions?
2. If the proposed project is approved, what are the risks to persons consuming:
    a. Fish?
    b. Wild game?
    c. Waterfowl?
    d. Wild plants?
    e. Water?

The HHRA also needed to consider the domestic uses of the land by the various local First Nation communities. In addition, the most recent scientific evidence on health effects from mercury was required to be part of the assessment.

It is important to note that through a formal agreement with the Keeyask Cree Nations (KCNs), they participated in the environmental assessment (EA) for the Keeyask Generation Project; as part of the EA, a Mercury and Human Health Technical Working Group was established with representatives from the KCNs and Manitoba Hydro and their respective consultants. The First Nations consisted of representatives from:

- Tataskweyak Cree Nation
- War Lake First Nation
- Fox Lake Cree Nation
- York Factory First Nation

The Mercury and Human Health Technical Working Group played an important role in providing guidance and knowledge on traditional use of the land that has been incorporated into this HHRA.

This report outlines the methods, results, conclusions and recommendations of the HHRA and is organized as follows:

- Section 2 of the report introduces mercury as a chemical of potential concern, and the concept of HHRA;
- Section 3 summarizes the site setting and relevant documents that provide information cited in the HHRA;
- Section 4 provides methods used to complete the HHRA;
- Section 5 provides the results;
- Section 6 provides a discussion of the results including an uncertainty analysis;
- Section 7 provides the overall conclusions of the HHRA; and
- Appendix 5C-1 provides detailed technical information, worked example calculations and detailed risk estimates.

2.0 MERCURY AND HUMAN HEALTH RISK ASSESSMENT

2.1 WHAT IS MERCURY?

Mercury is a metal that naturally occurs in very small quantities in the soil, water, plants, animals, etc. in the Keeyask Project area as well as many other parts of Canada. Mercury can be found in various forms categorized as follows:

- Elemental mercury (a shiny silver-coloured liquid that slowly evaporates at room temperature and more rapidly when heated to moderate temperatures);
- Inorganic mercury (a form of mercury that results when elemental mercury combines with sulphur, chlorine or oxygen to form “mercury salts”); and
- Methyl mercury (a form of mercury that results when elemental mercury combines with carbon to form “organic mercury” and is naturally present in very small quantities in all foods, but almost always highest in carnivorous fish).

2.2 WHAT ARE TYPICAL SOURCES OF MERCURY?

Mercury is used by humans in a wide-variety of industrial processes and commercial products. Metallic mercury is used to produce chlorine gas and caustic soda. In consumer products, metallic mercury can be found in thermometers, dental fillings, batteries and fluorescent lights. Inorganic mercury salts can sometimes be found in various anti-septic creams and ointments. In terms of exposure to people, the vast majority of exposure is in the form of methyl mercury through the consumption of fish.

Although mercury occurs naturally in the environment, human activities may result in increased exposures. Human-contributed sources of mercury exposures include:

- Releases of mercury into the air from combustion processes such as coal-fired power generation, metal mining, metal smelting operations and waste incineration;

- Disposal of mercury containing products (*e.g.*, fluorescent lights, batteries, thermostats, barometers, switches and relays) into landfill sites and subsequent leaching into the environment; and
- Flooding of soils for new dam sites (this can result in mercury from flooded soils releasing mercury into the aquatic food chain).

2.3 HOW ARE CANADIANS EXPOSED TO MERCURY?

Canadians may be exposed to mercury from activities that include:

- Eating fish flesh of any kind. Fish consumption typically represents the greatest source of exposure to most Canadians. Fish with the highest muscle mercury concentrations tend to be the large and long-lived predatory fish; however, essentially all fish contain some levels of mercury. Fish in some lakes in Canada have naturally high concentrations of mercury and it is not an issue that is totally restricted to impoundments. Also, some marine fish often contain elevated concentrations of mercury. A list of fish with relatively high mercury concentrations includes the following:
    - Fresh and frozen tuna;
    - Canned albacore tuna (other canned tuna do not typically contain as much mercury);
    - Lake trout;
    - Burbot;
    - Walleye (or pickerel);
    - Jackfish (or pike);
    - Shark;
    - Swordfish;
    - Marlin;
    - Orange roughy; and
    - Escolar (a type of mackerel that is commonly used in sushi);

- Eating fish from localized areas impacted by mercury releases (concentrations also tends to be greatest in the larger, long-lived predatory fishes);
- Breathing vapours in air from spills, incinerators and industrial operations that release mercury into the air;
- Breathing mercury vapours that are released into a person's mouth during dental treatments (mercury amalgams used as fillings for cavities); and
- Use of medical treatments which contain mercury (various topical ointments and creams).

2.4 WHAT ARE THE HEALTH EFFECTS ASSOCIATED WITH MERCURY?

The health effects of concern depend on the form of mercury and the duration and magnitude of exposures. If the exposure is of elevated concentrations for a long duration, all forms of mercury may cause health effects to the nervous system. Methyl mercury (primarily from fish consumption) and elemental mercury (primarily from inhalation of vapours) tend to have greater ability to cause health effects than inorganic mercury due to an increased ability of these forms to cross body tissues and enter the nervous system. Important aspects of mercury toxicology include the following:

- Health effects primarily associated with methyl mercury have included damage to the brain (*e.g.*, motor skills, irritability, shyness, tremors, changes in vision/hearing, memory problems, decreased IQ);
- Health effects primarily associated with inorganic mercury have been associated with the kidneys, gastrointestinal damage and autoimmune effects. Mercury salts can cause blisters and ulcers on the lips and tongue. Rashes, excessive sweating, irritability, tremors, muscle weakness and high blood pressure have also been noted in persons exposed to elevated concentrations of inorganic mercury;
- Health effects primarily associated with elemental mercury, such as vapours, have included hand tremors and memory problems;

- Short-term exposures to high levels of metallic mercury (primarily as vapours) may be associated with effects that include lung damage, nausea, vomiting, diarrhea, blood pressure, increased heart rate and skin rashes, and eye irritation; and
- Although there is some evidence of mercury causing cancer in animals at elevated exposures, there is not considered to be adequate evidence to conclude that mercury is a human carcinogen and most health agencies do not consider it necessary to consider the cancer endpoint in establishing safe levels of exposure.

Fortunately, mercury in most foods, consumer products, and the environment are at concentrations not great enough to cause the health effects listed above.

It is also noted that in order for mercury to cause toxicity, it must be absorbed. For example, if a child accidentally swallowed liquid mercury from a broken thermometer, it is unlikely that much of the ingested mercury would be absorbed into the body; however, mercury could enter the body via inhalation of vapours from the spill.

2.5 WHO IS MOST SENSITIVE TO MERCURY EXPOSURES?

Generally speaking, young children and pregnant women (or women of child-bearing age) (due to the potential harmful effects on the developing fetus) are of primary concern to health agencies with respect to mercury exposure; however, persons of any age may experience health effects if the exposures are great enough. Consequently, health authorities can have different recommendations for minimizing exposures depending upon the segment of the population a person may represent. For example, many health agencies recommend that pregnant or breastfeeding women and young children restrict their consumption of certain types of fish containing high concentrations of mercury; however, most health agencies also agree that consumption of fish is an important part of the diet and these agencies stress that consumption of fish containing low concentrations of mercury represent a healthy part of the diet for pregnant and breastfeeding women (as well as for young children).

2.6 IF MERCURY IS TOXIC, HOW IS ANY EXPOSURE SAFE?

Although mercury exposure is associated with some serious health effects, there are certain exposures considered to be "safe" and without appreciable health risks to the general public. Because mercury is ubiquitous in the global environment, health agencies around the world have dedicated considerable effort in determining mercury exposure rates considered to be acceptable. This process has allowed health agencies to recommend that people continue to consume fish because the benefits outweigh the risks.

Using a risk assessment approach, it is possible that no unacceptable health risks may exist from mercury even when concentrations in the environment are considered to be elevated above normal levels. This conclusion is most common when persons are not receiving elevated exposures to the mercury (despite its presence at elevated concentrations in the environment). Situations that can result in a conclusion of "no appreciable risk" from elevated mercury concentrations in the environment include:

- The mercury is found in environmental media with which people do not often come into contact (*e.g.,* located in subsurface soils that do not leach into groundwater and are not releasing appreciable mercury vapours);
- The mercury is found in a food (or foods) that people are not consuming or are consuming infrequently;
- The mercury is found in a form in the environment that is not very soluble and, therefore, cannot readily be absorbed into the body even when it is consumed (*i.e.,* it is in a form that is not very bioavailable); and
- The mercury is found in environmental media at concentrations that people regularly contact; however, the concentrations are low enough that exposures are still below levels considered to be acceptable by agencies such as the World Health Organization and Health Canada.

In such cases, it may be possible to arrive at conclusions that indicate acceptable risks from mercury even though elevated concentrations are present in the environment.

Nevertheless, in all cases, conclusions must be based on a careful analysis supported by the available science (*e.g.*, risk assessment).

2.7 WHAT ARE ACCEPTABLE CONCENTRATIONS OF MERCURY IN FOOD?

For mercury occurring in commercial fish sold at the retail level, Health Canada (2007) provides a guideline of 0.5 µg/g (wet weight). Similarly, the European Community (2006) provides a maximum permissible mercury concentration of 0.5 µg/g (wet weight) for most fish but then allows up to 1.0 µg/g (wet weight) for a list of specific fish that includes northern pike (*Esox lucius*). It needs to be stressed that these maximum permissible concentrations are specific to commercial fish.

In the case of fish consumed for subsistence purposes, there is no official recommendation available from either Health Canada or WHO. Part of the difficulty in establishing acceptable concentrations of mercury is that fish (*i.e.*, often the major source of mercury exposure) has tremendous nutritional benefits.

Health Canada (2007) has noted the following:

> *"It is considered essential that any communications to the public include information on the health benefits of fish consumption alongside information on the risks of methylmercury exposure so that citizens can consider both the benefits and risks in reaching their own decisions about appropriate fish consumption. Studies on the nutritional benefits of fish are supportive of efforts to influence consumers' behaviour by modifying the types of fish regularly chosen rather than by decreasing overall fish consumption."*

Notwithstanding the above, provincial and federal health authorities have the ultimate responsibility for making consumption recommendations and this HHRA avoids providing final advice on recommendations on how much fish and country foods are safe to consume.

In the case of other foods (*i.e.*, wild game, waterfowl and plants), no health agency recommendations were identified for allowable mercury content.

2.8 WHAT IS HUMAN HEALTH RISK ASSESSMENT?

Human health risk assessment is a process that is accepted by Canadian and international health agencies for evaluating the potential for chemical, biological and physical agents to cause adverse health effects in people. Although it is desirable to minimize exposures to some environmental chemicals, exposures to chemicals and physical agents cannot be avoided in many circumstances. Potentially harmful chemicals and physical agents can exist naturally, and there were exposures prior to modern civilization. This is also true for mercury. Regulatory agencies across Canada and around the world have adopted risk assessment as a scientifically-defensible tool for the evaluation of potential health risks to chemicals and physical agents. Examples of regulatory agencies that currently use risk assessment to assist in making health-based decisions include the World Health Organization, US Environmental Protection Agency and Health Canada.

Risks from environmental chemicals and physical agents are normally evaluated using the same principles and fundamentals that regulatory agencies use to develop standards to protect the general public from unacceptable risks for soil, water, air and food. It is stressed that there are uncertainties in risk assessment and it is virtually impossible to prove complete safety in almost anything that is evaluated. Consequently, risk assessment normally comments on the reasonable likelihood of adverse health effects in people exposed to various environmental chemicals or physical agents rather than providing absolute certainties of no adverse health effects.

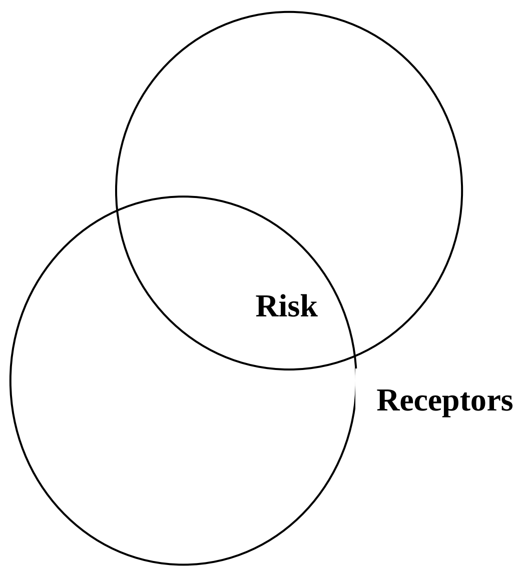
It should also be noted that most health agencies and scientists contend that risk assessment is much more likely to overestimate than underestimate risks. Due to the various uncertainties in risk assessment, health agencies tend to use large safety factors and default assumptions that result in overestimation of health risks. Further details on the HHRA methods are provided in Sections 4 and 5 of this report while some of the particularly important concepts are discussed below.

Basic Elements Required for Risk to Exist

One of the basic tenets of risk assessment is that in order for human health risks to exist the following elements must be present:

- A person (or receptor) is present in the area of concern;
- A chemical is present in the area of concern; and
- An exposure pathway must exist that allows a person (or persons) to be exposed.

For example, if a non-volatile chemical (such as lead) was present in subsurface soil and not leaching into groundwater, there would be virtually no risk from this chemical (as long as persons were not digging in the soil) as exposure pathways would not exist. However, as soon as persons dig in the subsurface soil, an exposure pathway would be open and exposures could then potentially exist.



Dose-Response Relationships

A second important fundamental of risk assessment is that the magnitude of risk is proportional to both the magnitude of exposure and the inherent potency of the chemical. Most health agencies agree that there are acceptable or "safe" levels of exposures unlikely to cause adverse health effects for even the most potent chemicals (*e.g.*, there are acceptable levels of exposure to chlorinated dioxins from pulp and paper effluent, benzo[a]pyrene from car exhaust, aflatoxin in peanut butter and various chemicals in a cup of coffee). Likewise, some seemingly innocuous chemicals may pose unacceptable risks if consumed in excess quantities (*e.g.,* although quite rare, people have become ill or even died from consumption of excessive amounts of water [due to electrolyte imbalance] or over consumption of Vitamin A from polar bear livers and carrot juice). In other words, there can be acceptable levels of the most hazardous substances and unacceptable levels of the most innocuous substances. Thus, for virtually all chemicals and physical agents that may be harmful to people, the principle of dose-response relationships apply.

According to the dose-response principle, as the level of exposure increases, the probability and/or magnitude of adverse health effects also increase. An important exception to this theory, however, is for exposure rates that are so low that adverse health effects are not expected to be observed until dose rates increase above a certain threshold of exposure. For example, certain minerals such as iron and zinc are required in our diet and are not expected to cause adverse health effects at levels at or below our recommended daily allowances for proper health and fitness. It is only when these levels are exceeded that the adverse health effects begin to increase with increasing levels of exposure.

The principle that the magnitude of risk is in proportion to the level of exposure and the potency of the chemical can be summarized as follows:

Risk = Magnitude of Exposure x Toxicity of the Chemical

Human health risks were estimated using the concept of dose-response relationships to the maximum extent possible in this report.

Important Terms Used in Human Health Risk Assessment

Scientific terminology is commonly used to describe human health risks from chemicals and physical agents. Some of the more important terms in the context of the human health risk assessment are provided below.

> *Tolerable Daily Intake (TDI):* The daily amount of exposure that is considered unlikely to cause adverse health effects in the general population (including sensitive individuals). Tolerable Daily Intakes are usually provided as daily dose rates in units of mass of chemical per kilogram of body weight of a person per day (*e.g.*, the Tolerable Daily Intake for methyl mercury exposure to pregnant women is 0.2 µg of methyl mercury/kg body weight/day such that a 60 kilogram pregnant woman should not exceed 12 µg of methyl mercury per day). Other terms that are similar in meaning are the Acceptable Daily Intake (used by the World Health Organization) and Reference Dose (used by the US Environmental Protection Agency). Health Canada-derived Tolerable Daily Intakes are meant to protect all members of the general public including First Nation individuals.
>
> *Hazard Quotient:* Used to estimate risks for non-carcinogens, Hazard Quotient values can be estimated according to the following formula:
>
> $$\textit{Hazard Quotient} = \frac{\textit{Estimated Exposure } (\mu g/kg \textit{ body weight/day})}{\textit{Tolerable Daily Intake } (\mu g/kg \textit{ body weight/day})}$$
>
> A Hazard Quotient value that is less than 1 indicates that exposures are less than the Tolerable Daily Intake and, thus, adverse health effects are unlikely. A Hazard Quotient value that is greater than 1 indicates a situation where chemical exposure rates may exceed the acceptable rate and, thus, may indicate excessive or unacceptable risks. In all cases, however, Hazard Quotients require careful consideration of the underlying assumptions and uncertainties before final conclusions are made.

Incremental Lifetime Cancer Risk: An estimate of the increased level of cancer risk posed by exposure to a carcinogen at a site. Incremental Lifetime Cancer Risks can be estimated according to the following formula:

ILCR = Lifetime Daily Exposure (μg/kg/day) x Potency Factor (μg/kg/day)$^{-1}$

In many parts of Canada, an Incremental Lifetime Cancer Risk estimate that is less than or equal to one in one hundred thousand (1×10^{-5}) is normally considered to be acceptable while an Incremental Lifetime Cancer Risk greater than this value generally indicates that clean-up or some other form of risk reduction/management is required. In all cases, however, interpretation of Incremental Lifetime Cancer Risk estimates requires consideration of the overall risk assessment process and assumptions to ensure conclusions on risks are not misrepresented.

It is noted that neither Health Canada nor the World Health Organization considers mercury to be a carcinogenic substance. Consequently, it was not necessary to estimate Incremental Lifetime Cancer Risks due to mercury exposures.

Some Limitations to Human Health Risk Assessment

With the above principles in mind, there are some important limitations to the HHRA process that need to be considered. Firstly, an HHRA is completed as a science-based toxicological evaluation of the possibility for risks posed by chemicals. As a result, this toxicological evaluation does not cover all elements of health that local First Nations may be concerned about. To evaluate non-toxicological indicators of health, a different approach would be required that may involve other expertise (*e.g.*, sociologists, social scientists, spiritual leaders, etc.). Although the proposed Keeyask Project may affect health indicators not related to toxicological outcomes, only the toxicological evaluation of the potential for physical disease was the focus of the HHRA. No conclusions have been made about mental, emotional or spiritual health in this document.

Finally, risk assessment carries with it uncertainties and it is never possible to ensure absolute safety. Daily events may present exposures to chemicals and physical agents including: eating burned food (exposure to polycyclic aromatic hydrocarbons), consuming chlorinated drinking water (exposure to chlorinated organic chemicals), using environmentally friendly compact fluorescent lights (exposure to mercury), breathing indoor air of homes with carpeting (exposure to volatile organic compounds) and using electrical appliances that release electromagnetic fields. These exposures are associated with similar uncertainties. Although it is possible to estimate risks that may be associated with each of these individual activities, there is a level of uncertainty that exists despite our best efforts.

Overall, risk assessment is recognized as a scientifically-defensible tool that provides a methodology for evaluating potential risks from chemicals and physical agents; however, uncertainty is an element of risk assessment that cannot be avoided. Due to the existence of these uncertainties, a conservative approach is typically applied in risk assessment and this approach tends to overestimate risks and, thus, minimize the potential for adverse health effects.

3.0 SUMMARY OF ENVIRONMENTAL CONCENTRATIONS USED IN THE HHRA

The focus of the HHRA was on the Keeyask Cree Nations (KCNs) communities since these people would have the greatest amount of exposure from country foods under both present and post-impoundment conditions. Nevertheless, similar methods and results would be expected for members of the general public who fish and hunt at similar rates as the KCNs within the Project area. The KCNs were assumed to be exposed to mercury from consumption of various local foods including fish, wild game, waterfowl and wild plants. Two scenarios were considered:

- Present conditions (*i.e.,* based on fish mercury data collected from 2001-2009).
- Post-impoundment conditions point in time when mercury concentration is predicted to reach peak concentrations in fish (it has been estimated in Keeyask Hydropower Limited Partnership [2011a,b] that this could occur approximately 3-7 years after impoundment).

The water bodies of primary interest were Gull and Stephens lakes. The HHRA did not measure mercury concentrations in food or people but relied on measured present and estimated post-impoundment concentrations in water and foods provided by other experts (*i.e.,* fish and surface water mercury concentrations by North/South Consultants Inc.; wild game mercury concentrations by Wildlife Resource Consulting Services MB Inc.; and waterfowl concentrations of mercury estimated by TetrES Consultants Inc. (now known as Stantec). Results of the various studies on mercury concentrations in fish, wild game, plants and water are critical input parameters used to assess human health risks. The reader is referred to Keeyask Hydropower Limited Partnership (2011a,b) for specific discussion on these concentrations and potential variability with time.

3.1 CONCENTRATION OF MERCURY IN FISH

The Aquatic Environment Supporting Volume (AE SV), Section 7.2) provides the present (up to year 2006) and predicted future concentrations of mercury in fish muscle and the reader is referred to that section for full details of historic, current, and potential future fish mercury concentrations in the Keeyask study area. To increase the sample size of fish mercury concentrations for the HHRA, particularly to strengthen the power of analysis for fish length-class specific exposure levels, available data from Stephens Lake for 2007 and 2009 were included.

For consideration in the HHRA, members of the Mercury and Human Health Technical Working Group arranged for a workshop in October 2009 with Members of local First Nations (known as the Keeyask Cree Nations). In this workshop, persons in the communities discussed how often and how much of each food type was consumed. The detailed results of this workshop are provided in the October 2009 memo provided by InterGroup Consultants. Although numerous fish species are available for consumption in the Keeyask area, the key fish species that are most frequently consumed by resource users and that will mainly contribute to human mercury exposure are:

- Lake whitefish;
- Northern pike (also known as jackfish);
- Walleye (also known as pickerel); and
- Lake sturgeon.

Table 3-1 provides a summary of the total mercury concentrations in fish muscle tissue that were used in the HHRA and referred to as present concentrations (AE SV Section 7.2). It is noted that NSC has indicated that present mercury concentrations in lake sturgeon are based on only 13 fish from one location (Gull Lake).

Total mercury in fish was assumed to exist as methylmercury as recommended by Health Canada (2007). It is noted that there is considerable variability in the portion of total mercury that will exist as methylmercury (Health Canada [2007] cites a range of 30 to 95% as methylmercury). Nevertheless, Health Canada (2007) recommends that HHRA consider the mercury in fish to be present only as methylmercury.

Table 3-1: Total Mercury in the Muscle Tissue of Length-Standardized* Fish from Gull and Stephens Lakes: Present (2001-2006 for Gull Lake, 2001-2005 for Stephens Lake) Concentrations

Fish species	Mercury Concentration in Fish Muscle (for Standardized Size)* (µg/g; wet weight)	
	Gull Lake	Stephens Lake
Lake whitefish	0.07	0.09
Northern pike	0.22	0.26
Walleye	0.23	0.29
Lake sturgeon	0.20	No measurements currently available

* Standard lengths: lake whitefish 350 mm; northern pike 550 mm; walleye 400 mm, lake sturgeon 1,300 mm. Individual mercury concentrations will be dependent upon the size of the fish with the smaller fish having generally lower concentrations than bigger fish.

To estimate maximum mercury concentrations in whitefish, pike, and walleye following impoundment, NSC have used various modeling approaches (AE SV, Section 7.2.2). Based on the modeling results and taking into account the strength and weaknesses of the different models used, NSC considered the best estimates of maximum post-impoundment concentrations would be equal to the values provided in Table 3-2. No model is available to predict maximum post-impoundment mercury concentrations in lake sturgeon, and the values included in Table 3-2 are “best guess” estimates by the author of the Fish Quality section of the Aquatics Environment SV (North South Consultants, *pers. comm*. 2010).

Based on this evaluation, it is evident that the mercury concentrations of certain fish may increase markedly following impoundment while other fish would be much less affected. Northern pike and walleye from Gull Lake would be the most affected fish species while the whitefish from Stephens Lake is predicted to have the lowest increase in mercury concentration following impoundment.

Table 3-2: Total Mercury in the Muscle Tissue of Length-Standardized* Fish from Gull and Stephens Lakes: Predicted Maximum Post-Impoundment Concentrations

Fish Type	Average Estimated Mercury Concentration in Fish Muscle (for Standardized Size)* (µg/g; wet weight)	
	Gull Lake	Stephens Lake
Whitefish	0.19	0.15
Northern pike	1.0	0.50
Walleye	1.0	0.50
Sturgeon	0.30	0.25

* Standard lengths: lake whitefish 350 mm; northern pike 550 mm; walleye 400 mm, lake sturgeon 1,300 mm. Individual mercury concentrations would be dependent upon the size of the fish with the smaller fish having generally lower concentrations than bigger fish.

3.2 CONCENTRATION OF MERCURY IN WILD GAME

The Terrestrial Environment Supporting Volume (TE SV) (Section 8) provides the present and future concentrations of mercury in wild game tissue compiled by Wildlife Resource Consulting Services MB Inc. (WRCS) and the reader is referred to that section for full details of the measured and predicted concentrations.

As discussed earlier, members of the Mercury and Human Health Technical Working Group arranged for a workshop in October 2009 with members of the KCNs communities. In this workshop, persons in the communities discussed how often and how much of each food type was consumed. Although numerous wild game species can be consumed, the key species of concern (based on frequency of consumption and likelihood to accumulate mercury) are as follows:

- Beaver;
- Muskrat;
- Moose; and
- Snowshoe hare.

Table 3-3 provides a summary of the mercury concentrations in muscle tissue of wild game that were used in the HHRA for present concentrations. Mercury in wild game was estimated as total mercury concentrations (*i.e.*, present in both inorganic and methylmercury forms).

Table 3-3: Total Mercury in the Muscle Tissue of Wild Game Collected from the Project Area: Present Concentrations

Species	Total Mercury as an Average Concentration in Muscle (µg/g; wet weight)	Range of Total Mercury Concentration in Muscle (µg/g; wet weight)
Beaver	0.01	<0.01 – 0.05
Muskrat	0.02	<0.01 – 0.06
Moose	0.07*	<0.01–0.17
Snowshoe Hare	0.05*	<0.01–0.12

* Mercury concentration in moose and snowshoe hare was only a literature estimate and may have greater uncertainty than other species for which measured values were obtained from the study area.

In the case of the mercury concentrations in wild game following impoundment, Wildlife Resource Consulting Services considered the best estimate of concentrations during the maximum year post-impoundment would be equal to the values provided in Table 3-4. Mercury in wild game was estimated as total mercury concentrations.

Table 3-4: Total Mercury in the Muscle Tissue of Wild Game from the Project Area: Predicted Maximum Post-Impoundment Concentrations

Species	Total Mercury Concentration in Muscle (µg/g; wet weight)	Most Likely Range in Total Mercury Concentration in Muscle (µg/g; wet weight)
Beaver	0.01	<0.01 – 0.05
Muskrat	0.04	<0.01 – 0.12
Moose	0.07*	<0.01–0.17
Snowshoe Hare	0.05*	<0.01–0.12

* Mercury concentration in moose and snowshoe hare was a literature based estimate and likely has greater uncertainty than other species for which measured concentrations were obtained from the study area

Based on this evaluation, it is evident that wild game would not be expected to be greatly impacted by the proposed impoundment. Beaver, moose and snowshoe hare would not be predicted to have any measurable change in mercury tissue concentrations while muskrat would be only expected have an increased concentration of 0.04 µg/g (although this is a doubling of concentrations, it is still an increase of only 0.02 µg/g).

3.3 CONCENTRATION OF MERCURY IN WATERFOWL

The TE SV (Section 8 and Appendix 8A) provide the present and future concentrations of mercury in waterfowl tissue compiled by Stantec and the reader is referred to that section for full details of the measured and predicted concentrations. Although various species of waterfowl can be consumed, the waterfowl assessed were (based on frequency of consumption and likelihood to accumulate mercury):

- Ducks (*e.g.*, mallard, ring-necked duck, teal, golden eye); and
- Gull eggs.

Table 3-5 provides a summary of the mercury concentrations in muscle tissue of ducks that were used in the HHRA of present concentrations. As described in TE SV (Section 8), Stantec has estimated that concentrations of mercury in ducks would be similar to or less than concentrations measured in local whitefish. Stantec has indicated that there is no information on mercury concentrations that may result in gull eggs and, as a result, could not provide an estimate of present concentrations for use in the HHRA. All mercury in ducks was assumed to exist as methylmercury (*i.e.*, mirrored lake whitefish concentrations).

Table 3-5: Total Mercury in Waterfowl from the Project Area: Present Concentrations

Taxon	Mean Mercury Concentration (µg/g; wet weight)	
	Gull Lake	Stephens Lake
Duck	≤0.07	≤0.09
Gull eggs	No measurements currently available	No measurements currently available

* Mercury concentration in ducks was an estimate where concentrations were assumed to be similar to or less than concentrations found in whitefish.

In the case of the mercury concentrations in waterfowl following impoundment, Stantec considered the best estimate of concentrations during the maximum year post-impoundment to equal the values provided in Table 3-6. Once again, Stantec has estimated that concentrations of mercury in ducks would be similar to or less than concentrations in whitefish and, consequently, the mercury levels provided in Table 3-6 for ducks are those previously provided for whitefish.

Based on this evaluation, it is evident that the increases in mercury concentrations in ducks are expected to be relatively modest following impoundment. No estimates are provided for gull eggs and, consequently, these would need to be directly measured in the field if further information is required.

Table 3-6: Total Mercury in Waterfowl in the Project Area: Predicted Maximum Post-Impoundment Concentrations

Taxon	Mean Mercury Concentration (µg/g; wet weight)	
	Gull Lake	Stephens Lake
Duck	≤0.19	≤0.15
Gull eggs	No estimates available	No estimates available

* Mercury concentration in ducks was an estimate where concentrations were assumed to be similar to or less than concentrations found in whitefish.

3.4 CONCENTRATION OF MERCURY IN WILD PLANTS

Although many types of wild plants can be consumed from the Project area, the key plants that were identified from discussions with the KCNs community Members are:

- Northern tea (also known as Labrador tea);
- Blueberries; and
- Seneca root.

There was no information available on present mercury concentrations in these plants. Nor were future concentration estimates provided for post-impoundment conditions. Consequently, these would need to be directly measured in the field if further information was required.

3.5 CONCENTRATION OF MERCURY IN SURFACE WATER

The AE SV (Section 2) provides a description of the present concentrations of mercury in surface water as well as an assessment of effects of the Project on concentrations in surface water in the study area and the reader is referred to that section for additional detail. The following provides a summary of this information presented in the AE SV.

Mean total mercury concentrations measured in Gull and Stephens lakes were less than the current analytical method detection limit of 0.05 µg/L. The maximum measured total mercury concentration for the entire study area (Split Lake to the Nelson River estuary) was 0.32 µg/L (site NR-5 August 2003). Mercury has been detected across the study area and at three sites (GT1, NR5, and NR6) concentrations have occasionally exceeded the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG) for freshwater aquatic life of 0.1 µg/L; however, all samples were within the Manitoba drinking water guideline of 1 µg/L.

Table 3-7 provides a summary of the measured total mercury concentrations in surface water that were used in the HHRA of present concentrations.

Table 3-7: Total Mercury Measured in the Surface Water from the Project Area: Present Concentrations

Mean Total Mercury Concentration in Surface Water (µg/L)	
Gull Lake	**Stephens Lake**
Less than 0.05	Less than 0.05

Project-related increases in mercury in surface water are not expected to exceed 0.05 µg/L or to cause or contribute to exceedences of the drinking water quality guideline in, or downstream of, the Keeyask reservoir (see Table 3-8). Based on modeling results and literature regarding measured concentrations of mercury in Manitoba and Ontario reservoirs, it is expected that total mercury concentrations would not exceed 0.05 µg/L; this value was therefore used as a conservative value in the HHRA. Concentrations of mercury are expected to remain below the Manitoba PAL water quality guideline and below the analytical detection limits employed in this study from the combined effects of peatland disintegration and flooding. Mercury was not detected in the Nelson River between Clark and Stephens lakes and the predicted average increases due to peatland disintegration and flooding are expected to be too small to exceed the analytical detection limit. However, during periods where organic particulate materials are notably elevated as a result of resuspension or peatland disintegration (*i.e.*, stochastic events), total mercury concentrations may be higher than existing conditions. Effects on Stephens Lake are also not expected to exceed total mercury concentrations of 0.05 µg/L.

Table 3-8: Total Mercury in Surface Water from the Project Area: Predicted Mean Post-Impoundment Concentrations

Mean Total Mercury Concentration in Surface Water (µg/L)	
Gull Lake	**Stephens Lake**
Less than 0.05	Less than 0.05

4.0 HHRA METHODOLOGY

4.1 INTRODUCTION

As mentioned earlier, the focus of the HHRA was on the KCNs communities but similar findings would be expected for members of the general public who frequently fish and hunt. These First Nations were assumed to be exposed to mercury from consumption of various local foods including fish, wild game, waterfowl and wild plants. Two scenarios were considered:

- Present conditions; and
- Post-impoundment conditions at the point in time when mercury concentration is predicted to reach peak concentrations in fish.

The methods used to estimate human health risks were primarily based on risk assessment provided by Health Canada, the World Health Organization (WHO) and the United States Environmental Protection Agency (US EPA). Important documents that have been used to estimate risks include the following:

- Health Canada. 2010a. (draft) Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment of Chemicals ($DQRA_{CHEM}$). Contaminated Sites Division, Safe Environments Programme, Health Canada, Ottawa, ON.
- Health Canada. 2010b. Toxicological Reference Values, Estimated Daily Intakes, or Dietary Reference Values for Trace Elements.
- Health Canada. 2009a. (draft) Federal Contaminated Site Risk Assessment in Canada – Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA).
- Health Canada. 2009b. Federal Contaminated Site Risk Assessment in Canada – Part IV: Spreadsheet Tool for Human Health Preliminary Quantitative Risk Assessment (PQRA).

- Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption.
- Health Canada. 2004. Canadian Handbook on Health Impact Assessment.

Briefly, exposures to mercury were estimated based on a variety of assumptions relating to the use of areas and the possible dietary habits (*i.e.,* consumption of animals and plants) of people in the vicinity of the site. The toxicological literature was then reviewed to identify exposure rates for mercury that have been determined by international health agencies to be acceptable or "safe" (or more specifically, exposure rates without appreciable risks of adverse effects). The next step in the risk assessment was a comparison of the estimated exposure rates to the dose rates considered acceptable or "safe" for humans for the various consumption scenarios considered in the assessment.

Risks from historic exposures that may have occurred in previous decades were not evaluated in the assessment of off-site receptors. Instead, the focus of the exposure assessment was on exposures that may possibly occur under present and post-impoundment use.

In addition, it should be noted that health agencies have undertaken blood and hair analysis for mercury in the KCNs communities in the Keeyask study area in the 1990s. These data are confidential and were not available to Wilson Scientific for inclusion in this HHRA. As discussed by the Mercury and Human Health Technical Working Group, community specific data were available, in summary form at the community level (*i.e.,* no individual results), to each community by request directly to Health Canada.

The methods used to complete the risk assessment are described in detail in the following sections.

4.2 PROBLEM FORMULATION

4.2.1 Chemicals of Potential Concern

The HHRA focused on mercury as the main chemical of potential concern. Mercury was evaluated since it has appreciable potential to accumulate in the environment at concentrations that could affect food and other sources. Mercury can enter the aquatic food chain and prompt fish consumption advisories following reservoir creation. It should be emphasized that mercury occurs naturally in many foods, particularly predatory fish at the top of the food chain. Nevertheless, it is clear that some fish concentrations of mercury are expected to increase appreciably following impoundment.

4.2.2 Receptors of Concern

The Keeyask study area is used for a variety of purposes including the traditional collection of foods by the KCNs community Members. Persons participating in such activities could be of any age. Consistent with Health Canada (2009a; 2010a) guidance, the most sensitive toddler (ages 0.5 to four years) was the key receptor used to evaluate risks to mercury in the Keeyask area. Other receptors included women of childbearing age and adult males.

4.2.3 Assumed Receptor Characteristics

To the extent possible, receptor characteristics were based on data specific to the Canadian population. Values used in the risk assessment were based primarily on recommendations provided by Health Canada (2009a; 2010a). Other sources such as CCME (2006), Richardson (1997) and other published scientific literature were also considered.

Body Weight

For body weight, the values recommended in Health Canada (2009a; 2010a) were considered for the assessment of child and adult receptors.

Accordingly, the following values were selected as receptor characteristics in the assessment:

Younger Child (ages 0.5-4 yrs):	16.5 kg (Health Canada 2009a; 2010a);
Women of Child-bearing Age:	60 kg (Health Canada 2009a; 2010a);
Adults:	70.7 kg (Health Canada 2009a; 2010a).

It is noted that Health Canada (2009a; 2010a) has different age groups for consideration than provided in Manitoba Water Stewardship (2007) (*i.e.*, the latter focuses upon children under 12 years of age). Nevertheless, the consumption information provided by the KCNs representatives was for toddlers and, consequently, the Health Canada (2009a; 2010a) information was used.

Water Consumption Rate

Water consumption rates for the various human receptor types recommended by Health Canada (2009a; 2010a) were used in the exposure assessment.

Accordingly, the following values were selected as receptor characteristics in this assessment as the drinking water consumption estimates:

Younger Child (ages 0.5-4 yrs):	0.6 L/day (Health Canada 2009a; 2010a);
Adults:	1.5 L/day (Health Canada 2009a; 2010a).

Skin Surface Area

In the case of skin surface area available for contact with surface water, Health Canada (2009a; 2010a) has adopted values recommended by Richardson (1997) for the whole body surface area.

The following values were selected as receptor characteristics in the assessment:

Younger Child (ages 0.5-4 yrs):	0.60 m^2 (whole body) (Health Canada 2009a; 2010a)
Adults:	1.8 m^2 (whole body) (Health Canada 2009a; 2010a).

Time Spent at the Site

For traditional land use, it was assumed that these persons would spend seven days per week, 52 weeks per year for their entire life at the site. These estimates are not from literature sources but instead are based on input from the KCNs, professional judgment and acceptable practice in HHRA (*i.e.*, use of conservative estimates).

The following values were selected as receptor characteristics in the assessment:

Traditional Land Use:	7 days per week, 52 weeks per year for 80 years (professional judgment)
Country Foods Consumer:	Various rates of consumption for an entire lifetime (see below).

Country Foods Consumption

The term “country foods” refers to foods that are not bought in stores or grown in home gardens or farms but instead are collected from the environment. Country foods (or wild foods) include fish, wild game, waterfowl and wild plants.

The scientific literature contains an appreciable amount of information on the rate of country (wild) food consumption by First Nation communities in Canada. Although this information provides excellent sources for consideration, use of such data has limitations since rates of country (wild) food consumption vary from locale to locale. As a result, it is preferable to have site-specific information on the rates of consumption when such estimates are available.

For consideration in the HHRA, members of the Mercury and Human Health Technical Working Group arranged for a workshop in October 2009 with members of the KCNs. In this workshop, persons in the communities discussed how often and how much of each food type was consumed. The detailed results of this workshop are provided in the October 2009 memo provided from InterGroup Consultants. According to this memorandum, the most common food types and rate of consumption are provided below.

It is recognized that the fish serving sizes provided in Table 4-1 represent quite large serving sizes compared to those typical, as identified by Health Canada. These serving sizes were determined through consultations with KCNs representatives at the October 2009 workshop. It is possible that many persons would consume smaller portion sizes or may eat foods at a lower frequency. It is noted that in the case of fish consumption, different consumption rates are used by Manitoba Water Stewardship (2007) for recreationally angled fish (i.e., 114 g per serving for 30 kg children and 227 g per serving for 60 kg women of child-bearing age); however, the KCNs provided assurance that the increased serving size for fish was applicable to their habits. Consequently, the information provided by the KCNs was used to estimate risks.

Table 4-1: Assumed Consumption Rates of Various Country (Wild) Foods Consumed by the Keeyask Cree Nations Communities

Food Type	Serving Size for Young Child	Serving Size for Adult	Frequency of Consumption
Fish			
Whitefish	100 g (or 3.5 ounces)*	400 g (or 14 ounces)	Three times per week
Northern pike	100 g (or 3.5 ounces)	400 g (or 14 ounces)	Three times per week
Walleye	100 g (or 3.5 ounces)	400 g (or 14 ounces)	Three times per week
Sturgeon	100 g (or 3.5 ounces)	400 g (or 14 ounces)	Three times per week
Wild Game			
Beaver	57 g (or 2 ounces)	200 g (or 7 ounces)	Three times per week
Muskrat	57 g (or 2 ounces)	200 g (or 7 ounces)	One time per week
Moose	100 g (or 3.5 ounces)	400 g (or 14 ounces)	Five times per week
Snowshoe hare	57 g (or 2 ounces)	200 g (or 7 ounces)	One time per week
Waterfowl			
Duck	57 g (or 2 ounces)	200 g (or 7 ounces)	One time per week

* One ounce = 28.4 grams

The above information was used to estimate exposures to mercury that persons may receive from the consumption of various country (wild) foods. Using the period of exposure that may result in the greatest daily exposure over a period of one week, the daily intake rate was estimated for each of the food groups. For example, in the case of sturgeon which is consumed only in spring and fall, risk estimates are based on the period that it is consumed three times per week. This is considered to be a conservative assumption because it does not distinguish risks from foods consumed on a seasonal basis versus those consumed all year round. Nevertheless, no health agencies were identified that provide recommendations for addressing short-term exposures to methylmercury and, thus, this approach was conservatively adopted.

It is noted that the KCNs communities also identified the following country foods as a concern:

- Gull eggs;
- Wild plants:
    - Northern tea;
    - Blueberries; and
    - Seneca roots

However, as noted in Section 3, there are no estimates of mercury concentrations in these animals or plants either presently or that would occur following impoundment. Consequently, these foods were not further evaluated in the quantitative HHRA. It is recommended that these foods be part of future monitoring if information on risks from consumption is desired.

4.2.4 Exposure Pathways of Concern

The exposure pathways for the off-site receptors are receptor-dependent. In the case of traditional land use, the exposure pathways evaluated included:

- Ingestion of surface water from Gull Lake or Stephens Lake; and
- Dermal contact with surface water from Gull Lake or Stephens Lake.

In the case of the country (wild) foods consumers, risks from consumption of the following food groups were estimated:

- Fish:
    - Whitefish;
    - Northern pike;
    - Walleye; and
    - Sturgeon.
- Wild Game:
    - Beaver;
    - Muskrat;
    - Moose; and
    - Snowshoe hare;
- Waterfowl:
    - Ducks.

4.2.5 Conceptual Model

Based on the information provided in the previous section and following the guidance from Health Canada and various other international health agencies, conceptual models were developed to illustrate the receptors and exposure pathways identified for evaluation of risks to off-site receptors.

As discussed earlier, it is usually not possible to evaluate every individual and/or exposure pathway present; however, if the most sensitive receptors and most important pathways are evaluated, it can safely be concluded that other receptors and exposure pathways not considered would be adequately addressed by the result and conclusions of the HHRA. Consequently, the conceptual models summarized here have been developed with this objective in mind.

For the persons using the area for traditional land uses, the receptors and exposure pathways are provided in Table 4-2. Once again, the consumption of country (wild) foods was addressed as a separate pathway (see below).

Table 4-2: Conceptual Model for Traditional Land Use

Critical receptor		Exposure pathways	
	Infant		Soil Ingestion
X	Toddler		Soil dermal absorption
	Child		Particulate inhalation
	Teen		Vapour inhalation
X	Adult	X	Water dermal exposure
		X	Water ingestion
		X	Wild plant ingestion
		X	Fish ingestion
		X	Wild game ingestion

X – Requires evaluation in the human health risk assessment

4.3 EXPOSURE ASSESSMENT

4.3.1 Environmental Concentrations

As discussed earlier, receptors were assumed to consume country (wild) foods that include wild game, fish and plants. In addition, receptors were assumed to be exposed to surface water. The assumed concentrations of mercury in the various country (wild) foods and surface water are discussed in sections below.

Assumed Concentrations of Mercury in Fish

As identified by the Mercury and Human Health Technical Working Group, consumption of the following fish species was the primary concern to human health:

- Lake whitefish;
- Northern pike;
- Walleye; and
- Lake sturgeon.

Section 3.1 provides the measured and predicted concentrations of mercury in fish tissue that were used in the HHRA. The HHRA was based on the mean concentrations of mercury in fish tissue (current concentrations were measured while future concentrations were predicted).

The mercury concentrations reported in section 3.1 are specific to a standardized length of the various fish species. Because mercury concentrations are generally positively related to fish length, fish that are larger than the specified standard length usually have greater concentrations while smaller fish have lower concentrations. The standard lengths used here are based on the approximate size of fish that would typically be caught and eaten. Therefore, using mercury concentrations from fish of this size provides the best average estimate of mercury exposure to people over the long-term.

Assumed Concentrations of Mercury in Wild Game

As identified by the Mercury and Human Health Technical Working Group, consumption of the following wild game species were the primary concern to human health:

- Beaver;
- Muskrat;
- Moose; and
- Snowshoe hare.

Section 3.2 provides the measured and estimated concentrations of mercury in wild game tissue that were used in the HHRA. Similar to that discussed for fish, the HHRA of wild game consumption was based on the mean concentrations of mercury.

It is noted that other wild game species may be consumed by First Nations that were not directly evaluated in the HHRA. In most cases, these species would likely have similar or lower concentrations of mercury than those assumed in the HHRA. For example, caribou are consumed from the area but caribou would be expected to have lower concentrations of mercury than moose because they spend less time in the area (*i.e.*, larger home range) and less time in contact with aquatic habitat. Consequently, it is likely that risks from such foods would be even lower than from the wild game evaluated in the HHRA. Nevertheless, it will be recommended that a program is established whereby hunters may submit tissue samples of any species of wild game that they have hunted in the area for mercury analysis. In this manner, the mercury content of other country (wild) foods can be monitored.

Assumed Concentrations of Mercury in Waterfowl

As identified by the Mercury and Human Health Technical Working Group, consumption of the following waterfowl species was the primary concern to human health:

- Ducks; and
- Gull eggs.

Section 3.3 provides the assumed concentrations of mercury in ducks. As discussed earlier, no estimate of mercury concentrations in gull eggs was possible for either present or future scenarios. Consequently, gull eggs would need to be monitored if risk estimates from this food group are required.

It is noted that other waterfowl may be consumed by the KCNs that were not directly evaluated in the HHRA (*e.g.*, geese). In the case of geese, they would likely have similar or lower concentrations of mercury than those assumed in the HHRA (due to their mainly plant-based diet, geese have a lower ability to accumulate mercury than ducks). Consequently, it is likely that risks from geese would be lower than from the ducks evaluated in the HHRA. Nevertheless, it will be recommended that a program is established whereby hunters may submit tissue samples of any species of waterfowl that they have hunted in the area for mercury analysis. In this manner, the mercury content of other country (wild) foods can be monitored.

Assumed Concentrations of Mercury in Wild Plants

As identified by the Mercury and Human Health Technical Working Group, consumption of the following wild plant species was the primary concern to human health:

- Northern tea;
- Blueberries; and
- Seneca root.

As discussed earlier, no estimates of mercury concentrations in wild plants were available for either present or post-impoundment scenarios. Consequently, wild plants would need to be monitored if risk estimates from this food group is required and it will be recommended that a program be established whereby food gatherers may submit tissue samples of species of edible plants that have been gathered for mercury analysis. In this manner, the mercury content of wild plants can be monitored.

Assumed Concentrations of Mercury in Surface Water

The approach for estimating potential human exposure to off-site receptors was based on measured water concentrations at the current time and estimated water concentrations that would occur at the maximum time following impoundment. As discussed previously in Section 3.5, the surface water concentrations were largely compiled from data presented in the AE SV, Section 2.5.2. Briefly, North/South Consultants have indicated that both present and post-impoundment concentrations of mercury in surface water would be expected to be less than the method detection limit of 0.05 µg/L. For the purposes of the HHRA, it was assumed that mercury would be found in surface water at a concentration equal to the method detection limit of 0.05 µg/L.

4.3.2 Mathematical Equations Used to Estimated Exposures

As discussed earlier, the exposures that off-site receptors may receive were estimated for the following pathways:

- Ingestion of surface water;
- Dermal contact with surface water (bathing or swimming); and
- Consumption of country foods (wild game, fish and plants).

The mathematical equations used to estimate exposures from these pathways are discussed in Appendix 5C-1. Some of the other important concepts applied in the exposure assessment approach are discussed below.

4.3.2.1 Exposure Amortization

As noted earlier, the number of weeks assumed for the exposure duration of concern was important to the outcome of the risk assessment. Essentially, it is important that the exposure data match as closely as possible the toxicological data (*i.e.*, toxicity reference values [TRVs]) in terms of exposure duration.

For assessment of risks from mercury, no lifetime exposure amortization was completed for less than lifetime exposures. Although it was previously stated that persons spend 80 years of their lifetime at the site, this timeframe does not play a role in estimation of risks to the non-carcinogens. According to Health Canada guidance, any exposure that lasts more than three months is considered to be chronic in duration and lifetime exposure amortization is typically appropriate for exposures that last longer than this duration. With the above in mind, it was considered appropriate and consistent with Health Canada guidance to amortize exposures that occur two times per week over the entire week. Although it is likely that receptors will have lower exposures in the winter than in the summer (due to snow cover and potentially reduced use of off-site areas in some cases), the HHRA did not consider this in the quantitative evaluation.

As a result, the HHRA has been completed for exposures that occur during the season where the exposure took place (*i.e.*, exposures that occur over a one or two month period were not spread out over the entire year).

4.3.2.2 Bioavailability Assessment

As shown in the Appendix 5C-1 calculations, bioavailability was used to estimate the fraction of exposure that may actually enter a person's body. Bioavailability is an important factor that allows for the comparison of exposures via multiple routes. For example, bioavailability allows the risk assessment to compare health risks from dermal exposures to TRVs established for oral exposure routes. For the purposes of the HHRA, the bioavailability of mercury in food was assumed to be 100%. For dermal absorption from surface water, mercury was assumed to have a permeability constant of 1×10^{-5} m/hr as recommended by Health Canada (2009b).

4.4 TOXICITY ASSESSMENT

Toxicological data were available from regulatory agencies such as Health Canada, US EPA and the World Health Organization. In the case of mercury, the following TRVs were used:

- Tolerable Daily Intake (TDI) for methyl mercury = 0.2 µg/kg bw/day (for children, women of child bearing age) and 0.47 µg/kg bw/day (for other members of the general population) (Health Canada, 2010b).
- TDI for total mercury = 0.57 µg/kg bw/day for all persons (based on WHO [2010] provisional tolerable weekly intake of 4 µg/kg/week).

For mercury in fish and waterfowl, all mercury was assumed to be present as methylmercury since most experts would agree that the vast majority of mercury would be present in this form. For mercury in wild game and wild plants, mercury was assumed to be present as total mercury since information is not readily available on the mercury form in muscle tissue and, thus, was compared to the WHO/Health Canada total mercury toxicity reference value. Appendix 5C-1 provides additional details regarding these TRVs.

4.5 RISK CHARACTERIZATION

Risks were estimated as Hazard Quotient values according to the following formula:

$$\textit{Hazard Quotient} = \frac{\textit{Estimated Exposure } (\mu g/kg \textit{ body weight/day})}{\textit{Tolerable Daily Intake } (\mu g/kg \textit{ body weight/day})}$$

With respect to Health Canada guidance for foods, a Hazard Quotient value of 1 is typically considered to be the maximum acceptable exposure that will not be associated with unacceptable risks (Health Canada 2004). Although a Hazard Quotient value of 0.2 is considered to be acceptable for contaminated soils (when environmental concentrations represented by the arithmetic means are considered) (Health Canada 2009a, 2010a), this value is not typically used for evaluation of foods. Indeed, there are numerous precedents where Health Canada has considered Hazard Quotient values of 1 to be acceptable (especially when food sources are considered). Consequently, a Hazard Quotient value of 1 was used as the acceptable risk for mercury.

Since mercury is not evaluated as a carcinogen by most health agencies (*e.g.*, Health Canada, World Health Organization and US Environmental Protection Agency), it was not necessary to estimate cancer risks.

5.0 RESULTS

The results of the risk assessment for receptors exposed to mercury are provided in the sections below. Worked examples of the risk calculations are provided in Appendix 5C-1.

5.1 RISKS FROM CONSUMPTION OF FISH

Risks from consumption of fish were estimated for the present conditions and for the possible post-impoundment scenario. Based on information provided by the KCNs communities, all fish were assumed to be consumed at a frequency of three meals per week with a serving size of 100 g (3.5 ounces) per meal for toddlers and 400 g (14 ounces) per meal for adults. These rates of consumption were used at the request of the KCNs and are considered to represent upper bound exposures (especially in regard to serving size). Nevertheless, the HHRA considered these values in order to ensure a conservative assessment and address all concerns of the KCNs communities.

It is recognized that certain fish are only consumed at certain times of the year (*e.g.*, sturgeon are only consumed in the spring and the fall). Nevertheless, this less than continuous exposure is not quantitatively considered in the HHRA because the key concern regarding methylmercury is developmental toxicity. Developmental toxicants sometimes only require a couple of weeks of exposure to illicit adverse effects and the fact that a pregnant woman only consumed a certain country (wild) food for a few weeks during pregnancy would not necessarily be a mitigating factor that would diminish the potential developmental toxicity.

Although Hazard Quotient values greater than 1 are predicted from certain fish and consumption frequencies, it is stressed that this does not automatically mean that the consumption of these types of fish need to be restricted altogether. There are numerous fish in Gull and Stephen Lakes that have mercury concentrations that are considered to be low (less than 0.2 ppm) and very low (less than 0.1 ppm).

Even though Hazard Quotient values greater than 1 can theoretically be predicted from consumption of large amounts of these fish, many scientists would consider that there is no reason to advise the First Nations that the consumption of the low and very low mercury concentration fish needs to be unduly restricted. There are numerous health advantages to a fish-based diet, particularly for northern Aboriginal communities where healthy and affordable alternatives are often lacking; consequently it is anticipated that the benefits of eating fish will also be considered in preparing consumption recommendations. As requested by Health Canada and Manitoba Health, this HHRA does not provide consumption advice. Manitoba Health and Health Canada have committed to providing their opinion on this issue to the KCNs and Manitoba Hydro as a separate undertaking.

5.1.1 Present Conditions

Table 5-1 provides the risk estimates for consumption of fish under present conditions. Using the methods discussed previously, the key results of the risk analysis of present conditions include the following:

- In evaluation of the results of the HHRA, it is important to consider that relatively high rates of fish consumption were assumed.
- Toddlers and women of childbearing age had risks that were two to three times higher than adult males and Elders consuming the same fish species. This is mainly because the TDI for methylmercury is approximately 2.5 times lower for toddlers/women of child bearing age than for adults.
- The greatest risks were estimated from consumption of northern pike and walleye due to their higher tissue mercury concentrations relative to other fish species. These two predatory fish species have mean mercury concentrations that are greater than 0.2 µg/g but less than 0.5 µg/g and various health agencies have recommended that young children and women of childbearing age may want to restrict consumption of fish to a meal or so per week when mercury concentrations are in this range.

- Risks from consumption of lake whitefish were the lowest due to their low mercury concentrations; however, consumption of three large meals per week could still result in Hazard Quotient values that exceed the acceptable value.
- In the case of lake sturgeon in Gull Lake, these fish presently contain arithmetic mean mercury concentrations equal to 0.2 µg/g (the relationship between mercury concentration and fish length was not significant and standardized means should not be used; see AE SV (Appendix 7A). Consumption of three large meals per week could result in Hazard Quotient values that exceed the acceptable value.

Based on the results, frequent consumption of large meals of certain types of fish may exceed the acceptable Hazard Quotient. It should be noted that the adult Hazard Quotient values would have been lower in Table 5-1 if a more common serving size of 150 grams per meal was used (*i.e.,* 150 grams is the serving size commonly assumed by Health Canada). Indeed, the Hazard Quotient values for adults (both women of childbearing age and adult males and all Elders) would have been about 2.5 times lower than provided in Table 5-1; however, for toddlers, Health Canada policy uses a serving size of 106 g/meal and a body weight of 14 kilograms such that Hazard Quotient values would have been about 20% higher than provided in Table 5-1. Nevertheless, the information on serving sizes obtained directly from the communities is considered to supersede the Health Canada recommendations.

Notwithstanding the above, it is anticipated that the benefits of eating fish will be considered along with the Hazard Quotient values in determining fish consumption recommendations. As requested by Health Canada and Manitoba Health, this HHRA does not provide consumption advice and instead these agencies will provide this advice as a separate undertaking.

Table 5-1: Risk Estimates from Consumption of Fish: Present Conditions

Fish Species	Standardized Concentration* (µg/g, wet weight)	Hazard Quotient from Consumption of Three Large Meals per Week (Acceptable Value = 1)***		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Gull Lake				
Lake Whitefish	0.07	0.9	1.0	0.4
Northern Pike	0.22	2.8	3.1	1.1
Walleye	0.23	3.0	3.3	1.2
Lake Sturgeon**	0.20	2.6	2.8	1.0
Stephens Lake				
Lake Whitefish	0.09	1.3	1.4	0.5
Northern Pike	0.26	3.5	3.8	1.4
Walleye	0.29	4.2	4.7	1.7
Lake Sturgeon	No measurements currently available	No estimates currently available	No estimates currently available	No estimates currently available

* Standard lengths: lake whitefish 350 mm; northern pike 550 mm; walleye 400 mm,
Individual mercury concentrations would be dependent upon the size of the fish with the smaller fish having generally lower concentrations than bigger fish.
** Arithmetic mean concentration.
*** Based on information provided by local First Nation communities, all fish were assumed to be consumed at a frequency of three meals per week with a serving size of 100 g for toddlers and 400 g for adults.

Table 5-2 provides the risk estimates from consumption of various sizes and species of fish in terms of Hazard Quotient values of three large meals/week under present conditions. The table illustrates the influence of the size of fish by species that result in Hazard Quotient values either less than or greater than 1. For example, lake whitefish from Gull Lake consumed by women of child-bearing age can range from a Hazard Quotient value of 0.6 for the smallest category fish (< 300 mm) to 2.1 for the largest category fish (> 450 mm).

Table 5-2: Risk Estimates from Consumption of Fish for Various Fish Size Classes: Present Conditions

Species	Fish Size Class								
	Lake Whitefish			Northern Pike			Walleye		
	<300 mm	300-450 mm	>450 mm	<400 mm	400-800 mm	>800 mm	<400 mm	400-550 mm	>550 mm
Gull Lake									
Mean concentration of mercury in tissue (µg/g; wet weight)	0.042	0.071	0.149	0.129	0.270	0.789	0.117	0.394	0.688
Hazard Quotient from Three Large Meals per Week for Toddlers	0.5	0.9	1.9	1.7	3.5	10.1	1.5	5.1	8.9
Hazard Quotient from Three Large Meals per Week for Women of Child Bearing Age	0.6	1.0	2.1	1.8	3.8	11.2	1.7	5.6	9.7
Hazard Quotient from Three Large Meals per Week for Adult Males/ All Seniors	0.2	0.4	0.8	0.7	1.4	4.0	0.6	2.0	3.5
Stephens Lake									
Mean concentration of mercury in tissue (µg/g; wet weight)	0.070	0.094	0.154	0.096	0.318	1.07	0.183	0.422	0.716
Hazard Quotient from Three Large Meals per Week for Toddlers	0.9	1.2	2.0	1.2	4.1	13.8	2.4	5.4	9.2
Hazard Quotient from Three Large Meals per Week for Women of Child Bearing Age	1.0	1.3	2.2	1.4	4.5	15.1	2.6	6.0	10.1
Hazard Quotient from Three Large Meals per Week for Adult Males/ All Seniors	0.4	0.5	0.8	0.5	1.6	5.4	0.9	2.1	3.6

5.1.2 Post-Impoundment Conditions

Table 5-3 provides the risk estimates for consumption of fish that would occur under post-impoundment conditions. These risk estimates are based on the peak concentrations that would occur following impoundment and assuming consumption of fish of standard size (*i.e.*, lake whitefish = 350 mm; northern pike = 550 mm; walleye = 400 mm; and, lake sturgeon = 1,300 mm). Key results of the risk analysis include the following:

- The greatest risks were estimated from consumption of northern pike and walleye from Gull Lake due to tissue concentrations of mercury predicted to reach or slightly exceed 1.0 µg/g (Keeyask Hydropower Limited Partnership, 2012a).
- In the case of northern pike and walleye from Stephens Lake and lake sturgeon from either Stephens Lake or Gull Lake, these fish are predicted to have mercury concentrations that are greater than 0.2 µg/g but less than or equal to 0.5 µg/g.
- Risks from lake whitefish from Gull Lake and Stephens Lake were the lowest of the fish evaluated; however, consumption of three large meals per week could still result in Hazard Quotient values that exceed the acceptable value.

As noted earlier, as requested by Health Canada and Manitoba Health, this HHRA does not provide consumption advice and instead these agencies will provide this advice as a separate undertaking.

Table 5-3: Risk Estimates from Consumption of Fish: Post-Impoundment Conditions

Fish Species	Assumed Concentration* (µg/g, wet weight)	Hazard Quotient from Consumption of Three Large Meals per Week (Acceptable Value = 1)***		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Gull Lake				
Lake Whitefish	0.19	2.4	2.7	1.0
Northern Pike	1.0	12.9	14.2	5.1
Walleye	1.0	12.9	14.2	5.1
Lake Sturgeon**	0.30	3.9	4.2	1.5
Stephens Lake				
Lake Whitefish	0.15	1.9	2.1	0.8
Northern Pike	0.50	6.4	7.1	2.5
Walleye	0.50	6.4	7.1	2.5
Lake Sturgeon	0.25	3.2	3.5	1.3

* Standard lengths: lake whitefish 350 mm; northern pike 550 mm; walleye 400 mm,
Individual mercury concentrations would be dependent upon the size of the fish with the smaller fish having generally lower concentrations than bigger fish. Nevertheless, NSC (North South Consultants pers. comm. 2010) concluded that there was not sufficient information to do a length-class specific analysis of mercury concentrations for the post-impoundment scenario.
** Arithmetic mean concentration.
*** Based on information provided by local First Nation communities, all fish were assumed to be consumed at a frequency of three meals per week with a serving size of 100 g for toddlers and 400 g for adults.

If impoundment occurs, it will be important that fish consumption recommendations for fish be communicated to local First Nations people through community health practitioners.

5.1.3 Health Effects from Consuming Fish at Rates Greater than Hazard Quotient Values of One

This section addresses the potential health effects that could be associated with persons who consume fish at rates greater than Hazard Quotient values greater than one.

Both the present and post-impoundment conditions have estimated certain scenarios with Hazard Quotient values greater than one.

5.1.3.1 Present Conditions

Under present conditions, it is apparent that persons could have elevated Hazard Quotient values for certain fish. The key concern is consumption of larger northern pike and walleye by women of childbearing age and young children. Nevertheless, potential unacceptable risks could affect persons of any age if unrestricted consumption of the larger fish occurred on a frequent basis.

Blood and hair measurements are a well known and accurate method for estimating both exposure and risks from methylmercury in fish. To evaluate potential health risks, the Health Canada approach has been employed whereby mercury hair concentrations less than 5 ppm (or 20 µg/L in blood) are considered to be in the "normal range" while concentrations between 5 and 25 ppm (25 to 100 µg/L in blood) are in the "increasing risk" range and concentrations above 25 ppm (or 100 µg/L in blood) are considered to be "at risk" levels (INAC 2009). In addition to these broad classifications, the following tissue concentrations would be close to known effects levels from the literature:

- Health Canada (1998) and US EPA (2011) have indicated that maternal mercury concentrations of 10 ppm in hair and/or 58 µg/L in blood are generally equal to the threshold for a 5% increased risk of developmentally delayed children. Although there have been no clear-cut clinical abnormalities in children born to mothers with mercury concentrations above 10 ppm in hair or 58 µg/L in blood, there have been effects on language, attention and memory that have been reported to be mercury-related.
- US EPA (2011) has developed a Benchmark Dose Level (BMDL05) (the lower 95% confidence limit of the BMD05) of 59 µg/L in maternal blood for neurological effects in children. This blood concentration would result in a doubling of the number of children with a neurological response at the fifth percentile of the population.

- Axelrad et al. (2007) has estimated that mercury concentrations of 1 ppm in maternal hair may be associated with a 0.18 IQ point decrement in children (i.e., 10 ppm may be associated with a 1.8 IQ point decrement); however, it is unclear if Axelrad et al. (2007) appropriately controlled for other factors and this relationship has not yet been used by any major health agency. It is stressed there can be a great number of everyday factors that can affect IQ at rates much greater than 1.8 IQ (as summarized in Wilson et al. [2005][1] a person's environment may affect their IQ by 20 to 25 points) and, thus, the proper context should be provided to a potential 1.8 IQ decrement at 10 ppm.
- In addition to the comparison of these literature-effect levels, it is possible that to compare the exposure to the Inuit in the Canadian Arctic. INAC (2009) data indicate that only 2% of Nunavut/Inuit women sampled between 2005 and 2007 had blood levels of mercury greater than 20 µg/L.

It is beyond the scope of this analysis to attempt to predict the blood and hair levels of mercury that may currently be present in the communities due to fish consumption. We understand that the KCNs communities have a dialogue with health agency officials regarding such testing but this information is considered to be private medical information that is not to be used in this HHRA. With the above noted, the greatest Hazard Quotient under present conditions when expressed for standardized length was estimated to be 4.7 for women of childbearing age (as shown in Table 5-1). It is not clear that actual adverse health effects would occur at such exposures and, instead, it is only clear that a desired margin of safety would be intruded upon. Nevertheless, it is stressed that Hazard Quotient values of 4.7 are not desirable and would place women and their developing babies in the "increasing risk" that has been defined by Health Canada. Consequently, there is importance to making good decisions regarding fish consumption under the present scenario since there would be much lower risks for women of

[1] As summarized in Wilson *et al.* (2005), example of factors that may each cause an IQ decrement of three points or more include: socio-economic status (SES); parent's education, family size and child's position in family; enriched pre-school and breast feeding. Furthermore, it is noted that the standard deviation on an IQ test is three points.

childbearing age consuming lake whitefish or smaller northern pike and walleye (*i.e.*, fish with mercury concentrations less than 0.2 µg/g and in the case of lake whitefish less than 0.1 µg/g).

In addition to the effects on development, there have been concerns regarding cardiovascular effects of mercury. Clinical effects in adults have included increased blood pressure. Roman *et al.* (2011) have indicated that a dose-response relationship could be developed for methylmercury exposure and acute myocardial infarction; however, at the current time, we are not aware of any recognized relationship that can be quantified and applied to the results of this risk assessment. Moreover, in two very large US cohorts, Mozaffarian *et al.* (2011) found no evidence of any clinically relevant adverse effects of mercury exposure on coronary heart disease, stroke, or total cardiovascular disease. Consequently, at the current time, the effect of mercury on cardiovascular risk remains unclear.

Overall, there is a recognized risk of children being born who later do not perform as well in various mental tasks. In addition, there is the potential for other health effects that may include cardiovascular effects. Ideally, it would be prudent for persons to attempt to lower exposures through good choices of fish consumption. On the other hand, there could also be risks from persons not consuming fish (since fish can be such an important source of nutrients)[2]. As a result, it is stressed that this information should be used to make informed choices about fish consumption.

5.1.3.2 Post-Impoundment Conditions

There is potential for unacceptable health risks for persons who decide to frequently consume fish from Gull and Stephens lakes under post-impoundment conditions. For example, there would be greater risks associated with the consumption of northern pike and walleye from Gull Lake. On the other hand, there could also be health risks if persons choose not to consume fish and instead substitute less healthy foods in their diet. Thus, it

[2] The health effects of not eating fish have not been quantified in this HHRA report.

is important that persons should be encouraged to use, to the maximum extent possible, the programs that enable use of lakes unaffected by the Project.

Similar to that discussed for present-day conditions, it is beyond the scope of this analysis to attempt to predict the blood and hair levels of mercury that may be present in the communities following impoundment with maximum Hazard Quotient values of 14.2 (for women of childbearing age). Future hair and blood concentrations would be expected to follow fish mercury concentrations (for which we have estimated levels) but would also be dependent on how many and which people choose to use the lakes unaffected by the Project versus Gull Lake versus Stephens Lake (all unknown variables). Nevertheless, it should be apparent that for persons frequently consuming fish at mercury concentrations of 1 µg/g (*i.e.,* Hazard Quotient values up to 14.2 for women of childbearing age), exposures would be classified in the Health Canada "at risk" range. For women of childbearing age who continue to consume Gull Lake northern pike or walleye at 1.2 kilograms of northern pike or walleye (1.0 ppm for standardized size) per week, it could be expected that hair and blood concentrations would exceed the previously described known effects levels from the literature (main concerns would be developmental effects in children and potential cardiovascular effects in adults). Such populations would be considered to be in the Health Canada "at risk" range. In addition, such concentrations would be greater than the majority of Nunavut/Inuit women sampled between 2005 and 2007 by INAC (2009) (*i.e.,* only two percent had blood levels of mercury greater than 20 µg/L).

It is noted that this Hazard Quotient was estimated by assuming that a 60 kg woman of childbearing age consumes 1.2 kg of northern pike or walleye per week on a consistent basis. If a woman consumed less fish, the exposure and risk values would accordingly decrease. For example, if a woman of childbearing age consumed serving sizes of seven ounces rather than 14 ounces (but still at a rate of three meals of northern pike or walleye per week), the Hazard Quotient values would be halved (*i.e.,* Hazard Quotient values of

7.1). Such halving would place women of childbearing age in the “increasing risk” range of exposure (rather than in the “at risk” range).

Although these levels of exposures are of concern, it is important to recognize that these are not estimates of blood and hair concentrations that will occur in the community as a whole. First of all, there are programs in the Adverse Effects Agreements to enable the KCNs to access lakes unaffected by the Project that will provide an alternate source of fish and, thus, if the people use these programs, it should not be a health concern. In addition, these estimates apply to consumption of 1.2 kg of northern pike or walleye from Gull Lake per week on a consistent basis. Appreciably lower hair and blood levels would be associated with less frequent consumption of the same fish. It is also noted that accumulation of such levels takes several weeks of such consumption, such that lower blood and hair concentrations would be associated with lower frequencies of consumption of fish from Gull Lake.

Overall, it is considered to be important that persons follow fish consumption recommendations provided by health authorities; and for the KCNs, to utilize the programs to access areas unaffected by the Project under post-impoundment conditions. If persons frequently consume certain fish from Gull and Stephens lakes following impoundment, individuals could be in the “at risk” range of tissue concentrations. On the other hand, under the programs in the Adverse Effects Agreements to enable the KCNs to access lakes unaffected by the Project, there would be no adverse effects or unacceptable risks if persons follow health authority recommendations. This information should be used to make informed choices about fish consumption with special emphasis on the consumption of fish from unaffected lakes during the post-impoundment elevation in fish concentrations.

5.2 RISKS FROM CONSUMPTION OF WILD GAME

Risks from consumption of wild game (beaver, muskrat, moose and snowshoe hare) were estimated for the present and post-impoundment conditions. Based on information provided by the KCNs communities, the following consumption rates of wild game were assumed:

- Moose was assumed to be consumed at a frequency of five meals per week with a serving size of 100 g (3.5 ounces) per meal for toddlers and 400 g (14 ounces) per meal for adults.
- Beaver was assumed to be consumed at a frequency of three meals per week with a serving size of 57 g (two ounces) per meal for toddlers and 200 g (seven ounces) per meal for adults.
- Muskrat and snowshoe hare were assumed to be consumed at a frequency of 1 meal per week with a serving size of 57 g (two ounces) per meal for toddlers and 200 g (seven ounces) per meal for adults.

These rates of consumption were used at the request of the KCNs and are considered to represent upper bound exposures. It is recognized that some wild game are only consumed at certain times of the year (*e.g.*, muskrat and beaver are mostly consumed in the colder months). Similar to that discussed for fish consumption, less than continuous exposure was not quantitatively considered in the HHRA because the key concern regarding mercury is developmental toxicity. In addition, although moose are mainly harvested in the fall, the meat is stored in a freezer and can be consumed all year. As a result, the risks from consumption of the various forms of wild game were not adjusted for less than all year round consumption patterns.

5.2.1 Present Conditions

Table 5-4 provides the risk estimates for consumption of wild game under present conditions. Key results of the risk analysis include the following:

- Consumption of wild game at present concentrations of total mercury is not associated with unacceptable risks. The greatest risks were estimated from consumption of moose; however, five times per week consumption of large serving sizes resulted in Hazard Quotient values approximately equal to 0.5.

- Even lower Hazard Quotient values were estimated from consumption of muskrat, beaver and snowshoe hare (due to a combination of lower total mercury concentrations, less consumption frequency and smaller serving sizes).

Based on the results, consumption of large meals of any wild game does not pose unacceptable health risks under present conditions. As noted in Section 3, there is some uncertainty in regard to the moose and snowshoe hare concentrations of mercury and it is recommended that monitoring of these species be completed to ascertain that the assumed mercury concentrations were reasonable.

Table 5-4: Risk Estimates from Consumption of Wild Game: Present Conditions

Wild Game Species	Assumed Concentration* (µg/g, wet weight)	Hazard Quotient (Acceptable Value = 1)**		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Beaver	0.01	0.03	0.02	0.02
Muskrat	0.02	0.02	0.02	0.01
Moose*	0.07	0.5	0.29	0.24
Snowshoe hare*	0.05	0.04	0.04	0.03

* Mercury concentration in moose and snowshoe hare was only a literature estimate and may have greater uncertainty than other species for which measured values were obtained from the study area
** Hazard Quotient estimated assuming either five meals per week for moose, three meals per week for beaver or 1 meal per week for snowshoe hare/muskrat

5.2.2 Post-Impoundment Conditions

Table 5-5 provides the risk estimates for consumption of wild game that would occur under post-impoundment conditions. In some cases, it is important to realize that these risk estimates are based on very high rates of wild game consumption (*i.e.*, moose was assumed to be consumed at a frequency of five meals per week with a serving size of 100 g per meal for toddlers and 400 g per meal for adults).

Key results of the risk analysis include the following:

- In the case of moose, beaver and snowshoe hare, the concentrations of total mercury in the tissue of these animals would not be expected to change post-impoundment (i.e., Hazard Quotient less than 1). As a result, there is no change in risk from consumption of these animals and risks are estimated to remain acceptable.
- In the case of muskrat, the risks from consumption were estimated to be acceptable for the post-impoundment scenario (i.e., Hazard Quotient less than 1) even though total mercury concentrations may increase from 0.02 µg/g to 0.04 µg/g.

It is noted that some aquatic mammals such as otter and mink may experience appreciably higher increases in total mercury concentrations than the mammals considered in the HHRA. However, consultation has indicated that these mammals are not consumed by the KCNs communities. Nevertheless, it should be clear that risks from consumption of such aquatic mammals were not considered in the HHRA.

It is also noted that certain other wild game has not been considered in the HHRA. For example, the HHRA has not evaluated consumption of lynx, bear or caribou. These animals are not expected to have higher concentrations of mercury than the wild game considered in the HHRA (*i.e.,* the animals considered in the HHRA will have more direct contact with the aquatic ecosystem and/or more potential to accumulate mercury). In addition, these animals are not consumed as frequently as the animals considered in the HHRA. Since risks were acceptable from consumption of the wild game that was more likely to contribute risks from mercury, it can be conservatively concluded that risks would be even lower and, therefore, acceptable for these other animals not formally considered in the HHRA.

Overall, based on the results (see Table 5-5), consumption of large meals of any wild game does not pose unacceptable health risks under post-impoundment conditions. As noted in Section 3, there is some uncertainty in regard to the moose and snowshoe hare concentrations of mercury and it is recommended that monitoring of these species be completed to ascertain that the assumed mercury concentrations were reasonable.

Table 5-5: Risk Estimates from Consumption of Wild Game: Post-Impoundment Conditions

Wild Game Species	Assumed Concentration* (µg/g, wet weight)	Hazard Quotient (Acceptable Value = 1)**		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Beaver	0.01	0.03	0.02	0.02
Muskrat	0.04	0.03	0.03	0.03
Moose*	0.07	0.5	0.29	0.24
Snowshoe hare*	0.05	0.04	0.04	0.03

* Mercury concentration in moose and snowshoe hare were based on a literature estimate and may have greater uncertainty than other species for which measured values were obtained from the study area
** Hazard Quotient estimated assuming either five meals per week for moose, three meals per week for beaver or 1 meal per week for snowshoe hare/muskrat

5.3 RISKS FROM CONSUMPTION OF WATERFOWL

Risks from consumption of waterfowl (*i.e.*, ducks) were estimated for the present and post-impoundment conditions. Based on information provided by the KCNs communities, ducks were assumed to be consumed at a frequency of 1 meal per week with a serving size of 57 g (two ounces) per meal for toddlers and 200 g (seven ounces) per meal for adults. These rates of consumption were used at the request of the KCNs.

It is recognized that ducks are only consumed at certain times of the year (*i.e.*, mostly in the spring and fall). Similar to that discussed for fish consumption, less than continuous exposure was not quantitatively considered in the HHRA because the key concern regarding mercury is developmental toxicity. In addition, duck meat could be placed in a freezer and can be consumed all year. As a result, the risks from consumption of waterfowl were not adjusted for less than all year round consumption patterns.

Finally, it is noted that the mercury present in duck tissue was assumed to be methylmercury rather than total mercury. Consequently, the more conservative methylmercury TRV (i.e., 0.2 µg/kg bw/day for sensitive populations) was used rather than the 0.57 µg/kg bw/day that the WHO has recommended for use when mercury is not present in fish and shellfish. Although this is considered to be conservative, the avian experts have indicated that the mercury concentrations in waterfowl are expected to mirror the whitefish concentrations and that no further information on mercury speciation was available. If monitoring of waterfowl indicates that the mercury is not present as methylmercury, it would be possible to adjust these risk estimates (*i.e.*, even lower risks would be predicted).

5.3.1 Present Conditions

Table 5-6 provides the risk estimates for consumption of waterfowl under present conditions. Key results of the risk analysis include the following:

- Consumption of waterfowl at present concentrations of total mercury is not associated with unacceptable risks.
- Even lower Hazard Quotient values would be estimated from consumption of other waterfowl (such as geese) (due to a combination of lower total mercury concentrations and possibly less consumption frequency).
- No risk estimate was available for gull eggs since no estimate of the mercury concentration of these eggs was available. To provide an estimate of risks from eggs, monitoring of gull eggs would likely be required.

Based on the results, consumption of duck and other waterfowl does not pose unacceptable health risks under present conditions. No estimate can be provided on the risks from consumption of gull eggs. As noted in Section 3, there is some uncertainty in regard to the duck concentrations of mercury and it is recommended that monitoring of these species be completed to ascertain that the assumed mercury concentrations were reasonable.

Table 5-6: Risk Estimates from Consumption of Waterfowl: Present Conditions

Fish Species	Assumed Concentration* (µg/g, wet weight)	Hazard Quotient (Acceptable Value = 1)**		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Gull Lake				
Duck	0.07	0.17	0.17	0.06
Stephens Lake				
Duck	0.09	0.22	0.21	0.08

* Mercury concentration in duck was assumed to be similar to that estimated for lake whitefish
** Hazard Quotient estimated assuming 1 meal per week

5.3.2 Post-Impoundment Conditions

Table 5-7 provides the risk estimates for consumption of waterfowl that would occur under post-impoundment conditions. Key results of the risk analysis include the following:

- In the case of ducks from Stephens Lake, a small increase in methylmercury concentration is predicted. As a result, there is no or little change in risk from consumption of these ducks and risks are estimated to remain acceptable.
- In the case of ducks from Gull Lake, the risks from consumption were estimated to be acceptable under post-impoundment conditions (i.e., Hazard Quotient less than 1) even though total mercury concentrations may increase from 0.07 µg/g to 0.19 µg/g.

It is also noted that certain other waterfowl has not been considered in the HHRA. For example, the HHRA has not evaluated consumption of geese. Geese are not expected to have higher concentrations of mercury than the ducks considered in the HHRA. Since risks were acceptable from consumption of ducks, it can be safely concluded that risks would be even lower and, therefore, acceptable for geese even though it was not formally considered in the HHRA.

Overall, based on the results, consumption of waterfowl would not pose unacceptable health risks under post-impoundment conditions. As noted in Section 3, there is some uncertainty in regard to duck concentrations of mercury and it is recommended that monitoring of these species should be completed to ascertain that the assumed mercury concentrations were reasonable.

Table 5-7: Risk Estimates from Consumption of Waterfowl: Post-Impoundment Conditions

Fish Species	Assumed Concentration* (µg/g, wet weight)	Hazard Quotient (Acceptable Value = 1)**		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Gull Lake				
Duck	0.19	0.47	0.45	0.16
Stephens Lake				
Duck	0.15	0.37	0.35	0.13

* Mercury concentration in duck was assumed to be similar to that predicted for lake whitefish
** Hazard Quotient estimated assuming 1 meal per week

5.4 RISKS FROM CONSUMPTION OF WILD PLANTS

The KCNs communities identified the following plants as primary concern:

- Northern tea;
- Blueberries; and
- Seneca root.

As discussed earlier in Section 3.4, no estimates of mercury concentrations in wild plants are available under either present or post-impoundment conditions. Consequently, no risk estimates are available from consumption of wild plants. If risk estimates are required, it will likely be necessary to collect samples from the study area.

5.5 RISK FROM CONTACT WITH SURFACE WATER

The final media of concern that was evaluated in the HHRA was surface water. For the purposes of the HHRA, it was assumed that the KCNs communities would consume surface water as their drinking water source. In addition, it was assumed that the communities would use the water for bathing/swimming. For both the present and post-impoundment scenarios, mercury was assumed to be present in surface water at a concentration equal to the method detection limit of 0.05 µg/L.

5.5.1 Present Conditions

Table 5-8 provides the risk estimates from contact with surface water under present conditions. Key results of the risk analysis include the following:

- Present surface water concentrations (less than method detection limit of 0.05 µg/L) are appreciably lower than the Canadian Drinking Water Guideline of 1 µg/L for total mercury.
- Hazard Quotient from ingestion and dermal contact with surface water is not associated with unacceptable risks.

Based on the results, contact with surface water does not pose unacceptable health risks under present conditions.

Table 5-8: Risk Estimates from Contact with Surface Water: Present Conditions

Route of Concern	Assumed Concentration* (µg/L)	Hazard Quotient (Acceptable Value = 1)		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Drinking (direct ingestion)	0.05	0.0032	0.0022	0.0019
Bathing/swimming (dermal)	0.05	0.000032	0.000026	0.000022
Total		0.0032	0.0022	0.0019

* Mercury concentration in surface water was assumed to equal the method detection limit

5.5.2 Post-Impoundment Conditions

Table 5-9 provides the risk estimates from contact with surface water under post-impoundment conditions. Key results of the risk analysis include the following:

- No changes in surface water concentrations of mercury are expected under post-impoundment conditions (i.e., surface water concentrations would be expected to remain less than method detection limit of 0.05 μg/L).
- Hazard Quotient from ingestion and dermal contact with surface water is not associated with unacceptable risks.

Based on the results, contact with surface water would not pose unacceptable health risks under post-impoundment conditions.

Table 5-9: Risk Estimates from Contact with Surface Water: Post-Impoundment Conditions

Route of Concern	Assumed Concentration* (μg/L)	Hazard Quotient (Acceptable Value = 1)		
		Toddlers	Women of Childbearing Age	Adult Males and All Seniors
Drinking (direct ingestion)	0.05	0.0032	0.0022	0.0019
Bathing/swimming (dermal)	0.05	0.000032	0.000026	0.000022
Total		0.0032	0.0022	0.0019

* Mercury concentration in surface water was assumed to equal the method detection limit

5.6 CHEMICAL INTERACTION ASSESSMENT OF VARIOUS FORMS OF MERCURY

A final consideration in the HHRA involves estimation of risks for persons who may be involved in multiple activities. For example, what are the health risks for a person who is exposed to surface water (mercury primarily as inorganic) and also consumes country (wild) foods? Or, what are the health risks for a person who consumes multiple types of country (wild) foods?

In the case of adding mercury-related risks from surface water exposures to consumption of country (wild) foods, the combination of these activities will not change the conclusions. As illustrated previously in Tables 5-8 and 5-9, it is expected that risks from mercury due to contact with surface water would be associated with a Hazard Quotient value of 0.0032 for toddlers (and even less for other age groups). When this Hazard Quotient is added to the values associated with consumption of fish, wild game or waterfowl, the sum of the Hazard Quotient values remains essentially unchanged in all cases.

When the Hazard Quotient of 0.0032 from surface water is added to the values associated with consumption of certain fish, the sum of the Hazard Quotient values will remain above 1 for various consumption scenarios; however, there is no reason to recommend that persons consuming fish should avoid using the surface water (and vice versa). In past guidance from international health agencies (such as Health Canada and the World Health Organization), consumption advice to the general public has typically allowed for exposures from fish to contribute a Hazard Quotient value of 1 from methylmercury, irrespective of other forms of mercury exposures.

In the case of interactive effects from consumption of multiple country (wild) foods, it is clear that fish consumption is the dominant contributor in terms of risks. Although moose consumption also theoretically contributes a Hazard Quotient of 0.5, this is based on a person consuming large amounts of moose on a daily basis and, thus, it is likely that their fish consumption would drop under such circumstances. In addition, it has not been confirmed that the mercury concentrations of 0.07 µg/g for moose muscle tissue would actually occur at the study area. Finally, mercury concentrations in moose tissues was predicted to be essentially unaffected by impoundment. Nevertheless, the possible implications of cumulative exposure is discussed in greater detail below.

There are too many possible combinations to fully evaluate all possible interactions that may occur. As an alternative, the percentage of the TDI that 1 meal per week of each food group would represent was estimated as shown below. In completing these calculations, the meal sizes provided earlier were used:

- Toddler fish and moose meal = 100 g;
- Toddler beaver/muskrat/snowshoe hare/duck meal = 57 g;
- Adult fish and moose meal = 400 g; and
- Adult beaver/muskrat/snowshoe hare/duck meal = 200 g.

Once again, it should be noted that these represent rather large portion sizes for adults and Health Canada often uses a fish serving size of 200 g in most of their evaluation of adults (while in the case of the toddler, the 100 g is similar to Health Canada policy).

5.6.1 Present Conditions

As discussed above, the percentage of the TDI that 1 meal per week of each food would represent was estimated for present conditions and is provided in Table 5-10. As shown in this table, some food combinations would likely result in exposures exceeding the TDI under present conditions and, indeed, some foods by themselves (*i.e.*, northern pike and walleye) could result in exposures exceeding the TDI if consumed on a once per week basis under present conditions. Nevertheless, health authority advice should be sought before determining if these foods should be avoided under present day conditions.

Table 5-10: Risk Estimates from Mercury for Combined Sources: Present Conditions

Food	% of TDI Used Based on 1 Meal per Week		
	Toddlers	Women of Childbearing Age	Other Members of the General Population
Gull Lake			
Lake whitefish	30	33	12
Northern Pike	94	104	37
Walleye	99	108	39
Lake sturgeon	86	94	34
Duck	17	17	6
Beaver	3	<1	<1
Muskrat	<1	<1	<1
Moose	10	12	10
Snowshoe hare	4	4	3
Stephens Lake			
Lake whitefish	40	42	15
Northern Pike	110	123	44
Walleye	120	137	49
Lake sturgeon	No estimate available	No estimate available	No estimate available
Duck	17	17	6
Beaver	<1	<1	<1
Muskrat	2	2	1
Moose	10	12	10
Snowshoe hare	4	4	3

5.6.2 Post-Impoundment Conditions

Under post-impoundment conditions, the percentage of the TDI that 1 meal per week of each food would represent is provided in Table 5-11. As shown in this table, some food combinations will likely result in exposures exceeding the TDI under present conditions and, indeed, some foods by themselves (*i.e.*, northern pike and walleye) could result in exposures exceeding the TDI if consumed on a once per week basis from either Gull Lake or Stephens Lake under post-impoundment conditions.

Another alternative to reduce mercury exposures would be consumption of fish from appropriate lakes unaffected by the Project. However, even from pristine lakes unaffected by the Project, it will be necessary to consider size and species of fish for persons desiring to reduce their mercury exposures (*i.e.*, certain fish from these offset lakes may have mercury concentrations that warrant consumption recommendations).

Table 5-11: Risk Estimates from Mercury for Combined Sources: Post-Impoundment Conditions

Food	% of TDI Used Based on 1 Meal per Week		
	Toddlers	**Women of Childbearing Age**	**Other Members of the General Population**
Gull Lake			
Lake whitefish	80	90	32
Northern Pike	430	470	170
Walleye	430	470	170
Lake sturgeon	130	140	50
Duck	47	45	16
Beaver	<1	<1	<1
Muskrat	3	3	3
Moose	10	12	10
Snowshoe hare	4	4	3
Stephens Lake			
Lake whitefish	60	71	25
Northern Pike	210	240	85
Walleye	210	240	85
Lake sturgeon	110	118	42
Duck	37	35	13
Beaver	<1	<1	<1
Muskrat	3	3	3
Moose	10	12	10
Snowshoe hare	4	4	3

6.0 DISCUSSION AND UNCERTAINTY ANALYSIS

The HHRA was completed using a series of upper-bound assumptions that are intended to over-estimate actual health risks and thereby ensure a conservative assessment. Given the conservative assumptions used in this assessment, it is quite possible that actual risks may be substantially lower than estimated here. Nevertheless, certain assumptions were key determinants in the acceptability of risks. The following sensitivity analysis discusses some of the most important assumptions that had key influences on the risk assessment.

Mercury Concentrations in the Environment

One source of uncertainty is the concentrations of mercury in surface water and country (wild) foods that persons may be exposed to through their typical daily activities. The HHRA relied heavily on present and post-impoundment concentrations that have been measured or predicted by other disciplines. The prediction of the magnitude and extent of the changes in environmental concentrations was considered to be beyond the scope of the HHRA.

In the case of fish concentrations, the largest uncertainty with the most substantial impact on how much people can eat is for mercury concentrations in northern pike and walleye (*i.e.*, the NSC modeled post-impoundment estimates range from 0.81-1.33 µg/g and 0.83-1.46 µg/g). In addition, it is noted that there was particular uncertainty reported by the other disciplines in the mercury concentrations in the tissues of the following animals:

- Moose;
- Lake sturgeon;
- Snowshoe hare; and
- Ducks and geese.

It is anticipated that continued monitoring of concentrations can be used as a direct measure of the impact that present conditions and impoundment would have on mercury concentrations. Nevertheless, there remain uncertainties and, in all cases, future environmental monitoring and risk management should be used to determine if environmental concentrations increase beyond those assumed in the HHRA.

Toxicity Reference Values

The approach that health agencies use to estimate acceptable or "safe" levels of exposure are typically very conservative and employ considerable safety factors to ensure protection of the general population. It is unlikely that such regulatory agency-derived exposure limits would underestimate health risks. Overall, the TRVs for methylmercury and total mercury used in this assessment represent dose rates that are unlikely to present unacceptable health risks and may actually overestimate health risks.

Country (Wild) Foods Consumption Rates

Highly conservative estimates of country (wild) foods consumption were assumed for the HHRA. The rate of country (wild) foods consumption was provided directly by members of the KCNs communities as high-end estimates of food consumption. As a result, it is considered unlikely that these consumption rates underestimate exposures.

Overall Uncertainty in the Risk Assessment

Overall, it is unlikely that human health risks have been underestimated in the risk assessment and it is quite possible that already low risks have been overestimated. The potential combination of upper bound estimates of consumption patterns and conservative TRVs likely resulted in an overestimate of actual risks. Nevertheless, it is still possible (but not likely) that risks may have been underestimated for certain receptors in some cases. The two main conditions where risks may have been underestimated would include:

- Any situations where environmental sampling or modeling has underestimated mercury concentrations either currently or that would occur following impoundment; and
- Any situations where people are not accurately represented by the assumed receptor assumptions.

Risk management measures should be undertaken to ensure that neither of the conditions described above occur. If such conditions do occur, additional risk analysis would be recommended to address potential increases in human health risks.

7.0 CONCLUSIONS

For fish from Gull and Stephens lakes, the present arithmetic mean mercury concentrations of lake whitefish are less than 0.1 µg/g while northern pike and walleye have an arithmetic mean concentration of approximately 0.3 µg/g. Nevertheless, potential unacceptable risks are estimated from these fish when Hazard Quotient values are the only consideration used. In the case of wild game, moose meat concentrations of mercury are largely unknown for the study area but have been estimated to perhaps be in the range of 0.07 µg/g while muskrat, beaver and snowshoe hare would have concentrations of mercury in muscle tissue in the range of 0.01 to 0.05 µg/g, depending on the species.

Under post-impoundment conditions, the mercury concentrations of fish in Gull Lake and Stephens Lake will increase. Specifically, during years of maximum mercury concentrations in fish (perhaps 3 to 7 years post-impoundment; refer to Keeyask Hydropower Limited Partnership [2012a,b] for specific discussion on patterns of variation), the concentrations of mercury in fish and ducks from Gull Lake may increase by 0.5 to five times (smallest increase was in lake sturgeon and lake whitefish while greatest increase was in northern pike and walleye) while the concentrations of mercury from Stephens Lake would be more modest (perhaps 0.3 to 0.7 times increase). In the case of waterfowl, it is possible that fish eating ducks may experience an increase in mercury concentrations; however, the increase is not expected to result in Hazard Quotient values greater than 1. The mercury concentrations of wild game tissues consumed by the KCNs (*i.e.,* beaver, muskrat, moose or snowshoe hare) are expected to be essentially unaffected by the impoundment.

The key conclusions of the HHRA are as follows:

1. Hazard Quotient values greater than 1 are predicted from consumption of certain fish under both the present conditions and the predicted post-impoundment conditions. Under post-impoundment conditions, Hazard Quotient values increase since the mercury concentrations in various fish are estimated to increase. The

fish with the predicted highest increase in mercury concentrations are from Gull Lake and include northern pike (0.22 µg/g to just over 1 µg) and walleye (0.23 µg/g to just over 1 µg/g) while the increase in lake whitefish would be less (0.07 µg/g to just below 0.2 µg/g). The same species from Stephens Lake would be impacted less than fish from Gull Lake. There are currently numerous fish in Gull and Stephen lakes that have mercury concentrations that are considered to be low (less than 0.2 ppm) and very low (less than 0.1 ppm). This is expected to change after impoundment.Issuance of consumption advisories is a complex task that requires evaluation of the benefits and risks of fish consumption. Manitoba Health and Health Canada have committed to working with the KCNs and Manitoba Hydro on consumption advisories in a separate process.

2. No Hazard Quotient values greater than 1 are predicted from consumption of wild game or waterfowl under current or post-impoundment conditions. Muskrat is the only mammal that was predicted to have increased tissue concentrations of mercury following impoundment; however, the increases are considered to be very minor (*i.e.*, 0.02 µg/g under baseline conditions versus 0.04 µg/g under post-impoundment conditions). No measurable changes in mercury tissue concentrations under post-impoundment conditions in moose, beaver and snowshoe hare were predicted by Wildlife Resource Consultants. In the case of waterfowl, Stantec estimate that these may mirror changes in lake whitefish concentrations; however, no Hazard Quotient values greater than 1 were predicted from consumption of waterfowl.

3. Mercury concentrations in surface water do not pose unacceptable risks from contact or drinking under present or post-impoundment conditions (*i.e.*, risks are considered to be negligible). Typical total mercury surface water concentrations are predicted to remain less than the currently used analytical method detection limit (*i.e.*, less than 0.05 µg/L as compared to the Canadian Drinking Water Guideline of 1 µg/L).

4. No conclusions can be provided on consumption of wild plants or gull eggs since discipline experts have not been able to estimate mercury concentrations either presently or under post-impoundment conditions.

STATEMENT OF LIMITATIONS

This report has been prepared by Wilson Scientific Consulting Inc. (Wilson Scientific) for the sole benefit of InterGroup Consultants Limited (InterGroup) and Manitoba Hydro. Any use that a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Wilson Scientific accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional staff in accordance with generally accepted scientific practices current at the time the work was performed.

Any site-specific information provided by InterGroup, Manitoba Hydro or other parties has been assumed by Wilson Scientific to be accurate. Conclusions presented in this report should not be construed as legal advice.

This risk assessment was undertaken exclusively for the purpose outlined herein and was limited to those contaminants, exposure pathways, receptors, and related uncertainties specifically referenced in the report. This work was specific to the site conditions and land use considerations described in the report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations.

This report describes only the applicable risks associated with the identified environmental hazards, and is not intended to imply a risk-free site. Should any conditions at the site be observed or discovered that differ from those at the sample locations, or should the land use surrounding the identified hazards change significantly, Wilson Scientific requests that to be notified immediately to reassess the conclusions provided herein.

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APPENDIX 5C-1-1: DETAILED TECHNICAL INFORMATION, WORKED EXAMPLE RISK CALCULATIONS AND DETAILED RISK ESTIMATES

APPENDIX 5C-1-1: DETAILED TECHNICAL INFORMATION, WORKED EXAMPLE RISK CALCULATIONS AND DETAILED RISK ESTIMATES

5C-1-1 Introduction

This appendix provides detailed technical information on the human health risk assessment (HHRA). The appendix includes the following:

- Section 5C-1-2 provides the mathematical equations used to estimate exposures.
- Section 5C-1-3 provides worked examples of the risk calculations for various scenarios.
- Section 5C-1-4 provides information on the toxicological reference values selected for the HHRA.
- Section 5C-1-5 provides the detailed results of the HHRA (results expressed on an exposure pathway basis)

5C-1-2 Mathematical Equations Used to Estimate Exposures

As discussed earlier, the exposures that receptors may receive were estimated for the following pathways:

- Ingestion of surface water.
- Dermal contact with surface water.
- Ingestion of country foods.

The mathematical equations used to estimate exposures from these pathways are discussed in greater detail below.

Estimation of Exposure from Ingestion of Surface Water

In order to estimate exposure from ingestion of surface water, the following Health Canada (2009a; 2010a) equation was applied:

$$EWG = \frac{C_W \times IR_W \times RAF_{Oral} \times D_2 \times D_3}{BW}$$

where:

EWG	=	exposure from the water ingestion pathway (µg/kg body weight/day)
C_W	=	water chemical concentration (µg/L)
IR_W	=	water ingestion rate of person (L/day)
RAF_{Oral}	=	relative bioavailability fraction via the ingestion route (chemical specific)
D_2	=	days per week exposed/7 days (unitless)
D_3	=	weeks per year exposed/52 weeks (unitless)
BW	=	body weight of person (kg)

Estimation of Exposure from Dermal Contact with Drinking Water

Dermal contact with surface water was another pathway of exposure that was quantitatively evaluated in the HHRA. Dermal exposure was estimated according to the following Health Canada (2009a; 2010a) equation:

$$EDW = \frac{C_w \times SA_B \times PC \times D_1 \times D_2 \times D_3}{BW}$$

where:

EDS	=	exposure from the dermal pathway for drinking water (µg/kg/day)
C_W	=	water chemical concentration (µg/L)
SA_B	=	surface area of the entire body (m^2)
PC	=	permeability constant (m/hr) (chemical specific)
D_1	=	hours per day exposed to water (hr/day)
D_2	=	days per week exposed/7 days (unitless)
D_3	=	weeks per year exposed/52 weeks (unitless)
BW	=	body weight of person (kg)
UCF	=	unit correction factor (1,000 L/m^3)

Estimation of Exposure from Ingestion of Country Food

In order to estimate exposure from consumption of country food, the following Health Canada (2009a; 2010a) equation was applied:

$$EFG = \frac{C_F \times IR_F \times RAF_{Oral} \times D_2 \times D_3}{BW}$$

where:

EFG	=	exposure from the country food ingestion pathway (µg/kg body weight/day)
C_F	=	food chemical concentration (µg/g)
IR_F	=	food ingestion rate of person (g/day)

RAF_{Oral}	=	relative bioavailability fraction via the ingestion route (chemical specific)
D_2	=	days per week exposed/7 days (unitless)
D_3	=	weeks per year exposed/52 weeks (unitless)
BW	=	body weight of person (kg)

5C-1-3 Worked Example Risk Calculations

5C-1-3.1 Worked Example #1: Risks Posed to a Person Using Surface Water

In this worked example, risks posed to a woman of child-bearing age using surface water from mercury are estimated. To estimate exposures and risks, a surface water concentration of 0.05 µg/L (equal to the method detection limit) was assumed.

<u>Estimation of Risks from Ingestion of Surface Water</u>

In order to estimate exposure from surface water, the following equation was applied:

$$EWG = \frac{C_W \times IR_W \times RAF_{Oral} \times D_2 \times D_3}{BW}$$

where:

EWG	=	exposure from the water ingestion pathway (µg/kg body weight/day)
C_W	=	water chemical concentration (0.05 µg/L)
IR_W	=	water ingestion rate of person (1.5 L/day)
RAF_{Oral}	=	relative bioavailability fraction via the ingestion route (1.0)
D_2	=	days per week exposed/7 days (1.0)
D_3	=	weeks per year exposed/52 weeks (1.0)
BW	=	body weight of person (60 kg)

Under this scenario, the estimated exposure to mercury from surface water ingestion was estimated to be 0.0012 µg/kg bw/day.

The Hazard Quotient from this route was then estimated as follows:

$$\text{Hazard Quotient} = \frac{\text{Estimated Exposure } (0.0012\ \mu g/kg\ bw/day)}{\text{Tolerable Daily Intake } (0.57\ \mu g/kg\ bw/day)}$$

Thus, the Hazard Quotient value from surface water ingestion was estimated to be 0.0021.

Estimation of Risks from Dermal Contact with Drinking Water

Dermal contact with drinking water was another pathway of exposure that was quantitatively evaluated in the HHRA. Dermal exposure was estimated according to the following Health Canada (2009a) equation:

$$EDW = \frac{C_w \times SA_B \times PC \times D_1 \times D_2 \times D_3}{BW}$$

where:

EDS	=	exposure from the dermal pathway for drinking water (µg/kg/day)
C_W	=	water chemical concentration (0.05 µg/L)
SA_B	=	surface area of the entire body (1.8 m^2)
PC	=	permeability constant (1 x 10^{-5} m/hr)
D_1	=	hours per day exposed to water (1 hr/day)
D_2	=	days per week exposed/7 days (1.0)
D_3	=	weeks per year exposed/52 weeks (1.0)
BW	=	body weight of person (60 kg)
UCF	=	unit correction factor (1000 L/m^3)

Under this scenario, the estimated exposure to mercury from dermal contact with surface/drinking water was estimated to be 0.000015 µg/kg bw/day.

The Hazard Quotient from this route was then estimated as follows:

$$\textit{Hazard Quotient} = \frac{\textit{Estimated Exposure (0.000015 µg/kg bw/day)}}{\textit{Tolerable Daily Intake (0.57 µg/kg bw/day)}}$$

Thus, the Hazard Quotient value from dermal contact with drinking water was estimated to be 0.000026.

Estimation of Risks from All Surface Water Exposures

Summing the risks from all exposure routes, the following Hazard Quotient was estimated:

Hazard Quotient from ingestion of drinking water	0.0021
Hazard Quotient from dermal contact with drinking water	0.000026
Sum of all Hazard Quotients	0.0021

5C-1-3.2 Worked Example #2: Risks Posed from Consumption of Walleye

In this worked example, risks posed to the young child receptor from consumption of post-impoundment walleye from Gull Lake are estimated. It was assumed that the young toddler consumed walleye at a rate of one time per week (serving size = 100 g).

To estimate exposures and risks, the following environmental concentrations were assumed:

- Methylmercury concentration in walleye (peak year post-impoundment) = 1.0 µg/g

In order to estimate exposure from consumption of walleye, the following equation was applied:

$$EFG = \frac{C_F \times IR_F \times RAF_{Oral} \times D_2 \times D_3}{BW}$$

where:

EFG	=	exposure from the country food ingestion pathway (µg/kg body weight/day)
C_F	=	food chemical concentration (1.0 µg/g)
IR_F	=	food ingestion rate of person (100 g/week or 14.3 g/day)
RAF_{Oral}	=	relative bioavailability fraction via the ingestion route (1.0)
D_2	=	days per week exposed/7 days (1.0)
D_3	=	weeks per year exposed/52 weeks (1.0)
BW	=	body weight of person (16.5 kg)

Under this scenario, the estimated exposure to methylmercury from consumption of walleye was estimated to be 0.87 µg/kg bw/day.

The Hazard Quotient from this route was then estimated as follows:

$$\text{Hazard Quotient} = \frac{\text{Estimated Exposure (0.87 µg/kg bw/day)}}{\text{Tolerable Daily Intake (0.2 µg/kg bw/day)}}$$

Thus, the Hazard Quotient value from consumption of walleye at a rate of once per week during the peak year following impoundment was estimated to be 4.3 for the young toddler.

5C-1-4 Toxicological Reference Values Used in the HHRA

As discussed in the Main Report, toxicological reference values were selected using Health Canada guidance. The rationale for the selected TRVs is provided below.

Mercury, Methyl

Health Canada (2010b) recommends the following TDIs for methyl mercury:

- 0.2 μg/kg body weight/day for sensitive members of the general population (i.e., pregnant women, women of child-bearing age, infants and young children)

- 0.47 μg/kg body weight/day for non-sensitive member of the general population

Health Canada (1998; 2002) proposed an interim revised TDI of 0.2 μg/kg body weight/day for sensitive members of the population. The proposed interim revision of the TDI was based on a studies completed in human populations consuming fish in New Zealand, Republic of Seychelles and the Faroe Islands. The endpoint of primary concern was related to neurological development of children born to women consuming large amounts of fish with elevated methyl mercury concentrations. Based on these studies, Health Canada (1998) developed a benchmark dose of dietary intake equal to 1 μg/kg body weight/day that was felt to represent a dose where no adverse effects were observed. With the application of a 5-fold uncertainty factor to this benchmark dose, Health Canada then proposed an interim TDI for pregnant women, women of child-bearing age, and infants of 0.20 μg/kg body weight/day. Health Canada (1998; 2002) advised that this should be regarded as a temporary measure only and revised guidance may still be developed. For non-sensitive members of the general population, Health Canada (2010) cited a TDI of 0.47 μg/kg body weight per day. These TDIs were assumed to be protective of adverse health effects from methyl mercury.

Mercury, Inorganic

For evaluation of mercury when it is not present in fish, the human health risk assessment has relied on the recommendations of WHO (2010). WHO (2010) Committee established a provisional tolerable weekly intake (PTWI) for inorganic mercury of 4 μg/kg bw. WHO (2010) indicated that this PTWI for inorganic mercury was considered applicable to dietary exposure to total mercury from foods other than fish and shellfish. WHO (2010) also indicated that this was applicable to the whole population and did not indicate that risks would be additive with methylmercury exposures (i.e., WHO [2010] concluded that the upper limits of estimates of average dietary exposure to total mercury from foods other than fish and shellfish for adults (1 µg/kg bw per week) and for children (4 µg/kg bw per week) were at or below the PTWI for inorganic mercury and did not indicated a requirement to sum the methylmercury exposures). Consequently, this PTWI was used as the source of the TDI. To estimate a TDI, the PTWI was simply divided by 7 days. Consequently, a TDI of 0.57 µg/kg bw/day was estimated. This value was used to estimate risks from total mercury present in foods other than fish and shellfish and from mercury present in surface water.

In summary, the following Tolerable Daily Intakes were used to evaluate the neurological potential of inorganic of mercury:

- Total mercury TDI of 0.57 µg/kg bw/day for young children and women of child-bearing age;
- Total mercury TDI of 0.57 µg/kg bw/day for the rest of the population.

5C-1-5 Detailed Risk Estimates

The risk estimates for the various receptors and issues of concern are provided in Tables 5C-1-1 to 5C-1-7.

Table 5C-1-1 Preliminary Risk Estimates from Mercury Due to Consumption of Country Foods: Baseline Conditions at Gull Lake

Food Item	Assumed Concentration (ug/g wet weight)	Proposed Consumption Frequency (meals per week)	Serving Size for Toddler (ounces)	Serving Size for Adult (ounces)	HQ for Toddlers	HQ for Women of Childbearing Age	HQ for Adult Males and All Seniors
Fish							
Lake Whitefish	0.07	3	3.5	14	0.9	1.0	0.4
Jackfish (pike)	0.22	3	3.5	14	2.8	3.1	1.1
Pickerel (walleye)	0.23	3	3.5	14	3.0	3.3	1.2
Lake Sturgeon	0.2	3	3.5	14	2.6	2.8	1.0
Birds							
Duck	0.07	1	2	7	0.17	0.17	0.06

HQ = Hazard Quotient

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Table 5C-1-2 Preliminary Risk Estimates from Mercury Due to Consumption of Country Foods: Baseline Conditions at Stephens Lake

Food Item	Assumed Concentration of Mercury (ug/g wet weight)	Assumed Consumption Frequency (meals per week)	Serving Size for Toddler (ounces per meal)	Serving Size for Adult (ounces per meal)	HQ for Toddlers	HQ for Women of Childbearing Age	HQ for Adult Males and All Seniors
Fish							
Lake Whitefish	0.09	3	3.5	14	1.2	1.3	0.5
Jackfish (pike)	0.26	3	3.5	14	3.3	3.7	1.3
Pickerel (walleye)	0.29	3	3.5	14	3.7	4.1	1.5
Birds							
Duck	0.09	1	2	7	0.22	0.21	0.08

HQ = Hazard Quotient

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Table 5C-1-3 Preliminary Risk Estimates from Mercury Due to Consumption of Country Foods: Post-Impoundment Conditions at Gull Lake

Food Item	Assumed Concentration of Mercury (ug/g wet weight)	Assumed Consumption Frequency (meals per week)	Serving Size for Toddler (ounces per meal)	Serving Size for Adult (ounces per meal)	HQ for Toddlers	HQ for Women of Childbearing Age	HQ for Adult Males and All Seniors
Fish							
Lake Whitefish	0.19	3	3.5	14	2.4	2.7	1.0
Jackfish (pike)	1.0	3	3.5	14	12.9	14.2	5.1
Pickerel (walleye)	1.0	3	3.5	14	12.9	14.2	5.1
Lake Sturgeon	0.3	3	3.5	14	3.9	4.2	1.5
Birds							
Duck	0.19	1	2	7	0.47	0.45	0.16

HQ = Hazard Quotient

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Table 5C-1-4 Preliminary Risk Estimates from Mercury Due to Consumption of Country Foods: Post-Impoundment Conditions at Stephens Lake

Food Item	Assumed Concentration of Mercury (ug/g wet weight)	Assumed Consumption Frequency (meals per week)	Serving Size for Toddler (ounces per meal)	Serving Size for Adult (ounces per meal)	HQ for Toddlers	HQ for Women of Childbearing Age	HQ for Adult Males and All Seniors
Fish							
Lake Whitefish	0.15	3	3.5	14	1.9	2.1	0.8
Jackfish (pike)	0.5	3	3.5	14	6.4	7.1	2.5
Pickerel (walleye)	0.5	3	3.5	14	6.4	7.1	2.5
Lake Sturgeon	0.25	3	3.5	14	3.2	3.5	1.3
Birds							
Duck	0.15	1	2	7	0.37	0.35	0.13

HQ = Hazard Quotient

Table 5C-1-5 Preliminary Risk Estimates from Mercury Due to Consumption of Country Foods: Baseline Conditions

Food Item	Assumed Concentration of Mercury (ug/g wet weight)	Assumed Consumption Frequency (meals per week)	Serving Size for Toddler (ounces per meal)	Serving Size for Adult (ounces per meal)	HQ for Toddlers	HQ for Women of Childbearing Age	HQ for Adult Males and All Seniors
Mammals							
Beaver	0.01	3	2	7	0.03	0.02	0.02
Muskrat	0.02	1	2	7	0.02	0.02	0.01
Moose	0.07	5	3.5	14	0.53	0.58	0.49
Rabbit*	0.05	1	2	7	0.04	0.04	0.03

* Concentrations of mercury in rabbit have only been evaluated semi-quantitatively at the current time

HQ = Hazard Quotient

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Table 5C-1-6 Preliminary Risk Estimates from Mercury Due to Consumption of Country Foods: Future Conditions

Food Item	Assumed Concentration of Mercury (ug/g wet weight)	Assumed Consumption Frequency (meals per week)	Serving Size for Toddler (ounces per meal)	Serving Size for Adult (ounces per meal)	HQ for Toddlers	HQ for Women of Childbearing Age	HQ for Adult Males and All Seniors
Mammals							
Beaver	0.01	3	2	7	0.03	0.02	0.02
Muskrat	0.04	1	2	7	0.03	0.03	0.03
Moose	0.07	5	4	14	0.53	0.58	0.49
Rabbit*	0.05	1	2	7	0.04	0.04	0.03

* Concentrations of mercury in rabbit have only been evaluated semi-quantitatively at the current time

HQ = Hazard Quotient

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Table 5C-1-7 Risk Estimates for Traditional Land Use - Based on Total Mercury Surface Water Concentrations (Present and Future Assumed to Equal 0. 05 ug/L)

Receptor of Concern	Assumed Surface Water Conc (ug/L)	HQ dermal - surface water	HQ - ingestion of drinking water	HQ all routes of surface water contact
Toddler	5.0E-02	0.000032	0.0032	0.0032
Woman of Childbearing Age	5.0E-02	0.000026	0.0022	0.0022
Adult Male	5.0E-02	0.000022	0.0019	0.0019

HQ = Hazard Quotient

2012 KEEYASK TRADITIONAL PLANTS WORKSHOP SUMMARY

October 22-23, 2012

St. Johns United Church, Thompson, Manitoba

Purpose of Notes: These summary notes were shared for KCN community review and approval[1]. These notes are intended for public use, including potential use at the Keeyask hearings or other regulatory purposes as required.

Workshop Attendees:

- Ahab Flett (TCN)
- John G. Beardy (TCN)
- Joseph Harvey (TCN)
- Joyce Mayham (TCN)
- Arlene Flett (TCN)
- Lorna Keeper (TCN)
- Obediah Wastesicoot (YFFN)
- Dorothy Redhead (YFFN)
- Stella Chapman (YFFN)
- Wayne Redhead (YFFN)
- Bailey Saunders (YFFN)
- Roberta Spence (YFFN)
- Martina Saunders (YFFN)
- Marie Ryle-Beardy (YFFN)
- Amelia Saunders (YFFN, translator)
- Eric Saunders (YFFN)
- Robert M. Beardy (FLCN)
- Jimmy Lockhart (FLCN)
- Randy Naismith (FLCN)
- Lillian Spence (FLCN)
- Rebecca Beardy (FLCN)
- Wendy Ross (FLCN)
- John Whitaker (CNP, Advisor)
- Adrian Skok (CNP, Advisor)
- Elly Bonny (YFFN, Advisor)
- Monica Wiest (Manitoba Hydro)
- Maria Zbigniewicz (Manitoba Hydro)
- Jackie Krindle (Calyx Consulting)
- Gaylen Eaton (North/South Consultants Inc.)

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[1] Cree Nation Partner attendees have reviewed these notes and indicated on March 11, 2013 that they had no comments. The Fox Lake Cree Nation (FLCN) and the York Factory First Nation (YFFN) provided comments on March 13, 2013 and March 7, 2013 respectively. FLCN and YFFN comments have been addressed to their satisfaction.

Workshop Objectives:

- To bring KCNs members and Manitoba Hydro representatives together to share knowledge with respect to traditional plants and Cree worldview;
- To document KCNs knowledge and perspectives on plants, focusing on the Project area;
- To prepare for a future plant field trip; to share knowledge with and prompt interest in plants with KCNs youth; and
- To provide an opportunity for the Partners to continue building positive relationships.

October 22, 2012 – Day 1

Following the opening prayer and round table introductions, Monica Wiest (MW) reviewed the objectives of the 2012 workshop (see above) and some history on previous workshops in 2009 and 2010 which were held at Notigi and the Gillam area respectively.

MW invited people to express their thoughts in a sharing circle which provided opportunity for all participants to reflect and speak on plants. Plant samples, photos and plant books were available as reference materials.

October 23, 2012 – Day 2

Day 2 began with a summary of what was learned the previous day. Participants added their perspectives on the previous day events. Breakout groups were assembled around maps to identify plants of interest and their location. Participants shared knowledge about plants in specific locations. To protect the privacy of the knowledge holders, these maps will not be made public.

In the afternoon, MW led a discussion on next steps, specifically discussing plans for a 2013 field trip and associated planning activities. Participants offered some additional thoughts and the workshop finished with a closing prayer.

On both days, many participants spoke in Cree. Comments from Cree speakers were summarized in English once the Cree speakers had finished. Notes were taken by an English speaker based on the oral translations.

Key concepts recorded from both days include:

Views on the Workshop:

Participants were in general consensus on the following:

- This workshop was regarded as an opportunity to share knowledge among the Cree and also to help the broader community understand the Cree relationships with plants.
- Important that people continue to learn about who they are as Cree and what they relied on for survival.

Plants and Cultural Knowledge / Way of Life:

- The Elders regard all plants as sacred.
- One participant shared the view that plants are no less important than sturgeon or caribou.

- The Cree regard plant knowledge to be important and it is a priority to teach this knowledge to the youth. One goal is to teach the youth about plants through the school.
- Many agreed that youth also need to be taught that the Cree way of understanding the world is just as valid as western science.
- Many participants fondly remember times with grandparents and parents on the land where they were taught by experience about plants. This helped them learn the Cree way of life.
- Participants also spoke about water nourishing the plants, plants nourishing the animals which, in turn, nourish the people.

Plant Practices and the Power of Plants

- In the memory of the Elders, they did not get many doctor or nurse visits to the community (example was for Split Lake). Traditional medicine was used to treat the people. In the past, a healer would often do the healing.
- Plants are regarded to be powerful, with powerful abilities to heal even the very wounded or sick. Some examples of the remarkable healing powers of plants were shared.
- Traditional plants heal relationships with land / *Aski*. They provide strong healing, healthy food and help the mind, body and spirit.
- Being out on the land is healing for the people.
- For medicines to work, you need to have faith in them to work in the way you want them to.

Some of the concepts shared in the 2010 workshop were reiterated by participants including:

- A gift of tobacco is offered to the Creator after harvesting plants (from 2010 workshop).
- A photo must not be taken of a person harvesting plants (from 2010 workshop).
- Plant remains are to be put back to the earth in a quiet place where no one walks (from 2010 workshop).
- Plants are for personal use – never sold (from 2010 workshop).

Plants and Previous Hydroelectric Projects:

- A TCN Elder explained how the environment changed when Manitoba Hydro development began. He explained that plants that were used by his people were destroyed. Animals changed affecting hunters and trappers and fish, for example, at Kelsey were affected by the muddy waters and the change in water plants so much that nothing is there now. He explained that the changes in water levels make it difficult to land your boat and get on and off the shoreline. Standing timber in flooded areas prevent landing a boat in many places. The Cree had regarded the area clean prior to this development.
- Trees and plants that used to be gathered have already been destroyed by development. These areas are now flooded and people have to go further. The rise and fall of the water has affected the shorelines in particular preventing plant growth. Erosion along islands was also mentioned to have affected plant areas.

- The medicine along the Nelson River is already gone because of previous development.

Plants and Keeyask:

- Concerns were raised with respect to Keeyask and Conawapa Projects because of the conversion of lands to waters. Birds, animals, plants and trees that live on land will lose their habitat and the fish will start using the land under the water. Travel to areas will be affected increasingly by the rise and fall of the river. These conditions also affect community life as it remains difficult to get family out on the land. Though there are community goose and moose hunts, these are not the same as getting the family out on the land. Areas that will be affected by Keeyask have vast numbers of plants and because they will be affected, it will prevent the children and grandchildren from going there.
- Plants must be picked from a clean area for them to work. Having continuous developments in the area forces people to go further away. One participant indicated that this is expected to affect both the resources and the medicinal value of plants from Lake Winnipeg to the Hudson Bay.
- Concerns were raised with respect to rehabilitating borrow pits. Unrehabilitated borrow pits are considered eyesores (scars on the land). It was suggested that rehabilitation could include useful plants such as berries instead of weeds or grass.
- TCN Elder and community members expressed concerns that the extents of flooding would affect the Split Lake community and the lands around it directly.

Keeyask and ATK Monitoring Activities pertaining to Plants:

- The TCN advisor suggested thinking about ATK monitoring which each community will have the opportunity to undertake. He suggested a series of visits to the affected areas (for example, four times per year) including community elders and youth on the land.

Medicinal Plants:

- All sorts of plants were and are used in different ways to treat sickness.
- Weekis[2] were emphasized as the #1 medicine. It was noted that some people get weekis in trade with those who gather it, sometimes from areas far removed from the communities.
- A list of medicinal plants noted at the workshop and their purposes is provided in Table 1 below. It should be noted that this is not a complete list of plants used. It also should be noted that in some instances, plants and their uses discussed reflect individual perspectives while others reflect broad consensus among the KCN communities.

Plants for Food:

- Key foods that come from plants that were mentioned at the workshop are listed in Table 2 below. It should be noted that this is not a complete list of plants harvested or consumed.

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[2] Cree spellings vary.

Other Plant Products:

- Plants used for other purposes were also mentioned in the workshop. A description of the plants and their uses is located in Table 3. It should be noted that this is not a complete list of plants or plant products used for other purposes.

Plants and Mapping:

The objectives of the mapping session were:

- What plants in the Keeyask study area have been gathered by your community in the past? What are the Cree or local names?
- What plants in the Keeyask study area are being gathered by your community now?
- Are there certain locations of the Keeyask study area that are important to your community for gathering these plants?

Maps will not be published but general information shared includes the following:

- Tataskweyak Cree Nation and Fox Lake Cree Nation Members identified areas of active plant harvest on maps[3]. Though not likely a complete list, plants identified as currently used include blueberries, strawberries, cranberries, cloudberries, Labrador tea, trappers tea, sweet grass, and weekis. Plants noted to be used historically were cattail, sphagnum moss, blackberries, gooseberries, puffballs, strawberry blite and an unidentified plant species used like tobacco (Note: it might be likely that some species are still picked among some community members). People also mentioned creeping juniper, flowers, larch and moose graze areas but did not specify whether these plants were used historically or currently.
- Labrador tea (*Rhododendron groenlandicum)* was noted to be widely abundant.
- Some areas where trappers tea (*Rhododendron tomentosum)* has been picked and is currently picked will be lost due to flooding. These places are important because they are special areas where family has walked and the area has history. As discussed above, all plants are considered sacred.
- Concerns about the extents of flooding were raised for the Split Lake vicinity including the community of Split Lake. Carscadden Lake also was specifically mentioned.
- Weekis are harvested by all three communities in locations relatively close to communities (Assean Lake, Burntwood River, Kettle River, and the Ripple and Aiken rivers [in areas of those rivers not affected by water fluctuations]). Harvest of weekis was not mapped in areas expected to be affected by the Keeyask Project. A TCN Elder said that the medicine from these areas has been lost already due to water fluctuations. It should be noted, however, that one of the primary TCN knowledge holders was not able to attend the workshop.

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[3] York Factory First Nation Members chose not to take part in the mapping exercise as they were not comfortable documenting the locations of important plants. Instead, York Factory First Nation Members continued discussions about plants.

Next Steps:

The group discussed next steps to continue to explore this topic. It was suggested that a planning meeting be held in February 2013 to start planning for a summer of 2013 field trip. August was suggested to be the best month for both the plants and the youth (who would be out of school). Some follow-up was suggested with respect to the status of access on the North Access Road and the possibility of staying at the camp or camping to avoid the commute to Gillam or Thompson each day.

Several participants also highlighted the need to incorporate a 'traditional plants' perspective in Keeyask monitoring activities (through the ATK monitoring programs), and in remediation and re-vegetation plans for both the Keeyask Infrastructure Project and the Keeyask Generation Project.

The Fox Lake Cree Nation expressed that the South Access Road area was a priority for further investigation.

Table 1: Medicinal Plants and Uses Shared at the Workshop

Plant	Cree Name[4]	Other Common Names	Latin Name[5]	Purpose or Treatment[6]
Sweet flag	Weekis	Muskrat root, Seneca root	*Acorus americanus*	Fever; sore throat; for maintaining body temperature in winter (used by trappers).
Labrador Tea		Trappers tea	*Rhododendron groenlandicum*	Diuretic / water pill; healing mosquito bites and sores. Chewed and put on wounds to stop bleeding.
Puffballs			various	Bleeding (noses).
Sphagnum moss (red/orange)			*Sphagnum* spp.	Absorbent material for diapers; rash prevention; has healing element.
Spruce (gum)			*Picea mariana*	Eczema; cover for cuts and sores; typically mixed with other ingredients.
Spruce (cones)			*Picea mariana*	Disinfectant.
Larch (roots)			*Larix larcina*	Skin treatment.
Willow (red) (possibly red-osier dogwood)			*Salix* spp. or *Cornus sericea*	Leaves cover / close a wound like stitches; also disinfectant from bark.
Birch (root)			*Betula papyrifera*	Disinfectant.
Common juniper			*Juniperus communis*	Unknown.
Creeping juniper			*Juniperus horizontalis*	Coughs, sores. Noted to grow near jack pine.
Cattails			*Typha latifolia*	Medicine.

[4] Limited time prevented documenting the Cree names of many plants. When the Cree name was shared, it was recorded.

[5] Latin names were derived from literature.

[6] It should be noted that the use of plants in some instances reflect use by individuals while other plants are commonly used among all the KCN. How plants are used may vary across the KCN communities.

Table 1: Medicinal Plants and Uses Shared at the Workshop

Plant	Cree Name[4]	Other Common Names	Latin Name[5]	Purpose or Treatment[6]
Sage			*Artemisia* spp.	Unknown
Leaves (species not specified)			n/a	Cover for cuts or rashes.
Other Plants mentioned but not found in the Keeyask Area				
Balsam Fir			*Abies balsamea*	Mixed with other ingredients to treat infections.
Cedar			*Thuja occidentalis*	Unknown
Basil				Unknown

Table 2: Plants Used for Food[7]

Plant	Cree Name	Other Common Names	Latin Name[8]
Raspberries		-	*Rubus* spp.
Blueberries		-	*Vaccinium* spp.
Bog Cranberries		-	*Vaccinium oxycoccos*
Cloudberries		-	*Rubus chamaemorus*
Strawberries		-	*Fragaria* spp.
Birch (root) for Tea		-	*Betula papyrifera*
Trappers Tea		Muskeg tea	*Rhododendron tomentosum*
Cattails		-	*Typha latifolia*
Other Plants mentioned but not found in the Keeyask Area			
Maple Syrup			

[7] May not be a comprehensive list.

[8] Latin names were derived from literature.

Table 3: Other Plant Products[9]

Plant	Cree Name	Other Common Names	Latin Name	Use
Birch (bark)		-	*Betula papyrifera*	Bark was used for making art
Sweet grass		-	*Hierochloe odorata*	Ceremonial
Strawberry blite		-	*Chenopodium capitatum*	Used for dye
Wood (rotted and turned red)	A tos piy a tik	-	n/a	Burnt to tan hides
Lily pads			*Nuphar* spp.	Unknown
Unknown		-	n/a	Used as tobacco
Flowers		-	n/a	As gift
Poplar bark		aspen	*Populus tremuloides*	Bark cut in long strands to make string
Spruce		-	*Picea* sp.	Wood used to make hammers
Other Plants mentioned but not found in the Keeyask Area				
None				

[9] May not be a comprehensive list.