KEEYASK GENERATION PROJECT

PHYSICAL ENVIRONMENT SUPPORTING VOLUME

INTRODUCTION

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1.0 INTRODUCTION

This Physical Environment Supporting Volume (PE SV) is one of six volumes produced in support of the Keeyask Generation Project: Response to EIS Guidelines. The **Environmental Impact Statement (EIS)** has been developed by the Keeyask Hydropower Limited Partnership (the Partnership) as part of the regulatory review of the **Project** under the *Canadian Environmental Assessment Act* and *The Environment Act* (Manitoba).

The EIS consists of the following:

- A video, Keeyask: Our Story, which presents the **Keeyask Cree Nations' (KCNs)** history and perspectives related to hydroelectric development. Presented through the prism of their holistic Cree worldview, it explains the journey taken by the KCNs as they evaluated their concerns about the Project, the nature of their participation as Partners, and the decisions they ultimately made to support the Project.
- An executive summary.
- The Keeyask Generation Project: Response to EIS Guidelines document, which addresses guidelines issued by Canada and Manitoba in response to an application by the Partnership for environmental approvals under the government regulatory **environmental assessment** process. This response includes findings and conclusions, with charts, diagrams, and maps to clarify information in the text, and a concordance table to cross-reference requirements of the EIS Guidelines with information in the EIS.
- The KCNs' Evaluation Reports providing each of the KCNs' own evaluation of the **effects** of the Project on their communities and Members and including **Aboriginal traditional knowledge (ATK)** relevant to the Partnership's response to the EIS Guidelines.

Six supporting volumes were developed by the Manitoba Hydro environmental team in consultation with the KCNs and their Members, to provide details about the Project Description (PD SV) and about the research and analysis of the following topics:

- Public Involvement Program (PI SV),
- Physical Environment (PE SV),
- Aquatic Environment (AE SV),
- Terrestrial Environment (TE SV), and
- Socio-economic Environment, Resource Use, and Heritage Resource (SE SV).

The supporting volumes have been reviewed, commented on, and, as appropriate, finalized in a manner consistent with the arrangements of the Partnership.

This supporting volume examines the effects of the Project on the physical environment and describes:

- The existing **environment** that could be affected by the Project, including the current situation, past influences that have shaped the existing environment, as well as how the existing environment may evolve in the future without the Project.
- The nature and estimated effects of the Project within the context of **mitigation** measures that will be used to reduce effects.
- **Residual effects** remaining after mitigation.
- **Monitoring** plans designed to track actual effects and unanticipated effects.

The PE SV is organized into the following **key topic** areas:

- Climate;
- Air quality and noise;
- Surface water and ice regimes;
- Physiography (including surficial geology, **topography**, soils, etc.);
- Shoreline **erosion** processes (both **mineral soil** and peatland);
- Sedimentation;
- Groundwater;
- Surface water temperature and **dissolved oxygen**;
- Debris;
- Sensitivity of effects assessment to climate change; and
- Effect of the environment on the Project.

The assessment has been conducted in consideration of guidance documents from Canada and Manitoba related to environmental assessments and in response to the Federal Environmental Impact Statement Guidelines for the Keeyask Generation Project, as described in Chapter 1 of the Keeyask Generation Project: Response to EIS Guidelines document.

1.1 OVERVIEW OF ASSESSMENT APPROACH

1.1.1 The Physical Environment in the Keeyask Study Area

Within the Project **study area**, the physical environment along the lower Nelson River system has been altered in the past, and continues to be influenced by changes brought about by the operation of **Churchill River Diversion** (**CRD**) and **Lake Winnipeg Regulation** (**LWR**), which were commissioned in the mid-1970s. The CRD and LWR resulted in substantial changes in **water regime** and ice processes along the river system. The CRD and LWR, as well as the generating stations built on the Nelson River,

form part of the existing environment and are assumed to continue to operate into the future with or without the Project.

The Keeyask physical environment forms the foundation of the biological and many of the socioeconomic activities that occur in the area. The interactions of the various physical processes with the proposed Project were studied to create a comprehensive understanding of the existing physical environment so that the effects of the Project on the physical environment could be predicted. Figure 1.1-1 illustrates the various physical environment studies and how they interact with one another. The consideration of Project effects on the physical environment includes the physical changes to the land as a result of constructing the principal structures and supporting **infrastructure** (see PD SV). **Construction** will require the extraction of materials such as rock, **sand**, **gravel** and clay. As a result of building and operating the Keeyask **Generating Station (GS)**, the water regime (water levels and variations, water depth, river **flows**, water **velocities**) and ice conditions will be changed. By raising the water level upstream of the **dam**, Gull Rapids will be flooded out, land will be flooded, new shorelines

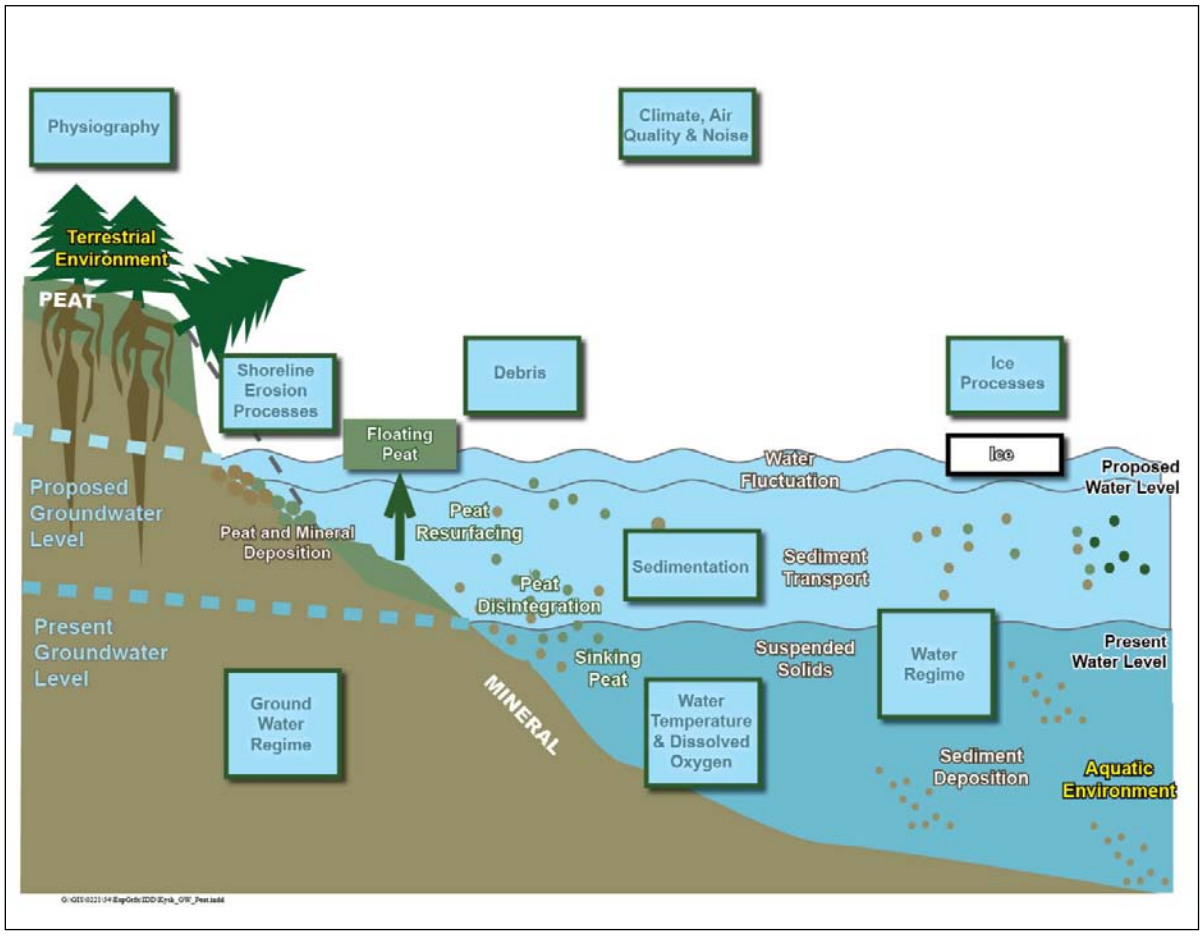

Figure 1.1-1: Physical Environment Studies and How They Interact

will develop and erosion of mineral shorelines as well as **peatland disintegration** will occur. Erosion and peatland disintegration will cause material to enter the waterway and affect **sedimentation**, dissolved oxygen, and debris conditions. Changes to the water levels in the river will also cause subsequent changes in **groundwater** levels adjacent to the **reservoir**.

1.1.2 Scope of the Physical Environment Assessment

1.1.2.1 Scope of the Project

The **scope** of the Project covers all of the physical works and activities involved in the construction and operation of the Project, including:

- Temporary and permanent access roads to the Project site and within the construction area.
- Supporting infrastructure (*e.g.,* construction camp, contractor work areas, etc.).
- Major civil works for the principal structures (*e.g.,* **dykes**, **powerhouse**, **spillway** etc.).
- Source areas for construction material (*e.g.,* borrow pits and rock quarries).
- **Impoundment** of the **reservoir** and regulation of water levels.

A full description of the scope of the Project is provided in the PD SV. The scope of this Project does not include the following separate projects in the general area.

- The Keeyask Infrastructure Project (KIP) – this is a separate project involving the construction of an access road to the Keeyask GS site, a temporary construction camp and some civil works related to the camp required for the Keeyask Project. The KIP was licensed under *The Environment Act* (Manitoba) (Environment Act Licence No. 2952, March 8, 2011). The operation of the access road is part of the scope of the Keeyask Project.
- The Keeyask Construction Power Transmission – this is a separate Manitoba Hydro project involving a temporary **transmission line** to the Project site, which will deliver power from an existing transmission line to the site for construction purposes. It will undergo Provincial review as a separate project, concurrent with the Keeyask Project.
- The Keeyask Generation Outlet Transmission Lines – this is a separate Manitoba Hydro project involving three transmission lines that will transfer power from the Project to an existing **converter station** at Radisson. This will also be a separate Project reviewed under the Provincial process concurrently with the Keeyask Project.

These separate projects will be considered in the **cumulative effects** assessment with respect to potential interactions with the Project.

In addition to Manitoba Hydro's Corporate Environmental Management Policy, key guidance to avoid or reduce **adverse** effects in the design of the Project was obtained through the KCNs' "Principles Regarding Respect for the Land" (JKDA, Schedule 7-1) and measures that would comply with these

principles, as well the KCNs Partners shaped the design of the Project and mitigation measures through ongoing consultation.

1.1.2.2 Scope of the Assessment

The Physical Environment assessment considered both Provincial and Federal environmental assessment (EA) guidance documents. Project specific guidelines (CEAA 2012) for the environmental assessment of the **Keeyask Generation Project** were followed in the assessment of Project effects on the Physical Environment. A concordance table that identifies guideline requirements and corresponding locations where the guidelines are addressed is provided in the Keeyask Generation Project: Response to EIS Guidelines document.

The scoping process for the assessment of the Project involved the identification of environmental issues as well as KCNs and **stakeholder** issues and concerns. The process also facilitated the delineation of spatial and temporal boundaries for the assessment of the **environmental effects**. Potentially affected environmental components were then identified for the physical, **aquatic**, **terrestrial** and socio-economic environment, and for **heritage resources**.

For the Physical Environment assessment, **valued environmental components** were not identified. The effects of changes in the physical environment are identified and described for consideration of their associated effects on valued environmental components in the other supporting volumes. For example, the effects of changes in water level due to impoundment of the reservoir on aquatic valued environmental components are discussed in the Aquatic Environment Supporting Volume (AE SV).

Potential environmental effects of the proposed Project were identified and assessed, and mitigation was proposed using available scientific studies, professional judgement, expert and **local knowledge**, First Nations input and stakeholder consultation. Environmental effects were identified for construction and operation periods, and mitigation measures were identified to avoid or minimize adverse effects. Both direct and **indirect environmental effects** of the proposed Project were considered. Interactions of the proposed Project, in combination with the effects of other existing and proposed projects and activities, were also considered. The approach to the cumulative effects assessment is described in the Keeyask Generation Project: Response to EIS Guidelines (Chapter 7), which lists relevant past and future projects with which the Keeyask Project may have a cumulative effect.

The effects of the Project on climate are discussed in Section 2, Climate, of this Supporting Volume. The Climate section also presents projections of future changes in climate for the study area based on a range of scenarios climate. Climate is a consideration in the assessment of all the effects on the physical environment. Section 11 at the end of the PE SV discusses the sensitivity of the predicted residual physical environment effects to projected changes in future climate conditions. As well, the potential effects of the environment on the Project are discussed in Section 12 of the PE SV.

Follow-up requirements were identified where appropriate and residual environmental effects were evaluated using predetermined factors and criteria. The overall approach to the assessment is intended to examine the existing and evolving environmental setting without the Project and compare this to the projected future environment with the Project – all of which will inform decision makers on the sustainability of this Project.

1.1.2.3 Spatial Scope

The proposed Project is located in northern Manitoba, approximately 180 **km** northeast of Thompson and approximately 40 km southwest of Gillam, and about 74 km east of Split Lake (Map 1.1-1). The Project is located in the **Split Lake Resource Management Area**. In order to conduct the assessment in an organized way, the following study areas were established for the biophysical environment assessment:

- **Regional study area** or biophysical study area.
- Local study area.
- Project **footprint**.

The majority of the physical environment assessments were completed for areas within the Keeyask Physical Environment Study Area, a regional area extending eastward from Thompson to the Limestone Generating Station (Map 1.1-1). Within this large area, each physical environment component considered a study area that was appropriate to its topic. These individual study areas are defined in each section of the PE SV (see Sections 2 through 10). In general, the "**Local Study Area**" for all the Physical Environment key topics extends from just downstream of Clark Lake to the inlet of Stephens Lake (Map 1.1-1), within the open water **hydraulic zone of influence** (see PE SV Section 4).

The Project footprint during construction and operation of the Project includes the physical works and associated activities where direct physical environmental effects are expected to occur (Map 1.1-2, Map 1.1-3, and Map 1.1-4). This area includes the proposed south access road, **borrow areas**, camp areas, **cofferdams**, powerhouse, spillway and associated infrastructure footprints and the flooded area.

1.1.2.4 Temporal Scope

The time period considered in the environmental assessment includes the past, present and future. The past provides context for today's environment and future changes. The assessment examined long-term trends and natural variability in the historic information. It considered KCNs experience with previous **hydroelectric** development (*e.g.,* erosion, debris generation) and considers Stephen Lake, which can serve as a proxy for the future Keeyask reservoir since the Stephen Lake is the reservoir upstream of the existing Kettle GS.

For some sections, the present conditions were characterized using data collected over the past few years of environmental studies for the Project while other sections have 30 years of data available to describe present conditions. The future conditions include the construction phase and the operations phase.

Subject to regulatory approval, construction of the Project is anticipated to commence in mid 2014, with some site clearing and installation of an **ice boom** being early tasks. The main camp will also be expanded and the first cofferdams will be constructed. Initial reservoir clearing will begin and continue at appropriate times in preparation for reservoir **impoundment**. Installation of the **turbines** and **generators** for power production is expected to begin in 2018 and continue until 2021. In 2019, the reservoir will be raised to its **Full Supply Level** and subsequently the first turbine/generator will be commissioned. In 2020, the remaining units will be commissioned and, as the Project nears completion,

decommissioning will begin on various components of the supporting infrastructure required for construction. The GS will be in full service in 2021, although final construction, decommissioning work and site rehabilitation will continue into 2022. A more detailed description of the construction schedule is provided in the PD SV.

The operation and maintenance phase could be over 100 years in duration, with the immediate or short-term being 1 to 5 years after impoundment dates, transitional or mid-term being 5 to 25 years after impoundment and long-term being over 25 years post impoundment.

1.1.3 Assessment Methodology

The approach for the environmental assessment has been structured to address the environmental effects that may occur during construction, operation and decommissioning of the various **Project components**. This Supporting Volume focuses on assessing the environmental effects on the physical components of the environment according to the guidelines for the environmental assessment. The process began with the characterization of the existing environment processes and conditions as well as identifiable trends in the future environment without the proposed Keeyask GS Project. Effects were then determined by comparing this future environment without the Project to conditions that are predicted to occur with the Project. The influence of past projects and activities were considered, especially with regard to the potential interactions of these past projects and activities with the anticipated effects of the Project. These past influences are largely considered in the description of the existing environmental setting, which integrates the effects of past projects. There typically is not sufficient historical information to differentiate the effects of specific past projects and activities but an understanding of the past contributes to the understanding of the current environmental setting and trends.

The anticipated effects of the Project on the physical environment are described in terms of their:

- **Magnitude**;
- Geographic extent;
- **Duration**; and
- Frequency.

An explanation of these terms is shown in Table 1.1-1.

The prediction of future conditions involves some **uncertainty**, which will differ for the various issues under consideration. The uncertainties result for various reasons, including:

- Lack of data and limitations of existing data.
- Lack of experience regarding certain effects or the timeline for the effect to be exerted.
- Differences in data obtained from various sources.

The uncertainties were addressed in various ways, such as:

- Presenting ranges of effects using upper and lower bounds of the range (*e.g.*, 5% and 95% results).
- Presenting results under different sets of assumptions, for example, average and extreme conditions for temperature and wind in the case of dissolved oxygen predictions.
- Identifying mitigation and/or monitoring plans, such as the Waterways Management Program in the case of debris management.

Potential environmental effects of the proposed Project were identified, and assessed, and mitigation to avoid or minimize adverse effects was proposed using available scientific studies, professional judgment, expert and local knowledge, stakeholder consultation and First Nation input. Both direct and indirect environmental effects of the proposed Project were considered.

Follow-up requirements were identified where appropriate and residual environmental effects were evaluated using predetermined factors and criteria. The assessment conclusions for the proposed Project were determined for residual environmental effects after the application of mitigation actions. The approach considered the nature and magnitude of the residual effect along with its temporal characteristics and **spatial boundaries** (Table 1.1-1).

A description of the main features of **environmental monitoring** that will be carried out during the construction and operating phases to verify the assessment predictions is also provided.

Information contained in Sections 2 through 12 of this volume have also been used to assess the expected effects or implications of the Project on living components of the aquatic and terrestrial environments and aspects of the socioeconomic, resource use and heritage resource environments, as reported in those supporting volumes.

1.2 SOURCES OF INFORMATION

A considerable body of historical information is available to characterize and assess the physical environment. The length of the field data collection period varies for the different physical **parameters**. Sources of information include extensive field data collection over the past 30 years of water levels and ice conditions throughout the study area, as well as upstream and downstream of the study area. Studies have been completed, assessing the shorelines and sedimentation within the study area, and in areas outside the study area that have been affected by other projects that can act as proxies for the proposed Project. Groundwater monitoring wells and continuous monitoring of dissolved oxygen as well as long-term climatic records have also been used. In addition to field data, the various physical environment studies have used information available from technical publications (journals, books, etc.) and other sources relevant to the specific technical subject areas. The details of the sources of information for each subject area are provided in each of the sections in this supporting volume.

Table 1.1-1: Factors Considered in Assessment of Residual Environmental Effects

Factor	Explanation
Magnitude	**Describes the predicted severity or degree of disturbance the residual effect has on a component of the biophysical or socio-economic environment. Magnitude is described as:**
Small	No definable, detectable or measurable effect; or below established **thresholds** of acceptable change; or within range of natural variability; or minimum impairment of ecosystem component's function.
Moderate	Effects that could be measured and could be determined within a normal range of variation of a well-designed monitoring program; or are generally below or only marginally beyond guidelines or established thresholds of acceptable change; or are marginally beyond the range of natural variability or marginally beyond minimal impairment of ecosystem component's function.
Large	Effects that are easily observable, measured and described (*i.e.,* readily detectable without a monitoring program) and well beyond guidelines or established thresholds of acceptable change; or well beyond the range of natural variability; or well beyond minimal impairment of ecosystem component's functions.
Geographic Extent	**Describes the spatial boundary within which the residual environmental effect is expected to occur. Geographic extent is described as:**
Small Extent	Effects that are confined to a small portion of one or more areas where direct and indirect effects can occur (*e.g.,* rights-of-way or component sites and adjacent buffer areas).
Medium Extent	Effects that extend into local surrounding areas where direct and indirect effects can occur.
Large Extent	Effects that extend into the wider regional area where indirect or cumulative effects may occur.
Duration	**The temporal boundary or length of time within which the predicted residual environmental effect would last. Duration is described as:**
Short-term	Effects that generally occur within the construction period or initial period of impoundment, or occur within only one generation or recovery cycle of the VEC.
Medium-term	Effects that extend through a transition period during the operations phase, or occur within one or two generations or recovery cycles.
Long-term	Effects that extend for a long-term during the operations phase or are permanent, or extend for two or more generations or recovery cycles.
Frequency	**Describes how often the predicted effect would occur. Frequency is described as:**
Infrequent	Effects that only occur once or seldom.
Sporadic/Intermittent	Effects that occur only occasionally.
Regular/Continuous	Effects that occur continuously or at regular periodic intervals.

Through the course of developing this EIS, many technical memoranda were produced which provided the underlying detailed technical analysis for the study of changes in the physical environment. These were available to all the environmental assessment team and are listed in Appendix 1A of this Introduction.

1.3 SUMMARY OF PROJECT COMPONENTS RELEVANT TO THE PHYSICAL ENVIRONMENT

A number of activities involved in the construction and operation of the proposed Project (see PD SV) were identified as either potentially affecting components of the physical environment or as required input to assess physical environment Project effects on other aspects of the biophysical and socio-economic environment. Accordingly, they were considered during the assessment of the respective physical environment components (see Sections 2 through 10). These activities were as follows:

- Construction and operation of physical land-based components of the proposed Project including the supporting infrastructure (access road, camp, borrow areas, cofferdams, etc.), principal structures (dams, powerhouse, spillway, dykes), and any land adjacent to the proposed Project footprint that may be disturbed or indirectly altered by the Project footprint (*e.g.,* effects on groundwater in the land adjacent to the reservoir).
- Overall construction activities, sequence and durations (including the equipment that will be involved).
- Impoundment and operation of the reservoir, reservoir levels and powerhouse and spillway discharges (*e.g.,* modes of operations).
- Permanent facility operation.
- Activities during operation and maintenance.
-

1.4 STUDY INTEGRATION AND PEER-REVIEW PROCESS

The physical environment studies were integrated during the assessment using a variety of methods. Meetings were held between various study team specialists to share information that was used by other team members (*e.g.,* water regime with sedimentation or shoreline erosion). There were also large-scale workshops including all members of the physical environment team as well as members from the **aquatic environment**, socio-economic and terrestrial environment teams to present methods, results and obtain feedback on the information needs. There were many meetings interacting with the KCNs representatives and their consultants presenting data collection methods, methods of analysis and initial

results to ensure that the local environment was fully understood and that important effects were considered.

In addition to these internal working groups, Manitoba Hydro engaged expert independent peer reviewers from outside the study team (Table 1.4-1). These peer reviewers included experts with extensive experience in their specialized fields, often related to **Environmental Impact Assessments**. The peer reviewers reviewed the technical work developed by the team, provided independent critiques and assisted in assuring that current information and methods were used in this assessment and that the analyses and results were reasonable and credible.

In general, the peer reviewers observed that the technical approach and results were credible and appropriate for the various issues. Some suggestions were made for additional work and clarity of discussion of results, which were considered by the study team in finalizing the assessment.

Table 1.4-1: List of Independent Peer Reviewers Used to Review the Physical Environment Technical Work Developed by the Physical Environment Team

Peer Reviewer	Current Affiliation	Physical Environment Topic Reviewed
Frank Penner, P.Geo. (retired)	Retired professional geologist	Mineral Shoreline Erosion
Pete Zuzek, P.Geo.	Baird and Associates	Mineral Shoreline Erosion
Suzanne Leclair Ph.D.	Environnement Illimite Inc.	Sedimentation
Charlie Neill, P.Eng.	Northwest Hydraulics	Sedimentation
Greg McCullough, Ph.D.	University of Manitoba	Sedimentation
Paul Glaser, Ph.D.	University of Minnesota	Peatland Disintegration
Christopher Neville, M.Sc., P.Eng.	S.S. Papadopulos & Associates Inc.	Groundwater
Bert Smith, M.Sc., P.Eng.	KGS Group	Groundwater
Andrews Takyi, Ph.D., P.Eng.	Total E&P Canada Ltd.	Water Temperature and Dissolved Oxygen
Marco Braun, Ph.D.	Ouranos Consortium	Climate
Diane Chaumont, M.Sc.	Ouranos Consortium	Climate

1.5 REFERENCES

Canadian Environmental Assessment Agency (CEAA). 2010. Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners [online]. Available from http://www.ceaa.gc.ca/default.asp?lang=En&n=A41F45C5-1 [accessed February 17, 2012].

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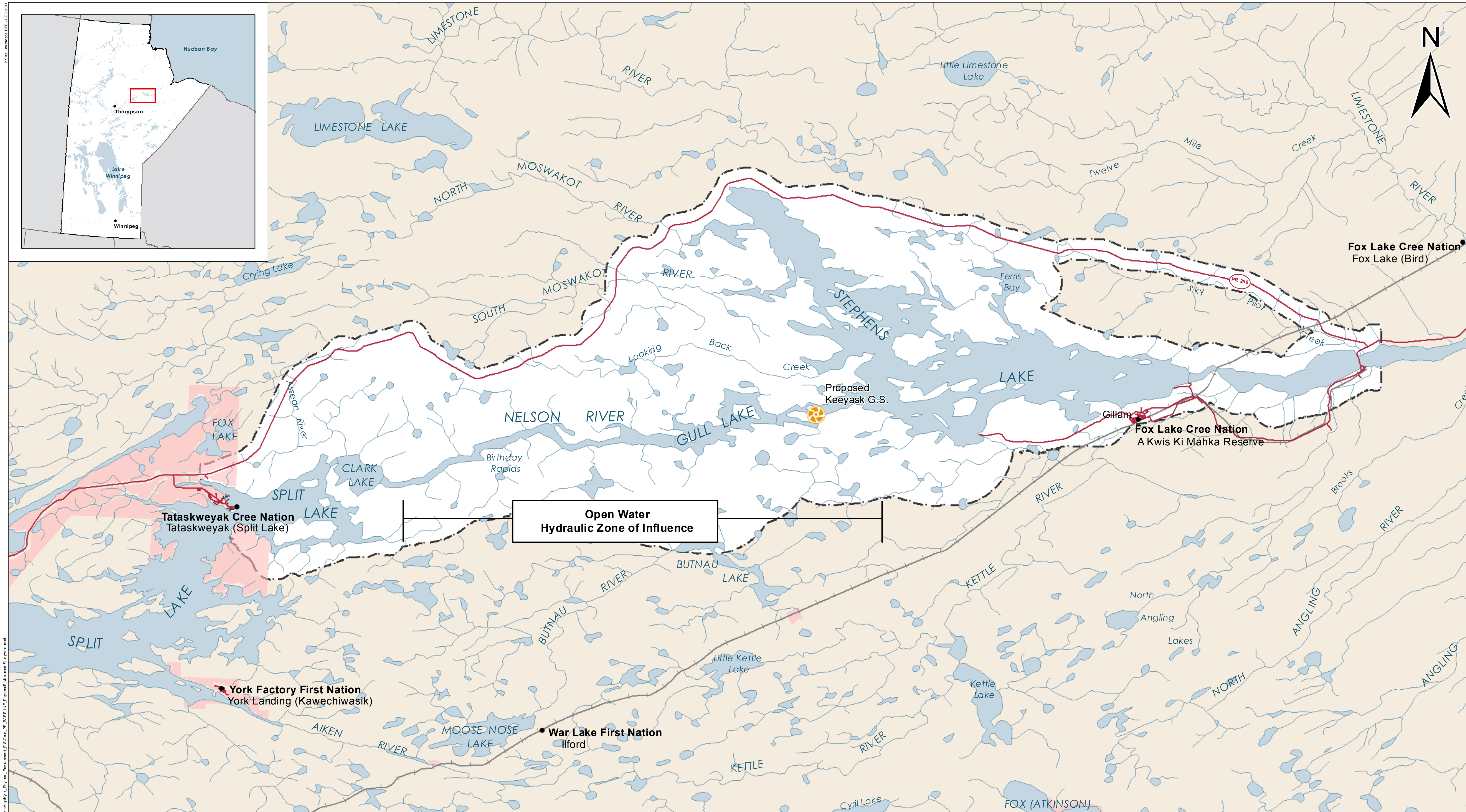


KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Province of Manitoba, Manitoba Hydro, Stantec Consulting Ltd., NTS, NR CAN

CREATED BY:
Stantec Consulting Ltd.

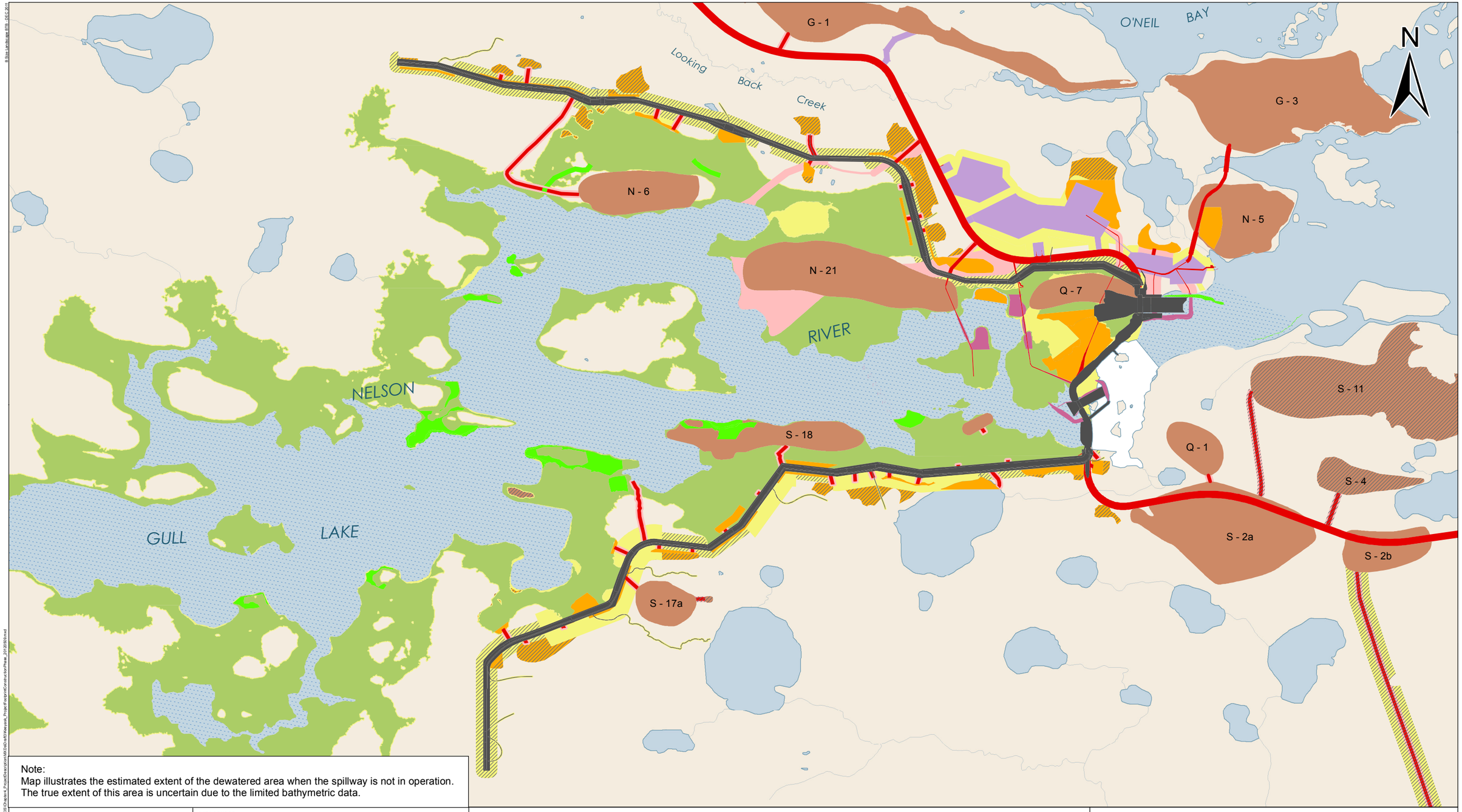
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-FEB-11	18-MAY-12
0 4 8 Kilometres / 0 3.5 7 Miles	VERSION NO: 1.0	QA/QC: APPROVED

Legend

- Generating Station (Planned)
- Physical Environment Local Study Area
- Highway
- Rail
- First Nation Reserve
- Waterbody

Physical Environment Local Study Area

Map 1.1-1



Note:
Map illustrates the estimated extent of the dewatered area when the spillway is not in operation. The true extent of this area is uncertain due to the limited bathymetric data.

KEEYASK
Hydropower Limited Partnership

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

CREATED BY:
Hydro Power Planning - Keeyask & Burntwood Planning Section

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	09-MAY-12
0 0.6 1.2 Kilometres 0 0.5 1 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

- Road
- Road Corridor
- Infrastructure
- River Management
- Borrow Area
- Camp and Work Area
- Excavated Material Placement Area
- Mitigation Area
- Possible Disturbed Area
- Reservoir Clearing
- Altered Water Level or Flow
- Potential Dewatered Area
- Existing Water Surface Area
- Areas Unlikely to be Used

Project Footprint Construction Phase
Site Level

Map 1.1-2

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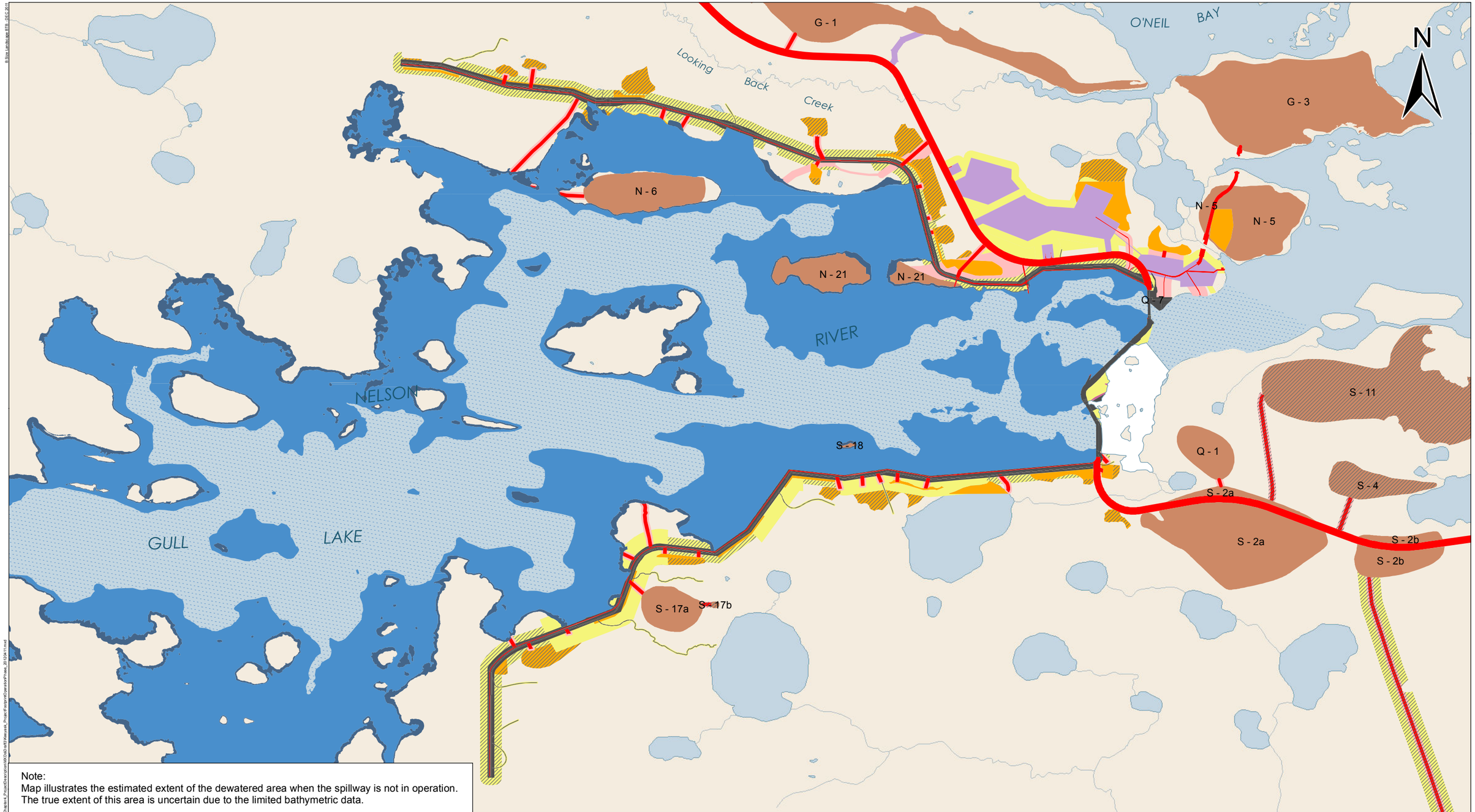


Note:
Map illustrates the estimated extent of the dewatered area when the spillway is not in operation. The true extent of this area is uncertain due to the limited bathymetric data.

KEEYASK
Hydropower Limited Partnership

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

CREATED BY:
Hydro Power Planning - Keeyask & Burntwood Planning Section

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	18-APR-12
0 0.55 1.1 Kilometres 0 0.45 0.9 Miles	VERSION NO: 3.0	QA/QC: APPROVED

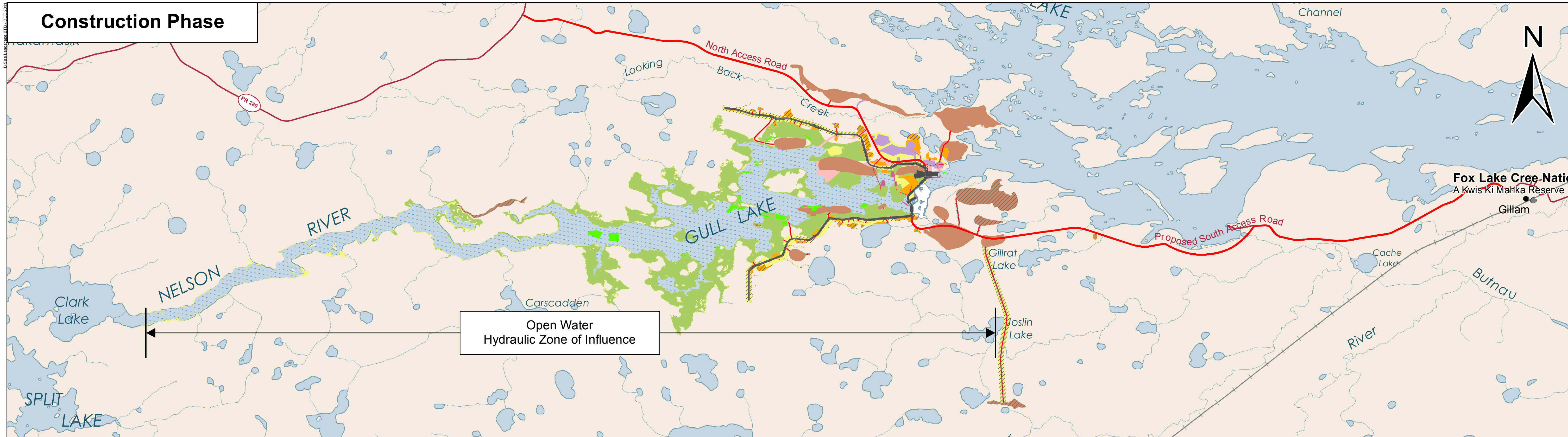
Legend

- Road
- Road Corridor
- Infrastructure
- River Management
- Borrow Area
- Camp and Work Area
- Excavated Material Placement Area
- Mitigation Area
- Possible Disturbed Area
- Initial Flooded Area (159 m)
- 30-year Reservoir Expansion Area (159 m)
- Altered Water Level or Flow
- Potential Dewatered Area
- Existing Water Surface Area
- Areas Unlikely to be Used

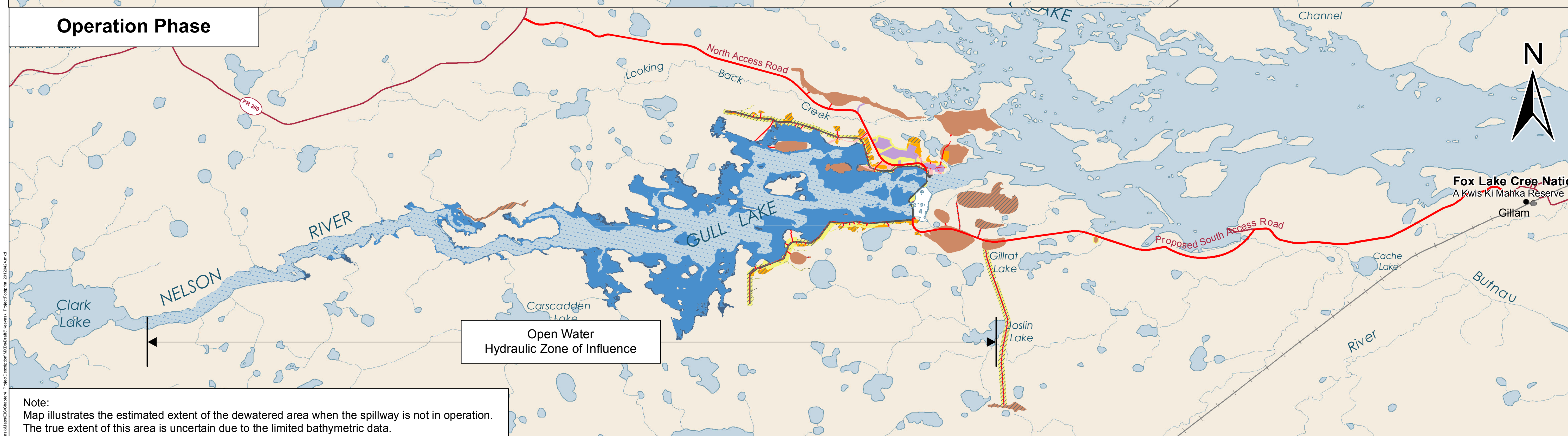
Project Footprint Operation Phase
Site Level

Map 1.1-3

Construction Phase



Operation Phase



Note:
Map illustrates the estimated extent of the dewatered area when the spillway is not in operation. The true extent of this area is uncertain due to the limited bathymetric data.

KEEYASK Hydropower Limited Partnership

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

CREATED BY:
Manitoba Hydro - Hydro Power Planning

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	18-JAN-12	25-APR-12
0 3 6 Kilometres / 0 2 4 Miles	VERSION NO: 3.0	QA/QC: APPROVED

Legend

- Road
- Road Corridor
- Infrastructure
- River Management
- Borrow Area
- Camp and Work Area
- Excavated Material Placement Area
- Mitigation Area
- Possible Disturbed Area
- Reservoir Clearing
- Initial Flooded Area (159 m)
- 30-year Reservoir Expansion Area (159 m)
- Altered Water Level or Flow
- Potential Dewatered Area
- Existing Water Surface Area
- Areas Unlikely to be Used

Project Footprint Overview
Construction and Operation Phase

Map 1.1-4

APPENDIX 1A
LIST OF TECHNICAL MEMORANDA

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Keeyask Generation Project Environmental Study Report List

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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.	In preparation	
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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
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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.	In preparation	

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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.	In preparation	
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.	In preparation	
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.	In preparation	
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GN-9.5.1	Manitoba Hydro, 2009. Historical Climate Analysis. Keeyask Project Environmental Studies Program Report prepared for Manitoba Hydro. 29 pp.	In preparation	
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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
GN-9.5.6	Environnement Illimité Inc., 2012. Keeyask Environmental Impact Statement – Reservoir Greenhouse 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	

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APPENDIX 1A
LIST OF TECHNICAL MEMORANDA

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