Macro Environmental Presentation

Need for and Alternatives to Review
Manitoba Hydro's Preferred Development Plan

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Section 1

MNP Scope of Work

MNP Scope of Work

- Perform a critical analysis of **the macro environmental impacts and benefits** of Manitoba Hydro's Preferred Development Plan and alternative Plans, specifically, the collective macro-economic consequences of changes to **air, water, flora and fauna**, including the potential significance of these changes, their equitable distribution within and between present and future generations

- Review Manitoba Hydro's NFAT filing with a focus on macro-environmental factors that could impact the economics of the project and alternate scenarios, including:
  - (a) Direct greenhouse gas emissions
  - (b) Indirect greenhouse gas emissions
  - (c) Global impacts of projects (including Bipole III)
  - (d) MISO wind energy expansion
  - (e) MISO energy mix shift away from coal

- Review Manitoba Hydro's NFAT filings with respect to the need and cost for a sturgeon fishway at either Keeyask G.S. or Conawapa G.S.

- Review Manitoba Hydro's NFAT filings with respect to the Lake Winnipeg and Upper Nelson River Water Regime change and the potential mitigation costs to the NFAT projects

- Review the potential global warming impacts on water supply/river flows/lake and reservoir evaporation

Principal Limitations of Scope to the Analysis

- Definition of macro-environmental impacts is not discrete or definitive
  - A high-level review of broad impacts that could fundamentally shift the collective and interdependent set of decision points
  - Impacts with reasonable potential to incur macro-economic implications for the development plans
- Avoiding redundancy to the environmental assessment processes which evaluates impacts of each project in detail, while capturing comparisons with alternative plans
- As directed by the PUB, latitude required to interpret and focus efforts on key air, water, flora and fauna issues that do or could lead to economic consequences

Summary of Key Messages of MNP Macro Environmental Report

- Our review focuses on impacts considered to be significant and material in the local and global context
- Investigates the extent to which MH's consideration of these impacts is prudent
- Assesses the reasonability of MH's analysis, data and assumptions
- Generally, we find the PDP's consideration for resource conservation, sustainable energy development and avoidance of GHG emissions to be attractive
- Conversely, there are a number of local environmental impacts and significant risks that should be considered carefully and managed accordingly
- MH's analysis in the NFAT provides an acceptable narrative of macro environmental concerns with a few noteworthy exceptions where insufficient examination exists in the NFAT for the Panel's review

Rebuttal Evidence of Manitoba Hydro

Carbon Pricing

- Embedding carbon pricing in economic analysis
  - Common practice
  - Question of methodology
  - Lack of transparency which forced MNP to develop reasonable assumptions of its treatment
- MNP was clear that carbon value modelling was an estimated representation of the potential incremental value of the environmental attributes
- Unclear what “improperly extrapolated” means due to absence in the record
- MNP Elected to develop new scenarios using different extrapolation assumptions

Drought Analysis

- Considerable uncertainty identified in predicting level of drought, but acknowledged that more severe drought is possible
- Therefore, in analysing low case scenarios (particularly the NPV), a low end scenario of the most critical risk should be assessed and included in such a large investment decision

Section 2

Climate Change: Direct Impacts

Modelling Predicts Increased Precipitation

Reasonable Findings:

- Annual Basis - Greater precipitation and therefore greater run-off and higher stream flows are standard climate change scenarios
- Increased precipitation and run-off are expected to occur during the winter and spring seasons in Manitoba

Reasonable Analysis:

- Timing is important to the economic analysis of the plans
- Further examination of the system's ability to store and leverage seasonal changes in greater detail, is a reasonable expectation to assist the Panel in its recommendations
- MH Rebuttal evidence provides greater clarity on the election of SPLASH modelling to consider average increases on an annual basis

Increased Frequency and Severity of Drought

- As a result of climate change in the mid to later part of the century, many models predict that the frequency and severity of drought events will increase
- Hydrologic drought in the context of hydro operations is intrinsically linked to the climatic drought forces
  - Hydrologic drought for Manitoba Hydro is defined as a period of below average hydro conditions (less than the average volume of surface water availability) over an extended period - ICF Report, Independent Review of Hydro Export Power Sales and Associated Risks, 2009
  - "Multi-annual hydrological drought poses the most severe risk to energy safety of Manitoba Hydro" – Ouranos, 2014
  - "Further, there is always the possibility of a drought occurring worse than the drought of record, particularly given the increasing impacts of climate change" – Rebuttal Evidence of Manitoba Hydro, 2014 NFAT
- MNP agrees, there is significant uncertainty and complexity associated with forecasting hydrologic drought
  - In the context of this NFAT, the historical record may no longer be a sufficient proxy for the future to support full economic insight

Section 3a

Climate Change: GHGs and Air Pollutants

Cumulative Operating GHG Emissions

- Preferred development plan has low operating emissions relative to alternative development plans reliant on gas generation

- Some alternative plans (i.e. K19/C31/750MW) could have lower overall operating emissions (NFAT App. 9.1)

- However, not all plans provide the same level of energy and potential for export and therefore prospective emissions displacement in other markets

Net GHG Emissions Displacement

- The preferred development plan has the highest net GHGs displacement potential
- The 750 MW transmission line and WPS Sale & Investment contributes to increased energy trading and emissions offsetting
- Hydroelectric generation has lower GHG emissions than the marginal capacity generation in MISO, which is currently primarily coal and natural gas

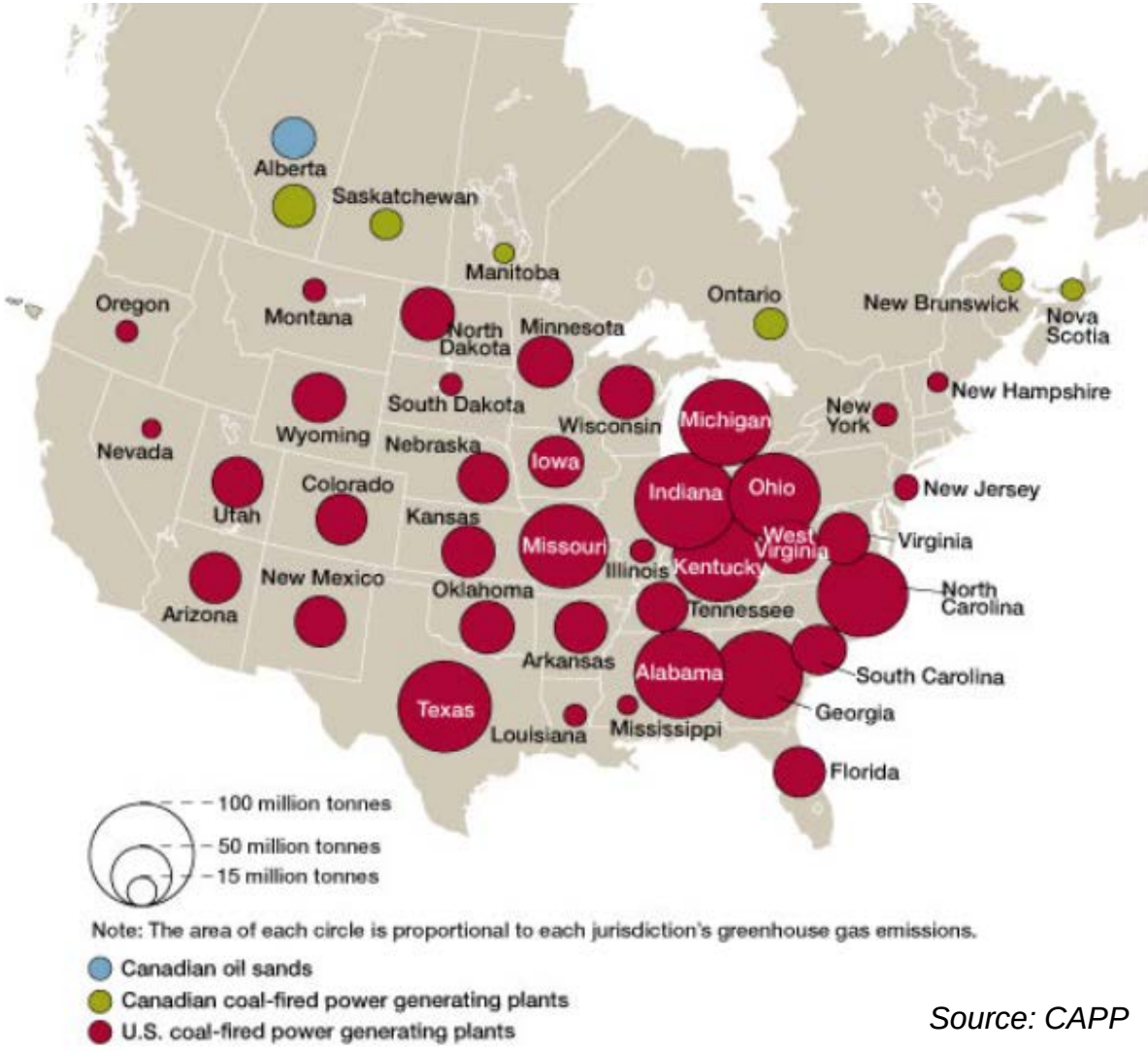
Selected Plans' Air Impacts

Air Impacts*	Preferred Plan #14: K19/C25/ 750MW (WPS Sale & Investment)	Plan #1: All Gas	Plan #4: K19/Gas24/ 250MW	Plan #5: K19/Gas25/ 750MW (WPS Sale & Investment)	Plan #7: SGCT/C26
Cumulative GHG Operating Emissions	7.5 Mt CO2e	33.2 Mt CO2e	25.4 Mt CO2e	16.3 Mt CO2e	13.0 Mt CO2e
Cumulative Regional GHG Displacement Potential	191.6 Mt CO2e	22.5 Mt CO2e	107.7 Mt CO2e	94.4 Mt CO2e	102.1 Mt CO2e

**All values were taken from MH NFAT filing, Appendix 9.1 – High Level Development Plan Comparison Table*

Displacement Potential

- MISO and the US Midwest are heavily reliant on coal for baseload generation
- The last MISO market assessment demonstrated coal on margin over 90% of peak and off peak periods
- Exports will displace GHG emitting generation and contribute to regional reductions



Source: CAPP

Regulatory Policy Review

- Current and future policies were considered while developing the development plans
- MNP has reviewed existing policies and strategy directions applicable to Manitoba
- The preferred development plan aligns with Canadian, regional and provincial regulatory requirements
- There is some export value risk associated with expected future US policies:
  - MISO estimates that current or proposed EPA regulation will affect 84% of its 295 coal-fired plants
  - The capacity mix in MISO is likely to change significantly over time (coal reduced)
  - The emissions intensity of MISO is likely to experience downward pressure, also negatively impacting export values

Policy Review – Indirect Impacts

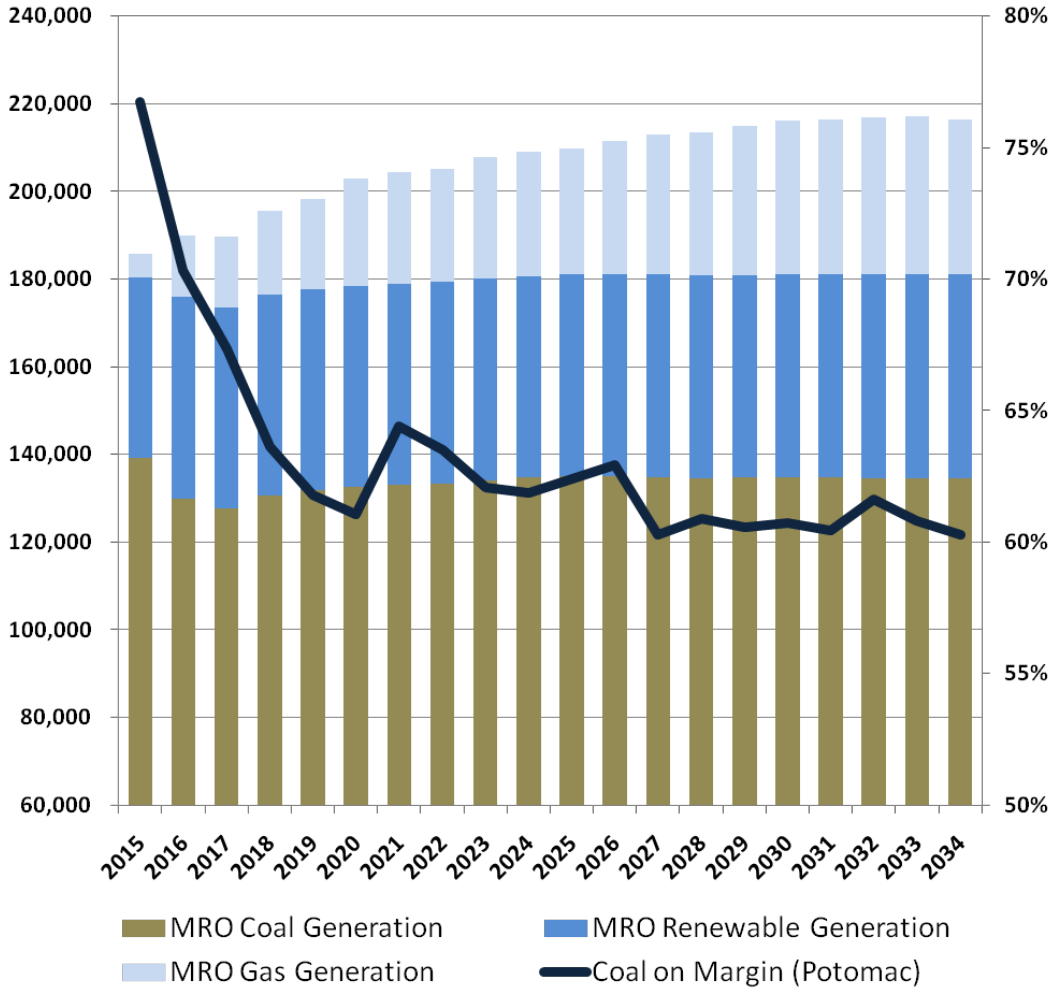
Policy / Strategy	Overview
Mercury Air Toxic Standards (US Environmental Protection Agency)	• Requirement for new and existing plants to reduce air pollutants up to 90% by April 2015
Cross-State Air Pollution Rule (US Environmental Protection Agency)	• Designed to reduce SO_2 by 73% and NO_x by 54% from 2005 levels starting January 1, 2012 with further tightening of emissions caps in 2014 • Struck down on December 31, 2011
Resource Conservation and Recovery Act (US Environmental Protection Agency)	• Proposed to regulate the disposal of coal fly ash in landfills and surface impoundments
Clean Water Act (US Environmental Protection Agency)	• Requires that new power plants use the best available cooling water intake technologies to prevent the impingement and entrainment of aquatic organisms
Renewable Portfolio Standards (US State-Level)	• State level mandatory RPS standards in the MISO market are as follows (% of total GWh delivered): North Dakota – 10% by 2015 Minnesota – 25% by 2025 Wisconsin – 10% by 2015 Illinois – 25% by 2025 Michigan – 10% by 2015 Ohio – 25% by 2025 Iowa – 1000 MW wind by 2010 Missouri – 15% by 2021

MISO Market Forecast (GWh)

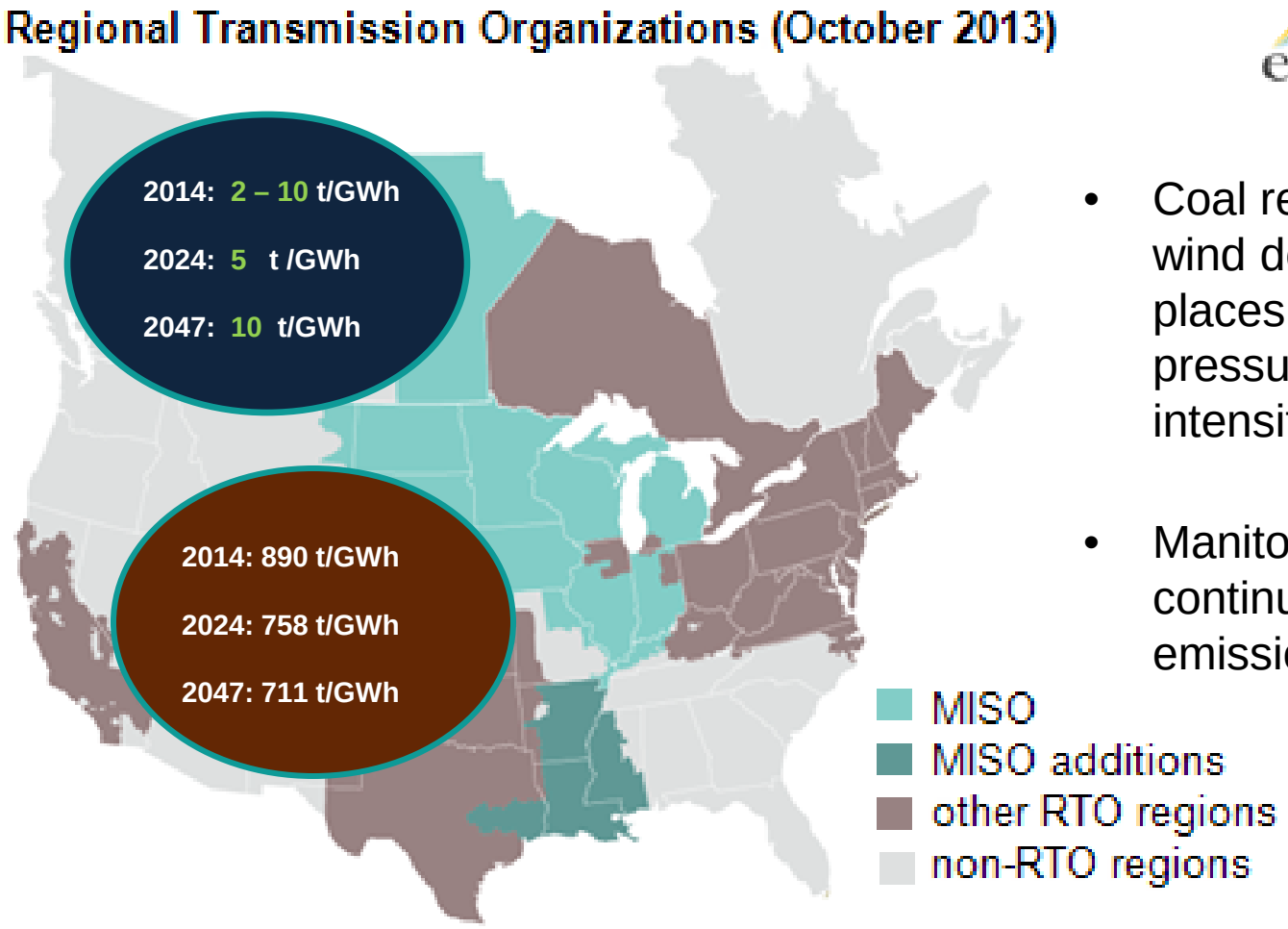
- After the expected coal retirements, increased generation from retrofitted plants remains relatively flat
- Growth in wind and gas generation meet demand growth looking forward
- Wind and gas generation increase in share of margin

MRO represents the directly neighbouring jurisdictions to MH

Source: Data from EIA AEO 2014



GHG Emissions Intensity in MISO (tonnes CO_2e/GWh)



- Coal retirements and wind development places downward pressure on emissions intensity
- Manitoba Hydro exports continue to be far less emission intensive

Carbon Policy Review

- Considerable uncertainty exists regarding the stringency and nature of carbon policy

- The preferred development plan aligns with expected Canadian, regional and provincial carbon trading schemes

- Export risk associated with expected future US broad-based carbon trading policies:
  - Small likelihood of federal cap-and-trade or market based in the near term
  - No incremental environmental value is likely placed on non-emitting generation until the mid part of the next decade
  - Tempered carbon pricing could negatively impact the economics of the preferred development plan
  - Other direct regulations (such as MATS) will likely favour imports for energy purposes
  - Materiality of these interdependent regulations cannot be understated
  - Any combination of regulations of this nature will lead to significant impacts on the operations and investment decisions of Midwest electricity generators

Policy Review – Direct Impacts

Policy / Strategy	Overview
Coal-Fired Electricity Generation Regulation (Environment Canada)	• Requires existing coal plants to retire at 50 years of age or meet stringent performance standards • New coal plants built after July 1, 2015 must match the GHG emissions of combined cycle natural gas generation
Manitoba's Emissions Tax on Coal Act (Government of Manitoba)	• Introduced January 1, 2012 • Requires purchasers of coal for use in Manitoba to pay an emissions tax of approx. $10/tonne of CO_2
Manitoba's Coal-Fired Emergency Operations Regulation (Government of Manitoba)	• Came into force on January 1, 2010 • Precludes coal-fired electricity generation except for emergency operations
Manitoba's Clean Energy Strategy (Government of Manitoba)	• Released in December 2012 • Provides an overview of the strategic direction of the province to meet future electricity needs • Emphasizes the development of hydroelectric generating stations
Midwest Greenhouse Gas Reduction Accord (Regional)	• Commitment by six Midwest states and Manitoba to a regional cap and trade program • Signed in 2007 • No longer being pursued, but not formally suspended
Western Climate Initiative (Regional)	• Cap-and-trade program • California and Quebec officially linked on January 1, 2014 • Includes electricity generation, industrial facilities and fuel distributors with annual emissions greater than 25 kt of CO_2 equivalent in its current scope

Keeyask Life Cycle Assessment (LCA)

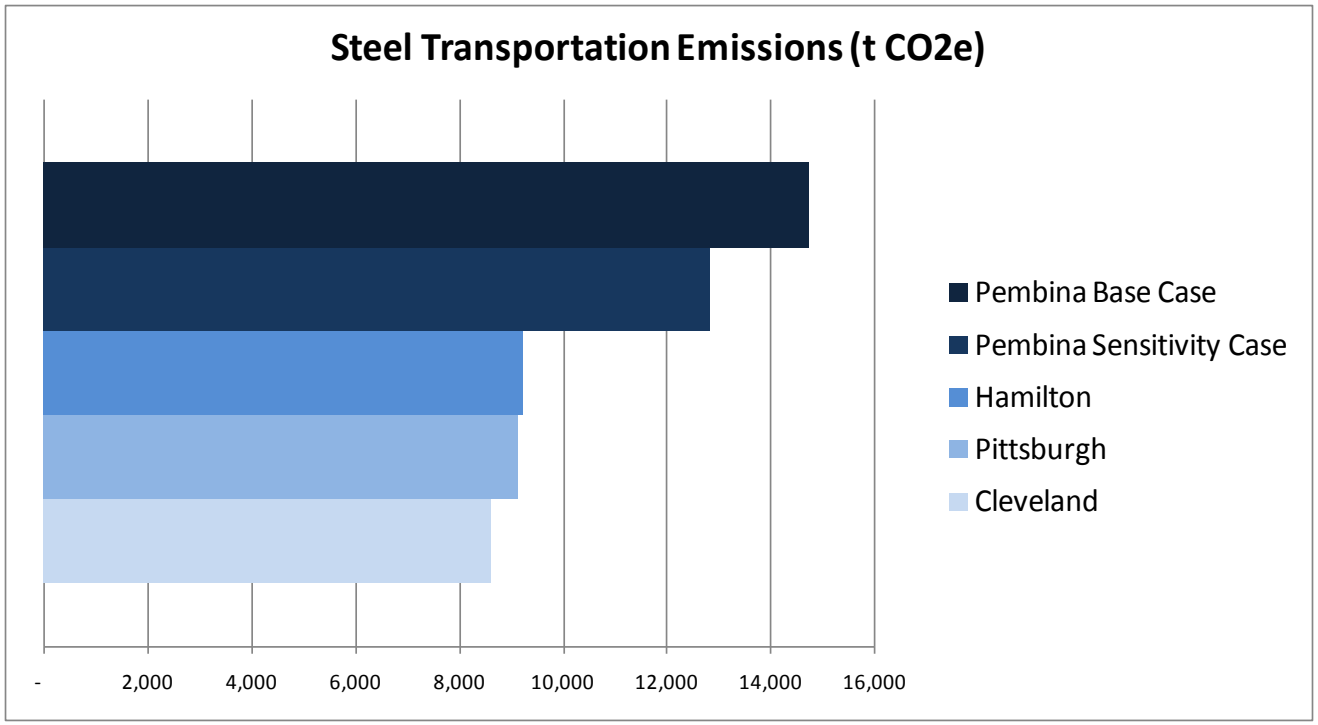
- The LCA analysis performed for Keeyask includes accuracy risks and limitations
- Actual life cycle emissions could be different
- Reasonable levels of caution and risk mitigation were performed
- Materiality
  - Limited concern in comparative analysis of the development plans
  - PDP will continue to perform well on a life cycle emissions basis

Overall, the LCA values for Keeyask are reasonable.

Sensitivity Analysis Review

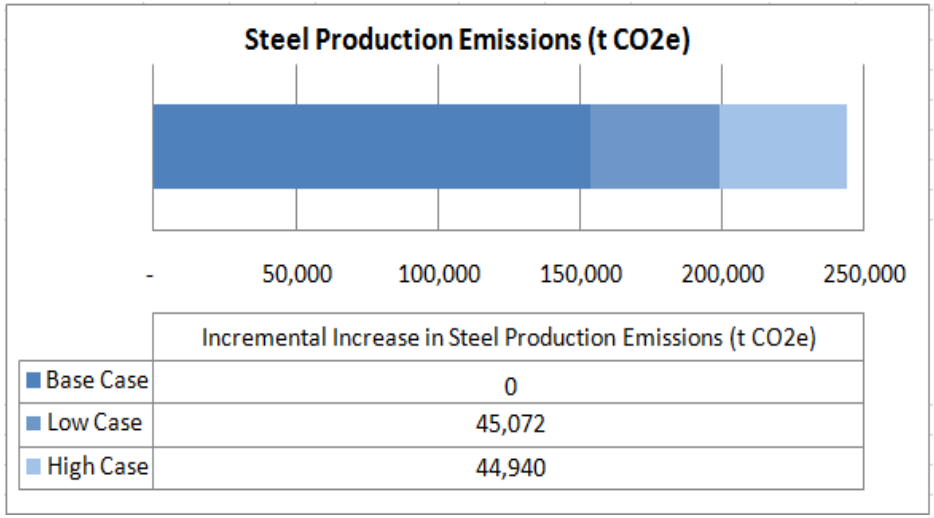
- Materials Transportation
- Steel Production
- Cement Production
- Fuel Sources

LCA Sensitivity #1 – Steel Transportation Distances

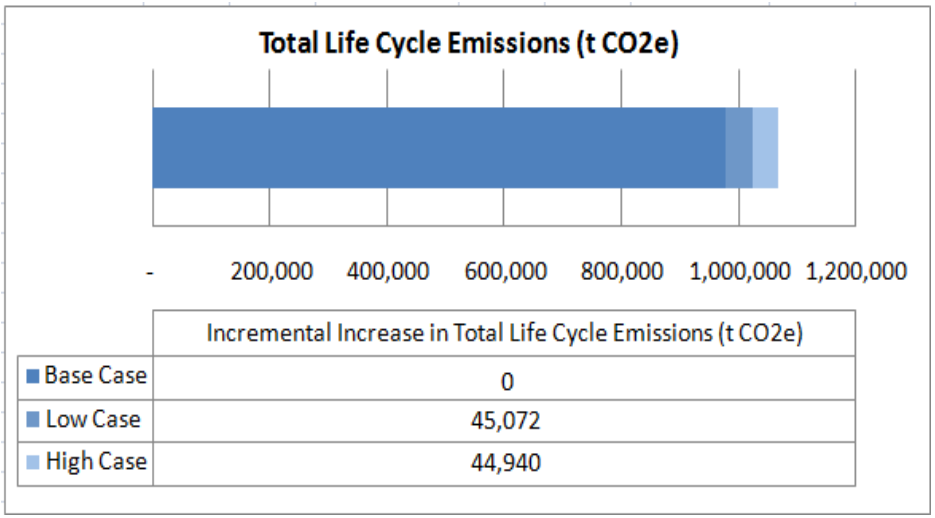


Overall, a further reduction, beyond the 13% in transportation emissions found within the LCA sensitivity analysis, could be realized if all steel were sourced from US producers.

LCA Sensitivity #2 – Steel Source and Emissions Factor



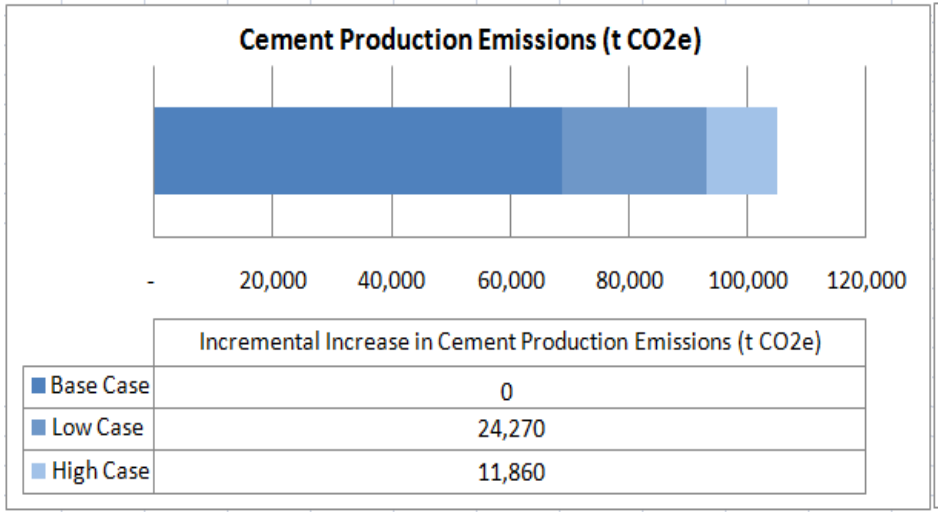
	Incremental Increase in Steel Production Emissions (t CO2e)
Base Case	0
Low Case	45,072
High Case	44,940



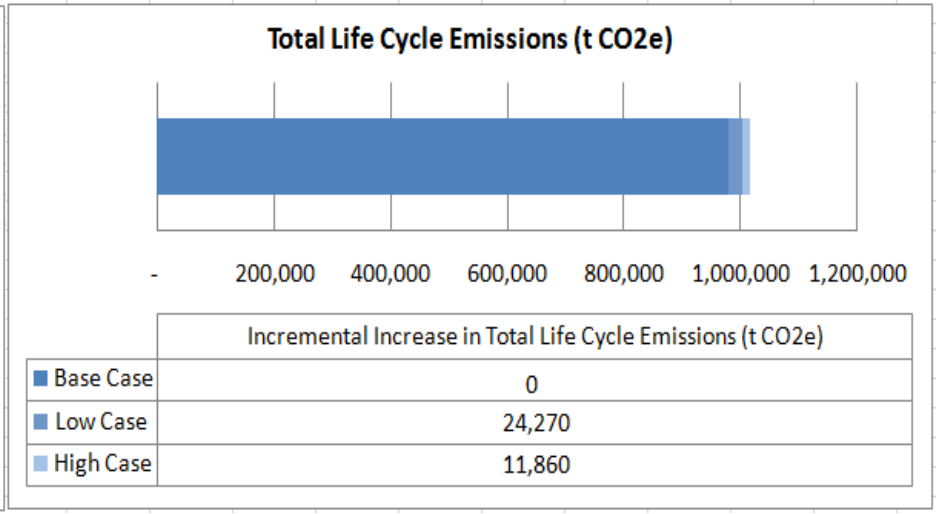
	Incremental Increase in Total Life Cycle Emissions (t CO2e)
Base Case	0
Low Case	45,072
High Case	44,940

Overall, producing steel in China could increase total life cycle emissions between 5% and 9%, which is material to the LCA calculation. However, it is immaterial in comparison with other generation technologies included in development plans reliant on gas generation.

LCA Sensitivity #3 – Cement Emissions Factor



	Incremental Increase in Cement Production Emissions (t CO2e)
Base Case	0
Low Case	24,270
High Case	11,860



	Incremental Increase in Total Life Cycle Emissions (t CO2e)
Base Case	0
Low Case	24,270
High Case	11,860

Overall, the cement emission factor could increase total life cycle emissions between 2% and 9%, which is material to the LCA calculation. However, it is immaterial in comparison with other generation technologies included in development plans reliant on gas generation.

LCA Sensitivity #4 – Fuel Source

Assumption	PI Base Case	PI Sensitivity	MNP Sensitivity
Fuel Source (Bitumen)	40%	100%	100%
Diesel Allocation Factor	0.36	0.36	0.24*
Results and Sensitivities			
Emissions from Diesel fuel production	31.6 kt	+86%	+63%
Total life cycle emissions	979 kt	+10%	+7%

Notes: Refining emissions intensity is unclear in the Pembina LCA cases

Unclear data source for diesel allocation factor in the MH LCA cases

**Average diesel product ratio per barrel of US oil (Source: EIA)*

Overall, the approach taken by MH in the sensitivity case calculation is *conservative*, by overestimating the likely emissions level. Therefore, MH calculation is *not* reasonably likely to result in a *material understatement* of life cycle emissions.

Comparison Technologies

Technology	Keeyask LCA Median	IPCC Report Minimum	IPCC Report Median	IPCC Report Maximum	Operating Emissions Intensity
Pulverized Coal Combustion (PCC)	**975**	675	**1001**	1689	**959**
Coal with Carbon Capture and Storage (CCS)	**183**	98	**N/A**	396	**22**
Natural Gas Combined/ Single Cycle	**509/764**	290	**469**	930	**413 / 557**
Wind (Larger than 100 MW)	**13**	2	**12**	81	**0**
Nuclear	**15**	1	**16**	220	**0**
Hydropower	**2.46**	0	**4**	43	**0**

Note: All values in the above table are expressed in t CO2e / GWh

Wind LCA Emissions Intensity

Table I Studies and technologies that passed the screening criteria and produced an estimate of life cycle greenhouse gas (GHG) emissions, including key harmonization parameters

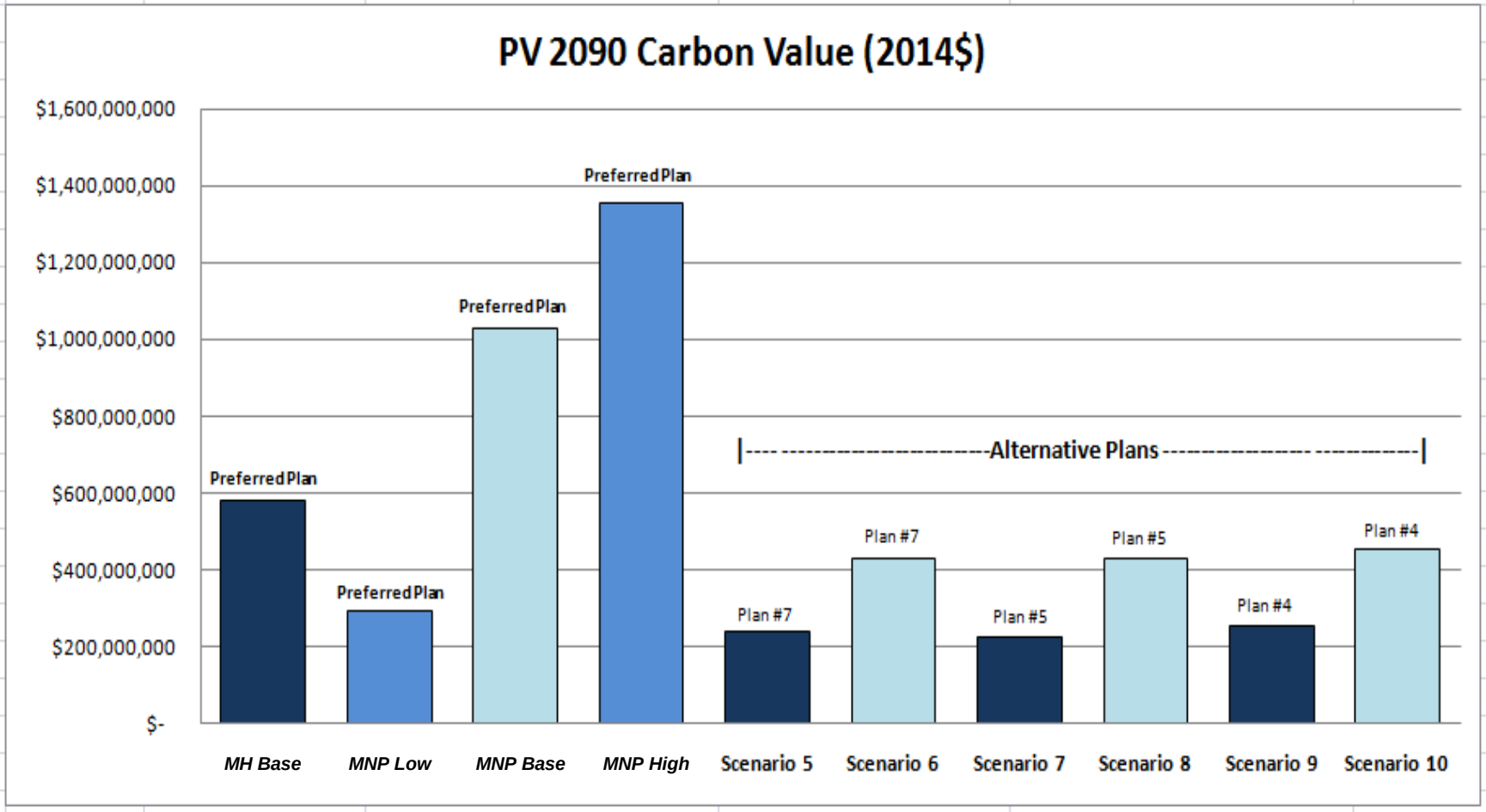
Author	Year	Technology type	Turbine capacity (MW)	Lifetime (years)	Capacity factor (%)	Wind farm name, location	Study type	Notes
Ardente et al.	2008	Onshore	0.66	20	19%	Italy (Sicily)	Empirical	
Berry et al.	1998	Onshore	0.3	—	31%	Penryddlan and Llidiartywaun, Wales	Empirical	
Chataignere and Le Boulch	2003	Onshore	0.6	20	29%		Theoretical	(1) Vestas 600 kW turbine
Chataignere and Le Boulch	2003	Onshore	2.5	20	34%		Theoretical	(1) Nordex 2.5 MW turbine
Chataignere and Le Boulch	2003	Offshore	2.5	20	46%		Theoretical	(50) Nordex 2.5 MW turbines, cassion
Chataignere and Le Boulch	2003	Offshore	2.5	20	46%		Theoretical	(100) Nordex 2.5 MW turbines
Chataignere and Le Boulch	2003	Offshore	2.5	20	46%		Theoretical	(50) Nordex 2.5 MW turbines, monopile
Chataignere and Le Boulch	2003	Onshore	1.5	20	29%		Theoretical	(1) Enercon 1.5 MW turbine
Crawford	2009	Onshore	3	20	33%		Theoretical	
Crawford	2009	Onshore	0.85	20	34%		Theoretical	
Dolan	2007	Offshore	1.8	20	30%	U.S. (Florida)	Theoretical	
Dones et al.	2005	Onshore	0.8	20/40	20%	Germany	Empirical	Turbine parts assume different lifetimes
Dones et al.	2005	Offshore	2	20	30%	Middelgrunden, Germany	Empirical	
Dones et al.	2007	Onshore	0.8	20/40	20%	Europe	Empirical	Turbine parts assume different lifetimes
Dones et al.	2007	Offshore	2	20	30%	Europe	Empirical	
Dones et al.	2007	Onshore	0.8	20/40	14%	Mont Crosin, Switzerland	Empirical	Turbine parts assume different lifetimes
DONG Energy	2008	Offshore	2	20	46%	Horns Rev, North Sea	Empirical	

- Wind LCA studies utilized may not result in comparable findings
- Material analysis assumptions include
  - Capacity factors
  - Lifetime
  - Life cycle boundary (fuel production emissions inclusion)
- Source: NREL Wind Harmonization Project
  - Seeks to levelize wind related LCA emissions factors for comparability

Section 3b

Environmental Attributes and Value

Financial Impacts of Sensitivities



Source: MNP Report Figure 3.7

Section 4

Water Regime

Key Impacts to Water Regime

- **Loss of Gull Rapids** – As one of the few remaining naturally valued river components with importance as fish habitat, Gull Rapids holds unique value that should be considered

  High Significance

- **Split Lake Flooding** – Although not anticipated by MH, it is unclear what effects will occur on and around Split Lake; There is concern for greater than expected flooding due to interdependencies, which has consequences for communities residing on the lake

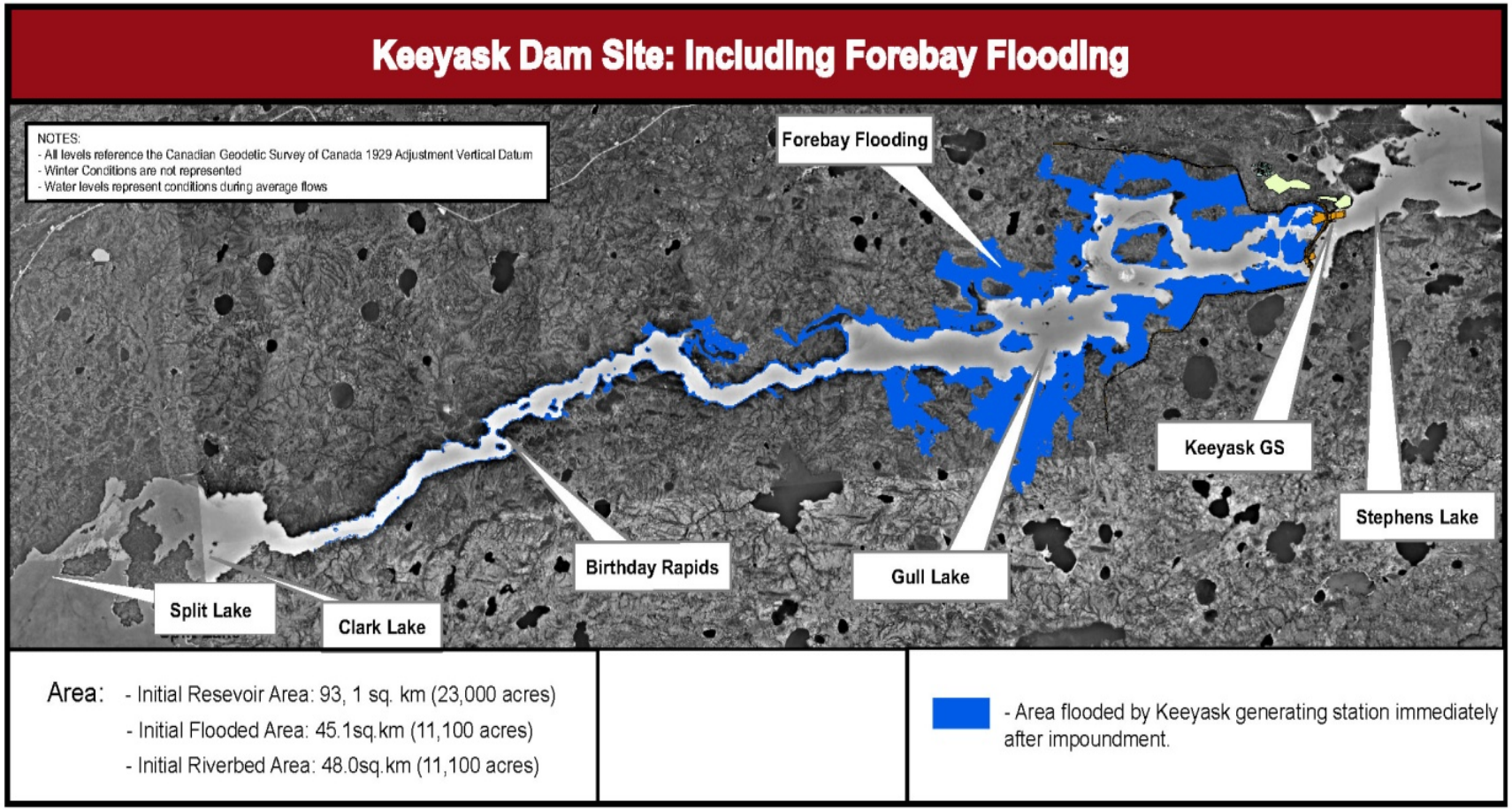
  Medium Significance

- **Continued Erosion** – Shoreline erosion occurring over time can present hazards for wildlife, First Nations and other groups using the area; Erosion estimates appear to be robust, however there is risk of unanticipated consequences

  Medium Significance

- **Wetlands** – Loss of wetlands leads to several noteworthy impacts, including loss of key habitat, increased debris in the flow regime and reduced water quality that is difficult to mitigate

  Medium Significance



Source: Keeyask Response to EIS Guidelines

Comparative Flooding Analysis

Reservoir Analysis - Selected Historical Hydro Projects in Canada						
Company	Generating Station	Location	Year Construction Completed	Capacity (MW)	Reservoir Area (km2)	Ratio of Reservoir Area to Capacity
Manitoba Hydro	**Keeyask**	**Nelson River**	**In Progress**	**600**	**138**	**0.23**
Manitoba Hydro	Limestone	Nelson River	1990	1,340	27	**0.02**
Manitoba Hydro	Kettle	Nelson River	1974	1,220	337	**0.28**
Hydro Quebec	Eastmain-1/Eastmain-1-A	Eastmain River	2012	768	603	**0.79**
Hydro Quebec	Laforge-1	La Grande River	1994	878	1,288	**1.47**
Hydro Quebec	Toulnustouc	Manicouagan River	2005	526	235	**0.45**
Hydro Quebec	Sainte-Marguerite-3	Sainte Marguerite River	2003	882	253	**0.29**
Hydro Quebec	Manic-5/Manic-5-A	Manicouagan River	1990	2,660	1,950	**0.73**
BC Hydro	Kootenay Canal	Kootenay River	1976	583	389	**0.67**
BC Hydro	Mica Dam	Columbia River	1976	1,805	430	**0.24**
BC Hydro	Revelstoke Dam	Columbia River	1984	1,843	115	**0.06**
BC Hydro	W.A.C. Bennet Dam	Peace River	1968	2,730	1,761	**0.65**

Average Ratio of Reservoir to Capacity	**0.51**
Average Reservoir Size (km2)	**671.65**

Lake Winnipeg Regulation

- MH expects that operation of Keeyask will not affect the operation of LWR
- No risk that MH will not be able to release the maximum volume of water when required from Jenpeg, due to the requirements of their operating licence
  - 711 to 715 feet – outflows set by MH to meet power production needs
  - Outside of this range, instructed or maximum outflows respectively are required
  - Recent observation has shown that when water levels are high or above the licensed maximum water level at Lake Winnipeg (715 feet) and maximum flows are released down the Nelson River, higher than average water levels on Split Lake and along the Nelson River are observed
- It is possible that longer-term water regime changes will occur on the Upper Nelson River as an already highly altered system
  - Critical to MH's plans is to monitor the ongoing changes to water regime during and upon completion of the development of Keeyask

Possible Impacts to Split Lake

- Water levels on Split Lake are already regulated and controlled by Manitoba Hydro
  - Water flowing from the Churchill River Diversion (Burntwood River) and Lake Winnipeg Regulation (Nelson River) combine at Split Lake
  - Flow into Split Lake – 68% from Kelsey outflow, 29% CRD and 3% Local inflow
- Recently, there have been high water levels on Split Lake (July 2011), which were attributed largely to the operation of the Lake Winnipeg Regulation project and sustained maximum releases of water from Jenpeg
- There are indications that the Keeyask project could impact water levels at Split Lake during conditions requiring full release from Lake Winnipeg

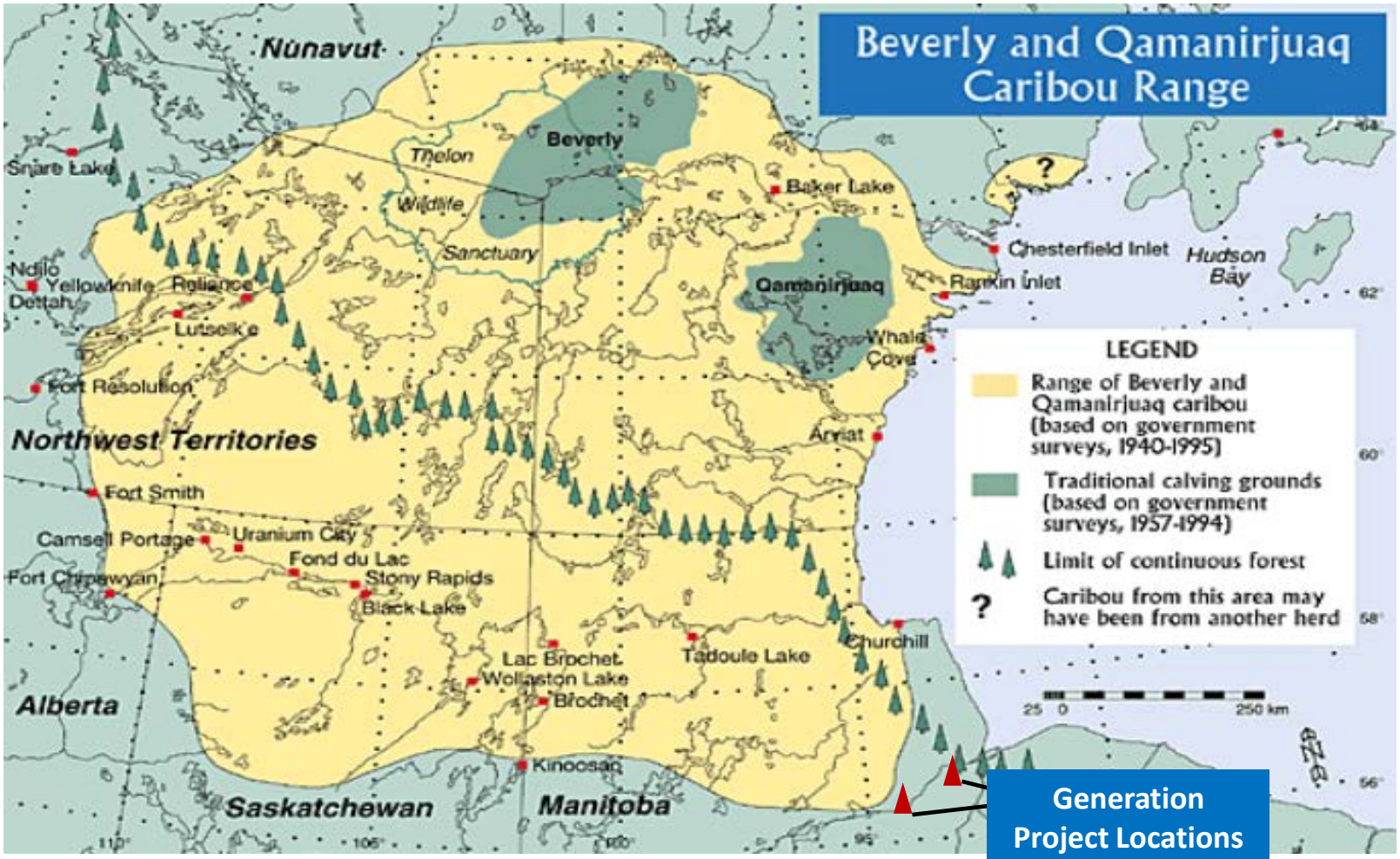
Although noted as highly unlikely by MH, the risk is sufficient for consideration in this review.

Section 5

Macro-Environmental: Caribou

Key Impacts to Caribou

- **Three distinct populations**
  - Barren-ground (Beverly & Qamanirjuaq), Coastal (Pen Islands) and Boreal Woodland (Summer Resident)
  - The extent of interactivity is unclear in the record
  - Impacts will be different in nature and significance for each
- **Increased vulnerability of caribou populations**
  - Habitat loss due to infrastructure, flooding and changes to habitat composition and diversity
  - Direct loss of known quality resident caribou calving habitat
  - Changes in ice conditions and navigation risks
  - Increased hunting and predation
- **Threats to traditional hunting opportunities**
  - Further disruption could have substantial impacts on the ability of current and future generations to hunt in areas affected by the projects



Source: Beverly and Qamanirjuaq Caribou Management Board

Calving Habitat for Boreal Caribou

- Calving habitat is of particular concern for resident caribou
- Overall, MH expects there to be a net increase in calving habitat with new islands being formed in the reservoir and with artificial habitat being created
- There is risk, however, that caribou will not respond to new habitat
- Migratory caribou may continue to access the area despite increased threats - High site fidelity to sensory disturbance
  - May also be at greater risk of mortality if mitigation measures are not effective
  - Based on past experience, we anticipate their migration into the Keeyask affected areas and the Gillam region will be reduced
  - Resident caribou may not respond to new calving habitat and this behaviour may change
- Based on the observation of relatively few individuals in the study area, habitat impacts could drive the subspecies away from the Keeyask area entirely, particularly if new calving habitat is not favoured and sensory disturbance leads to further abandonment

Drowning Risk

- KCNs note concerns regarding increased chance of drowning due to altered ice regimes in winter and river flows at other times
  - Evidence from other jurisdictions supports these observations
- Mortality of large numbers is possible with increased risk near typical river crossing routes
  - In 1984, an estimated 10,000 caribou were found drowned in hydro reservoirs near Fort Chimo Quebec
  - Similar incidents have been recorded as recently as 2007 in Quebec, involving 300 caribou

Inuit blame drowning of 10,000 caribou on Hydro-Québec dam

UNGAVA BAY
FORT CHIMO
LIMESTONE FALLS
Islands of caribou drowned in area shown in circle

The Citizen
Wednesday, October 3, 1984
Ottawa
Final Edition
$1.50 weekly
home delivered
30¢ per copy

Tories plan shakeup of top PS

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Caribou found dead in Nunavik-area river

CBC News Posted: Oct 11, 2007 4:33 PM CT | Last Updated: Oct 11, 2007 5:58 PM CT

Facebook 0 Twitter 0 Reddit 8+1 0 Share 0 Email

More than 300 dead caribouwere spotted Wednesday floating down the Kuujjuaq River in northern Quebec's Nunavik region.

Quebec wildlife officer Valley Saunders told CBC News that the caribou were drowning at the Limestone Falls, about 150 kilometres south of Kuujjuaq. The area is home to the George River Caribou Herd, which is in the middle of its fall migration.

An estimated 10,000 caribou drowned at the same spot in 1984, making international news. In response, the province built a single fence on the south end of the falls to divert caribou migration.

Saunders said this time around, the herd was migrating from the west side, falling to their deaths from there.

Kuujjuaq Mayor Larry Watt saidworkers erected three more fences on Thursday, hopefully to divert the caribou away from the falls.

"After having spoken with a game warden officer, we made a temporary measure to put up fencing right at the Limestone Falls to mitigate the

Section 6

Macro-Environmental: Lake Sturgeon

Key Impacts to Lake Sturgeon

- **Habitat Fragmentation and Loss**
  - Loss of spawning habitat at Birthday Rapids, Gull Rapids and Gull Lake
  - Blocked upstream movement, as well as altered downstream movement represents material barriers to lake sturgeon productivity

- **Increased Threat to Existing Lake Sturgeon Population**
  - Impacts on water quality, spawning habitat loss, introduction of the dam and impoundment of Gull Lake likely to result in a decline in lake sturgeon population levels

MH's Mitigation Strategies

- Difficult to ascertain whether strategies proposed by MH aimed at preserving or enhancing the lake sturgeon population will be sufficient
- Lack of data on the effectiveness of stocking methods and reliance on constructed habitat
  - Science is challenging because of the long life cycle of the sturgeon and their late sexual maturity
  - Supporting conditions of a self-sustaining population in the Keeyask reservoir and Stephens Lake areas is not guaranteed
  - 25 years or more to see the results of stocking efforts and the fact that
  - Short term declines and MH's 78 year planning horizon introduces risks that the proposed strategy may not result in sustainable population levels
- MH's plans will bolster and add additional resources to the role currently being played by the Saskatchewan and Nelson River Lake Sturgeon Management Boards, Split Lake Resource Management Board, academia and the government on lake sturgeon protection and conservation in the medium- to long-term, but short-term population risk is a reasonable concern

Fishway Needs and Cost

- It is not known how sturgeon will respond to the constructed spawning habitat
- It is reasonable that passage will be necessary to ensure sturgeon are able to fulfill all of their life stage requirements for population sustainability (DFO – habitat degradation + protection of habitat)
- More study is necessary on the need and requirements for upstream fish passage, which will likely be necessary in order to support the goal of providing *viable habitat* for sturgeon
- A better understanding of fish mortality as a result of turbine injury and entrainment is needed

MNP believes it is prudent to monitor sturgeon use of altered and constructed habitat prior to finalizing the design of a fishway. We estimate the fishway cost between $12 million and $50 million for each project, with a reasonable adder for the Conawapa increase in head ($75 million high side).

Fishway Cost Study

	Keeyask	Conawapa	Combined Costs
Gross Head Rise (in meters)	19.2	32.0	
Expected Fishway Cost (Average)	$ 37,636,591.48	$ 62,727,652.46	$ 100,364,244
Expected Fishway Cost (Dunvegan - Low)	$ 38,231,578.95	$ 63,719,298.25	$ 101,950,877
Expected Fishway Cost (Dunvegan - High)	$ 55,073,684.21	$ 91,789,473.68	$ 146,863,158
Median	$ 38,231,578.95	$ 63,719,298.25	$ 101,950,877
Average	$ 43,647,284.88	$ 72,745,474.80	$ 116,392,760
High End of Range	$ 55,073,684.21	$ 91,789,473.68	$ 146,863,158
Low End of Range	$ 37,636,591.48	$ 62,727,652.46	$ 100,364,244

- Based on publicly available cost information for 5 separate Canadian projects
- Scenario analyses of cost per meter of gross head aligns with MNP findings

Section 7

Macro-Environmental: Other At Risk Fauna

Key Impacts to Other At Risk Fauna

- **Increased Mercury Concentration in Fish**
  - Fish and aquatic animals are at risk of mercury contamination, causing them to become unsafe for consumption
  - Impacts could last as long as 20-30 years post-initial flooding of the reservoir, which will equate to the loss of these animals as a source of food for at least one generation
- **Availability of Traditional Food**
  - Compromises the ability of KCNs to pursue, obtain and consume traditional foods due to habitat loss and declining quality of wildlife in the area
- **Wildlife Risk Associated with Transmission Infrastructure**
  - Transmission infrastructure associated with the projects may pose further consequence to at-risk avian species due to collision
  - SARA listed endangered species (olive-sided flycatcher, common nighthawk) prefer associated habitat
  - Increases edge habitat enhance hunting opportunities for predator species

MH's Mitigation Strategies

- Provided MH manages the effects of the projects as expected, including:
  - Replacement of habitat for threatened species,
  - Mitigating impacts to the ecosystems in the Keeyask area

  consequences of development are anticipated to be manageable and will not affect the long-term viability of wildlife populations in the region
- Though the effects on fauna are not expected to be extremely adverse or widespread, based on the studies conducted to date, precaution should be taken to ensure that all potential impacts are understood and the proper procedures are in place to prevent and manage any unexpected adverse effects

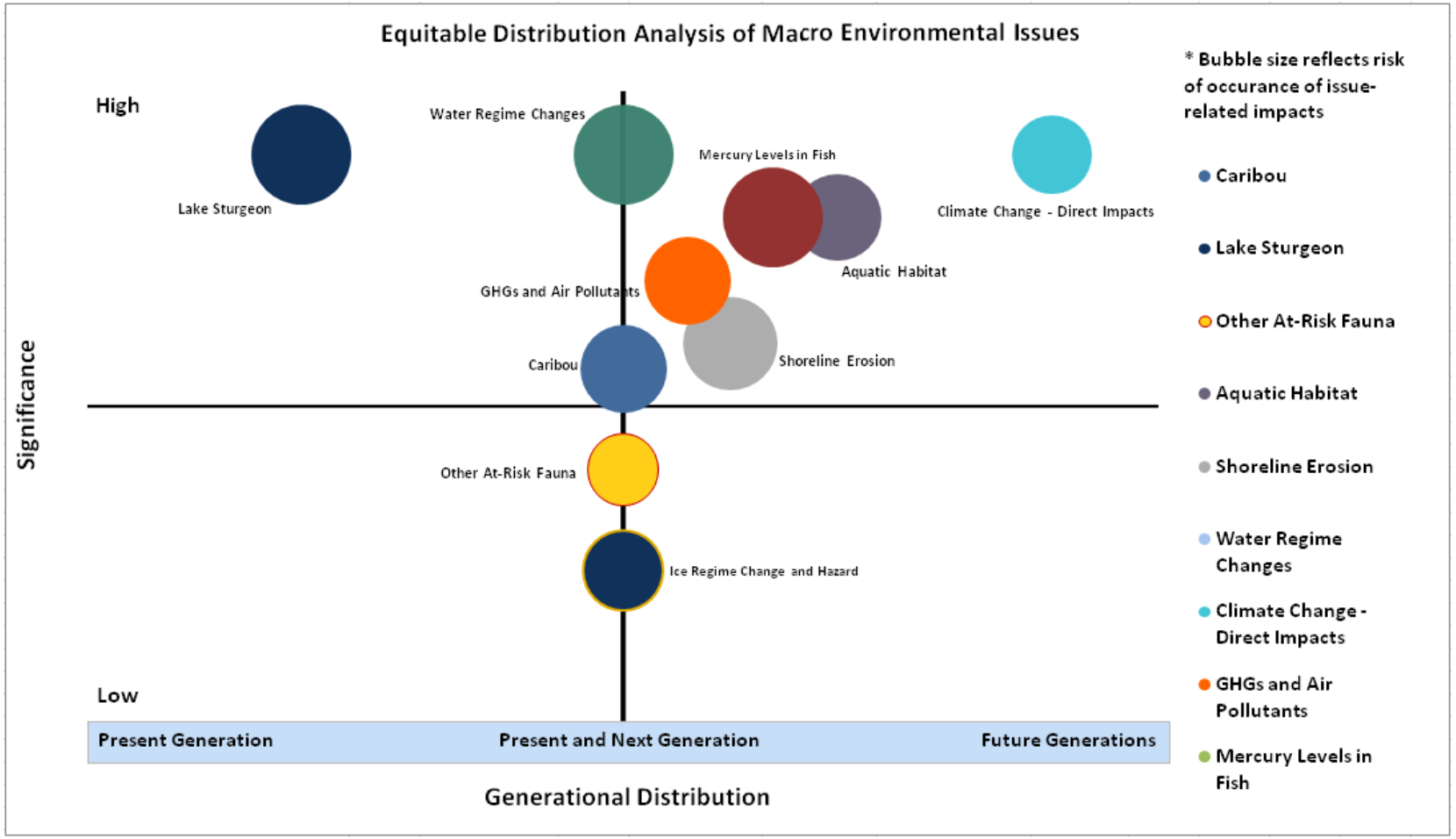
Section 8

Equitable Distribution

Key Impacts

- The majority of **significant impacts** (i.e. those with a medium or high rating) occur in the medium-term
  - This indicates that current generations will carry the bulk of the burdens of negative impacts from, water regime changes, aquatic habitat changes, shoreline erosion, mercury levels, GHGs and air pollutants and impacts to caribou
- The **most significant short-term impact** occurs on water regime and lake sturgeon
  - In respect to sturgeon, based on research and analysis performed, we are unclear on the duration of the effects beyond the short-term
- The **most significant long-term impacts** are the direct impacts of climate change, which may be further exacerbated by GHGs and air pollutants in the short- to medium-term
  - This represents the largest area of inequitable distribution, as climate change will impact future generations much more significantly than the current generation

Equitable Distribution



*Bubble Size reflects the risk of occurrence (larger = higher risk; smaller = lower risk)