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While the economic benefits of wetlands are not the focus of this report, the estimated CAD$430 million lost in ecosystem services in the Little Saskatchewan watershed in the study period, and CAD$15 million in 2005 alone, provides a strong argument to conserve and restore wetlands.

Zubrycki, K. et al. (2015). Strategic Large-Basin Management for Multiple Benefits: Submission to the Manitoba Clean Environment Commission. Footnote 2.

Local residents acknowledge that the biological character of the Netley-Libau Marsh has changed radically over the past three decades. Between 1979 and 2001, the erosion of vegetated uplands between adjoining water bodies has been extensive, resulting in the amalgamation and expansion of many marsh bays and ponds. Half the entire complex (13,125 ha, 51%) was open water in 2001, compared to 35% (8,884 ha) in 1979. Waterfowl populations have declined precipitously, so much so that few recreational hunters visit the marsh now compared to the past.

Goldsborough, Gordon. (2015). The Ecology of Coastal Wetlands around Lake Winnipeg and Vegetation Loss in Netley-Libau Marsh. Page 6.

2.2
MODEL LIMITATIONS

The use of manual adjustments for re-regulation of Jenpeg releases, as opposed to algorithms for simulation of Jenpeg release decisions following logical and conditional operating rules, constitutes the models' most serious limitation relative to the following applications:

- System analysis, i.e. simulation of coordinated operation of all major MH system components upstream and downstream of Lake Winnipeg, both existing and planned, including Grand Rapids, Jenpeg, Kelsey, Keeyask, Kettle, Long Spruce and Limestone, to balance system storage for multiple flood and conservation purposes
- Analysis of more complex and systemwide operational alternatives than the two at-site constant-pool power range alternatives considered for Lake Winnipeg
- Reconstitution of natural flow regimes and lake levels throughout the MH system by removal of effects of system regulation under LWR, enabling a uniform 1915-2013 period of record for assessment of LWR effects based on hydrometric data (Appendix 3 to the MH Report); this approach was recently used to synthesize continuous 70-year periods of daily naturalized flows in multiple river basins for statewide water planning in Georgia (ARCADIS, 2010).
- Analysis of implications of climate change to LWR and evaluation of adaptive responses.
- Analysis of effects of LWR and alternatives to LWR under stationary-climate and climate-adjusted hydrologic conditions outside the range of those experienced during the 1977-2013 period of LWR implementation.
- Analysis of combined LWR operational and structural strategies to address other water management issues raised during the licencing process that could affect the operation of the MH system but are not addressable using the current MH models, including flow control for ice management, the Lake Manitoba drainage channel, protection/restoration of the Netley-Libau Marsh, and others.

McMahon, George. (2015). Review of Hydrologic and Operational Models. Page 2-3.

5.2
LONG-TERM RECOMMENDATIONS
The focus of models and data developed for future LWR operation should not be a comparison of Lake Winnipeg water levels and flow regime with and without-LWR, as is the case in the current licence application, but on system operation to maximize and equitably allocate the benefits of multipurpose regulation while minimizing basinwide flood risks, drought risks and environmental impacts. Several complex water management issues have been raised in the LWR licensing process, some of which may not directly pertain to the current licence application and would not in any case be amenable to analysis using the present generation of MH spreadsheet water balance models. Nonetheless these issues are likely to assume greater importance in the future and others may emerge that will require detailed analysis in support of future licence applications. These issues will require a new generation of decision-support tools to comprehensively address, with the following capabilities:

- Incorporation of, at minimum, the major existing and planned components of MH's LWR and Nelson River power system outlined in Figure 5.1 for integrated analysis and assessment of systemwide storage balancing and coordinated operation for flood protection, hydropower, environmental and drought management objectives; consideration should be given to incorporation of all MH system components that are hydraulically connected to Lake Winnipeg and the Nelson River and currently included in its HERMES decision-support system for energy operations planning.
- Consideration of wind setup effects on rating curves, and river routing to account for lag and storage of reach inflows.
- Testing operational responses to ice conditions on the Nelson River (Bijeljanin and Clark, 2010; Tuthill, 1999).
- Analysis of effects of major inflow changes, for example the Lake Manitoba drainage channel, into the LWR plan.
- Analysis of effects of LWR operational alternatives on wetlands, particularly Netley-Libau marsh and feasibility assessment of operational and/or structural alternatives
Lake Winnipeg Regulation – Review of Hydrologic and Operational Models
- Testing and evaluation of operational and structural alternatives to better control Cross Lake levels and flow regime
- Testing and evaluation of operational and structural alternatives for shoreline management and improvements to Nelson River flow regime relative to flood protection, environmental, water quality, and bank erosion objectives
- Analysis of LWR operational alternatives using climate-adjusted streamflow, precipitation and evaporation ensembles (as opposed to averaging of multiple downscaled climate model

McMahon, George. (2015). Review of Hydrologic and Operational Models. Pages 5-6 & 5-7.

196.378 Renewable resources.

1o. An electric provider may count electricity derived from a large hydroelectric facility toward satisfying the requirements of par. (a) 2. only if the facility was initially placed in service on or after December 31, 2010, and, if the facility is located in Manitoba, Canada, all of the following are satisfied:

a. The province of Manitoba has informed the commission in writing that the interim licenses under which the Lake Winnipeg Regulation Project and the Churchill River Diversion Project were operating on December 31, 2015 have been replaced by final licenses.

b. The final licenses specified in subd. 1o. a. are in effect under Canadian law.
NOTE: Subd. 1o. is created eff. 12-31-15 by 2011 Wis. Act 34.

Relevance: Summarize and make comment on the concerns raised pertaining to the issuance of final licence to Manitoba Hydro under the *Water Power Act* including but not limited to future monitoring and research that may be beneficial to the project and Lake Winnipeg.

2013 Wisconsin Statutes & Annotations 196. Regulation of public utilities.196.378 Renewable resources.

The 1989 drought led to a CAD$28 million loss, while the 2002–2003 drought led
to a CAD$436 million loss (Simard & Joyce, 2005). In 2007, Manitoba Hydro calculated that a five-year drought could result in decreased electricity generation of 31,952 gigawatt hours and cost roughly between CAD$2.2 billion (conservative estimate) and CAD$3.5 billion (Manitoba Hydro, 2007).

Zubrycki, K. et al. (2015). Strategic Large-Basin Management for Mutiple Benefits: Submission to the Manitoba Clean Environment Commission. Page 11.

1) **2015-2017 GRA**

4.1 Tab 9, Page 22

The reduction in hydroelectric energy supply during periods of extended low flow conditions can have a significant negative impact on Manitoba Hydro's financial situation. A repeat of a recent historic five-year drought (1987/88 to 1992/93) starting in 2016/17 would result in the lowest flow year of that historic drought occurring in 2017/18. In that lowest flow year (2017/18) net revenue would decrease by $0.5 billion compared to the net revenue based on the average of all flow conditions for that year. If the five-year historic drought (1987/88 to 1992/93) was repeated starting in 2016/17 and ending in 2020/21, net revenue would be about $1.5 billion less than expected over the five year period. This impact on net revenues would increase to $1.7 billion with consideration of financing costs associated with additional borrowing requirements up to the year 2020/21.

The estimate of $1.7 billion for the financial impact of a five-year drought is due to a significant reduction in export revenue combined with the requirement to operate high cost Manitoba Hydro thermal generation facilities for long time periods and to import significant quantities of high-cost energy. There is a significant risk that this estimate could be greater if a series of adverse conditions occurred coincident with this time period. It is possible that natural gas prices, and consequently electricity prices in the export market, could be higher resulting not only in additional cost to operate Manitoba Hydro's gas-fired generation but also resulting in increased cost of import energy, especially during peak periods. Based on a high price scenario, the financial impact of a five-year drought would increase by $0.3 billion compared to the expected price scenario.

Another factor that has similar impacts as electricity prices in the export and import market is the currency exchange rate for the US dollar. A low Canadian dollar relative to the US dollar increases the export revenue that is lost in a drought and increases the cost of import energy and cost of operating thermal generation in Manitoba. This would be offset to some degree by reductions in finance expense denominated in USD.

A further factor that could increase the cost of drought is the occurrence of a more extreme drought compared to that which occurred during the five year period between 1987 and 1992. For example, a seven-year drought spanning from 2016/17 to 2022/23, based on flows from the period 1936/37 to 1942/43, increases the cost of drought from $1.5 billion to $2.1 billion under expected market prices.

Manitoba Hydro - 2015/2016 & 2016/17 General Rate Application, Tab 9, Energy Supply, Page 22.

6 (c)

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"72. Every license shall be deemed to have been executed on the express condition that the licensee shall -

(a) Divert, use, or store the water authorized to be diverted, used, or stored by him in such a manner as not to interfere in the opinion of the Minister, with the maximum advantageous development of the power and other resources of the river or stream upon which his works are located;

Province of Manitoba. Department of Mines and Natural Resources. Water Resources Branch. (1970). Interim License for the Regulation of Water Levels for Water Power Purposes. Lakes Winnipeg, Playgreen, and Kiskittogisu. Page 4.

15 (b)

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Province of Manitoba. Department of Mines and Natural Resources. Water Resources Branch. (1972). Supplementary Interim License for the Regulation of Water Levels for Water Power Purposes. Lakes Winnipeg, Playgreen, and Kiskittogisu. Page 6-7.