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Abbreviations and Acronyms

BCCAQ	bias correction/constructed analogues with quantile mapping reordering
BCSD	bias-correction spatial disaggregation
CMIP5	Coupled Model Intercomparison Project Phase 5
EIS	environmental impact statement
GCM	global climate model

QUESTION IAAC-57

EIS Guideline Reference: 7.6.2. Effects of the environment on the project

EIS Reference: 6.0 Assessment of Potential Effects on Physical Environment; 15.0 Effect of the Environment on the Project; 15.5 Effects of Long-term Climate change on the Project

Context and Rationale

The EIS guidelines require that effects of the environment on the project be considered in different probability patterns (e.g., 5-year flood vs. 100-year flood), under a range of future climate states and that the potential impact of climate change on these probability patterns be considered over the lifetime of the project including a description of climate data and projections used.

The EIS uses secondary sources of information to describe climate scenarios in relation to effects of long-term climate change on the project.

The EIS does not provide enough information on the source, rationale, or details (e.g., data source, study methods and assumptions) of climate change information used in the development of the EIS.

This information is required to validate that the full range of relevant potential climate change impacts on the Project are considered and used to assess the full range of potential impacts of the environment on the Project and of the Project on the environment.

Information Requests

a) Describe the source, rationale, and details (e.g., data source, study methods and assumptions) of the climate change information used in the development of the EIS. Consider and discuss relevant climate projections for the region for the full lifetime of the Project (including any post-closure periods where Project components remain sensitive to climate) from a range of emission scenarios (low to high forcing) from multiple climate models to reflect uncertainty in future climate projection.

Response IAAC-57

a) The purpose of the Lake Manitoba and Lake St. Martin Outlet Channels Project is to develop a permanent flood control management system for Lake Manitoba and Lake St. Martin for alleviating flooding in the Lake St. Martin region. The Project is designed to reduce peak water levels from those of the 2011 flood (a 1:300-year frequency) and, thus, is designed to withstand the effect of a flood on the Project. As public flood mitigation infrastructure, the Project life is indefinite.

   Climate change predictions for the environmental impact statement (EIS) were based on the Pacific Climate Impacts Consortium's (2019) modeling, which used 12 global climate models, and a climate study done for the Manitoba-Minnesota Transmission Project (Manitoba Hydro 2015), which used 15

global climate models, supported by other publications, as listed in Volume 5, Section 15.5.1 of the EIS.

The methods used for Pacific Climate Impacts Consortium's modelling, as stated in their publication, were:

> "… downscaling outputs are based on [global climate model] GCM projections from the Coupled Model Intercomparison Project Phase 5 (CMIP5; Taylor et al. 2012) and historical daily gridded climate data for Canada (McKenney et al. 2011; Hopkinson et al. 2011). Statistical properties and spatial patterns of the downscaled scenarios are based on this gridded observational dataset, which represents one approximation of the actual historical climate…. Data from the GCM sources described above is downscaled to a finer resolution using two different methods. The first is Bias-Correction Spatial Disaggregation (BCSD) (Wood et al. 2004) following Maurer et al. (2008) with the following modifications: the incorporation of monthly minimum and maximum temperature instead of monthly mean temperature, as suggested by Bürger et al. (2012) and bias correction using detrended quantile mapping with delta method extrapolation following Bürger et al. (2013)…. In addition to BCSD, projections are also available using Bias Correction/Constructed Analogues with Quantile mapping reordering (BCCAQ)."

Pacific Climate Impacts Consortium modelled climate scenarios for the years 2021 to 2050 (lower emissions) and 2051 to 2080 (higher emissions).

For the 2021-2050 scenario, the annual mean temperature was predicted to be more than two degrees Celsius (2°C) higher, with more +30°C days (7). There were fewer frost days (21) predicted and fewer -30°C days (8). An increase in the change from average mean precipitation was also predicted (2.3%), with most change (more than 12%) occurring in the winter and spring.

For the 2051-2080 scenario the annual mean temperature was predicted to be more than 4°C warmer (more than 6°C in winter), based on mean annual temperatures, and more +30°C days (25). Fewer frost days (39) and fewer -30°C days (11) were predicted. An increase in the change from average mean precipitation was predicted (8%), with most (more than 25%) occurring in the winter and spring.

The methods used for Manitoba Hydro (2015) consisted of three components: climate normals analysis, climate trends analysis and the trends in extremes analysis. This study is applicable to the Project as part of its study area overlaps with part of the Project area. Climate normals (temperature, precipitation and wind) were analyzed for the period 1981-2010 and extremes. Climate Trends consisted of a trend analysis of mean temperature, total precipitation and mean wind speed to determine the statistical significance and magnitude of trend. The analysis used the Mann-Kendall test for trend. Trends in Extremes included trend analysis of 25 historic extreme indices for Winnipeg, Sprague, Steinbach, Cyprus River and Brandon, Manitoba. Data sources were the 1981 to 2010 climatic normals from Environment Canada.

Future climate scenarios were derived from GCMs. The Manitoba Hydro (2015) study developed scenarios assuming the evolution of demographic, social, economic, regulatory, technological, and environmental conditions. The period 1981-2010 was used as the baseline period and three future

horizons (2010-2039, 2040-2069, and 2070-2099) were calculated for changes in future climate. Sixty-nine GCM simulations from 15 GCMs were used to assess future climate projections. The results are presented in Volume 5, Section 15.5.1 of the EIS.

References

Bürger, G., T.Q. Murdock, A.T. Werner, S.R. Sobie, and A.J. Cannon. 2012. Downscaling extremes - an intercomparison of multiple statistical methods for present climate. *Journal of Climate, 25, 4366–4388. doi:10.1175/JCLI-D-11-00408.1.*

Bürger, G., S.R. Sobie, A.J. Cannon, A.T. Werner, and T.Q. Murdock. 2013. Downscaling extremes - an intercomparison of multiple methods for future climate. *Journal of Climate*, 26, 3429-3449. doi:10.1175/JCLI-D-12-00249.1.

Hopkinson, R.F., D.W. McKenney, E.J. Milewska, M.F. Hutchinson, P. Papadopol, and L.A. Vincent. 2011. Impact of Aligning Climatological Day on Gridding Daily Maximum–Minimum Temperature and Precipitation over Canada. *Journal of Applied Meteorology and Climatology*, **50**, 1654–1665. doi:10.1175/2011JAMC2684.1.

Manitoba Hydro. 2015. Manitoba-Minnesota Transmission Project Historic and Future Climate Study. Manitoba-Minnesota Transmission Project EIS Biophysical Technical Data Report.

Maurer, E.P., and H.G. Hidalgo. 2008. Utility of daily vs. monthly large-scale climate data: an intercomparison of two statistical downscaling methods. *Hydrology and Earth System Sciences*, **12**, 2, 551-563. doi:10.5194/hess-12-551-2008.

McKenney, D.W., M.F. Hutchinson, P. Papadopol, K. Lawrence, J. Pedlar, K. Campbell, E. Milewska, R. Hopkinson, D. Price, and T. Owen. 2011. Customized spatial climate models for North America. *Bulletin of the American Meteorological Society*, **92**, 12, 1611-1622. doi:10.1175/2011BAMS3132.1.

Pacific Climate Impacts Consortium. 2019. Statistically Downscaled Climate Scenarios. Available at: https://www.pacificclimate.org/data/statistically-downscaled-climate-scenarios. Accessed June 2019.

Taylor, K.E., R.J. Stouffer, and G.A. Meehl. 2012. An Overview of CMIP5 and the Experiment Design. *Bulletin of the American Meteorological Society*, **93**, 485–498. doi: 10.1175/BAMS-D-11-00094.1.

Wood, A.W., L.R Leung, V. Sridhar, and D.P. Lettenmaier. 2004. Hydrologic implications of dynamical and statistical approaches to downscaling climate model outputs. *Climatic Change*, **62**, 189–216, doi:10.1023/B:CLIM.0000013685.99609.9e.