APPENDIX 5.4A

Climate Change Discussion

CLIMATE CHANGE DISCUSSION

Climate is projected to change in the region of the Project. The transmission line infrastructure associated with the Project must be robust enough to accommodate these projected changes in expected climate conditions. Adaptation to changing climate conditions can either be dealt with in the Project design itself or through adaptive management. Adaptive management considers what further information on changes to the expected conditions will be gathered and how this information will be incorporated into Project operation and maintenance to make it more robust. Future climate projections have already been considered as part of the Project design.

To understand climate projections, current climate conditions near the Project must be understood. The current climate and current climate trends and extreme weather events for the region were described using the observations in *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation* (Warren and Lemmen 2014). The projected ranges of future climate conditions were described using publicly available, peer-reviewed literature. This includes the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5; IPCC 2013), along with Warren and Lemmen (2014).

Current Climate Conditions

In general, under current climate conditions, Canada is becoming warmer and wetter. Canadian annual average temperatures have risen by 1.5 degrees Celsius (°C) in the years from 1950 to 2010 with the greatest warming occurring in winter and spring (Warren and Lemmen 2014). In the northwest of Ontario, the average annual temperature has increased by 1.4°C in the years from 1950 to 2010 (OCCIAR 2011). Total precipitation in Canada has increased 16% from 1950 to 2010 (Warren and Lemmen 2014); however, the majority of this change is due to large increases in precipitation in British Columbia and the Atlantic provinces. Trends in the region of the Project are similar but may vary in magnitude (Warren and Lemmen 2014).

Projected Ranges of Future Climate Conditions

The approximate two-year construction stage occurs during the first half of the 21st century and is too short for any measurable change to either the climate normals (e.g., means) or extreme weather events (e.g., storms). Construction of the Project has a low potential for being affected by climate change effects, as projected changes in climate are likely to be within the variability currently experienced in the weather in the region of the Project. Projected changes in climate are more easily measured over longer periods, for example the 30-year period between the current climate and projected mid-21st century climate used in the peer-reviewed literature discussed below. Over shorter periods, the projected change in climate is difficult to distinguish as a statistically significant trend outside of the day to day, seasonal and year to year (interannual) variability experienced in weather. For this reason, climate change projections focus on mid to late 21st century climate, as presented in literature.

Climate factors (Table 5.4A-1) have been selected to describe the potential climate-infrastructure interactions for the Project and to describe the projected changes in climate for the region. The climate factors include changes to rainfall, temperature, and extreme events (e.g., storms). These factors are further subdivided into specific event type factors that describe long-term changes such as increasing temperatures or extreme events such as increased storms with intense precipitation.

Table 5.4A-1: Climate Factor Trends for the Project Region

Climate Factor Description	Trend	Comments on Future Trends
Rain		
Drought	Decreasing	In the mid-21st century, droughts are expected to decrease in the Project region as the area becomes wetter with increased precipitation (Easterling et al. 2000). Long-term (late 21st century) projections predict that wet areas will continue to become wetter and drier areas will become drier (IPCC 2013). In Canada, higher evaporation rates associated with warmer summers will increase the tendency towards drier conditions, with large variability between the modelled projections (Warren and Lemmen 2014).
Amount of rain	Increasing	In the mid-21st century precipitation is expected to increase, with the largest precipitation increase occurring in spring and winter (Stone et al. 2000). Long-term (late 21st century) projections predict increases in precipitation in the mid-latitude regions, including the Project region (IPCC 2013).
Frequency of heavy rainfall events	Increasing	In the mid-21st century intense rainfall frequency is expected to increase in Ontario (Coulibaly et al. 2005, IPCC 2013, Kunkel et al. 1999, Warren and Lemmen 2014) but there are relatively large uncertainties associated with these projections. Under future scenarios with higher GHG emission scenarios, a 1-in-20 year storm is projected to become a 1-in-10-year storm for mid to high latitudes, including the Project area (Warren and Lemmen 2014).
Amount of rainfall per event	Increasing	In the mid-21st century rainfall intensity is expected to increase in Ontario (Coulibaly et al. 2005, IPCC 2013, Kunkel et al. 1999). Long-term projections predict continued increases in rainfall intensity through the late 21st century.
Amount of snow	Increasing	In the mid-21st century precipitation, including snowfall, is expected to increase, with the largest precipitation increase occurring in spring and winter (Stone et al. 2000). Coupled with increased temperatures, it is unclear if the distribution of precipitation between snow and rain will change in the Project region.
Frequency of heavy snowfall events	Increasing	An increase in snowfall in the northern latitudes, including Ontario, is projected in the mid-21st century (Colombo et al. 2007, IPCC 2013, Zhang et al. 2000).
Amount of snowfall per event	Increasing	An increase in snowfall intensity in the northern latitudes, including Ontario, is projected in the mid-21st century (Colombo et al. 2007, IPCC 2013, Zhang et al. 2000).
Temperature		
Mean temperature	Increasing	In the mid to late 21st century mean temperature is expected to increase for the Project region (IPCC 2013). In Canada at the mid-latitudes the greatest increase in temperature is projected to occur during the summer (Warren and Lemmen 2014). Warmings of 1.5 to 2.5°C are projected in the summer using modelled projections based on lower future concentrations of GHGs (Warren and Lemmen 2014).
High temperatures	Increasing	In the mid to late 21st century mean temperature is expected to increase for the Project region (IPCC 2013). Increases in the number of warm days and nights are also projected, with the number of extreme hot days are also projected to increase (Warren and Lemmen 2014).
Heat waves	Increasing	In the mid-21st century it is projected that the frequency and intensity of heat waves will increase (IPCC 2013; Warren and Lemmen 2014).
Annual changes effecting snow deposition and rate of melt (freeze-thaw cycles)	Decreasing	Wide-spread decreases in the duration of snow cover are projected across the Northern Hemisphere (Warren and Lemmen 2014). Mid-21st century projections of snow deposition predict a decrease in snow cover extent (IPCC 2013).

Table 5.4A-1: Climate Factor Trends for the Project Region

Climate Factor Description	Trend	Comments on Future Trends
Other Events		
Increase in extreme events (e.g., storms, including ice storms)	Increasing	Mid-21st century projections of occurrence of extreme events predict a shift to more intense storms and an increase in frequency of extreme weather phenomena such as tornadoes on a global scale (IPCC 2013).
Forest fires	Increasing	Occurrence, extent and severity of forest fires are expected to increase in most regions of Canada (Lemmen et. al. 2014). The timing of the fire season (earlier), peak of the fire season (later) and the number of large fires (increased) are projected to change by the end of the century (Lemmen et. al. 2014). Forest fire prone areas in northwestern Ontario are projected to receive less precipitation and higher temperatures, leading to greater risk of forest fires (Columbo et. al. 2007).

Notes:
IPCC = Intergovernmental Panel on Climate Change; °C = degrees Celsius.

The long-term infrastructure of the Project consists of the transmission line and access roads. This infrastructure may be vulnerable to changes in precipitation, namely extreme events (e.g., rain storms, winter storms, ice storms). Combinations of low temperatures, wind and rain, and ice storms could lead to physical damage due to ice build-up on the transmission line infrastructures (Arent et al. 2014). While extreme events are projected to increase, no publicly available, peer-reviewed literature was available for changes in the frequency or intensity of specific types of extreme events (e.g., ice storms). While temperature is projected to increase, the projected increase is less than the seasonal variability experienced by the infrastructure. For this reason, the infrastructure is likely much less vulnerable to the projected temperature increases.

Forest fires may impact operations in the future, however this cannot be included in the design at this time and must be considered as part of adaptive management.

As there is no publically available information on the projected change to the frequency or intensity of ice storms, Wataynikaneyap is designing the structural elements of the Project to withstand a 1-in-50-year return period meteorological event (ice or wind) in accordance with the current code requirements. The weather cases applied in the design of the transmission structures and other components of the Project are based on code and design requirements set forth by the Canadian Standards Association documents C22.3 No. 1-15 “Overhead Systems” and C22.3 No. 60826-10 (R2015) “Design criteria of overhead transmission lines (Adopted CEI/IEC 60826:2003, third edition, 2003-10, with Canadian deviations).” Designing to the current code should attain an appropriate level of reliability consistent with other new transmission line projects.

5.4A1.1 References

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