SECTION 8
SENSITIVITY OF EFFECTS ASSESSMENT TO CLIMATE CHANGE

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8.0 SENSITIVITY OF EFFECTS ASSESSMENT TO CLIMATE CHANGE

8.1 INTRODUCTION

The preceding sections of the Aquatic Environment Supporting Volume (AE SV) have described the effects of the Keeyask Generation Project on the various components of the aquatic environment. This section will evaluate the sensitivity of these assessments to climate change.

8.2 APPROACH AND METHODS

The probable scenarios of climate change are described for future 30-year average periods until the 2080s (2070–2099) in the Physical Environment Supporting Volume (PE SV; Section 11). The conclusions of the Project's residual effects on the physical environment indicate that the assessment is not sensitive to climate change. The robustness of the conclusions is largely due to two factors. First, the water regime within the open water hydraulic zone of influence and the reservoir operating range are not substantially changed when considering climate changes and resulting potential effects to river flows. Second, the largest effects of the Project on the physical environment occur early in the operating period when the effects of climate changes are still relatively small.

The aquatic environment assessment and the conclusions on residual effects were reviewed to determine if these would change as a result of climate change based on the results provided in the PE SV. For all aquatic environment components, the review of sensitivity to climate change focused on the operations phase of the Project as the construction period will take place in the near term (less than 10 years). Although climate change is an ongoing phenomenon, its effects are expected to increase over time and will be most noticeable in the longer term. Studies conducted as part of the EIS suggested that the changes arising from physical processes in the reservoir will have largely stabilized prior to Year 30 (*i.e.,* a model for the long-term condition of the reservoir).

The probability scenario of climate change for 2020, 2050, and 2080 predicts:

- Increasing air temperatures, predominantly in winter;
- Increasing precipitation, predominantly in winter and spring; and
- Increasing annual evapotranspiration (PE SV Section 2).

8.3 WATER QUALITY

The primary pathways by which water quality is affected by Project operation is through alterations to water levels and flows, flooding of terrestrial areas, and changes to sediment transport and deposition. The long-term (greater than 30-year) residual effect of the Project on water quality is predicted to be a decrease in mineral total suspended solids (TSS) in the reservoir and the southwestern portions of

Stephens Lake, particularly during high flow scenarios. There may be some episodic increases in TSS in nearshore areas of the reservoir during high wind events. Given that predicted changes to sedimentation, as described in Section 11.5 of the PE SV, are not expected to be altered by climate change, conclusions related to effects on TSS are expected to be similarly unaffected. There may be an increase in the frequency of short-term increases in TSS in nearshore areas if climate change results in more frequent high wind events.

The duration of predicted increases in nutrient and metal concentrations in nearshore areas of the reservoir will persist for approximately 10–15 years and would be greatest during the initial years post-impoundment. Because the largest effects occur in the first few years of operation and are lower in later years, climate change is not expected to substantively change the residual effects assessment.

In Section 11.7 of the PE SV, the sensitivity of the effects assessment for dissolved oxygen (DO) and water temperature to climate change were assessed. Water temperature will increase as a result of climate change, which could cause low DO conditions to occur more frequently over a larger area. However, the duration of low DO conditions in winter would decrease with the shorter period of ice cover. Overall, the likely effects of climate change were not expected to materially affect the conclusions regarding Project effects for either component.

An additional consideration is that climate change will cause general changes to water quality, but the nature of these changes cannot be definitively predicted. For example, water quality is closely related to conditions in upstream watersheds and varies at present depending on the relative contribution of the Burntwood/Churchill versus the Nelson River systems. Hydrological conditions, and, thus, water chemistry of these watersheds could be negatively affected by climate change. Effects could arise due to an increased frequency of forest fires or the seasonal dry-up of creeks (Schindler 1998) and because boreal wetlands and forests are generally the most vulnerable to climate warming among terrestrial ecosystems Woodwell *et al.* (1995). Altering the relative contribution of watersheds to the flow of the Nelson River, in particular as areas become wetter or drier, would also affect water quality in the Project area.

In conclusion, although water quality in the future may be affected by climate change, the residual effects of the Project are not expected to change because (i) most effects will occur in the first years of the Project operation and diminish over time; and (ii) the long term decline in TSS is related to changes in the velocity on the mainstem, which is controlled by the impoundment and not affected by climate change.

8.4 AQUATIC HABITAT/LOWER TROPHIC LEVELS

The primary pathways by which aquatic habitat, and subsequently lower trophic levels, are affected by the Project is through changes to the surface water regime, sediment deposition, and water quality and the presence of the generating station (GS) itself.

As described in Section 11 of the PE SV, increases in temperatures and precipitation under climate change scenarios could result in higher runoff and stream flows in the study area. However, the reservoir operating range of 158–159 m will remain unchanged regardless of the Nelson River flows. The effects to aquatic habitat resulting from mineral bank erosion and peatland disintegration will be highest in the first five years of operation, after which they will stabilize at relatively lower rates. Increases in shoreline peatland disintegration due to climate change would correspondingly increase the footprint of the Project (PE SV Section 11). Because the effects of climate change will be smaller in the first few years of operation and greater in the future, combined with the fact that the operating range of the reservoir will not change, the conclusions regarding the residual effects to aquatic habitat are not substantially affected by climate change.

In general, a trend to a longer ice-free period and warmer waters will result in an increase in productivity in the ecosystem. Lower trophic level biomass is expected to increase with rising average water temperatures. An increase in the number of invasive species and the complexity of community interactions may also occur (Magnuson *et al.* 1997; Schindler 1997).

The majority of aquatic vascular plant beds, and associated plant-dwelling macrophytes, will be lost in the reservoir due to flooding. While new plant beds will re-establish in the reservoir over 10–15 years, the total area will be less than in the existing environment. These residual effects may be partially offset by the anticipated increase in temperatures and longer ice-free periods resulting in more favourable growing conditions for aquatic plants.

The reservoir could experience periodic phytoplankton blooms and an increase in zooplankton biomass due to the effects of the Project. Higher water temperature may cause larger increases in these groups. The greatest Project-related effects are expected in the first 5–10 years with the addition of large amounts of newly flooded terrestrial organic matter, but climate-related increases in water temperature during this time will have little effect on the biota.

Low DO concentrations in backbay areas of the reservoir are expected to limit macroinvertebrate colonization to a few resilient groups (*e.g.*, chironomids). As discussed above, climate change may result in DO depletion occurring over a greater area or with a higher frequency. However, oxygen demands due to flooding are expected to be highest in the early years of operation and decline over time; whereas, climate change effects will be initially small and increase over time. A shorter period of ice cover due to climate change would reduce the duration, but not the severity or extent, of low DO conditions in winter.

Overall, the assessment of the effects of the Project to aquatic habitat and lower trophic levels do not change as a result of climate change.

8.5 FISH COMMUNITY

Residual effects of the Project over the long-term include an increase in fish production in the reservoir and a shift in species composition towards those species adapted to lacustrine conditions (*e.g.*, walleye/lake whitefish).

Increased production of lower trophic level organisms in response to climate change (Section 8.4) has the potential to accelerate growth and increase reproduction in fish. An increase in water temperature and alterations in the thermal regime of Project area waterbodies would have the potential to extirpate some cold-water species and allow range extension of more southerly, native species and the invasion of exotic species. Meisner *et al.* (1987) noted that climate change would allow northern range extensions of cyprinids (minnows), esocids (pike/jackfish), centrarchids (sunfish/bass), and ictalurids (catfish) concurrent with shrinking populations of salmonines (salmon/trout/char) and coregonines (whitefish/cisco). A northward expansion of native smallmouth bass (*Micropterus dolomieu*) and an increased abundance of exotic common carp (*Cyprinus carpio*) could profoundly alter species composition in the Keeyask study area, as has been predicted for Ontario waters (Minns and Moore 1995). One of the VEC species vulnerable to negative effects of climate warming is lake whitefish, though substantial warming would be required before the Nelson River mainstem is no longer suitable (Jansen and Hesslein 2004). Higher system productivity and warmer open water temperatures may also increase the capacity of the environment to support greater populations of cool water species such as walleye and lake sturgeon.

Overall, the assessment of residual effects for fish populations does not change as a result of climate change. Monitoring of fish populations in waterbodies away from the direct influence of the Project will assist in determining whether any changes observed in the area affected by the Project are as a result of regional changes (*e.g.*, climate change) or a result of the Project.

8.6 FISH MERCURY CONCENTRATIONS

Increasing mercury concentrations in arctic freshwater fish over the past 25 years have been attributed to effects of climate change (Carrie *et al.* 2010). It is not known if similar increases have happened in northern Manitoba, where little long-term data exist for natural lakes.

Maximum mean mercury concentrations for lake whitefish, northern pike, and walleye from the Keeyask reservoir and Stephens Lake are predicted to be reached within three to seven years post-construction of the Keeyask GS (*i.e.*, approximately 15 years from now) and the return times of these maximum concentrations to pre-Project levels have been estimated at least 30 years post-impoundment. Considering these timelines, and for reasons outlined below, it is likely that climate change effects will affect the magnitude and duration of elevated fish mercury concentrations. It is also possible that mercury levels may be established in the long-term that exceed pre-Project baseline concentrations.

Prediction of the effects of climate change on fish mercury concentrations and timelines for their decline is difficult for several reasons. Both the length of the ice-free period and average summer surface temperatures of study area waterbodies are predicted to increase (PE SV Section 11). The higher water temperatures may increase bacterial methylmercury production, the transfer efficiency of methylmercury between trophic levels, and the rates of fish respiration and feeding, all of which have the potential to increase fish mercury concentrations (Bodaly *et al.* 1993). However, the response of fish mercury concentrations to increases in water temperature is likely to be complex and will vary among on-system and off-system waterbodies.

Overall, the assessment of residual effects for fish mercury concentrations is not materially affected as a result of climate change. The duration of elevated levels of mercury may be somewhat longer than predicted and may stabilize at higher levels than occur at present.

8.7 SUMMARY/CONCLUSIONS

A review of the conclusions of the Project's residual effects on the aquatic environment indicates that the assessment is not sensitive to climate change. Given that predicted changes to the physical environment are not expected to be altered by climate change, conclusions related to effects on the aquatic environment are expected to be similarly unaffected. While climate change may cause general changes in the aquatic environment, the nature of these changes cannot be definitively predicted. Climate change could cause minor alterations in predicted effects, but these are expected to be obscured by substantially larger changes in the aquatic environment as a direct result of the Project. Overall, the residual effects of the Project are not materially changed as a result of predicted changes in future climate conditions.

8.8 REFERENCES

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