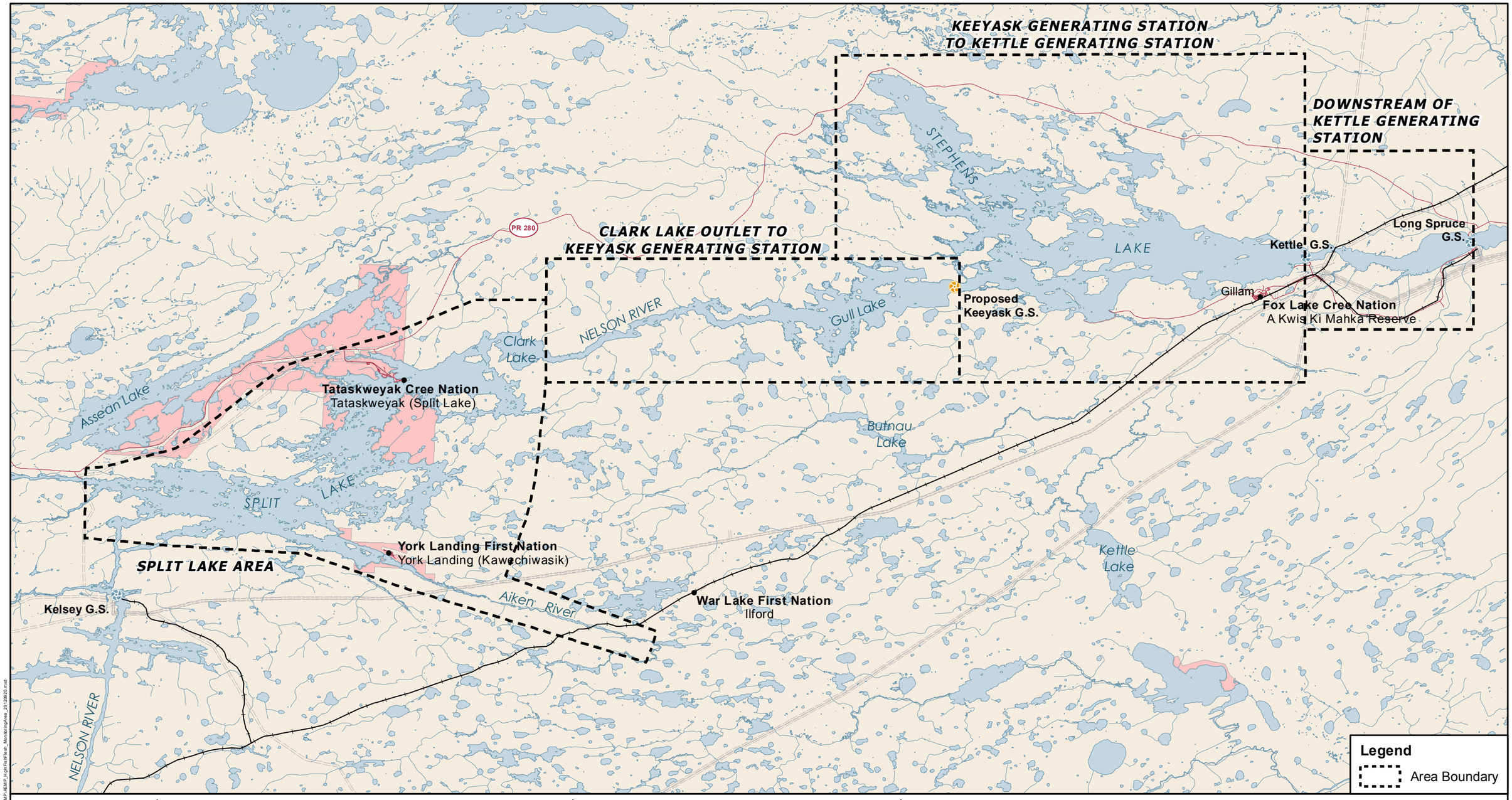

KEEYASK
Hydropower Limited Partnership

0 10 20 30 Kilometres
0 5 10 15 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000,
Stephens Lake Shoreline-Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro

Mercury in Fish Flesh Monitoring Areas

File Location: G:\EIS\Keeyask\Publish_MXDs\AEMP\AEMP_HighFishFlesh_MonitoringArea_20120920.mxd

Map 19

Differences in species-specific standardized mean mercury concentrations between waterbodies or years (including existing data for pre-Project years) will be established based on their 95 percent confidence limits with a non-overlap indicating a significant difference between means. In those cases where the relationship between mercury concentration and fish length is not significant (and length standardization is not applicable), analysis of variance (ANOVA) and Holm-Sidak's pairwise multiple comparison test (SPSS 2003) will be used to compare arithmetic means. In particular, means will be compared between pre- and post-Project years, and between measured and predicted post-Project means (see AE SV Section 7.2.4.2.2). Maximum post-Project and stable post-Project mercury concentrations will be considered attained for a species if standardized means are not statistically different for three consecutive years or sampling periods. Mercury concentrations will be compared to the 0.5 ppm total mercury Health Canada standard for commercial marketing of freshwater fish in Canada (Health Canada 2007), which also represents the Manitoba guideline for mercury in fish for the protection of human consumers (MWS 2011). Comparisons will also include the 0.2 ppm total mercury guideline instituted as a "safe consumption limit" for people eating "large quantities of fish" (Wheatley 1979) and is still unofficially recognized by Health Canada today, and the Canadian and Manitoba tissue residue guidelines of 0.033 ppm methylmercury for the protection of wildlife consumers of aquatic biota (CCME 2000; MWS 2011).

7.2.4 Parameters

The primary parameter of concern for this monitoring program is the concentration of total mercury in fish skeletal muscle from the following species: lake whitefish, northern pike, walleye, and yellow perch. Information on supporting biological variables will also be collected including: fork length, total weight, sex, maturity, and age.

7.2.5 Sampling Sites

Samples will be collected from fish captured during the conduct of the fish community core monitoring program (Section 5.2.2) in Keeyask reservoir, Stephens Lake, and Split Lake. The Aiken River will also be sampled under the fish mercury monitoring program. In the unlikely event that the target sample sizes of fish for mercury analysis are not captured during the fish community monitoring program, some additional sampling or sampling in a different location may be necessary to meet the minimum sample size requirements.

If substantial increases are observed in Stephens Lake, the monitoring program will be extended further downstream (e.g., Long Spruce Forebay). Fish mercury monitoring is also conducted by MCWS and Manitoba Hydro under CAMP at several sites in the region (see Table 1).

7.2.5.1.1 Sampling Frequency and Schedule

The periodicity of fish mercury monitoring will depend on the waterbody and Project time periods. During the operation phase, monitoring will proceed yearly in the directly affected waterbodies (i.e., Keeyask reservoir, Stephens Lake) until maximum fish mercury concentrations are reached. Thereafter, monitoring of mercury levels will be conducted every three years until they have reached pre-Project

concentrations or are considered stable at a new background level. To decide if a new background level has been established, results will be compared to lakes from other monitoring programs (i.e., CAMP).

Whenever possible, fish will be collected concurrently with the sampling of the fish community in August (Section 5.2.2.1). Fish from waterbodies not part of fish community sampling will also be collected in late summer, except for northern pike and walleye from the Aiken River, which will be captured in spring at ice-off.

7.2.5.2 Methods

A sub-sample (36 northern pike, walleye, and lake whitefish, and 25 juvenile yellow perch) of fish collected as part of the fish community core monitoring program (Section 5.2.1) that are fresh and in good condition will be processed for mercury analysis. Upon capture, large-bodied fish will be measured for fork length (±1 mm) and total weight (±1 g), examined internally to determine sex and maturity (not yellow perch; see below), and bony structures will be removed for age analysis. Dorsal spines will be taken from walleye, cleithra from northern pike, and otoliths from lake whitefish and yellow perch for age determination.

A sample of axial muscle (fillet) with skin attached weighing approximately 10-60 g will be removed from each large-bodied fish anterior to the caudal (tail) fin, wrapped in cling wrap, placed into a plastic bag, and frozen for later mercury analysis at a CALA-accredited analytical laboratory. Juvenile yellow perch will not be dissected in the field but will be placed individually into labeled mercury-free plastic bags and stored on ice before freezing. In the laboratory, perch will be partially thawed, measured (±1 mm fork length) and weighed (±0.1 g), all internal organs will be removed, and the head (dorso-ventral oblique cut to anterior of the pelvic girdle) and the tail (at the caudal peduncle) will also be collected. Otoliths will be taken for age determination of selected individuals from length-stratified groups. What remains of the fish, including skin and bones will be weighed (±0.01 g), wrapped in cling wrap, placed in a Ziploc® bag, and refrozen before submission to the analytical laboratory.

Total mercury analysis at the CALA-approved laboratory will be performed using internal protocols and procedures. The QA/QC program includes the analysis of different standard (certified) reference materials (SRMs with each sample run and the submission of duplicate samples to a second analytical laboratory to evaluate inter-laboratory differences).

8.0 REFERENCES

8.1 LITERATURE CITED

Abernethy, C.S., Amidan, B.G., and Cada, G.F. 2001. Laboratory studies of the effects ofpressure and dissolved gas supersaturation on turbine-passed fish. Report No.PNNL-13470 to the U.S. Department of Energy, Idaho operations Office.

Arntzen, E.V., Geist, D. R., Murray, K. J., Vavrinec, J., Dawley, E. M., and Schwartz, D. E. 2009. Influence of the hyporheic zone on supersaturated gas exposure to incubating chum salmon. North American Journal of Fisheries Management 29:1714-1727 pp.

Barth, C.C., Anderson, W.G., Henderson, L.M., and Peake, S.J. 2011. Home range size and seasonal movement of juvenile lake sturgeon in a large lake in the Hudson Bay drainage. Transactions of the American Fisheries Society. 140: 1629-1641.

Bouck, G. R. 1980. Etiology of gas bubble disease. Transactions of the American Fisheries Society 109:703-707 pp.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB. Updated to 2012

CCME. 2000. Canadian tissue residue guidelines for the protection of wildlife consumers of aquatic biota: methylmercury, 7 p.

DFO (Department of Fisheries and Oceans). 1995. Freshwater intake end-of-pipe fish screen guideline. 27 pp.

Environment Canada. 2002. Metal Mining EEM Guidance Document. (available at www.ec.gc.ca/eem/English/MetalMining/Guidance/default.cfm).

Environment Canada. 2011. 2011 Metal Mining Environmental Effects Monitoring (EEM) Technical Guidance Document. 83pp.

Health Canada. 2007. Human health risk assessment of mercury in fish and health benefits of fish consumption. Health Canada: Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch, Ottawa, Ont., 70 pp.

Health Canada. 2012. Guidelines for Canadian Drinking Water Quality—Summary Table. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. 22 p.

Jansen, W. and Strange, N. 2007. Mercury in fish from northern Manitoba reservoirs: results from 1999-2005 sampling and a summary of all monitoring data for 1970 2005. Report prepared by North/South Consultants for Manitoba Hydro, 102 pp.

Mason, J.C. and Phillips, A.C. 1986. An improved otter surface sampler. Fishery Bulletin, U.S. 84(2): 480-484.

Mota, J.P., Graveline, P.G., and Kroeker, K. 2000. Rat/Burntwood river system fish spawning investigations, 1999. ix-34 pp.

MWS (Manitoba Water Stewardship). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Water Science and Management Branch, MWS. MWS Report 2011-01, July 4, 2011. 68 p.

NSC (North/South Consultants Inc.) and Normandeau Associates Inc. 2007. Fish movements and turbine passage at selected Manitoba Hydro generating stations – 2005-2006 interim report. A report prepared for Manitoba Hydro by North/South Consultants Inc. and Normandeau Associates Inc.

NSC and Normandeau Associates Inc. 2009. Survival and movement of fish experimentally passed through a re-runnered turbine at the Kelsey Generating Station, 2008. A report prepared for Manitoba Hydro by North/South Consultants Inc. and Normandeau Associates Inc.

Pradel, R. 1996. Utilization of mark-recapture for the study of recruitment and population growth rate. Biometrics 52:703-709.

SPSS. 2003. SigmaStat 3.01. SPSS Inc., Chicago, Ill.

Strange, N.E. and Bodaly, R.A.. 1999. Mercury in fish in northern Manitoba reservoirs and associated waterbodies: results from 1998 sampling. Prepared for the Program for Monitoring of Mercury Concentrations in Fish in Northern Manitoba Reservoirs. 54 pp.

TCN (Tataskweyak Cree Nation) and Manitoba Hydro. 2009. TCN Adverse Effects Agreement. (available at www.hydro.mb.ca/projects/keeyask/tataskweyak/aea.pdf).

Wheatley, B. 1979. Methylmercury in Canada; Exposure of Indian and Inuit Residents to methylmercury in the Canadian Environment. Mercury Program Findings to December 31, 1978. Medical Services Branch, Health and Welfare Canada, Ottawa, Ont., 200 pp.

White, G.C. and Burnham, K.P. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46 Supplement: 120-138.

Wright, D.G. and Hopky, G.E. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2107. 15 pp. + 5 App.