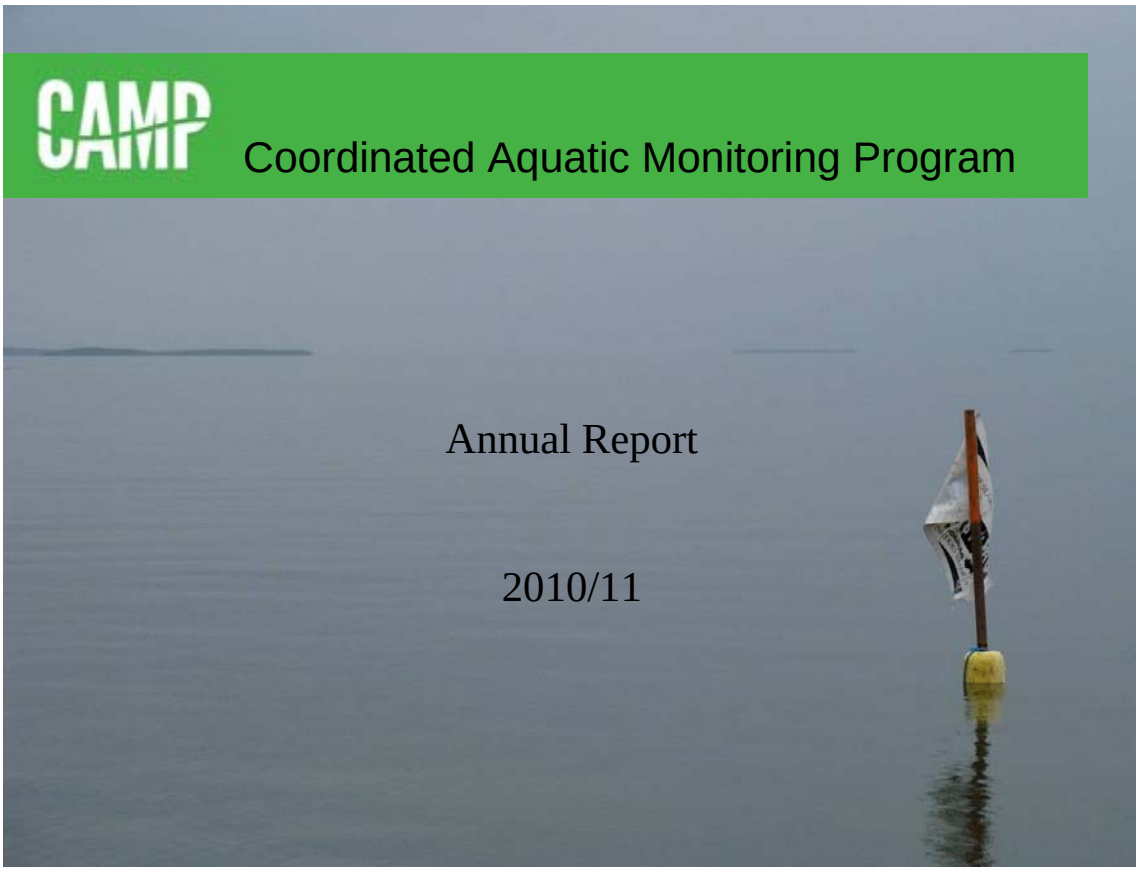

Annual Report

2010/11

Submitted to:
Minister of Water Stewardship
Minister of Conservation
President/CEO Manitoba Hydro

Submitted by:
MOU Working Group

April 2011

Background

According to the *"Memorandum of Understanding about Program of LWR/CRD Monitoring Activities, dated October 16, 2006"* between the Province of Manitoba and Manitoba Hydro (**Attachment 1**) a Coordinated Aquatic Monitoring Pilot Program (CAMPP) was developed and first implemented in 2008/09. This annual report summarizes the activities associated with the third year of the pilot program.

Meetings

The annual CAMPP Workshop was held in February 2010. The objective of this workshop was to review the status of the 2009/10 program activities and discuss/advise on the development of the 2010/11. A number of technical items that were proposed for implementation during the 2010/11 program were discussed as was the development of a reporting framework (**see Attachment 2)**. Approximately 30 attendees representing various provincial/federal agencies, University of Manitoba, external consultants and Manitoba Hydro participated in the event.

The Subcommittee met on March 25, 2010 to finalize the protocols for three new components to be added to the CAMPP (mercury in fish sampling, phytoplankton sampling and sediment quality sampling). Some minor revisions to the fish sampling protocol were made in order to simplify the assessment of deformities, erosion, lesions, and tumours (DELT) component. Short and long-term data management issues were discussed as well annual reporting via a website (**see Attachment 2**). The 2010/11 draft workplan/budget was presented and a draft agenda for the upcoming MOU Working Group meeting was prepared.

On April 27, 2010, a draft workplan for 2010/11 was presented to the MOU Working Group. Additional items that were presented and discussed included an update on community dialogue efforts, a proposed reporting framework and an update on data management efforts (**see Attachment 3**). No significant concerns or issues were raised by the Working Group members during the meeting and the 2010/11 workplan was subsequently endorsed by the group upon conclusion of a two week review period

Numerous smaller, issue-specific technical meetings and conversations between MH, MWS and NSC staff also occurred throughout 2010/11 to ensure a coordinated and consistent program.

Activity Summary

Field Program

Hydrometric – Hydrometric information associated with hydro developments on Manitoba's waterways is captured in an annual report prepared by MH, entitled: "*Water Power Act Licences Annual Water Levels and Flows Report 2010 Calendar Year*", (In Prep). Copies of this report will be forwarded to the Ministers of Water Stewardship and Conservation once completed.

To address CAMPP needs, a request was made to establish hydrometric gauges on the Hayes River, Leftrook Lake and the Manigotagan River. Manitoba Hydro Hydraulic Operations staff installed gauges on the Hayes River and Leftrook Lake in July 2010 (to be managed by MB Hydro). Water Survey of Canada re-established the hydrometric gauge on the Manigotagan River and will be responsible for managing that site.

Aquatic Habitat – Aquatic habitat (bathymetry and substrate) surveys were completed at the scheduled sites in 2010. These included Apussigamasi, Assean and Billard lakes as well as the eastern portion of Northern Indian Lake where CAMPP sampling occurs.

Water Quality - All scheduled water quality sampling was completed with one exception. One site on Lake Winnipegosis was not sampled in summer 2010 due to weather issues (i.e., issues associated with accessing the site).

Lower Trophic Level Biota - With one exception, all scheduled benthic invertebrate sampling was completed. The exception is the off-shore site on the Hayes River; sampling was attempted over a wide area but no suitable substrate for sampling could be located. It is anticipated that sampling will not be successful at this site in future years due to the presence of hard substrate. All scheduled phytoplankton sampling was completed in 2010/11, with the exception of the water quality site on Lake Winnipegosis that could be accessed in summer 2010.

Fish (small and large bodied) - All scheduled fish community sampling was conducted.

Mercury in Fish – All waterbodies scheduled for collection of fish muscle for analysis of mercury in 2010 were sampled. The full target sample size of fish for some species was not obtained at all sites. No or few lake whitefish and one-year old yellow perch were obtained from a number of lakes.

Community Consultations - Various community meetings/conversations were performed by MB Water Stewardship (see **Attachment 4**).

Reporting Framework – To address the annual data reporting needs and promote the program, development of a dedicated CAMPP website began in late 2010. An external website designer was hired to build a website, which is expected to reach completion and be launched sometime in mid-2011.

Emerging Issues

Data Management Strategy – Results of a Request for Information process indicated there were sufficient external interest and expertise to move ahead and develop a Request for Proposal. A draft RFP has been prepared, which will be finalized and issued sometime in spring 2011.

Attachment 1

Memorandum of Understanding

Memorandum of Understanding about Program of LWR/CRD Monitoring Activities, dated October 16 , 2006.

The Government of Manitoba and Manitoba Hydro are committed to work together on matters relating to monitoring of hydrometric (water level and stream flow) and environmental data in certain areas in the Lake Winnipeg Regulation and Churchill River Diversion system.

Manitoba and Manitoba Hydro have the common objective of developing a program of activities ("the activities"), building on the existing monitoring program of Manitoba Hydro, that would provide objective information about hydrometric and environmental effects of hydro-electric development on agreed rivers and lakes comprising the Lake Winnipeg Regulation and Churchill River Diversion systems ("the system"). The information from the activities could be of benefit to Manitoba, Manitoba Hydro and other interested parties, including communities in the area of the Lake Winnipeg Regulation/Churchill River Diversion project. Objectives of the program of activities would include:

(a) assisting in evaluating whether and to what extent the water regime in areas of the system is or will be affected by the addition of additional hydro-electric facilities;

(b) assisting in identifying adverse effects and positive effects resulting from effects on the water regime; and

(c) assisting in considering measures that may be undertaken to address any identified adverse effects.

Manitoba and Manitoba Hydro may establish additional objectives of the activities.

Manitoba and Manitoba Hydro recognize that Manitoba Hydro has made commitments to monitoring and follow up programs as part of the environmental licensing process for the Wuskwatim Generating Station. These commitments will be considered in developing the activities.

The program of activities will be reviewed each year and annual workplans will developed by Manitoba and Manitoba Hydro to assist in achieving the program of activities. The agreed workplan for the fiscal year ending March 31, 2007 is attached as Appendix A to this Memorandum.

Manitoba and Manitoba Hydro will consider methods of making information from the activities available to interested parties.

It is intended that the nature and scope of activities will be developed starting in Fiscal Year 2006-07 (starting April 1, 2006) and will continue until Manitoba and Manitoba Hydro agree to no longer proceed with a program of activities.

As part of the development of the annual program of activities, Manitoba and Manitoba Hydro will consider the resources each will provide in order to carry out the activities

It is intended that Manitoba and Manitoba Hydro personnel will prepare an Annual Report to be delivered to the Minister of Water Stewardship and the Minister of Conservation, on behalf of Manitoba and to the President and CEO of Manitoba Hydro. Additional reports may be prepared as Manitoba and Manitoba Hydro determine to be appropriate. The Annual Report may include:

- a description of the activities for that year;
- a description of any information determined as a result of the activities;
- information about any circumstances where water levels or flows were outside of ranges provided for in licences;
- methods of making the information available to interested parties and to the public;
- any other matters that are considered appropriate. It is expected that Manitoba and Manitoba Hydro will make the Annual Reports available to the public.

Manitoba and Manitoba Hydro may amend this Memorandum from time to time by further Memorandum.

for Manitoba

Oct. 16, 2006
Date

for Manitoba Hydro

06 09 06
Date

Attachment 2

Summary of 2010/11 CAMPP Meetings

Workshop - February 9, 2010

AGENDA

- Review outcomes of 2009/10 program.
- Present and discuss additional components to be implemented starting in 2010/11 program
- Discuss annual data reporting framework

Subcommittee Meeting - March 25, 2010

AGENDA

- Finalize Hg in fish, sediment quality and phytoplankton protocols
- Finalize Fish Community Protocol (DELT component)
- Short and long-term data management
- Annual Reporting (website format)

MOU Working Group Meeting – April 27, 2010

AGENDA

- Present and seek endorsement for the 2010/11 CAMPP workplan.
- Provide an update on system-wide community dialogue efforts.
- Present and discuss a proposed reporting framework.
- Provide an update on CAMPP data management efforts.

Attachment 3

Manitoba Water Stewardship (MWS)/ Manitoba Hydro (MH) MOU Working Group Meeting

Date: April 27, 2010
Time: 9:00 to !2:00
Location: Rm 402 – 3rd Floor, 360 Portage Ave

Agenda –

1. Overview of CAMPP (MH - Gary Swanson)

2. Review the 2009/10 Coordinated Aquatic Monitoring Pilot Program (CAMPP) that was implemented this past year (Discussion to be lead by MWS - Don Macdonald)
    a. including summary of the workshop on CAMPP held in February with MWS, MH, Environment Canada, Department of Fisheries & Oceans.

3. Overview of new components and implementation (Discussion to be lead by MH - Warren Coughlin)

4. Review and seek endorsement for the proposed 2010/11 CAMPP. (Discussion to be lead by MH - Warren Coughlin)

5. Update on the system-wide community dialogue. (Discussion to be lead by MWS - Don Macdonald)

6. Reporting Framework (Discussion to be lead by MH - Warren Coughlin)

7. Data Management (Discussion to be lead by MH - Gary Swanson)

8. Working Group Business

Attachment 4

Listing of CAMPP Community Discussions/Presentations 2010/11

Community/Resource Management Board (RMB) meetings attended by Don Macdonald:

March 26, 2010. Southern Indian Lake Environmental Monitoring Committee Technical Working Group.

May 7, 2010. Norway House Commercial Fisherman's Association AGM.

May 13, 2010. Southern Indian Lake Environmental Monitoring Steering Committee.

May 18, 2010. Fox Lake Resource Management Board.

Dec. 8, 2010. Norway House Resource Management Board.

MANITOBA / MANITOBA HYDRO
COORDINATED AQUATIC MONITORING

2010 / 2011 Pilot Program

1.0 INTRODUCTION

This document describes the third year (2010/2011) of the Government of Manitoba and Manitoba Hydro's long-term coordinated aquatic monitoring efforts, herein referred to as the Coordinated Aquatic Monitoring Pilot Program (CAMPP). CAMPP has been developed under a Memorandum of Understanding between Manitoba Hydro and Manitoba Water Stewardship (the "MOU") which summarizes and defines the need for coordinating aquatic monitoring to address the growing expectation from environmental regulators, local communities, and the general public for a program that facilitates monitoring and assessment of Manitoba Hydro's facilities. The 2010/2011 CAMPP was designed to document the environmental condition of waterways affected by Manitoba Hydro's hydroelectric generation system and facilitate better understanding of the environmental effects of hydroelectric development. A copy of the MOU is provided in Attachment 1.

The primary objectives of this long-term aquatic monitoring program are:

- To monitor and document the physical, chemical, and biological conditions of Manitoba Hydro's existing hydraulic system, in accordance with best management practices;
- To provide long-term information on key physical, chemical, and biological parameters that will enable assessment over time of environmental conditions with recognized environmental quality indices and guidelines; and
- To provide information that can be used for the licensing of future developments and re-licensing of existing developments and to assess potential impacts of the existing hydraulic system (it should be noted that given the broad geographic scale of the program, information collected will by necessity lack the intensive sampling rigor required to prepare comprehensive Environmental Impact Statements for new facilities).

The third year of the program is intended to build off of the second year and continue to test methodology in areas where either Manitoba Water Stewardship (MWS) or Manitoba Hydro (MH) are already conducting ongoing monitoring programs. A new component, mercury (Hg) in fish sampling, will be introduced to the program beginning in 2010/11. The addition of this component represents a continuation of the long-term Hg in fish program conducted by MB Hydro and includes some important methodological revisions to bring the protocol up to current scientifically acceptable standards. As CAMPP matures, MWS and MH will continue to present and communicate the program to First Nations and aboriginal communities along the system. Keeping communities informed through regular meetings will provide valuable opportunities to openly share information collected by the program and also encourage community feedback.

2.0 BACKGROUND

Over the last 35 years, numerous environmental studies and monitoring programs have been conducted by Manitoba, Manitoba Hydro, Fisheries and Oceans Canada (DFO) and Environment Canada (EC) on waterways affected by hydroelectric development in Manitoba. These studies have included:

- Post-project environmental monitoring programs to determine the effects of existing facilities;
- Environmental assessment studies to determine the potential effects of future hydroelectric developments;
- Issue- and site-specific environmental studies to address community concerns and/or formal obligations;
- Monitoring of intensively used fish stocks on the system, such as commercial fisheries;
- Ongoing monitoring of water quality;
- The collection of hydrometric data;
- Monitoring associated with the debris management program; and
- Research in areas such as reservoir greenhouse gases, marine mammals, mercury, and lake sturgeon.

The majority of Manitoba Hydro's studies and research conducted to date has been focused on the northern part of Manitoba Hydro's hydraulic system. These studies have been effective at meeting regulatory requirements and assessing impacts caused by Manitoba Hydro's facilities. The studies, however, have been largely issue-driven and site-specific, and have not been conducted in a comprehensive manner across Manitoba Hydro's hydraulic system primarily due to the varying regulatory requirements at the time of approval of each of the facilities and because greater emphasis has been placed on regions where communities are located.

At the same time, Manitoba Water Stewardship has also been collecting information within the regulated system for its own management needs. In some instances, this information has been collected more consistently, but due to limited resources these programs also contain gaps in terms of spatial scope and sampling intensity.

2.1 SCOPE OF AQUATIC MONITORING PROGRAM

The development of the coordinated program is guided by the premise that in order to maximize utility in a complex system "*…an effective monitoring plan uses the fewest key variables while retaining a sense of the whole and its complexity"* (Krawetz et al., 1987).

It is also understood that assessing aquatic ecosystem health requires an understanding of the interactions within an ecosystem, including energy transfer through the food web, as well as information on chemical and physical variables that define the habitat in which biota reside. To this end, and within the context of

determining the *"fewest key variables"*, CAMPP incorporates an ecosystem-based approach with sampling of key parameters at different trophic levels, as well as evaluation of water quality and physical habitat. The parameters selected are based on the "best advice" obtained from workshops held in November 2007, December 2008 and February 2010 that included representation from MWS, MH, DFO, University of Manitoba, EC and North/South Consultants Inc. To ensure appropriate coverage of Manitoba Hydro's hydraulic generation system, the CAMPP was divided into nine monitoring regions (Figure 1). Each monitoring region contains two or more annual and rotational sampling sites (Figure 2). Rotational sites within each region were selected to be sampled on a three year rotational period. A number of existing water quality monitoring sites maintained by MWS and EC are located in some of the nine monitoring regions. These monitoring sites are listed on Table 2 and presented on Figure 3.

The scope of CAMPP is as follows:

- The program monitors key physical, chemical, and biological parameters associated with waterways affected by Manitoba Hydro's hydraulic generation system, including the Churchill River Diversion/Lake Winnipeg Regulation, the Winnipeg River, and the Saskatchewan River.
- Parameters and sampling frequency have been selected to provide scientifically defensible monitoring information to meet scientific expectations and regulatory requirements within the limitations of what is technically feasible.
- Opportunities for local input, with respect to sampling site selection and other aspects of the program, will arise during community consultations that will be conducted prior to finalizing the program.
- Where established Agreements with First Nations or aboriginal communities for environmental monitoring already exist, the program will work within the framework of these existing Agreements as much as possible.
- Reporting under the MOU is expected to occur at two levels:
  (1) Annual reports describing the sampling program and summarizing the data collected; and
  (2) Periodic program reviews to determine if the program needs to be revised and to identify sites requiring more intensive sampling.

References:

Krawetz et al. 1987. A Framework for Effective Monitoring. Prepared for Canadian Environmental Assessment Research Council.

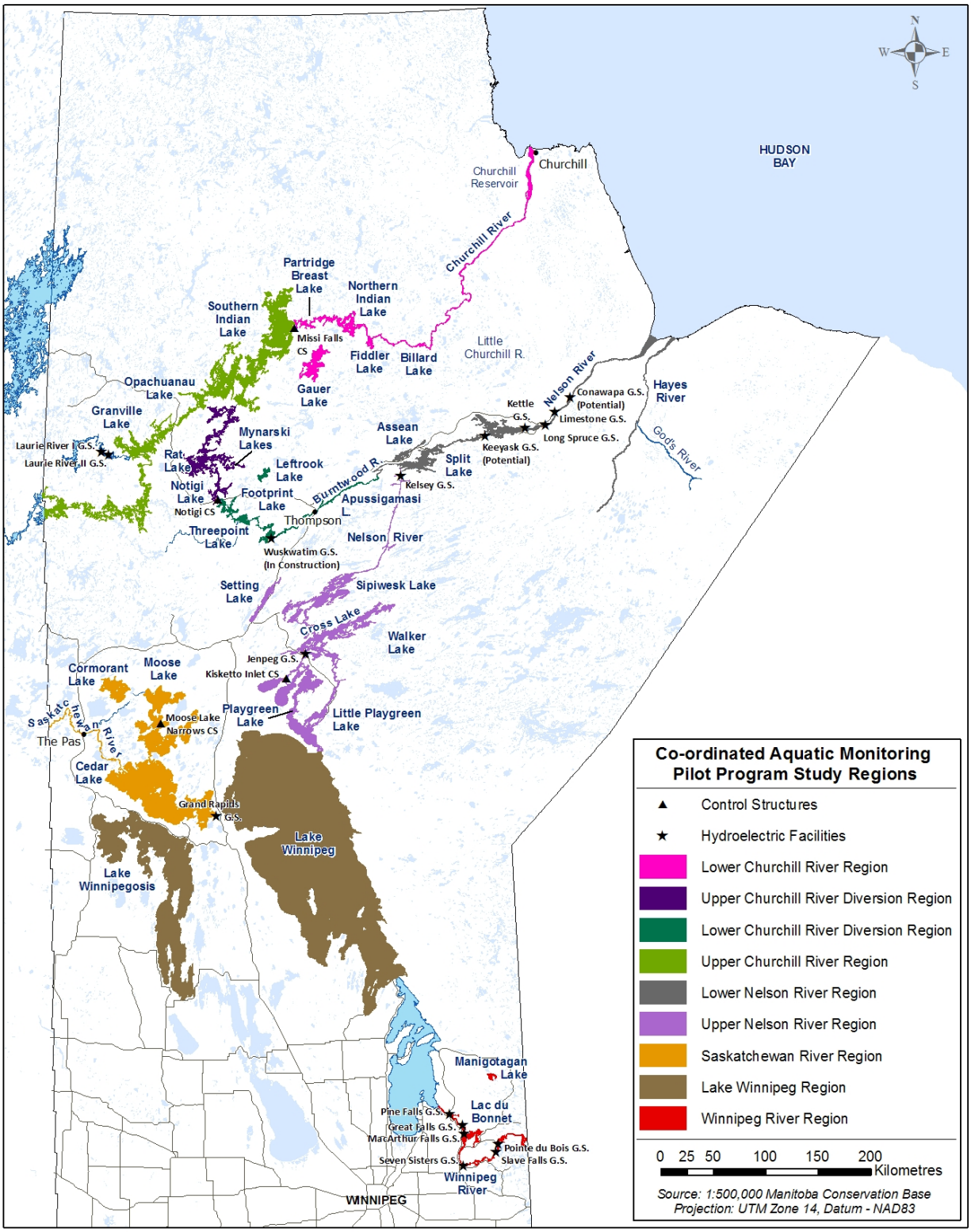

Figure 1: CAMPP Monitoring Regions.

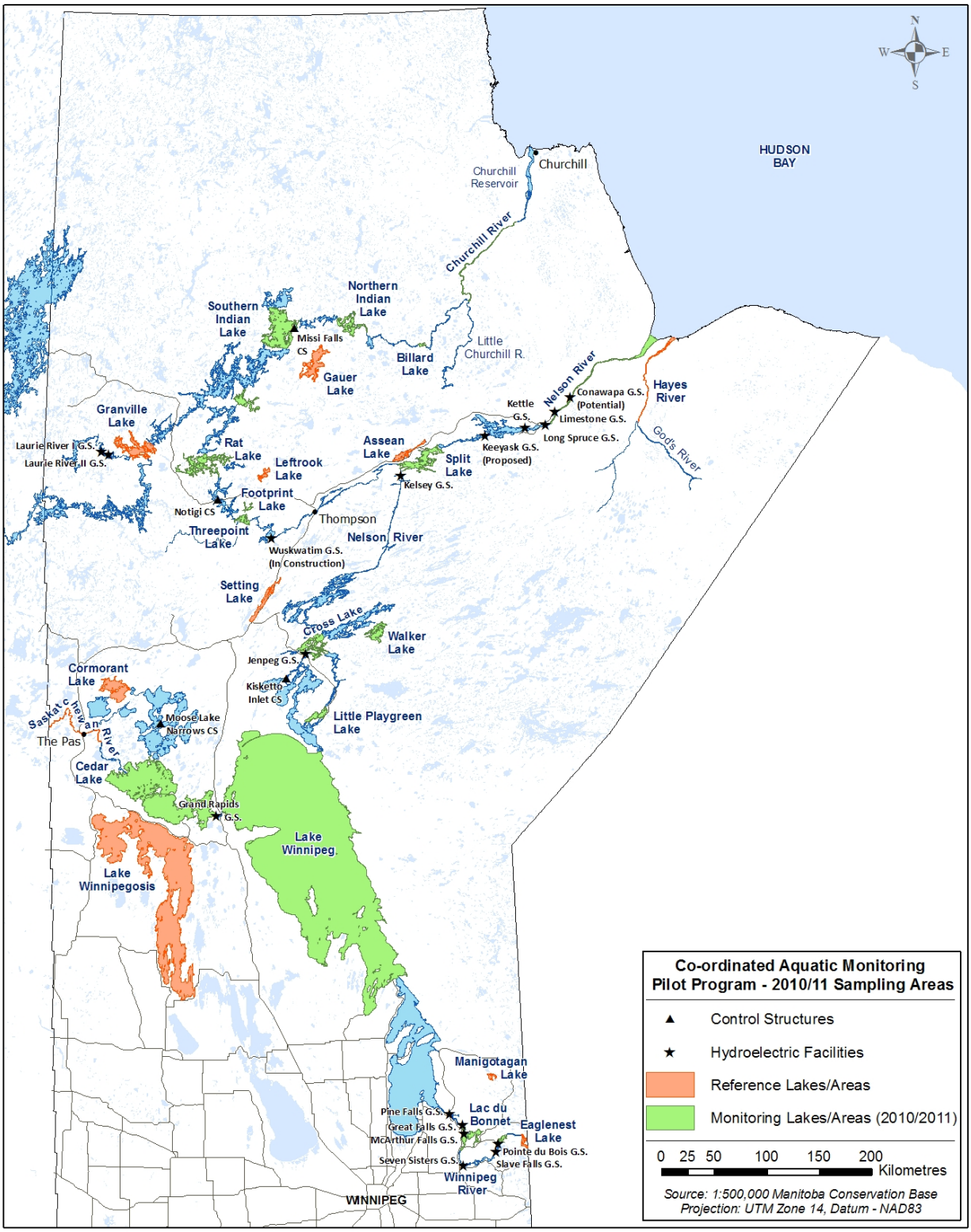

Figure 2: Waterbodies monitored under CAMPP in 2010/11.

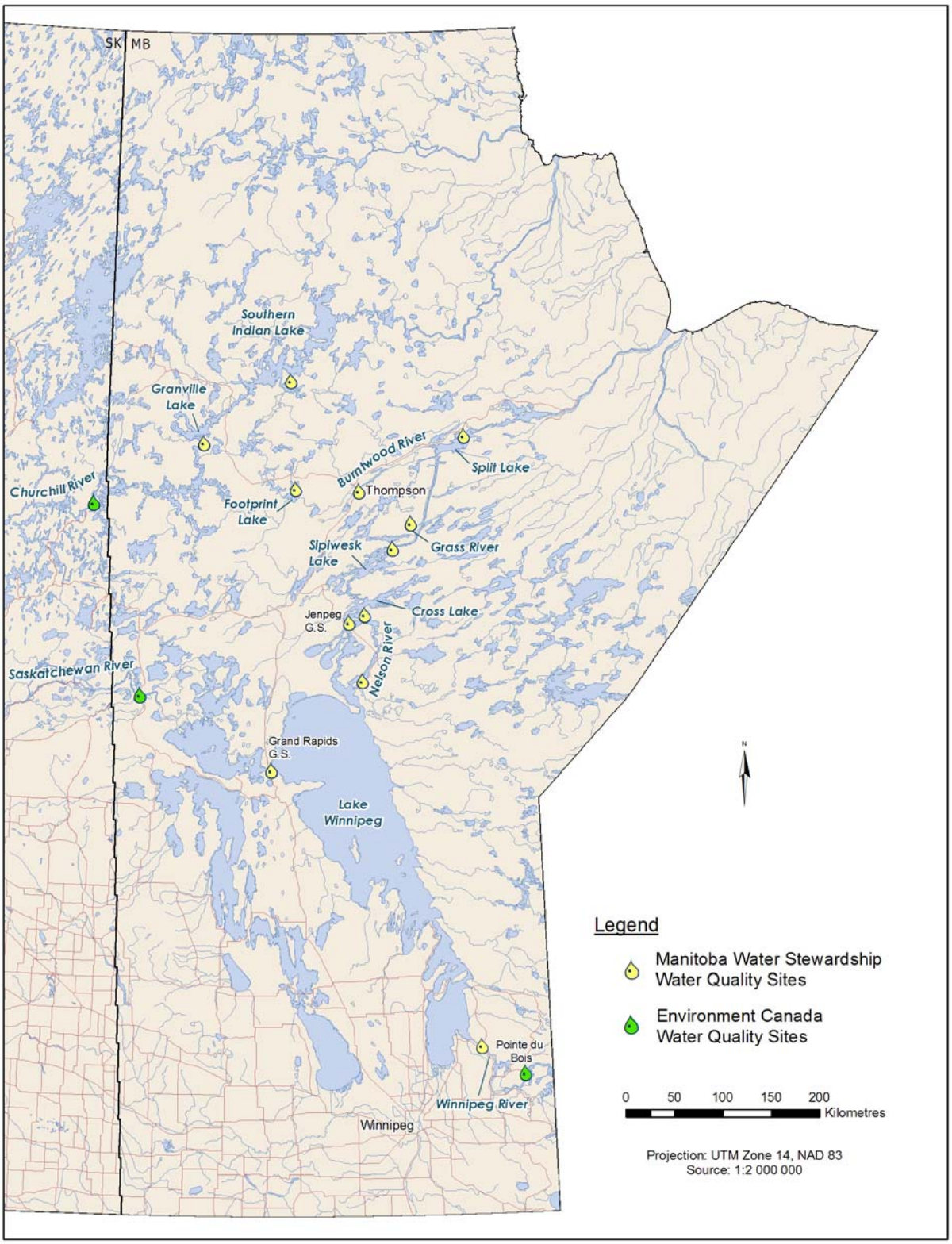

Figure 3: Existing Manitoba Water Stewardship and Environment Canada water quality sampling sites in the CAMPP regions.

Table 1. Waterbodies to be sampled in 2010/11 program by monitoring region.

Region/Waterbody	Type of Site	Rationale
Winnipeg River		
Lac du Bonnet	Annual	On-system site with an existing dataset.
Winnipeg River (u/s Pointe. du Bois)	Annual	On-system riverine stretch.
Manigotagan Lake	Annual	Reference waterbody.
Eaglenest Lake	Rotational	On-system lacustrine site.
Lake Winnipeg		
Lake Winnipeg (N basin)	Annual	On-system site. MB Water Stewardship partner. Confluence of multiple watersheds. High profile.
Lake Winnipegosis	Annual	Reference site. Hydrologically unimpacted with minimal WQ impacts.
Saskatchewan River		
Cedar Lake	Annual	On-system site. Most important lake in this region. Existing monitoring could be merged with CAMPP.
Cormorant Lake	Annual	Reference site unaffected by hydrologic changes.
Saskatchewan River	Rotational	On-system riverine stretch.
Upper Nelson River		
Cross Lake	Annual	On-system site with existing dataset and monitoring program (post-weir monitoring).
Setting Lake	Annual	Reference site with existing dataset and annual monitoring program.
Little Playgreen Lake	Rotational	On-system site with commercial fishery.
Walker Lake	Rotational	Reference site, unaffected by hydrologic changes
Lower Nelson River		
Split Lake	Annual	On-system site with an existing dataset.
Assean Lake	Annual	Reference site, unaffected by hydrologic changes.
Nelson River (d/s of Limestone GS)	Annual	On-system site with existing dataset. Significant hydrological effects.
Hayes River	Annual	Reference site, unaffected by hydrologic changes.
Limestone Forebay	Rotational	On-system lacustrine site.
Burntwood River @ inflow to Split Lake	Rotational	On-system riverine site.
Lower Churchill River		
Northern Indian Lake	Annual	On-system site with significant hydrologic effects.
Gauer Lake	Annual	Reference site, unaffected by hydrologic changes.
Churchill River @ Little Churchill River	Annual	On-system riverine site. Significant hydrologic effects.
Billard Lake	Rotational	On-system lacustrine site with significant hydrologic effects.

Table 1. Continued.

Upper Churchill River		
Southern Indian Lake (Area 4)	Annual	On-system site with existing dataset. Allows CAMPP to merge with portions of the SIL Env. Mon. Committee.
Granville Lake	Annual	Reference site, unaffected by CRD/LWR.
Southern Indian Lake (Area 6)	Rotational	On-system lacustrine site with commercial fishery.
Churchill River Diversion (lower)		
Threepoint Lake	Annual	On-system site with existing dataset.
Leftrook Lake	Annual	Reference site, unaffected by hydrologic changes and limited existing dataset.
Footprint Lake	Rotational	On-system lacustrine site.
Churchill River Diversion (upper)		
Rat Lake	Rotational	On-system lacustrine site.

Table 2. Manitoba Water Stewardship (MWS) and Environment Canada (EC) water quality monitoring sites affiliated with CAMPP watercourses and waterbodies.

Watercourse/Waterbody	Responsible Agency	Study Region
Burntwood River	MWS	Churchill River Diversion Region
Churchill River u/s Granville Lake	MWS	Churchill River Diversion Region
Churchill River below Wasawakasik Lake	EC	Churchill River Diversion Region
Cross Lake	MWS	Upper Nelson River Region
Footprint Lake	MWS	Churchill River Diversion Region
Grass River	MWS	N/A
Nelson River (Jenpeg)	MWS	Upper Nelson River Region
Nelson River (Norway House)	MWS	Upper Nelson River Region
Saskatchewan River (Grand Rapids)	MWS	Saskatchewan River Region
Saskatchewan River (above Carrot R.)	EC	Saskatchewan River Region
Sipiwesk Lake	MWS	Upper Nelson River Region
Split Lake (at community)	MWS	Mid/Lower Nelson River Region
Southern Indian Lake (at community)	MWS	Churchill River Diversion Region
Winnipeg River (Pine Falls)	MWS	Winnipeg River Region
Winnipeg River (Pointe du Bois)	EC	Winnipeg River Region

3.0 PARAMETERS AND PROTOCOLS

A significant portion of what was discussed in the development of CAMPP (i.e., bathymetry, portions of erosion sampling, cataloguing and categorizing components of the system and determining and cataloguing status/classification of shorelines as sources of sediment) is for the purposes of this document, considered "inventory". This information will augment the biological component of the "monitoring" program, but should only be acquired as under the auspices of a separate initiative or an *"as time and resources permits"* activity for which additional partners, such as other regulatory agencies, should be approached to participate. Erosion and sediment "monitoring" can also inform biological assessments but for now are considered over and above what is being assessed in this Program. Some thoughts on how these activities should link to aquatic ecosystem monitoring are included in Appendix 1.

3.1 AQUATIC HABITAT

Rationale:

- Components of CAMPP, such as the Benthic Invertebrates and Fish Communities, are habitat based and therefore require an understanding of habitat types and distribution within the study lakes. Since habitat information (i.e., depth, substrate types and aquatic plant communities) is currently lacking for a number of CAMPP lakes a bathymetry and habitat mapping program will be initiated in 2010/2011. Lakes that have been selected for surveying in 2010/2011 include Apussigamasi, Assean, and Billard lakes and the portion of Northern Indian Lake where CAMPP sampling is occurring.

Sampling Standards / Protocols:

- Habitat maps (i.e. substratum and depth) will be developed by means of acoustic bottom typing and benthic validation. Bottom typing and depth data will be collected using single vertical beam echo sounder manufactured by Quester Tangent Corporation. Survey-grade echo-sounders will be used with real time differentially corrected GPS (DGPS). Where feasible the survey boat will navigate along a pre-determined survey course. Data collection will be conducted using a stratified approach where areas of greater habitat complexity receive more effort than more simple areas. For the purposes of CAMPP it will be assumed that the elevation of the water surface observed during survey is equal to the elevation observed in the federal shoreline mapping product.
- A host of additional "metadata" parameters will be collected from all CAMPP waterbodies surveyed in the 2010/11 field program (*i.e.*, site characteristics, time, and weather). These "habitat" parameters are collected each time a site is sampled and as such are appropriately considered part of the "monitoring" program. The details of the metadata collected for each component of the program are described in the relevant appendices. Specific attention will be paid to the use of standard methods for determining GPS locations and for the development of standards for sampling site GIS referenced digital photography.

3.2 WATER QUALITY

Parameters:

- All water quality parameters to be assessed are listed in Appendix 2.

Sampling Standards / Protocols:

- The establishment of a water quality collection initiative for the purposes of CAMPP will ensure data collection standards and quality are maintained.
- Water quality samples collected will adhere to the standards outlined in Appendix 2 and will, generally, be surface grabs (*i.e.,* samples collected directly into sample bottles just below the surface of the water) with two exceptions. Samples will be submitted to an accredited analytical laboratory for analysis of the designated water quality parameters.
    - If the water at the site is determined to be stratified, samples will also be collected from the bottom of the water column using a Kemmerer sampler.
    - Chlorophyll *a*, *Microcystin*, and phytoplankton samples will be collected from a composite sample taken from the euphotic zone (*i.e*., defined as two times the Secchi depth) at lake sites in the open-water season (sampling for all variables for laboratory analysis would be restricted to grab samples at river sites where high velocities prevent accurate measurement of Secchi disk depths).
    - In winter, all sampling will be conducted as surface grabs due to the presence of ice cover.
- Depth profiles will be obtained at each site for *in situ* variables (dissolved oxygen, temperature, turbidity, pH, and conductivity) where conditions are conducive (*i.e*., where velocities and/or depth are not limiting factors). In large rivers, velocities are often too high to obtain measurements at depth; where this occurs measurements will be restricted to the surface.
- Secchi disk depths will be measured at lake sampling sites and at river sites where conditions are suitable (i.e., where velocities are sufficiently low) in the open-water season.

Annual / Rotational Sample Site Considerations:

- A core set of annual monitoring sites would include collecting samples from a minimum of one reference site and one affected site within each monitoring region (Table 1 and Figure 2). Sites will be sampled 3 times per year under ice-free conditions and once during ice-covered conditions (winter). Sites were selected in consideration of availability of existing or historical water quality sites monitored by MWS, EC, Manitoba Hydro, or other agencies, as well as bathymetry (where available) and the presence of tributary influences. Where there are no existing or historical sites, or where existing or historical sites were deemed to be unsuitable for the purposes of the CAMPP program, sites have been selected mid-basin (i.e., at or near the deepest are of the lake) or mid-stream and/or in consideration of site-specific conditions and sampling areas for the biological components.

Analytical Considerations:

- All water quality samples collected are to be submitted to and analyzed at a Canadian Association for Laboratory Accreditations, Inc. (CALA) accredited laboratory.
- Duplicate samples collected on Lake Winnipeg and elsewhere, and submitted to different CALA accredited laboratories will serve to advise CAMPP with respect to any institutional differences in analyses.
- CAMPP will be subject to pre-defined quality assurance/quality control (QA/QC) criteria (Appendix 2), to minimize sample contamination, as well as issues pertaining to sample handling and transport. Typical QA/QC approaches for water quality monitoring programs include the submission of field blanks, trip blanks, and sample replication. In addition, duplicate samples will be collected and submitted to different laboratories for an inter-laboratory comparison. This practice, often done during the initial stages of a program until data quality has been assured to evaluate the comparability of data, is particularly relevant where different analytical laboratories are used over the course of a sampling program.
- An allocation of approximately 10% of the analytical budget will be assigned to assure QA/QC for CAMPP. In this Pilot year, and in the early subsequent years of CAMPP, greater financial resources may be directed QA/QC, but once confidence in the quality of the data is determined, this contribution will decrease.
- While CAMPP water quality data will be collected and retained by both MWS and Manitoba Hydro, the intent is to transfer all information for storage in the Province of Manitoba's Environmental Management System (EMS).

Preliminary Qualitative Review:

Water quality data from a small set of representative high frequency water quality monitoring sites that are maintained by MWS (Nelson River at Jenpeg and the Winnipeg River at Pine Falls) and Environment Canada (Winnipeg River at Pointe du Bois) were qualitatively evaluated to assess the adequacy of timing and frequency of sampling conducted in the open-water season under CAMPP. This was done through an evaluation of the potential seasonality of key water quality parameters measured at these sites with the available data record. It was concluded that the sampling frequency employed for CAMPP was adequate based on this qualitative exercise.

3.3 SEDIMENT QUALITY

The sediment quality monitoring program is planned to be initiated in 2011/12 and would include sampling at annual CAMPP monitoring sites. However, a pilot sampling program will be conducted in 2010/11 at two locations to determine if the proposed sampling approach is logistically feasible. The following provides a brief description of the sediment quality program.

Parameters:

- All sediment quality parameters to be analysed are listed in Appendix 3.

Sampling Standards / Protocols:

- Sediment quality sampling will adhere to the standards outlined in Appendix 3.
- In brief, triplicate samples will be collected at each monitoring site and the upper 5 cm of sediment will be submitted for analysis. Sites will be located at or near water quality monitoring sites.
- Sampling will be conducted during the water quality monitoring program where logistically feasible (lake/reservoir sites). River sites will be sampled during the benthic invertebrate or fish monitoring programs.
- Sites will be sampled once per monitoring year.
- Sediment quality will be measured at a minimum of one reference site and one on-system site within each monitoring region, with the exception of the Upper Churchill River Diversion Region where no sampling will be conducted.

Analytical Considerations:

- All sediment quality samples collected are to be submitted to and analyzed at a CALA accredited laboratory.
- Duplicate samples collected on Lake Winnipeg and elsewhere, and submitted to different CALA accredited laboratories will serve to advise CAMPP with respect to any institutional differences in analyses.
- CAMPP will be subject to pre-defined QA/QC criteria (Appendix 3), to minimize sample contamination, as well as issues pertaining to sample handling and transport. Typical QA/QC approaches for sediment quality monitoring programs will be applied as described in Appendix 3.
- While CAMPP sediment quality data will be collected and retained by both MWS and Manitoba Hydro, the intent is to transfer all information for storage in the Province of Manitoba's EMS.

3.4 PHYTOPLANKTON

Parameters:

The phytoplankton monitoring program consists of:

- Chlorophyll *a* Monitoring: this component is incorporated directly into the water quality sampling program. Sampling is conducted at all sites and sampling times.

- Phytoplankton Bloom Monitoring: Samples across the euphotic zone are collected at all water quality sampling sites in the open-water season concurrent with the water quality sampling. Where concentrations of chlorophyll *a* are equal to or greater than 10 µg/L at a site, the phytoplankton samples are submitted to ALS Laboratories (Winnipeg, MB) for analysis of *Microcystin* and phytoplankton taxonomic identification and enumeration.
- Phytoplankton Community Composition Monitoring: samples will be collected at each water quality sampling site during each sampling period in the open-water season and submitted for taxonomic identification and enumeration on a 3-year rotational basis. Analysis of annual monitoring sites was undertaken in 2009/10; therefore, only rotational waterbodies/areas will be analysed in 2010/11. In addition, two on-system and two reference sites will be sampled annually to provide more comprehensive monitoring.

Sampling Standards / Protocols:

In Year 1 (2008/2009), two chlorophyll *a* samples were submitted to a CALA accredited laboratory for analysis during all four sampling events: a surface grab sample; and a composite sample of water taken from the euphotic zone (estimated as two times the Secchi disk depth). Data collected using both methods were compared for the open-water seasons of 2008 and 2009 to determine which sampling method was most appropriate. The results indicated that chlorophyll *a* concentrations were similar in the grab and euphotic zone samples. Beginning with the 20l0/11 sampling year, chlorophyll *a* samples will only be collected from the euphotic zone (concurrent with collection of samples for taxonomy and *Microcystin* analysis) where euphotic zone depths can be accurately determined (i.e., where velocities are conducive).

Samples for analysis of *Microcystin* and phytoplankton community composition will be collected at each site but will only be submitted for analysis where the chlorophyll *a* concentration is ≥ 10 µg/L. Where the secchi depth is difficult to estimate, therefore compromising the accuracy by which the euphotic zone is determined, *Microcystin* and phytoplankton samples will be collected as surface grabs (i.e., at river sites where velocities preclude measurement of Secchi disk depth).

Annual / Rotational Sample Site Considerations:

- Chlorophyll *a* will be assessed at each site concurrent with the collection of samples for analysis of water chemistry.
- Samples for algae community composition and *Microcystin* will be collected at each monitoring site in parallel with all water quality sampling and retained until preliminary results of chlorophyll *a* concentrations are received. Where chlorophyll *a* concentrations exceed 10 µg/L, *Microcystin* and phytoplankton samples will be submitted to an accredited laboratory for analysis.

Analytical Considerations:

- Standardized protocols allow for comparison with existing provincial and federal programs.

- Owing to the various methods used for the analysis of chlorophyll *a,* prior to combining datasets, differences will need to be identified.
- While data will be collected and retained by both parties, the intent is to provide all chlorophyll *a* and phytoplankton data obtained through CAMPP to MWS for storage in the Environmental Management System (EMS).

3.5 BENTHIC INVERTEBRATES

Rationale:

- Benthic invertebrates (sediment-dwelling) are included in the pilot program as they are standard indicators of ecological integrity used in biomonitoring programs worldwide. Similar to most biological indicators, benthic invertebrate community metrics (i.e., indices) are particularly valuable as they integrate environmental conditions over time. Finally, aquatic macroinvertebrates are an important food source for fish and integral in describing the quality of fish habitat available for key life stages.
- Benthic invertebrates will be sampled to provide a replicable, habitat-based, quantitative description of the benthic macroinvertebrates communities in terms of abundance, taxonomic composition, and distribution.

Parameters:

- For the majority of the CAMPP sampling areas (reservoirs/lakes and rivers), the benthic community are sampled using an Ekman or petite Ponar grab sampler (opening = 0.023m^2) depending on substrate type and compaction.
- For the northern river sampling areas, the benthic community are sampled using artificial substrate samplers (rock baskets) in areas of hard substrate habitat[1] (i.e., bedrock and boulder), or a Petite Ponar grab (opening = 0.023 m^2) in soft and medium substrate habitat[2] (i.e., gravel, sand, silt, and mud). The sampling method employed reflects the predominant conditions in the reach of interest. In all situations, the method of sampling at both the reference and affected sites would be the same.
- Depending on substrate type and compaction, some locations classified as reservoir/lake sites require deployment of both Ekman and petite Ponar grabs.

[1] Sampling methods suitable for hard substrata in stream environments (*i.e.*, Hess samplers) are not suitable for the large river habitat of interest in this program.

[2] The lower Nelson River is predominantly hard substrate and sampling will be primarily based on the use of artificial substrate samplers. For this reason it was decided that the two other northern river sites (Hayes and Churchill) would be sampled using the same method. Note: the Winnipeg River and Saskatchewan River consist of substrate that is suitable for a petite Ponar grab sampler.

- Benthic invertebrate communities in lake/reservoir and riverine environments will be described based on a variety of metrics related to community composition and abundance. Suggested metrics include:
    - Abundance of major groups (*i.e.*, Amphipoda, Oligochaeta, Chironomidae, Ephemeroptera, Trichoptera, Pisidiidae, Gastropoda, and Plecoptera);
    - Total number of taxa
    - Taxonomic analysis: Order-level: Oligochaeta, Hirudinea, Ostracoda, Conchostraca, Mysidacea, Platyhelminthes, Hydrozoa; Family-level: Arachnida, Amphipoda, Bivalva, Gastropoda, and Insecta; Chironomidae to Sub-family-level; and Genus-specific analysis of Ephemeroptera since this group appear to be sensitive to changes caused by hydroelectric development;
    - Percent of Ephemeroptera, Plecoptera, and Trichoptera taxa (EPT Index);
    - Ratio of EPT taxa to chironomid abundance;
    - Percentage of samples with only oligochaetes and chironomids
    - Percentage of samples with no aquatic invertebrates
    - Taxa richness (Family-level)
    - Bray-Curtis Index
    - Simpson's Diversity index

Sampling Standards / Protocols:

- The benthic community is sampled during late summer/fall in northern areas (later in southern areas) to coincide with the completion of reproduction and emergence of most aquatic insects. Sampling during this time period assures that the larval forms of benthic populations are comparable between years.
- In 2008/09 and 2009/10, sampling at lake/reservoir environments was conducted at pre-determined randomly selected locations within pre-determined polygons (see Appendix 3 for additional details):
    - Polygons were situated to represent the predominant habitats in the offshore and nearshore (defined as the area bounded by the lowest typical water elevation to depths defined by the lower extent of the littoral zone and/or a clear site-specific demarcation between "nearshore" and "offshore" *i.e.*, change in substratum/gradient of lake bottom).
    - Polygons were positioned away from the immediate influence of any inflows and outflows, or any other features that may cause localized effects (*i.e.*, proximity to cottages, heavy boat traffic).

  - Polygons were at least 1 ha in size and large enough to allow 20-30 m between randomly located samples (as per guidance provided for representative sampling in Environment Canada, 2005).

- Detailed field protocols for the collection of benthic invertebrate and sediment are provided in Appendix 3.
- Artificial substrate samplers in the northern riverine environments are placed along a transect of various depths to sample both shallow and deeper environments. The locations and positioning of samplers are affected by practical limits imposed by site-specific characteristics (*i.e.*, samplers must be positioned so that they will not be lost in high river flows or present navigational hazards). A detailed field protocol for deployment and retrieval are provided in Appendix 3.
- Limitations of the current study design were identified during the power analysis conducted on the 2008 benthic invertebrate data sets (draft version: *Benthic Macroinvertebrate Baseline Data: Power Analysis Report 2008 [Year I]* 2010) during the preliminary analysis of a sample dataset (2008 Cross Lake data). Based on the analyses, modifications to the lake/reservoir and riverine study design have been proposed for the 2010/11 field program in order to minimize the inherent variability within the benthic invertebrate data. These modifications would increase the statistical power of the data, but would not increase sampling effort or analytical costs. The proposed new study design for near and offshore sampling within CAMPP lakes and rivers gives consideration to DFO protocols, Ontario's Benthos Biomonitoring Network (OBBN), Environment Canada's Canadian Aquatic Biomonitoring Network (CABIN) and EEM programs. In general, this would involve, using a travelling-kick-sweep approach for shallow nearshore sampling targeting depths of ≤ 1 m; and using a Ponar or Ekman grab sampler for offshore sampling targeting water depths of >5-10 m with homogeneous substrate. This study design modification would potentially eliminate the use of artificial substrate samplers in the three northern riverine areas. The specific modified sampling protocol is under development.

Annual / Rotational Sample Site Considerations:

- Mixture of both reservoir/lake and riverine sites.
- It is expected that the benthic invertebrate community will be sampled in relatively the same locations where basic limnology and fish community information is being obtained.

Analytical Considerations:

- Invertebrates will be sieved from the organic matrix using a 500 µm sieve.
- All organisms will be identified to major group (Subclass, Order, and Family); Ephemeroptera will be identified to Genus.
- A reference collection of macroinvertebrates will be maintained to ensure taxonomic consistency throughout the Program duration.

- The use of reference sites will provide the opportunity for comparison between impacted and unaffected sites within regions. It is recognized, however, that far more reference sites are required to develop a model for application of the Reference Condition Approach (RCA) (Bailey et al., 2004).
- Initial data storage at NSC as per Fisheries data statements that follow.

References:

Bailey, R. C., R. H. Norris, and T. B. Reynoldson. 2004. Bioassessment of Freshwater Ecosystems Using the Reference Condition Approach. Springer Science + Business Media, Inc. 170 pp.

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Environment Canada. 2005. Environmental Effects Monitoring Guidelines for Pulp and Paper. Environment Canada, Gatineau, QC.

Jones, C., K.M. Somers, B. Craig, and T.B. Reynoldson. 2007. Ontario Benthos Biomonitoring Network: Protocol Manual. Ontario Ministry of the Environment (Dorset, ON); Environment Canada: EMAN Coordinating Office (Burlington, ON); and Acadia Centre for Estuarine Research (Wolfville, NS). Available online: http://www.svca.on.ca/download/benthos/2009/OBBN%20Protocol%20Manual.pdf

Rosenberg, D.M., I.J. Davies, D.G. Cobb, and A.P. Wiens. Protocols for measuring biodiversity: benthic macroinvertebrates in fresh waters. Department of Fisheries and Oceans, Freshwater Institute, 501 University Crescent, Winnipeg, MB, R3T 2N6. Available online: http://www.eman-rese.ca/eman/ecotools/protocols/freshwater/benthics/benthic_fresh_e.pdf

3.6 FISH COMMUNITY

Parameters:

- Large Bodied Fish Community: primarily focused on fish community composition and relative abundance; secondary focus is population parameters for specific species (i.e. walleye, sauger, whitefish and/or pike).
- Small/Forage Fish: focus is exclusively community composition and relative abundance.

Sampling Standards / Protocols:

- Sampled with standard gangs of index gill nets and ‘small mesh ‘Swedish’ gangs as described in Appendix 5.
- The site selection and sampling protocol is described in Appendix 6.
- In the initial years of CAMPP, it would be desirable to conduct power analysis for the appropriate number of sets for a given waterbody by significantly oversampling that waterbody. There may

be advantages to doing this on both a northern and a southern waterbody. As a trial, a power analysis was conducted on historical data from Cross Lake in 2009/2010.

- Sampling will occur throughout the open-water season, outside of both the spring and fall spawning periods. Timing for each waterbody would be consistent annually (i.e., Setting Lake in mid July every year).
- CAMPP is primarily a fish community/relative abundance monitoring program. Individual metrics will only be collected from fish species where there are specific management objectives for that species on that waterbody. Fisheries management objectives are identified by Fisheries Branch and are included in Appendix 6 (Table 6-1).
- Individual metrics will be recorded for all target species (walleye/sauger, pike, whitefish, white sucker) and for all sturgeon captured in the large mesh index gill nets. Other species will be enumerated and bulk weighed by species and mesh size. All fish captured in small mesh nets will be enumerated and bulk weighed by species.
- All walleye, pike, sauger, sturgeon and white sucker caught in the large mesh index gill nets will be individually examined for DELTs (external Deformities, Erosions, Lesions or Tumours).

Analytical Considerations:

- Need to develop indices with broadest possible applicability to compare "health".
- Data storage - MWS is pursuing new data storage/analysis tools. In the interim, data will be stored by those collecting it, and data files shared.

3.7 FISH MERCURY

The primary objective of the fish mercury sampling program is to support a description of the aquatic ecosystem health and to provide information regarding the usability of fish by humans. Data will be compared to the Health Canada (2009) and Manitoba guidelines (Williamson 2002) for mercury in fish for the protection of human consumers. Sampling will be conducted during the conduct of the fish community monitoring field sampling programs.

Sampling Standards / Protocols:

Thirty-six northern pike, lake whitefish, and walleye and 25 one year old yellow perch will be collected at selected waterbodies for analysis of mercury in muscle A summary of the mercury program sampling standards and protocols are provided in Appendix 7. A detailed protocol currently being finalized will provide additional information on sampling, handling, storage and shipping of samples. It will also elaborate on procedures specific to sampling in remote locations.

Analytical Considerations:

- Standardized protocols allow for comparison with existing databases and guidelines.

- Data will be collected by both parties, but all samples will be shipped to a central location (NSC) prior to submission to analytical labs.
- All mercury analyses will be conduced at a CALA accredited analytical laboratory.
- The QA/QC program includes submission of duplicate samples to a second analytical laboratory to evaluate interlaboratory differences.

APPENDICES

Appendix 1

Additional Program Context:

Fish Habitat Inventory:

The most direct impact of modifying the water flow regime will be to the physical habitat within Manitoba Hydro's system. Inventorying (i.e., benchmarking) and cataloguing the current configurations of aquatic habitat within Manitoba Hydro's system is therefore of obvious interest with respect to accurately assessing the impacts of water flow manipulations on the Province's aquatic ecosystems. Monitoring aspects of physical habitat change over time also brings additional resolution when assigning cause and effects.

Consequently, bathymetry and fish habitat characterization and cataloguing of different fish habitat types is required as the basis upon which to assess the status or health of the aquatic ecosystem. While system wide monitoring of aquatic ecosystem parameters can provide a sense of change over time, a fish habitat inventory would serve to assist with system stratification and meaningful comparisons and ultimately more accurate statements about the state of the ecosystem.

Appendix 2

Water Quality Sampling Standard:

Sampling sites will be accessed by float plane or boat in the open-water season and by float-plane or helicopter in winter. In winter, samples will be taken through a 10-inch hole drilled in the ice using a gas-powered auger. Water depth measurements will be made using a weighted, metered rope (accurate within ± 0.1 m) or a depth sounder, and ice thickness will be measured using a metering stick. All samples will be collected in 'offshore' areas (i.e., near the centre of the river channel or deeper area of a lake).

Metadata associated with sample sites include:

- Sampling site GPS coordinates (UTM, NAD 83, and UTM Zone -14 or 15);
- Depth of water column;
- *In situ* water quality meter used;
- Water quality sampling equipment;
- Ice depth;
- Depth at which samples were taken;,
- Secchi disk depth;
- Type of sample (*i.e*., grab, composite);
- Site conditions and observations;
- Where sampled from (*i.e.,* boat, shore, float plane);
- Site access (*i.e*., helicopter, snowmobile); and
- Pictures – taken from the sample site looking N – S – E – W using a Ricoh© Caplio 500 SE GPS digital camera

***In Situ* Measurements**

In situ parameters (pH, temperature, conductivity, DO, and turbidity) will be recorded using a Eureka© Manta Water Quality multi-probe at 1-m depth intervals. Where the depth of the water column exceeds 20 metres, *in situ* measurements will be taken at 2.0 m intervals below 20.0 metres until the bottom of the site is reached and/or the length of the meter chord is reached.

Secchi disk depth will be measured as the average of two measurements: the depth at which a black and white disk lowered into the water from the shady side of the boat is no longer visible; and the depth at which the disk re-appeared when raised from the water column.

Surface Sample Collection

In the open-water seasons, surface grab samples are to be collected for submission by directly filling the sample bottles provided by the analytical laboratory at a depth of approximately 30 cm. With one exception, the collection procedure will entail the submergence of sample bottles (with the cap on) provided by the analytical laboratory, directly into the surface water to approximately elbow depth (approximately 30 cm below the surface), removing the cap, allowing the bottle to fill, and retrieving the bottle to the surface. Samples for analysis of *E. coli* will be collected in a secondary vessel and then transferred to the laboratory-supplied sample bottle to avoid loss of pre-added preservatives. Under ice-

cover conditions, 'surface' grabs will be obtained through the deployment of a Kemmerer water sampler below the ice with the sample bottles then filled at the surface. All samples will be submitted to a CAEAL accredited laboratory for analysis

Discrete Depth Sample Collection

In certain circumstances, water samples will need to be collected at discrete depths. For example, at sites where stratification has been determined based on a difference in temperature of 1.0 degree Celsius across 1 m of water when obtaining the *in situ* profile, water samples will be collected from the bottom of the water column. Discrete depth samples are to be collected at a depth of approximately 1 m above the sediments by lowering a Kemmerer sampler to the desired depth, triggering the instrument, and retrieving the sample to the surface. Sample bottles provided by the analytical laboratory will then be filled and processed as required. The suite of parameters to be measured from the water retrieved at the bottom of the column is similar to those analyzed at the surface, with the exception that chlorophyll *a* and *E. coli* are excluded.

Sample Handling and Transport

Upon collection, preservatives will be added to samples as required (mercury, metals), as indicated by the analytical laboratory, and the sample bottles are then to be capped and mixed. Where samples are required to be filtered prior to analysis, these procedures will be completed by the laboratory. Samples will be kept cool and in the dark and shipped for analysis as soon as possible following sample collection.

Laboratory Methods

Samples will be submitted to a CALA accredited laboratory for analysis. All analyses will be performed using standard methods and laboratory QA/QC procedures.

Field QA/QC Samples

The water quality sampling program will incorporate several QA/QC procedures, including collection of triplicate samples, field blanks, trip blanks, interlaboratory comparison samples, and samples for laboratory analysis of dissolved oxygen, pH, conductivity, and turbidity for verification of field measurements.

- **Triplicate Samples -** Triplicate samples will be collected at three randomly selected sites during each sampling period. Each sampling team (MWS, NSC) will be responsible for collecting these samples on each of their field expeditions.

- **Field Blanks** – A minimum of one field blank is to be submitted to the analytical laboratory during each sampling period. Field blanks are to prepared by filling one set of sample bottles provided by the analytical laboratory with deionized water (also provided by the analytical laboratory) in the field

and treating the blanks in exactly the same manner as actual samples. Field blanks will be stored and transported with field samples.

- **Trip Blanks** – A minimum of one trip blank will be submitted to the analytical laboratory during each sampling period. Trip blanks are prepared at the analytical laboratory prior to departure for the field program. A full set of sample bottles are to be filled at the laboratory with deionized water and preservatives (where appropriate). Trip blanks are transported to the field site and submitted to the analytical laboratory, using the same handling and transport protocols as for actual samples but the bottles are not opened at any point in the field and thus not exposed to the environment. Trip blanks were treated similarly to field blanks**.**

- **Dissolved Oxygen pH, Conductivity and Turbidity QA/QC Samples** – A minimum of two samples of surface water will be collected for analysis at the laboratory during each sampling period. These samples are intended to provide QA/QC respecting the accuracy of the field DO measurements.

- **Interlaboratory Comparison** - During each sampling period two sets of samples are taken in quick succession at one of the water quality sites. One set of samples are submitted to each of two CAEAL accredited laboratories for comparison of analytical results obtained.

Table 2-1. Water quality parameters to be monitored in the CAMPP program.

Parameter	Units
Laboratory Analyses	
Bacteria[a]	
Escherichia coli (E.coli)	CFU/100 mL
Conventional Parameters	
Hardness (Total as $CaCO_3$)	mg/L
Total Dissolved Solids	mg/L
Turbidity	NTU
Total Suspended Solids	mg/L
True Color	TCU
pH	pH units
Conductivity	uS/cm
Total Alkalinity ($CaCO_3$)	mg/L
Bicarbonate Alkalinity (HCO_3)	mg/L
Carbonate Alkalinity (CO_3)	mg/L
Hydroxide Alkalinity (OH)	mg/L
Nutrients	
Nitrate and Nitrite N	mg/L
Total Kjeldahl Nitrogen N	mg/L
Ammonia Nitrogen N	mg/L
Total Phosphorus P	mg/L as P
Total Particulate Phosphorus P	mg/L as P
Total Dissolved Phosphorus P	mg/L as P
Total Organic Carbon C	mg/L
Total Inorganic Carbon C	mg/L
Total Carbon C	mg/L
Metals and Major Ions[b]	
Total Aluminum (Al)	mg/L
Total Antimony (Sb)	mg/L
Total Arsenic (As)	mg/L
Total Barium (Ba)	mg/L
Total Beryllium (Be)	mg/L
Total Bismuth (Bi)	mg/L

Parameter	Units
Total Boron (B)	mg/L
Total Cadmium (Cd)	mg/L
Total Calcium (Ca)	mg/L
Total Chromium (Cr)	mg/L
Total Cobalt (Co)	mg/L
Total Copper (Cu)	mg/L
Total Iron (Fe)	mg/L
Total Lead (Pb)	mg/L
Total Magnesium (Mg)	mg/L
Total Manganese (Mn)	mg/L
Total Mercury (Hg)	mg/L
Total Molybdenum (Mo)	mg/L
Total Nickel (Ni)	mg/L
Total Potassium (K)	mg/L
Total Selenium (Se)	mg/L
Total Silver (Ag)	mg/L
Total Sodium (Na)	mg/L
Total Thallium (Tl)	mg/L
Total Uranium (U)	mg/L
Total Vanadium (V)	mg/L
Total Zinc (Zn)	mg/L
Dissolved Chloride (Cl)	mg/L
Dissolved Sulphate (SO_4)	mg/L
***In Situ* Measurements**	
Temperature	^oC
Turbidity	NTU
pH	-
Dissolved Oxygen	mg/L
Conductivity	µS/cm
Secchi Disk Depth[a,c]	m
Biological Parameters	
Chlorophyll *a*[a]	µg/L
Pheophytin[a]	µg/L

[a] Parameters will not be measured in samples collected at depth (where depth samples are collected). [b] With the exception of mercury, parameters are provided as an analytical package from the analytical laboratory, as part of a metals scan. [c] At lake sites and river sites with low velocity only.

Appendix 3

Sediment Quality Sampling Standard:

Sediment quality samples will be collected at the same time and in the same locations as water quality samples to the extent feasible (i.e., if adequate fine substrate is present). The program will be conducted at each annual water quality monitoring site (where possible) every 6 years, beginning in 2011/12. A pilot field program will be conducted at two CAMPP sites in 2010 to test the field methodologies, in particular, whether replicate sites can be sampled from a confined area from a fixed-wing aircraft. Should an issue be identified in 2010/11 or during the conduct of the field program in 2011/12 associated with sampling from a fixed wing aircraft, sampling will be conducted from a boat during either the benthic invertebrate of fish monitoring components. It is anticipated that river sites will be sampled by boat during the benthic invertebrate of fish monitoring components.

Sediment samples will be collected using sediment sampling devices such as Ekman or Ponar grab samplers. A triplicate sample will be collected at each sampling site. The upper 5 cm of sediment will be collected and submitted for laboratory analysis at a CALA accredited laboratory for the parameters indicated in Table 3.

In addition, the following will be recorded for each site:

- Sampling site name, location ID, and Sampling site UTMs using a hand-held GPS unit;
- Water depth;
- Method of collection (e.g., wading; from boat etc.);
- Date and time of sampling;
- Site conditions;
- Water temperature, pH, DO, conductivity, and turbidity near the sediment-water interface;
- Sediment collection device;
- Penetration depth;
- Number of grabs collected for each sample;
- Type of sample submitted for analysis (discrete sample, composite sample);
- Location of each replicate sample (not multiple grabs that are composited to form one sample – only discrete sampling sites);

- Description of the sediments including texture, consistency, colour, odour, presence of biota, presence of debris.

- Photograph each grab that is collected, with an appropriate scale indicator. Camera settings should be used consistently across sampling sites (level of resolution, flash etc.).

The following will also be noted once per day or more frequently as required:

- Weather conditions (air temperature, precipitation (day of sampling and the preceding day where available), wind speed and direction, cloud cover);

- Any deviations from the sampling protocols; and

- Names of personnel collecting the samples.

Sample Handling and Transport

Samples will be kept cool and in the dark until submission to the analytical laboratory.

Laboratory Methods

Samples will be submitted to a CALA accredited laboratory for analysis. All analyses will be performed using standard methods and laboratory QA/QC procedures as follows.

Field QA/QC Samples

The sampling program will incorporate sample replication, as well as submission of homogenate duplicates (should homogenization of samples be required) and interlaboratory comparison samples, as follows:

- **Triplicate Samples** - Triplicate samples will be collected at each site.

- **Homogenate Duplicate** – Three homogenate duplicates (approximately 13% of total number of samples) will be prepared and submitted for analysis. The purpose of a homogenate duplicate is to ascertain the quality of the homogenization (i.e., adequate mixing).

- **Interlaboratory Comparison** – A minimum of one sample will be submitted to a second accredited analytical laboratory for comparison of analytical results with the primary analytical laboratory. One set of samples are submitted to each of two CALA accredited laboratories for comparison of analytical results obtained.

References:

British Columbia Ministry of Water, Land, and Air Protection. 2003. British Columbia field sampling manual: For continuous monitoring and the collection of air, air-emission, water, wastewater, soil, sediment, and biological samples. January 2003.

Environment Canada. 2002. Metal mining guidance for environmental effects monitoring. Various pagination.

Environment Canada. 1994. Guidance document on collection and preparation of sediment for physicochemical characterization and biological testing. Environmental Protection Series, Report EPS 1/RM/29, December 1994. 122+ pages.

Table 3-1. Sediment quality monitoring parameters.

Parameter	Unit
Nutrients	
Total Phosphorus	µg/g (dry weight [d.w.])
Total Kjeldahl Nitrogen	µg/g (d.w.)
Nitrate/nitrite-N	µg/g (d.w.)
Metals/Metalloids	
Aluminum	µg/g (d.w.)
Antimony	µg/g (d.w.)
Arsenic	µg/g (d.w.)
Barium	µg/g (d.w.)
Beryllium	µg/g (d.w.)
Bismuth	µg/g (d.w.)
Boron	µg/g (d.w.)
Cadmium	µg/g (d.w.)
Calcium	µg/g (d.w.)
Chromium	µg/g (d.w.)
Cobalt	µg/g (d.w.)
Copper	µg/g (d.w.)
Iron	µg/g (d.w.)
Lead	µg/g (d.w.)
Magnesium	µg/g (d.w.)
Manganese	µg/g (d.w.)
Mercury	µg/g (d.w.)
Molybdenum	µg/g (d.w.)
Nickel	µg/g (d.w.)
Potassium	µg/g (d.w.)
Selenium	µg/g (d.w.)
Silver	µg/g (d.w.)
Sodium	µg/g (d.w.)
Strontium	µg/g (d.w.)
Sulfur	µg/g (d.w.)
Thallium	µg/g (d.w.)
Titanium	µg/g (d.w.)
Tin	µg/g (d.w.)
Uranium	µg/g (d.w.)
Vanadium	µg/g (d.w.)
Zinc	µg/g (d.w.)
Zirconium	
Supporting Variables	
Total Organic Carbon	%
Total Carbon	%
Inorganic Carbon	%
Moisture	%
Particle Size (Silt, Clay, and Sand)	%

Appendix 4

Benthic Invertebrate Sample Collection and Processing Standard:

Lake and Reservoir Environments

Field collection:

Benthic invertebrate samples will be collected in the late summer or fall at pre-determined random sites in polygons established at sampling locations. Sites will be generated by the Random Point Generator extension for ArcGIS®. The program creates a geospatial set of random sites within the bounds of predetermined sampling polygons. These randomly generated sites will then be mapped on 1: 60,000 scale digital ortho-imagery. Field crews will use a handheld Garmin GPS unit to sample sites in consecutive order as provided by the Random Point Generator. If field crews are unable to sample certain sites (due to water velocity or compaction of substrate, for example) they would move onto the next site.

Invertebrates will be sampled using a grab sampler (Ekman or Ponar). At each site, one benthic invertebrate sample will be retrieved to the surface and carefully sieved through a 400 µm mesh rinsing bucket. All material, including invertebrates, retained by the screen will be transferred to labelled plastic jars and fixed with 10% formalin. Internal labels will be added to individual sample jars and will be checked to ensure the information (i.e., project name, sample location, grab sample number, sample date, and composite) matches the external sample jar data. Fixed and labelled samples will then be shipped to the laboratory for processing.

Three additional Ekman or Ponar grab samples will be taken at a subset of locations within each polygon. Each sediment grab will be sub-sampled with a 5 cm diameter core tube (0.002 m^2 surface area) to provide a sample of approximately 100 mL of sediment. These sediment sub-samples will be kept cool in the field and then refrigerated. Sediment samples will be sent to the analytical laboratory for analysis of total organic carbon and particle size (percent sand, silt, and clay).

Physical variables that will be measured/recorded at each polygon location include:

- Water transparency (measured using a Secchi disc);
- Riparian vegetation;
- % canopy cover;
- Water temperature; and
- Velocity (riverine sites).

Supporting physical variables that will be measured at each grab sub-sample site include:

- Water depth (measured with a depth sounder at each grab location); and

- Substrate composition (visual inspection of each grab – *i.e.*, % cobble, gravel, silt).

The initial Pilot Program will collect 15 benthic invertebrate samples in each of the deep and nearshore polygons (a total of 30/lake). In subsequent monitoring years, the number of samples taken at each site may need to be increased or decreased depending on the variability evident from the initial assessment of the metrics calculated during this Pilot year. Three samples for sediment analysis will be collected in each of the polygons, for a total of six per lake.

Laboratory analysis:

In the lab, each benthic invertebrate sample will be thoroughly rinsed with water through a 500 µm test sieve. The entire sample is examined visually to determine whether splitting is required (target is 300 organisms sorted per sample). If splitting is required, a 1.0 or 4.0 L Folsom Plankton Splitter (specific to sample volume) will be used to divide the sample into subsamples, which will then be sorted until at least 300 animals are counted. In sparse samples (i.e., containing fewer than 300 animals), the entire sample will be processed. When the 300 organism count is achieved part way through a sub-sample, the remainder of this fraction will be sorted so that a known fraction is sorted.

- All samples will be sorted under a 3x magnifying lamp and the invertebrates will be transferred to 70% ethanol prior to being identified to the appropriate taxonomic level. Vegetation/debris collected in the sample will be noted on the lab sheets
- Invertebrates will be identified to major group: Subclass, Order, or Family. Ephemeroptera will be identified to Genus.
- All samples will be processed following Quality Assurance/Quality Control (QA/QC) guidelines. All sorted samples will be checked by a second technician, with provision for resorting of the entire sample if sorting efficiency was found to be less than 95%. Taxonomic identifications will be verified by submitting 10% of samples from each in-house taxonomist to an external taxonomic specialist. All sorted samples will be retained and archived for two years should further identification be required.
- Sediment samples will be analyzed for particle size and total organic carbon.

Northern Riverine Environments

Artificial substrate samplers (rock baskets) are typically placed in the river in spring/early summer and retrieved in late summer/fall. Locations will be selected where samplers can be placed and retrieved readily. Site-specific conditions may require a modified design, but the following text describes rock baskets that were successfully deployed and retrieved in the lower Nelson River.

Rock basket samplers are comprised of two parts: a basket and a topper. The baskets are made of an outer ring of tent material approximately 10 cm deep, lined with 250 µm mesh on the inside and abrasion resistant plastic mesh on the outside. The outer ring has eight equally spaced grommets for

attaching retrieval lines and topper. The toppers are made of a 15" steel ring covered with stainless-steel wire mesh and reinforced with 20 gauge galvanized wire. A collection of ten river bed rocks (of approximately equal size) are placed in the basket on top of the 250 μm mesh. The topper is then secured to the basket using four UV-resistant zip ties. Four lines are secured through the remaining grommets on the basket and tied onto a 1.5-2" steel harness ring. The steel harness ring serves two purposes; it serves as an attachment point between the sampler and the anchor block/float line, and it serves as a 'pulley' through which a lowering rope is run for deployment. The anchor block is attached directly to the float line, which is folded in half, looped and tied. The rockbasket retrieval line is attached to this loop from the harness ring

A deployment rope is threaded through the retrieval line ring and held at each end. Once the boat is in position, the driver holds position while one person at the bow of the boat lowers the anchor block until it hits the river bottom. As the boat drifts back with the flow, the basket is lowered by letting one end of the deployment line out until the anchor line draws taught and the basket touches the river bottom. A last light pull on the deployment lines ensures the basket is on the bottom and the anchor line is taught. The GPS coordinates and water depth will be recorded at each rock basket deployment location; water velocity will be measured at points along the rock basket transect to adequately characterize the flow regime at the time of rock basket deployment.

To retrieve the rock baskets, the boat driver approaches the marker float from downstream while one person at the bow of the boat retrieves the float. The rockbasket retrieval line is cut from the float/anchor leaving the float attached to the anchor. With the loose end of the retrieval line in hand, a second person places the loose end through a weighted and vented retrieval funnel which slides down the rockbasket line until it covers the basket. The basket is then lifted from the bottom and into the boat. Once the basket is retrieved, the marker float and anchor block are retrieved for reuse. The GPS coordinates and water depth will be recorded at each rock basket retrieval location; water velocity will be measured at points along the rock basket transect to adequately characterize the flow regime at the time of rock basket retrieval.

Rock basket samples are processed in the field by removing the topper and washing all rockbasket contents through a 400 μm mesh sieve bucket. Caution is used to not wash invertebrates colonized on the outside of the rockbasket; as the defined sampling arena is the inside of the basket. Rocks are individually washed in order to remove all invertebrates from all sides of substrate. Samples are retained in a labelled jar (internal and external with matching and complete data), and preserved and processed in the laboratory as described for the Ponar and Ekman grab samples.

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Appendix 5

Standard Gang and Swedish Net Specifications Standard:

These standards are to be used when purchasing nets.

Large Bodied Fish Sampling Index Net

Index netting gangs for large bodied fish will consist of 5 mesh sizes, each constructed as a separate net. Each net is 25 yards long, and is cut to approximately 2 yards deep. Each net is seamed on to #30 leadline and 3/8" floatline. All mesh is tied on the half. All mesh is twisted nylon and coloured light green.

The specifications for each mesh are:

- 2" stretched mesh measure 210-3, 45 mesh deep
- 3" stretched mesh measure 210-3, 30 mesh deep
- 3 ¾" stretched mesh measure 210-3, 24 mesh deep
- 4 ¼" stretched mesh measure 210-4, 21 mesh deep
- 5" stretched mesh measure 210-4, 18 mesh deep

Gangs are assembled by joining the nets floatline to floatline and leadline to leadline. Gangs are organized with the meshes in sequence (2", 3", 3 ¾", 4 ¼" and 5"). The ends of each gang have 4m sideline bridles.

Small Bodied Fish Sampling Net

Index netting gangs for small bodied fish will consist of 3 mesh sizes, each constructed as a separate net. Each net is 10 m long and 1.8 m deep. These nets are purchased with integral float and leadline (Swedish gill nets). Mesh sizes are 16 mm, 20 mm and 25 mm stretched mesh measure. All mesh is multi-strand nylon and is coloured green.

Gangs are assembled by joining the nets floatline to floatline and leadline to leadline. Gangs are organized with the meshes in sequence (16 mm, 20 mm and 25 mm). The ends of each gang have 4m sideline bridles.

Appendix 6

Standard Gangs and Swedish Gill Net Set / Data Collection Standard:

The standard index gang specifications for large bodied and small bodied fishes are described in Appendix 4. For lacustrine sites, set locations are to be distributed as evenly as possible across the waterbody or basin. Set locations should be selected to avoid bias towards certain habitat types or species preferences. Since most of the lakes being sampled in the Pilot Program already have a history of sampling programs, maintaining consistency with previous programs is a valid consideration when selecting set locations. Once set locations have been established, they will be used consistently in future years.

For riverine sites, set locations will be selected based on the practicality of setting at a given location. Set locations should be chosen to encompass the full extent of the sample area, and as many habitat types as possible given flow conditions. If necessary, net gangs may be split up to accommodate limited area to set the gang, but all meshes for the gang should be set in close proximity and for the same time period.

Gangs are set to be pulled, with the net tied to an anchor, which is then tied to the buoy. Each gang must be clearly marked with either Fisheries Branch flags or the Scientific Collection Permit number and agency name on net buoys.

A large bodied fish gang is set at every sample location. At every third set location a small bodied fish gang is attached to the large bodied fish gang. The largest mesh end of the small bodied gang is attached to the smallest mesh end of the large bodied gang. If fewer than nine large bodied fish gangs are set, a minimum of three small bodied fish gangs must be set.

The following information will be collected for every gill net set:

- Type of index net: large bodied gang only (labelled as GN#) or large and small bodied gang (labelled as GN# and SN#);
- Date and time set;
- Field crew initials;
- GPS coordinate at each end of the gang. GPS coordinates should be UTM, NAD 83 and should identify the UTM Zone (14 or 15);
- A digital photo of the nearest shoreline to each set location;
- Water depth at each end of the gang to the nearest decametre;
- Water temperature;
- Secchi disc depth;
- Proximity and orientation to shore: main channel, flow, perpendicular, parallel;
- Shoreline conditions (if applicable) (e.g., bedrock, treed, boulder, etc.);

- Local weather conditions;
- Water velocity for riverine sets (low, medium, high);
- Aquatic vegetation present (low, medium, high); and
- Set locations should be clearly identified on field maps.

The following information will be collected for every gill net lift:

- Date and time lifted;
- Field crew initials;
- Local weather conditions;
- Substrate (based on the anchors): compaction: hard vs. soft; composition: gravel, boulder, bedrock, sand, mud, etc.;
- Water velocity for riverine sets (low, medium, high);
- Quantity of debris present in the net (none 0%, low <5%, medium 5-15%, high 16-25%, very high >26%, gang destroyed, gang lost); and
- Type and percentage of debris present (e.g., aquatic vegetation, aquatic moss, silt/mud, sticks, algae, terrestrial vegetation).

Manitoba Fisheries Branch has identified certain fish species to be of management interest on specific waterbodies (Table A1). On these waterbodies individual metrics are to be collected from all fish of that species captured in the large bodied gangs only. In addition, a minimum of 250 fish of that species may have to be caught and sampled in order to ensure that the sample is large enough to provide useful population statistics. The metrics are:

- Fork length (FL) to 2 mm;
- Weight to 10 gm for fish <4 kg, and 25 gm for fish > 4kg;
- Sex and maturity;
- Occurrence of DELTs;
- Ageing structures will be collected and placed in an envelope marked with the waterbody, date, set number, species and sample number. Ageing structures are:
  - Walleye – otolith
  - Sauger - otolith
  - Whitefish – otolith
  - Pike – cleithria

All other species of fish caught in each net are sampled as follows:

- Fish from each mesh in the large bodied gang are separated by species, counted and bulk weighed to the nearest 25 gm;
- Fish from the small bodied gang are not separated by mesh, but are separated by species, counted and bulk weighed to the nearest 25 gm; and

- All fish caught in the large bodied gang will be examined for DELTs (external Deformities, Erosions, Lesions or Tumours), which will be noted for each species and mesh.

Lake sturgeon are of specific management interest in all locations. Although not specifically targeted in the CAMPP program, all sturgeon caught are to be sampled as follows and released alive:

- Total length (TL) and fork length to 2 mm;
- Weight to 250 gm for fish > 10,000 gm, 10 gm for fish <=10,000 gm;
- Occurrence of DELTs; and
- Ageing structures are not being collected from sturgeon caught as part of CAMPP.

Table 6-1. 2009/10 CAMPP fish sampling program.

Waterbody	Type of Site	Spp. of management interest	Requirement for individual metrics	Min. # of Sets
Winnipeg River				
Lac du Bonnet	Annual / On-system	Walleye, sauger, pike	All walleye, sauger and pike	9
Winnipeg River (u/s Pointe. Du Bois)	Annual / On-system	Walleye, sauger, pike	All walleye, sauger and pike	9
Manigotagan Lake	Annual / Reference	Walleye, pike	All walleye and pike	6
Lake Winnipeg				
Lake Winnipeg (North basin)	Annual / On-system	Walleye, whitefish	All walleye, whitefish and pike	12
Lake Winnipegosis	Annual / Reference	Walleye	All walleye and pike	12
Saskatchewan River				
Cedar Lake (middle basin)	Annual / On-system	Walleye, whitefish	Walleye - Min. 250 All whitefish.and pike	12
Cormorant Lake	Annual / Reference	Walleye, whitefish	All walleye, whitefish and pike	12
Moose Lake	Rotational / On-system	Walleye, whitefish	All walleye, whitefish and pike	12
Upper Nelson River				
Cross Lake (west basin)	Annual / On-system	Walleye, whitefish	All walleye, whitefish and pike	12
Setting Lake	Annual / Reference	Walleye, whitefish	Walleye - Min. 250 All whitefish and pike	12
Playgreen Lake	Rotational / On-system	Walleye, whitefish	All walleye, whitefish and pike	12
Mid / Lower Nelson				
Split Lake	Annual / On-system	Walleye, whitefish, pike	All walleye, whitefish and pike	12
Assean Lake	Annual / Reference	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Nelson River (d/s Limestone GS)	Annual / On-system	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Hayes River	Annual / Reference	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Stephens Lake (north arm)	Rotational / On-site	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Stephens Lake (south end)	Rotational / On-site	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Lower Churchill				
Northern Indian Lake	Annual / On-system	Walleye, whitefish, pike	All walleye, whitefish and pike	12
Gauer Lake	Annual / Reference	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Churchill River	Annual / On-system	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Partridge Breast Lake	Rotational / On-system	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Upper Churchill				
Southern Indian Lake (Area 4)	Annual / On-system	Walleye, whitefish	Whitefish - Min. 250 All walleye and pike	12

Waterbody	Type of Site	Spp. of management interest	Requirement for individual metrics	Min. # of Sets
Granville Lake	Annual / Reference	Walleye, whitefish	All walleye, whitefish and pike	12
Southern Indian Lake (Area 1)	Rotational / On-site	Walleye, whitefish	All walleye, whitefish and pike	12
Churchill River Diversion				
Threepoint Lake	Annual / On-system	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Leftrook Lake	Annual / Reference	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Notigi Lake	Rotational / On-site	Walleye, whitefish, pike	All walleye, whitefish and pike	9
Apussigamasi Lake	Rotational / On-site	Walleye, whitefish, pike	All walleye, whitefish and pike	9

Appendix 7

Fish mercury:

Detailed Mercury Sampling Protocol

This appendix is intended to provide an overview and summary of the sampling and handling protocol for the CAMPP mercury program. The detailed protocol currently being finalized will provide additional information on sampling, handling, storage and shipping of samples. It will also elaborate on procedures specific to sampling in remote locations.

General Overview

The primary objective of the fish mercury sampling program is to support a description of the aquatic ecosystem health and to provide information for human health risk assessments. Data will be compared to the Health Canada (2009) and Manitoba guidelines (Williamson 2002) for mercury in fish for the protection of human consumers. Sampling will be conducted during the conduct of the fish community monitoring field sampling programs.

Choice of Species

Large-bodied fish species that will be sampled are lake whitefish (*Coregonus clupeaformis*), northern pike (*Esox lucius*), and walleye (*Sander vitreus*). These species were selected for historic reasons (i.e., these species were commonly sampled in historic studies), because of their economic importance, and in the case of northern pike and walleye, because they are top predators and are therefore at the greatest risk for biomagnifications of mercury. In addition to these large-bodied, long-lived fish, 1-year old (1+) yellow perch (*Perca flavescens*) will be sampled for the analysis of mercury for the following reasons:

- Young yellow perch could provide insights regarding annual changes in the supply of mercury to the ecosystem (long-lived predatory species integrate and reflect temporal changes over longer time scales). This is particularly important considering that the sampling frequency for the fish mercury monitoring program will mainly be every 3 years.
- Young yellow perch are not known to undertake extensive movements and therefore are more likely to be indicators of "local" conditions, reflecting localized methylmercury production and bioaccumulation.
- The inclusion of indicator species of different sizes, ages, and trophic positions (than walleye, northern pike, and lake whitefish) improves the interpretation and understanding of temporal patterns in mercury concentrations and in changes of mercury concentrations in species at the top of the aquatic food chain (i.e., northern pike and walleye),

- Yellow perch are wide-spread and abundant in the waterbodies selected for CAMPP and are important prey fish for the above predatory species.
- At age 1+ yellow perch can be identified based on the length distribution of the catch in the field and only a few reference individuals have to be actually aged (unlike shiner species, for example).
- There are historic data for (mostly adult) yellow perch for several Manitoba waterbodies, including those selected under CAMPP, and for many other regions in North America.
- 1-yr old prey fish, particularly yellow perch are the preferred biological indicator for the monitoring and evaluation of trends in methylmercury accumulation in freshwater systems (Wiener et al. 2007).

Number and Length of Fish to be Collected

- 36 whitefish, pike, and walleye will be collected; there should be a good representation across the range of fish lengths in the samples;
- 25 1-yr old yellow perch will be collected.

Sampling Sites

Fish mercury monitoring will be conducted in 24 of the CAMPP waterbodies, at a total of 25 sites, as indicated in Table 7-1. Samples will be collected from fish captured during the conduct of the fish community 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.

Sampling Frequency

Generally, sampling will be conducted every three years (Table 7-1). One on-system and one reference lake will be monitored annually to ensure short-term changes in mercury concentrations that may be indicative of regional (i.e., northern Manitoba) effects on the rates of mercury methylation and biomagnification are not being missed. Threepoint and Leftrook lakes are prime candidates for annual monitoring as Leftrook Lake is the only reference water body sampled under CAMPP with a strong historic record and Threepoint Lake is one of the waterbodies that has experienced the longest recovery time since construction of the Churchill River Diversion (CRD).

Sampling Times

Sampling for fish mercury will be conducted concurrent with the sampling of the fish community in June-September. Consistency of sampling time will be maintained within individual waterbodies, but because of logistical constraints due to the south-north phenology gradient, sampling times will differ among waterbodies.

Table 7-1. CAMPP waterbodies where monitoring of mercury in fish will be conducted.

Region/Waterbody	Reference or on-system	Sampling Frequency	Last Year of Hg Sampling	Comments Rationale for Hg sampling
Winnipeg River				
Winnipeg River. upstream of Pointe du Bois	On-system	3 years	2007; Aug-Nov (NSC)	Pre-existing dataset: samples for 2 years.
Manigotagan Lake	Reference	3 years	No Hg data exist	Reference waterbody
Lake Winnipeg				
North Basin, Grand Rapids	On-system	3 years	2006 (MWST)	Pre-existing dataset; samples for 5 years from the North basin; only 2006 identified as GR
Saskatchewan River				
Cedar Lake	On-system	3 years	2007 (NSC)	Most important lake in this region. Pre-existing dataset: samples for 17 yrs.
Cormorant Lake	reference	3 years	2008 (MBWSt)	Pre-existing dataset: mainly small samples for ~7 years .
Upper Nelson River				
Playgreen Lake	On-system	3 years	1994 (CFIA database)	Pre-existing dataset; samples for 5 years from 1978-1994.
Little Playgreen Lake	On-system	3 years	1994 (CFIA database)	Pre-existing dataset; samples for 2 years in1981 and 1994.
Cross Lake – West Basin	On-system	3 years	2007; (NSC)	Pre-existing dataset: samples for 9 yrs; for 5 yrs separately for East & West basins starting in 71.
Setting Lake	reference	3 years	1998 (small sample); (?)	Pre-existing dataset: small samples for ~9 yrs.
Sipiwesk Lake	on-system	3 years	1999; (NSC)	Pre-existing dataset; samples for 24 yrs.

Table 7-1. continued.

Region/Waterbody	Reference or on-system	Sampling Frequency	Last Year of Hg Sampling	Comments Rationale for Hg sampling
Lower Nelson				
Split Lake	on-system	3 years	2007; (NSC)	Pre-existing dataset: samples for 25 yrs (most complete record of any waterbody in MB).
Nelson R. downstream of Limestone GS	on-system	3 years	2004; (NSC)	Pre-existing dataset: small samples for ~18 yrs starting in 1978.
Hayes River	reference	3 years	2006; (NSC)	Pre-existing dataset: samples for 2 years.
Assean Lake	reference	3 years	2002; (NSC)	Pre-existing dataset; samples for 16 years.
Stephens Lake – south	on-system	3 years	2009; (NSC)	Pre-existing dataset; samples for 16 years (may be monitored under Keeyask).
Limestone Forebay	on-system	3 years	2005; (NSC)	Pre-existing dataset; samples for 11 yrs.
Lower Churchill				
Northern Indian Lake	on-system	3 years	1996 (small sample); (?)	Pre-existing dataset: small samples for 5 years starting in 1978.
Gauer Lake	reference	3 years	1996 (small sample); (?)	Pre-existing dataset: mainly small samples for 7 years starting in 1978.
Churchill River (near Little Churchill River)	on-system	3 years	No Hg data exist;	Riverine site.
Upper Churchill River				
Southern Indian Lake (Area 4)	on-system	3 years	1988; (DFO)	Pre-existing dataset. Samples for 13 years starting in 1975.
Southern Indian Lake (Area 6)	on-system	3 years	2007; (NSC)	Pre-existing dataset; samples for 18 yrs starting in 1975 (most complete dataset for all SIL areas). Comparison between Area 4 & 6 addresses regional differences in large lakes).
Granville Lake	reference	3 years	1999; (?)	Pre-existing dataset; samples for 14 years.
Churchill River Diversion (upper)				
Rat Lake	on-system	3 years	2007; (NSC)	Pre-existing dataset; Sampling started in 1978
Churchill River Diversion (lower)				
Threepoint Lake	on-system	Annually	2007; (NSC)	Pre-existing dataset: samples for 16 yrs (slow Hg recovery time)
Leftrook Lake	reference	Annually	2007; (NSC)	Pre-existing dataset; samples for 6-8 years (largest historical record of the reference lakes)

Sampling Methods:

Fish selection, sampling equipment, and measurements

In most cases the fish for mercury analysis will represent a sub-sample of the fish captured during the fish community monitoring. Finish processing the fish captured in the gill nets before starting collecting tissue samples for mercury analysis, provided that the fish selected for mercury sampling are properly labelled and stored.

Select fish for mercury analysis from the available pool of fish that are fresh and in good condition (i.e., with red gills and no or few gill net marks). If possible, mercury sampling should be carried out immediately after a net has been pulled and all of the fish have been removed. This would be particularly desirable if the weather conditions are excessively warm and fish spoilage will occur quickly. If, as is likely in most cases, all nets will be retrieved before fish sampling commences, then it is very important that only fish that are in good condition are set aside for mercury sampling. Placing these fish directly into a cooler with ice is preferred. Take care that each fish is properly labelled before it is set aside. If surveys are conducted during very warm conditions, field crews should make whatever provisions are necessary to ensure that fresh samples are available for mercury sampling (e.g., ensure that plenty of ice is available; keep fish covered before sampling or otherwise protect them from the sun; reduce the number of sets that are set and retrieved daily).

Keep a running tally of how many juvenile perch and how many large-bodied fish of each size class have been selected for mercury analysis using the templates. This template is meant to be a guideline; it is more important to get 36 individuals of each target species (whitefish, pike, and walleye) than to have each size class fully represented. If available, check existing data indicating the size distribution of 1-year old yellow perch in the specific sampling lake (will measure approximately 70-100 mm in the fall).

Measure large-bodied fish to the nearest mm of fork length and to a weight that is at least within 1% of their total weight. Collect ageing structures (i.e., otoliths, cleithra or fin rays) in the field for all large-bodied fish sampled for mercury.

Collection and handling of muscle samples for mercury analysis

Fish should be sampled as soon as possible following capture. If both large-bodied fish and 1-year old yellow perch are collected concurrently, process the perch before taking muscle samples of larger fish. Note that all juvenile yellow perch will be preserved whole and that their ageing structures are not collected in the field. Muscle samples and whole juvenile perch should be put on dry ice in a cooler as soon as possible following bagging. If dry ice is not available, ice packs or regular ice may be substituted.

Quality control during muscle/fish sampling

Take care to avoid contamination of samples either from direct handling (use clean Nitril/latex gloves at all times when processing fish; i.e. wash hands with gloves on thoroughly before handling the next fish,

or change gloves if necessary) or from contamination with knives/scalpels used to process the fish. Knives with non-corrosive stainless steel blades should be used. Prior to daily use, all sampling tools should be washed thoroughly with a detergent, rinsed in water, and rinsed in distilled water. Tools and weighing dishes should also be cleaned of attached tissues or visible blood and be rinsed with distilled water between every tissue. The dissection surface should be covered with clean, heavy plastic wrap which is to be replaced between every fish. Utensils should be wrapped in heavy plastic wrap and stored in a tightly closing container after use.

Mercury tissue/fish sample labelling

All information recorded during the fish community sampling component also applies to the fish mercury sampling program. If a fish identification number was assigned under the fish community monitoring program, use the same number to identify a fish sampled for mercury. Do not use any codes for species, waterbody, etc.

Individual WhirlPak bags should include both an outside label and an inside paper label. The outside (written on the bag) label should include the following information:

- Sampling date;
- Species;
- Sample ID (i.e., fish number);
- Waterbody; and
- Initials of field crew and affiliation.

The internal label (written in pencil on “Rite in the rain” paper) should include the following information:

- Sampling date;
- Species;
- Sample ID (i.e., fish number); and
- Waterbody

The written label on the large Ziplock bags containing the samples from one species should include the following information:

- Sampling date;
- Species;
- Waterbody;
- Initials of field crew and affiliation; and

- Bag number and total number of bags used for a species (e.g. bag 1 of 3).

Sample handling and storage

Mercury is not lost during normal fish/tissue storage and concentrations are therefore not affected by holding times. However, because mercury will be analysed and expressed on a wet weight basis, tissue desiccation/moisture loss can affect mercury concentrations. Therefore, the quality of the fish mercury data is critically dependent on minimizing moisture loss during handling, transport, and storage of samples.

Whole fish and muscle samples should be kept on dry ice (preferably) or (in the short-term) on blue ice packs/ice bags as soon as each sample has been processed. Provide sufficient coolers and ice for the expected number of samples, so that sample bags stay in direct contact with an ice surface. Keep tissue samples separate from samples of yellow perch to prevent mechanical damage of the small fish. After processing is completed, make sure that all the samples are stored on a sufficient amount of dried ice in coolers to ensure freezing. If dry ice is not available, ensure that samples are placed in a freezer as soon as possible.

Quality control of laboratory analyses

As a measure of additional quality control it is recommended to submit tissue/fish samples for mercury analysis to two different analytical laboratories in the first year of the fish mercury program. This would provide an independent check on the quality of the data produced by the primary laboratory chosen to do the mercury analyses on fish tissues under CAMPP. Five samples from each fish species from one waterbody (for a total of 20 samples) will be submitted as split samples to both the primary analytical laboratory (i.e., ALS) and a second laboratory (e.g., Flett Research Ltd.). Based on a comparison of the results from the two laboratories a decision can be made on how to proceed with fish mercury analyses in the future.

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Attachment 1 - MOU

Memorandum of Understanding about Program of LWR/CRD Monitoring Activities, dated October 16, 2006.

The Government of Manitoba and Manitoba Hydro are committed to work together on matters relating to monitoring of hydrometric (water level and stream flow) and environmental data in certain areas in the Lake Winnipeg Regulation and Churchill River Diversion system.

Manitoba and Manitoba Hydro have the common objective of developing a program of activities ("the activities"), building on the existing monitoring program of Manitoba Hydro, that would provide objective information about hydrometric and environmental effects of hydro-electric development on agreed rivers and lakes comprising the Lake Winnipeg Regulation and Churchill River Diversion systems ("the system"). The information from the activities could be of benefit to Manitoba, Manitoba Hydro and other interested parties, including communities in the area of the Lake Winnipeg Regulation/Churchill River Diversion project. Objectives of the program of activities would include:

(a) assisting in evaluating whether and to what extent the water regime in areas of the system is or will be affected by the addition of additional hydro-electric facilities;

(b) assisting in identifying adverse effects and positive effects resulting from effects on the water regime; and

(c) assisting in considering measures that may be undertaken to address any identified adverse effects.

Manitoba and Manitoba Hydro may establish additional objectives of the activities.

Manitoba and Manitoba Hydro recognize that Manitoba Hydro has made commitments to monitoring and follow up programs as part of the environmental licensing process for the Wuskwatim Generating Station. These commitments will be considered in developing the activities.

The program of activities will be reviewed each year and annual workplans will developed by Manitoba and Manitoba Hydro to assist in achieving the program of activities. The agreed workplan for the fiscal year ending March 31, 2007 is attached as Appendix A to this Memorandum.

Manitoba and Manitoba Hydro will consider methods of making information from the activities available to interested parties.

It is intended that the nature and scope of activities will be developed starting in Fiscal Year 2006-07 (starting April 1, 2006) and will continue until Manitoba and Manitoba Hydro agree to no longer proceed with a program of activities.

As part of the development of the annual program of activities, Manitoba and Manitoba Hydro will consider the resources each will provide in order to carry out the activities

It is intended that Manitoba and Manitoba Hydro personnel will prepare an Annual Report to be delivered to the Minister of Water Stewardship and the Minister of Conservation, on behalf of Manitoba and to the President and CEO of Manitoba Hydro. Additional reports may be prepared as Manitoba and Manitoba Hydro determine to be appropriate. The Annual Report may include:

- a description of the activities for that year;
- a description of any information determined as a result of the activities;
- information about any circumstances where water levels or flows were outside of ranges provided for in licences;
- methods of making the information available to interested parties and to the public;
- any other matters that are considered appropriate. It is expected that Manitoba and Manitoba Hydro will make the Annual Reports available to the public.

Manitoba and Manitoba Hydro may amend this Memorandum from time to time by further Memorandum.

for Manitoba

for Manitoba Hydro

Oct. 16, 2006
Date

06 09 06
Date