MANITOBA / MANITOBA HYDRO
COORDINATED AQUATIC MONITORING

2009 / 2010 Pilot Program

1.0 INTRODUCTION

This document describes the second year (2009/2010) 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 2009/10 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 second year of the program is intended to build off of the first year and continue to test methodology in areas where either Manitoba Water Stewardship or Manitoba Hydro are already conducting ongoing monitoring programs. Both Parties recognize the value of the extensive amount of knowledge held by the First Nations and aboriginal communities that live along the system and hope that through future discussions with these communities that this knowledge can be incorporated into the program as it develops.

2.0 BACKGROUND

Over the last 35 years, numerous environmental studies and monitoring programs have been conducted by Manitoba, Manitoba Hydro, and Fisheries and Oceans Canada, 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 parameters;
- 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- and site-specific driven, 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 and December 2008 that included representation from Manitoba Water Stewardship, Manitoba Hydro, Fisheries and Oceans Canada (DFO), University of Manitoba, Environment Canada, and North/South Consultants Inc. To ensure appropriate coverage of Manitoba Hydro's hydraulic generation system, the CAMPP was divided into seven monitoring regions (Figure 1). Each monitoring region, excluding Lake Winnipeg, 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 monitoring sites maintained by Manitoba Water Stewardship and Environment Canada are located in some of the seven monitoring regions. These monitoring sites are listed on Table 2 and drawn 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.

Reference:

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

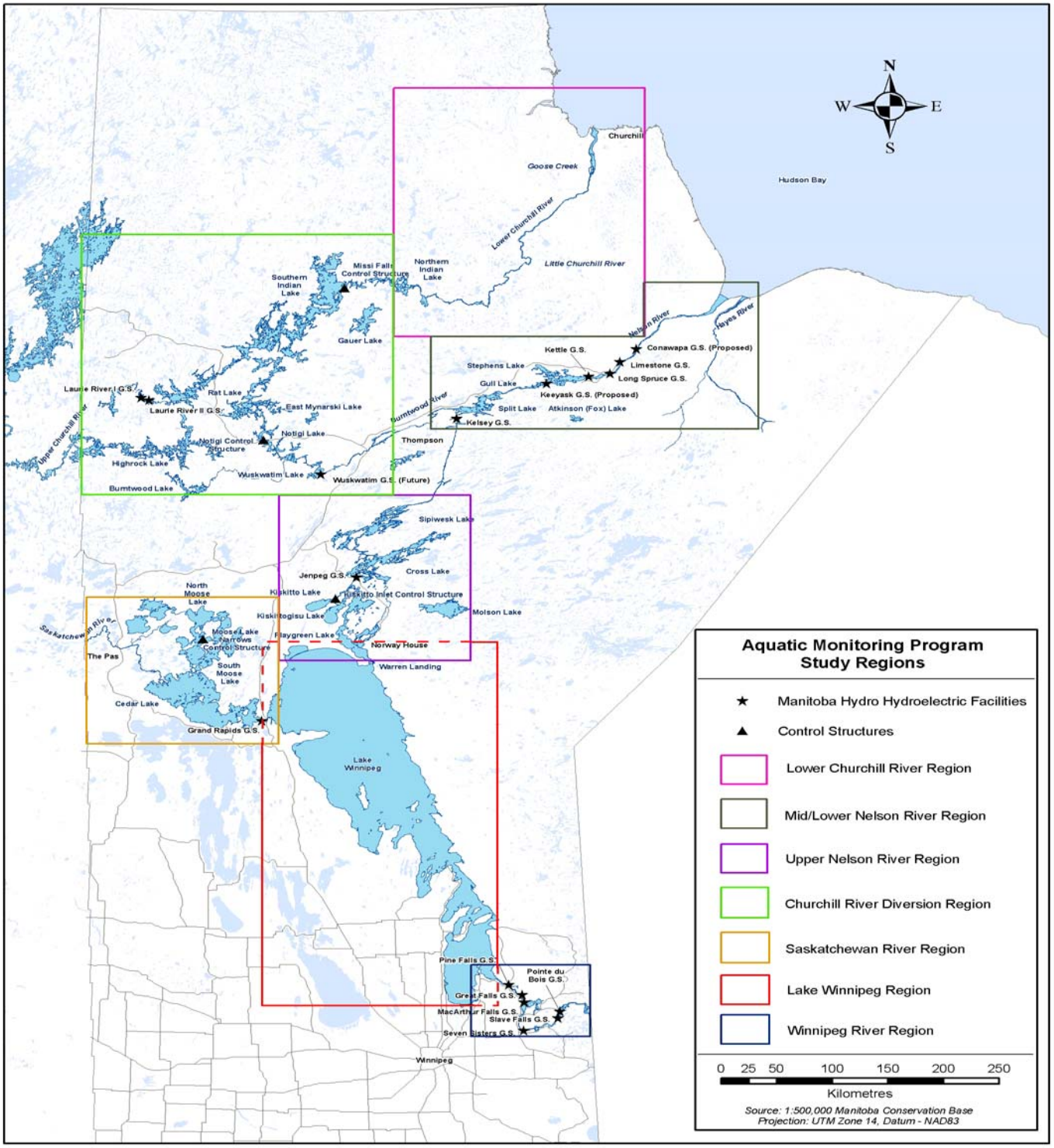

Figure 1: CAMPP Monitoring Regions.

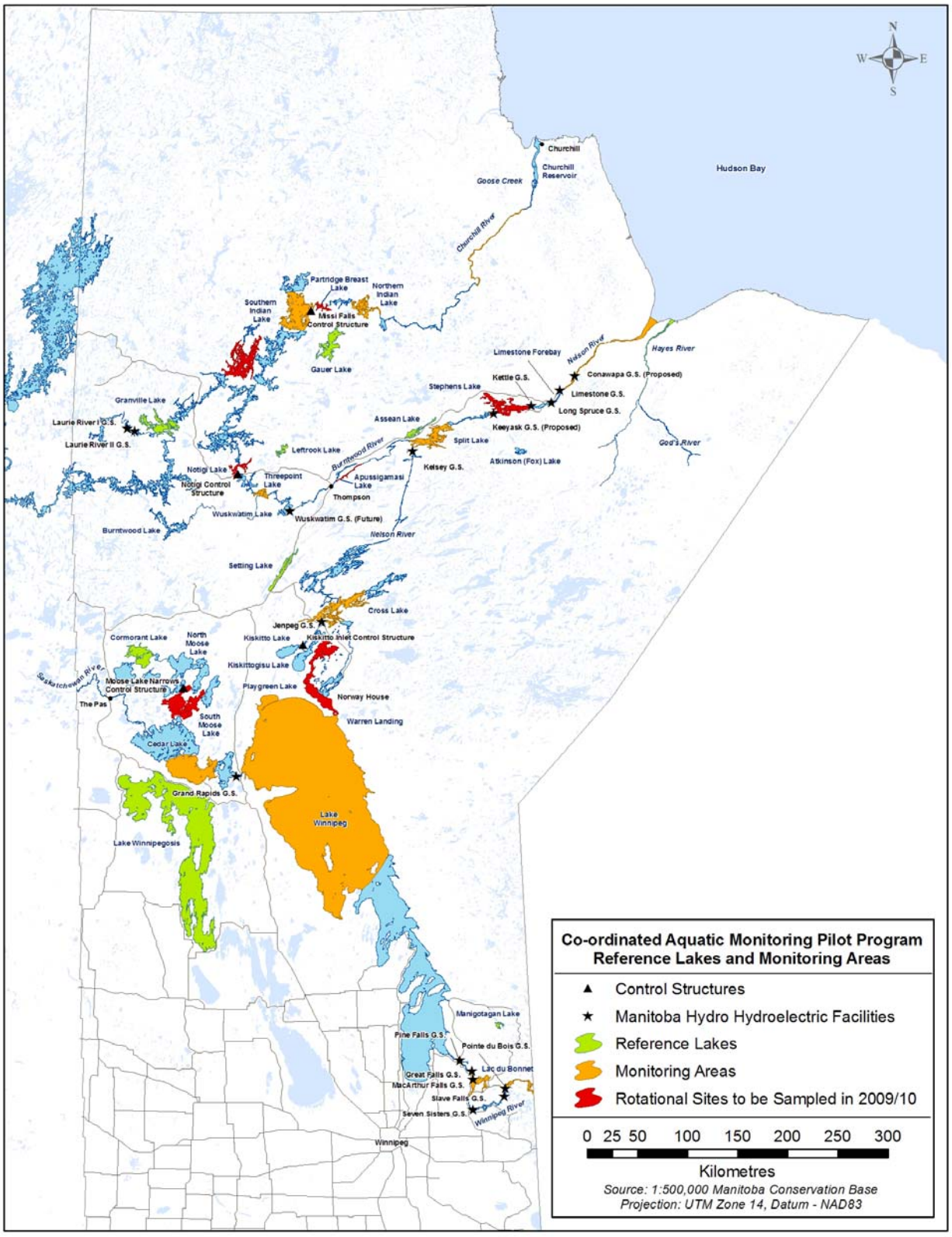

Figure 2: Waterbodies monitored under CAMPP in 2009/10.

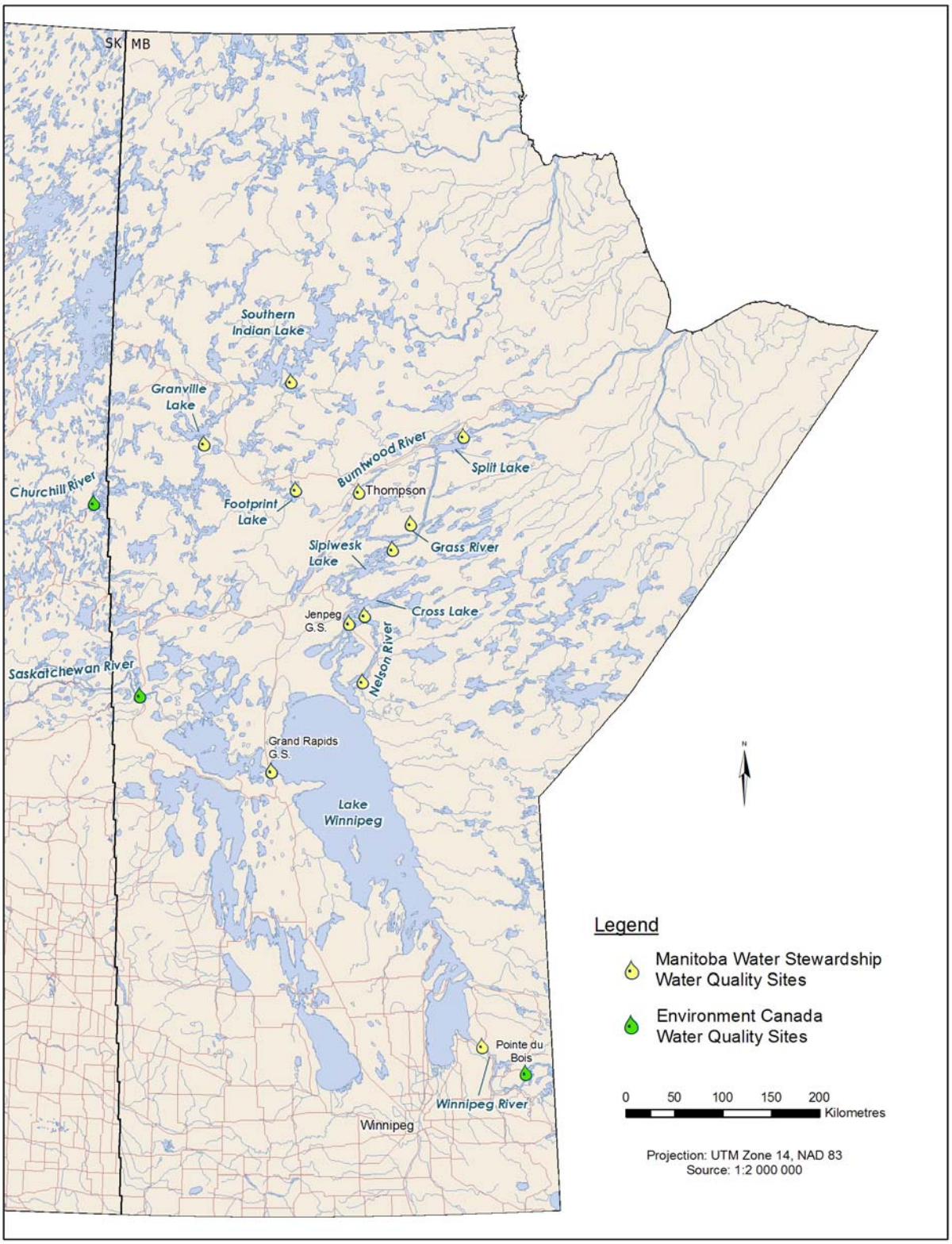

Figure 3: Existing Manitoba Water Stewardship and Environment Canada water quality sampling sites in the CAMPP regions.

Table 1. Waterbodies to be sampled in 2009/10 program by monitoring region. Sites were selected based on results of the 2008/09 program.

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.
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.
Moose Lake	Rotational	On-system site with a commercial fishery.
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.
Playgreen Lake	Rotational	On-system site with commercial fishery.
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 monitoring program. Significant hydrological effects.
Hayes River	Annual	Reference site, unaffected by hydrologic changes.
Stephens Lake - north arm	Rotational	On-system 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.
Partridge Breast Lake	Rotational	On-system site with significant hydrologic effects.
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 1)	Rotational	On-system site.
Churchill River Diversion (lower)		
Threepoint Lake	Annual	On-system site with existing dataset.
Leftrook Lake	Annual	Reference site, unaffected by hydrologic changes.
Apussigamasi Lake	Rotational	On-system site.
Churchill River Diversion (upper)		
Notigi Lake	Rotational	On-system 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 L.	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:

- Parameters included in the 2009/10 field program constitute the "metadata" for samples collected (*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 AND SEDIMENT QUALITY

Parameters:

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

Sampling Standards / Protocols:

- The establishment of a separate water quality and sediment 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).
- Sediment samples will be taken from the upper 5 cm of material collected with an Ekman or Petite Ponar dredge (0.023 m^2).

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 cover (winter). Sites will be selected based on availability of existing or historical water quality sites monitored by MWS or Manitoba Hydro. Where no existing or historical sites are available, sites would be selected mid-basin 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 of Environmental Analytical Laboratories (CAEAL) accredited lab.
- Duplicate samples collected on Lake Winnipeg and elsewhere, and submitted to different CAEAL 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 Manitoba Water Stewardship 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 Manitoba Water Stewardship (Nelson River at Jenpeg and the Winnipeg River at Pine Falls) and Environment Canada (Winnipeg River at Pointe du Bois) are being qualitatively evaluated to assess the adequacy of timing and frequency of sampling conducted in the open-water season under CAMPP. This is being done through an evaluation of the potential seasonality of key water quality parameters measured at these sites with the available data record. In addition, data collected under CAMPP in 2008 near the Pointe du Bois GS are being compared to the data collected monthly at a similar site by Environment Canada to assist in determining if the timing and frequency of sampling conducted under CAMPP provides a reasonable representation of water quality conditions over the open-water season.

3.3 PHYTOPLANKTON

Parameters:

- Algal biomass and community composition.
    - Biomass will be determined via chlorophyll *a* concentrations (See water quality parameters).
- Samples will be collected for phytoplankton community composition and microcystin-LR .

Sampling Standards / Protocols:

In Year 1 (2008/2009), two chlorophyll *a* samples were submitted to a CAEAL accredited laboratory for analysis during all four sampling events: a surface grab from the site, as well as a composite sample of water taken from the euphotic zone (estimated as two times the Secchi disk depth). Following the March 2009 winter sampling excursion, the final of four sampling events from Year 1, a preliminary assessment of all chlorophyll *a* results will take place. This assessment should identify whether one or two chlorophyll *a* samples (surface and / or integrated) need to be taken during each sampling event in 2009/2010. When chlorophyll *a* is collected from the surface, *Microcystin*, and phytoplankton community composition will also be collected as surface grabs in this situation.

Samples for analysis of *Microcystin* and phytoplankton community composition will be collected at each site (either as surface grabs or as integrated samples; see above) but will only be submitted for analysis where the chlorophyll *a* concentration is $\geq$ 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-LR 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).

3.4 BENTHIC INVERTEBRATES

Rationale:

- Benthic invertebrate monitoring allows for an understanding of fish abundance and production, and is an indicator of aquatic ecosystem health.
- Benthic invertebrates have a lifespan conducive to responding to environmental impacts quickly. In addition, the longevity of their lifespan allows the integration of changes in their environment over an annual cycle.

Parameters:

- 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
        - To family - Arachnida, Amphipoda, Bivalva, Gastropoda, and Insecta (Chironomidae will be to sub-family)
        - To Order - Oligochaeta, Hirudinea, Ostracoda, Conchostraca, Mysidacea, Platyhelminthes, and Hydrozoa)
    - Genus-specific analysis of Ephemeroptera - 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 (i.e. Family)
    - Bray-Curtis Index
    - Simpson's Diversity index

- Riverine Habitat: The benthic community will be sampled using artificial substrate samplers in areas of hard substrate habitat[1] (i.e., bedrock and boulder), or a Petite Ponar grab (opening = 0.023m^2) in soft and medium substrate habitat[2] (i.e.,. gravel, sand, silt, and mud). The sampling method employed will reflect 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.
- Reservoir/lake: The benthic community will be sampled using an Ekman grab (opening = 0.023m^2) in areas of soft substrate (i.e., mud and silt).

[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] It is anticipated that the riverine sites selected will be predominantly hard substrate, so sampling will be primarily based on the use of artificial substrate samplers.

- Note: Depending on substrate type and compaction, some locations classified as reservoir/lake sites will require deployment of both Ekman and a Petite Ponar grabs.

Sampling Standards / Protocols:

- The benthic community will be sampled during late summer/fall in northern areas (later in southern areas) to coincide with the emergence of all insects and to ensure that the populations being assessed are as stable as can be.
- In lake/reservoir environments, sampling will occur at pre-determined randomly selected locations within pre-determined polygons (See Appendix 3 for additional details):

    - Polygons will be 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 will also be 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). A Pilot Program to determine the within and between site habitat characteristics resulting in between sample variation will be required so that polygons are established in uniform areas (*i.e.*., small differences in the delineation of the shallow water extent of the polygon may result in large differences in community composition).
    - Polygons should be 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, 2002).
    - Protocols for sample collection (benthic invertebrate and sediment) are provided in Appendix 3.

- Artificial substrate samplers in riverine environments will be placed along a transect of various depths to include both shallow and deeper environments. The locations and positioning of samplers will be 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). Additional details are provided in Appendix 3.

Annual / Rotational Sample Site Considerations:

- Mixture of both reservoir 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.

3.5 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 as described in Appendix 4.
- The site selection and sampling protocol is described in Appendix 5.
- In the initial year 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.
- 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 Table A1.

- All fish caught from each mesh will be individually examined for DELTs (external Deformities, Erosions, Lesions or Tumours), counted and bulk weighed

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.

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.

Sediment and Erosion Sampling:

Erosion processes where shorelines disintegrate and material is suspended in fast flowing water, moved along the bottom of water courses or deposited in areas of reduced velocity have been at work in Manitoba's waterways for thousands of years. These processes are critical to the aquatic ecosystem as many organisms in the aquatic ecosystem have evolved and adapted to the cycle of water flows and associated sediment transport. Manitoba Hydro's facilities and related operations can affect these processes and the related changes, can either directly affect fish both as a deleterious substance that affects fish biology (e.g., migrations/movements and perhaps even respiration), but more typically affect fish by altering fish habitat depending on the amount and location where it is deposited.

From a biological perspective, individual components of the process cannot be separated; water management → erosion/disintegration processes → sediment load → sediment deposition → fish biology/habitat effects. All components of this chain of effects are therefore critical in assessing changes to aquatic ecosystem health and function arising from modified water management (i.e., flooding, changing seasonal flows, daily cycling, and sediment dynamics within Manitoba's "system").

Erosion:

- **Inventory:** Eroding and disintegrating shorelines need to be assessed and catalogued at a higher scale to help stratify the system or reaches within the system into areas of concern and those of lesser issue.

Critical sites would then be assessed with the end result being to estimate the rate of erosion and volumes released to the system and to model areas likely to be impacted by the associated sediment.

- **Monitoring:** Observing changes at these erodible sites is required to confirm the estimates of sediment volume contributed to the system, and assist with adjustments to sampling programs based on changing circumstances or unanticipated issues and rates.

Sediment:

- **Inventory** - Current status (basin morphometry and substrate characteristics) of waterbodies is required to benchmark future assessments of change relative to fish habitat and aquatic ecosystem health.

- **Monitoring** - Monitoring suspended sediment and bed-load transportation / deposition is required to determine the effects of any future modifications to the hydraulic regime (i.e., changes to the configuration and health or status of the aquatic ecosystem). Specifically, the change in basin morphology is of critical interest.

Appendix 2

Water Quality / Sediment Sampling Standard:

Sampling sites will be accessed by float plane or boat in the open-water season. 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 lake).

Metadata associated with sample sites include:

- Water Quality:
    - 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
- Sediment Quality:
    - Sediment sampling equipment (type and surface area sampled);
    - Description of sediments (texture, colour, odour, biota);
    - Number of grabs;
    - Depth of sediment collected; and
    - Water depth.

***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.

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. 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. 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 (dissolved 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 CAEAL accredited laboratory for analysis. All analyses will be performed using standard methods and laboratory QA/QC procedures as follows.

Field Procedures for QA/QC

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: Water quality parameters to be monitored in the CAMPP program.

Parameter	Units
Laboratory Analyses	
Bacteria[a]	
Escherichia coli (E.coli)	CFU/100 mL
Faecal Coliform Bacteria	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.

Table 3: Sediment quality monitoring parameters

Parameter	Unit
Nutrients	
Total Phosphorus	µg/g (dry weight [d.w.])
Total Nitrogen	µg/g (d.w.)
Metals/Metalloids	
Aluminum	µg/g (d.w.)
Arsenic	µg/g (d.w.)
Antimony	µg/g (d.w.)
Barium	µg/g (d.w.)
Beryllium	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.)
Thallium	µg/g (d.w.)
Uranium	µg/g (d.w.)
Vanadium	µg/g (d.w.)
Zinc	µg/g (d.w.)
Supporting Variables	
Total Organic Carbon	%
Moisture	%
Particle Size (Silt, Clay, and Sand)	%

Appendix 3

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. Fixed samples will then be shipped to the laboratory for processing.

Additional Ekman or Ponar samples will be taken at a subset of locations within each polygon and 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 frozen and sent to the analytical laboratory for analysis of total organic carbon and particle size (percent sand, silt, and clay). Three samples will be collected per sampling polygon.

Physical variables that will be measured at each site include: water depth (measured with a weighted, metered rope (accurate within ± 0.1 m) or a depth sounder), water transparency measured using a Secchi disc, and where feasible:

- Substrate composition (visual inspection – *i.e.*, % cobble, gravel, silt);
- Riparian vegetation;
- % canopy cover;
- Water temperature; and
- Velocity (riverine sites).

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 organic content.

Riverine Environments

Artificial substrate samplers 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.

To retrieve 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.

Rockbasket 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, and preserved and processed in the laboratory as described for the dredge samples.

Reference:

Environment Canada. 2002. Metal mining guidance document for aquatic environmental effects monitoring (www.ec.gc.ca/eem/English/MetalMining/Guidance/default.cfm).

Environment Canada. 2006. Invertebrate biomonitoring field and laboratory manual for running water habitats. (http://cabin.cciw.ca/Main/cabin_online_resources.asp).

Appendix 4

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 5

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 A1. 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
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
Granville Lake	Annual / Reference	Walleye, whitefish	All walleye, whitefish and pike	12

Waterbody	Type of Site	Spp. of management interest	Requirement for individual metrics	Min. # of Sets
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

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

Oct. 16, 2006
Date

for Manitoba Hydro

06 09 06
Date