

CAMP Water Quality Sampling Protocol

Water quality sampling is conducted three times during the open-water season (spring, summer, and fall) and once during the ice-cover season (winter) at all sites excepting in Lake Winnipeg and 2-Mile Channel. In the open-water season, sampling sites are accessed primarily by float plane. In winter, sites are typically accessed by plane and sampling is conducted through a 10-inch hole drilled in the ice using a gas powered or electric auger. Generally, samples are collected in ‘offshore’ areas (i.e., near the centre of a river channel or deeper area of a lake).

Sampling Methods

***In Situ* Measurements**

In situ parameters (pH, temperature, specific conductance, dissolved oxygen [DO], and turbidity) are recorded using a Eureka© Manta Water Quality multi-probe (or similar instrument) near the water surface (i.e., 0.3 m) and at 1-m depth intervals. Where the depth of the water column is less than 5 m, *in situ* measurements are taken at 0.5 m intervals. *In situ* measurements are collected to a depth of 1 m above the bottom or to the depth at which the length of the meter cable is reached. At high velocity sites, only near surface measurements are taken.

Secchi disk depth is measured as the average of two measurements: the depth at which a black and white disk lowered into the water is no longer visible; and the depth at which the disk re-appears when raised from the water column. Secchi disk depths are measured in the shade (i.e., in shade from the wing of the aircraft).

Water depth is measured using a depth sounder and ice thickness is measured using a metered stick.

Surface Sample Collection

In the open-water season, surface grab samples are collected for laboratory analysis by directly filling the sample bottles provided by the analytical laboratory at a depth of approximately 30 cm. The sample bottle is submerged (with the cap on) to elbow depth (approximately 30 cm below the surface), removing the cap, allowing the bottle to fill, and retrieving the bottle to the surface. Sample bottles with pre-added preservatives (e.g., bottles for the analysis of total nutrients and *E. coli*) are filled by first collecting a sample in a secondary vessel (i.e., a preservative-free bottle supplied by the laboratory) and then transferring the water sample to the laboratory-supplied sample bottle to avoid loss of preservatives.

Under ice-cover conditions, surface grabs are obtained through the deployment of a Kemmerer water sampler below the ice. The Kemmerer sampler is retrieved, and sample bottles are filled at the surface.

Euphotic Sample Collection

At most sites, water samples for analysis of chlorophyll *a* are collected from the portion of the water column that is within the euphotic zone. The depth of the euphotic zone is estimated as two-times the Secchi disk depth measured at the time of sampling. To collect a euphotic sample, an uncapped weighted bottle is lowered to the bottom of the euphotic zone and then retrieved to the surface. The bottle is lowered and retrieved at a consistent rate such that the bottle fills continuously until it is recovered at the surface. For high-velocity sites where Secchi disk depths cannot be reliably obtained, samples for chlorophyll *a* are collected as surface grabs.

Discrete Depth Sample Collection

Water samples are collected near the bottom of the water column (“bottom samples”) at sites where thermal stratification is observed. Stratification is defined as the occurrence of a difference in water temperature of ≥ 1.0 degree Celsius across 1 m of water. Discrete depth samples are 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 are then filled and processed as required. The suite of parameters measured in bottom samples is identical to that analyzed

for surface samples, excepting *E. coli* which is not measured.

Supporting Data

Supporting information that is collected includes:

- Sampling site GPS coordinates (UTM, NAD 83);
- *In situ* water quality meter used;
- Water quality sampling equipment;
- Depth at which samples are collected;
- Type of sample (i.e., grab, composite);
- Site conditions and observations;
- Site access (i.e., floatplane, snowmobile); and
- Representative photographs of the site conditions, shoreline, unusual conditions (i.e., algal blooms, forest fires), and/or where possible, aerial photographs of the shoreline and site using a GPS enabled digital camera.

Sample Handling and Transport

Upon collection, any required preservatives are added as instructed by the analytical laboratory and the sample bottles are capped and mixed. Samples are kept cool and in the dark and shipped for analysis as soon as possible following sample collection.

Laboratory Methods

Samples are submitted to a Canadian Association for Laboratory Accreditation (CALA) accredited laboratory for analysis of the parameters indicated in Table 1. All analyses are conducted using standard methods and laboratory quality assurance/quality control (QA/QC) procedures.

Field QA/QC Samples

The water quality sampling program incorporates 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 are collected at selected sites during each sampling period.
- **Field Blanks** – Field blanks are submitted during each sampling period. Field blanks are 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 the same manner as actual samples. Field blanks are stored and transported with field samples.
- **Trip Blanks** – Trip blanks are submitted 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 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 environmental samples but the bottles are not opened at any point and thus not exposed to the environment. Trip blanks are submitted along with the environmental samples.
- **Dissolved Oxygen QA/QC Samples** – Samples of surface water are collected for analysis of DO at the analytical laboratory during each sampling period. These samples are intended to provide QA/QC respecting the accuracy of the field DO measurements.

- **Interlaboratory Comparison** – Samples for interlaboratory comparison are collected during each sampling period. Samples for interlaboratory comparison are collected by filling an additional set of sample bottles for submission to a second CALA accredited laboratory for comparison of analytical results with the primary analytical laboratory. Both sets of bottles (one for each of the two laboratories) are filled in as close proximity and time to each other as possible.

Table 1. Water quality parameters monitored under CAMP.

Parameter	Units	Parameter	Units
<u>Laboratory Analyses</u>		<u>Laboratory Analyses</u>	
Conventional Parameters		Total Copper (Cu)	mg/L
Hardness (Total as CaCO ₃)	mg/L	Total Iron (Fe)	mg/L
Total Dissolved Solids	mg/L	Total Lithium (Li)	mg/L
Turbidity	NTU	Total Magnesium (Mg)	mg/L
Total Suspended Solids	mg/L	Total Manganese (Mn)	mg/L
True Color	colour units	Total Mercury	mg/L
pH	pH units	Total Molybdenum (Mo)	mg/L
Conductivity	µS/cm	Total Nickel (Ni)	mg/L
Total Alkalinity (CaCO ₃)	mg/L	Total Potassium (K)	mg/L
Bicarbonate Alkalinity (HCO ₃)	mg/L	Total Rubidium (Rb)	mg/L
Carbonate Alkalinity (CO ₃)	mg/L	Total Selenium (Se)	mg/L
Hydroxide Alkalinity (OH)	mg/L	Total Silicon (Si)	mg/L
		Total Silver (Ag)	mg/L
		Total Sodium (Na)	mg/L
Nutrients		Total Strontium (Sr)	mg/L
Nitrate and Nitrite	mg/L as N	Total Sulfur (S)	mg/L
Total Kjeldahl Nitrogen	mg/L as N	Total Tellurium (Te)	mg/L
Ammonia Nitrogen	mg/L as N	Total Thallium (Tl)	mg/L
Total Phosphorus	mg/L	Total Thorium (Th)	mg/L
Total Particulate Phosphorus	mg/L	Total Tin (Sn)	mg/L
Total Dissolved Phosphorus	mg/L	Total Titanium (Ti)	mg/L
Total Carbon	mg/L	Total Tungsten (W)	mg/L
Total Inorganic Carbon	mg/L	Total Uranium (U)	mg/L
Total Organic Carbon	mg/L	Total Vanadium (V)	mg/L
Total Dissolved Carbon	mg/L	Total Zinc (Zn)	mg/L
Dissolved Inorganic Carbon	mg/L	Total Zirconium (Zr)	mg/L
Dissolved Organic Carbon	mg/L	Dissolved Chloride (Cl)	mg/L
		Dissolved Sulphate (SO ₄)	mg/L
		Dissolved Fluoride (F)	mg/L
Metals and Major Ions		Biological Parameters	
Total Aluminum (Al)	mg/L	<i>Escherichia coli</i> (<i>E. coli</i>) ^a	MPN/100 mL
Total Antimony (Sb)	mg/L	Chlorophyll <i>a</i> /pheophytin ^a	µg/L
Total Arsenic (As)	mg/L		
Total Barium (Ba)	mg/L		
Total Beryllium (Be)	mg/L		
Total Bismuth (Bi)	mg/L		
Total Boron (B)	mg/L		
Total Cadmium (Cd)	mg/L		
Total Calcium (Ca)	mg/L		
Total Cesium (Cs)	mg/L		
Total Chromium (Cr)	mg/L		
Total Cobalt (Co)	mg/L		
		<u>In situ Measurements</u>	
		Temperature	°C
		Turbidity	NTU
		pH	pH units
		Dissolved Oxygen	mg/L
		Specific Conductance	µS/cm
		Secchi Disk Depth ^b	m

^a Parameters are not measured in samples collected at depth (where depth samples are collected).

^b At lake sites and river sites with low velocity only. Not measured in winter.