Long Term Trend Lakes Protocol

State of Wisconsin Department of Natural Resources

STANDARD OPERATING PROCEDURES

May 2022

Wisconsin Department of Natural Resources
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Wisconsin DNR, Water Quality
Bureau Monitoring Program

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Contents

Monitoring Objectives

The primary objective of Long Term Trend (LTT) Lakes monitoring is to document long-term trends in lake water chemistry. This data set also provides context for water chemistry in other lakes in terms of intra and inter-annual variability. Given that many lakes were initially included in the program due to a management action, data may also be used to evaluate management action effectiveness.

Lake Selection

The water quality of sixty-two lakes has been monitored annually as part of the LTT Lakes program since approximately 1986. Some lakes have records dating back to 1968 whereas others were added more recently (as late as 2000). The LTT lakes are distributed across Wisconsin and represent most natural community types. "Small lakes" (< 10 acres area) are not represented. The smallest, median, and largest LTT lakes are 38, 382, and 132,000 acres in area, respectively. The LTT lakes were chosen based on societal value and ongoing management actions. A subset of the LTT lakes have minimal human disturbance.

Design

Water quality monitoring on Long Term Trend lakes occurs at spring overturn and three times during summer (July 15 - September 15 with at least 2 to 3 weeks between sample events). Take field profiles for temperature, dissolved oxygen, conductivity and possibly pH on all four dates as well as Secchi depth and total phosphorus. Collect chlorophyll *a* during the three summer sample events and the following water quality parameters once each summer: pH, conductivity, alkalinity, color, nitrate + nitrite and Total Kjeldahl Nitrogen (TKN). Sample calcium and magnesium once every 5 years.

Every attempt should be made to coordinate with the Citizen Lake Monitoring Network (CLMN) volunteers to maximize efficiency. For example, if CLMN volunteers collect Secchi depth, total phosphorus and chlorophyll *a*, DNR staff do not need to do that portion of the protocol. However, staff may need to collect DO and temperature profiles if the volunteer does not and should visit the lake once during the summer index period to collect the expanded list of parameters along with Secchi, TP, and chlorophyll *a*. CLMN volunteers do not currently collect pH, alkalinity, conductivity, color, nitrogen series, calcium or magnesium. Ensure that the volunteers are collecting data by contacting volunteers in the spring prior to the field season and checking the database in the fall.

Similar coordination should happen if partners such as USGS or UW Madison collect data. DNR staff may still need to visit the lake to fulfill the complete monitoring design. The field data from these partners needs to be entered into SWIMS if the data is not served online elsewhere. Lake coordinators are responsible for ensuring this happens.

Maintain sampling equipment in prime condition and disinfect between lakes to prevent the spread of invasive species.

Table 1. Summary of LTT Lake Water Quality Monitoring Protocol

Parameter	Category	Description
*Secchi	Method	To nearest 0.1 m or ¼ ft
	Equipment	8-inch black and white disk
	Frequency	Spring turnover + 3X during summer index period (15 July – 15 Sept)
	QA/QC	Paired observers at least 10% of time, record both readings separately
*Total P	Method	Field preserved (sulfuric acid), persulfate digestion
	Equipment	6-foot integrated sampler
	Frequency	Spring turnover + 3X during summer index period (15 July – 15 Sept)
	QA/QC	Field reps and blanks on 10% of samples
*Chl *a*	Method	Filter in field or lab same day, fluorometric
	Equipment	6-foot integrated sampler
	Frequency	3X during summer index period (15 July – 15 Sept)
	QA/QC	Field reps on 10% of samples
*Temperature & DO profile	Method	Profile at 1-m intervals
	Equipment	DO meter or multi-parameter meter
	Frequency	Spring turnover + 3X during summer index period (15 July – 15 Sept)
	QA/QC	Annual temperature comparison to certified thermometer, DO calibration record
*Conductivity & pH profile in field (optional)	Method	Profile at 1-m intervals
	Equipment	Multi-parameter meter
	Frequency	Spring turnover + 3X during summer index period (15 July – 15 Sept)
	QA/QC	Conductivity and pH calibration record
Conductivity, pH, and alkalinity in lab	Method	No acidification, standard lab methods
	Equipment	6-foot integrated sampler
	Frequency	1X during summer index period (15 July – 15 Sept)
	QA/QC	Field reps and blanks on 10% of samples
Color	Method	No acidification, Platinum-Cobalt (Pt-CO) scale
	Equipment	6-foot integrated sampler
	Frequency	1X during summer index period (15 July – 15 Sept)
	QA/QC	Field reps and blanks on 10% of samples
Nitrogen: NO_2+NO_3, TKN	Method	Field preserved (sulfuric acid)
	Equipment	6-foot integrated sampler
	Frequency	1X during summer index period (15 July – 15 Sept)
	QA/QC	Field reps and blanks on 10% of samples
Ca, Mg	Method	Field preserved (nitric acid)
	Equipment	6-foot integrated sampler
	Frequency	Once every 5 years: 2020, 2025, 2030, etc.
	QA/QC	Field reps and blanks on 10% of samples

*Citizen Lake Monitoring Network may collect samples for these parameters

Standard Operating Procedures for Lake Water Quality

Detailed field sampling standard operating procedures (SOPs) are linked below. Sampling crews should be familiar with these protocols before engaging in sampling.

Secchi Disk Monitoring Procedure

Temperature, Dissolved Oxygen, Conductivity, and pH Depth Profile Monitoring Procedure on Lakes

Water Chemistry Sampling Procedure for Lakes

Chlorophyll *a* Filtering Procedure

Procedures for Sampling

Equipment

- Multiparameter meter for measuring dissolved temperature oxygen, conductivity, and pH (if possible)
- Black & white 8-inch diameter Secchi disk with line measured in 1-ft or 0.5-m intervals
- Depth finder
- Integrated water sampler to sample top 6 feet of water (see Appendix A)
- Composite bottle (and spare) fitted with emptying device that dislodges the ball check valve in the integrated sampler (half gallon or 2 L jug works well)
- 1 250 mL bottle from State Lab of Hygiene (SLH) for nutrients (spring & summer)
- Sulfuric acid ampoule for preserving nutrients from SLH (spring & summer)
- 1 250 mL bottle from SLH for metals (summer)
- Nitric acid ampoule for preserving metals (summer)
- 1 L polyethylene bottle for Alkalinity, pH, Conductivity, Color, and Chlorophyll *a* (summer)
- Extra bottles for blanks and/or field duplicates
- Multiparameter meter calibration log
- Field data sheet
- Lab slip: SLH form 4800-024
- Ziploc/plastic bags for packing water samples and lab slips
- Sharpie pen
- Pencil
- Plastic gloves
- Safety glasses
- Cooler
- Cubed Ice

Field Procedure

The spring sample event occurs after ice out and before thermal stratification. The three summer sample events occur between July 15 and September 15. Summer samples should be taken at least 2 weeks apart. Try to space sampling events to occur within three periods: July 15 – August 4, August 5 – August 25, and August 26 – September 15.

Calibrate your multiparameter meter and record results in your calibration log the day of sampling. In the field, anchor boat at the sampling station, which should be away from shore at the point of maximum depth. The Station ID should be linked to GPS coordinates in SWIMS and can be used to locate the correct sampling location. Ensure that the station location matches the location in SWIMS. Note who the observers are, date, time, and weather conditions including: % cloud cover, air temperature, precipitation, wind speed and direction,

water color, water column appearance, user perception of water quality, and lake level. Note on field sheets whether you use feet or metric units and record what depth(s) you sampled on the lab slip.

Take the Secchi depth, a lake profile with the multiparameter meter, and the water samples at the deepest point of the lake following the standard operating procedures. Filter the chlorophyll *a* sample on the shore in the shade immediately after sample collection if possible. Otherwise, you may filter back at the lab. You may submit a water sample to the SLH for chlorophyll *a* filtration if you can ensure that they filter within 48 hours of collection but filtering yourself will yield the best results.

Shipping

1. Store water samples cooled (not frozen) and store chlorophyll *a* filter frozen until shipment.
2. Fill out SLH form 4800-024 (Appendix A) checking the boxes for appropriate parameters on each date.
3. Ensure that the field number on the lab slip matches the labels on each bottle.
4. Place the sample bottles in Ziploc bags and place those in a plastic bag with cubed ice. Seal the bag containing ice to prevent leakage (e.g., gooseneck top of bag and zip tie).
5. Place the lab slip in a Ziploc bag in the cooler to ensure it stays dry.
6. Ship sample overnight to the SLH.

Clean-up

Clean all equipment between lakes and at the end of the day to prevent the spread of invasive species. The boat, integrated sampler, and other equipment that goes in the lake (e.g., anchor), should be cleaned according to the most recent disinfection procedures. You could also use designated sets of equipment for each lake or sample the lake with a citizen volunteer and use their equipment. At the end of the day after following disinfection procedures, rinse the composite bottles and integrated samplers with deionized water and hang integrated samplers with ball end at top to allow water to drain out.

Quality Assurance

Testing data quality and precision is an important step of water quality monitoring. Take duplicate Secchi depth readings on 10% of readings by asking two observers to make independent Secchi disk observations on the same outing. Record both readings in SWIMS. This provides a measure of variability in Secchi depth caused by differences in observers.

Calibrate multiparameter meters on each sample date for all parameters according to your multiparameter meter's instructions. At a minimum, this includes dissolved oxygen each day. Use calibration solutions for conductivity and pH. Refer to your meter's operations manual and keep a multiparameter meter calibration log.

Field blanks test for contamination of the samples during collection, and field duplicates test the precision of the sample collection procedure. Collect field duplicates for chlorophyll *a* and collect both field duplicates and blanks for all water chemistry parameters at a rate of 10%. Make separate lab slips for duplicate and blank samples. Obtain fresh ASTM Type I water (deionized/reverse osmosis water that is then run through a US Filter Corp or Milli Q filter) from SLH each field season. If you supply your own carboy (20 L recommended), SLH will clean it and fill the carboy for free. You should also ask them to clean a smaller bottle (4 L should be sufficient) to make it easier to collect a blank sample in the field. Follow the collection procedures detailed in Water Chemistry Sampling Procedure for Lakes to collect blank and duplicate samples.

If a field blank has elevated concentrations, test the deionized water in the carboy for contamination. Pour water directly from the carboy into a sample bottle, check "Blank" on the lab slip, label as "Lab Water Blank" in the "Sample Description" text field and send to SLH. If the "Lab Water Blank" returns a non-detect, take another field blank to ensure that contamination is not occurring during your field procedures.

Data Entry

Field Data

Enter general observations, Secchi depth, and profile data into SWIMS. Go to the Submit Data tab, click "Add New" and choose the Long Term Trends project. Note that SLH will enter Secchi depth and surface temperature data into SWIMS if it is written on the back side of the lab slip. Because the lab slip does not have space to enter the full profile, it is best to enter the data yourself and avoid duplicative records in SWIMS.

Chemistry Data

Properly fill out the lab slip with all the information about your water samples (see Water Chemistry Sampling Procedure for Lakes and Appendix A). The water chemistry results and associated information will automatically upload to the SWIMS project after the SLH completes analysis.

Appendix A. Sample Lab Slip Illustrating Fieldwork Event for All Chemistry Parameters

State of Wisconsin
Department of Natural Resources
and Laboratory of Hygiene

** DO NOT PHOTOCOPY **

Test Request - Inorganic Surface Water & Microbiology

Form 4800-024 (R 7/21)

Billing and Reporting

Account Number	Field Number (Bottle Label ID)	Report to Address (Non-DNR only)		
WT068	Crystal071620			
DNR User ID	Report to Name	City	State	Zip
HEINC	HEIN, CATHERINE			
Date Results Needed (mm/dd/yyyy)		Report to Email (Non-DNR only)		

Date and Time of Sample Collection

Date (mm/dd/yyyy)	Time (24-hr clock)	End Date (mm/dd/yyyy)	End Time
07/16/2020	13:00		

Sample Type

Sample Type: (select one)

- (X) SU Surface Water
- ( ) NP Storm Water
- ( ) EF Effluent (Treated Wastewater)
- ( ) IF Influent (Untreated Wastewater)
- ( ) D Public Drinking Water
- ( ) MW Monitoring Well
- ( ) PO Private Well
- ( ) SE Sediment
- ( ) SL Sludge
- ( ) SO Soil
- ( ) TI Tissue
- ( )

Who collected the sample

Collected By Name	Telephone	Email
CATHERINE L HEIN, MICHAELA A KROMREY	608-267-2376	catherine.hein@wisconsin.gov

Where the sample was collected

Station ID (STORET #)	Sample Address or Location Description	
603120	CRYSTAL LAKE - DEEP HOLE	
County	Waterbody ID (WBIC)	Point / Outfall (or SWIMS Fieldwork Seq No)
60-Sheboygan	45200	309959917

Sample Details

Sample Description / Device Description

Deep hole / integrated sampler

Enforcement? ( ) Yes (●) No
If yes, include chain of custody form.

If Field QC Sample (select one)
( ) Duplicate ( ) Blank ( )_____

Depth of Sample: _____ ( ) ft ( ) m ( ) in ( ) cm

Is Sample Disinfected? ( ) Yes (●) No
If yes, how? _____

Grant or Project Number
LTT-Lakes

Or Top and Bottom of Sample Interval:
0 - 6 ( ) ft ( ) m ( ) in ( ) cm

Analyses Requested

If field filtered, indicate by checking the box on this sheet and noting on the lid of the sample bottle.

Plastic Quart Bottle (No chemical preservation)
[ ] Sample field filtered (Check box if yes)

- [X] Alkalinity, pH, Conductivity
- [X] Color
- [ ] BOD_5 Dissolved
- [ ] Fluoride
- [ ] BOD_5 Total (900 ml needed)
- [ ] MBAs Screening
- [ ] $CBOD_5$ Total (carbonaceous)
- [ ] pH only (non compliance)
- [ ] Chloride
- [ ] Sulfate
- [X] Chlorophyll A (if Field Filtered, give ml 100 filtered)
- [ ] Turbidity
- [ ] _____

Solids

- [ ] Suspended Sediment
- [ ] Total Dissolved Solids
- [ ] Total Solids
- [ ] % Sand, Silt, Clay
- [ ] Total Suspended Solids (500 ml needed)
- [ ] Total Vol. Susp. Solids (inludes Total Susp. Solids)
- [ ] Total Volatile Solids (includes total solids)

60 ml Bottle (No chemical preservation)
[ ] Sample field filtered (Check box if yes)

- [ ] Orthophosphate
- [ ] Silica
- [ ] $NO_2 + NO_3$ as Nitrogen (drinking water)
- [ ] Nitrite (NO_2) as Nitrogen

250 ml Metals Bottle (Acidify w/ Nitric Acid)
[ ] Sample field filtered (Check box if yes)
[ ] Low Level Metals. Note: Clean sampling with special bottles
[ ] TCLP (Toxicity Characteristic Leaching Procedure - use mason jar)

Total recoverable metals will be run unless otherwise instructed.

[ ] Aluminum	[ ] Copper	[ ] Selenium
[ ] Antimony	[ ] Hardness-as $CaCO_3$	[ ] Silver
[ ] Arsenic	[ ] Iron	[ ] Sodium
[ ] Barium	[ ] Lead	[ ] Strontium
[ ] Beryllium	[X] Magnesium	[ ] Thallium
[ ] Boron	[ ] Manganese	[ ] Titanium
[ ] Cadmium	[ ] Mercury	[ ] Vanadium
[X] Calcium	[ ] Molybdenum	[ ] Zinc
[ ] Chromium, Total	[ ] Nickel	[ ] _____
[ ] Cobalt	[ ] Potassium	[ ] _____

250 ml Nutrients Bottle (Acidify w/ Sulfuric Acid)
[ ] Sample field filtered (Check box if yes)

[X] Tot.-Phosphorus	[X] $NO_2 + NO_3$ as Nitrogen	[X] Total Kjeldahl-N
[ ] Ammonia-N	[ ] COD	[ ] Total Nitrogen

- [ ] Tot. Dis. Phosphorus (filter, then acid perserve in 60 ml bottle)
- [ ] Low Level Total Phosphorus (special bottles needed)