Workplan for Monitoring Algae and Water Quality in Lake Catherine (including Spencer Bay) City of Hot Springs, Arkansas REVISED – April 9, 2024

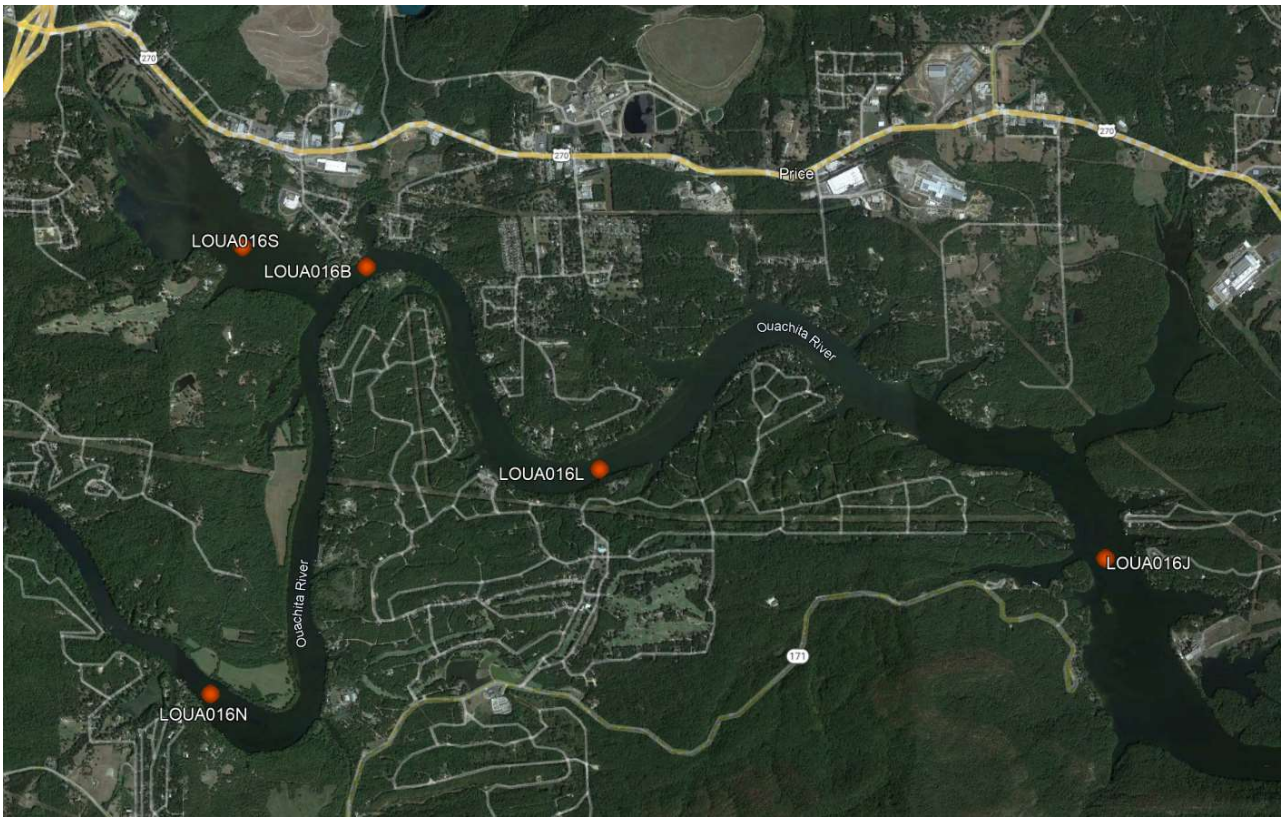
Introduction

In a letter dated January 31, 2024, the Arkansas Department of Energy & Environment Division of Environmental Quality (DEQ) required the City of Hot Springs to submit a Workplan to document and evaluate filamentous algae in Lake Catherine. DEQ's letter required the Workplan to include, at a minimum, the sampling methods detailed in a study design proposal that was attached to the letter. The Workplan described below is based on DEQ's study design proposal, with modifications to be more geographically focused in and around Spencer Bay, and with clarifications regarding details of certain procedures.

Monitoring Locations

Five monitoring locations have been selected based on DEQ's study design proposal and discussions between DEQ and the City of Hot Springs in a meeting on February 28, 2024, as well as DEQ's conditional approval letter dated April 9, 2024. These monitoring locations are shown in the table and figure below.

Site Name	Location Description	Latitude	Longitude	Rationale	Established DEQ Monitoring Location
LOUA016N	Lake Catherine 0.5 miles upstream from Camp Couchdale	34.431194	-92.976433	Included in DEQ study design proposal	Y
LOUA016S	Lake Catherine in Spencer Bay	34.458206	-92.974091	Included in DEQ study design proposal	Y
LOUA016B	Lake Catherine - upper - downstream of Spencer Bay	34.457 (approx.)	-92.965 (approx.)	Discussed by City of Hot Springs and DEQ in Feb. 28 meeting	Y
LOUA016L	Lake Catherine 0.5 miles downstream of Marina Point	34.444778	-92.947914	Included in DEQ study design proposal	Y
LOUA016J	Lake Catherine near entrance to State Park Cove	34.439369	-92.910828	Required by DEQ Conditional Approval Letter	Y



Sampling Method

Monitoring under this Workplan will be conducted at approximately monthly intervals starting within 30 days of DEQ approval of the Workplan and ending no later than November 2024. Water quality data should be collected monthly at each site for pH, dissolved oxygen, conductivity, temperature, chlorophyll a, total nitrogen, total phosphorous, depth, and Secchi depth. Filamentous algae estimates will be collected monthly in congruence with water samples. Water collection procedures are modified from the DEQ Lake Sampling Standard Operating Procedures and Work Plan.

Secchi Depth Collection

Measure Secchi depth directly in the water. The Secchi disk should be clean, weighted, and suspended on a metric-calibrated chain, wire, or a non-stretch rope. Collect Secchi depth before any water sample collection as it will determine depth of sampling. Follow these procedures for measuring Secchi disk transparency under normal conditions:

a) Remove sunglasses and hat.
b) On the shaded side of the boat, slowly lower the Secchi disk vertically into the waterbody until it disappears. The viewer should maintain an eye level of less than 2 meters above the water's surface. Note the depth at which the Secchi disk disappears.
c) Slowly raise the Secchi disk until it becomes visible again. Take a mental note of the depth at which the disk becomes visible again.
d) Compute the average (mean) of the two depths noted and record the value. The recorded average value is the Secchi disk transparency.
e) If the disk is still visible on the lake bottom, place a "B" on the field sheet.

Depth Measurement

Measure lake depth at the site using a sounding line, depth finder, or other applicable method.

Water Sample Collection

Water samples at each site are paired with *in situ* water quality data. Epilimnion samples shall be taken between 0.5 and 2 meters below the surface. Hypolimnion samples shall be taken 1 meter above the bottom. In Spencer Bay (LOUA016S), no hypolimnion samples or measurements will be collected. Before sampling, triple-rinse the collection vessels and put on gloves to avoid contamination. Avoid submerging bare skin in the water at sampling locations. Collect water samples as far from the boat motor as possible. All water samples must be analyzed in a State accredited laboratory.

Grab Sample Collection Using a Van Dorn or Kemmerer Sampler

A Van Dorn sampler is a horizontal cylinder used to collect water samples at specified depths, and a Kemmerer sampler is a vertical cylinder. Use of a Van Dorn or Kemmerer sampler is an accepted method for collecting water samples. Follow these procedures to collect a water sample using a Van Dorn or Kemmerer sampler:

a) Record "Van D." or "Kem." in the "Collection Method" column of the field sheet.
b) Triple rinse the inside and outside of the Van Dorn or Kemmerer sampler. Expel the rinsate water away from the work area, ensuring that none of the rinsate water is included in the sample.
c) Close all discharge valves.
d) Lock end seals in the open position.
e) Using a marked rope, lower to the appropriate depth. Be sure to hold on to the messenger apparatus while lowering the instrument.
f) Once the desired depth is reached, release the messenger apparatus to close both ends of the instrument and collect a water sample.
g) Return instrument to boat.
h) Deposit the sample into the plastic bucket.
i) Repeat until the needed amount of water is collected.
j) Aliquot sample water to the sample containers as described.

Sample Aliquoting

Prior to aliquoting, label all sample containers with the Site Name. Labels must be written directly on the side of the container with permanent, waterproof ink. Do not label lids.

One duplicate sample is taken for every 10 samples collected, or at least once per calendar day. The sampler can choose which site will be the duplicate. Refer to the section entitled "Duplicate Sample Collection" below for more information regarding duplicate samples.

Aliquot water sample into containers as outlined below.

If you do not have enough volume in the sample container to aliquot all samples, repeat the water collection procedure to acquire more sample water. Keep in mind that duplicates should be aliquoted from the same container of sample water. To ensure data quality, follow all procedures described in these procedures regarding sample container preparation.

Nutrients

A 946 mL (quart) plastic container.*†

1. Gently swirl sample in collection vessel to homogenize.
2. Fill labeled 946 mL (quart) plastic container with sample water.
3. Tightly secure the lid back on the sample container so that it does not leak.
4. Refer to the Duplicate Sample Collection Section below for instructions on taking a duplicate sample.
5. Immediately place sample container(s) on ice and store at ≤ 6.0 °C until relinquished to the lab.

   *If holding times cannot be met, bring an additional labeled 946 mL plastic container with H_2SO_4 preservative for each sample (and duplicate) and follow procedures above. Take care to not spill contents.

   † Sample containers may vary depending on lab used for analysis

Sestonic Chlorophyll *a* Sampling

A 1,000 mL brown plastic bottle.

The following methodology described is for sestonic chlorophyll *a* only.

1. Swirl sample in collection vessel to homogenize. Do not aerate the sample.
2. Fill labeled container with sample water, leaving a little head space.
3. Close the sample container, ensuring that the lid is properly threaded and tightened so that the sample does not leak or get contaminated.
4. Immediately place sample container(s) on ice and store at ≤ 6.0 °C.

Duplicate Sample Collection

Duplicate collection procedures may differ depending on laboratory requirements. At DEQ, duplicate samples are taken for all parameters at a rate of 10% (1 duplicate per 10 samples or at least 1 duplicate per day). Take all duplicates at a single selected site. Duplicate sites are selected at the discretion of the sampler and are usually selected based on ease of collection and distance of sample processing location from the road.

To collect a duplicate sample, fill one additional container with sample water. Label all applicable containers with their Site Name followed by "-dup". If holding times cannot be met, collect a duplicate 946 mL plastic container with H_2SO_4 preservative. Record the duplicate sample on the datasheet by indicating the Site Name-dup (i.e. LOUA016N – dup). Ensure that the time of duplicate sample collection is recorded.

Collect a sestonic chlorophyll *a* duplicate at the same location as the other duplicates.

In Situ Meter Calibration

Record calibration data on a calibration datasheet or lab notebook. Scan and save all calibration datasheets.

Before each calibration, clean probes using the central wiper (if available) and a lint-free cloth such as lab-tissue. Use care while cleaning sensors.

Prior to meter use, calibrate according to methods outlined in the user manual/manufacturer's guidelines. Perform proper maintenance if any sensor is not reading or calibrating correctly. Calibrate probes in the following order (as applicable). Rinse probes with Type I DI water between standards. Record both the pre-calibration and post-calibration values:

- Temperature
    - Check temperature measurements quarterly.
    - Place a NIST thermometer and the meter in the same bucket of water (can be Type 1 DI, tap, or sample water).
    - Record readings from the NIST thermometer and the meter on a calibration datasheet.
- Conductivity
    - Calibrate conductivity before each sampling event.
    - Calibrate using specific conductance with one calibration standard greater than 1000 µs/cm. Ensure that there are no air bubbles in the sensor and that the meter is reading in the correct units.
    - Record pre- and post-calibration values on a calibration datasheet.
    - Check calibration standard against a second source on a monthly basis.
    - Record monthly checks on a calibration datasheet.
- pH
    - Calibrate pH before each sampling event.
    - Conduct a 3-point calibration as described here using pH 7 and pH 4 and pH 10 standards or follow the calibration procedure recommended in the User Manual for the meter.
    - Record pre- and post-calibration values on a calibration datasheet.
    - During calibration for each standard, write down the millivolts (mV) (mVs will not have a pre- and post-calibration value).
        - mVs can provide information about the effectiveness of the pH sensor.
            - While calibrating at ~25ºC, the mV range between standards should fall between 165 and 180. If the range falls outside of these values, the pH sensor needs replacement.
            - mVs for pH 7 should be 0 ± 50
            - mVs for pH 4 should be 177 ± 50
            - mVs for pH 10 should be -177 ± 50.
                - E.g. mV for pH 4 = 173
                    - mV for pH 7 = -30
                    - 173 – (-30) = 203
                    - mV range = 203 pH sensor needs replacement
                - E.g. mV for pH 4 = 147
                    - mV for pH 7 = -20
                    - 147 – (-20) = 167
                    - mV range = 167 pH sensor is OK

- Dissolved Oxygen (DO)
    - Calibrate DO before each sampling event.
    - Ensure there are no water droplets on the DO or temperature probe.
    - Record the barometric pressure using an internal barometer, a local barometer or an online resource. If not done automatically in the instrument's programming, adjust the reading for elevation. Refer to a solubility table to check appropriate calibration values.
    - Calibrate DO using percent saturation. Put a small amount (~1/8 inch) of water into the calibration cup. Loosely thread the calibration cup (do not seal) to the meter. Wait for the % DO and temperature to equilibrate.
    - Record pre- and post-calibration values on a calibration datasheet.
- Depth
    - Calibrate depth before each sampling event.
    - Record pre- and post-calibration values on a calibration datasheet.

To ensure accuracy of measurements, calibrate specific conductance, DO, and pH within 12 hours of beginning each monitoring event. If temperature is not accurate, send the instrument in for servicing.

Post Sampling Quality Assurance Check

When monitoring is complete for the day, perform a post-field QA check in the lab or other controlled environment by checking readings against calibrations standards. Place standards in the calibration cup in the same order as calibration (pH, specific conductance, DO) and record readings on a calibration datasheet. See the table below for maximum allowable deviations from calibration standards for post-field checks. If a value falls outside of the maximum allowable limit ranges, flag the data recorded from whichever probe malfunctioned as unusable.

Acceptable value ranges for post-field QA check (TCEQ, 2012)

Measured Field Parameter	**Maximum allowable limits for water-quality sensor values**
Temperature	±0.2 °C (pursue factory maintenance) **±0.5 °C (flag data)**
Specific conductance	±5%
Dissolved Oxygen	±6% saturation, ±0.5 mg/L
pH	±0.5 pH units

In situ Data Collection

In situ data at sampling depth

During each monitoring event, paired *in situ* data should be collected using a calibrated multisensor meter or instrument(s). Collect and record discrete *in situ* data at approximately the same depth as the water sample collection (not to exceed 2 m for epilimnetic samples). Collect dissolved oxygen (DO), temperature, conductivity, and pH readings in a manner that won't disturb or be disturbed by water sample collection.

Take a duplicate *in situ* reading where duplicate water chemistry samples are collected by lifting the meter out of the water for several moments and lowering back into the water at the depth of the previous reading. Record results and ensure that DO readings are within 0.5 mg/L of one another. If not, flag the data.

Vertical Profile

Collect a vertical profile of in situ measurements at each monitoring location.

Meters that can internally store profile information should be programmed to collect the profile under a unique file name with the following naming convention:

Site_mmddyyyy.ext (Example: LOUA016N_01062023.ext)

Ensure that the meter is logging information. Slowly lower the meter into the lake at a consistent rate. Recall the depth of the lake and do not lower more than 1 m above the lake bed. Stop logging information on the meter and pull the meter back into the boat. Bring the meter back to the surface where the discrete measurement was taken and note the DO. If DO is within 0.5 mg/L of initial reading, indicate that the profile has passed QC on the datasheet. Verify that the file was accurately recorded. Refer to the instrument's user manual for logging and verification procedures.

Meters that do not have the ability to internally store profile data should follow EPA's National Lakes Assessment method:

- Determine Measurement Intervals:
  a) The number of readings and the depth intervals taken depends on the site depth. Below is a list of rules for determining the intervals:
     i. The profile will always begin with a measurement just below the surface (e.g., approximately 10 cm or the minimum depth required to keep all probes submerged).
     ii. The last (deepest) measurements will always be at 0.5 m above the bottom.
     iii. If the site is < 2.0 m deep, record measurements beginning just below the surface and at 0.5 m intervals, until 0.5 m above the bottom.
     iv. If the depth is between 2.0-20 m (inclusive), record measurements beginning just below the surface and then at 1.0 m intervals until reaching 0.5 m above the bottom.

v. If the depth exceeds 20 m, record measurements beginning just below the surface, then at 1.0 m intervals until you reach 20 m, then at 2.0 m intervals until 0.5 m above the bottom.
vi. If the metalimnion is encountered (observed as a change of ≥1 °C per meter of depth), take measurements at least every meter within the metalimnion.
vii. Record the intervals on the Profile Data Sheet.

- Measure Temperature, DO, specific conductance, and pH:
  a) Lower the meter in the water and measure the vertical profile of temperature, DO, specific conductance and pH at the predetermined depth intervals. Be careful not to let the probe touch the bottom.
  b) Record the measurements on the Profile Data Sheet.
  c) Use the provided comment box to provide extra information about any measurements that the crew feels needs further comment or when a measurement cannot be made.

Filamentous Algae

Filamentous algae sampling procedures for Lake Catherine have been modified from the subsampling method for longitudinal surveys detailed in Griggs, et al., 2015. These procedures will accompany each monthly water sample.

Upon arrival to each site, samplers will navigate to each bank and follow a transect perpendicular to the bank. Samplers will measure the horizontal distance from shore to the point where the water is 3 meters deep (average photic zone) or 50 meters from shore, whichever is less. This horizontal distance will be split into 10 m plots for visual estimation of filamentous algae. Plot 1 will always be closest to shore, with plot numbers increasing towards mid-lake. Each plot should also be identified as to whether it is associated with the right bank or left bank (looking downstream). All samplers must be able to recognize the difference between filamentous algae, macrophytes, and cyanobacteria.

Estimates will be made in a 1 m wide strip under the transect line (i.e. 10 x 1 m^2 plot). During normal pool, maximum distances from each bank should be 50 meters resulting in a maximum of 5 samples per bank or 10 samples per transect. For any transects that do not include 5 plots, the unused plots should be marked on the datasheet as "NA" in the appropriate "% Cover" field. Filamentous algae estimates will be conducted visually to the maximum extent possible and shall be recorded as a percent coverage of the plot. Samplers will navigate along each plot and determine a visual estimate at the end. While navigating along the plot, at least 3 depth measurements will be made in meters to determine the average plot depth. At least two samplers will visually estimate independently and the result will be the average of the two estimates. Samplers will indicate if the observed algae was benthic, floating, or a combination of both. In plots where visual estimates are not possible due to lack of water clarity, the sampler will note on the "% Cover" field of the datasheet with "VDI" (for visual determination inhibited) along with a Secchi depth at mid-plot, which will be recorded in the adjacent "Position" field.

During times of draw-down, samplers will measure the distance between the wetted width and the normal pool height to determine the length of exposed bank. Samplers will estimate the percent coverage of filamentous algae on the shoreline; the exposed bank will count as an additional plot (drawdown plot = exposed bank length x 1m^2).

Incidental sampling

As samplers navigate between sites, any noticeable blooms of filamentous algae will be investigated if the blooming area is approximately 5 m^2 (about the size of a sedan) or more. At these incidental sites, samplers will indicate the relative size of the blooming area, collect in situ data, and a Secchi depth. Samplers will indicate if the algae is benthic, floating, or a combination of both.

References

Griggs, A.N., Selckmann, G.M., Cummins, J. and Buchanan, C., 2015. Methods for estimating filamentous algae cover in streams and rivers of the Shenandoah River Basin. *Final Report. US EPA Region*, *3*, p.33.

WVDEP (West Virginia Department of Environmental Protection). 2018. Watershed Assessment Branch 2018 Field Sampling Standard Operating Procedures. Division of Water and Waste Management, Watershed Assessment Branch, Charleston, WV.

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