New Mexico Environment Department
Surface Water Quality Bureau

Standard Operating Procedure (SOP)

for

LAKE SAMPLING

Approval Signatures

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1.0 Purpose and Scope

The purpose of this document is to describe the sample collection techniques, preservation requirements, equipment, and quality control activities associated with chemical, physical, and biological sampling of surface water in lentic environments. The following describes accepted approaches used in the studies of lentic systems in New Mexico. For purposes of this document, the term "lake" shall include natural lakes, as well as reservoirs, impoundments, and any other human-made lentic waters. Where appropriate, this SOP references the chemical sampling techniques used for lotic waters (SOP 8.2) and only discusses where lake sampling differs.

2.0 Responsibilities

Bureau personnel who conduct sampling activities in lentic environments or who supervise those who do are responsible for implementing this procedure.

3.0 Background and Precautions

All water sampling field activities in lentic waters will be conducted in accordance with this SOP.

Water quality samples will be collected according to Subsection C Paragraph (3) of 20.6.4.14 NMAC in the State of New Mexico Standards for Interstate and Intrastate Surface Waters, which states:

> *Lakes: ... lake sampling stations shall be located at any site where the attainment of a water quality criterion is to be assessed. Water quality measurements taken at intervals in the entire water column at a sampling station shall be averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to determine attainment of criteria, except that attainment of criteria for toxic pollutants shall be assessed during periods of*

complete vertical mixing, e.g., during spring or fall turnover, or by taking depth-integrated composite samples of the water column.

Methods of sample collection, preservation and handling used in this SOP are in accordance, except where otherwise noted, with methods described in the following references:

- "Guidelines establishing test procedures for the analysis of pollutants under the Clean Water Act," 40 CFR Part 136 or any test procedure approved or accepted by EPA using procedures provided in 40 CFR Parts 136.3(d), 136.4 and 136.5;
- Standard Methods for the Examination of Water and Wastewater, latest edition, American Public Health Association (APHA 1998);
- Methods for Chemical Analysis of Water and Waste, and other methods published by EPA Office of Research and Development or Office of Water;
- Techniques of Water Resource Investigations of the USGS;
- Annual Book of American Society for Testing and Materials (ASTM) Standards. Volumes 11.01 and 11.02, Water (I) and (II), latest edition, ASTM International;
- Federal Register, latest methods published for monitoring pursuant to Resource Conservation and Recovery Act regulations;
- National Handbook of Recommended Methods for Water-Data Acquisition, latest edition, prepared cooperatively by agencies of the U.S. Government under the sponsorship of the USGS; or
- Federal Register, latest methods published for monitoring pursuant to the Safe Drinking Water Act regulations.
- Clean Lakes Program Guidance Manual (USEPA 1980).
- Subsection C Paragraph (3) of 20.6.4.14 NMAC in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC 2011).
- Chemical Sampling SOP 8.2 (NMED SWQB 2011).

Site conditions or project-specific data collection objectives may necessitate the use of alternative field procedures not included in this SOP. The use of field methods other than those presented in this SOP must be approved by the Program Manager and alternative methods must be accurately documented.

Use gloves when handling caustic and acidic substances and waters suspected to have high bacterial contamination. Follow lab safety procedures if preparing Lugol's solution. All reagent containers and chemicals must be properly stored, labeled, and properly disposed. Take precautions to minimize exposure to chemicals in the lab and in the field.

4.0 Definitions

Euphotic zone – the depth of water in a lake that is exposed to enough light for photosynthesis to occur.

Thermocline – zone of the water column where the temperature changes one degree C or more per meter of depth. In a thermally stratified lake, the thermocline is a relatively thin transition between the warmer, shallower layer (epilimnion) and the colder, deeper layer (hypolimnion).

5.0 Equipment

See Lake/Reservoir sampling equipment checklist in the forms section for necessary equipment.

6.0 Collecting a Water Sample (Process Description)

6.1 Collecting Physical Data

At each station, use a calibrated multi-parameter sonde (Sonde Calibration and Maintenance SOP 6.1) and data logger to measure the depth profile for dissolved oxygen concentration, specific conductance, temperature, turbidity and pH. Data are collected at one-meter intervals up to 30 meters depth or the top one third of the lake, whichever is greatest. After 30 meters or the top one third of the lake, collect measurements every five meters. Measurements are taken at the surface to within one meter of the bottom of the lake or to the maximum depth allowed by current equipment (75m). Record measurements on the Depth Profile section of the Lake and Reservoir Field Sheet.

Examine the profile for the presence of a thermocline (greater than one degree Celsius change per meter). If present, measurements taken within the epilimnion (above the thermocline) are averaged for assessment. If absent (i.e., the lake is well mixed), measurements taken from the upper one-third of the depth profile are averaged for assessment purposes in accordance with 20.6.4.14 NMAC referenced in section 3.0 above.

Determine water color at the lake surface using a Forel-Ule Color scale. Measure secchi depth on the shaded side of the boat with sunglasses removed. In estimating the euphotic zone, limnologists have multiplied the secchi depth by various values (Cole 1983 and 1994). At present, NMED uses 3.2 times the secchi depth to estimate euphotic zone (Davis 2011). Record the estimate for the euphotic zone on the Lake and Reservoir Field Sheet.

6.2 Collecting Lake Water Samples for Chemical Analysis

Double rinse collection equipment used for multiple sites, such as the Kemmerer, 5-gallon carboy, and chlorophyll flask and funnel, with lake water prior to use. Collect water samples in accordance with Subsection C Paragraph (3) of 20.6.4.14 NMAC. For biological data (i.e., phytoplankton, *E. coli*, and chlorophyll) refer to Section 6.3.

If possible, compositing equipment (e.g., Kemmerer, Carboy, etc.) should be constructed of glass, Teflon, or stainless steel when samples are to be analyzed for organic compounds. Organic samples collected with equipment that is not constructed of glass, Teflon, or stainless steel are inconsistent with sampling methods described in the Chemical Sampling SOP and Table 2 of 40CFR Part 136. Previous results from samples collected using non-compliant equipment have not shown detections of organic analytes that would implicate the sampling equipment as a potential source of contamination. Regardless, organic results obtained through the use of non-compliant equipment should be flagged. If using a stainless steel Kemmerer for organic composite sampling, a separate composite sample must be collected for metals using a non-metallic Kemmerer.

During periods of lake stratification (**thermocline is present**), State Water Quality Standards require depth-integrated composite samples from the entire water column for toxic pollutants (Figure 1). Collect one 5-liter sample from the top (within the epilimnion), middle, and bottom of the entire water column using a rinsed Kemmerer water sampler. For the bottom sample, keep the Kemmerer at least 1 meter away from the bottom to avoid stirring up sediments. All water quality samples are poured off from the composited sample into their respective containers; 1-liter Cubitainers® or other containers as prescribed by the analysis to be performed. Dissolved metal samples are filtered prior to being poured into 1-liter Cubitainers®.

When the lake is well mixed (**thermocline is not present**), collect one 5-liter sample from the top, middle, and bottom of the euphotic zone (Figure 2) or the upper 1/3 of the water column (Figure 3), whichever is shallowest . Composite the three 5-liter samples in a 5-gallon carboy. If the lake max depth is 3 meters or less, samples need to be collected at one meter or less. If the lake is one and a half meters or less the vertical Kemmerer cannot be used and water samples must be taken from just below the surface. All

water quality samples, except organics, are poured off from the composited sample into their respective containers. Samples collected for organics during periods of complete vertical mixing should be collected as grab samples directly into glass sample containers from approximately 4"- 8" below water surface. Dissolved metal samples are filtered prior to being poured into 1-liter Cubitainers®.

For either sample collection method described above, refer to Chemical Sampling SOP 8.2 for the specific sampling and preservation requirements, quality control activities, and handling, packaging, and transporting procedures based on the analyte suite. See Figure 1 for a visual explanation of the sample collection methods.

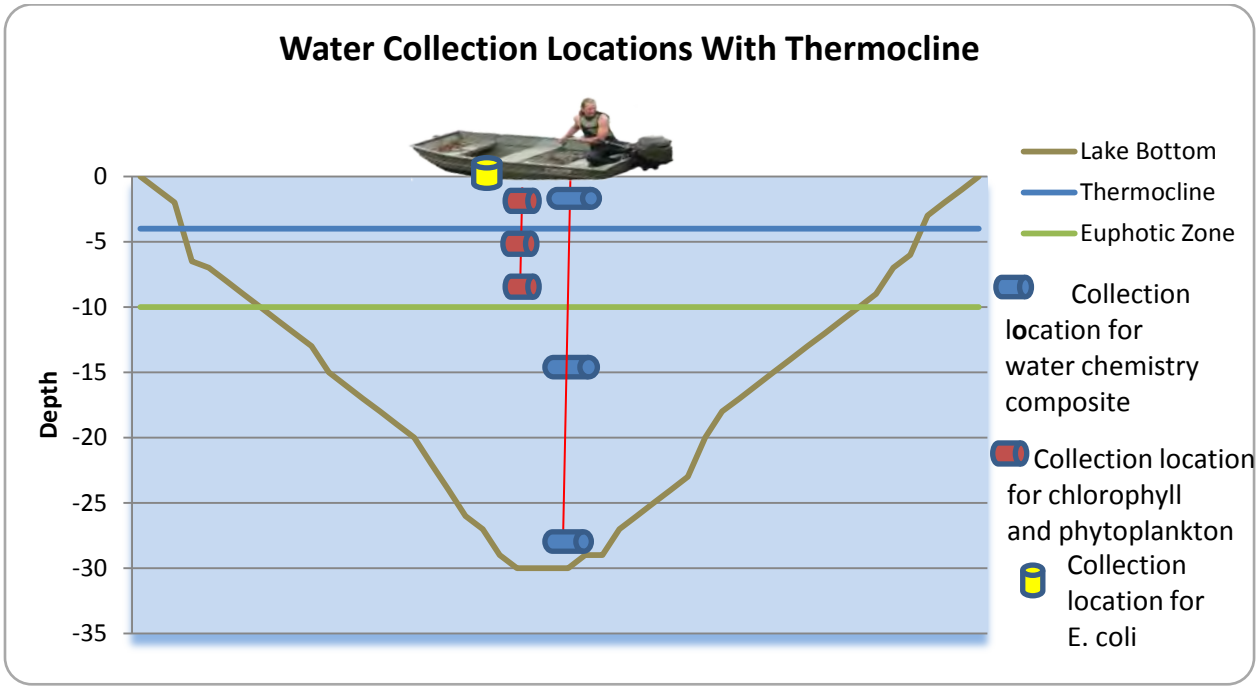

Figure 1. Sample collection methods when a thermocline is present.

Note: When the euphotic zone is equal to the max lake depth, the water chemistry, chlorophyll, and phytoplankton can be taken from the same composite as the water chemistry.

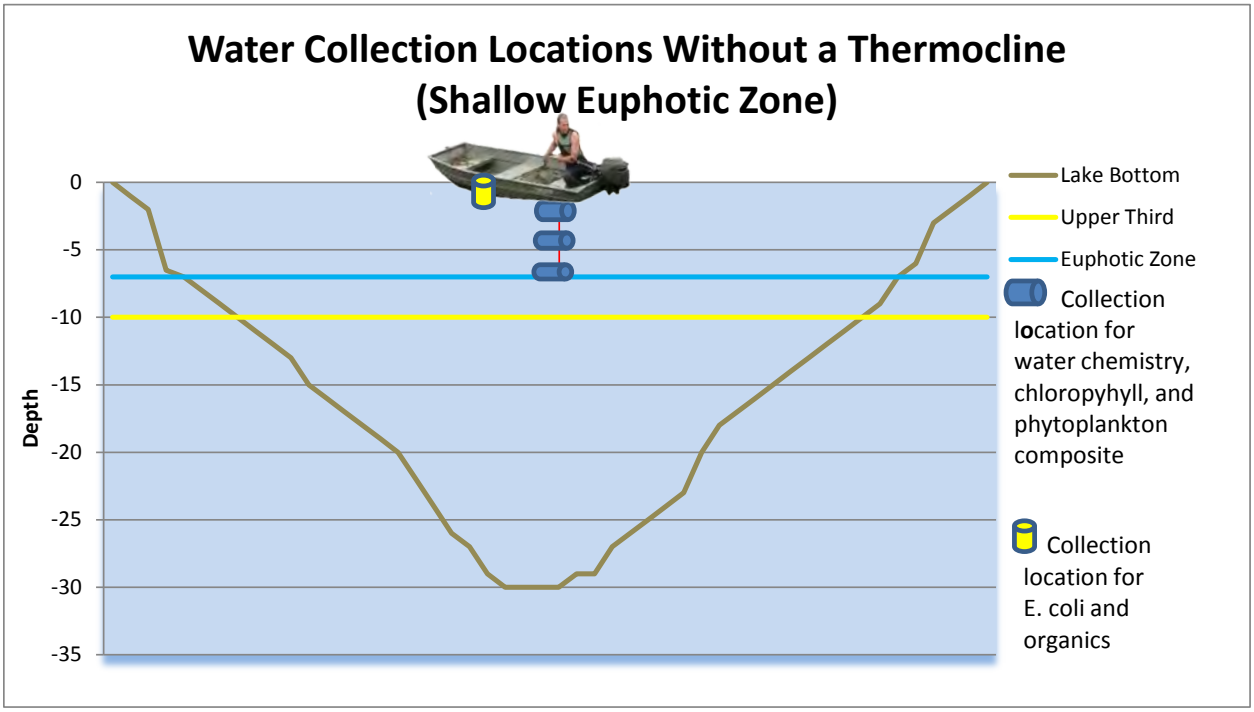

Figure 2. Sample collection methods with a shallow euphotic zone and no thermocline.

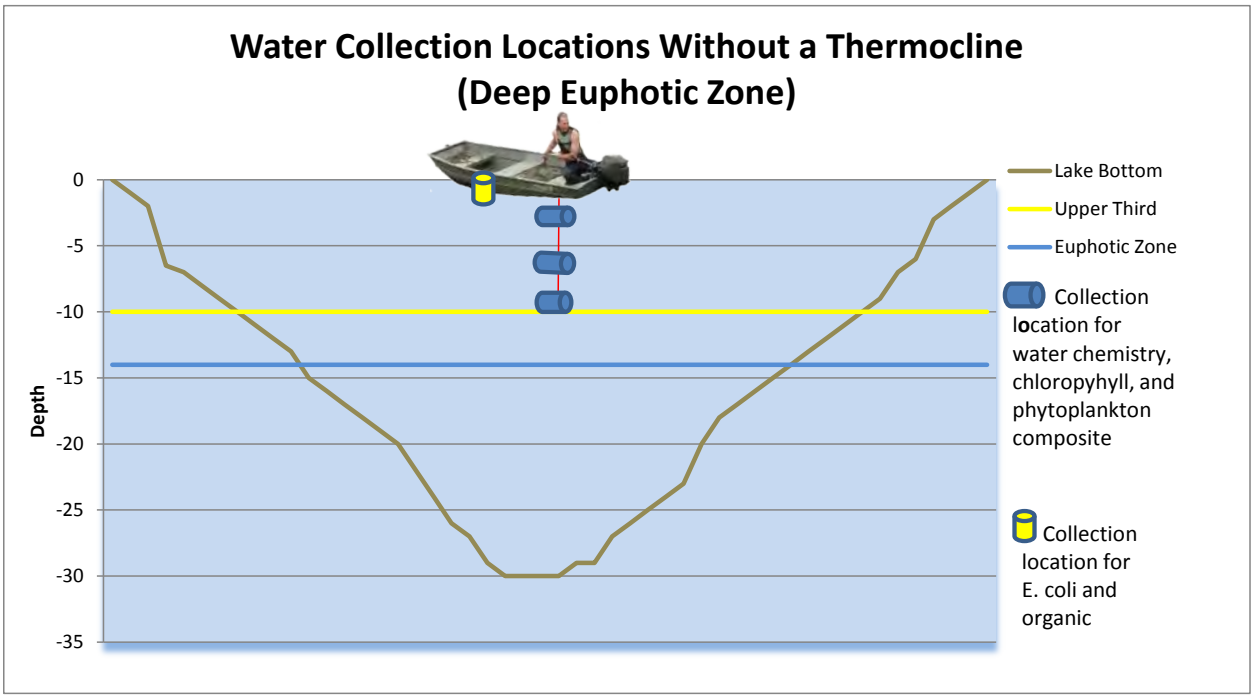

Figure 3. Sample collection methods with a deep euphotic zone and no thermocline.

6.3.1 Macrophyte Coverage

Visually estimate the percent of macrophyte coverage in the lake or reservoir and record estimate on the Lake and Reservoir Field Sheet.

6.3.2 Phytoplankton Sampling

Phytoplankton samples are composited from the top, middle, and bottom of the euphotic zone (Figure 1, 2, and 3). Collect samples from the euphotic zone with a rinsed Kemmerer and fill a 1-liter Cubitainer®. When the lake is well mixed (thermocline is not present) a phytoplankton sample can be collected with the chemistry sample from top, middle, and bottom of the euphotic zone (Figure 2) or the upper 1/3 of the water column (Figure 3), whichever is shallowest. If the lake max depth is 3 meters or less, samples need to be collected at one meter or less. If the lake is one and a half meters or less in depth, the Kemmerer cannot be used and water samples must be taken from just below the surface. Preserve sample within 2 hours of collection using approximately 10 milliliters of Lugol's solution until the sample turns to a weak tea color. Store samples in the dark and under refrigeration (EPA 2002).

At the end of the sampling season after all samples are collected ship samples to the contracted lab for identification and enumeration.

6.3.3 E. coli

Collect *E. coli* samples from the surface of the water, either from the boat or at the dock in accordance with the procedures in Bacteriological Sampling SOP 9.1. See Figure 1, 2, and 3 for a visual representation of the sample collection method.

6.3.4 Chlorophyll Samples

Chlorophyll samples are composited from the top, middle, and bottom of the euphotic zone (Figure 1, 2, and 3). Collect samples from the euphotic zone with a rinsed Kemmerer and fill a 1-liter Cubitainer®. If the lake is well mixed (thermocline is not present) a chlorophyll sample can be collected with the chemistry sample from top, middle, and bottom of the euphotic zone (Figure 2) or the upper 1/3 of the water column (Figure 3), whichever is shallowest. If the lake max depth is 3 meters or less, samples need to be collected at one meter or less. . If the lake is one and a half meters or less in depth, the Kemmerer cannot be used and water samples must be taken from just below the surface. Filter sample water through a Whatman Glass Fiber Grade GF/F or GF/C filter until substantial color development is on the filter medium, indicating adequate chlorophyll pigment is present. If clogging or filtering time is a concern, use the larger retention of the GF/C filter. It has been shown that there is no difference between chlorophyll concentrations collected on Whatman GF/F of GF/C filters (Prepas et al. 1988). Be sure to record the volume of water filtered on the field sheet. Remove the filter from the filtering apparatus, fold it in half, place it in a labeled petri dish and wrap with aluminum foil, then put in a zip lock and place on dry ice. Upon return to the SWQB lab store samples in a freezer until processed or until shipped to contract lab. Samples should be processed as soon as possible after collection; however, samples on filters taken from water having pH 7 or higher can be frozen for up to 28 days before analysis, if necessary. Samples from acidic water (< pH 7) should be processed promptly after filtration to prevent possible chlorophyll degradation from residual acidic water on filter. If processing must be delayed, hold sample water on ice or at 4°C and protect from exposure to light by using opaque bottles and storing in the dark. Samples are analyzed for Chlorophyll *a* concentration using either a certified contract lab or the method described in the Biological Sampling SOP 11.2.3 *Chlorophyll Sample Preparation and Analysis*. Results from in-house analysis or outside lab are then uploaded to SQUID using the *Chlorophyll a Analysis Sheet*..

When using a contract lab confirm sample processing methods. If processing methods differ from above follow instructions provided by the contract lab for processing samples.

7.0 QUALITY ASSURANCE/CONTROL ACTIVITIES

All field data and chemical / biological samples collected following the procedures outlined above are entered in SWQB's water quality database as part of a Lake Sampling Event. A second staff member verifies that the data are entered correctly. Date of entry and verification are noted on the field sheet.

QA/QC activities for chemical sampling are the same as described in the Chemical Sampling SOP for streams (SOP 8.2)

In addition, equipment blanks for organics should be performed as needed based on the QAPP to confirm that sampling equipment is not a source of contamination. De-ionized water used for this equipment blank should be obtained from SLD in glass containers and exposed to the sampling equipment for a combined residence time of 30 minutes to accurately characterize field exposure.

8.0 FORMS

- Lake/Reservoir sampling equipment checklist
- Lake/Reservoir field sheet

9.0 REVISON HISTORY

Revision 3 – March 2014 – revised language and figures to clarify sampling depths during different mixing conditions. Added the use of either a contract lab or in-house analysis.

Revision 2 – March 2013 – added information regarding compliant and non-compliant sampling equipment for organic samples to be consistent with SOP 8.2 Chemical Sampling and 40 CFR Part 136; added clarification for sampling in shallow lakes (≤ 3 meters in depth) and use of larger filters for chlorophyll

Revision 1 – March 2012 –clarified sampling procedures for conditions with a thermocline present (stratified) and when a thermocline is absent (mixed); added guidance on sampling lakes where low DO is a suspected water quality concern

Original modified from SOP 2007.

10.0 REFERENCES

American Public Health Association (APHA). 1998. Standard methods for the examination of water and wastewater, 20th Edition. Washington, D.C. 1112 p.

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