32125 Bio Station Lane
Polson, Montana, U.S.A. 59860
http://flbs.umt.edu/newflbs/outreach/mmw

2021
Sampling and Analysis Plan (SAP)

Clearwater Resource Council
Lake and Stream Monitoring

Date: March 26, 2021

Prepared by:
Haylie Brown, Emily McGuirt, and Caryn Miske
Clearwater Resource Council
PO Box 1471
Seeley Lake, MT 59868

Approved by:

Rachel L Malison

Digitally signed by Rachel L Malison
DN: cn=Rachel L Malison, o=Flathead Lake Biological Station, ou, email=rachel.malison@umontana.edu, c=US
Date: 2021.05.26 15:38:09 -06'00'

Dr. Rachel Malison (Monitoring Montana Waters Program Manager) Date

TABLE OF CONTENTS

PREFACE

Monitoring Montana Waters offers a wide range of assistance to help citizen-led watershed groups complete this SAP template. For many groups, this may be the first time that volunteers or personnel will have completed this type of document. The purpose of a SAP is to make sure groups have a detailed monitoring plan, that they know why and how they will sample, and that the data produced from all the effort expended will be scientifically credible and available to support the management of our waters. MMW can answer any questions and provide support for groups as they write their SAP. Though it is expected that each group has volunteers or personnel that actively work on the SAP, MMW will provide feedback and assist groups to complete the document. Don't hesitate to contact us via email mmw@flbs.umt.edu or phone 406-872-4518.

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

The Clearwater Basin has unique natural resource values as this watershed forms the southernmost portion of the Northern Continental Divide Ecosystem (NCDE), which extends from the Highwood River in Alberta to the Blackfoot River in Montana. The NCDE is also known as the "Crown of the Continent'' and has a high global conservation status. Moreover, together with the Swan Lake region and the Lincoln Ranger District, the Clearwater has unique landscape connectivity value, linking the Bob Marshall, the Lincoln Scapegoat, and the Mission Mountain Wilderness areas. Locally, the Clearwater is known as the "Chain of Lakes." These glacially created lakes, from north to south include Lake Alva, Lake Inez, Seeley Lake, Big Sky Lake, Salmon Lake, and Placid Lake (Figure 1).

Since 2003, the Clearwater Resource Council (CRC) has facilitated efforts to enhance, conserve, sustain, and protect the aquatic resources of the Clearwater Valley for present and future generations. Through citizen science monitoring, CRC has worked with community members to build a foundational knowledge of the conditions of our lakes and streams, how they function, and their vulnerability to change.

In late summer of 2008, CRC initiated a community-based lake-monitoring program, which was continued and expanded in subsequent years. The 2021 field season represents the 13th year of lake monitoring and will be an expansion on previous lake monitoring efforts. CRC began facilitating stream data collection in 2013 in collaboration with the Southwest Crown Collaborative. With help from local citizen scientists, CRC has collected comprehensive data on more than 20 streams over the historical monitoring period. Although our goals and the associated sampling sites have changed over time, 2021 will be the 6th year of stream monitoring in the Clearwater Basin. CRC hopes that the program will continue to grow spatially, temporally and in scope over time to better address aquatics protection on-the-ground. As CRC's monitoring program grows, updated goals and objectives will be published via our annual SAP revisions.

Population growth and the subsequent increase in septic tank density in the region has led to water quality concerns. CRC hopes that with the expansion of lake and stream monitoring in 2021 we will be able to better inform our understanding of anthropogenic influences on our lakes. CRC hopes to monitor all parameters on both lakes and streams each year, depending upon funding availability. During years when budgetary constraints occur, the monitoring parameters will be limited according to the available budget. It is also CRC's goal to ensure that lake nutrient parameters are monitored on a five-year interval, at a minimum.

A budget table for laboratory analytical costs is included in **Appendix A**.

1.2 PROJECT AREA OVERVIEW

Clearwater Resource Council will monitor six lakes, the Clearwater River and Morrell Creek, for water quality. Big Sky Lake is a highly developed private lake, while the other five lakes are public, larger in size, and range in development and usage. The Clearwater River connects four of the lakes (Alva, Inez, Seeley, and Salmon), while Placid Lake outflows via Owl Creek into the Clearwater River upstream of Salmon Lake. Lake sites are located at mid-lake deep points and along the perimeter, near development, to capture data associated with septic systems and sedimentation. The Clearwater River runs the length of the watershed. CRC will sample the Clearwater River near the headwaters and the mouth, near the confluence with the Blackfoot River. Morrell Creek is a larger stream that flows on the east side of the Seeley Swan valley that runs through the Double Arrow Ranch Land Owners Association. CRC will monitor Morrell Creek above the development at an already established site at the Seeley Swan High School to serve as a control to compare to the downstream site. The second site on Morrell Creek is downstream of the confluences with Trail and Drew creeks and most of the development. Morrell is a tributary of the Clearwater River above Salmon Lake.

See Appendix D for more site maps.

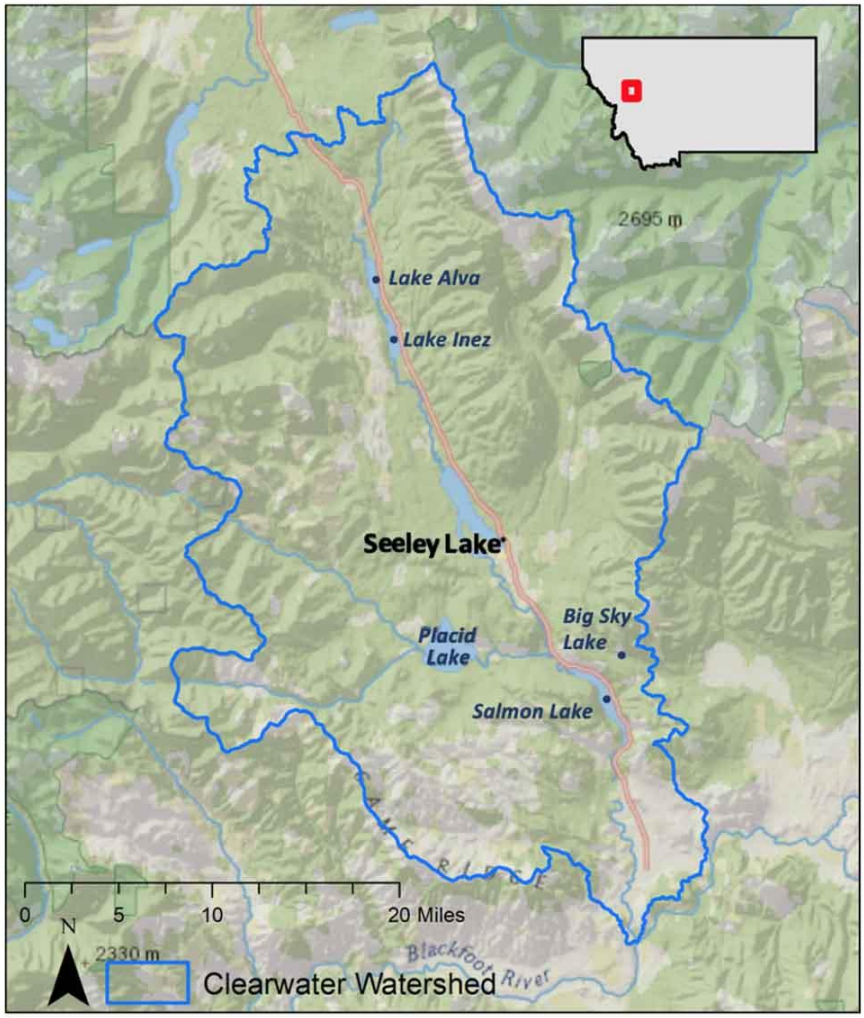

Figure 1. The Clearwater watershed.

1.3 Project Team and Responsibilities

Table 1. Project Team Roles and Responsibilities

Role	Person(s)	Contact phone, email
Develop Sampling and Analysis Plan (SAP)	Haylie Brown	crc.tech.asst@crcmt.org
Oversee monitoring personnel	Haylie Brown	crc.tech.asst@crcmt.org
Training monitoring personnel	Haylie Brown	crc.tech.asst@crcmt.org
Primary monitoring personnel (known people who will help collect data)	Alicia Dixon and Kristjan Johnson	crc.watshd.coord@crcmt.org krawrj19@gmail.com

Review field forms	Haylie Brown	crc.tech.asst@crcmt.org
Lab coordination (e.g., bottle orders, shipping notifications, lab EDDs)	Haylie Brown	crc.tech.asst@crcmt.org
Ship or deliver samples to lab	Haylie Brown, Alicia Dixon, and Kristjan Johnson	crc.tech.asst@crcmt.org crc.watshd.coord@crcmt.org krawrj19@gmail.com
Complete chain of custody form/s	Haylie Brown and Alicia Dixon	crc.tech.asst@crcmt.org crc.watshd.coord@crcmt.org
Review data quality and enter field data into EDD prior to upload	Haylie Brown	crc.tech.asst@crcmt.org
Upload data into MT-eWQX database	Haylie Brown	crc.tech.asst@crcmt.org
Write final report	Haylie Brown	crc.tech.asst@crcmt.org

2.0 OBJECTIVES AND SAMPLING DESIGN

2.1 PROJECT GOALS AND OBJECTIVES

Table 2. Project Goals, Objectives and Analyses

Goal	Objective	Data Analysis
Evaluate current nutrient conditions in six lakes and two streams to establish a baseline for future comparisons.	To collect nutrient samples (TP, TN, NO_2+NO_3, and SRP) on six lakes (30 sites) and two streams (four sites) once during runoff and three times during the growing season (July 1- September 30).	Compare stream nutrient (TP, TN, NO_2+NO_3, and SRP) concentrations to DEQ wadable streams nutrient thresholds during the period July 1-September 30 and levels that could lead to harmful algae blooms
	To obtain baseline data to begin to understand conditions contributing to blue-green algae blooms on Seeley, Salmon and Placid lakes.	Compare to past data and for future comparisons and plot total algae profiles from Sonde data

Evaluate water quality in six lakes and two streams to continue monitoring and establish baselines for new parameters.	To obtain baseline data (transparency, temperature, pH, conductance, dissolved oxygen, total algae) for six lakes in the Clearwater chain-of-lakes to track water quality trends over time and provide data necessary for crafting individual lake management plans.	Plot profile and point data for future comparisons.
Evaluate whether septic systems are a likely source of excess nutrients in the six lakes and two streams.	To obtain baseline nutrient data on the Clearwater River at the headwaters and the mouth to determine whether septic systems could be a source of excess nutrients in the Clearwater Watershed and downstream waters.	Compare nutrient concentrations to DEQ thresholds during the period July 1-September 30.
		Plot data for future comparisons.
	To obtain baseline data to better understand potential septic leachate impacts to surface water quality, by comparing the upstream and downstream sites.	Compare nutrient concentrations between the site above development and the site below to determine if there is a significant increase.
	To collect E. Coli samples on six lakes (18 sites) and on two streams (four sites) once during runoff and three times when DEQ standards apply.	Compare E. Coli concentration to DEQ standards during the period of July 1-September 30.

2.2 MONITORING LOCATIONS

Table 3. Monitoring Locations*

Lake	Site Name	Site Description	Latitude	Longitude	Parameters to Collect						Rationale for Site Selection
					TP,TN	NO_2+NO_3,SRP	E. Coli	Sonde	DO	Secchi	
Big Sky	Mid Lake	Surface	47.116	-113.396	1	1	1	Profile	Profile	Y	Private lake that is highly developed.
		Deep (50 ft / 15.2 m)			1	1					
Alva	Mid Lake	Surface	47.316	-113.583	1	1	1	Profile	Profile	Y	First larger lake in the watershed before major development, used as a control.
		Deep (90 ft / 27.4 m)			1	1					
Inez	S Homes	Surface	47.271	-113.569	1	1	1	Point			Second larger lake with

	E Homes	Surface	47.278	-113.561	1	1	1	Point			moderate development.
	W Homes	Surface	47.287	-113.571	1	1	1	Point			
	Mid Lake	Surface	47.279	-113.565	1	1		Profile	Profile	Y	
		Deep (74 ft / 22.6 m)			1	1					
Placid	S Homes	Surface	47.108	-113.519	1	1	1	Point			Larger lake with major development.
	N Homes	Surface	47.133	-113.529	1	1	1	Point			
	E State Park	Surface	47.119	-113.504	1	1	1	Point			
	Mid Lake	Surface	47.118	-113.521	1	1		Profile	Profile	Y	
		Deep (93 ft / 28.3 m)			1	1					
Salmon	S Bay	Surface	47.076	-113.388	1	1	1	Point			Last large lake in the watershed, downstream of most of the major development.
	Cove	Surface	47.069	-113.386	1	1	1	Point			
	E Homes	Surface	47.100	-113.403	1	1	1	Point			
	Paws up	Surface	47.105	-113.410	1	1	1	Point			
	Mid Lake	Surface	47.097	-113.405	1	1		Profile	Profile	Y	
		Deep (60 ft / 18.3 m)			1	1					
Seeley	S Bay	Surface	47.174	-113.482	1	1	1	Point			Larger lake with major development.
	SW Cabins	Surface	47.173	-113.492	1	1	1	Point			
	Montana Pines	Surface	47.193	-113.508	1	1	1	Point			
	Tamarack's	Surface	47.204	-113.512	1	1	1	Point			
	Ranger Station	Surface	47.213	-113.522	1	1	1	Point			
	SLCG	Surface	47.190	-113.515	1	1	1	Point			
		Surface		-113.489	1	1				Y	

	Mid Lake (S Hole)	Deep (60 ft / 18.3 m)	47.175		1	1		Profile	Profile		
	Mid Lake (Mid Hole)	Surface	47.186	-113.504	1	1		Profile	Profile	Y	
		Deep (70 ft / 21 m)			1	1					

Stream	Site Name	Latitude	Longitude	Parameters to Collect						Rationale for Site Selection
				TP/TN	NO_2/NO_3/SRP	E. Coli	pH	Temp	Discharge	
Clearwater River	Near Rainy Lake	47.347	-113.588	1	1	1	1	1	Y	Near the headwaters of the river and chain of lakes, above development, used as a control.
Clearwater River	Near the confluence with the Blackfoot River	47.000	-113.382	1	1	1	1	1	Y	Near the confluence with the Blackfoot River, see how much exits our watershed.
Morrell Creek	Near HWY 83	47.146	-113.465	1	1	1	1	1	Y	Just above the confluence with the Clearwater River, and below the confluences with Trail and Drew creeks, where a lot of residential development is.
Morrell Creek	At SSHS	47.173	-113.469	1	1	1	1	1	Y	Already an established site through the SIA program and is above major development.

*These are proposed sampling locations that may change due to unforeseen access or other issues.

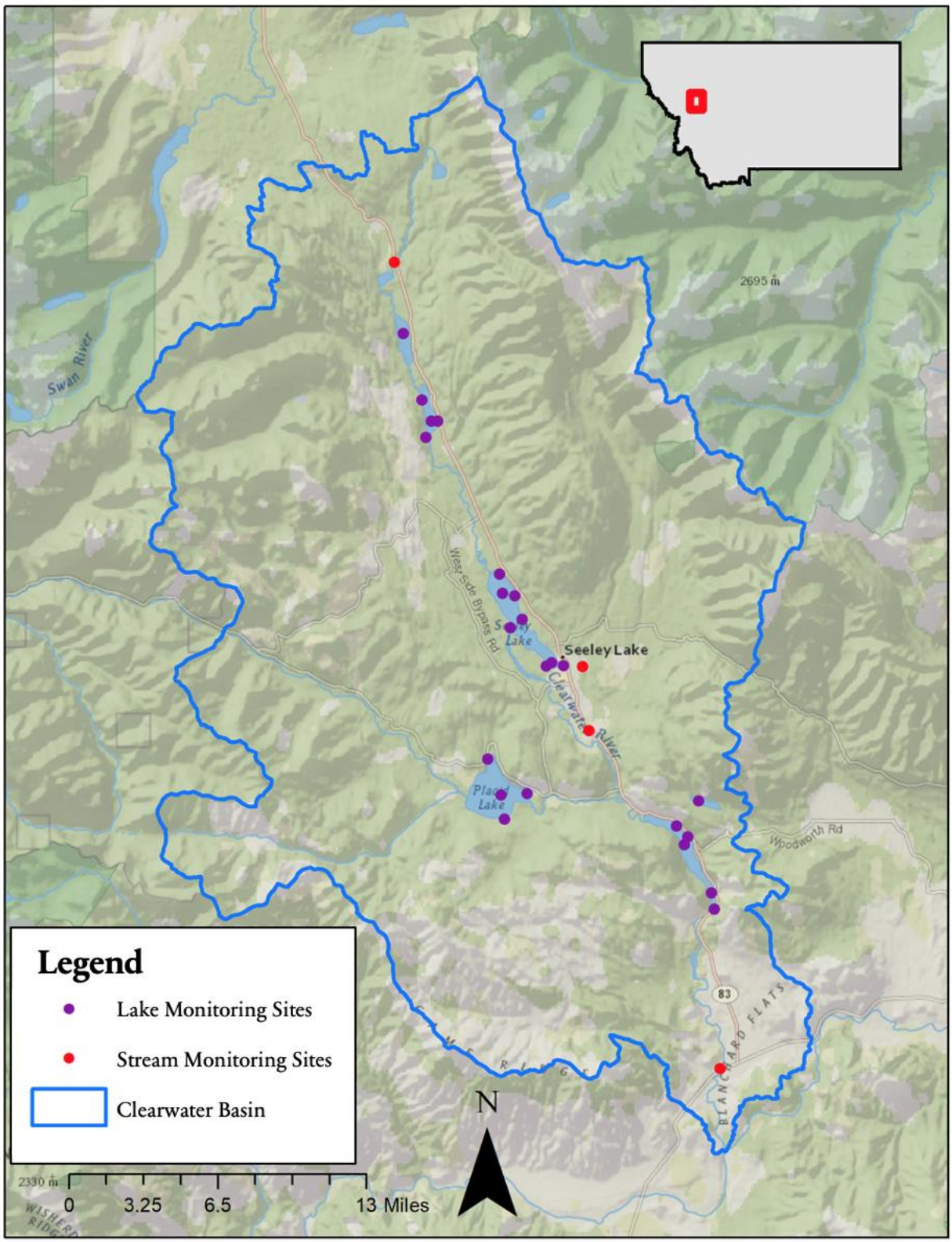

Figure 2. Map of the Clearwater basin showing all the sampling sites. More maps can be found in Appendix D.

2.3 MONITORING SCHEDULE

Table 4. Monitoring Schedule

Date	Parameters	Rationale for Timing
Mid-Spring rising limb of hydrograph or peak flows.	Lakes: Water quality (TP, TN, NO_2+NO_3, SRP, and E. Coli), dissolved oxygen, Sonde (pH, total conductance, total algae, temperature, and depth), and Secchi. Streams: Water quality (TP, TN, NO_2+NO_3, SRP, and E. Coli), pH, temperature, and discharge.	Overland flow, runoff before growing season.
July		Base flow and summer growing season.
August		
September		

2.4 WATER QUALITY PARAMETERS

Table 5. Water Quality Parameters

Parameter or Data Type	Collection Approach	Justification for Collecting
Total Nitrogen (TN)	Parameters measured by lab analyzed by the lab through water sampling	Used to track trends over time for comparisons.
Total Phosphorus (TP)		
Nitrite + Nitrate and Soluble Reactive Phosphorus		
E. Coli		
pH	Lake (all): Parameters measured in situ with Sonde EXO3 field meter. Streams (pH and temp): parameters measured in situ with pH strips and thermometer.	Description water quality measurements.
Water temperature		
Specific conductance (SC)		
Total Algae		
Dissolved oxygen (DO)	Measured in situ with YSI Pro 20 DO Meter.	
Transparency	Measured with Secchi Disk	
Discharge (flow)	Flow meter	Used to calculated total loads.
Photos	Taken with digital camera	Used to track site conditions (algae, riparian vegetation, etc.).

3.0 FIELD PROCEDURES

3.1 REQUIRED FIELD GEAR

- EXO3 Multiparameter Sonde
- YSI Pro 20 DO Meter
- Flow meter
- Kemmerer bottle
- Sampling bottles
- Filters
- Syringes
- Secchi disk
- pH strips
- Thermometer
- Fine point sharpies
- GPS (or phone)
- Site maps
- Snowmobile/snowshoes/etc. to get to sites
- Cooler to hold samples
- Rite-in-the rain notebooks, pencils
- Boat
- Safety equipment
- Anchor(s)

3. 2 ORDER OF OPERATIONS

This section gives an overview of all the sampling tasks for the field day and the subsequent sections give a more detailed description of the tasks. Safety protocols will be followed throughout the sampling process (Section 5.7).

Each field day:

1. Review field equipment checklist and collect all gear needed for the sites that will be visited that day.
2. For lake sites, conduct calibration of Sonde probes and YSI Pro 20 meter.
3. Inspect vehicles being used for the day.
    a. Inspect the boat for lake sites.
4. Drive to the site(s).

Each field site (lakes):

1. Arrive at the site.
2. Prepare the boat for data collection—load all equipment in the boat.
3. Navigate to the sampling site on the lake. Verify that you are at the correct location with GPS coordinates and field photos.
4. Set up your workstation.
    a. Turn on equipment and prepare for data collection.
    b. Fill out field forms and label sample bottles.
5. Collect and record field measurements using the Sonde.
6. Collect and record field measurement with YSI Pro 20 instrument.
7. Collect and store water samples. Make sure all samples are properly labeled.
8. Collect and record field measurement with Secchi Disk.
9. Record other physical field information. Make sure all sections of the field form are filled in, including photos.
10. Take photos of completed data sheets in case data is lost or damaged.
11. Pack up your workstation and continue to the next site or back to shore.
12. Once back to shore, respect the boat and load all equipment to be transported to the next lake or back to the office.

Each field site (streams):

1. Arrive at the site.
2. Prepare all sample bottles for samples being collected that day.
3. Collect and store water samples in the cooler.
4. Test pH using pH strip and record.
5. Take temperature using a thermometer and record.
6. Record other physical field information. Make sure all sections of the field form are filled in, including photos.

7. Take photos of completed data sheets in case data is lost or damaged.
8. Pack up all the field equipment and continue to the next stream or back to the office.

Back at the office:

1. Unload all field equipment and clean all equipment, follow all proper protocols for cleaning and storing.
2. Store all samples in the office freezer until they can be transported to the Flathead Lake BioStation for testing/processing.
3. Upload all photos and data onto the computer according to DEQ protocols.

3.3 FIELD FORMS

Field forms are found in Appendix B.

- Equipment Checklists
- Field Data Forms
- Chain of Custody

3.4 DATA COLLECTION STANDARD OPERATING PROCEDURES (SOP'S)

3.4.1 Dissolved oxygen

Dissolved oxygen (DO) measurements will be collected with a YSI Pro 20 instrument. The YSI Pro 20 uses a polarographic oxygen sensor and provides both mg/L and percent saturation of dissolved oxygen along with water temperature to identify the thermocline. Above the thermocline, the water is well mixed and generally maintains a high amount of DO because of diffusion from the air and photosynthesis from aquatic algae or phytoplankton. Below the thermocline, the water is colder and does not mix well, and has little photosynthesis. Decomposition of organic material either settling from above or in the sediments can cause the DO to decline once stratification takes place.

Method steps:

1. Arrive at the site. Remove the YSI Pro 20 instrument and assemble. Attach the weight if necessary.
2. Calibrate the YSI Pro 20 instrument by using the self-calibration capability designed into the instrument.
3. Begin taking measurements with the first measurement at the surface and then continue taking them every one meter until reaching one meter above bottom.
4. Record the depth, temperature and DO measurements in the DO field notebook for lakes and the on the Stream Field form for streams.

a. The YSI Pro20 instrument only holds 50 data points; manually record all data (temperature, DO, and depth).
5. Disassemble and pack the YSI Pro 20 instrument back into its case.

3.4.2 Secchi Disk

In summary, transparencies will be measured using a 20 cm black and white quadrant Secchi disk suspended on a fiberglass tape measure and lowered until it is no longer visible. Two measurements will be taken and then averaged together for the final reading. In an attempt to control some of the limiting factors associated with Secchi readings, data will be recorded between 11 AM and 3 PM, without sunglasses, on the shady side of the boat that is held in the same place during the reading.

Method steps:

1. Arrive at the site and anchor the boat. For the most accurate reading, the boat needs to remain steady in the same place, and the disk should hang straight down.
2. Take the reading between 11 AM and 3 PM on the shady side of the boat, without sunglasses. Try to remove any glare from the water to improve the visibility with your body.
3. Slowly lower the Secchi disk straight down into the lake until it is no longer visible (no white glow) and record the depth, to the nearest inch, from the fiberglass tape on the Field Data Form. Slowly, raise the disk and record the depth when it becomes visible again on the Field Data Form.
4. Repeat Step 3 for a second reading.
5. Average the two readings and record on the Field Data Form.
6. If the Secchi disk reaches the lake bottom and is still visible, then the true Secchi disk reading is greater than the site's depth and is an inappropriate measure for the site. Comment on the Field Data Form that the site is too shallow for a Secchi disk reading.

3.4.3 EXO3 Sonde

The Sonde will be used to collect the following data: depth and profiles of water temperature, pH, conductivity, chlorophyll, and blue-green algae.

Calibrating the Sonde
The Sonde must be calibrated prior to any data collection (Section 6.2).

Method steps:

1. Remove the Sonde from its case and power on.
2. Remove the calibration cup from the sensors and replace it with the sensor guard for field use. Allow 10-15 minutes for the sensors to acclimate in preparation for data collection.
3. Determine the depth to the lakebed of the site with the depth sensor.

4. Collect data at one-meter intervals to create a profile for the site, starting at the surface.
5. At each depth, observe the display screen until the value(s) stabilize, record on the Field Data Form.
6. Once data collection is complete, replace the sensor guard with the calibration cup filled with tap water for transportation and storage.
7. If there were any issues with the Sonde, record them in both the calibration logbook and the Field Data Form.

3.4.4 Lake water samples for laboratory testing (TN and TP)

Sample Bottles and Labels

Total nitrogen and total phosphorus samples will be collected in the bottle provided by the lab. Before collecting each sample, use a permanent, fine-point marker to label the sample bottles needed for each water sample at a site. Include the Sample ID (site ID), date collected, time collected, and collector's initials. Cover each label with clear plastic tape to protect the label from water damage.

Collecting Lake Samples from Below Water Surface

1. Label the sample using a fine point sharpie. Cover the label with a piece of clear tape.
2. Triple-rinse the bottle and lid: Collect a small amount of water in the bottle, replace the lid, and shake gently. Discard this rinse water on the opposite side of the boat, away from where the sample will be collected. Repeat this process three times to triple-rinse the bottle.
3. Grab the bottom of the bottle with the opening facing towards the surface of the water. Submerge the bottle until your arm is about elbow deep, let the bottle fill, leaving enough space for preserving (freezing) the sample, and bring it to the surface and tightly secure the lid.
4. Place a sample in the cooler on ice and freeze at the end of the sampling day.
5. Fill out the Field Data Form.

Collecting Lake Samples from 1 Meter Above the Lake Bed

Kemmerer samplers allow for collecting water samples from a known depth:

1. Label the sample using a fine point sharpie. Cover the label with a piece of clear tape.
2. Determine the total depth (to the lake bed) and then one meter above the total where samples will be collected.
3. Securely attach the Kemmerer to a sturdy line (e.g., rope, chain, cable); use of a winch is optional.
4. Open the Kemmerer: each end of the cylinder is fitted with a rubber cover; hold one side firmly and pull the other side to open until it clicks to remain open.
5. Attach a messenger (metal weight) to the line.

6. Hold the messenger above the water surface, slowly and steadily, lower the Kemmerer to the desired depth (one meter above the lake bed).
7. Hold the Kemmerer line in place and drop the "messenger" down the line to trigger the rubber end seal to snap shut. Raise the Kemmerer to the surface.
8. Use the drain valves to release water from the Kemmerer to perform rinsing and sample collection; follow the unfiltered grab samples procedure. Triple-rinse the bottle and lid: Collect a small amount of water in the bottle from the Kemmerer, replace the lid, and shake gently. Discard this rinse water. Repeat this process three times to triple-rinse the bottle.
9. Fill the rinsed sample bottle from the water remaining in the Kemmerer, leave enough space for freezing (preserving) the sample. Tightly secure the lid.
10. Place a sample in the cooler on ice and freeze at the end of the sampling day.
11. Fill out the Field Data Form.

3.4.5 Stream water samples for laboratory testing: whole water samples (TN and TP)

Method Steps:

1. Label the sample using a fine point sharpie. Cover the label with a piece of clear tape.
2. Unscrew the lid and hold it in one hand. Be sure not to touch the lip of the lid or bottle.
3. Using the other hand, submerge the bottle into the water until approximately ¼ of the bottle is full. Samples should be collected in the main flow away from eddies or areas influenced by shoreline debris.
4. Without screwing it on, place the cap over the partially filled bottle and agitate it to ensure that the water rinses the entire volume of the bottle and splashes onto the cap.
5. Repeat the rinsing process three times.
6. After the third rinse, fill the bottle and tighten the cap. Leave enough space for freezing (preserving) the sample.
7. Place the sample in the cooler on ice and freeze at the end of the sampling day.

3.4.6 Filtered water samples (NO_2+NO_3 and SRP)

Method Steps:

1. Label the sample using a fine point sharpie. Cover the label with a piece of clear tape.
2. Partially fill and rinse a 60 cc syringe with water from the main flow away from eddies or areas influenced by shoreline debris. Fill and rinse syringe 3 times by sucking 20-30 cc of water in, then filling the remainder of the syringe with air. Shake the water in the syringe 3-4 times, then expel the water and air with the plunger being careful not to touch the tip.

3. After rinsing three times, fill the syringe fully and fit the tip with a clean, 0.45 um disposable filter.
4. Force a small amount of water through the filter into the sample bottle, rinse the bottle and cap, then dump the water. Repeat twice more.
5. Remove the filter (careful not to touch), refill the syringe, refit the filter, and push water into the sample bottle. Repeat until you have filled the sample bottle to the appropriate level. If the water is very turbid you may need to replace the filter to get enough of a sample through the filters.
6. Check the headspace on each nutrient sample to avoid bursting when freezing. If overfilled, invert the bottle gently 3-4 times, then swirl the bottle (to mix well) and "flick" out extra water.
7. Place the sample in the cooler on ice and freeze at the end of the sampling day.

3.4.7 pH using test strips in streams

Method steps:

1. Dip a pH test strip into the freely moving water.
    a. Hold the strip in the water for the amount of time specified on the pH strip box, the time can vary according to the brand.
2. Remove the strip from the water and compare to the pH chart and record the value on the field data form.

3.4.8 Water temperature using a thermometer in streams

Method steps:

1. Hold thermometer in freely moving water and wait for the temperature to stabilize and record.
    a. Be careful not to break the thermometer, as it is made of glass.

3.4.9 Measuring Discharge

Stream discharge is the measure of how much water is flowing through a river over a given time period. To calculate discharge, the velocity of the water (flow) and area of the transect (width and average depth) must first be measured. Both the stream flow and stream transect methods included below are taken from DEQ's *Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring*. While not perfectly accurate, these methods allow for a general estimate of stream discharge.
If a group is interested in the load of an analyte then discharge must be measured. Load is a measure of how much of an analyte is being discharged through a river over a period of time (e.g. 10 pounds of nitrogen per year), while concentration simply measures the mass of an analyte in a given volume of water at one moment (e.g. 10 milligrams of nitrogen per liter).

Equipment and Software:

- Stakes or flags for marking start/end points
- Measuring tape/range finder
- Field notebook
- Flow meter (if available)
- Biodegradable stick (if using the floating stick method)
- Waterproof digital camera

FLOW/VELOCITY Floating Stick/Ball Method

If a flow meter is not available then the floating stick/ball method can be used to make a general estimate of water velocity. It is a semi-quantitative method that tends to underestimate the flow due to slower velocity near the surface, but it is more accurate than a visual estimate.

Method steps:

1. Find a stream reach that is straight and uniform in width and depth; a glide is preferred. This will assure that laminar flow is achieved to the greatest extent possible. Measure a length at least twice the mean wetted width (≥50 ft is preferable) and mark each end by hanging flagging or driving a stake or rebar into the ground at the high water line.
2. Determine the mean width (from the water's edge) by measuring at least three cross-sections (if wadable), using a rangefinder, or by making a visual estimate.
3. Determine the mean depth by measuring depth at multiple points throughout the reach (if wadable) or by making a visual estimate.
4. Record the measured distance and a description of each stake's location in the stream discharge field notebook for high flow. Note landmarks and make a sketch if necessary to help identify stake locations in the event that they are no longer in place during subsequent flow measurements. Photograph both stakes to record their location along the streambank and the water level.
5. Toss a small stick or other biodegradable floating object heavy enough to stay in and move consistently with the main current into the middle of the stream above the upstream marker of the measured reach. Begin timing when the object passes the upstream marker. Count (with a watch or stopwatch) the seconds it takes the object to reach the downstream marker. The object must stay in the main current. If it does not, repeat the measurement. Complete three measurable floats. Remove the stakes upon completion unless subsequent site visits requiring flow measurement are anticipated.
6. Record the following information in the discharge field notebook for high flow:
    a. Reach length (ft or m)
    b. Mean depth (ft or m)
    c. Mean width (ft or m)
    d. Float times (sec)
8. Complete the following calculations in the discharge field notebook for high flow:
    a. **Cross-sectional area** (m^2 or ft^2) = Mean width **x** Mean depth
    b. **Average float time** (sec) = (Float time 1 **+** Float time 2 **+** Float time 3) **/** 3
    c. **Float velocity** (ft/sec or m/s) = Reach Length **/** Average float time

d. **Discharge** (ft^3/sec or m^3/sec) = Cross-sectional area **x** Float velocity

Flow Meter

Method steps:

1. Assemble the meter and adjust the settings
    a. Refer to the instrument operations manual for further details on use, calibration and maintenance.
    b. Set the flow meter to the "fixed point average" (FPA) setting, which provides an average of velocities over a fixed period of time, and specify a FPA interval of 10 seconds. Set the units to either ft/s or m/s.
2. The flow meter method is appropriate for narrow streams where 10-15 points along a cross- section can be measured, or wide streams where 20-30 points along a cross-section can be measured. A flow meter with a wading rod can only be used in streams that have sufficient water depth to reliably use the instrument (≥0.2 in).
3. Choose a location for the cross-section in a straight reach with laminar flow; a glide is preferred. Consider the following guidance:
    a. Location should be free of disturbances (i.e., boulders, aquatic growth, pipe joints, inflowing or out flowing side channels or tributaries, other obstructions)
    b. Flow should be free of swirls, eddies, vortices, backward flow, and dead zones
    c. Avoid areas downstream of sharp bends, upstream or downstream of vertical drops or where stream empties into a stationary body of water
    d. Use best judgment in choosing the best site when all of the above criteria do not exist.
4. Stretch a tape (ft or m) between end-points of your cross-section, ensuring that it is oriented perpendicular to flow. The tape should be stretched at a minimum from water's edge to water's edge; however, it is acceptable to extend the tape beyond water's edge on either bank to allow for ease of securing the tape. Use bank pins or stakes to secure the ends of the tape in place.
5. For narrow streams, divide the distance from left water's edge to right water's edge by 10-15; for wide streams, divide the distance from 20-30 to determine the number of equidistant points along the cross-section at which flow measurements will be collected. It is acceptable to round to nearest 0.25 ft or 0.1 m for ease of determining the distance between points of measurement.
6. Flow is measured at multiple equidistant points from left water's edge to right water's edge to account for complexity and variability in channel shape and flow patterns. Start at left water's edge and call out the location on the tape to the person recording the data. At left water's edge and right water's edge (the initial and final points of measurement, respectively) the depth and velocity will each be recorded as "0".
7. From left water's edge, move across the channel cross-section toward right water's edge, locate the next point of measurement on the tape (calculated previously) and, holding the wading rod vertical and steady with the base on top of the substrate, position the probe directly into (parallel to) the flow. Stand downstream from the tape and meter and at least 18" off to the side of the wading rod to avoid disrupting the flow measurement.

8. Read the depth on the graduated hex main rod at this point to the person recording the data. Each mark on the rod is 0.1 ft. Double marks are at 0.5 ft and triple marks are at 1 ft.
   IMPORTANT: Be careful not to push the base of the wading rod down into the substrate when measuring flow in streams with soft substrates.
9. Position the probe to 0.6 depth by adjusting the round setting rod to the depth of the water (from the previous step). Slide the round sliding rod to line up the foot (or meter) scale on the sliding rod with the tenth scale on top of the main hex rod. For example, if the water depth is 2.7 ft, line up the 2 on the round sliding rod with the 7 on the tenth scale on the top of the main hex rod.
10. Once positioned to begin recording measurements, wait for a new averaging interval to begin or hit the reset button (ON/C). Allow the flow meter to cycle through three 10-second fixed point average intervals, then call out the average of these three values to the person recording the data.
11. Fill in information in the discharge field notebook:
    a. Waterbody name
    b. Activity ID
    c. Transect letter nearest to flow cross-section
12. Fill in the following information in the discharge field notebook with proper units
    a. Distance on tape (ft or m)
    b. Depth (ft or m)
    c. Velocity at point (ft/s or m/s)
    d. Comments (i.e., "left water's edge", "right water's edge", channel irregularities, unavoidable obstructions like channel islands, etc.)

3.4.10 Water Samples for E. Coli

IMPORTANT: E. Coli samples must be delivered to the lab within 6 hours and before 3 PM.

Method steps:

1. Label the bottle and cover the label with clear tape to prevent water damage.
2. Carry the bottle to a suitable sampling location:
   a. Sampler can safely wade and stand or access the water from a boat.
   b. Water column is well-mixed and deep enough to allow sampler to avoid surface scum and bottom sediments.
   c. Upstream or away from any disturbance to water column or bottom sediments.
3. Collect the sample:
   a. For wadable locations, submerge the bottle so the mouth is below the water surface but above the bottom and allow the bottle to fill.
   b. For lake surfaces (from a boat), submerge the bottle until the sampler's elbow is at the water surface and allow the bottle to fill.
4. Leave appropriate headspace: For most samples, the bottle should be filled to the shoulder or line that denotes the target volume; this will leave a small amount of head space, especially necessary if preservative will be added to the sample.
5. Place the sample in the cooler on ice and deliver samples to the analytical laboratory within required holding time (**6 hours**).

3.3.11 Site Photos

During sampling at each site, photos will be taken and recorded photo number(s) on the Field Data Form. These photos will document visual changes in algae growth and other site changes. Photos will be uploaded and stored on the office computer for later use.

4.0 LABORATORY ANALYTICAL REQUIREMENTS

Table 6. Monitoring Parameter Suite, Sample Handling, Analysis & Preservation

Water Quality Parameter	Required Reporting Limit	Sample Container	Preservation	Holding Time
Total Nitrogen (TN)	25 µg/L	60 mL HDPE	Freeze	45 days if samples are kept frozen
Total Phosphorus (TP)	1.5 µg/L	60 mL HDPE	Freeze	45 days if samples are kept frozen
Nitrate/Nitrite and Soluble Reactive Phosphorus (SRP)	1.5 µg/L and 0.8 µg/L	60 mL HDPE	Freeze	45 days if samples are kept frozen
E. Coli	1 cfu/100 mL	250 mL Polypropylene	4 °C	6 hours

5.0 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

5.1 OVERVIEW

Projects require adequate documentation, proper sample collection, handling, analysis, and additional measures to produce high quality, credible data that accurately represents conditions in the watershed and can be used to answer scientific questions or guide resource management decisions.

Quality Assurance (QA) is the overall system used to ensure a monitoring project produces high quality data to meet project goals and objectives. For example, QA activities include developing a sampling and analysis plan (SAP), properly training volunteers, communicating analytical requirements to the lab, and adhering to standard operating procedures (SOP's).

Quality control (QC) are technical activities used to detect and control errors. For example, QC activities include collecting field duplicates, preparing field blanks, reviewing field forms for accuracy, and calibrating equipment. Good QC will help to identify problems with the data if they arise and help identify what the cause of the problem likely is.

A list of QA/QC terms and definitions is included in **Appendix C**.

5.2 TRAINING

The Sonde EXO3 and YSI Pro 20 DO Meter will only be operated by trained CRC staff members or reliable and train volunteers. Staff members will attend training before using the Sonde. Volunteers will be trained on protocols and asked to review the SAP sections and field forms that they will be contributing too. All collectors will have a copy of the sampling and analysis plan, field manuals for all equipment used, and examples of how to fill out all of the Field Data Forms. Copies of these documents will be available on-site for reference.

5.3 QUALITY CONTROL SAMPLES: FIELD DUPLICATES

Field duplicates are two samples (i.e., a routine sample and a duplicate sample) of ambient water collected from a waterbody as close as possible to the same time and place by the same person and collected using identical sampling and analytical procedures. Field duplicate samples are labeled, collected, handled and stored in the same way as the routine samples and are sent to the laboratory at the same time.

Field duplicates are typically collected at a rate of approximately 10% of the total number of routine samples collected. Therefore, to achieve this, one set of field duplicates will be collected during each sampling event. Duplicates will be collected at different site according to the sampling schedule shown in **Section 2.2**.

Field duplicates are used to determine field precision to ensure that proper procedures are followed consistently. For each field duplicate set collected, the relative percent difference will be calculated:

$$\text{Relative Percent Different (RPD)} = ((D1 - D2) / ((D1 + D2)/2)) \times 100$$

where: D1 = routine sample result value
D2 = duplicate sample result value

Precision will be assessed by ensuring that relative percent difference (RPD) between duplicates is less than 25%. If the RPD of field duplicates is greater than 25% and the parent and duplicate result values are greater than five times the lower reporting limit, the result values will be flagged with a "J".

5.4 QUALITY CONTROL (QC) SAMPLES: FIELD BLANKS

Field blanks are samples of analyte-free, laboratory-grade deionized water poured into a sample container in the field using the same method, container, and preservation as routine samples, and shipped to the lab along with other field (i.e., routine and duplicate) samples. All labeling, rinsing, preservation, and storage requirements applied for routine and duplicate

samples are applied to field blanks; the only difference is that the water is deionized water rather than ambient stream water. Field blanks must be prepared while in the field. Deionized water is provided by the lab along with other sampling equipment.

One set of field blanks is submitted to the laboratory with each batch of samples delivered to the laboratory. Therefore, one set of field blanks will be prepared at or near the end of each monthly sampling event and submitted to the laboratory alongside the other routine and duplicate samples from that trip.

Field blanks are used to determine the integrity of the field personnel's handling of samples, the condition of the sample containers supplied by the laboratory, and the accuracy of the laboratory methods. Accuracy will be assessed by ensuring that field blanks return values less than the lower reporting limit (i.e., non-detects) (shown in **Section 4.0**). If an analyte is detected in a field blank, all result values for that analyte from that batch of samples associated with the field blank will be qualified with a "B" flag. The exception is that data with a value greater than 10 times the detected value in the blank does not need to be qualified.

5.5 Instrument Calibration and Maintenance

Before each field season a trained CRC staff member will calibrate the EXO3 Sonde and YSI DO meter according to their manuals. Sonde calibrations will be recorded in it and then downloaded into the computer and stored with the Sonde data. YSI Pro 20 DO meter calibrations will be recorded in its logbook that remains with the meter at all times. Both the Sonde with all its sensors and parts and the DO meter will be cleaned, stored, and maintained according to their manual.

5.6 Data Quality Indicators (DQI's)

Data quality indicators (DQIs) are attributes of samples that allow data users to assess data quality. Because there are large sources of variability in streams and rivers, DQIs are used to evaluate the sources of variability and error and thereby increasing confidence in our data.

This section describes how the sampling and analysis plan (SAP) and study design aims to achieve data quality for each data quality indicator (representativeness, comparability, completeness, sensitivity, precision and accuracy).

Representativeness
Representativeness refers to the extent to which measurements represent an environmental condition in time and space.

Spatial representation

Lake sampling sites were chosen on lakes that we could readily access and vary in size, usage, and development. For the smaller lakes (Alva and Big Sky), we have only one sampling location in the middle of the lake at the deepest point. Larger lakes have multiple sampling sites including, the middle of the lake at the deepest point and perimeter sites closer to the shore and development that we are trying to capture. The Clearwater River sampling sites were chosen near the headwaters and mouth to represent the entire length of the river. Morrell Creek sites were chosen based on the development that we want to try and capture.

Temporal representation
Sampling will take from downstream to upstream in both streams and lakes as to not sample the same water twice. Samples will be taken once a month at least 14 days apart during the growing season (July-September) and once outside of the growing season in mid-spring before during peak for or the rising limb of the hydrograph. Samples will be collected at the same time of day for each site. When water samples are collected discharge measurements will also be collected.

Comparability
Comparability is the degree to which methods, data, or decisions are similar. Comparability expresses the confidence with which one data set can be compared to another. To achieve a comparable result, both the field collection method and the analytical method must be comparable.

All samples will be collected following the procedures outlined in this SAP. CRC will work with the Flathead Biological Station Research lab to perform analysis according to their protocols each year.

Completeness
Completeness is a measure, expressed as a percentage, of the amount of data that you planned to collect compared to the amount of data that you actually collected. The overall project goal is to collect 100 percent of the data. While in the field, sampling the field data form will be checked before departure to ensure that all parameters were collected. If not all parameters were collected (for example, it wasn't safe), it will be noted on the form and reported to the Aquatics Director so sampling can be rescheduled. Samples that are damaged will be recollected within a reasonable timeframe. Lab reports will be reviewed upon receiving them to ensure results for all samples submitted are accounted for.

Sensitivity
Sensitivity refers to the limit of a measurement to reliably detect a characteristic of a sample. Related to detection limits, the more sensitive a method is, the better able it is to detect lower concentrations of a variable; for analytical methods, sensitivity is expressed as the method detection limit (MDL).

Detection and reporting limits are specified for this project, which are adequately low enough to enable comparison to the thresholds of interest (e.g., numeric nutrient standards). The

laboratory routinely checks sensitivity (e.g., method blanks, continuing calibration blanks, and laboratory reagent blanks) per their quality management plan.

Precision, Bias, and Accuracy
Bias is the degree of systematic error in an assessment or analysis process; when bias is present, the sampling result value will differ from the accepted, or true, value of the parameter. Adhering to standard operating procedures during sampling will reduce sampling bias.

Precision measures the level of agreement or variability among a set of repeated measurements obtained under similar conditions. Field duplicates (**Section 5.3**) will be collected during this project and used to determine field precision. If problems are linked to field crew sampling error, supplemental training will be provided prior to the next sampling event.

Accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. Field blanks (**Section 5.4**) will be prepared during this project and used to evaluate accuracy for field activities. The laboratory uses EPA approved and validated methods and performs precision and accuracy performance evaluations per their quality management plan.

Holding Time
All samples will be checked to verify that they were processed within their specified holding times. Sample results whose holding time was exceeded prior to being processed will be qualified with an "H" flag.

5.7 FIELD HEALTH AND SAFETY

Field personnel commonly encounter hazards while performing monitoring activities. All participants are advised to take adequate precautions to avoid injury or loss of life due to hazards including, but not limited to, driving, wading, boating and other activities in and around water, weather conditions, wildlife interactions, human interactions, use of chemical preservatives, etc.

On every sampling trip, field personnel should carry with them a communication device (e.g., cell phone), first aid kit, bear spray, adequate drinking water, clothing appropriate for a range of weather conditions, personal protective equipment including waders, adequate footwear, and gloves to be worn while handling preservatives, and any other necessary safety-related items.

Each volunteer will be required to sign a waiver acknowledging risk and these waivers will be kept on file by the project coordinator. If, for any reason, field personnel feel unsafe while navigating to or from monitoring sites or while collecting data, they should err on the side of caution and not collect the data. Any delays or changes should be reported to the project coordinator as soon as possible so sampling can be rescheduled if possible.

For lakes, sample collectors will follow all boating regulations. Sample collectors will also bring the appropriate safety equipment. Safety equipment includes but is not limited to a throw rope, ice picks, life jackets, first aid kits, sunscreen, etc. Prior to each outing, the weather forecast will be checked to ensure conditions are safe for monitoring. The monitoring team will not be deployed in the event of high winds or inclement weather.

For both lakes and streams, a minimum of two person monitoring teams are required. Teams are to inform the CRC Aquatics Director or Executive Director of all field work times/dates/sites in advance of deployment. Volunteers and staff will be required to complete all required training and provide emergency contact information prior to field deployment. During high flow events in streams, staff/volunteers are required to collect samples from the shore only. Waders are not to be worn during high flow events. The use of felt soled waders are prohibited.

6.0 DATA MANAGEMENT, RECORD KEEPING & REPORTING

The person(s) responsible for data management, record keeping, data quality review and data upload will perform the following activities:

- Review field forms for completeness and accuracy, especially Site Visit and Chain of Custody forms.
- Draft a brief synopsis of any SAP derivations that occurred.
- Store and backup all data generated during this project, including field forms, laboratory reports obtained from the laboratories, electronic copies of field photographs, and written field notes.
- Review data quality and flag result values, as needed, prior to uploading into the database(s). Upload all laboratory data into MT e-WQX database (if MT DEQ funding or support is provided).
- Maintain records of volunteer hours, travel and other budget tracking, as needed.
- Be the main Point of Contact with MMW

6.1 FLATHEAD LAKE BIOLOGICAL STATION (FLBS) DATABASE

All data produced in the FLBS Freshwater Research Lab (FRL) will be uploaded into the Flathead Lake Biological Station's database and data will be shared with FLBS researchers. All groups funded by MMW will need to sign a Memorandum of Understanding (MOU) with FLBS.

6.2 MONTANA DEQ'S MT-EWQX DATABASE AND DATA QUALITY REVIEW

FRL will prepare and analyze the samples in accordance with the chain-of-custody forms and analytical methods specified in **Table 6**. FRL will then supply the project coordinator with laboratory analytical reports and Electronic Data Deliverable (EDD) spreadsheets.

If MMW funding is received in support of the monitoring project, all data collected must be entered by the project coordinator into DEQ's MT-eWQX database (also known as EQuIS).

Instructions for preparing, validating and submitting the EDD to MT-eWQX must be followed (available at http://deq.mt.gov/Water/SurfaceWater/SubmitData). For example, steps include:

- Compiling data (including site information, field measurements and lab results),
- Transforming the data into the required format,
- Performing a thorough quality control check of the data to correct errors, qualify problematic sample result values with data flags, etc.,
- Validating the data, and adding field data to the EDD prior to upload,
- Submitting EDDs to MT-eWQX.

6.2 Other Data Management Approaches

All hand-written notes, field forms, and photos will be stored by Clearwater Resource Council. CRC members will fill out field forms at each site where sampling takes place and maintain the original hard copies as well as digital copies (scanned or photos) in the office. A chain of custody form from the Flathead Lake BioStation will be filled out for all samples and remain with the samples until hand-off with the Flathead Lake BioStation.

7.0 DATA ANALYSIS AND REPORTING

7.1 Data Analysis

All data from the 2021 sampling year aims to give preliminary baseline data to begin to understand trends over time in water quality, conditions contributing to blue-green algae blooms on lakes, and better understand septic leachate impacts to surface waters, and will be used to inform future sampling plans.

Once all data has been collected and all water sample results returned from the lab, CRC will begin data analysis. The profile data collected via the Sonde (pH, specific conductance, total algae, temperature, and depth) and the dissolved oxygen data profiles will be plotted for each site. 2021 is the first year CRC will be collecting data with the Sonde and, all data will be used for future comparisons. CRC has collected DO and temperature data for multiple years and will compare this year's profiles against past year's profiles. CRC has monitored lake transparencies for many years now and will continue to contribute to our database for comparisons against past and future transparencies.

2021 is the first year that CRC will be collecting total nitrogen, total phosphorus, nitrite, nitrate, soluble reactive phosphorus, and E. Coli samples on any of the lakes data will be plotted and used in future comparisons. If the concentrations exceed DEQ thresholds they will be reported to the proper authority. In the past, CRC has collected total nitrogen, total

phosphorus, nitrite, nitrate, and soluble reactive phosphorus on streams. For the Morrell Creek sites, a direct comparison will be done. The sites on the Clearwater River are new and will be used in future comparisons and to address the question of how much the watershed/Chain of Lakes starts as opposed to how much exits the watershed. On streams pH, DO, and temperature data has not been collected before, this data will be plotted and used for future comparisons.

2021 is the first year CRC will be collecting E. Coli on lakes and streams. Concentrations will be plotted and used to determine if more in-depth testing is needed on both lakes and streams. E. Coli concentration data will be used in future comparisons.

A direct comparison will be done between the upstream and downstream sites on both the Clearwater River and Morrell Creek for all parameters to address the source of contamination and inform future stream sampling plans.

7.2 REPORTING

All data will be uploaded to the MT-eWQX database. The final reports summarizing the data will be made available on the CRC website. Highlights of the final reports will be published on our social media accounts and in our newsletters.

8.0 REFERENCES

Friends of Lake Mary Ronan. 2019. *Lake Mary Ronan, Donaldson Creek, Freeland Creek and Ronan Creek Water Quality Monitoring, 2019-2020 Sampling and Analysis Plan.*

APPENDIX A - PROJECT BUDGET

Projected Budget for Laboratory Analysis and Shipping

	Analyte	Price per Analyte	Number of Sites	Number of visits per site	Number of routine samples (number of sites x number of visits per site)	Number of field blanks (often one per sampling event)	Number of field duplicates (often ~10% of the total number of routine samples)	Total number of samples (routine + duplicates + blanks)	Total Cost (Total number of samples x cost per parameter)
Lakes	TN/TP	31	30	4	120	4	12	136	4216
	NO2/NO3/ SRP	23	30	4	120	4	12	136	3128
	E. Coli	43	18	4	72	4	7	83	3569
Streams	TN/TP	31	3	4	12	3	1	16	496
	NO2/NO3/ SRP	23	3	4	12	3	1	16	368
	E. Coli	43	3	4	12	3	1	16	688
SIA Stream Site	TN/TP	31	1	4	4	1	1	6	186
	NO2/NO3/ SRP	23	1	4	4	1	1	6	138
	E. Coli	43	1	4	4	1	1	6	258
							Sample Total		13047
							Filters& Syringes		227.52
							Transporting to the lab		604.80
							Grand total		**13879.32**

*4 blanks total, one per sampling event
*allocate 10% for duplicates by habitat/site
*See table below for transporting all samples to the lab.

MMW funded samples budget

	Analyte	Price per Analyte	Number of Sites	Number of visits per site	Number of routine samples	Number of field blanks	Number of field duplicates	Total number of samples	Total Cost
Streams (non SIA)	TN/TP	31	3	4	12	3	2	17	527
	NO_2/NO_3/ SRP	23	3	4	12	3	2	17	391
	E. Coli	43	3	4	12	3	2	17	731
BIG SKY	TN/TP	31	2	4	8	1	2	11	341
	NO_2/NO_3/ SRP	23	2	4	8	1	2	11	253
	E. Coli	43	1	4	4	1	1	6	258
ALVA	TN/TP	31	2	4	8	1	2	11	341

	NO_2/NO_3/ SRP	23	2	4	8	1	2	11	253
	E. Coli	43	1	4	4	1	1	6	258
INEZ	TN/TP	31	5	4	20	1	2	23	713
	NO_2/NO_3/ SRP	23	5	4	20	1	2	23	529
	E. Coli	43	3	4	12	1	1	14	602
PLACID	NO_2/NO_3/ SRP	23	5	4	20	1	2	23	529
							Filters& Syringes		227.52
							Total		**5953.52**

Other funding sources samples budget

	Analyte	Price per Analyte	Number of Sites	Number of visits per site	Number of routine samples	Number of field blanks	Number of field duplicates	Total number of samples	Total Cost
SIA Funded									
SIA Stream Site	TN/TP	31	1	4	4	1	0	5	155
	NO_2/NO_3 /SRP	23	1	4	4	1	0	5	115
	E. Coli	43	1	4	4	1	0	5	215
								Total	485
BOR Funded									
SEELEY	TN/TP	31	10	4	40	0	2	42	1302
	NO_2/NO_3 /SRP	23	10	4	40	0	2	42	966
	E. Coli	43	6	4	24	0	2	26	1118
							Total (+ $139 from CRC)		3386
CRC Funded									
PLACID	TN/TP	31	5	4	20	1	2	23	713
	E. Coli	43	3	4	12	1	1	14	602
SALMON	TN/TP	31	6	4	24	0	2	26	806
	NO_2/NO_3 /SRP	23	6	4	24	0	2	26	598
	E. Coli	43	4	4	16	0	1	17	731
								Total	3450
								Grand total for sampling all sites	**13274.52**

Schedule with Blanks & Duplicates	
Lakes	Streams
May	
TP/TN: *Big Sky, Alva, Inez*	1st MMW Stream blank & duplicate
NO_2/NO_3/SRP: *Big Sky, Alva, Inez*	
E coli: *Big Sky, Alva*	
Blank: *Big Sky*	
June	
TP/TN: Placid, Salmon, Seeley	2nd MMW Stream blank & duplicate
NO_2/NO_3/SRP: *Placid*, Salmon, Seeley	
E coli: Seeley, Salmon	
Blank: *Alva*	
August	
TP/TN: *Big Sky, Alva, Inez*	3rd MMW Stream blank
NO_2/NO_3/SRP: *Big Sky, Alva, Inez*	
E coli: *Inez*	
Blank: *Inez*	
September	
TP/TN: Placid, Salmon, Seeley	*non MMW Stream Blank
NO_2/NO_3/SRP: *Placid*, Salmon, Seeley	
E coli: Seeley, Placid	
Blank: Seeley (not MMW funds)	

*Italic lakes are MMW funds

We plan to drive our samples to the Flathead Biological Station, for analysis after each of the four rounds. The mileage cost for four round trips (270 miles each, 1,080 total) at the reimbursement rate of $0.56 per mile comes to a total of $604.80 (see table below).

Number of miles for round trip	Number of trips	Reimbursement rate ($/mi)	Total cost
270	4	0.56	604.8

Cost and funding breakdown summary.

Cost for Sampling ($)		Funding Source	Amount ($)
Lakes	10913	BOR	3525
Streams	1552	MMW Samples	5953.52
SIA site	582	SIA	582
Fliters & Syringes	227.52	Total Funds	10060.52
Mileage	604.8	MMW Equipment	1500

APPENDIX B – FIELD FORMS

Lake Field Data Form

Project: Clearwater Resource Council Lake Monitoring

Date: _____ Arrival Time: _____ End Time: _____

Collector(s) _____

Site Information

Name of Lake _____ Site _____

Air Temp _____ Sky Cover _____ Wind Conditions _____

Water Sample Information				
Sample	Collected?	Time	QC?	QC Time
Total Nitrogen/Total Phosphorus	Yes / No		Dupe / Blank / No	
Nitrite/Nitrate/Soluble Reactive Phosphorus	Yes / No		Dupe / Blank / No	
E. Coli	Yes / No		Dupe / Blank / No	

Field Parameters/Measurements				
Secchi Disk Reading	Reading 1	Reading 2	Average	Time:
Depth (ft):				Max Depth:
in situ field parameters measured	Yes / No	DO Profile	Yes / No	Calibration date:

*these measurements will be recorded in the Sonde, this is only for the first and last measurements taken at the site. These will be used to check data if any issues arise.

Point Taken	Depth (m)	Water Temp (°C)	pH	SPC (uS/cm)	Chl RFU	BGA-PE RFU
First						
Last						

Site Photos	
Photo Number (caption you gave it)	Description

Additional Comments:

Stream Field Data Form

Project: Clearwater Resource Council Stream Monitoring

Date: _____ Arrival Time: _____ End Time: _____

Collector(s) _____

Site Information

Name of Stream _____ Site _____

Air Temp _____ Sky Cover _____ Wind Conditions _____

Water Temp _____ Water pH _____ DO (mg/L) _____ Discharge Yes / No

Water Sample Information				
Sample	Collected?	Time	QC?	QC Time
Total Nitrogen/Total Phosphorus	Yes / No		Dupe / Blank / No	
Nitrite/Nitrate/Soluble Reactive Phosphorus	Yes / No		Dupe / Blank / No	
E. Coli	Yes / No		Dupe / Blank / No	

Site Photos	
Photo Number	Description

Addition Comments:

Lake Monitoring Equipment Checklist

Logistical	*Amount Needed*	*Description*
Sampling and Analysis Plan	1	For reference
GPS or Phone	1	Determining coordinates of site
Digital Camera	1	Site photos
Site Visit Form(s)	1 per site	Record collected site data
Chain of Custody Form(s)	1 per site	For lab samples and chain of custody
Clipboard	1	Fill out forms with
Pens/Pencils	3	Fill out forms with
Fine point Sharpie	2	Label samples
Clear Tape	1 roll	Protect sample labels
Safety	*Amount Needed*	*Description*
First Aid Kit	1	Safety
Life Jackets	1 per person	Safety
Ice Pick	1	Safely during winter collection times
Throw Rope	1	Safety
Waders &/or Boots	1 per person	PPE
Sun Screen	1	Safety
Water	1 per person	Safety
Data Collection	*Amount Needed*	*Description*
Watercraft	1	Getting to site
Anchors	2	to keep boat in place during data collection
Kemmerer Bottle with Accessories	1	Sampling at depth
X size Sample Bottle with lid	1 per sample needed	Sending the sample to the lab
Deionized and Regular Water	I liter	Used for field blanks and Sonde
Cooler with Ice	1	Storing samples in the field
EXO3 Sonde with Accessories including logbook	1	Collecting data
Secchi Disk with Rope	1	Collecting data
YSI Pro20 with Accessories	1	Collecting data

Stream Monitoring Equipment Checklist		
Logistical	*Amount Needed*	*Description*
Sampling and Analysis Plan	1	For reference
GPS or Phone	1	Determining coordinates of site
Digital Camera	1	Site photos
Site Visit Form(s)	1 per site	Record collected site data
Chain of Custody Form(s)	1 per site	For lab samples and chain of custody
Clipboard	1	Fill out forms with
Pens/Pencils	3	Fill out forms with
Fine point Sharpie	2	Label samples
Clear Tape	1 roll	Protect sample labels
Safety	*Amount Needed*	*Description*
First Aid Kit	1	Safety
Life Jackets	1 per person	Safety
Throw Rope	1	Safety
Waders &/or Boots	1 per person	PPE
Sun Screen	1	Safety
Water	1 per person	Safety
Data Collection	*Amount Needed*	*Description*
X size Sample Bottle with lid	1 per sample needed	Sending the sample to the lab
Deionized and Regular Water	I liter	Used for field blanks and sensors
Cooler with Ice	1	Storing samples in the field
Syringe with Filter	1 per sample needed	Collecting data
Flow meter with tape	1	Collecting data
pH strips	1	Collecting data
Thermometer	1	Collecting data

Flathead Lake Biological Station
UNIVERSITY OF MONTANA

Freshwater Research Laboratory
32125 Bio Station Lane
Polson, MT 59860-6815
P: (406) 982-3301 F: (406) 982-3201
www.umt.edu/flbs/

Chain of Custody Record

Page _____ of _____

PLEASE PRINT and provide as much information as possible

Company/Project Name: **Lake and Stream Monitoring**	Contact Name/Phone: **Caryn Miske**	**LAB USE ONLY:**
Do you have a current contract with FRL?	Sampler(s):	LIMS LOGIN:
If **NO**, provide address for report/invoice: [X] YES [ ] NO		User: Date:
	W: Water; **P**: Precipitation; **WT**: Wastewater; **S**: Soil; **B**: Benthos	Batch ID #: _____
[ ] Email ONLY: _____		Login Notes:

Customer Sample ID	Collection Date	Collection Time	Matrix	Total # Bottles	TN/TP	TSS							Notes/Comments:	LIMS ID #:
					REQUESTED ANALYSIS									
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

Relinquished By:	Date/Time:	Received By:	Date/Time:	Cooler: Y N Ice: Y N
Relinquished By:	Date/Time:	Received By:	Date/Time:	

*Separate Chain of Custody forms will be returned to the lab for samples paid for by MMW vs. CRC.

APPENDIX C – QA/QC TERMS AND DEFINITIONS

Accuracy. A data quality indicator, accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. High accuracy can be defined as a combination of high precision and low bias.

Analyte. Within a medium, such as water, an analyte is a property or substance to be measured. Examples of analytes would include pH, dissolved oxygen, bacteria, and heavy metals.

Bias. Often used as a data quality indicator, bias is the degree of systematic error present in the assessment or analysis process. When bias is present, the sampling result value will differ from the accepted, or true, value of the parameter being assessed.

Blind sample. A type of sample used for quality control purposes, a blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the analyst's or laboratory's expertise in performing the sample analysis.

Comparability. A data quality indicator, comparability is the degree to which different methods, data sets, and/or decisions agree or are similar.

Completeness. A data quality indicator that is generally expressed as a percentage, completeness is the amount of valid data obtained compared to the amount of data planned.

Data users. The group(s) that will be applying the data results for some purpose. Data users can include the monitor entities themselves, as well as government agencies, schools, universities, businesses, watershed organizations, and community groups.

Data quality indicators (DQIs). DQIs are attributes of samples that allow for assessment of data quality. These include precision, accuracy, bias, sensitivity, comparability, representativeness and completeness.

Data quality objectives (DQOs). Data quality objectives are quantitative and qualitative statements describing the degree of the data's acceptability or utility to the data user(s). They include data quality indicators (DQIs) such as accuracy, precision, representativeness, comparability, and completeness. DQOs specify the quality of the data needed in order to meet the monitoring project's goals. The planning process for ensuring environmental data are of the type, quality, and quantity needed for decision making is called the DQO process.

Detection limit. Applied to both methods and equipment, detection limits are the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain and report as greater than zero.

Duplicate sample. Used for quality control purposes, duplicate samples are an additional sample taken at the same time from, and representative of, the same site that are carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitor, and/or analyst. More than two duplicate samples are referred to as replicate samples.

Environmental sample. An environmental sample is a specimen of any material collected from an environmental source, such as water or macroinvertebrates collected from a stream, lake, or estuary.

Field blank. Used for quality control purposes, a field blank is a "clean" sample (e.g., distilled water) that is otherwise treated the same as other samples taken from the field. Field blanks are submitted to the analyst along with all other samples and are used to detect any contaminants that may be introduced during sample collection, storage, analysis, and transport.

Instrument detection limit. The instrument detection limit is the lowest concentration of a given substance or analyte that can be reliably detected by analytical equipment or instruments (see detection limit).

Matrix. A matrix is a specific type of medium, such as surface water or sediment, in which the analyte of interest may be contained.

Measurement Range. The measurement range is the extent of reliable readings of an instrument or measuring device, as specified by the manufacturer.

Method detection limit (MDL). The MDL is the lowest concentration of a given substance or analyte that can be reliably detected by an analytical procedure (see detection limit).

Precision. A data quality indicator, precision measures the level of agreement or variability among a set of repeated measurements, obtained under similar conditions. Relative percent difference (RPD) is an example of a way to calculate precision by looking at the difference between results for two duplicate samples.

Protocols. Protocols are detailed, written, standardized procedures for field and/or laboratory operations.

Quality assurance (QA). QA is the process of ensuring quality in data collection including: developing a plan, using established procedures, documenting field activities, implementing planned activities, assessing and improving the data collection process and assessing data quality by evaluating field and lab quality control (QC) samples.

Quality assurance project plan (QAPP). A QAPP is a formal written document describing the detailed quality control procedures that will be used to achieve a specific project's data quality requirements. This is an overarching document that might cover a number of smaller projects a group is working on. A QAPP may have a number of sample analysis plans (SAPs) that operate underneath it.

Quality control (QC). QC samples are the blank, duplicate and spike samples that are collected in the field and/or created in the lab for analysis to ensure the integrity of samples and the quality of the data produced by the lab.

Relative percent difference (RPD). RPD is an alternative to standard deviation, expressed as a percentage and used to determine precision when only two measurement values are available. Calculated with the following formula: RPD as % = ((D1 – D2)/((D1 + D2)/2)) x 100 Where: D1 is first replicate result D2 is second replicate result

Replicate samples. See duplicate samples.

Representativeness. A data quality indicator, representativeness is the degree to which data accurately and precisely portray the actual or true environmental condition measured.

Sampling and Analysis Plan (SAP). A SAP is a document outlining objectives, data collection schedule, methods and data quality assurance measures for a project.

Sensitivity. Related to detection limits, sensitivity refers to the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. The more sensitive a method is, the better able it is to detect lower concentrations of a variable.

Spiked samples. Used for quality control purposes, a spiked sample is a sample to which a known concentration of the target analyte has been added. When analyzed, the difference between an environmental sample and the analyte's concentration in a spiked sample should be equivalent to the amount added to the spiked sample.

Standard operating procedures (SOPs). An SOP is a written document detailing the prescribed and established methods used for performing project operations, analyses, or actions.

APPENDIX D—MAPS

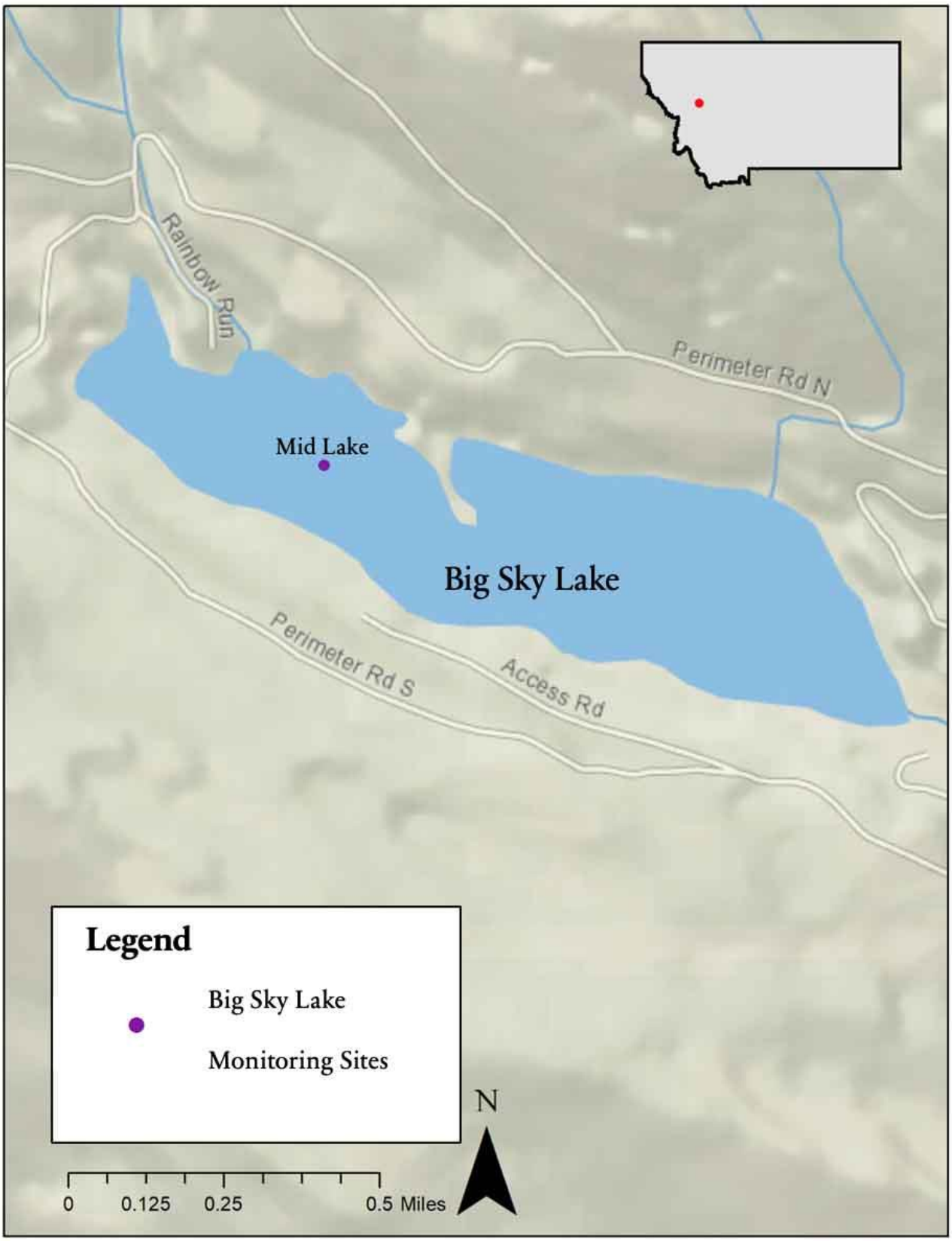

Figure 3. Map of Big Sky Lake showing the monitoring site.

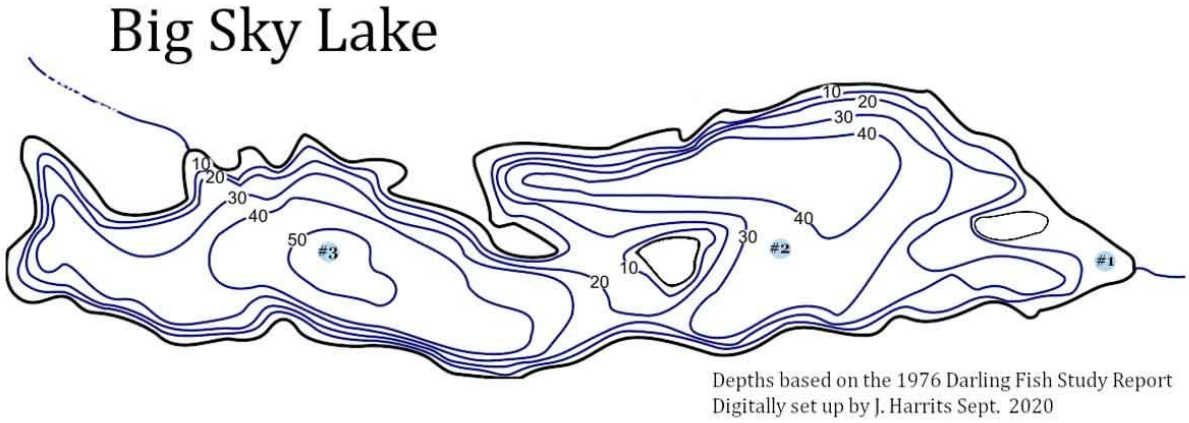

Figure 4. Bathymetry map of Big Sky Lake.

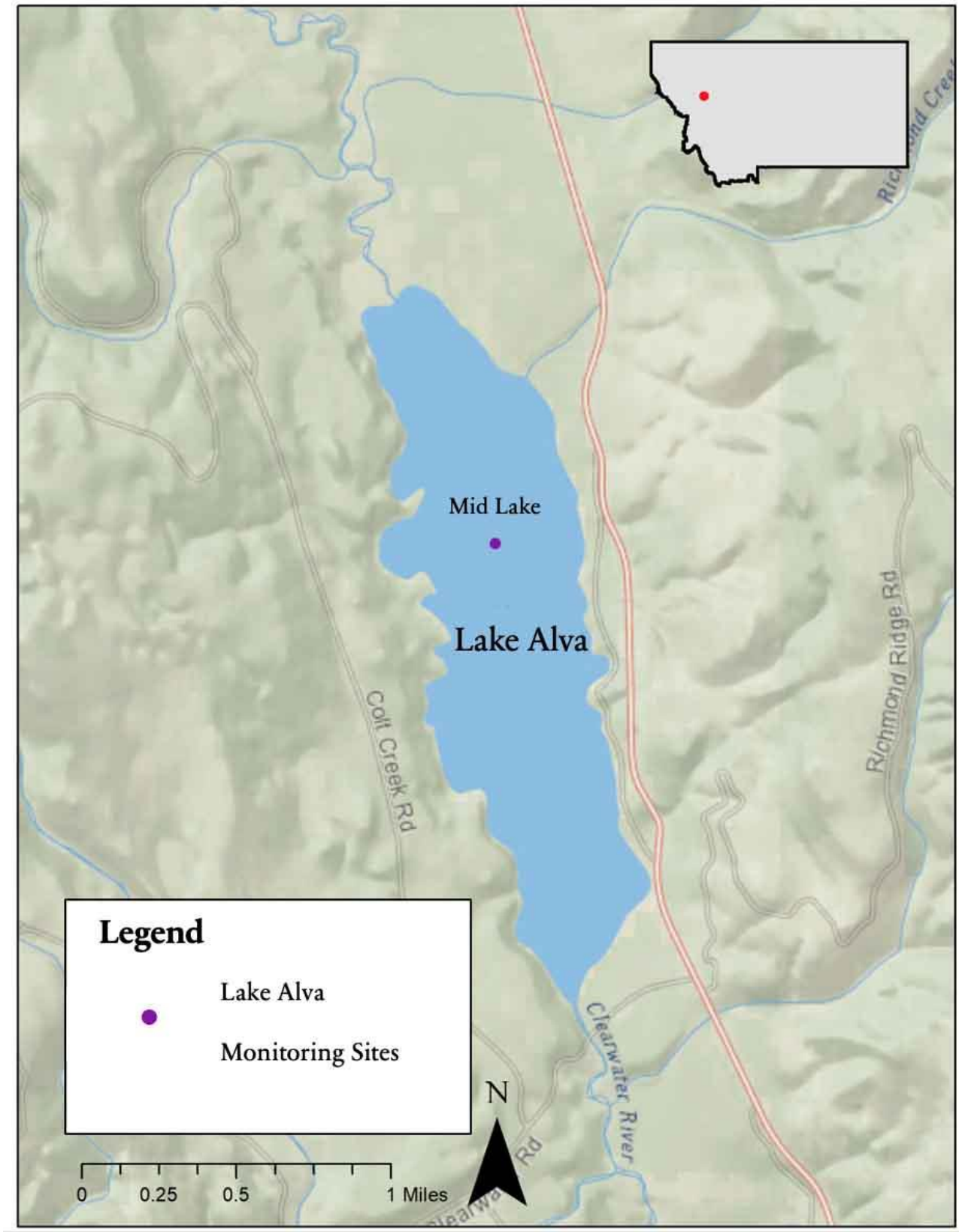

Figure 5. Map showing Lake Alva monitoring site.

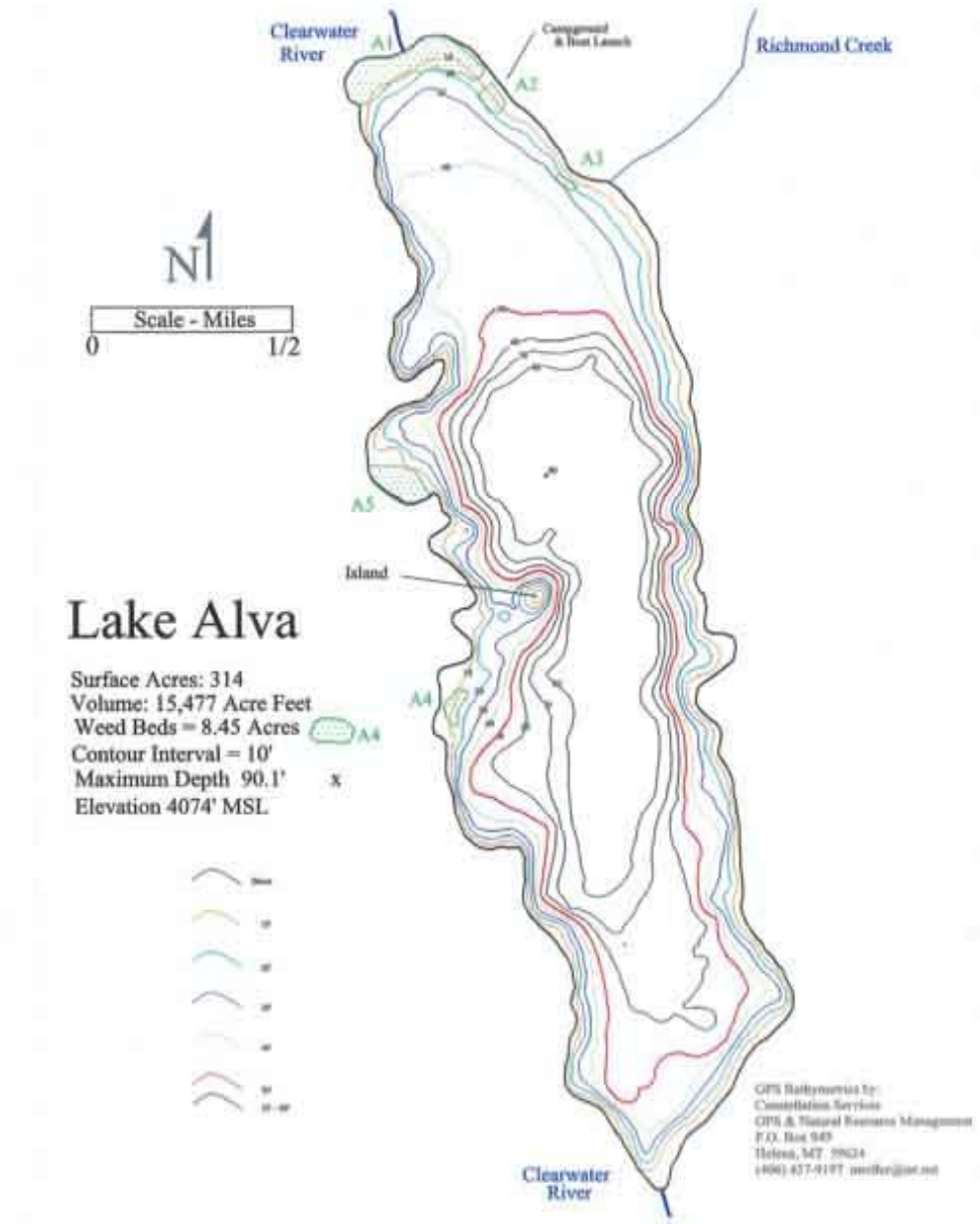

Figure 6. Bathymetry map of Lake Alva.

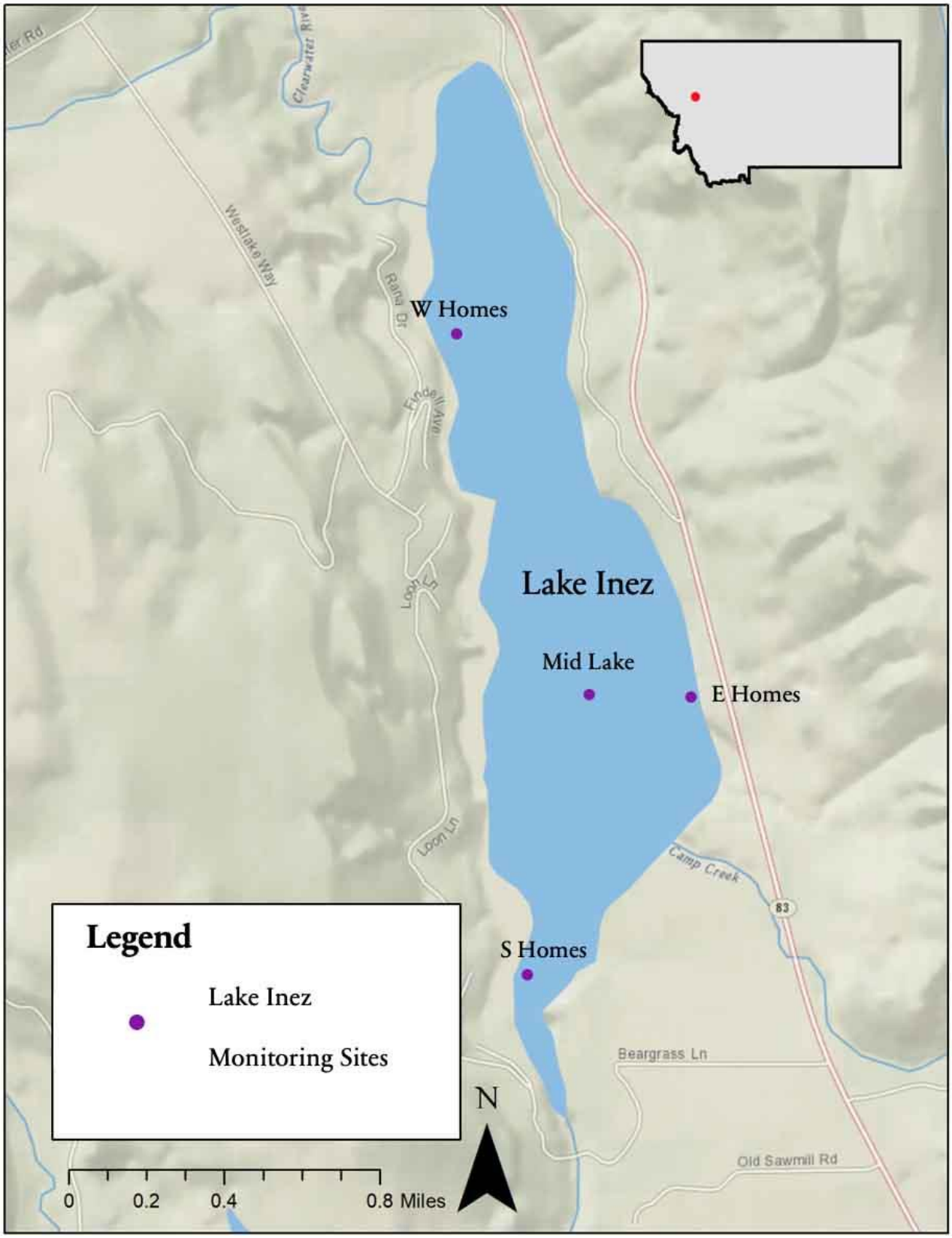

Figure 7. Map of Lake Inez monitoring sites.

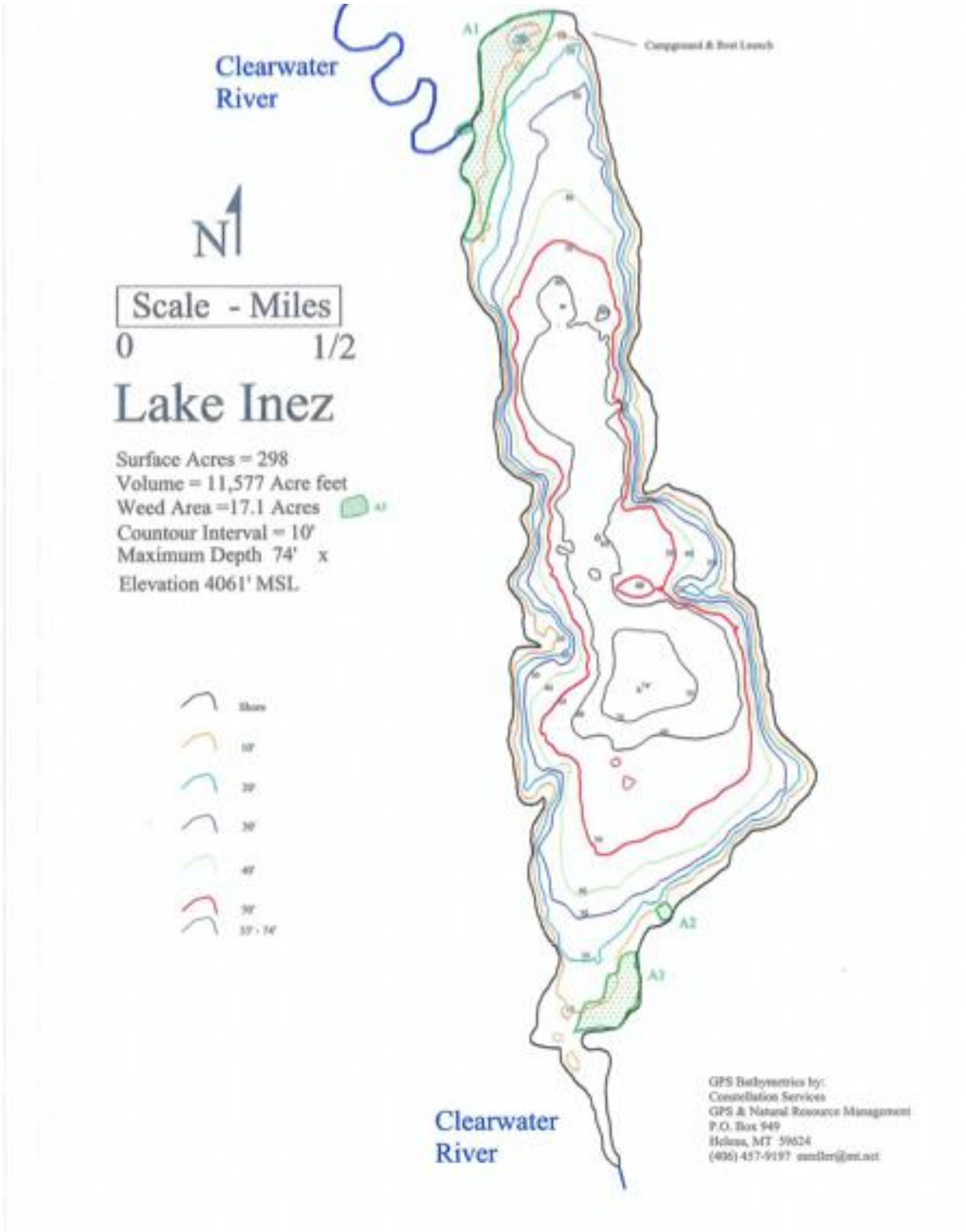

Figure 8. Bathymetry map of Lake Inez.

Figure 9. Map of Seeley Lake monitoring sites.

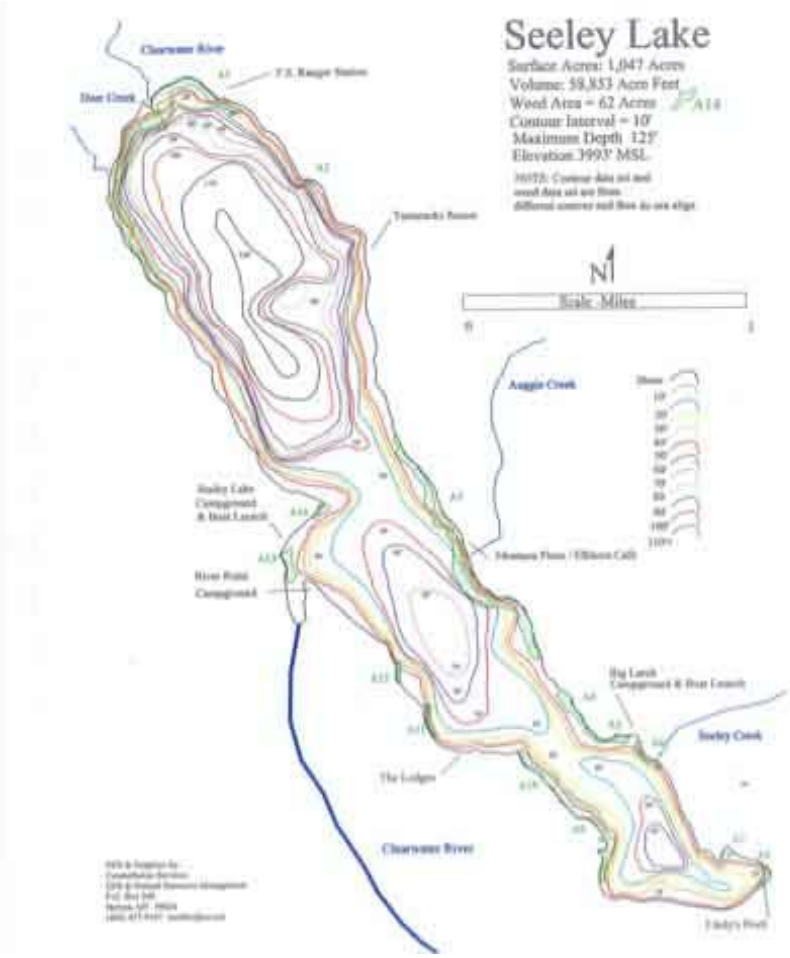

Figure 10. Bathymetry map of Seeley Lake.

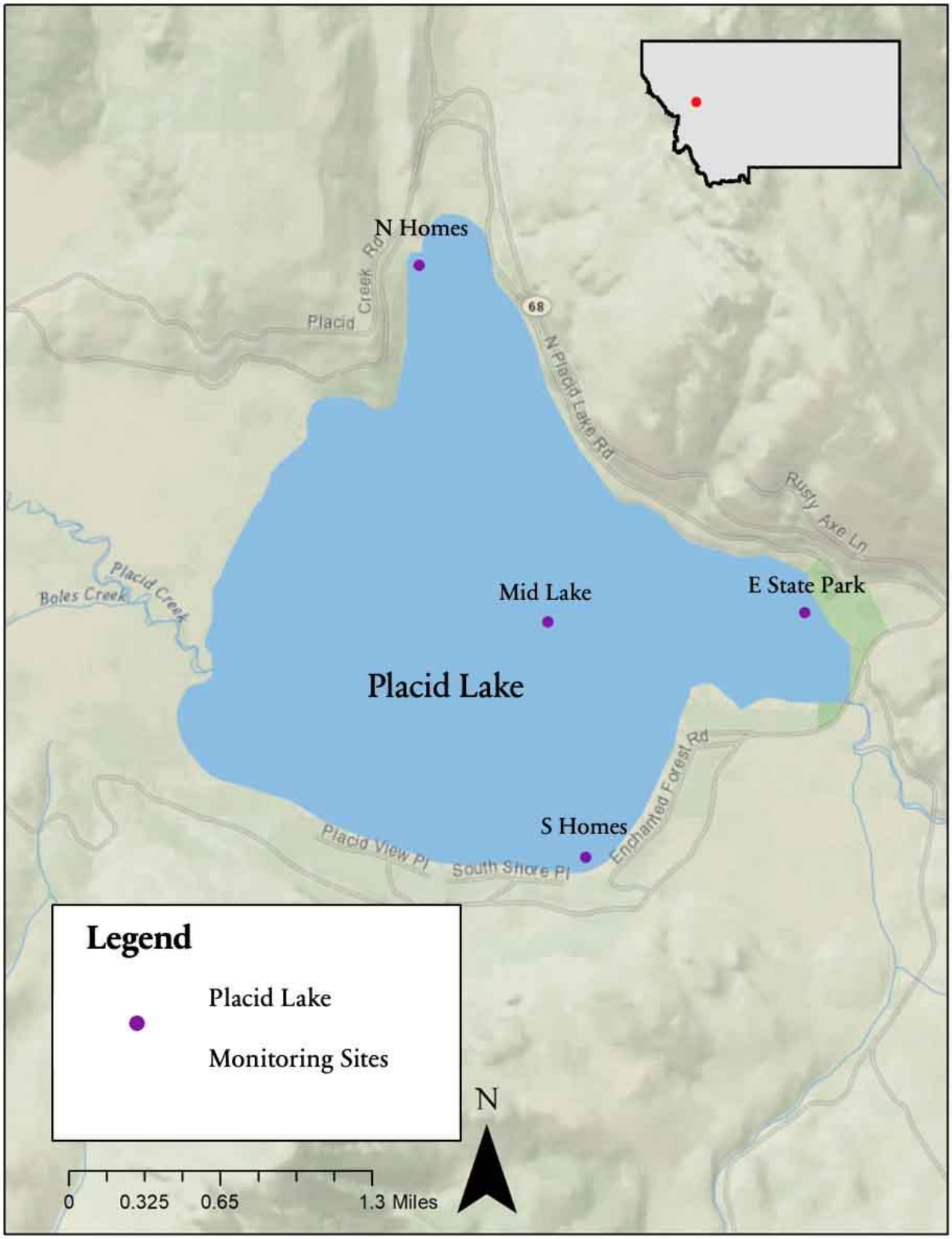

Figure 11. Map of Placid Lake monitoring sites.

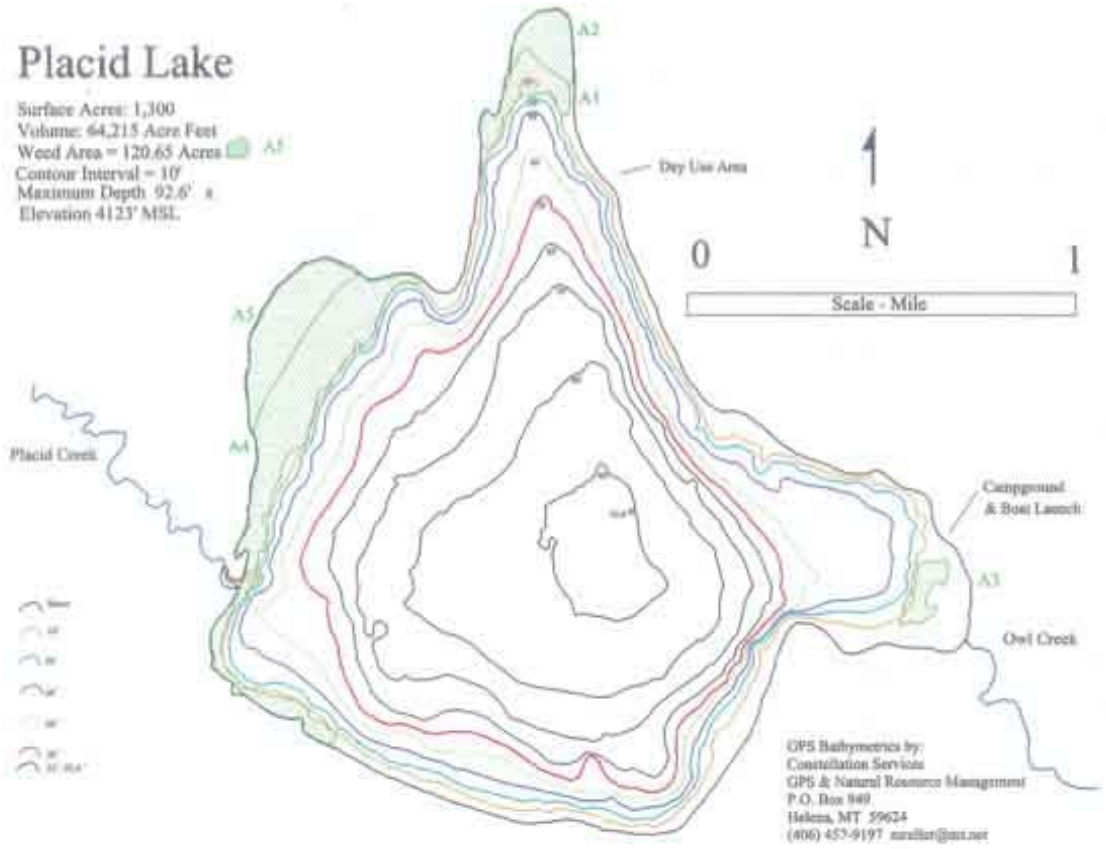

Figure 12. Bathymetry map of Placid Lake.

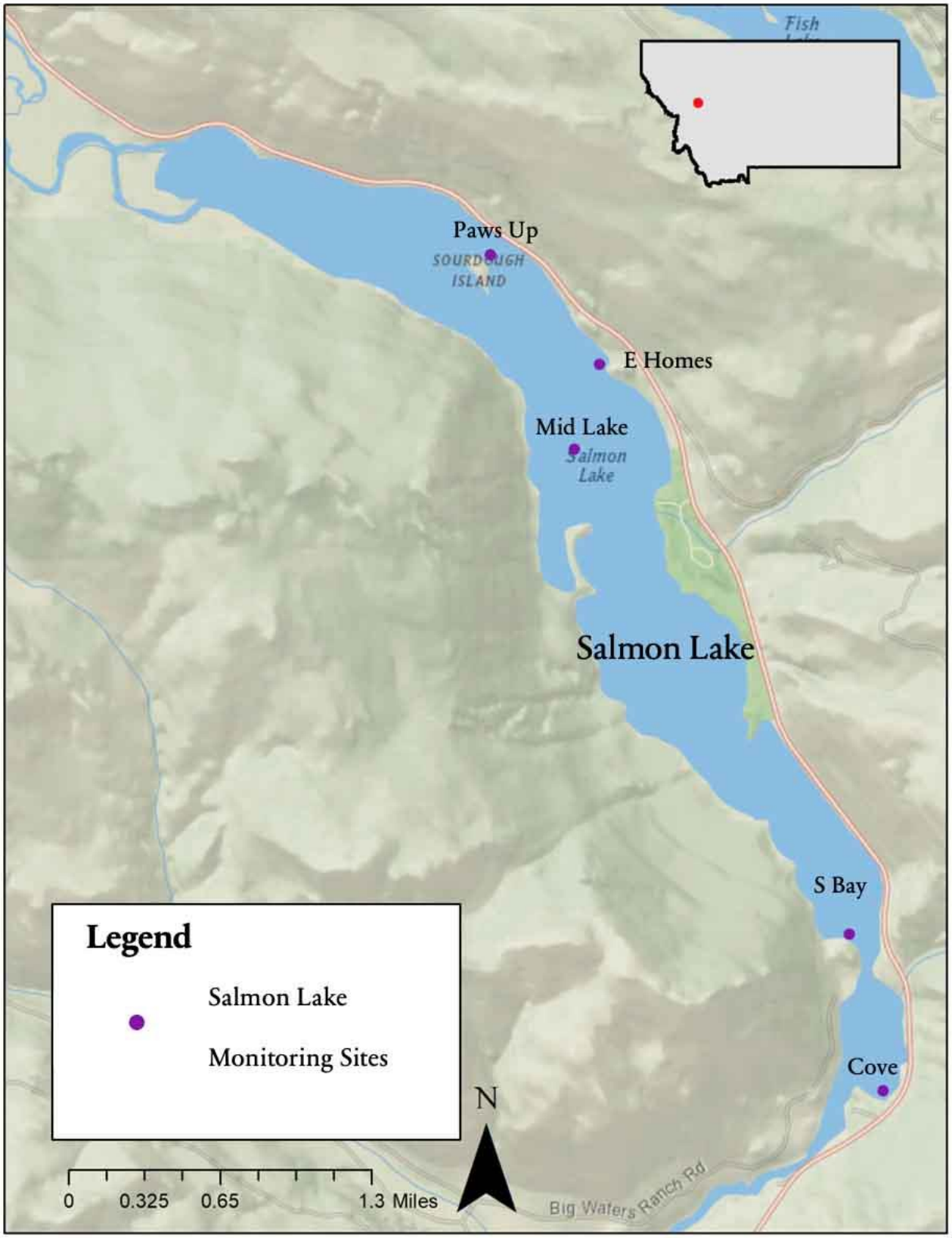

Figure 13. Map of Salmon Lake monitoring sites.

Figure 14. Bathymetry map of Salmon Lake.