R I V E R S

Water Quality Monitoring Program

2023 Volunteer Manual

Green Mountain Conservation Group

Saco River Corridor Commission

Dear RIVERS Volunteer,

On behalf of Green Mountain Conservation Group and the Saco River Corridor Commission we would like to thank you for volunteering with the 2023 RIVERS Water Quality Monitoring Program. Since 2001, the Regional Interstate Volunteers for the Ecosystems and Rivers of Saco (RIVERS) program has depended on dedicated community members to conduct high quality data science in the Saco/Ossipee Watershed.

By volunteering with RIVERS, you are collecting data to better understand the water quality in our area. You are helping to identify locations where water quality has been impacted, in addition to collecting valuable baseline data that can be utilized in planning for future regional development.

While science is our goal, your safety is our top priority. Data collection is nice, but not at the expense of your well-being. If at any point in time you feel unsafe at your site, discontinue monitoring and leave. This includes but is not limited to high waters, inclement weather, or any other observation that makes you feel unsafe. Follow your gut, and only do what you feel comfortable with.

Reach out to your volunteer coordinator if you have any issues or concerns about the program, even while out sampling. We want to help you if you get stuck on what to do, are having equipment issues, or have general comments on how to improve the program. We are here to help and value feedback from our volunteers.

The RIVERS program is only successful because of you - our intrepid, boots-on-the-ground volunteer group. We cannot thank you enough for your service and dedication year after year to the program. We don't say this enough, but you guys are really the best. Thank you for being a part of the GMCG and SRCC families.

Happy sampling,

Jill Emerson & Dalyn Houser

Contact Info

The 2023 RIVERS program is coordinated by Green Mountain Conservation Group in New Hampshire and Saco River Corridor Commission in Maine.

Green Mountain Conservation Group
236 Huntress Bridge Road, Effingham, NH
Office: (603) 539 - 1859

Jill Emerson
Water Quality Coordinator
water@gmcg.org
Cell: (603) 677-2920

Hailey Williams
Water Quality Resources Assistant water2@gmcg.org
Cell: (972)-655-8320

Saco River Corridor Commission
81 Maple Street, Cornish, ME 04020-0283
Office: (207) 625 - 8123

Dalyn Houser
Executive Director
dalyn@srcc-maine.org
Cell: (207)-749-3107

Tiger Peterson
Water Quality Assistant
Cell: (207)-381-7734

Emma Pierrotti
Water Quality Assistant
Cell: (207)-298-0365

RIVERS was created with the help of these organizations:

Table of Contents

Introduction

The Saco Watershed Monitoring Program created by Green Mountain Conservation Group (GMCG) in New Hampshire and Saco River Corridor Commission (SRCC) in Maine is one water quality monitoring program that encompasses one watershed, two states and twenty-six towns. One of the goals of the program is to provide the public with baseline knowledge of water quality in the watershed. These data are collected by people like you, volunteering time in their community. In 2020-2021, GMCG's AmeriCorps members collaborated with research partners at UNH, and SRCC hired FBE to analyze trends and create two reports on the last 15+ years of data collection. Because we now have a long-term data set, trends in water quality issues, such as road salting, have shown to be worsening consistently at select sampling locations. The long-term baseline data set helps us to establish consistent trends.

Of utmost importance to our program is safety for the volunteer. We want our volunteers to be comfortable with both the tasks required and the accessibility of their site. At the same time, attaining the most reliable data by measuring and conducting the procedures in a precise manner is also important. Therefore, GMCG and SRCC require training sessions to give the volunteers a hands-on experience with the equipment before the testing season begins. However, if at any time you have questions or comments, please contact either organization.

Saco River Basin

The Saco River Basin covers an area of approximately 1,700 square miles: 863 in Eastern New Hampshire and 837 square miles in Western Maine (1.1 million acres in total, 552,000 in NH and 536,000 in ME). The three major tributaries of the Saco River are the Swift, Ossipee, and Little Ossipee Rivers. The Swift River flows from the northern side of Mount Kancamagus for 21 miles before it enters the Saco River in Conway, New Hampshire. The Ossipee River begins at the outlet of Ossipee Lake in Effingham Falls, New Hampshire and flows for 18 miles before entering the Saco River in Cornish, Maine. The Little Ossipee River begins in Balch Pond which falls within Wakefield, New Hampshire, and Acton and Newfield, Maine. It joins with the Saco River in Limington, Maine.

Green Mountain Conservation Group

Since 1997, Green Mountain Conservation Group (GMCG), a nonprofit charitable organization, has dedicated its efforts to natural resource conservation in the Ossipee Watershed. We strive to promote an awareness and appreciation of our watershed's natural resources and encourage a commitment to protect them.

GREEN MOUNTAIN
CONSERVATION GROUP

The foundation of the organization rests on the R.E.A.L. principle, which includes:

Research - To collect data and sponsor scientific research that informs GMCG's educational and advocacy efforts.

Education - To foster an appreciation of the natural resources of the Ossipee Watershed by involving the public in activities such as symposiums, panel discussions or community presentations. GMCG also publishes a quarterly newsletter and offers a wide variety of educational opportunities to youth and individuals.

Advocacy – To present objective information with the belief that informed citizens will make good judgments about our unique watershed resources and to encourage individual and small group activism on resource protection and conservation issues.

Land Conservation - To encourage voluntary land conservation for the protection of water resources, wildlife habitat, sustainable forestry, and agriculture and quality of life.

GMCG Water Quality Monitoring Program

In 2000, GMCG worked with the University of New Hampshire (UNH) Cooperative Extension and the Society for the Protection of New Hampshire Forests to produce a series of Natural Resource Inventory (NRI) maps of each town in the Ossipee Watershed. These maps include information on hydrology, soils of statewide importance, town conservation land, unfragmented land, public water supplies, known and potential contamination sites as well as co-occurrences of important resources.

RIVERS grew out of the NRI mapping project as a way to further study our natural resources and as a way to work with the broader community to plan for growth while protecting the environment. The RIVERS program enables GMCG to study the health of the entire Watershed, track changes overtime, and educate the public.

Monitoring Locations

The selection of the water monitoring sites was a collaborative effort between GMCG and the town officials of Effingham, Freedom, Madison, Ossipee, Sandwich and Tamworth. The primary consideration was how current land uses were affecting nearby surface waters (Figure 1). All test site selections were validated by natural resource experts from UNH and UNH Cooperative Extension. GMCG monitors 29 sites in total.

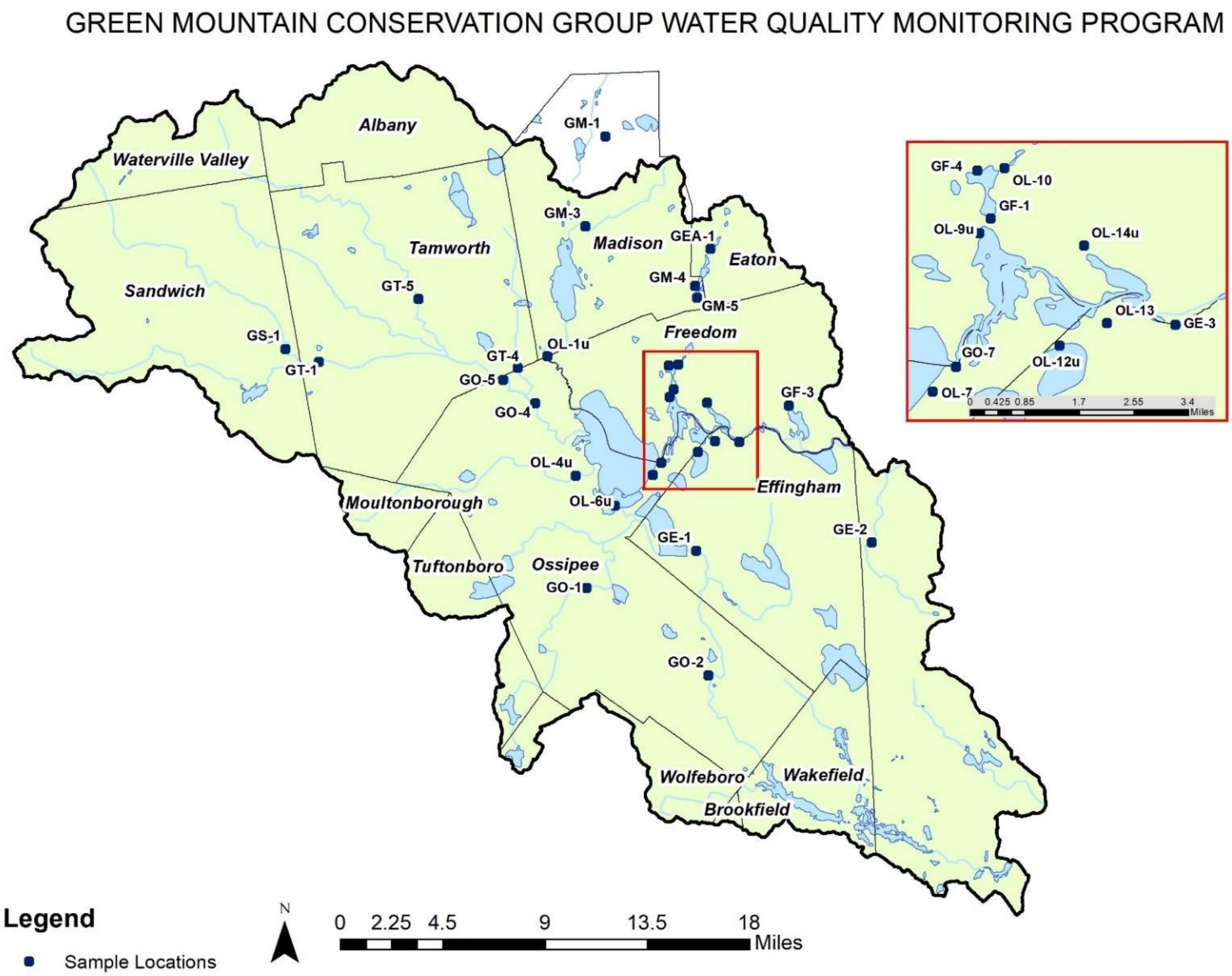


Figure 1: GMCG's RIVERS sampling locations in the Ossipee Watershed

Saco River Corridor Commission

Recognizing that uncontrolled growth would continue to occur in Corridor towns (for a complete listing please visit the website located at www.srcc-maine.org), a group of local citizens developed a plan which would require orderly growth and would prevent haphazard and intensive development in Corridor lands. The plan these concerned citizens developed also left administrative control in the hands of the valley people, who they felt would be closer and therefore more sensitive to the needs of Corridor citizens. The Saco River Corridor Commission, created by legislative action in 1973, is a regional level, land use regulatory agency made up of a member and an alternate from each of the twenty Corridor communities. The Commissioners are appointed for staggered three-year terms by their local selectmen or mayor. The SRCC is the perfect embodiment of a regional, state and local regulatory agency which carries out environmental regulations with the decision-making power kept in the hands of local community members.

SRCC Water Quality Monitoring Program

SRCC's primary goal for establishing the water quality monitoring program in July 2001 was to look for trends occurring in the waters that continuously flow through the basin. This program looks to establish trends in water quality through developing a baseline dataset. The SRCC began testing the water quality supplying the 20 communities within its corridor. The program tests for up to ten parameters: pH, turbidity, dissolved oxygen, temperature, bacteria, nitrate, nitrite, total dissolved nitrogen, orthophosphate, and total phosphorus. With the wrap of the successful pilot year, the SRCC began a cooperative working relationship with GMCG the following year to create a database that would house water quality data for the entire Saco River Basin. As the source of the waters under the regulatory jurisdiction of the Saco River Corridor Commission have their points of origin in New Hampshire, it seems nothing less than necessary to have partnerships with agencies "on the other side of the border." It is a lot easier to prevent a problem than to fix an existing one. Cooperatively monitoring water quality with GMCG, along with educated Basin residents, familiar with the program, is a giant step towards that prevention.

Monitoring Locations

Sample sites were chosen due to location or proximity down river from areas of intense development, large agriculture fields which may require use of pesticides or fertilizers, and areas of importance due to present fish and wildlife populations, recreational uses and other factors. The SRCC samples 42 sites in total.

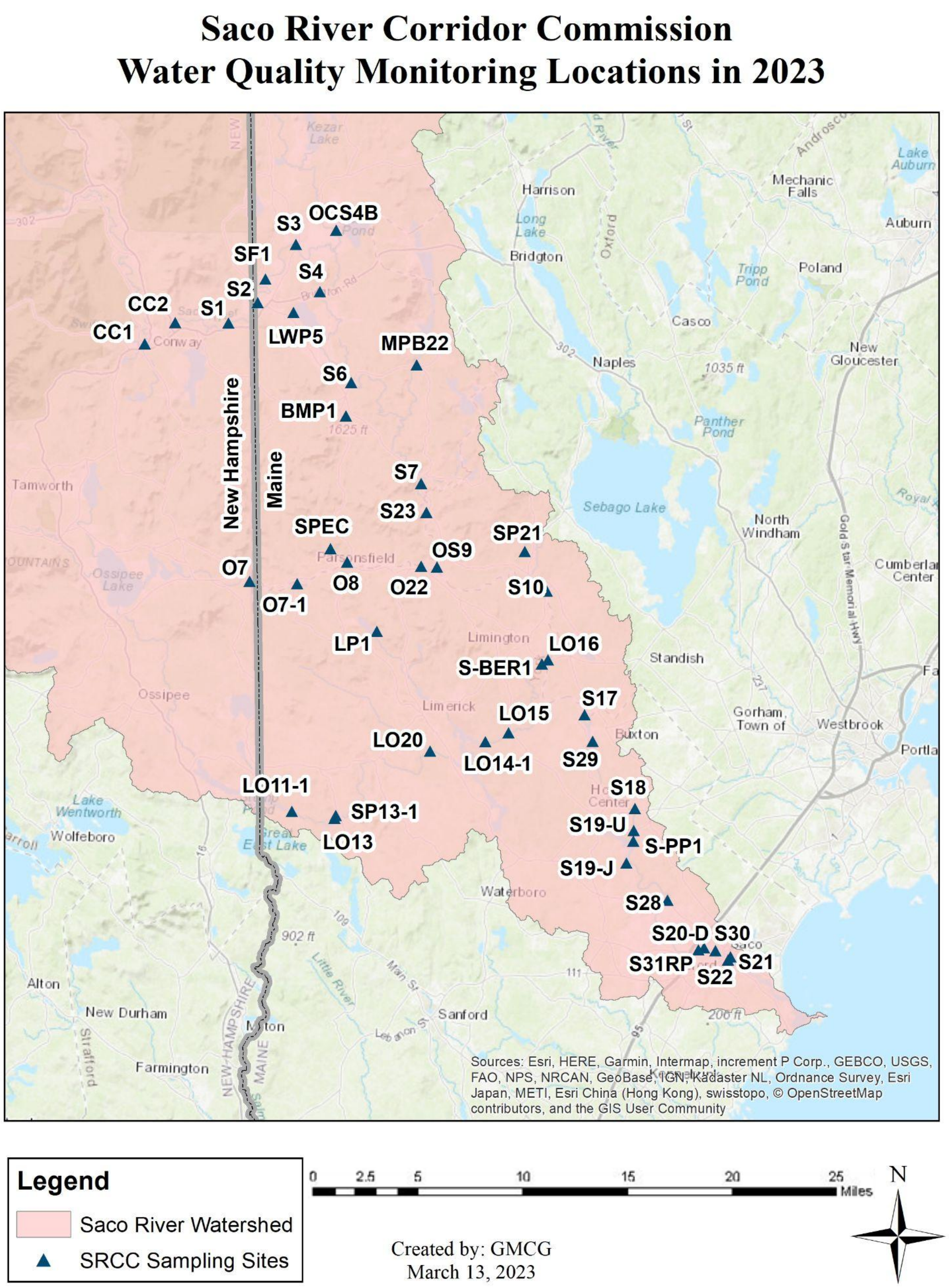


Figure 2: SRCC's RIVERS sampling location in the Saco Watershed

RIVERS Overview

Monitoring will be performed biweekly, Monday through Friday, beginning in May (or when conditions allow) and ending in September for SRCC and October for GMCG. Monitoring needs to be completed prior to 9:00 in the morning because some water quality parameters are affected with the passing of daylight hours, such as temperature and dissolved oxygen. Monitoring information is recorded during each event on a field data sheet. GMCG has expanded the program to include year-round monitoring at ten sites in the Ossipee Watershed.

Before going out into the field, volunteers undergo a training session provided jointly by GMCG and SRCC so that samplers both understand and feel comfortable with the collection protocol and the equipment that will be used. Volunteers are then assigned specific days, times, and sites to monitor, as determined by each of the organizations. Volunteers are responsible for collecting field parameters (listed below) and water samples of river/stream water as directed by each organization. Each organization will provide bottles and communicate with volunteers on a site-by-site basis for which water samples are needed and when.

Quality control (QC) testing is conducted once a season per volunteer group. This consists of a field visit by the water quality coordinator or water quality assistant while the volunteer group is out sampling. The water quality coordinator or assistant will take a second set of measurements and samples to cross check volunteer accuracy. This is a new addition to our 2020 QAPP renewal and its purpose is to confirm the collection protocol is being properly followed. This provides volunteers with an opportunity to demonstrate their knowledge, ask any questions, or share any concerns they may have while sampling.

Field Parameters

These are the measurements and observations that samplers gather every time they go out to a sampling site, aka “out in the field.” Observations on surroundings, recent past and current weather, and visual stream observations such as flow rate and bottom composition are recorded. Volunteers will then proceed to using meters and probes provided by each organization to collect the following parameters: dissolved oxygen, turbidity, temperature, and conductivity.

Dissolved Oxygen

The amount of oxygen contained in water is commonly expressed as a concentration in terms of milligrams per liter (mg/L), and/or as a percent (%) saturation. Accurate dissolved oxygen readings are dependent on temperature and atmospheric pressure. Levels rise from morning through the afternoon as a result of photosynthesis, reaching a peak in late afternoon. Photosynthesis stops at night, but plants and animals continue to respire and take in oxygen. As a result, dissolved oxygen levels fall to a low point just before dawn. Water temperature and the volume of water moving down a river also affect dissolved oxygen levels. Gasses, like oxygen, dissolve more easily in cooler water than in warmer water. Depletions in dissolved oxygen can cause major shifts in the kinds of aquatic organisms found in water bodies. Species that cannot tolerate low levels of dissolved oxygen will be replaced by a few species of pollution-tolerant organisms, nuisance algae, and anaerobic organisms.

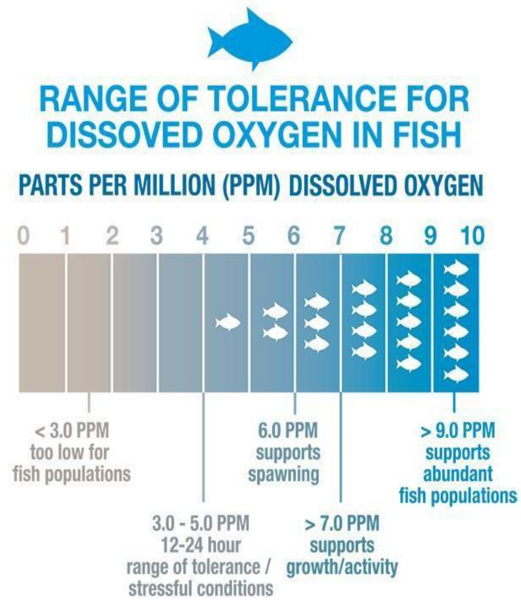


Figure 3: Dissolved oxygen ranges for aquatic life

Turbidity

Figure 4: Turbidity values and clarity

Turbidity is a measurement of the clarity of a fluid.

The greater the turbidity, the murkier the water. Higher levels of turbidity are usually the result of turbulent flow picking up large quantities of particulates, such as after a storm event or areas of erosion, both natural and man-made. Other causes are waste discharge, urban runoff, algal growth, or abundant bottom feeders that stir up bottom sediments. Also, improper sampling techniques, such as hitting the bottom sediments or sampling streams with little flow may also cause high turbidity readings.

These high levels of suspended particles, which absorb heat from the sun, increase the water temperature. Suspended solids can clog fish gills, reduce growth rates, decrease resistance to disease and prevent egg and larval development of aquatic life. Particles can also gather at the bottom of waterways and smother the eggs of fish and aquatic insects.

Temperature

The metabolic rates of organisms increase with rising water temperatures. An increased metabolism increases the need for oxygen. Temperature also influences the amount of oxygen dissolved in water and the rate of photosynthesis by algae and larger aquatic plants. Organisms that thrive in cooler water temperatures (13 degrees Celsius and below) can include trout and mayfly nymphs. Those that prefer warmer waters (20 degrees Celsius and above) are bass and numerous plant life. The middle range (13 to 20 degrees Celsius) best supports salmon, trout, water beetles and limited plant life.

Conductivity

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is determined by the presence of ions that carry a positive or negative charge. In streams and rivers, conductivity is affected primarily by the geology of the area through which the water flows. Streams that run through areas with granite bedrock tend to have lower conductivity; meanwhile, streams that run through areas with clay soils tend to have higher conductivity. Conductivity in some areas, typically those near roads, may have higher than average levels due to manmade issues such as road salting during the winter months. Conductivity is also influenced by temperature (warmer water has higher conductivity) and by flow volume.

Water Samples

Each sampling session volunteers will be directed to collect at least one water sample of river or stream water to return to their organization for pH determination. At other predetermined points throughout the sampling season, volunteers will be directed to take additional water samples for other parameters listed below. Each organization will provide bottles and communicate individually with each sampler to ensure the correct number of water samples have been obtained and returned to the organizations. Water samples for cations, anions, and nutrients are analyzed once per month for selected sites. Each organization will communicate the collection schedule to volunteers. Bacteria are sampled at selected sites, chosen based on proximity to high impact land uses (SRCC).

pH

Water contains both hydrogen ions and hydroxyl ions. At a pH of 7.0 (neutral) the concentration of both hydrogen ions and hydroxyl ions is equal. When the pH is less than 7.0 (acidic) there are more hydrogen ions than hydroxyl ions. When the pH is greater than 7.0 (alkaline or basic) there are more hydroxyl ions than hydrogen ions.

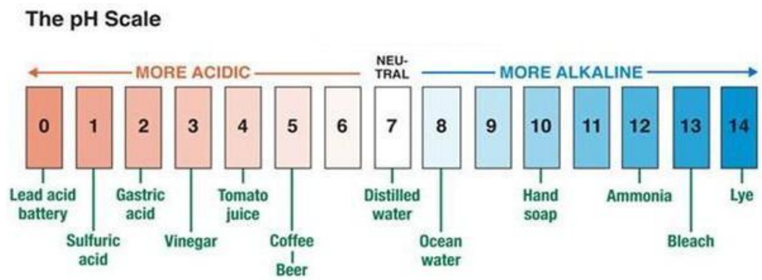


Figure 5: pH scale with familiar examples

Generally speaking, the ability of aquatic organisms to complete a life cycle greatly diminishes as pH falls below 5.0 or exceeds 9.0.

Chloride (Cl^-)

Chloride is present naturally in most water bodies, but typically the concentrations are low. Natural levels vary depending on geology. Exceptions can be seen when runoff from road salt applications or runoff from domestic sewage or farming are occurring.

Sodium (Na^+)

Natural levels of sodium can vary depending on geology. Human activities can influence the concentrations found in surface waters. The use of salt on roads and the reuse of water used for irrigating crops can have noticeable effects on sodium levels.

Sulfate (SO_4^{-2})

Sulfate is the stable, oxidized form of sulfur that is readily soluble and occurs naturally from weathering. Sulfates can be discharged into waterways from mines, smelters, paper mills, textile mills, and tanneries. The combustion of fossil fuels releases sulfur dioxide into the atmosphere also. Historically, acid rain resulted in elevated sulfate levels, but acid rain is not as problematic today.

Potassium (K^+)

One of the most abundant elements in the earth's crust, potassium compounds are used in glass, baking powder, soft drinks, and explosives. It is an essential element in both plant and human nutrition. It can occur naturally in groundwater as a result of the chemical breakdown of minerals in the weathering process, or through plant decomposition. However, high levels can result from human influences such as industrial pollution, over-fertilization of agricultural crops and leaky septic tanks.

Nitrogen

Nitrogen makes up about 80 percent of the volume of the earth's atmosphere and is found in all plants and animals. Its primary role is in the synthesis and maintenance of proteins.

Ammonium (NH_4^+) is the product of organic breakdown and is the preferred form of nitrogen for plant and microbial uptake since it is more energy efficient to use than nitrate. However, ammonium is typically very low in undisturbed streams. High levels of ammonium usually indicate some type of pollution (sewage, agricultural, runoff etc.).

Nitrate (NO_3^-) occurs naturally from nitrification of ammonium. Nitrification occurs in an oxygen rich environment, such as in stream water, where microbes convert ammonium to nitrite which is then quickly converted to nitrate. Elevated levels of nitrate indicate pollution from sewage, runoff, agriculture or other anthropogenic activity.

Nitrogen can be found in organic and inorganic forms throughout the surface water column which is why we also test for total dissolved nitrogen (TDN) and dissolved organic nitrogen (DON) in addition to NH_4^+ and NO_3^-.

Phosphorus

Of the two nutrients most important to the growth of aquatic plants, nitrogen and phosphorus, it is generally observed that phosphorus is the limiting factor to plant growth in freshwater systems. Phosphorus is primarily associated with human related activities within the watershed and is therefore important to monitor and control.

Phosphorus will accumulate in the slow-moving stream reaches and in impoundments (i.e. upstream of a dam, in lakes and in wetlands) where phosphorus that is attached to particulates settles out of the water column.

Table 1: Total Phosphorus (TP) Ranged for New Hampshire Lakes & Ponds

TP (µg/L)	**Category**
1 – 10	Low (Good)
11-20	Average
21 – 40	High
> 40	Excessive

Dissolved Organic Carbon (DOC)

DOC occurs naturally, through the process of leaching and the breakdown of organic materials. DOC can also come from urban runoff and sewage inputs. In fact, most DOC found in streams comes from an outside source. Chlorination of high DOC water can cause formation of trihalomethanes, which have been linked to cancer, reproductive problems, and other health issues.

Silica (SiO_2)

Most of the dissolved silica observed in natural water results originally from the chemical breakdown of silicate minerals in the weathering process of rocks. Silica is important for diatom (single-celled algae) growth and productivity. Silica can be used as a ground water tracer since ground water has higher concentrations of silica than rain and runoff.

Calcium (Ca^{+2})

Calcium is the most abundant of the alkaline-earth metals and makes up many common rock minerals. It is an essential element to plants and animals and is a major component of the solutes found in most natural water. Generally, calcium is the predominant cation in river water. Calcium is used in conjunction with magnesium to determine water "hardness."

Figure 6: Calcium buildup in a pipe

Magnesium (Mg^{+2})

Magnesium is a common element and is an essential part of plant and animal nutrition. Magnesium additions to streams are almost entirely from the natural environment, typically the weathering of magnesium-rich rocks or organic-rich soils. Magnesium is used in conjunction with calcium to determine water hardness.

Alkalinity

Alkalinity is a measure of how much acid can be added to a liquid without causing a large change in pH. Essentially, it looks at the capability of water to neutralize acid. Alkalinity is important for fish and aquatic life because it protects or buffers against rapid pH changes. Water contains natural buffering materials, such as the underlying soil and bedrock, that determine alkalinity. Main sources of natural alkalinity include rocks that contain carbonate, bicarbonate, and hydroxide compounds, such as limestone. Areas rich in these rocks tend to have higher alkalinity. Conversely, areas rich in granite or sandstone tend to have low alkalinity.

Escherichia coli and *Enterococcus*

E. coli are gram-negative bacteria and are a type of fecal coliform bacteria commonly found in the intestines of animals and humans. These bacteria are so small that they cannot be seen without a microscope. *E. coli* is known to cause illness in the gastrointestinal tract if it gets into the wrong place in the human body. The most common way to be exposed to *E. coli* is through contaminated food or water. If *E. coli* is found to be present in the water, it indicates recent sewage or animal waste contamination. It can wash into streams, rivers, lakes, or groundwater with rainfall or snow melt off the land surface. For its serious health impacts, *E. coli* is a vital parameter to test for in water quality.

Enterococcus is a similar type of organism that belongs to the genus of lactic acid bacteria. They are gram-positive bacteria that often occur in pairs or short chains. Two different species of *Enterococcus* are common organisms in the intestines of humans. They are also known to cause different types of clinical infections and it is essential that surface waters are tested to ensure minimal to no *Enterococcus* are found.

Sample Type	**Parameter**
Field Data GMCG & SRCC	Temperature, pH, dissolved oxygen (DO), specific conductance, turbidity
Water Samples GMCG	Dissolved organic carbon (DOC), total dissolved nitrogen (TDN), dissolved organic nitrogen (DON), ammonium (NH^+), silica (SiO_2), orthophosphate (PO_4^{3-}), chloride (Cl^-), nitrate (NO_3^-), sulfate (SO_4^{2-}), sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), calcium (Ca^{2+}), total phosphorus (TP)
Water Samples SRCC	Total phosphorus (TP), orthophosphate (PO_4^{3-}), nitrate (NO_3^-), total dissolved nitrogen (TDN), dissolved organic carbon (DOC), alkalinity, *E. coli, Enterococcus*

Table 2: Sample Summary

Field Sampling

Safety in the Field

Adapted from New Hampshire Department of Environmental Services

Safety is the first priority while conducting river and stream field monitoring. Please take note of the following safety precautions and if at any point, you feel uncomfortable, please terminate monitoring immediately.

- Always monitor with at least one other person. Use the buddy system!
- Look at the weather forecasted before sampling, making sure no storms are approaching or flood warnings are in effect.
- Avoid wading into a river if the water is high or fast moving.
- Secure your footing with each step. River bottoms accumulate slippery algae on the rocks.
- Watch out for wildlife (bears, skunks, etc.)
- Watch for poison ivy - many of our RIVERS sites are loaded with it.
- Check yourself for ticks when you get back to your car.

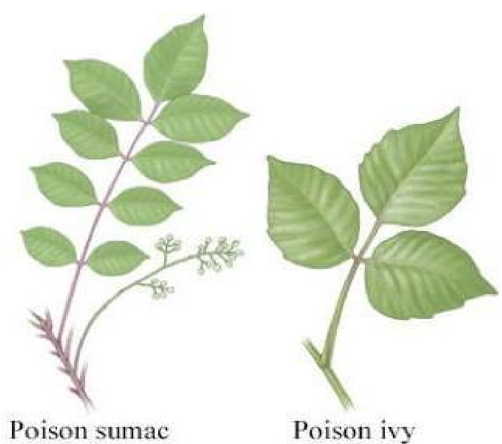


Figure 7: Potential plant hazards

Monitoring Equipment

- ❑ Equipment bag contains:
  - ❑ 1 Hach Portable Multi Meter
  - ❑ 1 Hach Conductivity Probe
  - ❑ 1 Hach LDO Dissolved Oxygen Probe
  - ❑ 1 pocket thermometer
  - ❑ 1 water resistant clipboard
    - ❑ Field sheets
    - ❑ Sampling Procedure Quick Guides
    - ❑ Calibration Quick Guides
    - ❑ Sampling Schedule
  - ❑ 1 permanent marker
  - ❑ Dissolved Oxygen Calibration Kit
    - ❑ DI water
    - ❑ DO calibration bottle
- ❑ Turbidity Meter box
  - ❑ 1 Hach 2100Q Turbidity Meter
  - ❑ Paper towels
  - ❑ Silicone oil
  - ❑ Black soft cloth
  - ❑ Glass sample vials
- ❑ Sample cooler
  - ❑ Sample bottles (1 – 5 bottles)
- ❑ Personal sampling kit
  - ❑ Pens and pencils
  - ❑ Disinfectant wipes
  - ❑ Gloves
  - ❑ Field sheets
  - ❑ Quick Guides

Monitoring Procedure

GMCG and SRCC share an EPA approved Quality Assurance Project Plan (QAPP). You must follow the procedure as outlined below to ensure that all volunteers collect samples in the same way.

We suggest the following order for sampling, but as long as all steps are followed you can sample however works best for you.

Site Observations

1. After safely parking without obstructing traffic, carefully make your way down to your site.

2. Take a minute to observe the area. You are looking for:

    - Anything that might pose a safety risk to you or your partner

    - Changes from your last monitoring

    - Weather and water condition (odor, color, flow)

3. If everything looks safe, fill out the field data sheet and continue with the monitoring procedure.

    - Part I - Site and Field Sampler Identification including the site code, date, and field samplers' names.

    - Part II - Weather Conditions are based on your best estimates. Check all that apply.

    - Part III - Site Observations are based on your best estimates. Check all that apply.

Measuring Dissolved Oxygen and Conductivity

1. Turn on the meter by pressing the power button

2. Take out the Hach multimeter and unfurl the yellow dissolved oxygen (LDO) and conductivity probes.

   - Do not submerge the pressure sensor. The pressure sensor is the black component on the yellow LDO probe cord located near where the probe connects to the meter.

3. Carefully connect dissolved oxygen and conductivity probes
4. by aligning the notch on the probe's end to the notch on the meter (Figure 8).

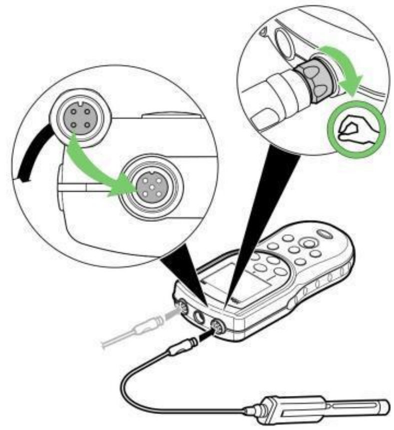
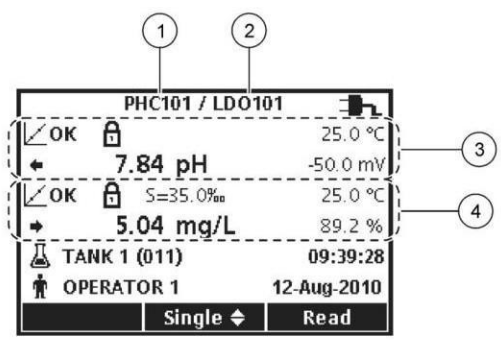


Figure 8: Connecting the probes to the meter

   - Push and turn the cable locking nuts to tighten.

   - Wait for the words "Probe Connecting" to disappear.

5. Check for the OK calibration symbol OK to appear twice: on the top measurement information for the probe connected to the left port and on the bottom measurement information for the probe connected to the right port (Figure 9). Fill out Part IV - Equipment Information and Calibration on the field data sheet.



1	Probe that is connected to port on left	3	Measurement information for probe on left
2	Probe that is connected to port on right	4	Measurement information for probe on right

Figure 9: Hach multimeter screen with two probes connected

- If you see the question mark symbol instead of the OK symbol this means the probe is not calibrated. If this is the case, please continue but note which probe is showing on your data sheet.

- If comfortable: If DO probe is not calibrated, you will need to follow the Calibrating Dissolved Oxygen Probe on page 26. If the conductivity probe is not calibrated continue sampling but notify your water quality coordinator.

6. Place the probes in an area of well mixed water clear of any obstruction (rocks, tree limbs, etc.) At this time, we also recommend putting the blue thermometer in the water as well at approximately the same depth as the probes.

   - If safe, you can rest them in the river so they start acclimating to the water while you continue with filling out the data sheet and collecting turbidity and any grab samples. By the time you are back to the meter it has acclimated (at least 5 minutes).

   - When you are ready, hold them in the well mixed water and proceed with the next step.
     - If possible to do so, please avoid touching the bottom.
     - Press the green button below **Read** on the screen and wait for probes to stabilize (Figure 10). You will hear a beep when stabilization is complete and readings have locked in.

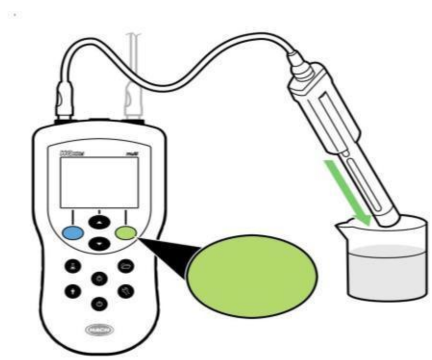


Figure 10: Press the green button to record a reading

- Record your Reading # 1 from the LDO probe (Dissolved Oxygen both in units of milligrams per liter (mg/L) and percent (%) and Temperature in degrees Celsius) and from the Conduct. probe (Conductivity in µs/cm) on Part V - Field Measurements on the field data sheet.

7. Collect second readings by pressing read and wait for probes to stabilize and enter Readings # 2 onto the field data sheet.

    - Check to verify that readings are within maximum allowable differences for each parameter. For dissolved oxygen, the readings should be within 0.5 mg/L of each other. For conductivity, the readings should be within 10 uS/cm at sites reading at 100 uS/cm or below or within 20 uS/cm at sites reading above 100 uS/cm. For estuary sites (SRCC only) the second reading must fall within 20% of the first reading. Temperature is also recorded from the dissolved oxygen probe (LDO) and readings should be within 1 ºC of each other.

Table 3: Maximum allowable differences for the Hach Multimeter

Measurements	**Maximum allowable differences**
Conductivity	For freshwater sites: 10uS/cm at sites reading at 100 uS/cm or below. 20 uS/cm accepted at sites reading above 100 uS/cm For estuary sites: second reading must fall within 20% of first reading
Dissolved Oxygen	0.5 mg/L
Temperature	1.0 ºC

8. Turn the meter off by pressing. 

9. Carefully disconnect probes by unscrewing cable lock.

10. Rinse probes with a small amount of distilled water. Coil probes and return to the equipment bag.

Measuring Temperature

1. Temperature is recorded from two sources: the dissolved oxygen probe and a blue pocket thermometer. Place the blue pocket thermometer in the water at the same time and depth as the dissolved oxygen and conductivity probes.

    - The thermometer needs at least 5 minutes to arrive at an accurate reading.

2. Record your Temperature Reading # 1 and # 2 from the LDO probe (degrees Celsius) in Part V - Field Measurements on the field data sheet.

3. Remove the thermometer from the water and record the temperature reading.

- Please read the temperature immediately upon removal. Avoid touching the bottom of the thermometer when reading.

4. Remember to return the blue thermometer to the gear bag.

Collecting Water Samples

When wading in the water, take slow careful steps. It is important not to stir up particulates before collecting these samples as contamination may affect the analysis readings (and wet rocks are slippery!). When collecting water samples, the rim of the bottle should not be touched with your hands after the cap is taken off. In situations where you might feel comfortable using a sampling collection device to collect water samples (bucket attached to a string for example), you may do so. Please make sure your sampling collection device is well rinsed with stream water before collecting your sample.

Labeling Sample Bottles

1. All water sample bottles should be labeled with site name and date (Figure 11).

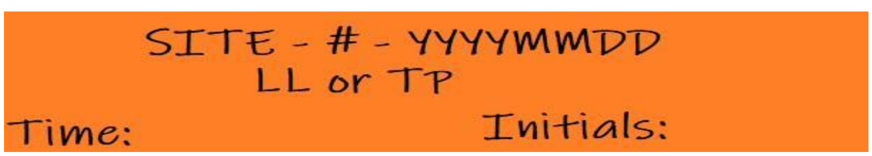


Figure 11: Example sample label

- Verify that this number matches the site you are at and the date of sampling.

- Write the time and your initials on the bottle(s) with the permanent marker provided.

- It is easiest to label the bottles when they are dry – before you collect the sample.

2. Fill out Part VI - Water Sample(s) on the field data sheet, especially noting the time on the bottle and your initials on the data sheet.

Collecting pH Samples (GMCG & SRCC)

1. With your bottle, carefully and slowly wade out into the stream to where the flow is fastest. If this is unsafe, find an area where current is moving at roughly 1 foot per second. Alternatively, go as far as you can safely get to. You may sample from bank edges if flow rate is adequate or from on top of rocks out in the current (at the sampler's discretion).

    - Be careful not to stir up particles in the stream, as contamination may affect readings. Take slow careful steps.

    - Face upstream, and position yourself upstream of the probes.
2. Rinse your pH bottle 1x before filling. To rinse, submerge your pH bottle in well mixed water under the surface and open it, allowing it to fill completely. Cap the bottle, bring it to the surface, and discard the water behind you. Reclose the bottle.

3. Collect samples as described in the rinse step above (step 3), though this time DO NOT DISCARD your water.

4. Return water to the cooler. Mark on data sheet time and whether the sample was collected in well mixed water.

Collecting Water Samples (GMCG & SRCC)

1. With your bottles, carefully and slowly wade out into the stream to where the flow is fastest. If this is unsafe, find an area where current is moving at roughly 1 foot per second. Alternatively, go as far as you can safely get to. You may sample from bank edges if flow rate is adequate or from on top of rocks out in the current (at the sampler's discretion).

    - Be careful not to stir up particles in the stream, as contamination may affect readings. Take slow careful steps.

    - Face upstream, and position yourself upstream of the probes.

2. Begin rinsing your bottles.

    - Carefully unscrew the cap, cover the bottle with the cap, submerge the bottle and cap to allow an inch or so of water in, cap the bottle before bringing it to the surface, remove bottle from stream, briefly shake bottle with cap on, and then discard stream water downstream (behind you).

- Repeat until rinsed 3 times.

3. After rinsing, collect lab samples.

    - Lightly cap bottle, submerge bottle and cap underwater, carefully remove cap to completely fill bottle, screw cap on, and then remove from water.
    - If you are unable to completely fill the bottle due to water depth please fill as much as you can without the mouth of the bottle hitting bottom sediment

4. Repeat for all sample bottles regardless of bottle size or shape.

E. coli/Enterococcus sample (SRCC only)

1. Wear the safety gloves that have been provided for you during the collection process.

2. With your bottles, carefully and slowly wade out into the stream to where the flow is fastest. If this is unsafe, find an area where current is moving at roughly 1 foot per second. Alternatively, go as far as you can safely get to. You may sample from bank edges if flow rate is adequate or from on top of rocks out in the current (at the sampler's discretion).

    - Be careful not to stir up particles in the stream, as contamination may affect readings. Take slow careful steps.

    - Face upstream and position yourself upstream of the probes.

    - Keeping the container capped, submerge the water sample container fully.

    - Open cap underwater and allow the bottle to fully fill. Remember not to touch the lip or the inside of the bottle when uncapping or recapping.

    - Once the bottle is filled, cap the bottle under water and bring up to the surface.

Collecting Duplicates

Occasionally, you may be asked to take a duplicate water sample. Use the same sampling procedure outlined above for all duplicate samples. Please fill all labeled sample bottles and remember to check the box for each additional water sample in Part VI - Water Sample(s) on the field data sheet.

Measuring Turbidity

1. Place the meter on a level, stationary surface. Do not hold the meter while taking a reading. If applicable to your specific site and vehicle style, we recommend using the meter in the trunk of your car (though it safely can be brought on site).

Figure 12: Hach turbidity meter

2. Collect at least two representative water samples in the small glass turbidity vials located in the turbidity meter box. More may be collected if sampling results are beyond the acceptable MAD.

   - Follow the same procedure for collecting pH samples: rinse the vial one time and keep the cap on the vial when passing through the surface.

3. Wipe the cell with a paper towel to remove water and fingerprints.

   - Take care to handle the sample cell by the top. Remember to cap the cell.

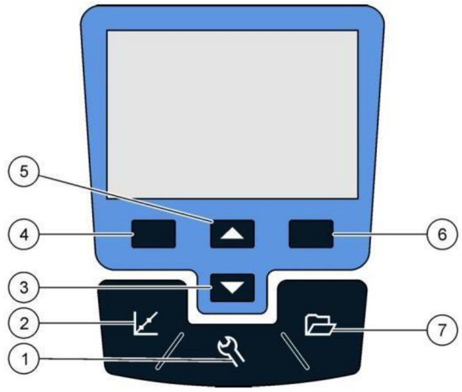
4. Apply a small drop of the silicone oil to the outside of the glass vial (Figure 13).

   - Wipe with the black velvet cloth to evenly spread the oil.

   - Remember to return the black velvet cloth to its plastic bag.

Figure 13: Apply silicone drops to vial and wipe with cloth

5. Gently invert to mix water samples. Then insert the sample cell in the instrument cell compartment so the arrow or orientation mark aligns with the raised orientation mark in front of the cell compartment. Close the lid.



1 **SETTINGS** key: select menu options for setting up the meter	5 **UP** key: scroll through menus, enter numbers and letters
2 **CALIBRATION** key: shows calibration screen, start calibration, select cal options	6 **RIGHT** key (contextual): read turbidity sample, selects or confirms options, opens/jumps to sub-menus
3 **DOWN** key: scroll through menus, enter numbers and letters	7 **DATA MANAGEMENT** key: view, delete or transfer stored data
4 **LEFT** key (contextual): access for calibration verification, cancels or exits the current menu screen to the previous menu screen	

Figure 14: Hach turbidity meter button options

6. Push the blue power key to turn the meter on.

7. Push RIGHT key under **Read** (Figure 14).

    - The display shows Stabilizing, then the turbidity in NTU.

8. Remove the first sample cell and test the second sample cell. Record Reading # 1 and Reading # 2 on the field data sheet.

    - Check to verify that turbidity readings are within 0.2 NTU of each other. If the difference between readings is greater than 0.2, re-wipe the vials and try again (remembering to invert the sample a few times before testing). If the difference is still greater than 0.2, collect an additional sample. Repeat until the difference between the two samples is less than or equal to 0.2 NTU.

Table 4: Maximum Allowable Differences for the Hach turbidity meter

Measurements	**Maximum allowable differences**
Turbidity	0.2 NTU

9. Turn the meter off. Remove sample vials and discard water. Return empty glass vials in the meter box.

Verifying Readings

Check to make sure readings are within maximum allowable differences. Collect a third reading for probes or sample another turbidity water sample. Note on your datasheet.

- Fill out Part VII - Verification on the field data sheet. Remember to note any issues and record your sampling end time.

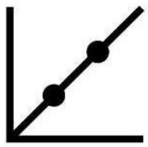
Table 5: Maximum Allowable Differences for all field parameters

Measurements	**Equipment**	**Maximum allowable differences**
Conductivity	Hach HQ40d Conductivity Probe	For freshwater sites: 10uS/cm at sites reading at 100 uS/cm or below. 20 uS/cm accepted at sites reading above 100 uS/cm For estuary sites: second reading must fall within 20% of first reading
Dissolved Oxygen	Hach HQ40d LDO Probe	0.5 mg/L
Temperature		1.0 °C
Turbidity	Hach 2100Q Turbidimeter	0.2 NTU

Collect Equipment

- When done, rinse probe ends with a small amount of DI water.
- Carefully coil up the probes and return them to the equipment bag. Check the site for anything you might have dropped.
- Record any problems you had on your datasheet. It's important to notify the water quality coordinator if you had any problems with the equipment.
- Get the meter to the next volunteer on time or return meter to your organization/drop location.
- Store samples in the cooler - don't leave samples or equipment in a hot car. This can damage the sensitive and expensive equipment and render grab samples invalid.

Calibration Procedure



Calibrating the dissolved oxygen probe is done once per day by the first person to sample. You will be notified if you are responsible for calibrating the dissolved oxygen probe. If you see the question mark symbol ? instead of the OK symbol OK, you may need to recalibrate the DO meter.

Allow up to 30 minutes for contents to equilibrate to room temperature. It is easiest to bring the meter into your house overnight and calibrate first thing in the morning when you wake up, or if picking up at a drop location to calibrate there before leaving for sampling. Calibrations are temperature based, so exposing equipment and solutions to changing temperatures (I.E. cold car to hot outdoors) will result in the equipment taking much longer to calibrate than normal OR a failure to calibrate.

Calibrating Dissolved Oxygen Probe

Calibration on average takes about 5 minutes, though it is not unusual to have calibration time exceed 15 minutes, so please allow ample time for calibration to occur.

1. Carefully connect the dissolved oxygen probe to the meter. Push and turn the cable locking nut to tighten.

2. Turn on the meter by pressing the power button and wait for the probe to connect. Begin calibration.

   - If the meter does not prompt calibration, press **Calibrate**.

3. Carefully unscrew protective cage from probe and rinse with deionized water from the DI water bottle (Figure 15). Blot dry with a Kimwipe (provided) or a lint free towel.

   - Be careful not to scratch the end of the probe. It is a rugged design, but it is still susceptible to damage.

   - The deionized water can be reused by rinsing the probe over the DO calibration bottle.

Figure 15: Rinse the probe with DI water

4. Add about a ¼ inch of distilled water to the DO calibration bottle and cap bottle. Vigorously shake the DO calibration bottle for about 30 seconds to saturate the entrapped air with water.

   - Keep the cap on this bottle until step 3 is completed.

   - This water can be used many times so do not dump it out.

5. Remove the cap on the DO calibration bottle. Insert probe into top of bottle (probe can be propped up so you do not need to hold it, but it must be balanced).

6. Push **Read**.

   - The display shows "Stabilizing" and a progress bar as the probe stabilizes. The display shows the standard value when the reading is stable.

   - Calibration on average takes no more than 5 minutes to stabilize and lock. Probe will not calibrate if wet (even just a drop) so if calibration will not stabilize: dry probe again, give the bottle a quick shake, reinsert probe, and then press calibrate.

7. Push **Done** to view the calibration summary. Push **Store** to accept the calibration and return to the measurement mode.

   - You must press **Store** to save the calibration!

8. Verify that the calibration was successful by locating the ✓OK symbol.

9. Install the protective cage back on the probe.

Other Calibrations

The conductivity probe is calibrated by the water quality coordinator on a weekly basis. If the conductivity probe is not calibrated and you see the ✓? image on the multiparameter meter, please note this on your data sheet and contact the appropriate organization's WQ coordinator.

Appendices

Sampling Quick Guide

1. Find safe parking and bring equipment to sampling site
2. Check that site is safe
3. Site observations
4. Put probes in water
5. Collect water samples
6. Test turbidity
7. Collect readings from probes
8. Verify that all readings are within maximum allowable differences
9. Give meter to next volunteer/bring to drop location
10. Check for ticks

GMCG Monitoring Locations

Table 2: Coordinates for GMCG RIVERS sampling sites. Sites in green are monitored year-round.

Name	Latitude	Longitude
GE-3 Ossipee River, Effingham	43.7937321	-71.0613418
GF-3 Cold Brook, Freedom	43.81033333	-71.02988889
GM-1 Banfield Brook, Madison	43.93391667	-71.1465
GT-4 Chocorua River, Tamworth	43.82769444	-71.20236111
GO-2 Frenchman's Brook, Ossipee	43.68638889	-71.08113889
GO-5 Bearcamp River, Ossipee	43.82216667	-71.21163889
GS-1 Cold River, Sandwich	43.83641667	-71.34983333
OL-12u Phillips Brook, Effingham	43.7890247	-71.0875427
OL-14u Square Brook, Freedom	43.811614	-71.081964
GO-7 Ossipee Lake, Ossipee	43.784172	-71.110886
GE-1 Pine River, Effingham	43.74377778	-71.08861111
GE-2 South River, Effingham	43.747471	-70.977087
GF-1 Danforth outlet, Freedom	43.817705	-71.103121
GF-4 Shawtown Brook, Freedom	43.82862	-71.106159
GM-3 Forrest Brook, Madison	43.89263889	-71.15930556
GT-1 Bearcamp River, Tamworth	43.83033333	-71.32866667
GO-1 Beech River, Ossipee	43.72658333	-71.15836111
GO-4 Bearcamp River, Ossipee	43.81147222	-71.19102778
OL-7 Red Brook, Effingham	43.77861	-71.116245
GT-5 Swift River, Tamworth	43.85925	-71.26525
OL-1u West Branch River, Freedom	43.833103	-71.183488
OL-6u Pine River, Ossipee	43.764431	-71.140347
OL-4u Lovell River, Ossipee	43.778246	-71.165252
GEA-1 Long Pond Outlet, Eaton	43.882192	-71.079831
OL-10 Huckins Pond Outflow, Freedom	43.829185	-71.100015
OL-9u Cold Brook, Freedom	43.814433	-71.105605
OL-13 Leavitt Brook, Effingham	43.794051	-71.076769
GM-4 Ferrin Brook, Madison	43.865189	-71.089645
GM-5 Mill Brook, Madison	43.859885	-71.08823

SRCC Monitoring Locations (need new sites added)

Table 3: Coordinates for SRCC RIVERS Sampling Sites.

Site Code	Description	Latitude	Longitude
CC1	Davis Park in Conway, NH	43.9829	-71.1166
CC2	Saco River (Redstone), Police Station, Conway, NH	44.001	-71.0828
S1	Saco River, ME/NH border in Conway, NH (Saco Pines)	44.00152	-71.02263
S2	Saco River, Weston's Beach, Fryeburg, ME	44.01866	-70.99017
S3	Saco River, Canal Bridge Beach, Fryeburg, ME	44.066839	-70.948322
S4	Saco River, Fryeburg, ME	44.028810	-70.920000
SF1	Below Swan Falls Dam, Fryeburg, ME	44.038067	-70.981875
LWP5	On Lovewell Pond, Fryeburg, ME	44.011467	-70.949447
OCS4-B	Old Course Downstream of Hemlock Bridge, Fryeburg, ME	44.0792663	-70.903382
S6	Down river of Brownfield Bog (Route 160 Bridge), Brownfield, ME	43.955489	-70.882614
MPB22	Below Moose Pond/at Moose Pond Brook, Denmark, ME	43.9711712	-70.8093
BMP1	Burnt Meadow Pond at public beach, Brownfield, ME	43.928358	-70.887544
O7	Ossipee River, ME/NH border in Effingham, NH	43.792069	-70.991778
O7-1	Ossipee River, Covered Bridge off Route 25 in Porter, ME	43.790781	-70.938231
O8	Ossipee River, Down river of Kezar Falls, Parsonsfield, ME	43.809581	-70.882397
OS9	Ossipee River, Route 5, Cornish, ME	43.806967	-70.781404
S10	Saco River, Off Route 11, Steep Falls, ME	43.7894254	-70.657379
S7	Saco River on the far side of Camp Hiawatha, Porter, ME	43.874717	-70.801303
S23	Saco River, Great Falls/Dam, Hiram, ME	43.851255	-70.794686
O22	Ossipee River, Bridge at Bridge Street - Cornish/Hiram, ME	43.80735	-70.798982
LO11-1	Little Ossipee River, Beside Balch Lake Dam, Newfield, ME	43.6056	-70.9381
LO13	Little Ossipee River, Below Shapleigh Pond, Shapleigh, ME	43.603162	-70.888727
SP13-1	Shapleigh Pond, Shapleigh, ME	43.600701	-70.890288
LO14-1	Little Ossipee River, Above Lake Arrowhead Dam, Waterboro, ME	43.665739	-70.722917
LO15	Little Ossipee River, Below Lake Arrowhead, Limington, ME	43.673408	-70.697039
LO16	Little Ossipee River, off Hardscrabble Rd, Limington, ME	43.730047	-70.661075
LO25	Little Ossipee Pond, Waterboro, ME	43.62664722	-70.72141667
S17	Saco River, Bonny Eagle Island, Standish, ME	43.689428	-70.611764
S18	Saco River, Above Bar Mills Dam, Buxton, ME	43.613953	-70.553721
S19-U	Saco River, Above Skelton Dam, Dayton, ME	43.595928	-70.554186
S19-J	Saco River, Dayton, ME	43.569187	-70.561721
S20-D	Saco River, South Street, Biddeford, ME	43.499642	-70.479444
S21	Saco River, Public Boat Launch Front Street, Saco, ME	43.494605	-70.443067
S22	Saco River, Runnery's Boat Yard, Biddeford, ME	43.491817	-70.445939
S28	Saco River, Route 5 Bridge, Saco, ME	43.539669	-70.514792

S29	Saco River, Saco, ME	43.667719	-70.602385
S30	Saco River, Off Irving Street, Saco, ME	43.499275	-70.460142
S31RP	Saco River, Rotary Park, Biddeford, ME	43.501533	-70.473281
LO20	Little Ossipee River, Bridge on Foss Road, Limerick, ME	43.657236	-70.784344
SP21	Sand Pond, Baldwin, ME; Town of Baldwin public beach	43.82111	-70.68295
SPEC	Spec Pond, Porter, ME; public access beach	43.81994	-70.90175
S-PP1	Pleasant Point Park, Buxton, ME; public access point	43.58719	-70.55452
S-BER1	Bony Eagle Recreation Area, Limington, ME; public access point	43.73349	-70.65434

FAQ

Why do samples have to be collected before 9 a.m.?

All testing needs to be completed in the early morning because as the day progresses, water temperature and biological activity increase, affecting the level of dissolved oxygen. Sampling at the same time each day assures that data are collected at the same point in the diurnal oxygen and chemical cycles.

Why do I need a buddy?

Safety in numbers! We want all of the volunteers to be safe while they are sampling. Plus, a buddy can help make sure samples are collected with the utmost accuracy.

I forgot I was supposed to sample. What should I do?

As all sites have to be sampled before 9 a.m., it's important that if one site is delayed, the rest aren't pushed back for the day. Please make sure to get the meter bag to the next volunteer on time. Getting the gear to the next person is more important than collecting all of the data at your site.

Please refer to the binder in the equipment bag for quick guide protocols on each collection protocol.

Do we sample in all weather conditions?

Mostly yes. We do sample in the rain; however, if there is a flash flood or flood warning in effect, or other storm conditions such as thunder and lightning, please do not sample. Please check for any weather advisories in your sampling area before going out.

What if I have equipment problems in the field, or a sample bottle is missing?

If you cannot get the equipment to work, please call your WQ coordinator or assistant. If you cannot get in touch with either person, please collect however much data you can with the unaffected equipment. Some data are better than no data - we'd rather you miss a single data point than the entire set if possible.

A set of spare clean sampling bottles are located in your equipment bag. If those are not there, just collect the other data points and record on your data sheet "no bottles supplied".

Troubleshooting

Table 4: Hach multimeter HQ40d Troubleshooting

Problem	Probable Cause	Action
No Display	Batteries not in place	Insert batteries
	Batteries not correct polarity	Check batteries
	Low batteries	Replace batteries
Connect a probe	Probe not connected correctly	Disconnect, then connect the probe. Tighten the locking nut.
	Damaged probe	Try to figure out if one or both probes are not working. Contact your RIVERS coordinator.
Slow stabilization time	Temperature fluctuations	Patience. Depending on stream conditions it may take more time than normal for readings to stabilize.
	Bubbles trapped under probe tip	Remove the probe and reinsert into water.
	Calibration not done correctly	If LDO probe and you are able, recalibrate the dissolved oxygen probe. If conductivity probe, contact your RIVERS coordinator and continue sampling.

Table 5: Hach 2100Q Turbidimeter Troubleshooting

Problem	Probable Cause	Action
No Display	Batteries not in place	Insert batteries
	Batteries not correct polarity	Check batteries
	Low batteries	Replace batteries
Close lid and push Read.	The lid is open or lid detection failed.	Make sure that the lid is closed during reading and re-read.
Low Battery!	Battery is low.	Insert new batteries
ADC Failure!	Hardware error causing reading to fail.	Repeat the reading.

Expected Values

Table 6: Quick reference sheet for expected values of different field parameters.

Parameter	Expected range
Conductivity	0-500 µS/cm
Dissolved Oxygen	6-11 mg/L and 75-120 %
Turbidity	0-10 NTU
Temperature	0-27 ºC

Please note: other values may be correct due to seasonal influences or natural flora/geology. Just because you do not obtain the expected value does not necessarily mean your data are wrong! If you are questioning the data collected, verify that calibrations on equipment have been done and repeat the protocol in full if time allows. If those values persist, make a note in the comments section of your data sheet.

Notes

Notes

Things to Remember

as a 2023 RIVERS Volunteer

- You DON'T have to get this data – you DO have to stay safe!
- Bring a partner to the river if you can.
- Watch out for wildlife and look out for poison ivy.
- Don't hurry at your site. Take your time.
- Don't reach. Instead, get your feet wet.
- Watch your footing. Rocks and roots are VERY slippery.
- If you lose a bottle/pen/etc., DON'T try to get it if it's not easy.
- Remember to fill your bottles but don't touch the bottle neck or inside of the cap.
- Don't leave the meter in a hot car.
- It's more important to get the meter to the next site on time than to finish your own site.
- Call the RIVERS coordinator or assistant if you need help:
    - GMCG – Jill: (603) 677-2920 or Hailey (972)-655-8320
    - SRCC – Dalyn: (207) 749-3107
- Check for ticks.
- Thank you!

RIVERS
WATER QUALITY MONITORING PROGRAM

Volunteer: ________________________________

Site(s): __________________________________