

Signature Pages

1. APPROVAL PAGE*

GMCG Executive Director
Matt Howe, Green Mountain Conservation Group

Signature

Date

SRCC Executive Director
Dalyn Houser, Saco River Corridor Commission

Signature

Date

SRCC Project QA/QC Officer & GMCG Water Quality Monitoring Director
Jillian Emerson, Saco River Corridor Commission & Green Mountain Conservation Group

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NH DES Volunteer River Assessment Program
Ted Walsh, NH DES

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NH DES QA Manager
Vincent Perelli, NH DES

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NH DES NPS Program QA Coordinator
Stephen Landry, NH DES

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ME DEP QAPP Review Coordinator
Bill Longfellow, ME DEP

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*There are currently no EPA funds for this project which would require an approved QAPP. However, EPA has conducted a courtesy review and found the document approvable to support the on-going monitoring efforts

Text of QAPP

Regional Interstate Volunteers for the Ecosystems and Rivers of Saco (RIVERS) Water Quality Monitoring Program QAPP (update to US EPA RFA 20078 – last approved March 2015)

Saco River Corridor Commission (SRCC)

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Initial funding for this project was provided by a grant from The Nature Conservancy and in part by a Watershed Assistance Grant from the New Hampshire Department of Environmental Services (NH DES) with Clean Water Act Section 319 funds from the United States Environmental Protection Agency (US EPA)

May 29th 2020



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3. DISTRIBUTION LIST

The following (Table 1) lists the people who will receive a copy of the Quality Assurance Project Plan (QAPP) and subsequent revisions:

Table 1: Document Distribution

QAPP Recipients	Organization/Address	Telephone/Email
Matt Howe	Green Mountain Conservation Group PO Box 95, 236 Huntress Bridge, Rd. Effingham, NH 03882	(603) 539-1859 director@gmccg.org
Dalyn Houser	Saco River Corridor Commission P.O. Box 283, 81 Maple Street, Cornish, ME 04020-0283	(207) 625-8123 dalyn@srcc-maine.org
Jillian Emerson	Green Mountain Conservation Group PO Box 95, 236 Huntress Bridge, Rd. Effingham, NH 03882	(603) 539-1859 water@gmccg.org
Ted Walsh	Volunteer River Assessment Program NH DES P.O. Box 95; Concord, NH 03302	(603) 271-2083 ted.walsh@des.nh.gov
Vincent Perelli	Office of the Commissioner NH DES P.O. Box 95; Concord, NH 03302	(603) 271-8989 vincent.perelli@des.nh.gov
Jillian McCarthy	Watershed Assistance Section NH DES P.O. Box 95; Concord, NH 03302	(603) 271-8475 jillian.mccarthy@des.nh.gov
Susanne Meidel	Division of Environmental Assessment ME Department of Environmental Protection (DEP) Bureau of Water Quality 17 State House Station, Augusta, ME 04333	(207) 441-3612 Susanne.K.Meidel@maine.gov
Jody Potter	Water Resources Research Center (WRRC) University of New Hampshire, James Hall; Durham, NH 03824	(603) 862-2341 jody.potter@unh.edu
William McDowell	Water Resources Research Center University of New Hampshire, James Hall; Durham, NH 03824	(603) 862-2249 bill.mcdowell@unh.edu
Michelle Daley-Shattuck	Water Resources Research Center University of New Hampshire, James Hall; Durham, NH 03824	(603) 862-2341 michelle.shattuck@unh.edu
Robert Craycraft	Educational Program Coordinator UNH Lakes Lay Monitoring Program (LLMP) University of New Hampshire Cooperative Extension Spaulding Hall Durham, NH 03824	(603) 862-3696 bob.craycraft@unh.edu
WQMP Volunteers	NA	NA
Erik Beck	US EPA Project Officer Environmental Protection Agency 5 Post Office Square - Suite 100 Boston, MA 02109-3912	617-918-1606 beck.erik@epa.gov
TBD	US EPA, New England Regional Laboratory 11 Technology Drive Chelmsford, MA 01863-2431	

This document will be available for reference at the GMCG's program office at 236 Huntress Bridge Road, Effingham NH and at SRCC program office at 81 Maple Street, Cornish, ME, as well as at the GMCG

website (www.gmcg.org) and the SRCC website (www.srcc-maine.org) for participants and other interested parties. Program participants will also receive a separately produced handbook containing all of the information needed for field and administrative work.

4. PROJECT & TASK ORGANIZATION

The Regional Interstate Volunteers for the Ecosystems and Rivers of Saco (RIVERS) Water Quality Monitoring Program (WQMP) is operated jointly by GMCG and SRCC. The WQMP will be managed by the Water Quality Monitoring Directors-QA/QC Officers (WQM Director) who will report to the Executive Directors of Green Mountain Conservation Group and Saco River Corridor Commission, respectively. The WQM Directors, will be responsible as a liaison with RIVERS volunteers and for ensuring that water samples are delivered to laboratory contact personnel at the University of New Hampshire (UNH) and/or Katahdin Analytical Services (KAS).

Figure 1 illustrates how the project has been organized and will be managed:

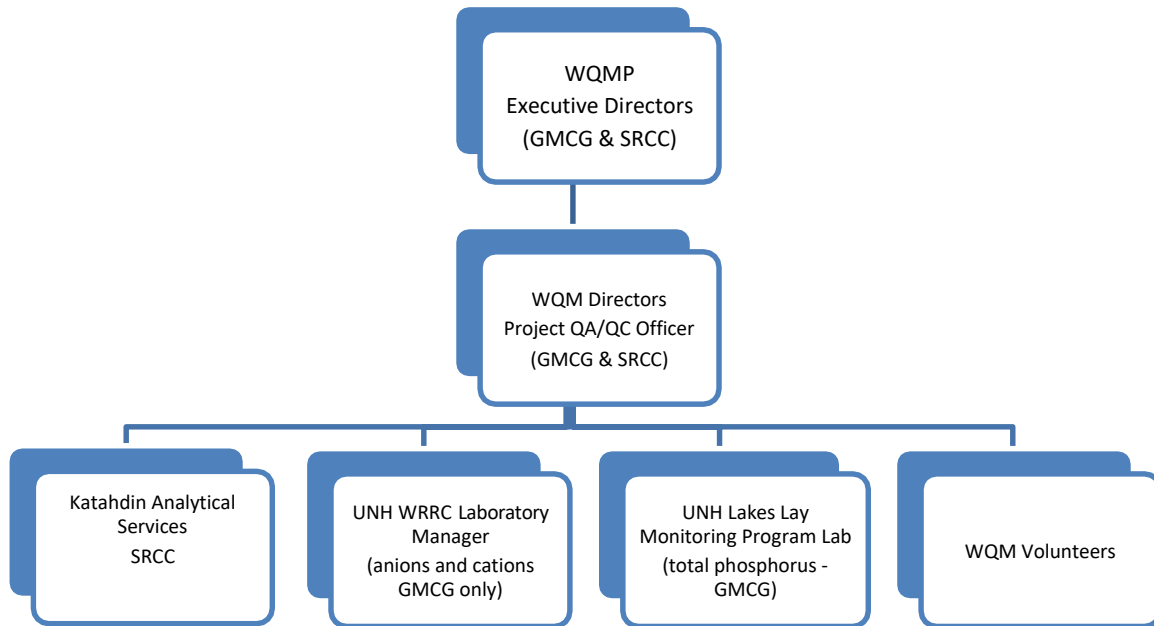


Figure 1: Organization Chart

As shown in Figure 1, the WQM Directors will be responsible to the WQMP Executive Directors for the day-to-day management of the WQMP. If the WQM Director is the same person as the WQMP Executive Director, then the Project QA/QC Officer and/or Coordinator will be responsible for the day-to-day management. The WQM Directors and/or Project Officer for GMCG and SRCC will train the volunteers for each of their river and tributary testing programs. The WQM Directors and/or the Project QA/QC Officer are responsible for the overall supervision of the WQM Volunteers obtaining water samples, and either processing them or delivering them to the appropriate laboratory. Throughout the rest of this document, the Project Officer is included as part of “WQM staff”, which also includes Coordinators and interns.

The RIVERS program collects water quality data through field measurements and through the collection of water samples in the Saco River Basin and the Ossipee River Watershed, with chemistry samples analyzed by UNH or Katahdin Analytical Services. Samples are collected biweekly from May through

October, with ten of GMCG’s sites also being sampled monthly from November through April. A few of GMCG’s sites are only sampled in the summer months, due to availability of resources. These summer-only sites have always been summer-only, though some are being added to the May through October season based on data needs and available resources. A sample of the monitoring schedules can be found in Appendix D.

The UNH Water Resource Research Center analyzes GMCG samples from the Ossipee River Watershed for a suite of 13 parameters listed in Table 9. The UNH Lakes Lay Monitoring Program lab analyzes GMCG samples for total phosphorus. Katahdin Analytical Services analyzes SRCC samples for a suite of 6 parameters listed in Table 9. The WQM Director(s) in charge at each organization, with supervision from the Executive Directors will write a final report on their respective data set at the end of the sampling season. Table 2: Responsibilities details the responsibilities of the key personnel.

Table 2: Responsibilities

POSITION	RESPONSIBILITIES
SRCC & GMCG Executive Directors	The SRCC and GMCG Executive Directors (EDs) will have overall responsibility for the WQMP. The EDs will manage the WQM Director(s) and ensure that the project is continuously working towards its goals. They will develop and update the QAPP and related program documentation and will continue funding efforts. They are also responsible for distributing QAPP updates to persons listed in Table 1.
SRCC & GMCG WQM Program Directors	The SRCC and GMCG WQM Director(s) will oversee daily operation of the WQMP. They will implement and monitor quality control procedures; monitor instrument maintenance, calibration, and reliability; audit documentation from sample analysis, manage data processing and storage of the Field Data Sheets; assist the Executive Directors with the development of the QAPP; act as QA/QC officers for field data collected; and ensure that all documentation is complete and accurate. The WQM Directors will train the WQM Volunteers on all aspects of sampling and will be responsible for maintaining consistent sampling protocols. The GMCG’s and SRCC’s WQM Directors will be the primary contact persons for the UNH Laboratory Managers and Katahdin Analytical Services, respectively.
SRCC & GMCG RIVERS Volunteers	RIVERS Volunteers are watershed residents who agree to participate in a training program for the protocols in collecting water quality samples. They will provide their own transportation to and from their designated sampling sites, perform sampling procedures and coordinate with their parent organization to pick up water testing equipment and drop off equipment and water samples.
UNH Laboratory Managers	UNH Laboratory Managers will supervise and/or perform all testing not done on site for GMCG; submit the test results to the WQM Director; work closely with WQM Director to ensure quality control; advise in data interpretation; and provide appropriate collection materials.
Katahdin Analytical Services Laboratory Managers	Katahdin Analytical Services Laboratory Managers will supervise and/or perform <i>E. coli</i> , <i>Enterococcus</i> , alkalinity, total Kjeldahl nitrogen, total phosphorus and orthophosphate tests for SRCC and submit test results to the WQM Director.

Table 3 lists the names and telephone contact numbers for the primary participants in the day-to-day implementation of the WQMP:

Table 3: 2020 WQMP Personnel Contact Information

Dalyn Houser, Executive Director and WQM Director, SRCC	207-625-8123
Jillian Emerson, Project QA/QC Manager, SRCC	207-625-8123
Rachelle Averhill, WQM Coordinator, SRCC	207-625-8123
Matt Howe, Executive Director, GMCG	603-539-1859
Jillian Emerson, WQM Director, GMCG	603-539-1859
Robert Craycraft, Manager, UNH Cooperative Extension Lakes Lay Program Laboratory	603 862-3696
Michelle Daley-Shattuck, Research Scientist, UNH Water Resources Research Center	603-862-1794
William McDowell, Director, UNH Water Resources Research Center	603-862-2249
Sara Colby, Laboratory Manager, Katahdin Analytical Services	207-874-2400

5. BACKGROUND INFORMATION

After an initial startup program by SRCC in 2001, GMCG and SRCC began monitoring water quality in the Ossipee River watershed and the Saco River Basin in order to establish a 10-year baseline of water quality data. This data provides a reference for assessing future water quality in order to help preserve the high quality surface and groundwater resources of the Saco River watershed.

Green Mountain Conservation Group

Formed in 1997, Green Mountain Conservation Group (GMCG) is a non-profit charitable organization whose mission is to promote an awareness of and appreciation for clean water and the wise use of shared natural resources across the Ossipee Watershed. GMCG also works with municipal leaders and residents to foster a commitment to protect these resources. GMCG's guiding principle is to present objective information in a non-confrontational manner to enable the public to make informed natural resource decisions.

Saco River Corridor Commission

The Saco River Corridor Commission (SRCC) is charged with the responsibility “to preserve existing water quality, prevent the diminution of water supplies... (and) to protect fish and wildlife populations” among other actions necessary to protect the Saco, Ossipee, and Little Ossipee Rivers (Saco River Corridor Act, 38 M.R.S. Section 951 *et seq.*, 1973). As such, the agency has extensive experience with these three rivers and their various characteristics, including adjacent and proximal uses. The SRCC can serve as a clearinghouse of information for future comprehensive river and estuary habitat management. In addition, the SRCC can develop, coordinate, implement, and supply a comprehensive water quality monitoring program along the Saco River, its tributaries including the Ossipee and Little Ossipee, and into the Saco River Estuary. As a quasi-state agency supported by the state, county, and twenty municipalities along the Saco, Ossipee, and Little Ossipee Rivers, the SRCC is in the unique position of being hybrid to state and local parentage, resulting in a regional body capable of overseeing the Saco River Basin Water Quality Monitoring Program, a.k.a. RIVERS (Regional Interstate Volunteers for the Ecosystems and Rivers of Saco).

Saco River Basin and the Ossipee Watershed

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. The Basin encompasses all or parts of sixty-three municipalities within the two states. Elevations in the basin range from 6,288 feet, the Summit of Mount Washington located in Sargent's Purchase, New Hampshire, to sea level at the mouth of the river in Saco and Biddeford, Maine (1).

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 in Livermore, New Hampshire easterly for 21 miles before it enters the Saco River in Conway, New Hampshire. The Swift River drains an area of 114 square miles and has a total fall of elevation over 1,400 feet. The Ossipee River begins at the outlet of Ossipee Lake in Effingham Falls, New Hampshire and flows easterly for 18 miles before entering the Saco River in Cornish, Maine. It drains a 455 square mile area and falls 140 feet from beginning to end.

The Little Ossipee River begins in Balch Pond which falls within Wakefield, New Hampshire, and Acton and Newfield, Maine. The Little Ossipee also flows in a meandering, easterly course until it joins with the Saco River in Limington, Maine. It drains an area of 187 square miles and has a total fall of 340 feet in elevation. The Saco River flows for a total of 130 miles from the outlet of Saco Lake in Crawford Notch, New Hampshire until it reaches the Atlantic Ocean in Saco and Biddeford, Maine. The river falls in elevation a total of 1,900 feet. Before the Saco River reaches Maine, it has already descended approximately 1,500 feet in elevation (2).

Ossipee Lake is at the heart of the Ossipee Watershed, the drainage area of which is bound by the mountains of the Sandwich Range to the northwest, the Ossipee Mountains to the south, and the sandy pine-barrens of the Ossipee-Freedom-Effingham plains to the east. The watershed contains New Hampshire's largest stratified-drift aquifer. This type of aquifer recharges more rapidly than any other aquifer, but also allows pollution and contamination to be carried more rapidly into the underground water supply. As a result, conservation of the recharge lands is vital to the protection of drinking water supplies.

Ossipee Lake is New Hampshire's seventh largest lake and includes five connecting bodies of water: Ossipee Lake (the main lake), Broad Bay, Leavitt Bay, Berry Bay, Danforth Pond, and Huckins Pond. These waters, fed by 14 tributaries, comprise more than 4,000 acres of water.

A significant economic contributor to the towns of Freedom, Ossipee, and Effingham, the lake is a primary destination for vacationers, boaters and wildlife enthusiasts and its attractiveness has put it under developmental pressure and environmental stress. Particularly vulnerable are its unique ecological assets. In addition to the aquifer, the lake's unique features include two extremely rare sandy pond shore communities, one of the state's finest examples of pine-barrens, and a federally-protected kettle-hole quaking bog.

History

Regional Interstate Volunteers for the Ecosystems and Rivers of Saco (RIVERS)

The Saco/Ossipee Watershed Monitoring Program created by Green Mountain Conservation Group (GMCG) in New Hampshire and Saco River Corridor Commission (SRCC) in Maine is designed to be 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 water quality data, collected by volunteers, giving an overall picture of the water quality in the watershed.

In 2000, GMCG worked with the University of New Hampshire (UNH) Cooperative Extension and the Society for the Protection of the New Hampshire Forests, through a grant from the US Forest Service, to

produce a series of Natural Resource Inventory (NRI) maps of each town in the Ossipee Watershed. GMCG's Water Quality Monitoring (WQM) program 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 WQM program will enable GMCG to study the health of the entire watershed, track changes overtime, and educate the public.

The SRCC established their water quality testing program in July of 2001 to look for trends occurring in the waters that continuously flow through the basin. SRCC began testing the water quality along the Saco River and the major tributaries supplying the 20 communities within its corridor. The program tested for eight parameters: pH, turbidity, dissolved oxygen, temperature, *Escherichia coli*, total Kjeldahl nitrogen, alkalinity and total phosphorus. Since then, testing parameters have grown to include specific conductance and nutrients as well as anions and cations (see Table 9). Following a successful sampling season in 2001, the SRCC began a cooperative working relationship with GMCG to create a database that will house water quality data for the entire Saco River Basin in Maine and the Ossipee Watershed in New Hampshire. With the source of all the waters of the Saco River having their points of origin in New Hampshire, it is logical for organizations in both states to work cooperatively to maintain water quality and work to protect the water resource.

In 2009, changes were made to GMCG's program due to the financial constraints related to cutbacks in the UNH WRRC lab funding. Following a review of the program and trends in the data by GMCG and UNH WRRC, changes to the frequency of chemical sampling and site sampling were made. Some sites are now monitored year-round, and some are monitored more frequently than others. Financial constraints have further limited the number of samples analyzed by the UNH laboratories each year, and the program had to be altered by GMCG to accommodate limited funding.

As such, samples are no longer analyzed for every site for every sampling day, but are analyzed once per month for selected sites. Field testing of physical parameters has been maintained for each testing date for all sites thanks to volunteer efforts.

Intended Use of the Data

Data from the WQMP will be used to understand the Saco River Basin as a whole and to educate the region about the watershed. As the program continues into the future, changes in water quality over time will be noted and the data will help to understand the overall condition of the water. Data will also be used for watershed modeling so that future planning for the region may be made based on sound scientific information.

Although there has been some water testing prior to these programs, prior to 2002, systematic water quality monitoring had never been conducted in the Saco River drainage, on Ossipee Lake, or on any of its tributaries. The data collected from the RIVERS program will improve the overall baseline of water quality information and enhance awareness of water quality in the region. The testing parameters for the WQMP were selected so that these three programs would have comparable data with only a few variations, thereby improving their overall usefulness.

Baseline data is important in multiple ways. The collection of this data helps expand the knowledge of how rivers and lakes behave and change over time. There are several possibilities for the use of these data: its importance cannot be overstated. Some of the surface waters monitored are located over a very large aquifer which in part makes up New Hampshire's largest stratified drift aquifer, extending from Bartlett, NH to Saco/Biddeford, ME. The data acquired through the WQMP program will be posted on the GMCG and SRCC websites at (<http://www.gmcg.org/>) and (<http://www.srcc-maine.org/>).

6. PROJECT/TASK DESCRIPTION

Water Quality Management

A broad selection of sampling sites is important to gain a better overall picture of the health of the watershed and to help find possible links to pollution where they may occur. Having several sampling locations will help determine baseline water quality conditions and develop a general picture of watershed health. Should the data indicate water quality problems, further testing and possible new site selections can help to pinpoint potential sources of contamination. GMCG samples 28 locations, with spot sampling or pilot testing at certain sites in order to bracket areas where land uses are of concern. SRCC samples 34 sites on the Saco, Ossipee, and Little Ossipee Rivers in addition to other minor tributaries for its portion of the RIVERS program.

Water quality data provide an understanding of how land use and underlying geological controls affect the water in our lakes, rivers and streams. Because we now have a long term data set, trends in water quality issues, such as road salting, have shown to be worsening at select sampling locations. Conversely, issues like nitrogen contamination have been improving at select sampling locations. Compiling a long-term record of water quality data will help towns and local officials assess specific lake and land use practices in maintaining good water quality. Parameters tested in GMCG and SRCC's RIVERS samples are listed in Table 9 below. To accomplish these goals, certain tasks must be accomplished. They are:

- 1 – Training
- 2 – RIVERS Monitoring (SRCC & GMCG)
- 3 – Laboratory Sample Analysis
- 4 – Laboratory Data Analysis
- 5 – Reports

Prior to each sampling year, an annual work plan will be appended to the QAPP in Appendix D. The work plan will specify sampling dates and volunteers who sample the sites as well as provide changes to sampling locations, sampling procedures or equipment (if applicable).

1. Training

All RIVERS volunteers will receive an initial overview of the project and training provided by GMCG and/or SRCC. Training will cover the specific protocols of each of the tests volunteers will be asked to perform during their participation in the river monitoring program. Quality control testing will be performed as part of the certification process after training with a follow up field visit. The training of volunteers will be documented as described in Section 8. Training Requirements and Certification.

The WQM Director leading the training will explain the use of sampling equipment and data recording protocols, and will supervise a practice sample collection by volunteer monitors. The WQM Director will occasionally supervise field visits for new and returning volunteers. The WQM Director will also be available to help answer questions about sampling or equipment on a one-on-one basis during the course of the sampling season.

2. RIVERS Monitoring

Sample collection is performed as specified in the Volunteer Manual and SOPs in Appendix A.

GMCG

GMCG will conduct basic monitoring of all physical parameters listed in Table 9 on a bi-weekly basis from May through October and once per month through the winter at 10 selected sites as weather and ground conditions allow. Total phosphorus sampling will occur once each month at all sites actively being

monitored; other chemical sampling will occur once each month at 10 selected sites year round and at selected additional sites as conditions and funding allow. Sampling will also be dependent on volunteer support.

SRCC

SRCC will conduct basic monitoring of pH, temperature, dissolved oxygen and turbidity at all river sites on a bi-weekly basis. *E. coli*, *Enterococci*, total Kjeldahl nitrogen (TKN), total phosphorus, alkalinity and orthophosphate will be sampled at selected sites, chosen based on proximity to high impact land uses, on the same bi-weekly sampling schedule. 34 sites within the Saco River Corridor will be sampled from the second week in May through the third week in September, as conditions and funding allow.

A complete list of the parameters used can be found in Table 9. The results should reflect several normal seasonal changes. For example, results should reflect the changes from a period of low use, spring, to a period of high use, summer, back to a period of low use, fall, and possibly reflect the impacts of higher human uses on the lake and rivers. We hope this will help identify the larger issues that affect the area today.

3. Laboratory Sample Analysis

All water samples will be processed according to the SOPs outlined in the Volunteer Manual (Appendix A). The UNH laboratories will process all water samples from GMCG for chemical analysis. Holding times for each parameter can be found in Table 10. The GMCG WQM Director will deliver the preserved samples to UNH laboratories on a regular basis. SRCC samples of *E. coli*, *Enterococci*, alkalinity, total Kjeldahl nitrogen, total phosphorus and orthophosphate samples will be delivered by SRCC staff to Katahdin Analytical Services laboratory of Scarborough, ME, within 6 hours on the same day they are collected for processing.

4. Laboratory Data Analysis

The laboratories will complete sample analysis for the parameters listed in Table 9. After analysis is completed, the laboratories will send results back to the GMCG and SRCC offices. The UNH LLMP and WRRC SOPs can be obtained upon request from the appropriate UNH laboratory.

Sample analysis results and field data are analyzed by the WQM Directors and as needed, the Research Committee for GMCG. The GMCG WQM Director will input the field parameters into an Access database that uses dropdown lists and QC ranges to minimize chances for data entry errors. The WRRC results are submitted to the GMCG WQM Director in spreadsheet format and appended to the GMCG Access database based on a Unique ID. The UNH LLMP results are sent to the GMCG WQM Director, and at GMCG they are appended into an Access database form and then related to the field parameter and WRRC results based on a unique ID. The GMCG and SRCC WQM Directors will be responsible for combining all results from the different laboratories and the field data into one final report.

5. Reports

This task is carried out by the GMCG and SRCC staff, with advisory aid from the UNH laboratories. The GMCG and SRCC staff each complete independent reports for their respective data. The final reports are produced in the winter following each sampling year, or as soon as all the results from the different laboratories are received. Yearly final reports are provided to NH DES, ME DEP, and each town that participates in the RIVERS program (either financially and/or those with active monitoring sites). SRCC's final reports are produced every two years and sent to the ME DEP along with the collected data, which are requested for the Maine biennial Integrated Water Quality Monitoring and Assessment Report to Congress [the 305(b)/303(d) water quality assessment report].

Since 2004, GMCG has completed comprehensive reports on water quality for RIVERS and VBAP sites (Volunteer Biological Assessment Program), with VLAP (Volunteer Lake Assessment Program) data processed yearly by NH DES. A 2008 report (Ossipee Watershed Water Quality Report 2002-2008) was reviewed by the GMCG Research Advisory Committee and provided to towns and program partners and is also available on the GMCG website. Since 2008, GMCG has been providing towns annually with brief reports and updates on any water quality issues and trends in the data. These reports and subsequent presentations about the program have traditionally happened in the fall or winter.

Table 4 shows the anticipated project timeline for the WQMP:

Table 4: WQMP Yearly Timeline

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
QAPP Preparation & Completion	X	X	X	X	X						X	X
Volunteer Recruitment & Training	X	X	X	X	X	X						X
GMCG RIVERS Monitoring (bi-weekly or monthly)	X	X	X	X	X	X	X	X	X	X	X	X
SRCC RIVERS Monitoring (bi-weekly)					X	X	X	X	X			
Quality Control Checks	X	X	X	X	X	X	X	X	X	X	X	X
Laboratory Analysis	X	X	X	X	X	X	X	X	X	X	X	X
Working Progress & Data Result Reports							X	X	X	X	X	X
Final Reports	X	X									X	X

GMCG RIVERS testing will begin at the beginning of May and occurs bi-weekly until the third week of October. Ten of the RIVERS sites (one site in each town except Eaton, plus additional sites being monitored for additional data) will be sampled once a month throughout the winter as well. Adjustments may be made as funding conditions allow.

SRCC RIVERS testing will begin in the second week of May and occurs bi-weekly until the third week of September. Adjustments may be made as funding conditions allow.

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. All testing will be completed before 9 AM in order to obtain consistent data. This does not apply to winter testing months (November – April) when biological activity and oxygen level fluctuations are not a factor.

Tables 12 and 13 in Appendix D show the 2019 schedule for the GMCG RIVERS and SRCC RIVERS sampling. These schedules will be updated yearly and added to the QAPP as part of the annual work plan.

7. DATA QUALITY OBJECTIVES FOR MEASUREMENT DATA

Precision, Accuracy and Measurement Range

Table 6 illustrates the precision, accuracy and measurement range for the parameters selected as part of the program. For field data, accuracy and measurement range were determined from the instrument manuals. Precision values were set in consultation with State water quality professionals. For water chemistry

parameters, the laboratories that are processing the samples have provided all values. All laboratory calculations are provided in the laboratory SOPs.

To assure that data collected in the field fall within acceptable precision levels, we have developed a standard figure which volunteers can use to check their replicate data to determine whether it meets precision requirements. We have calculated a Maximum Allowable Difference (MAD) for each of the parameters measured in the field by volunteers (Table 5). If the difference between two measurements taken for any parameter exceeds the MAD for that parameter, a third measurement will need to be made. A chart with the MADs will be included with the data sheets for the volunteers to use.

Table 5: Maximum Allowable Difference (MAD) for the RIVERS program

Parameter	MAD
pH	0.5 standard units
DO	0.5 mg/L
Turbidity	0.2 NTU
Specific Conductance	For freshwater sites: 10 uS/cm at sites reading at 100uS/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
Temperature	1.0 °C

Table 6: Data Quality Objectives for Water Quality Monitoring Parameters

Data recorded by:	Parameter	Reporting Units	Precision ¹ (+/-)	Accuracy (+/- %)	Measurement Range
WQM Volunteers or SRCC and GMCG staff	Temperature	Degrees Centigrade	1.0°C	0.3%	-5 – 45
	pH	Standard Units	0.5 pH units	0.2%	0 – 14
	Specific Conductance	µS/cm or mS/cm	10uS for under 100uS, 20uS above 100uS; estuary sites within 20% of first reading	0.5%	0.01µS/cm-200.00 mS/cm
	Dissolved Oxygen	mg/L and % Saturation	0.5 mg/L	Below 1 mg/L: ± 0.1; Above 1 mg/L: ±0.2	0 – 20 mg/L 0 – 200% saturation
	Turbidity	NTUs	0.2 NTUs	2.0%	0 – 1000
UNH Lakes Lay Monitoring Lab	Total Phosphorus UNH	µg/L	15%	10%	1.0 – 200
UNH Water Resource Research Center Lab	NPOC or Dissolved Organic Carbon	mg C/L	4.9%	3.0%	0 – 20
	Total Dissolved Nitrogen	mg N/L	7.8%	2.1%	0 – 10
	Dissolved Organic Nitrogen	mg N/L	10 – 15%	10%	0 – 2.0
	Ammonium	µg N/L	7.1%	5.0%	0 – 200
	Orthophosphate	µg P/L	7.8%	6.3%	0 – 200
	Silica	mg SiO2/L	3.5%	Not Given	0 – 40
	Chloride	mg Cl/L	1.6%	7.3%	0 – 15
	Nitrate	mg N/L	0.3%	3.7%	0 – 3
	Sulfate	mg S/L	2.2%	13.5%	0 – 8
	Sodium	mg Na/L	0.9%	12.7%	0 – 15
	Potassium	mg K/L	10.4%	2.2%	0 – 7
	Magnesium	mg Mg/L	4.5%	10.3%	0 – 7
	Calcium	mg Ca/L	4.0%	1.8%	0 – 10
Katahdin Analytical Services	Total Kjeldahl Nitrogen	mg N/l	10%	2.5%	0.25 to 10 mg/L
	<i>E. coli</i>	MPN/100 mL	4.5%	N/A	0 – TNTC (Too Numerous To Count)

¹ For field parameters (data recorded by WQM Director, staff, and/or volunteers) precision values are the MADs from Table 5.

Data recorded by:	Parameter	Reporting Units	Precision ¹ (+/-)	Accuracy (+/- %)	Measurement Range
	Orthophosphate	µg P/L	7.8%	6.3%	0 – 200
	<i>Enterococci</i>	MPN/100 mL	5.1%	N/A	0 – TNTC (Too Numerous To Count)
	Total Phosphorus	µg/L	15%	10%	1.0 – 200
	Alkalinity	Mg N/L	</+20%	+/- 20%	5 mg/L

Data Representativeness

GMCG RIVERS Samples: The data will reflect the physical and chemical properties of the surface water taken in well mixed waters clear of any obstruction (rocks, tree limbs, etc.) at each of the data collection sites. Monthly (either May to October, or year-round) sampling results will be representative of a range of seasonal variables such as flow, temperature and dissolved oxygen. Sample sites were chosen to obtain a representative group of stream and rivers within the watershed.

SRCC RIVERS Samples: The data will reflect the physical and chemical properties of the surface water taken in well mixed waters clear of any obstruction (rocks, tree limbs, etc.) at each of the data collection sites. Sampling results will be representative of a range of summer flow conditions depending on seasonal rainfall. Individual sample sites were chosen to obtain a representative group of streams and rivers within the river corridor.

Data Comparability

Due to the standardized sampling protocol, the extensive training volunteers undergo, and the oversight provided during the sampling season, the data collected by both organizations are highly comparable across time within the program. Year to year consistencies of the program in regards to equipment used, parameters measured, locations visited, and even volunteer retention help provide additional layers of quality control in comparability. As analytical methods are standardized to reflect various US EPA guidelines (as noted in Table 11), data collected in this program can be cross compared to other programs collecting analytical data under the same US EPA guidelines. This allows the program's data to be more versatile in its use, as many different organizations are able to utilize the data for regional, state, and national comparisons.

Completeness

In order for the collected data to be used with confidence, there must be enough valid data. It is expected that annually at least 90% of the data collection will be complete. The results for the 2002 season were 98.57% complete. We used the 2002 season as a standard for a successful season with regard to completed sampling and subsequent testing years completed under the RIVERS program have not fallen below the 90% figure. Missing data were mostly due to equipment failure or “acts of God”. Similar results for completeness are expected for this program in future years. There are no legal or compliance requirements for this data, as it is providing baseline information.

8. TRAINING REQUIREMENTS AND CERTIFICATION

Water Monitoring

At GMCG and/or the SRCC main office buildings, any WQM support staff such as seasonal interns will be trained by the WQM Director(s) to prepare samples for laboratory analysis, organize data in the database, and maintain the equipment. In the field the WQM staff will be trained how to use the multi-parameter

meter and turbidimeter, as well as how to gather water samples and record data on the field data sheet. Calibration training will occur prior to field training.

The WQM Director(s) with aid from WQM staff will host a volunteer training workshop prior to the biweekly sampling season, either combined or separately as decided annually by both organizations. All volunteers will receive a copy of the Volunteer Manual (Appendix A) which provides a program overview, calibration protocol, and detailed sampling instructions. The training workshop will include hands-on instruction in the use of the meters and other sampling processes to be used at the site. The WQM Director and WQM staff will answer questions and walk the volunteers through any steps they have difficulty with. Proper calibration of the multiparameter meter is included in this training event. When the WQM Director is satisfied that the volunteers understand the sampling procedures and can correctly demonstrate the sampling alone (either at a stream as conditions allow, or from a bucket of stream water), they will be certified.

If an experienced volunteer (one who has participated in the program for at least the last two previous years) is unable to make a training due to scheduling conflicts, the WQM director will go out with the volunteer on the first sampling day and provide onsite training. New volunteers to the program must complete a formal training with WQM staff before their first sampling. All training events and participants are documented on a master sheet (typically an Excel spreadsheet) in each organization's office, and participants who successfully completed the training are awarded a certificate of completion that is kept on site at either GMCG or SRCC.

Throughout the monitoring season the WQM Director and WQM staff will evaluate the volunteers' effectiveness by visiting the sampling site with the volunteer at least once per year and collecting their own field data at that time to cross-check the accuracy of the volunteer collection. This visit also allows the WQM Director or staff to answer questions volunteers may have in addition to ensuring that all sampling protocols are being properly followed.

The safety of participants is a prime consideration of the program, including ensuring ease of access to the sampling sites, that conditions are suitable for testing, and that participants are comfortable with the tasks required. GMCG and SRCC volunteers will sign a release form that confirms they know that they are performing sampling tasks, including boating, at their own risk and acknowledging their personal responsibility for knowing proper safety precautions on the water and exercising common sense and good judgment at all times. The participating camps adhere to the water safety criteria established by the Accreditation Committee of the American Camp Association. While WQMP personnel are using the camp boats they too are also expected to follow these safety rules.

9. DOCUMENTATION AND RECORDS

Volunteers will receive field data sheets (see Appendix C) printed on weatherproof paper and a suitable pen to record data. Field data sheets are filled out for each sample collected and submitted to the WQM Directors or WQM staff by the end of each sampling day.

Physical data sheets and any training materials will be stored for 5 years while all the data will be stored electronically in perpetuity in the GMCG and SRCC offices. Due to its large size, the QAPP will be kept electronically on a backed up server at GMCG and SRCC offices.

The Chain of Custody (COC, see Appendix C) record will be filled out when the samples arrive and are processed at the WQMP offices. WQMP (GMCG and SRCC) personnel will relinquish samples and the COC record to the UNH laboratories (GMCG) or Katahdin Analytical Services' lab (SRCC) in accordance with the holding times for individual samples. The COC will follow the samples to the laboratories and

remain with the samples until they are used or disposed of. The WQMP will retain a copy of each COC record after the laboratories have received the samples.

All physical reports, QAPPs, SOPs, handbooks, logbooks and other documents will be filed at the WQMP office for 5 years, including copies of the COCs and field data sheets. Original COCs may be kept by the laboratories for their records; in those instances, copies will be retained at the WQMP office. Digitized data, reports, documents, etc. will be kept in perpetuity.

GMCG Data Backup Procedure for Water Quality Monitoring Data: All electronic water quality data will be stored on the Water Quality Coordinator's computer. A daily process will occur that backs up this data to a commercial offsite "cloud" storage facility. Access to this data will be available to the GMCG Executive Director, Water Quality Coordinator, IT support, and any other persons approved by the Executive Director. A redundant daily process will occur that includes a periodic "image backup" of the Water Quality Coordinator's computer and daily "incremental" backups of any changed or new data. Two rolling iterations of the image and incremental backups will be kept on a local external hard disk attached to the Water Quality Coordinator's computer. Security of this data will be managed by normal office security procedures.

SRCC Data Backup Procedure for Water Quality Monitoring Data: All electronic water quality data will be stored on the Water Quality Coordinator's computer. In addition, data is backed up weekly on two separate external hard drives. One hard drive is maintained at the office and the other is held off-site at the IT support office. Security is maintained through normal office security procedures.

The laboratories will complete analysis of the samples and keep raw data at their offices. A report for each laboratory will be sent to the GMCG or SRCC office, which will include all of the QA/QC information for each laboratory with the monitoring results. Explanations will be made for any missing data when possible.

QAPP updates or amendments are distributed to individuals identified in Table 1 by the Executive Directors in a timely fashion.

10. SAMPLING PROCESS DESIGN

Data Collection Tasks

GMCG & SRCC RIVERS

Sampling will be managed by the WQM Directors and WQM staff, and conducted by staff and trained volunteers. The volunteers will sample at their designated sites on the bi-weekly schedule they have been assigned. Each volunteer will coordinate pick up and drop off of the sampling equipment and water samples with the WQM Coordinator.

A duplicate sample will be taken at a rate of at least 10% during each sampling session for each sampling location to demonstrate the consistency of the sampling techniques. This sample will be processed in the same manner as all other samples of the same type, and the two sets of data for that time and location will be compared to determine how precise the results are.

GMCG RIVERS Test Sites

The selection of the water monitoring sites was a collaborative effort between GMCG and the town officials of Eaton, Effingham, Freedom, Madison, Ossipee, Sandwich and Tamworth. The primary consideration for sites beginning with “G” was how current land uses were affecting nearby surface waters. All test site selections were validated by natural resource experts from UNH and UNH Cooperative Extension. Since the program began, some of the original sites have been dropped and new ones added to meet the requests of town officials or because better more representative sites were found.

Sites beginning with “OL” were part of the Ossipee Lake and Tributary program begun in 2003. A monitoring site was created for each tributary draining directly into Ossipee Lake. These sites were not selected with consideration of land uses, but as part of a lake assessment program. Some of these sites have continued to be monitored by GMCG since 2004.

Twenty-eight test site locations are currently being tested with 1 site in Eaton, 5 sites in Effingham, 5 sites in Freedom, 7 sites in Ossipee, 5 sites in Madison, 3 sites in Tamworth, 1 site in Sandwich, and 1 site in Parsonsfield. As the program expands in coming years, GMCG will continue to adjust the number of test sites to meet the needs of the towns. Detailed site descriptions can be found in Appendix E.

Green Mountain Conservation Group Water Quality Monitoring Program

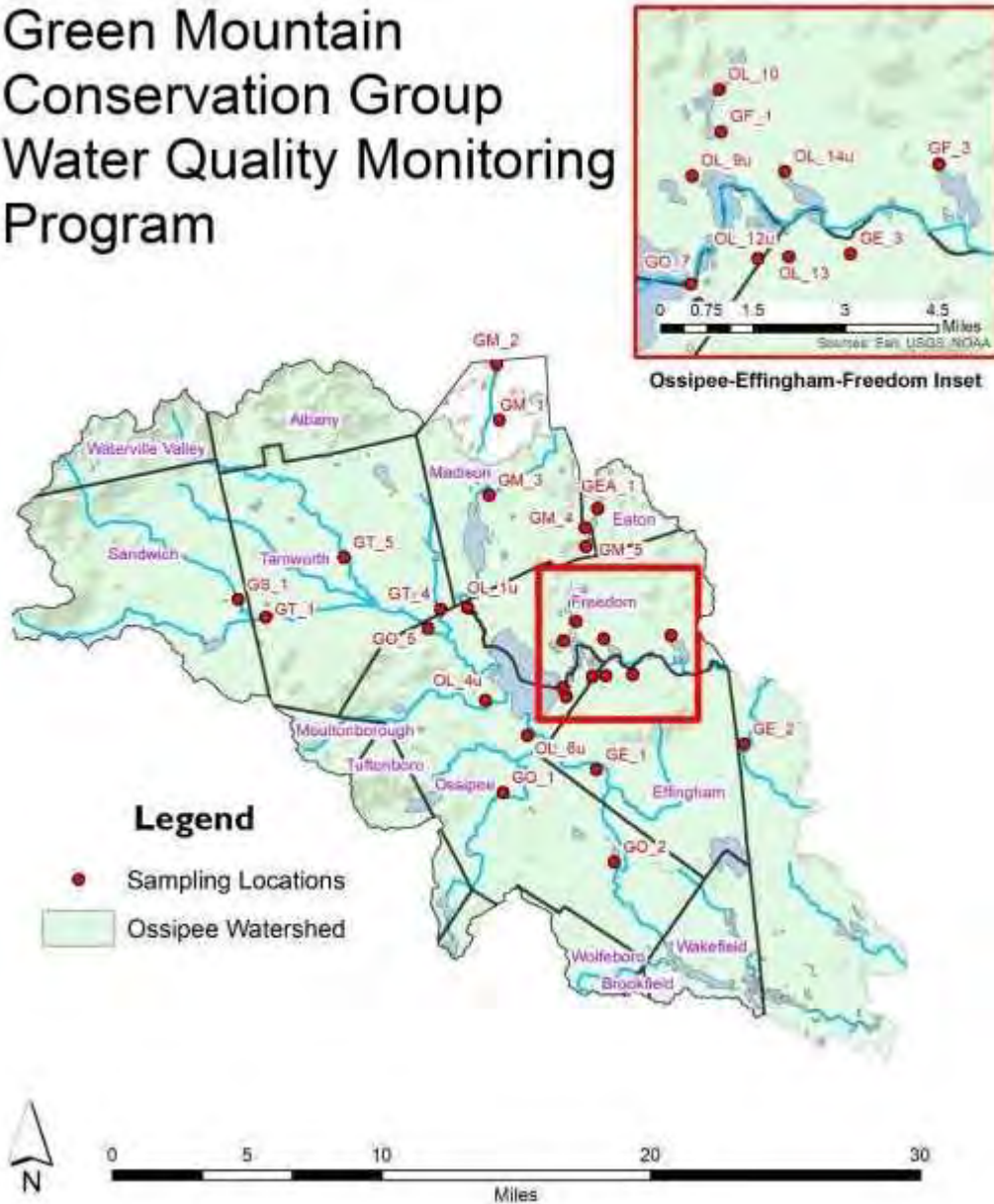


Figure 2: GMCG Water Quality Monitoring Sites

Table 7: GMCG RIVERS Site Location Coordinates

Site ID	Town	Water Body	Lat Decimal Degrees	Long Decimal Degrees
GE-1	Effingham	Pine River	43.743778	-71.088611
GE-2	Effingham	South River	43.747471	-70.977087
GE-3	Effingham	Ossipee River	43.793732	-71.06134
GF-1	Freedom	Danforth outlet	43.817705	-71.103121
GF-3	Freedom	Cold Brook	43.810333	-71.02989
GM-1	Madison	Banfield Brook	43.933917	-71.14650
GM-2	Madison	Pequawket Brook	43.960444	-71.147194
GM-3	Madison	Forrest Brook	43.892639	-71.159306
GT-1	Tamworth	Bearcamp River	43.830333	-71.328667
GT-4	Tamworth	Chocorua River	43.827694	-71.202361
GO-1	Ossipee	Beech River	43.726583	-71.158361
GO-2	Ossipee	Frenchman's Brook	43.686389	-71.081139
GO-5	Ossipee	Bearcamp River	43.822167	-71.211639
GS-1	Sandwich	Cold River	43.836417	-71.349833
OL-7	Effingham	Red Brook	43.77861	-71.116245
GT-5	Tamworth	Swift River	43.85925	-71.26525
GO-7	Ossipee	Ossipee Outflow	43.784172	-71.110886
OL-7	Ossipee	Red Brook	43.77861	-71.116245
OL-14u	Freedom	Square Brook	43.811614	-71.081964
OL-1u	Freedom	West Branch River	43.833103	-71.183488
OL-6u	Ossipee	Pine River	43.764431	-71.140347
OL-4u	Ossipee	Lovell River	43.778246	-71.165252
GEA-1	Eaton	Long Pond Outlet	43.882192	-71.079831
OL-12u	Effingham	Phillips Brook	43.7905427	-71.088047
OL-10	Freedom	Huckins Outflow	43.829185	-71.100015
OL-9u	Freedom	Cold Brook	43.814433	-71.105605
OL-13	Effingham	Leavitt Brook	43.794051	-71.076769
GM-4	Madison	Ferrin Brook	43.865189	-71.089645
GM-5	Madison	Mill Brook	43.859885	-71.08823

SRCC RIVERS Test Sites

Each site was chosen based on a variety of parameters including the site's ability to be consistently and easily accessed. Areas on the rivers that were chosen for inclusion in the program represent areas upstream and/or downstream of known high land use density. This land use density may be represented by direct, permanent land uses such as residential or commercial industrial activity, or by more transient uses such as forestry, agriculture and recreation. All sites samples are on the Saco River (S), Old Course Saco (OCS); its major tributaries the Ossipee (O) and Little Ossipee (LO); or minor tributaries. Site descriptions and directions can be found in Appendix E.

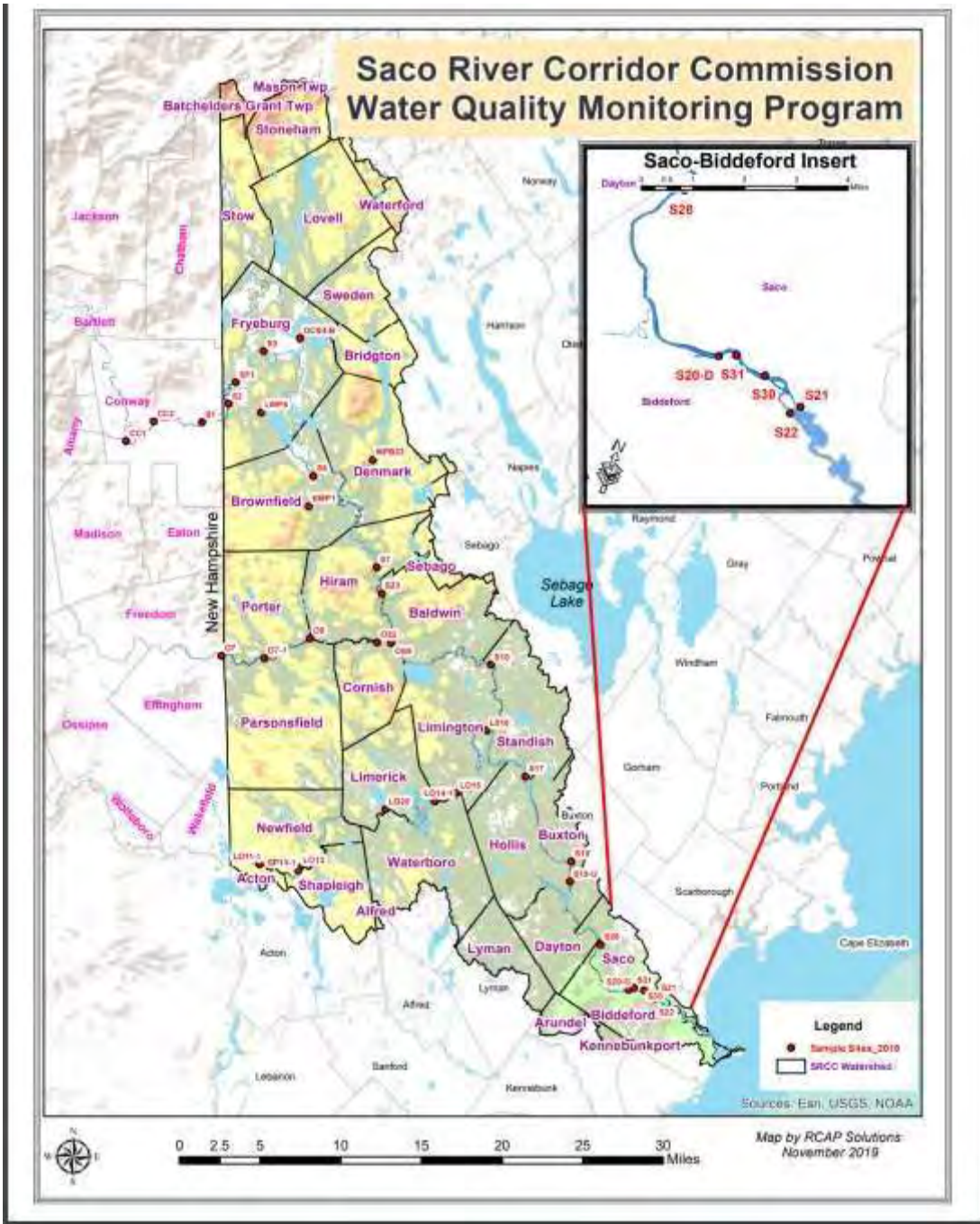


Figure 3: SRCC Water Quality Monitoring Sites

Table 8: SRCC RIVERS Site Location Coordinates

Site ID	Town	Water Body	Lat Decimal Degrees	Long Decimal Degrees
CC1	Conway, NH	Saco River	43.9829	-71.1166
CC2	Conway, NH	Saco River	44.001	-71.0828
S1	Conway, NH	Saco River	44.00152	-71.02263
S2	Fryeburg, ME	Saco River	44.01866	-70.99017
S3	Fryeburg	Saco River	44.066839	-70.948322
SF1	Fryeburg	Saco River	44.038067	-70.981875
LWP5	Fryeburg	Lovewell Pond	44.011467	-70.949447
OCS4B	Fryeburg	Saco River	44.0792663	-70.903382
S6	Brownfield	Saco River	43.955489	-70.882614
MPB22	Denmark	Moose Pond Brook	43.9711712	-70.80930
BMP1	Brownfield	Burnt Meadow Pond	43.928358	-70.887544
O7	Effingham, NH	Ossipee River	43.792069	-70.991778
O7-1	Porter	Ossipee River	43.790781	-70.938231
O8	Parsonsfield	Ossipee River	43.809581	-70.882397
OS9	Baldwin/Cornish	Saco River	43.806967	-70.781404
S10	Standish	Saco River	43.7894254	-70.657379
S7	Hiram	Saco River	43.874717	-70.801303
S23	Hiram	Saco River	43.851255	-70.794686
O22	Cornish/Hiram	Ossipee River	43.80735	-70.798982
LO11-1	Newfield	Little Ossipee River	43.6056	-70.9381
LO13	Shapleigh	Below Shapleigh Pond	43.603162	-70.888727
LO14-1	Limerick	Lake Arrowhead	43.665739	-70.722917
SP13-1	Newfield	Little Ossipee River	43.600701	-70.890288
LO15	Limington	Saco River	43.673408	-70.697039
LO16	Limington	Little Ossipee River	43.730047	-70.661075
S17	Standish	Saco River	43.689428	-70.611764
S18	Buxton	Saco River	43.613953	-70.553172
S19-A	Buxton	Saco River	43.595928	-70.554186
S20-D	Biddeford	Saco River	43.499642	-70.479444
S21	Saco	Saco River	43.494605	-70.443067
S22	Biddeford	Saco River	43.491817	-70.445939
S28	Saco	Saco River	43.539669	-70.514792
S30	Saco	Saco River	43.499275	-70.460142
S31	Biddeford	Saco River	43.501533	-70.473281
LO20	Waterboro	Little Ossipee River	43.657236	-70.784344

Table 9: Breakdown of Expected Sample Collections

Site ID	Parameters Measured in the Field	Laboratory Samples ²	Number of Times Sampled per Year	Samples Expected
GMCG RIVERS sites	Temperature DO specific conductance Turbidity	<u>In UNH WRRC lab:</u> DOC, TDN, DON, NH ₄ ⁺ , Ortho-P, Si, Cl, NO ₃ , SO ₄ , Na, K, Mg, Ca <u>In UNH LLMP lab:</u> TP <u>At GMCG HQ:</u> pH	13 for most sites; 10 sites are also sampled year round for a total of up to 19 times	28 sites x 13 times for Field Parameters; 10 sites an additional 6 times for Field Parameters. 28 sites x 6 times for TP samples; 10 sites x additional 6 times for TP samples plus 24 duplicates = 252 TP samples. 10 Sites x 12 times for ion samples + 12 duplicates = 132 ion samples.
SRCC RIVERS sites	Temperature DO specific conductance Turbidity	<u>At SRCC HQ:</u> pH	10	34 sites x 10 times for Field Parameters; same for pH
Selected SRCC sites See Table 13		Total Phosphorus	At least 5 times per site, per season	6 sites with a total of 30 samples plus 5 duplicates = 35 samples
		Orthophosphate	At least 5 times per site, per season	3 sites with a total of 15 samples plus 5 duplicates = 20 samples
		Total Kjeldahl Nitrogen	At least 10 times per site, per season	5 sites with a total of 50 samples plus 10 duplicates = 60 samples
		Alkalinity	At least 10 time per site per season	4 sites with a total of 40 samples plus 10 duplicates = 50 samples
	<i>E. coli</i> sampled per SOP and lab analyzed for geometric mean	<i>E. coli</i> /swimmability (swimmability is measured by at least three samples taken and averaged together)	At least 10 times at Rotary Park (RP) See table 13 for listing of all other <i>E. coli</i> sites	RP – 10 x 3 = 30 3 swim x 3 sites = 15 x 3 times = 75 3 sites x 2 times (swim off season sites) = 6 21 sites x 10 samples = 210 10 additional samples for weekly monitoring 30 duplicates taken TOTAL = 321 samples
<i>Enterococci</i> sampled per SOP and lab analyzed for geometric mean	<i>Enterococci</i> /swimmability	At least 10 times at S21 and S22 (estuary sites)	2 sites x 10 times, plus 10 duplicates = 30 samples	

² All SRCC laboratory samples are analyzed at Katahdin Analytical Services.

11. SAMPLING METHODS REQUIREMENTS

Refer to Appendices A and B as well as Tables 10 and 11 for detailed information regarding how samples will be taken, equipment and containers used, sample preservation methods used, and holding times. Tables 10 and 11 provide a summary of the information contained in the Appendices.

All volunteers will receive field data sheets (see Appendix C) printed on weather proof paper and a suitable pen to record data. These data sheets are used to document field measurements and qualitative data on recent and current weather events, wildlife, water observations and disturbances.

At GMCG RIVERS sites, volunteers will sample for turbidity, dissolved oxygen, specific conductance, and temperature with a water sample collected and returned to GMCG for pH determination. Additional water samples will be collected monthly in two bottles (acid washed by UNH) and analyzed by UNH for phosphorus, nutrients and other parameters (Table 9). Upon arrival at the GMCG office, one sample bottle will be preserved with 1 mL sulfuric acid and frozen. The second bottle will be filtered and frozen. Duplicates will be determined by a rotating schedule; volunteers will be notified when it is their turn to collect duplicates at their site(s).

At SRCC RIVERS sites, volunteers will sample for turbidity, dissolved oxygen, specific conductance, and temperature, with a water sample collected and returned to SRCC for pH determination. At select sites water samples for *E. coli*, *Enterococci*, alkalinity, TKN, orthophosphate and total phosphorus will be taken in plastic bottles provided by Katahdin Analytical Services, which will be delivered within six hours of sample collection to the laboratory for processing. A schedule of this additional sampling is determined by the WQM Director at the beginning of the season based on need and financing.

The pH samples collected will be processed by each organization that collected them. The pH probe will be calibrated directly before use in accordance with the manual located in Appendix B (Figure 7) in order to limit any drifting that may occur.

Table 10: Sampling Methods Requirements

Parameter	Sampling Method	Sample Container	Preservative	Holding Time (Max)
Temperature	Non-mercury Thermometer and Hach HQ40D multiparameter instrument	None, measurement taken in water	None	None, analyzed immediately
pH	Hach HQ40D multiparameter instrument	120 mL bottle rinsed on site	None	24 hours on ice, usually within 3 hours
Dissolved Oxygen	Hach HQ40D multiparameter instrument	None, measurement taken in water	None	None, analyzed immediately
Specific Conductance	Hach HQ40D multiparameter instrument	None, measurement taken in water	None	None, analyzed immediately
Turbidity	HACH 2100P Portable Turbidimeter	15 ml glass cells	None	None, analyzed immediately
Total Phosphorus	Katahdin/UNH Surface Water Sampling Method.	250 ml plastic sample bottles, screw top	None/Sulfuric Acid and Frozen	Delivered same day/12 months frozen
Dissolved Organic Carbon	UNH Surface Water Sampling Method.	250 ml plastic sample bottles, screw top, filtered using a 47 mm diameter 0.45 micron mesh Whatman filter	None/Frozen	1 month on ice 12 months frozen
Total Dissolved Nitrogen	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen

Parameter	Sampling Method	Sample Container	Preservative	Holding Time (Max)	
Dissolved Organic Nitrogen	UNH Surface Water Sampling Method.	into a 60 ml plastic bottle with a screw top.		1 month on ice 12 months frozen	
Ammonium	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
Orthophosphate	Katahdin/UNH Surface Water Sampling Method.			Delivered same day/1 month on ice 12 months frozen	
Silica	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
Chloride	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
Nitrate	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
Sulfate	UNH Surface Water Sampling Method.			Frozen	1 month on ice 12 months frozen
Sodium	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
Potassium	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
Magnesium	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
Calcium	UNH Surface Water Sampling Method.			1 month on ice 12 months frozen	
<i>E. coli</i>	Katahdin Surface Water Sampling Method.	250 ml plastic sample bottles, screw top	None	6 hours. Delivered same day	
<i>Enterococcus</i>	Katahdin Surface Water Sampling Method.	250 ml plastic sample bottles, screw top	None	6 hours. Delivered same day	
Total Kjeldahl Nitrogen	Katahdin Surface Water Sampling Method.	250 ml plastic sample bottles, screw top	None	6 hours. Delivered same day	
Alkalinity	Katahdin Surface Water Sampling Method	250 ml plastic sample bottles, screw top	None	6 hours. Delivered same day	

Equipment checklists are provided in Appendix C.

12. SAMPLE HANDLING AND CUSTODY PROCEDURES

Each water chemistry sample that will be transported to a lab will receive a specialized label (See Figure 4: Sample Labels for Water Sample Bottles) that will include information on the sample location, replicate identifier, time, date, and sampler’s initials. This information will be matched to the identification information on the field data sheets that will be completed for each monitoring session (See Appendix C for forms). Samples requiring transport to UNH will be frozen within 24 hours of sample collection until scheduled transport by a courier.

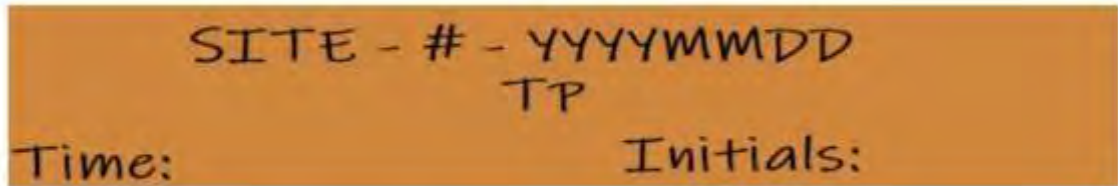
For collection of multiple grab samples on the same date, other than duplicates, separate samples will be indicated by a letter at the end of the date (YYYYMMDDA, YYYYMMDDB, etc.) in order to preserve a unique sample name for every grab sample (Site Code + Date = Unique ID)

The chain of custody (COC) procedure will require that samplers fill out the COC when they return to the office. They will record on the COC each sample’s date, time, sampler name, site number, number, type, and preservative method. All transfers will be recorded on the COC with the date and time of the transfer and the names of the personnel making the transfer. This will ensure that each person handling the sample will have signed the chain of custody form. See Appendix C for two examples of this form (Figures 11 and 12). After the laboratory has received the samples, a copy of the completed COC will be provided to the WQMP for filing.

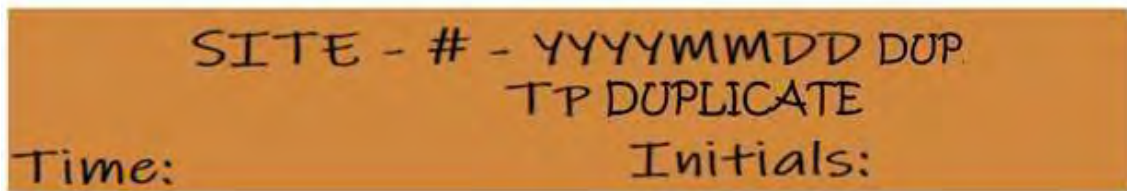
All samples, except for Total Phosphorus, are preserved without chemicals. Therefore, all other samples not required for analysis may be disposed of in a proper sewer system. Extra Total Phosphorus samples must be transported to the laboratory for proper disposal of acid solutions.

For laboratory sample handling at the UNH Laboratories, established SOPs are followed.

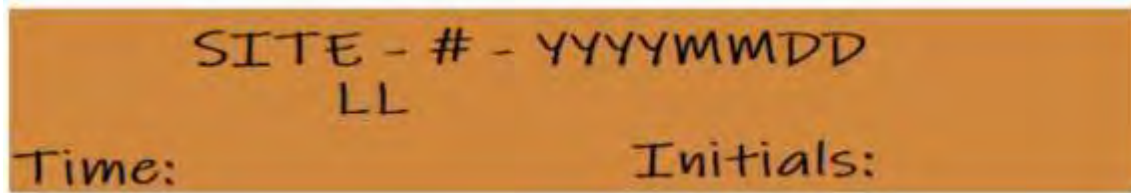
Sample to be analyzed for total phosphorus and preserved with sulfuric acid:



Duplicate sample to be analyzed for total phosphorus and preserved with sulfuric acid:



Sample to be analyzed for other nutrients filtered through 47 mm diameter 0.45-micron mesh Whatman filter frozen at <0 °c:



Duplicate sample to be analyzed for other nutrients filtered through 47 mm diameter 0.45-micron mesh Whatman filter frozen at <0 °c:

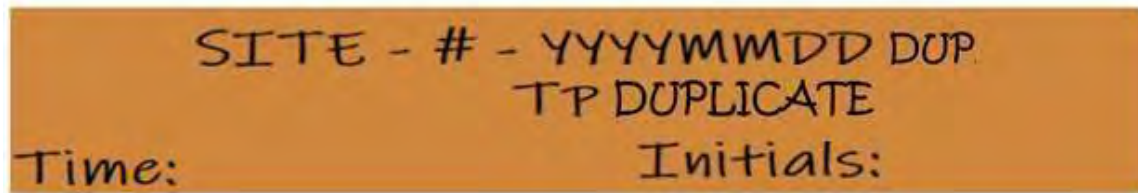


Figure 4: Sample Labels for Water Sample Bottles

13. ANALYTICAL METHODS REQUIREMENTS

The analytical methods that will be used for temperature, pH, specific conductance and dissolved oxygen come from the operation manuals for HACH meters (See Figures 5-7). The turbidity method comes from the operating manual published by HACH for the 2100P portable Turbidimeter (See Figure 8). All of the field meter methods come from the US EPA document #EPA 841-B-97-003 entitled “Volunteer Stream Monitoring: A Methods Manual,” (Nov. 1997) - <https://www.epa.gov/sites/production/files/2015-06/documents/stream.pdf>.

UNH will provide acid washed bottles for total phosphorus sampling for GMCG. At the GMCG office one milliliter of sulfuric acid is added by the WQM Director or staff to each 250 ml sampling bottle of water to be analyzed for total phosphorus and frozen. All other nutrient water samples are filtered in the GMCG office by the WQM Director or staff using a 47mm diameter 0.45-micron mesh Whatman filter. Sixty milliliter bottles are rinsed three times with filtered sample and the bottle is filled with filtered sample. Samples are frozen immediately after filtering and transported to UNH at a later date (typically 3x a year). KAS laboratory will provide ready to use sample bottles that volunteers fill without rinsing at each appropriate site. UNH and KAS laboratory personnel will analyze all water chemistry samples submitted to them and submit analytical results to the respective sampling organization. See Table 11 for sampling method requirements.

Protocols followed by the University of New Hampshire and/or Katahdin Analytical Services for dissolved organic carbon, total dissolved nitrogen, dissolved organic nitrogen, total Kjeldahl nitrogen, orthophosphate, ammonium, silica, chloride, nitrate, sulfate, sodium, potassium, magnesium, calcium, total phosphorus, *E. coli*, and *Enterococci* are listed in Table 11 (SOPs are kept in hardcopy and in digital file on site at UNH and KAS).

Table 11: Equipment and Methods Used for Sample Analysis

Parameter	Equipment	Method
Temperature	Hach HQ40d multiparameter Meter	None
	Non-mercury pocket thermometer, NIST certified	Used as a reference and not calibrated
Turbidity	Hach Patented Ratio™ Optics 2100P Portable Turbidimeter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
pH	Hach HQ40d multiparameter Meter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
Specific Conductance	Hach HQ40d multiparameter meter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
Dissolved Oxygen	Hach HQ40d multiparameter Meter	EPA 841-B-97-003 Volunteer Stream Monitoring: A Methods Manual
Anions (Chloride, Nitrate, Sulfate = Cl, NO ₃ ⁻ , SO ₄ ²⁻)	Ion Chromatograph with suppressed specific conductance detection	EPA Standard Method #300.1
Cations (Sodium, Potassium, Magnesium, Calcium = Na ⁺ , K ⁺ , Mg ⁺² , Ca ⁺²)	Ion Chromatograph with suppressed specific conductance detection	Ion chromatography with specific conductance detection using an Alltech Universal Cation Column (P/N 27106) with a dilute nitric acid/EDTA mobile phase,
Dissolved Organic Carbon (DOC)	Shimadzu TOC-V carbon analyzer	High Temperature Catalytic Oxidation (HTCO), or sometimes High Temperature Oxidation (HTO) EPA Standard Method #415.1
Total Dissolved Nitrogen (TDN)	Shimadzu TOC-V carbon analyzer with a Chemiluminescent Nitrogen detector	J.L. Merriam, W.H. McDowell, and W.S. Currie. 1996. A High-temperature oxidation technique for determining total dissolved nitrogen. Soil Science Society of America Journal 60:1050-1055.
Ammonium (NH ₄ ⁺)	Lachat Instruments QuikChem AE	EPA Standard Method #350.1
Total Phosphorus	Lachat Instruments QuikChem AE	Standard Methods 20th Edition- 4500 P.E
Soluble reactive phosphate (aka SRP, or orthophosphate, PO ₄ ³⁻)	Lachat Instruments QuikChem AE	Standard Methods 20th Edition- 4500 P.E
<i>E. coli</i>	IDEXX Colilert test	January 2018: 9223 ENZYME SUBSTRATE COLIFORM TEST (2017) Standard Methods For the Examination of Water and Wastewater, 23rd. https://doi.org/10.2105/SMWW.2882.194
<i>Enterococci</i>	IDEXX Enterolert test	ASTM D6503-19, Standard Test Method for Enterococci in Water Using Enterolert, ASTM International, West Conshohocken, PA, 2019
Total Kjeldahl Nitrogen	Lachat Instruments QuikChem AE	EPA METHOD 351.2: TKN

14. QUALITY CONTROL REQUIREMENTS

Quality control for GMCG and SRCC field parameters (dissolved oxygen, pH, turbidity, specific conductance and temperature) include replicate measurements at each sampling event, adherence to MAD requirements, adequate training for samplers, random spot checks of samplers and data entry checks by the WQM Director.

To ensure measurement accuracy, meters are calibrated as described in Section 16. The WQM Coordinator will review all field data sheets and perform periodic on-site reviews to monitor the samplers' knowledge of testing procedures.

A duplicate sample will be taken at a rate of 10% during each sampling session to demonstrate the consistency of the sampling techniques. This sample will be processed in the same manner as all other samples of the same type, and the two sets of data for that time and location will be compared to determine how precise the results are. Duplicates are selected at random, making sure no two locations are used in a single sampling year (unless all sites have been exhausted).

Laboratories perform their own quality control measures which include lab duplicates, spikes, splits, blanks, etc. as appropriate.

15. INSTRUMENT & EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

The WQMP owns and maintains its own equipment for tributary and river testing. All field analytical instruments are inspected at the beginning of the season to ensure they are in good working order. Equipment is also inspected each testing week prior to being released for field work and are re-inspected when returned to the office at the conclusion of the testing day by the Coordinator. Equipment is to be returned clean and in proper working order. If a sampler encounters an equipment problem during use, she/he/they will note it on the field sheet and communicate the issue when the equipment is returned. The Coordinator will review any problems, record issues in the database, and ensure that they are also noted on the relevant field sheet. The Coordinator is required to report problems to the WQM Director and Executive Director as soon as possible for instructions on handling the problem. Logbooks are stored at the WQMP office.

At the end of the sampling session, meters are cleaned gently with water to remove any debris accidentally collected during sampling. At the end of the sampling year, the equipment is rinsed and allowed to thoroughly dry, and batteries are removed from the equipment to prevent erosion. Equipment is stored in a cool, dry place in mouse proof containers until the next monitoring season.

Back-up equipment for emergency replacement is not currently available. For GMCG, one extra set of bottles is available in each field kit. If a bottle is lost or a meter does not work, the sample and data for that portion will not be collected. For SRCC, a replacement meter may be assigned as needed and available; the substitute meter number will be recorded on the data sheet for the sites affected.

16. INSTRUMENT CALIBRATION AND FREQUENCY

Detailed calibration procedures for all testing parameters are contained in the SOPs included in Appendix B. The Hach HQD40 meter is calibrated for dissolved oxygen at the beginning of each testing day. Recalibration at each site is unnecessary as the meter is taking barometric pressure readings at each site. This was independently confirmed by GMCG in a set of experiments in the winter of 2019/2020. The pH probe is calibrated right before use and used immediately on samples collected. Temperature is obtained through the use of the DO probe, though the reading is compared to a NIST-certified thermometer that is also used during sampling (See Appendix A for complete sampling procedure). The conductivity probe, used to measure specific conductance in the field, is calibrated once per week. Standard checks of calibration will be completed weekly in the office or as needed should calibration be unacceptable. The Turbidimeter is designed by the manufacturer to be calibrated using primary standards once every three months and by the use of secondary standards monthly. The WQM Director will be responsible for calibrating the Turbidimeter fully every month, and run a verification standard biweekly using Stablcal® Turbidity Standards (Hach).

See Appendix C for copies of the Calibration Logbooks, which are stored at the WQMP office. For equipment that is calibrated before each sampling session, please see the field data sheet, also found in

Appendix C or the Volunteer Manual found in Appendix A. The field data sheets will contain all calibration records for each sampling event.

17. INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES

All supplies, with the exception of sample collection bottles, will be purchased from reliable laboratory suppliers and inspected for defects, broken seals, expiration dates, etc. All serial numbers of meters will be checked and compared to certificates and logged for future reference. All supplies, including instruments and equipment, will be checked regularly and during random field audits. For GMCC, bottles that will be used to collect samples for the parameters listed in Table 9 will be provided by UNH. These bottles will be acid washed by UNH. For SRCC, bottles that will be used to collect samples for the parameters listed in Table 9 will be provided by Katahdin Analytical Services.

Supplies include: probes, bottles, spare batteries, thermometers, freeze packs, and coolers. All bottles will be checked for cracks upon receipt. Probes will be inspected visually then attached to the equipment and tested for acceptable results. Thermometers will not have any breaks or bubbles inside the capillary columns. Freeze packs will be checked for leakage and resealed or disposed of before each use. Coolers will be kept clean and will be inspected for proper closure.

Other minor supplies will include water resistant paper, writing utensils, and a small first aid kit. Field data sheets will be printed on waterproof paper approved by the WQM Director, who will also provide writing utensils that write clearly on the specialized paper.

18. DATA ACQUISITION REQUIREMENTS

A variety of information sources will be used to obtain both present and historical non water quality information on the area. These data sources include:

- ≈ United States Geological Survey (USGS) 7.5 Minute Topographic Maps will be used for site locations and project boundaries.
- ≈ Meteorological data will be obtained from the observations from all program participants involved. Scientifically collected data may be obtained from local weather stations if required. Rainfall amounts will be obtained at the end of each sampling season to supplement the field sheet data.

The first source is considered highly reliable because the USGS is the nation's authority on mapping. Meteorological data from participants in the study are considered sufficient for the QAPP's purposes. If specific amounts of rainfall, cloud cover, or other factors become apparent as important influences, however, local weather stations will be able to provide both historical and current data. The reliability of those data depends on the proximity of weather stations to monitoring sites, as weather, especially precipitation, can vary widely on a small scale.

19. DATA MANAGEMENT

The individual field data sheets and sample labels will be certified as complete and accurate and initialed by the Coordinator and/or WQM staff after each day of sampling. Completed data sheets will be submitted to the WQM Directors for final inspection. If the Directors find any questionable information on the sheets, he/she/they will contact the Coordinator to discuss the situation and tag the sample, if necessary. If the field data sheets have been done correctly, the Director will sign-off on the data sheet once monthly quality control has been completed. All numerical data on the sheets will be entered into a Microsoft Excel

spreadsheet, a Microsoft Access Database, or another suitable data organizer computer program under the supervision of the WQM Director. One hundred percent of the computerized data will be double checked monthly by at least one other person (whomever did not initially enter the data; either the Director or the WQM staff) as a form of quality control.

Results obtained from the laboratory will be entered into the computer into the same database as field data. Again, all computer entries will be double checked by the Director before the data are accepted.

20. ASSESSMENT AND RESPONSE ACTIONS

Attention to quality is a primary consideration of the program. All personnel associated with the program will ensure that the SOPs will be followed closely, for example by conducting field visits to evaluate volunteer performance and reviewing field and lab records. Training, calibration, maintenance and laboratory records will be filled out in a timely manner.

Equipment errors may occur and must be reported to the WQM Director. If the error is identified before sampling takes place, the equipment will be labeled as broken and will be replaced by properly working equipment, if available. If malfunctioning equipment affects the data, the equipment will be recorded as such on the field data sheet and immediately reported to the Director. Malfunctioning equipment will be cleaned, recalibrated, sent to the manufacturer for repairs or handled in other appropriate ways. If equipment cannot be fixed, it will be removed from the program.

Missing fields data and data results falling outside of DQOs (Table 6) must have satisfactory explanations before the data is accepted. Any data without QA/QC validation will not be used for analysis.

Laboratories must demonstrate that they currently meet all applicable standards and certifications for each analytic parameter and have a current Quality Assurance Plan or equivalent document³. Likewise with field data, missing laboratory data and data results falling outside of DQOs (Table 6) must have satisfactory explanations before the data is accepted. Any data without QA/QC validation will not be used for analysis.

21. REPORTS

A comprehensive report will be provided to the camps, local municipalities and other groups in order to increase public understanding of the program's goals and importance, and to underscore the implications of the results. The final report will be available for inspection on the GMCG and SRCC websites.

GMCG

At the end of each season, the Conservation Commissions in the towns of Madison, Tamworth, Sandwich, Freedom, Ossipee, Eaton, and Effingham will receive a report of analysis for their data from the WQ Director done to the best of each organization's abilities. These reports are also available on GMCG's website (<http://www.gmcg.org/research/water-quality-program-data/>). The data processing will be done without bias or prejudice and as accurately as possible, and all manipulations will be fully explained when requested. Upon request, the raw data from testing (without analysis or assumptions) will be made available to the program's participants and town officials if they wish to pursue independent analysis. All raw data received from all labs will also be submitted to NH DES on a yearly basis therefore making it accessible to anyone.

³ These laboratory documents are not included in this QAPP but can be obtained from the GMCG WQM Director.

The yearly report on the program will include all of the accepted data (including QC data), explanations for unaccepted data, a complete analysis, and any other important information the organizers of the program feel is appropriate. The report will credit everyone who has worked on the program.

SRCC

The final Data Summary submitted to ME DEP (Bureau of Water Quality) includes all accepted data, explanations for unaccepted data, and any other important information the organizers of the program feel is appropriate. The report will credit everyone who has worked on the program and provide a bibliography of resources used where appropriate. The final report will be completed during the winter, provided that all data has been received from all labs. Each town in the corridor that had sampling done will receive a report presenting their own data. The data processing will be done without bias or prejudice and as accurately as possible, and all manipulations will be fully explained when requested. Raw data from testing (without analysis or assumptions) will be made available to the program's participants and town officials if they wish to pursue independent analysis.

22. DATA REVIEW, VALIDATION, AND VERIFICATION

All field and laboratory data collected by each organization will be reviewed by that organization's Executive Director and WQM Director to determine if the data meet QAPP objectives. Decisions to reject or qualify data will be made jointly by the Executive Director and WQM Director for each organization. It will be the responsibility of the UNH and Katahdin Analytical laboratory managers to establish whether the data are acceptable based on their own QA/QC standards, and they may elect to disqualify data based on outliers. It will be the responsibility of the Executive Director and the WQM Director to determine if the data are acceptable according to the program's quality objectives.

Laboratory explanations for eliminated data must be given to the Executive Directors and WQM Directors prior to the analysis of the data. If analysis indicates that some data may be invalid, that statement must be included in the report with an explanation.

23. VALIDATION AND VERIFICATION METHODS

The WQM Director will perform the following tasks to ensure validity of all data associated with the program.

- ≈ Replicate samples of each meter-tested parameter on site will have their results compared for precision. If a deviation greater than the MAD (see section 7 above) is found, the program staff will attempt to identify the problem and correct it. If human error is found to be the issue, the WQM Director will re-train the samplers. If equipment failure is the issue, attempts to repair the equipment will be made or the equipment will be replaced. If the source of the error cannot be found, the Executive Director will consult specialists to resolve the problem.
- ≈ Field data sheets will be double-checked as soon as they are returned to the office. If errors are found, they will be corrected before computer data entry begins. If consistent errors are found, re-training on the particular issue will occur before the next sampling session.
- ≈ Equipment inspections will occur regularly to ensure that equipment is in proper working order. Multiple staff will be performing these inspections and records will be kept in the maintenance logbook and on the field data sheets when issues are found. If a piece of equipment is found to have a problem, qualified staff will verify the problem before corrective actions are taken.

- ≈ All data entered into the computer will be proofed by a second person for validation and to make corrections as needed.

24. RECONCILIATION WITH DATA QUALITY OBJECTIVES

Calculations and determinations for precision, accuracy and completeness will be made following each sampling season. If these data quality objectives are not met, the data will be flagged and subsequent corrective actions, taken prior to the next sampling season, will depend on the nature of the incident.

The data will be compared with the previous year's results to make note of any major discrepancies between the data. Over time, the data collection has provided better data quality objectives, such as tightening the accepted MAD values to increase the stringency of testing. Newer equipment and technique changes, such as altering the way the program has collected pH to reduce volunteer error, have also helped with achieving more accurate data sets.

The laboratories will compare all data to their own data quality objectives and qualify data as necessary.

25. RESOURCES:

1. Welcome to the Rivers Program Regional Interstate Volunteers for the Ecosystems and Rivers of Saco, by Brianne Fowles, Elisha Lindquist and Lynn M. Parker; Green Mountain Conservation Group and Saco River Corridor Commission, 2003.
2. Ossipee Watershed Water Quality Monitoring Program 2002 Pilot Season Summary Report, Green Mountain Conservation Group, 2003.
3. New Hampshire, Volunteer Lake Assessment Field Manual, Version 1.0, New Hampshire Department of Environmental Services, 2001.
4. Ossipee Lake Protection Program, Ossipee Lake Alliance, 2003.
5. Society for the Protection of the New Hampshire Forests, through a grant from the US Forest Service, to produce a series of Natural Resource Inventory (NRI) maps.
6. Saco River Basin Water Quality Monitoring Program (SRBP), 2002.
7. University of New Hampshire Standard Operating Procedures (SOPs), University of New Hampshire Cooperative Extension Agency, Durham, New Hampshire.
8. NH DES Limnology Center Laboratory Manual, 2003 Edition. New Hampshire Department of Environmental Services, 2003.
9. Maine NEMO Program, Guidelines and Standard Operating Procedures for Stormwater Phase II Communities in Maine
10. Think First . . . Spray Last, Gary Fish, Environmental Specialists, Maine Board of Pesticides.
11. US EPA – Preventing Waterborne Disease. A focus on EPA's Research

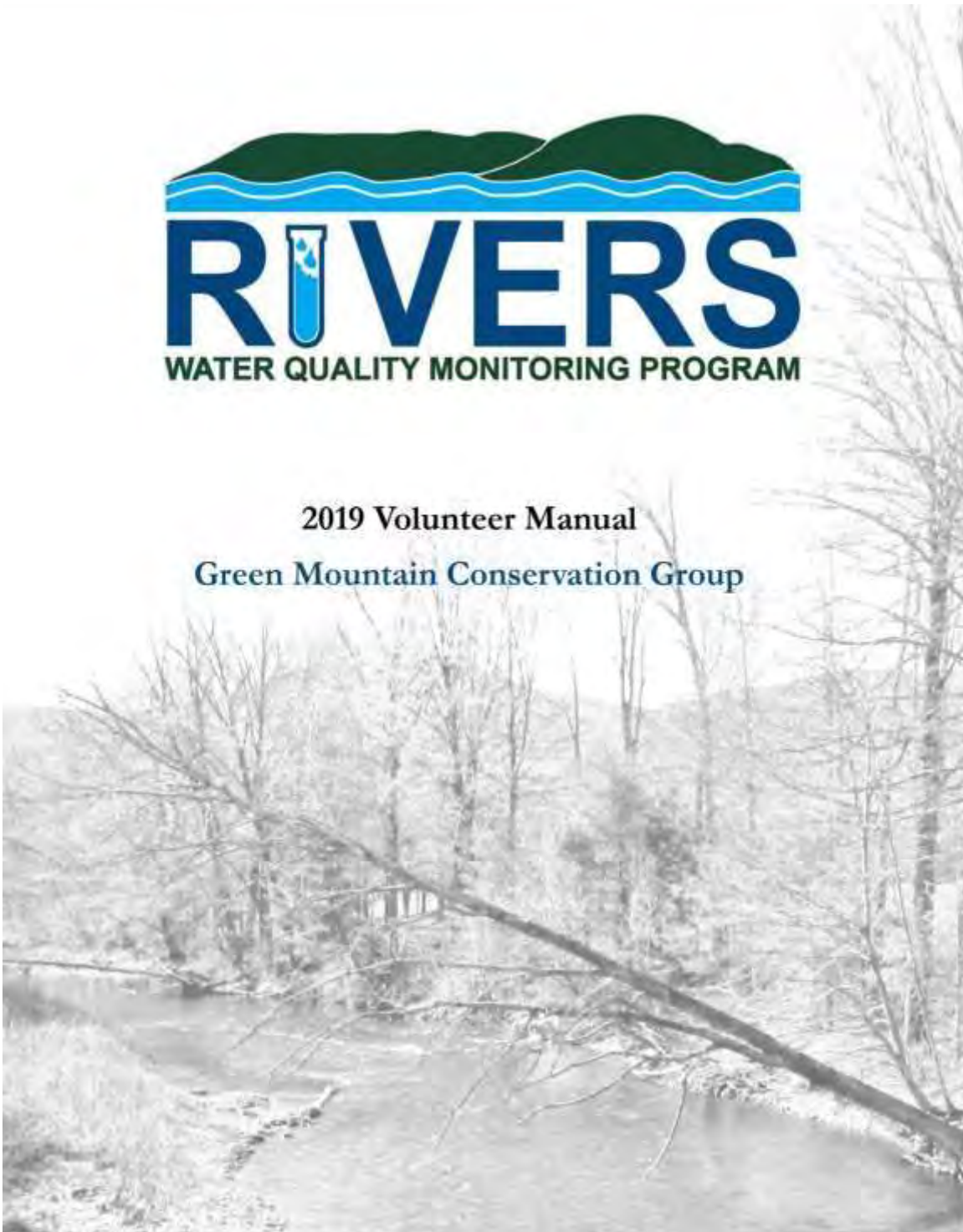
26. REFERENCES

1. The Saco River – A Plan for Recreational Management, Prepared by Southern Maine Regional Planning Commission, October 1983
2. Saco River Basin USDA Cooperative Study – Final Report, December 1983

APPENDIX A: Volunteer Manual



2019 Volunteer Manual Green Mountain Conservation Group



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 2019 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 citizen 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, suspicious persons, or inclement weather. 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 science,

Jill Emerson & Dalyn Houser

Contact Info

The 2019 RIVERS program is coordinated by Green Mountain Conservation Group in New Hampshire and Saco River Corridor Commission in Maine.



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RIVERS was created with the help of these organizations:



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2019 RIVERS Volunteer Manual

Introduction

The Saco/Ossipee 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 2019, our research partners at UNH and AmeriCorps volunteers are working with our data to analyze trends and create a report on the last 15+ years of data.

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 allow 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.

*2019 RIVERS Volunteer Manual***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.



The foundation of the organization rests on the R.E.A.I. 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.

2019 RIVERS Volunteer Manual

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.



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

*2019 RIVERS Volunteer Manual***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 our 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 seven parameters: pH, turbidity, dissolved oxygen, temperature, *Escherichia coli*, total Kjeldahl nitrogen, and total phosphorus. With the wrap of the successful pilot year, and the next season kicking off in April 2002, the SRCC began a cooperative working relationship with GMCG 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.

2019 RIVERS Volunteer Manual

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.



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

2019 RIVERS Volunteer Manual

RIVERS Overview

Monitoring will be performed biweekly, Mondays through Fridays, beginning in May (or when conditions allow) and ending in October. 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 both 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.

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

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

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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. Gases, 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 and nuisance algae and anaerobic organisms.

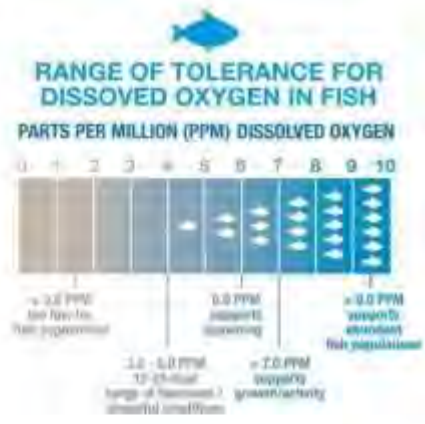


Figure 3: Dissolved oxygen ranges for aquatic life

Turbidity

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.



Figure 4: Turbidity values and clarity

These high levels of suspended particles, which absorb heat from the sun, increases 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 increasing water temperature. 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.

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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. Conductivity in streams and rivers 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 road, 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.

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 3 pH scale with familiar examples

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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 (SO₄²⁻)

Sulfate occurs naturally from weathering. 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 (NH₄⁺, NO₃⁻)

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.

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Ammonium 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 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, run off, agriculture or other anthropogenic activity.

Phosphorus

Of the two nutrients most important to the growth of aquatic plants, nitrogen and phosphorus, it is generally observed that phosphorus is more limiting 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 run-off and sewage inputs. In fact, most DOC found in streams come 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.

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Silica (SiO₂)

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 run off.

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 building in a yolk

Magnesium (Mg⁺²)

Magnesium is a common element and is an essential part of plant and animal nutrition. Magnesium is used in conjunction with calcium to determine water "hardness".

Table 2: Sample Summary

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 ₄ ⁺), 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 (total P)
Water Samples SRCC	Total phosphorus (total P), orthophosphate (PO ₄ ³⁻), total Kjeldahl nitrogen (TKN), alkalinity, <i>E. Coli</i>

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Field Sampling

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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 the car.



Figure 7: Potential plant hazards

*2019 RIVERS Volunteer Manual***Monitoring Equipment**

- Equipment bag contains:
 - 1 Hach HQ40d 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)

*2019 RIVERS Volunteer Manual***Monitoring Procedure**

GMCCG 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 sample 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 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.

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Measuring Dissolved Oxygen and Conductivity



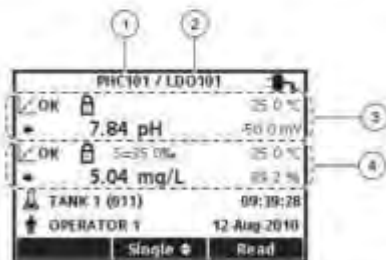
1. Turn on the meter by pressing the power button 
2. Take out the Hach multimeter and unfurl the yellow dissolved oxygen (LDO) and conductivity probes.
 - Do not submerge the pressure sensor. The pressure sensor is the black component on the yellow LDO probe cord located near where the probe connects to the meter.
3. Carefully connect dissolved oxygen and conductivity probes by aligning the notch on the probe's end to the notch on the meter (Figure 8).
 - Push and turn the cable locking nuts to tighten.
 - Wait for words "Probe Connecting" to disappear.
4. Check for the OK calibration symbol  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.



Figure 8: Connecting the probes to the meter.



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

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- If you see the question mark symbol **↵?** instead of the OK symbol **↵OK** 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.
5. Place the probes in the water anywhere from 2 to 24 inches deep, ideally between 6 to 12 inches. (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 correct depth and proceed with the next step.

- o If possible to do so, please avoid touching the bottom.
- o 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 stabilize readings

- 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 $\mu\text{S}/\text{cm}$) on Part V - Field Measurements on the field data sheet.

6. Collect second readings by pressing read and wait for probes to stabilize and enter Readings # 2 onto 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 30 $\mu\text{S}/\text{cm}$ of each other. Temperature is

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also recorded from the dissolved oxygen probe (LDO) and readings should be within 1 °C of each other.

Table 3: Maximum allowable differences for the Hach Multimeter

Measurements	Maximum allowable differences
Conductivity	30 µS/cm
Dissolved Oxygen	0.5 mg/L
Temperature	1.0 °C

7. Turn meter off by pressing .
8. Carefully disconnect probes by unscrewing cable lock.
9. Rinse probes with a small amount of distilled water. Coil probes and return to 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 temperature immediately upon removal. Avoid touching the bottom of the thermometer when reading.
4. Remember to return the blue thermometer to the gear bag.

*2019 RIVERS Volunteer Manual***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.

Labelling Sample Bottles

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

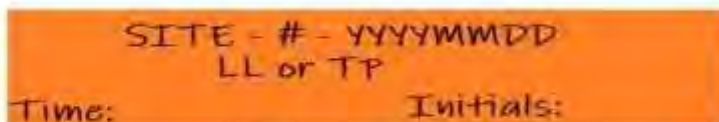


Figure 11. Example sample label

- 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 bottle and your initials on the data sheet.

Collecting pH Samples

1. With you 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.

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2. Rinse your pH bottle 1x before filling. To rinse, submerge your pH bottle at least 2 inches 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 sample as described in the rinse step above (step 3), though this time DO NOT DISCARD your water.
4. Return water to cooler. Mark on data sheet time and depth pH sample was collected at.

Collecting Water Samples (TP or LL)

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 a depth of at least 2 inches 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 sample.
 - Lightly cap bottle, submerge bottle and cap underwater, carefully remove cap to completely fill bottle, screw cap on, and then remove from water.
4. Repeat for all sample bottles regardless of bottle size or shape.

E. coli sample

1. Wear 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 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.

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Collecting Replicates

Occasionally, you may be asked to take a replicate water sample. Use the same sampling procedure outlined above for all replicate 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 truck of your car (though it safely can be brought on site).
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.



Figure 12: Hand turbidity meter

- Follow the same procedure for collecting water samples. Rinsing the vial three times and keeping 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).



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

- Wipe with the black velvet cloth to evenly spread the oil.
- Remember to return the black velvet cloth to its plastic bag.

5. Gently invert to mix water sample. 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 (Figure 14). Close the lid.



Figure 14: Insert vial into center by aligning the arrows

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Figure 15: Hach turbidity meter button options


6. Push the blue power key to turn the meter on. 
7. Push RIGHT key under **Read** (Figure 15).
 - The display shows Stabilizing, then the turbidity in NTU.
8. Remove first sample cell and test second sample cell. Record Reading # 1 and Reading # 2 on field sheet.
 - Check to verify that turbidity readings are within 0.2 NTU of each other. If difference between readings is greater than 0.2, collect an additional sample. Repeat until the difference between the two samples is less than or equal to 0.2.

Table 4: Maximum Allowable Differences for the Hach turbidity meter

Measurements	Maximum allowable differences
Turbidity	0.2 NTU

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

*2019 RIVERS Volunteer Manual***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 to record your sampling end time.

Table 5: Maximum Allowable Differences for all field parameters



Measurements	Equipment	Maximum allowable differences
Conductivity	Hach HQ40d Conductivity Probe	30 μ S/cm
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 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 meter to next volunteer on time or return meter to your organization.
- Store samples in 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 , 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 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 16). 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 16. Rinse the probe with DI water

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4. Add about a ¼ inch of distilled water to DO calibration bottle and cap bottle. Vigorously shake DO calibration bottle with 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 should not take 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  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.

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Appendices

*2019 RIVERS Volunteer Manual***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

Table 1: Maximum Allowable Differences for all field parameters

Measurements	Equipment Used	Expected Values	Maximum allowable differences
Conductivity	Hach HQ40d	0 to 200 $\mu\text{S}/\text{cm}$	30 $\mu\text{S}/\text{cm}$
Dissolved Oxygen	Hach HQ40d	0 to 20 mg/L or 0 to 200%	0.5 mg/L
Turbidity	Model 2100Q Portable Turbidimeter	0 to 200 NTU	0.2 NTU
Temperature	Non-mercury thermometer	0 to 35° C	1.0° C

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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 Chocoma 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
GM-2 Pequawket Brook, Madison	43.96044444	-71.14719444
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

Table 2: Coordinates for SRCC RIVERS sampling sites.

Site Code	Description
CC1	Davis Park in Conway, NH
CC2	Saco River (Redstone), Police Station, Conway, NH
S1	Saco River, ME/NH border in Conway, NH (Saco Pines)
S2	Saco River, Weston's Beach, Fryeburg, ME
S3	Saco River, Canal Bridge Beach, Fryeburg, ME
SF1	Below Swan Falls Dam, Fryeburg, ME
OCS4-B	Old Course Downstream of Hemlock Bridge, Fryeburg, ME
S6	Down river of Brownfield Bog (Route 160 Bridge), Brownfield, ME
MPB22	Below Moose Pond/at Moose Pond Brook, Denmark, ME
BMP1	Burnt Meadow Pond at public beach, Brownfield, ME
O7	Ossipee River, ME/NH border in Effingham, NH
O7-1	Ossipee River, Covered Bridge off Route 25 in Porter, ME
O8	Ossipee River, Down river of Kezar Falls, Parsonsfield, ME
OS9	Ossipee River, Route 5, Cornish, ME
S10	Saco River, Off Route 11, Steep Falls, ME
S23	Saco River, Great Falls/Dam, Hiram, ME
O22	Ossipee River, Bridge at Bridge Street - Cornish/Hiram, ME
LO11-1	Little Ossipee River, Beside Balch Lake Dam, Newfield, ME
LO13	Little Ossipee River, Below Shapleigh Pond, Shapleigh, ME
SP13-1	Shapleigh Pond, Shapleigh, ME
LO14-1	Little Ossipee River, Above Lake Arrowhead Dam, Waterboro, ME
LO15	Little Ossipee River, Below Lake Arrowhead, Limington, ME
LO25	Little Ossipee Pond, Waterboro, ME
S17	Saco River, Bonny Eagle Island, Standish, ME
S18	Saco River, Above Bar Mills Dam, Buxton, ME
S19-U	Saco River, Above Skelton Dam, Dayton, ME
S20	Saco River, South Street, Biddeford, ME
S21	Saco River, Public Boat Launch Front Street, Saco, ME
S28	Saco River, Route 5 Bridge, Saco, ME
S30	Saco River, Off Irving Street, Saco, ME
S31	Saco River, Rotary Park, Biddeford, ME
LO20	Little Ossipee River, Bridge on Foss Road, Limerick, ME

2019 RIVERS Volunteer Manual

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 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 ruined 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 go 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".

2019 RIVERS Volunteer Manual

Troubleshooting

Table 3: 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 probe and reinsert into water.
	Calibration not done correctly	If I.D.O probe and you are able, recalibrate the dissolved oxygen probe. If conductivity probe, contact your RIVERS coordinator and continue sampling.

Table 4: 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.

*2019 RIVERS Volunteer Manual***Expected Values**

Table 5: Quick reference sheet for expected values of different field parameters.

Parameter	Expected range
Conductivity	0-500 $\mu\text{S}/\text{cm}$
Dissolved Oxygen	6-11 mg/L, and 75-120 %
Turbidity	0-10 NTU
Temperature	0-27 °C

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.

Things to Remember
as a 2019 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 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:
 - o Jill: (603) 677-2920 or Victoria (386) 506-7088.
- Check for ticks.
- Thank you!



Volunteer: _____

Site(s): _____

2019 RIVERS Water Quality Monitoring
Program is coordinated by:



Appendix B: Calibration Manuals for Hach Water Quality Monitoring Equipment

Figure 5: Hach LDO Probe Manual

User Manual


DOC022.53.80021

Luminescent Dissolved Oxygen Probe: Model LDO10101, LDO10103, LDO10105, LDO10110, LDO10115 or LDO10130

Safety Information

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.



Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user.
Note: For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.

Specifications

Note: Specifications are subject to change without notice

Specifications	Details
Probe type	Luminescent dissolved oxygen (LDO) probe
Dissolved oxygen range	0.1 to 20.0 mg/L (ppm) 1 to 200% saturation
Dissolved oxygen accuracy	±0.1 mg/L for 0 to 8 mg/L ±0.2 mg/L for greater than 8 mg/L
% saturation resolution	0.1%
Stabilization time	T90% at 10 seconds (when stirred)
Temperature resolution	0.1 °C (0.18 °F)
Temperature accuracy	±0.3 °C (±0.54 °F)
Pressure resolution	1 mPa
Pressure accuracy	±0.8%
Operating temperature range	0 to 50 °C (32 to 122 °F)
Storage temperature range	0 to 40 °C (32 to 104 °F)
Minimum sample depth	25 mm (0.984 in.)
Dimensions (standard)	Diameter: 29 mm (1.14 in.) Length: 191 mm (7.52 in.) Cable length: 1 or 3 m (3.28 or 9.84 ft)
Dimensions (rugged)	Diameter: 46 mm (1.81 in.) Length: 223 mm (8.73 in.) Cable length: 5, 10, 15 or 30 meter (16.40, 32.81, 49.21 or 98.42 ft)
Cable connection	M12 digital output and connector compatible with HQd meters

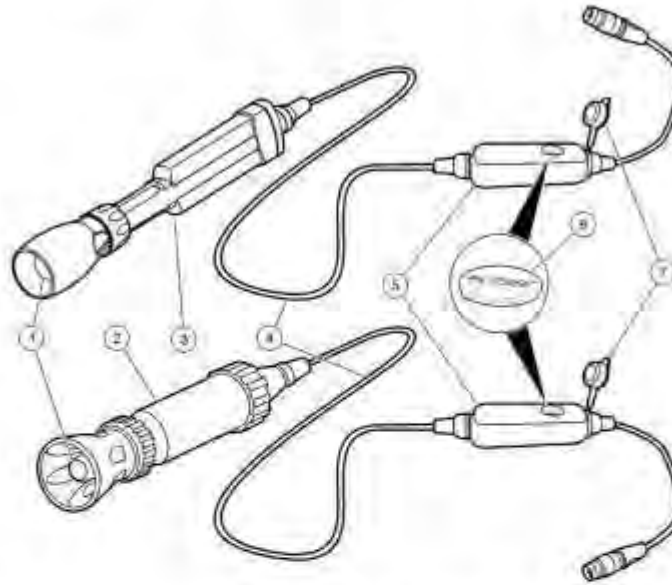
Product overview

The LDO101 series probe is a luminescent dissolved oxygen probe (Figure 1). The LDO10105, LDO10110, LDO10115 or LDO10130 rugged probe is available with a 5, 10, 15 or 30 m (16.40, 32.81, 49.21 or 98.42 ft) cable. The LDO10101 or LDO10103 standard

probe is available with a 1 or 3 m (3.28 or 9.84 ft) cable and is intended for laboratory use. The probe measures the dissolved oxygen concentration in wastewater, drinking water and general applications.

Note: For BOD applications, use the LBOD10101 probe which has LDO technology and a stirrer.

Figure 1 Probe overview



1 LDO probe cap	5 Pressure sensor module
2 Rugged probe (5, 10, 15 or 30 meter cable)	6 iButton® compartment ¹
3 Standard probe (1 or 3 meter cable)	7 Pressure sensor module cap
4 Probe cable	

¹ iButton is a registered trademark of Maxim Integrated Products, Inc.

Preparation for use

Note: Do not touch the probe cap with a hand, fingers or any surface that can scratch the cap.

Prepare the probe for use before calibration or sample measurement.

1. Make sure that the probe cap and iButton are installed correctly. The iButton label should be up.
2. Make sure that the probe cap and iButton have the same lot code.
3. If a rugged probe, make sure that the shroud is installed before field use (refer to [Install the shroud](#) on page 9).


Note: Damage to the sensing elements can occur if the shroud is not installed during field use. Damage under these conditions is not covered by the product warranty.

4. Rinse the probe cap with deionized water. Blot dry with a lint-free cloth.
5. If dissolved oxygen monitoring periods are longer than 6 hours, condition the probe cap for 72 hours. Calibrate the probe once every 8 hours.
Note: After 72 hours, the probe cap will reach a fully hydrated state.

Calibration

Before calibration:

The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached. It is not necessary to recalibrate when moving a calibrated probe from one HQd meter to another if the additional meter is configured to use the same calibration options.

To view the current calibration, push , select View Probe Data, then select View Current Calibration.

If any two probes are connected, push the **UP** or **DOWN** arrow to change to the single display mode in order to show the Calibrate option.

Prepare the probe for use (refer to Preparation for use on page 2).

If a rugged probe, remove the shroud from the probe (refer to Remove the shroud on page 9).

Calibration notes:

- % saturation or mg/L calibration methods are available in the Modify Current Settings menu.
- The slope value is the comparison between the latest calibration and the factory calibration shown as a percentage.
- An additional zero point calibration can be added to the calibration routine. Refer to Change calibration options on page 8.
- The calibration is recorded in the probe and the data log. The calibration is also sent to a PC, printer or flash memory stick if connected.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a calibration error occurs, refer to Troubleshooting on page 10.

Water-saturated air (100%) calibration procedure:



1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn on the meter.



2. Push **Calibrate**.








3. Push **Methods**. Select User Cal - 100%. Push **OK**.



4. Rinse the probe cap with deionized water. Blot dry with a lint-free cloth.



5. Add approximately 1/4 inch (6.4 mm) of reagent water to a narrow-neck bottle, such as a BOD bottle.

				
<p>6. Put a stopper in the bottle and shake the bottle vigorously for approximately 30 seconds to saturate the entrapped air with water. Allow up to 30 minutes for contents to equilibrate to room temperature.</p>	<p>7. Remove the stopper. Carefully dry the probe cap with a non-abrasive cloth. Put the probe in the bottle.</p>	<p>8. 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.</p>	<p>9. Push Done to view the calibration summary.</p>	<p>10. Push Store to accept the calibration and return to the measurement mode. If a rugged probe, install the shroud on the probe (refer to Install the shroud on page 9).</p>

Sample measurement

Before measurement:

The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached. If complete traceability is necessary, enter a sample ID and operator ID before measurement. Refer to the HQd meter manual for more information.

Regular calibration is required for the best measurement accuracy (refer to [Calibration](#) on page 3). Calibrate the probe if accuracy better than ±0.50 mg/L is necessary for the application.

Prepare the probe for use (refer to [Preparation for use](#) on page 2).

To deploy a rugged probe at a distance, toss the probe body with a gentle underhand throw. Do not swing the probe by the cable as this may cause injury to the user, will cause severe strain on the cable and will shorten the service life of the cell. Damage under these conditions is not covered by the product warranty.



Do not submerge the pressure sensor module.

Measurement notes:

- Stabilization times with smaller concentration changes generally will be longer and can be minimized by correct stirring and conditioning. Experiment to determine the correct stir rate if necessary.
- Salinity affects the concentration of dissolved oxygen in the sample. To correct for salinity effects, refer to [Advanced operation](#) on page 6 or do the [Auto salinity correction](#) on page 5.
- Data is automatically stored in the data log when **Press to Read** or **Interval** is selected in the Measurement Mode. When **Continuous** is selected, data will only be stored when **Store** is selected.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a measurement error occurs, refer to [Troubleshooting](#) on page 10.

Measurement procedure:

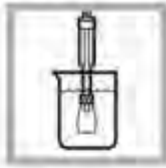
Note: Procedures also apply for rugged model probes.



1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn on the meter.



2. Rinse the probe cap with deionized water. Blot dry with a lint-free cloth.



3. Put the probe in the sample and stir gently or add a stir bar. Do not put the probe on the bottom or sides of the container. Stir the sample at a moderate rate or put the probe in flowing conditions.



4. Put the probe in the sample at least 25 mm (0.984 in.) deep. Push **Read**. The display will show "Stabilizing" and a progress bar as the probe stabilizes in the sample. The display will show the lock icon when the reading stabilizes.



5. Repeat steps 2-4 for additional measurements. When measurements are done, store the probe. Storage on page 10.

Auto salinity correction

Dissolved substances affect the amount of oxygen water can hold. Manually enter salinity settings for the most accurate dissolved oxygen measurements or use the optional Auto Salinity Correction feature.

The manufacturer recommends using the Auto Salinity Correction feature when measuring dissolved oxygen in samples where salinity varies. Auto salinity correction measures dissolved oxygen through the connection of one LDO101 probe and one CDC401 conductivity cell (set to Salinity parameter). The value obtained by the CDC401 conductivity cell automatically adjusts the salinity value for the LDO101 series probe. Salinity units are represented as parts per thousand (ppt) or (‰).

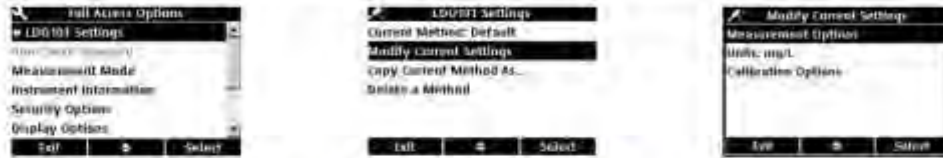
1. Connect the LDO101 probe and CDC401 conductivity cell to the HQd meter. Turn the meter on.
Note: Security options must be turned off to use auto salinity correction.
2. Push **↵** and select the CDC401 Settings.
3. Select Current Method, Hach Salinity. Push **OK**.
Note: To change more measurement options, choose Modify Current Settings, change the parameter to Salinity and any other desired settings.
4. Push **EXIT** until the Full Access Options menu is shown.
5. Select LDO101 Settings, Modify Current Settings, Measurement Options, Salinity Correction: Off. Then select Sal Correction Mode: Off. Push the **DOWN** arrow to select Auto (*) - Use CDC401. Push **OK**.
6. Push **EXIT** until the meter returns to the measurement mode. The HQ40d meter is now set up to automatically use the salinity values obtained by the CDC401 with the LDO101 probe. If the salinity value is out of range, the display will show *S= ---- above the dissolved oxygen reading as shown in Figure 2.
Note: The asterisk () indicates that salinity is automatically correcting the dissolved oxygen value. No asterisk indicates that salinity is being manually corrected. Warning messages will override the asterisk (*) priority.*

Figure 2. Salinity value out of range



Advanced operation

Parameter-specific settings can be changed through the Full Access Options menu. Details about menu navigation, available options and how to change them are given in the screens, tables and procedures throughout this section.



The settings that can be changed are shown in Table 1.

Table 1 Parameter-specific settings

Setting	Options	Description
Measurement Options	Resolution	Defines measurement resolution
	Measurement Limits	Upper and lower measurement limits
	Salinity Correction	Value for salinity correction
	Pressure Units	Atmospheric pressure units
	Averaging Interval	How often the meter calculates an average readings
Units	mg/L %	Primary unit of measurement
Calibration Options	Calibration	<ul style="list-style-type: none"> User 100% User 100% with 0 User mg/L User mg/L with 0 Factory
	Calibration Reminder	Reminder Repeat—Off, 8 h, 12 h, 1 d, 2 d, 5 d or 7 d Expires—Immediately, Reminder + 30 m, Reminder + 1 h, Reminder + 2 h or Continue Reading

Change measurement options

Methods are groups of default or user-defined settings relevant to specific applications. If the meter is set to the default method and the Modify Current Settings option is chosen, a prompt for a new name is shown after the changes are entered. The settings are saved with this name to distinguish them from the default method settings, which cannot be changed. A saved method can be used instead of multiple adjustments to the individual settings. Changes made to a user defined method are automatically saved with the existing name. Multiple methods can be saved for the same probe on each meter.

There are three default methods available for the LDO101 probe:

- Factory Cal (Calibration with default LDO calibration)
- User Calibration—100% (allows user calibration)


• Default

1. Make sure a probe is connected to the meter.
2. Push **↵** and select LDO101 Settings.
3. Select Modify Current Settings.
4. Select Units. Select mg/L (default) or %.
5. Select Measurement Options and update the settings:

Option	Description
Resolution	<p>Sets the resolution:</p> <ul style="list-style-type: none"> • 0.1—Fast (0.35 mg/L)/min • 0.01—Fast (0.35 mg/L)/min • 0.01—Medium (0.15 mg/L)/min (default), or • 0.01—Slow (0.05 mg/L)/min <p>The resolution affects the number of decimal places and the stabilization time. Higher resolution measurements take more time to stabilize.</p>
Measurement Limits	<p>Set the measurement limits—Lower limit (default: 0.0 mg/L; 0%) or Upper limit (default: 20.0 mg/L; 200%).</p> <p>The measurement limits can be set to match the acceptable values for the sample. When the measurement is above the upper limit setting or below the lower limit setting, the meter shows an "Out of limits" message. This message is an alert to a potential problem with the process conditions.</p>
Salinity Correction	<p>Sets the salinity correction—Off (default), Manual or Auto (connect conductivity probe).</p> <p>Salinity lowers the solubility of dissolved oxygen in water. To correct for salinity in the sample, set salinity correction to manual and then enter the salinity value.</p> <p><i>Note: When the HQ40d meter is used, a conductivity probe can also be connected for automatic salinity measurement and correction. The parameter setting for the conductivity probe must show salinity.</i></p>
Salinity Value	<p>Sets the salinity value—‰ (default: 35.0 ‰).</p> <p>When salinity correction is set to manual, sets the salinity value of the sample. Salinity can be measured with a conductivity probe.</p>
Pressure Units	<p>Sets the pressure units—hPa, mBar, inHg or mmHg.</p> <p>The meter shows the atmospheric pressure at the current elevation, which is necessary for accurate measurements.</p> <p><i>Note: This pressure reading will not agree with readings from sources such as weather stations, which report atmospheric pressure at sea level.</i></p>
Averaging Interval	<p>Sets the averaging interval—Off, 30, 60, 90 seconds, 3, 5 minutes.</p> <p>The averaging interval is useful for samples that contain a lot of air bubbles, for example in an aeration basin. The air bubbles cause the dissolved oxygen readings to vary greatly from one reading to the next. To make the readings more consistent, increase the averaging interval. The meter will take measurements at the same frequency but show only the average over a longer interval.</p> <p><i>Note: Labels and options may vary depending on the units selected.</i></p>

6. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
7. Push **EXIT** until the meter returns to the measurement mode.

Change calibration options

1. Make sure that a probe is connected to the meter.
2. Push  and select LDO101 Settings.
3. Select Modify Current Settings.
4. Select Calibration Options and update the settings:

Option	Description
Calibration	<ul style="list-style-type: none"> • User—100% (water-saturated air (100%) calibration) • User—100% with 0 (water-saturated air (100%) calibration with 0 point) • User—mg/L (calibration with a specified dissolved oxygen concentration (mg/L) solution) • User—mg/L with 0 (calibration with a specified dissolved oxygen concentration (mg/L) solution with 0 point) • Factory (calibration with the default LDO calibration)
Standard Value	When Calibration is set to mg/L or mg/L with 0, sets the concentration of the solution that will be used for calibration—2.00 to 20.00 mg/L (default=7.00 mg/L)

5. Select Calibration Reminder and update the settings:

Option	Description
Reminder Repeat	Meter will make an audible sound when calibration is due and repeat the sound at selected interval—Off, 9 hr, 12 hr, 1 d, 2 d, 5 d or 7 d.
Expires	Calibration expires after the selected time—Immediately, Reminder + 30 min, Reminder + 1 h, Reminder + 2 h or Continue Reading. <i>Note: The meter cannot be used to read samples after calibration has expired unless Continue Reading is selected.</i>

6. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
7. Push **EXIT** until the meter goes back to the measurement mode.

Maintenance

Clean the probe

Keep the probe cap free of deposits for the best measurements.

Note: Do not touch the black colored substrate of the probe cap. Do not use alcohol or other organic solvents to clean the black colored substrate of the probe cap. These solvents cause damage to the probe cap.

1. Remove the shroud (refer to [Remove the shroud](#) on page 9).
2. Gently clean the probe cap with a mild detergent, water and a soft cloth or cotton swab. Do not remove the black colored substrate from the probe cap. Do not scrub the probe cap or lens.
3. If water is present between the probe cap and lens:
 - a. Remove the probe cap.
 - b. Blot dry the probe cap and lens with a soft dry cloth.
 - c. Install the probe cap.
4. Install the shroud (refer to [Install the shroud](#) on page 9).

Replace probe cap

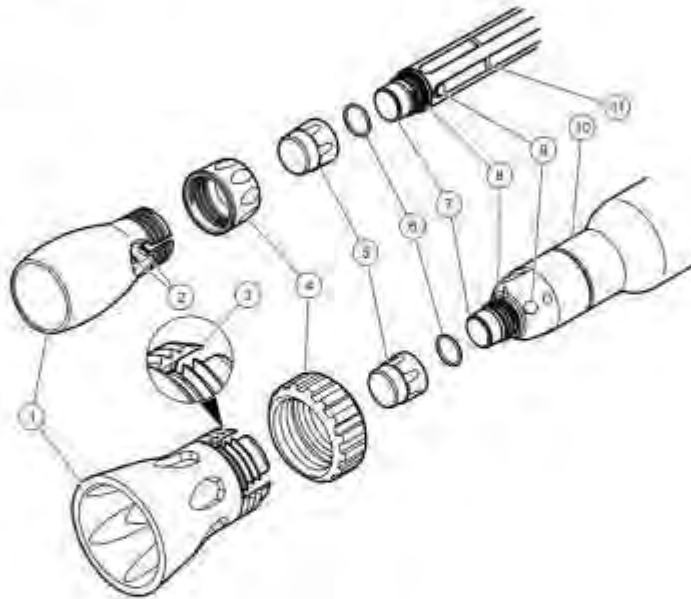
The probe cap must be replaced every 365 days or more often if the cap becomes damaged or fouled. The meter will show a reminder message when 30 days of probe service life remains on the probe cap.

For LDO probe cap replacement instructions, refer to the instructions provided with the LDO probe cap replacement kit.

Remove the shroud

1. Loosen and remove the locking ring (Figure 3).
2. Slide the shroud and locking ring off the probe.

Figure 3 Probe exploded view



1 Shroud	7 Probe lens
2 Locking ridges (8x)	8 Cap seal
3 Locking rib	9 Temperature sensor
4 Locking ring	10 Locking groove
5 Probe cap	11 Locking ribs (4x)
6 O-ring	

Install the shroud

1. Put the locking ring on the probe with the threads toward the probe cap (Figure 3 on page 9).
2. Slide the shroud on the probe until it is against the locking groove (rugged) or ribs (standard). Slide the standard probe shroud on the standard probe until the inside locking ridges align halfway between the ribs on the probe. Turn the shroud slightly until it is seated.
3. Hand-tighten the locking ring on the shroud.

Storage

- Dry storage—the manufacturer recommends that the probe is stored dry when the probe is used for measurements of short duration (less than 6 hours).
- Wet storage—the probe must be stored wet when the probe is used for monitoring periods longer than 6 hours.

Dry storage

Note: Rugged probes may be stored dry with the shroud installed if the storage container is sufficiently large.

1. Rinse the probe with deionized water. Blot dry with a lint-free cloth.
Note: The probe must be conditioned again in tap water for at least 30 minutes prior to use
2. If a rugged probe, remove the shroud (optional). Refer to **Remove the shroud** on page 9.

Wet storage

Note: The need for recalibration is minimized if the probe cap is kept wet.

1. Put the probe in tap water.
2. During the initial 72 hours in tap water, calibrate the probe once every 8 hours.
Note: After 72 hours of storage in tap water, the probe cap will reach a fully hydrated state.

Troubleshooting

Message or symptom	Possible cause	Action
Probe not supported	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website. Refer to the HQd Series meter manual for specific instructions for the meter model.
	HQd meter does not support IntelliCAL [®] probe	Contact a Technical Support Representative.
Connect a probe or probe requires service	Probe not connected correctly	Disconnect, then connect the probe. Tighten the locking nut.
	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website. Refer to the HQd Series meter manual.
	Large number of methods stored on the probe	Continue to let the probe connect. Do not disconnect the probe.
	Damaged probe	Make sure there is connectivity with another probe or meter to confirm isolated issue with probe. Contact a Technical Support Representative.

Message or symptom	Possible cause	Action
Out of range	Probe cap loose, scratched or damaged	Reposition or replace the probe cap.
	Temperature and/or pressure sensor error	Make sure that the temperature and pressure sensors are both reading correctly. ¹
	Damaged probe	Make sure that the blue and red LEDs are both illuminated on the probe. If not, replace the probe or contact a Technical Support Representative.
	Sample outside of specifications	Make sure that the sample concentration, temperature, and pressure are within the range of the probe.
	iButton number does not match probe cap lot number	Replace the iButton or probe cap or do a user calibration.
	Bubbles trapped under probe tip	Gently shake the probe until bubbles are removed.
Out of range	Probe cap exposed to direct sunlight	Install the protective shroud.
Slope out of range	Probe not prepared for sample	Let the probe reach equilibrium in a water-saturated air environment and do the calibration again.
	Calibration method settings	Make sure that the calibration standards in the method are correct.
	Probe cap loose, scratched or damaged	Locate and install the iButton that matches the probe cap and replace the probe cap.
	Temperature and pressure errors	Make sure that the temperature and pressure sensors are both reading accurately. Contact a Technical Support Representative. ¹
	LED lights do not function	Contact a Technical Support Representative.
	Bubbles trapped under probe tip	Gently shake the probe until bubbles are removed.
LDO—calibration not supported (factory calibration)	LDO method calibration option is set to Factory.	If user calibration is necessary, change the settings in Calibration Options. Refer to Change calibration options on page 8.
O2 Sensor 0 days remaining	There are 0 days remaining in the life of the probe cap.	Replace the probe cap. Calibration will be allowed, however the calibration icon and question mark will be shown on the measurement screen even if the calibration has passed.
	Meter set to incorrect date and time	Disconnect the probe from the meter. Set the correct date and time in the Meter Options menu. Connect the probe and make sure that the message has been removed.
	Software not updated	Update the HQd software to the latest version and test again.
O2 Sensor ## of days remaining	There are 30 days or fewer remaining in the life of the probe cap.	Replace the probe cap soon.

Message or symptom	Possible cause	Action
Calibration failed: outside of acceptance criteria/Temperature out of range/Offset out of limits	Water Saturated air equilibration not reached	Allow longer equilibration time.
	Probe cap loose, scratched, or damaged	Change the location of the probe cap or replace the probe cap.
	Temperature and/or pressure sensor error	Make sure that the temperature and pressure sensors are both reading correctly and within range. ³
	Damaged probe	Make sure that the blue and red LEDs are both illuminated on the probe. If not, replace the probe or contact a Technical Support Representative.

³ The pressure as measured by the probe is what is referred to as atmospheric pressure and is not corrected to sea level. Weather station pressures are reported at sea level and commonly referred to as mean sea level pressure. As a result the probe will not read the same as most household or professional barometers or weather station reports (which are compensated) unless reported at sea level. In order to compare the pressure results obtained from the probe barometer and these compensated barometers, it is necessary to first compensate the pressure reported by the probes mathematically.

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Figure 6: Hach Conductivity Probe Manual

User Manual

DOC022.53.80022

Conductivity Probe: Model CDC40101, CDC40103, CDC40105, CDC40110, CDC40115 or CDC40130

Safety information

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.



Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user.

Note: For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.

Specifications

Note: Specifications are subject to change without notice.

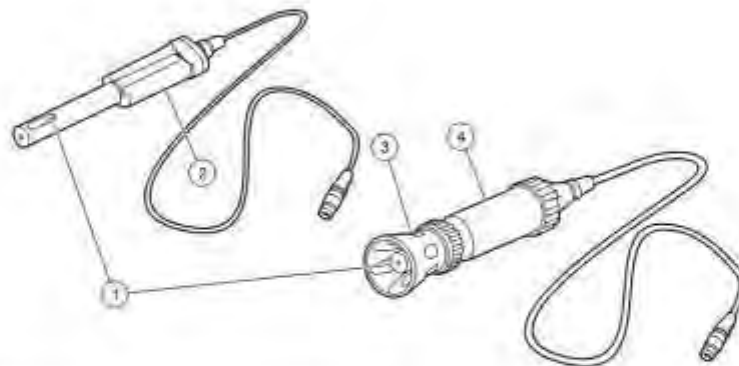
Specifications	Details
Probe type	Graphite, 4-pole, conductivity probe
Conductivity range	0.01 $\mu\text{S/cm}$ to 200.0 mS/cm
Cell constant	0.40 cm^{-1} $\pm 10\%$
Conductivity resolution	0.0 to 19.99 $\mu\text{S/cm}$: 0.01 $\mu\text{S/cm}$ 20.0 to 199.9 $\mu\text{S/cm}$: 0.1 $\mu\text{S/cm}$ 200 to 1999 $\mu\text{S/cm}$: 1 $\mu\text{S/cm}$ 2.00 to 19.99 mS/cm : 0.01 mS/cm 20.0 to 200.0 mS/cm : 0.1 mS/cm
Conductivity accuracy	$\pm 0.5\%$ of reading
TDS (total dissolved solids) range	0 to 50,000 mg/L as NaCl
TDS resolution	0.0 to 19.99 mg/L : 0.01 mg/L 200 to 1999 mg/L : 1 mg/L 2.00 to 19.99 g/L : 0.01 g/L 20.0 to 50.0 g/L : 0.1 g/L
TDS accuracy	$\pm 0.5\%$ of reading
Sample salinity range	0 to 42 (ppt) (‰)
Salinity resolution	0.01 parts per thousand (ppt) (‰)
Salinity accuracy	± 1 parts per thousand (ppt) (‰)
Temperature accuracy	± 0.3 °C (± 0.54 °F)
Operating temperature range	-10 to 110 °C (14 to 230 °F)
Storage temperature range	5 to 40 °C (41 to 104 °F)
Minimum sample depth	45 mm (1.77 in.)
Dimensions (standard)	Diameter: 15 mm (0.59 in.) Length: 184 mm (7.24 in.) Cable length: 1 or 3 m (3.28 or 9.84 ft)

Specifications	Details
Dimensions (rugged)	Diameter: 46 mm (1.81 in.) Length: 223 mm (8.73 in.) Cable length: 5, 10, 15 or 30 m (16.40, 32.81, 49.21 or 98.42 ft)
Cable connection	M12 digital output and connector compatible with HQd meters

Product overview


The CDC401 series probe is a graphite, 4-pole conductivity probe (Figure 1). The CDC40101 or CDC40103 standard conductivity probe is available with a 1 or 3 m (3.28 or 9.84 ft) cable and is intended for laboratory use. The CDC40105, CDC40110, CDC40115 or CDC40130 rugged conductivity probe is available with a 5, 10, 15 or 30 m (16.40, 32.81, 49.21 or 98.42 ft) cable. The probe measures electrical conductivity, salinity, resistivity or total dissolved solids (TDS) in wastewater, drinking water and general applications.

Figure 1 Probe overview



1 Temperature sensor and 4-pole graphite design conductivity cell	3 Shroud (rugged model)
2 Standard probe (1 or 3 meter cable)	4 Rugged probe (5, 10, 15, or 30 meter cable)

Calibration

Before calibration:
The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached.
It is not necessary to recalibrate when moving a calibrated probe from one HQd meter to another if the additional meter is configured to use the same calibration options.
To view the current calibration, push  , select View Probe Data, then select View Current Calibration.
If any two probes are connected, push the UP or DOWN arrow to change to the single display mode in order to show the Calibrate option.
If a rugged probe, remove the shroud from the probe (refer to Remove the shroud on page 8).

Calibration notes:

- Do not touch the tip of the probe.
- Additional conductivity standards can be selected in the Calibration Options menu.
- The cell constant is derived from the calibration standard.
- Do not dilute conductivity standards and samples.

- The meter will automatically correct the calibration measurement to the selected reference temperature (20 or 25 °C) using the default NaCl-based, non-linear temperature coefficient. Settings can be changed in the CDC401 Calibration Options menu.
- The calibration is recorded in the probe and the data log. The calibration is also sent to a PC, printer or flash memory stick if connected.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a calibration error occurs, refer to [Troubleshooting](#) on page 9.

Calibration procedure:



1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn on the meter.



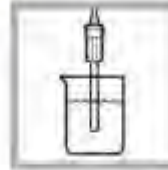
2. Push **Calibrate**. The display shows the conductivity standard solution that is necessary for calibration.



3. Add fresh conductivity standard solution to a beaker or an appropriate container.



4. Rinse the probe with deionized water. Blot dry with a lint-free cloth.



5. Put the probe in the standard solution and stir gently. Make sure that the temperature sensor is completely submerged.



6. Push **Read**. Stir gently. The display will show "Stabilizing" and a progress bar as the probe stabilizes in the standard. The display shows the standard solution value that has just been read and shows the temperature corrected value when the reading is stable.



7. Push **Done** to view the calibration summary.



8. Push **Store** to accept the calibration and return to the measurement mode. If a rugged probe, install the shroud on the probe (refer to [Install the shroud](#) on page 9).

Sample measurement

Before measurement:

The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached.

If complete traceability is necessary, enter a sample ID and operator ID before measurement. Refer to the HQD meter manual for more information.

To display other parameters (TDS, salinity or resistivity), push \leftarrow , select CDC401 Settings and then Current Method.

When using the CDC401 probe with the LDO101 probe to do auto salinity correction, set the CDC401 probe to measure salinity. Refer to Change measurement options on page 6.

Regular calibration is required for the best measurement accuracy (refer to Calibration on page 2).

If a rugged probe, make sure that the shroud is installed. Damage to the sensing elements can occur if the shroud is not installed during field use. Damage under these conditions is not covered by the product warranty.

To deploy a rugged probe at a distance, toss the probe body with a gentle underhand throw. Do not swing the probe by the cable as this may cause injury to the user, will cause severe strain on the cable and will shorten the service life of the probe.

Measurement notes:

- Do not touch the tip of the probe.
- Stabilization times with smaller concentration changes generally will be longer and can be minimized by correct stirring and conditioning. Experiment to determine the correct stir rate if necessary.
- Data is automatically stored in the data log when **Press to Read** or **Interval** is selected in the Measurement Mode. When **Continuous** is selected, data will only be stored when **Store** is selected.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a measurement error occurs, refer to [Troubleshooting](#) on page 9.

Measurement procedure:

Note: Procedure also applies for rugged model probes.



1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn on the meter.



2. Rinse the probe with deionized water. Blot dry with a lint-free cloth.



3. Put the probe into the sample so that the temperature sensor is completely submerged. Do not put the probe on the bottom or sides of the container.



4. Push **Read**. The display will show "Stabilizing" and a progress bar as the probe stabilizes in the sample. The display will show the lock icon when the reading stabilizes. The measurement is automatically corrected to the selected reference temperature (20 or 25 °C).



5. Repeat steps 2 - 4 for additional measurements. When measurements are done, store the probe (refer to [Storage](#) on page 9).

Run a check standard

The run check standard feature validates instrument performance between sample measurements. Use the run check standard feature for periodic or user-defined interval measurements of a traceable standard solution. Set the criteria for check standards from the CDC401 Settings menu.

Note: Access control must be off or a valid password must be entered before any of the check standard method options can be changed.

1. Push **☰**. The Full Access Options menu is shown.
2. Select Run Check Standard.
Note: Select the correct probe if two probes are connected to the meter.
3. Get the standard solution shown on the display.
4. Rinse the probe with deionized water. Blot dry with a lint-free cloth.
5. Put the probe in the standard solution until the temperature sensor is completely submerged. Move the probe up or down or gently tap on the beaker to remove air bubbles from the probe.
6. Push **Read**. The display will show "Stabilizing" and a progress bar as the reading stabilizes. The display shows the value of the check standard and either Check Standard Passed or Check Standard Failed.
7. If the display shows **Check Standard Passed**, the check standard measurement is within the accepted limits set by the administrative user. Select **Done** to continue with the sample measurement.
8. If the display shows **Check Standard Failed**, the measurement is outside of accepted limits set by the administrative user and a recalibration is recommended. If the acceptance criteria is set to Cal Expires on Failure: Yes, the display shows the calibration icon and a question mark until the probe is recalibrated. To correct the probe calibration and status indicator, calibrate the probe (refer to Calibration on page 2).

Advanced operation

Parameter-specific settings can be changed through the Full Access Options menu. Details about menu navigation, available options and how to change them are given in the screens, tables and procedures throughout this section.



The settings that can be changed are shown in Table 1.

Table 1 Parameter-specific settings

Setting	Options
Parameter	<ul style="list-style-type: none"> • Conductivity • Salinity • TDS • Resistivity
Measurement Options	<ul style="list-style-type: none"> • Units - Measurement limits • Temperature correction • Correction factor (if linear temperature correction is selected) • Reference temperature (if a temperature correction is selected)

Table 1 Parameter-specific settings (continued)

Setting	Options
Calibration Options	<ul style="list-style-type: none"> • Standard • Calibration reminder • Standard units (if Custom option is selected) • Standard value (if Custom option is selected) • Reference temperature (if Custom option is selected) • Temperature correction (if Custom option is selected)
Check Standards Options	<ul style="list-style-type: none"> • Standard solution for calibration verification • Reminder • Acceptance criteria

Change measurement options

Methods are groups of default or user-defined settings relevant to specific applications. If the meter is set to the default method and the Modify Current Settings option is chosen, a prompt for a new name is shown after the changes are entered. The settings are saved with this name to distinguish them from the default method settings, which cannot be changed. A saved method can be used instead of multiple adjustments to the individual settings. Changes made to a user defined method are automatically saved with the existing name. Multiple methods can be saved for the same probe on each meter.

Table 2 lists the five default methods available for the CDC401 conductivity cell.

Table 2 Default methods

Options	Description
Hach Conductivity	Default method with conductivity measurement values. Conductivity is typically used for natural water samples.
Hach TDS	Default method with TDS measurement values. TDS is typically used to estimate the amount of total dissolved solids in the sample. The conductivity value is also shown in the Detailed Reading screen.
Hach Salinity	Default method with salinity measurement values. Salinity is typically used for samples with a high salt content, such as sea water. The conductivity value will also be shown in the Detailed Reading screen.
Hach Resistivity	Default method with resistivity measurement values. Resistivity is typically used for ultra pure water applications.
Default	

1. Make sure a probe is connected to the meter.
2. Push $\left[\right]$ and select CDC401 Settings.
3. Select Modify Current Settings.
4. Select Parameter to change the parameter that is shown in the display.
5. Select Measurement Options and update the settings:

Option	Description
Units—Conductivity	Sets the units for conductivity—Auto (default), $\mu\text{S}/\text{cm}$ or mS/cm . When Auto is selected, the units will automatically change to mS/cm when the sample conductivity is high and $\mu\text{S}/\text{cm}$ when the conductivity is low. Select $\mu\text{S}/\text{cm}$ or mS/cm to always show the same units.
Units—Salinity	Sets the units for salinity—‰ (default), g/kg , <unitless> or ppt (parts per thousand).

Option	Description
Measurement Limits	<p>Sets the measurement limits—Lower limit (default: 0.01 µS/cm; 0 %) or Upper limit (default: 400000.00 µS/cm; 42 %).</p> <p>The measurement limits can be set to match the acceptable values for the sample. When the measurement is above the upper limit setting or below the lower limit setting, the meter shows an "Out of limits" message. This message is an alert to a potential problem with the process conditions.</p>
Temperature Correction	<p>Sets the temperature correction—None, Linear, NaCl non-linear (default) or Natural Water.</p> <p>The conductivity of a sample changes when the temperature changes. Temperature correction shows the conductivity at the user-selected reference temperature. Temperature correction can be changed or turned off when the parameter is set to conductivity, TDS or resistivity.</p>
Correction Factor	<p>When the temperature correction is set to linear, this sets a correction factor based on the sample type—% per °C (default: 1.90% per °C). The correction factor may need to be identified experimentally. For example, the factor for ultrapure water is 4.55% per °C and the factor for NaCl salt solution 2.125% per °C.</p>
Reference Temperature	<p>When the parameter is set to conductivity, TDS or resistivity, sets the reference temperature for temperature correction—20 °C or 25 °C (default).</p>
TDS Form	<p>When the parameter is set to TDS, sets the conversion factor from conductivity to total dissolved solids—NaCl (default, factor 0.5) or Custom.</p> <p>To change the factor, select Custom and enter the conversion factor and temperature correction information.</p> <p>Note: Labels and options may vary depending on the units selected.</p>

- If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
- Push **EXIT** until the meter returns to the measurement mode.

Change calibration options

- Make sure a probe is connected to the meter.
- Push **↵** and select CDC401 Settings.
- Select Modify Current Settings.
- Select Calibration Options and update the settings:

Option	Description
Standard	<p>Sets the conductivity calibration standard—</p> <ul style="list-style-type: none"> • 1 D KCl, 111.3 mS/cm, 25 °C • 0.1 D KCl, 12.85 mS/cm, 25 °C • 0.01 D KCl, 1408 µS/cm, 25 °C • 0.1 M KCl, 12.88 mS/cm, 25 °C • 0.01 M KCl, 1413 µS/cm, 25 °C • 0.001 M KCl, 146.93 µS/cm, 25 °C • NaCl, 18 mS/cm, 25 °C • NaCl, 1000 µS/cm, 25 °C • NaCl, 25 µS/cm, 25 °C • NaCl, 0.05%, 1015 µS/cm, 25 °C • Seawater (S=35) • Custom

Option	Description
Standard Units	When Standard is set to Custom, sets the units for the custom calibration standard.
Standard Value	When Standard is set to Custom, sets the values for the custom calibration standard.
Reference Temperature	When Standard is set to Custom, sets the reference temperature for the custom calibration standard.
Temperature Correction	When Standard is set to Custom, sets the temperature correction for the custom calibration standard.

5. Select Calibration Reminder and update the settings:

Option	Description
Reminder Repeat	Meter will make an audible sound when calibration is due and repeat the sound at selected interval—Off, 2 h, 4 h, 8 h, 2 d, 5 d or 7 d.
Expires	Calibration expires after the selected time—Immediately, Reminder + 30 min, Reminder + 1 h, Reminder + 2 h or Continue Reading. <i>Note: The meter cannot be used to read samples after calibration has expired unless Continue Reading is selected.</i>

- If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
- Push **EXIT** until the meter returns to the measurement mode.

Maintenance

Clean the probe

Clean the probe when:

- Drifting/inaccurate readings or slow stabilization time occurs as a result of mineral or sample buildup on the electrodes.
- The slope is out of range as a result of mineral or sample buildup on the electrodes.

Before a rugged probe can be cleaned, the shroud must be removed (refer to [Remove the shroud](#) on page 8). Install the shroud after the probe is clean (refer to [Install the shroud](#) on page 9).

For general contaminants:

1. Rinse the probe with deionized water and blot dry with a lint-free cloth.

For greases and oils:

1. Soak the glass bulb in a warm detergent solution for up to 2 hours.
2. Rinse or soak the probe for 1 minute in deionized water.
3. Blot dry with a lint-free cloth.

For mineral buildup:

1. Soak the probe in a dilute 10% hydrochloric acid (HCl) solution for no more than 5 minutes.
2. Rinse or soak the probe for 1 minute in deionized water.
3. Blot dry with a lint-free cloth.

Remove the shroud

1. Loosen and remove the locking ring.
2. Slide the shroud and locking ring off the probe.

Install the shroud

1. Put the locking ring on the probe with the threads toward the probe.
2. Slide the shroud on the probe until it is against the locking groove.
3. Hand-tighten the locking ring on the shroud.

Storage

Between uses, make sure the probe is dry and store it in ambient conditions. Rugged probes may be stored with the shroud installed if the storage container is sufficiently large.

Troubleshooting

Message or symptom	Possible cause	Action
Probe not supported	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website. Refer to the HQd Series meter manual for specific instructions for the meter model.
	HQd meter does not support IntelliCAL [®] probe	Contact a Technical Support Representative.
Connect a probe or probe requires service	Probe not connected correctly	Disconnect, then connect the probe. Tighten the locking nut.
	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website. Refer to the HQd Series meter manual.
	Large number of methods stored on the probe	Continue to let probe connect. Do not disconnect the probe.
	Damaged probe	Make sure there is connectivity with another probe or meter to confirm isolated issue with probe. Contact a Technical Support Representative.
Slow stabilization time	Mineral or sample buildup on electrodes	Clean the probe (refer to Clean the probe on page 8).
	Bubbles trapped under probe tip	Make sure that the sample concentration and temperature are both within the range of the CDC401 probe.
Out of range	Temperature and/or pressure sensor error	Make sure that the temperature and pressure sensors are both reading correctly.
	Damaged probe	Replace the conductivity probe or contact a Technical Support Representative.
	CO2 absorption in LIS/high purity samples	Replace the conductivity probe or contact a Technical Support Representative.
	Bubbles trapped under probe tip	Make sure that the sample concentration and temperature are both within the range of the CDC401 probe.

Message or symptom	Possible cause	Action
Drifting/Inaccurate readings	Incorrect settings	Measurement Options—Make sure that Temp Correction (Correction Factor if not set as NaCl) and reference temperature are both correct.
		Calibration Options—Make sure that Standard Value, Reference Temperature and Temp Correction are all correct.
	Mineral or sample buildup on cell	Clean the probe (refer to Clean the probe on page 8).
	CO2 absorption in LIS/high purity samples	Isolate LIS/high purity samples to prevent sample contamination.
Calibration failed - Out of limits/Out of range	Incorrect settings	Bubbles trapped under probe tip
		Gently shake the probe until bubbles are removed.
Calibration failed - Out of limits/Out of range	Incorrect settings	Measurement Options—Make sure that Temp Correction (Correction Factor if not set as NaCl) and reference temperature are both correct.
		Calibration Options—Make sure that Standard Value, Reference Temperature and Temp Correction are all correct.

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Figure 7: Hach pH Probe Manual

User Manual


DOC022.53.80023

Gel-filled pH Probe: Model PHC10101, PHC10103, PHC10105, PHC10110, PHC10115 or PHC10130

Safety information

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	<p>Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user.</p> <p>Note: For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.</p>
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Specifications

Note: Specifications are subject to change without notice.

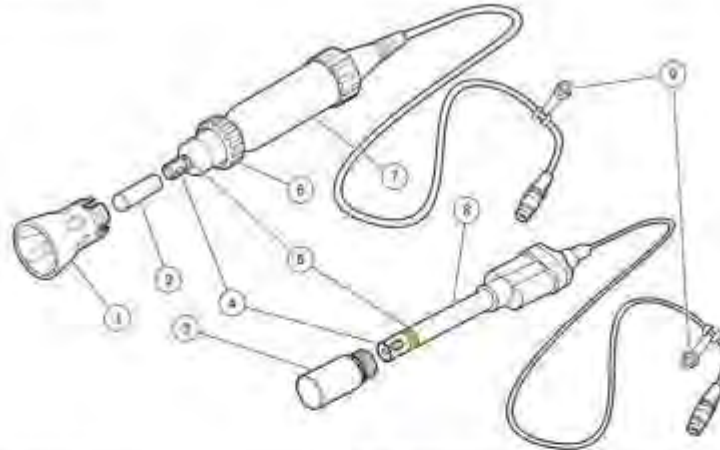
Specifications	Details
Probe type	Digital combination non-refillable, gel-filled probe with double junction reference and built-in temperature sensor
pH range	pH 2 to 14
pH resolution	User-selectable stabilization time and resolution—Fast: 0.1, Fast: 0.01, Medium: 0.01, Slow: 0.01 or Slow: 0.001
Slope	-50 mV/pH (80 to 110% at 25 °C (77 °F) per Nernstian theoretical value)
Operating temperature range	0 to 50 °C (32 to 122 °F)
Storage temperature range	5 to 40 °C (41 to 104 °F)
Junction	Open
Reference type	Ag/AgCl
Sodium (alkalinity) error	-0.6 pH at pH 12.8 in 1 M NaOH
Temperature accuracy	±0.3 °C (±0.54 °F)
Minimum sample depth	20 mm (0.79 in.)
Dimensions (standard)	Diameter: 12 mm (0.47 in.) Length: 175 mm (6.89 in.) Cable length: 1 or 3 m (3.28 or 9.84 ft)
Dimensions (rugged)	Diameter: 46 mm (1.81 in.) Length: 220 mm (8.73 in.) Cable length: 5, 10, 15 or 30 m (16.40, 32.81, 49.21 or 98.42 ft)
Cable connection	M12 digital output and connector compatible with HQd meters

Product overview

The PHC101 series probe is a non-refillable, gel-filled combination pH probe with a built-in temperature sensor (Figure 1). The standard PHC10101 or PHC10103 probe comes with a 1 or 3 m (3.28 or 9.84 ft) cable and is intended for laboratory use. The rugged PHC10105, PHC10110, PHC10115 or PHC10130 comes with a 5, 10, 15 or 30 m (16.40,

32.81, 49.21 or 98.42 ft) cable and is intended for field use. The probe provides pH measurement in wastewater, drinking water and general aqueous applications. The probe is not suitable for use with organic solvents or samples with pH less than 2.

Figure 1 Probe overview



1 Shroud (rugged model)	6 Locking ring (rugged model)
2 Probe storage cap	7 Rugged probe (5, 10, 15 or 30 meter cable)
3 Probe soaker bottle	8 Standard probe (1 or 3 meter cable)
4 Glass bulb and temperature sensor	9 Probe storage cap or soaker bottle holder
5 Reference junctions and protective tape	

Preparation for use

To prepare the probe for initial use:

1. If a rugged probe, remove the shroud and probe storage cap (refer to [Remove the shroud](#) on page 10).
2. If a standard probe, turn the probe soaker bottle cap counter-clockwise to loosen the cap. Remove the soaker bottle from the probe.
3. Remove the protective tape from the reference junctions (refer to [Figure 1](#) on page 2). Dispose of the protective tape.
4. If the probe will be used immediately, prepare the probe for calibration or sample measurement.
5. If the probe will not be used immediately, store the probe (refer to [Storage](#) on page 10).

To prepare the probe for calibration or sample measurement:


1. If a rugged probe, remove the probe storage cap.
2. If a standard probe, turn the probe soaker bottle cap counter-clockwise to loosen the cap. Remove the soaker bottle from the probe.
3. Rinse the reference junctions and glass bulb thoroughly with deionized water to remove the 3 M KCl solution completely. Blot dry with a lint-free cloth.
4. For the best stabilization time, condition the probe for several minutes in the sample before use.
5. If a rugged probe, make sure that the shroud is installed before field use (refer to [Install the shroud](#) on page 10).

Note: Damage to the sensing elements can occur if the shroud is not installed during field use. Damage under these conditions is not covered by the product warranty.

Calibration

Before calibration:

The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached. It is not necessary to recalibrate when moving a calibrated probe from one HQd meter to another if the additional meter is configured to use the same calibration options.

To view the current calibration, push , select View Probe Data, then select View Current Calibration.

If any two probes are connected, push the **UP** or **DOWN** arrow to change to the single display mode in order to show the Calibrate option.

Prepare the probe for use (refer to Preparation for use on page 2).

If a rugged probe, remove the shroud from the probe (refer to Remove the shroud on page 10).

Calibration notes:

- pH buffers can be used in any order. Use buffers that are two pH units apart.
- Additional standard sets along with the minimum number of calibration points can be selected in the Calibration Options. For a two point calibration, it is recommended that two buffers be selected: one with a pH above and one with a pH below the expected sample pH. For a one point calibration, select the buffer nearest to the expected sample pH.
- The calibration is recorded in the probe and the data log. The calibration is also sent to a PC, printer or flash memory stick if connected.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a calibration error occurs, refer to Troubleshooting on page 10.

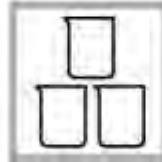
Calibration procedure:



1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn on the meter.



2. Push **Calibrate**. The display shows the buffers that are necessary for calibration.



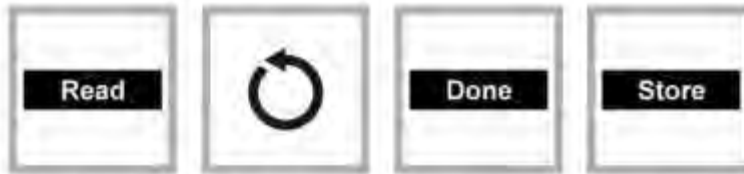
3. Prepare the fresh buffers in separate beakers or appropriate containers.



4. Rinse the probe with deionized water. Blot dry with a lint-free cloth.



5. Put the probe in the pH buffer solution and stir gently. Make sure that the reference junctions are completely submerged. Shake the probe from side to side in the standard solution to refresh the reference junction.



6. Push Read. Stir gently. The display will show "Stabilizing" and a progress bar as the probe stabilizes in the standard. The display shows the buffer that has just been read and shows the temperature corrected pH value when the reading is stable.

7. Repeat steps 4 - 6 until the minimum number of calibration points specified in the current method have been collected.

8. Push Done to view the calibration summary. The display will not show Done until the minimum number of calibration points have been collected.

9. Push Store to accept the calibration and go back to measurement mode. If a rugged probe, install the shroud on the probe (refer to install the shroud on page 10).

Sample measurement

Before measurement:

The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached.

If complete traceability is necessary, enter a sample ID and operator ID before measurement. Refer to the HQd meter manual for more information.

Regular calibration is required for the best measurement accuracy (refer to Calibration on page 3).

Prepare the probe for use (refer to Preparation for use on page 2).

To deploy a rugged probe at a distance, toss the probe body with a gentle underhand throw. Do not swing the probe by the cable as this may cause injury to the user, will cause severe strain on the cable and will shorten the service life of the probe.

Measurement notes:

- Data is automatically stored in the data log when **Press to Read** or **Interval** is selected in the Measurement Mode. When **Continuous** is selected, data will only be stored when **Store** is selected.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a measurement error occurs, refer to **Troubleshooting** on page 10.

Measurement procedure:

Note: Procedure also applies for rugged model probes.



1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn the meter on.

2. For the best stabilization time, condition the probe for several minutes in the sample or in a solution comparable to the sample in terms of pH and ionic strength before the initial sample measurement.

3. Rinse the probe with deionized water, then with the sample. Blot dry with a lint-free cloth.

4. Put the probe in the sample and stir gently. Make sure that the reference junctions are completely submerged. Do not put the probe on the bottom or sides of the container. Shake the probe from side to side in the sample to refresh the reference junction.

5. Push Read. The display will show "Stabilizing" and a progress bar as the probe stabilizes in the sample. The display will show the lock icon when the reading stabilizes.



6. Repeat steps 3-5 for additional measurements.




7. When measurements are done, store the probe (refer to Storage on page 10).

Run a check standard

The run check standard feature validates instrument performance between sample measurements. Use the run check standard feature for periodic or user-defined interval measurements of a traceable standard solution. Set the criteria for check standards from the PHC-101 Settings menu.

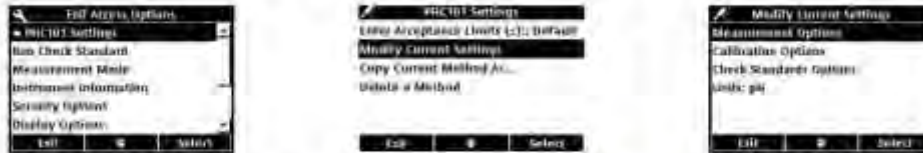
Note: Access control must be off or a valid password must be entered before any of the check standard method options can be changed.

- 1.** Push . The Full Access Options menu is shown.
- 2.** Select Run Check Standard.
Note: Select the correct probe if two probes are connected to the meter.
- 3.** Get the standard solution shown on the display.
- 4.** Rinse the probe with deionized water. Blot dry with a lint-free cloth.
- 5.** Put the probe in the standard solution until the temperature sensor is completely submerged. Move the probe up or down or gently tap on the beaker to remove air bubbles from the probe.
- 6.** Push **Read**. The display will show "Stabilizing" and a progress bar as the reading stabilizes. The display shows the value of the check standard and either Check Standard Passed or Check Standard Failed.

7. If the display shows **Check Standard Passed**, the check standard measurement is within the accepted limits set by the administrative user. Select **Done** to continue with the sample measurement.
8. If the display shows **Check Standard Failed**, the measurement is outside of accepted limits set by the administrative user and a recalibration is recommended. If the acceptance criteria is set to Cal Expires on Failure: Yes, the display shows the calibration icon and a question mark until the probe is recalibrated. To correct the probe calibration and status indicator, calibrate the probe (refer to [Calibration](#) on page 3)

Advanced operation

Parameter-specific settings can be changed through the Full Access Options menu. Details about menu navigation, available options and how to change them are given in the screens, tables and procedures throughout this section.



The settings that can be changed are shown in Table 1.

Table 1 Parameter-specific settings

Setting	Options
Measurement Options	<ul style="list-style-type: none"> • Resolution • Upper and lower range limits
Calibration Options	<ul style="list-style-type: none"> • Buffer set • Buffer set values (if Custom Buffer Set selected) • Reminder • Minimum Cal points • Slope limit
Check Standard Options	<ul style="list-style-type: none"> • Standard (temperature compensated buffer or custom at 25 °C) • Reminder • Acceptance criteria • Standard value at 25 °C (if custom standard selected)
Units	<ul style="list-style-type: none"> • pH • mV

Change measurement options

Methods are groups of default or user-defined settings relevant to specific applications. If the meter is set to the default method and the Modify Current Settings option is chosen, a prompt for a new name is shown after the changes are entered. The settings are saved with this name to distinguish them from the default method settings, which cannot be changed. A saved method can be used instead of multiple adjustments to the individual settings. Changes made to a user-defined method are automatically saved with the existing name. Multiple methods can be saved for the same probe on each meter.

1. Make sure a probe is connected to the meter.
2. Push $\left[\text{F} \right]$ and select PHC101 Settings.

3. Select Modify Current Settings.
4. Select Units. Select pH (default) or mV.
Note: The mV option can be used to find the probe offset in a pH 7 buffer or to measure the slope. Both units are shown when the detail display mode is selected.
5. Select Measurement Options and update the settings:

Option	Description
Resolution	<p>Sets the resolution:</p> <ul style="list-style-type: none"> • 0.1pH—Fast • 0.01pH—Fast (default) • 0.01pH—Medium • 0.01pH—Slow, or • 0.001pH—Slow <p>The resolution affects the number of decimal places and the stabilization time. Higher resolution measurements take more time to stabilize. Slower stabilization times provide higher accuracy measurements.</p>
Measurement Limits	<p>Set the measurement limits—Lower limit (default: 2.00 pH) or Upper limit (default: 14.00 pH).</p> <p>The measurement limits can be set to match the acceptable values for the sample. When the measurement is above the upper limit setting or below the lower limit setting, the meter shows an "Out of limits" message. This message is an alert to a potential problem with the process conditions.</p>

6. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
7. Push **EXIT** until the meter returns to the measurement mode.

Change calibration options

1. Make sure a probe is connected to the meter.
2. Push **↵** and select PHC101 Settings.
3. Select Modify Current Settings.
4. Select Calibration Options and update the settings:

Option	Description
Buffer Set	<p>Sets the temperature compensated buffer set used for calibration—</p> <ul style="list-style-type: none"> • Color Coded—4.01, 7.00, 10.01 (default) • IUPAC—4.01, 7.00, 10.01, 12.45 • DIN—4.65, 9.23 • IUPAC—4.01, 6.86, 10.01, 12.45 • IUPAC—4.01, 6.86, 9.18, 12.45 • IUPAC—4.01, 7.00, 9.18, 12.45 • Custom Buffer Set (refer to Table 2) <p>Custom buffer sets are characterized at 25 °C (77 °F). Buffer set values are shown on the Calibration Options screen. <i>Note: Only the minimum calibration points must be measured for DONE to be shown on the calibration screen.</i></p>
Buffer Set Values	<p>If the Buffer Set is set to Customer Buffer Set, sets the custom buffer set (refer to Table 2).</p>
Minimum Cal Points	<p>Sets the minimum number of calibration points necessary before a calibration can be completed—1 (default), 2 or 3.</p>
Slope Limit	<p>Sets the slope limit—1% to 10% (acceptable slope criteria, default = 5%). The slope must fall within set limits for successful calibration.</p>

5. Select Calibration Reminder and update the settings:

Option	Description
Reminder	Meter will make an audible sound when a calibration is due and repeat the sound at the selected interval—Off (default), 2 h, 4 h, 8 h, 2 d, 5 d or 7 d.
Repeat	
Expires	Calibration expires after the selected time—Immediately, Reminder + 30 min, Reminder + 1 h, Reminder + 2 h or Continue Reading. <i>Note: The meter cannot be used to read samples after calibration has expired unless Continue Reading is selected.</i>

6. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.

7. Push EXIT until the meter returns to the measurement mode.

Table 2 Custom buffer sets

Buffer set values	Option	Description
Std1	4.01pH—25 °C	Pre-set temperature compensated buffer values. <i>Note: Selected standards must differ by a minimum of 2 pH units. For example, if 4.09pH is chosen for the first standard, the second standard must differ by at least 2 pH. Standards that do not meet this minimum will appear gray on the screen and will not be selectable.</i>
Std2	4.85pH—25 °C	
Std3	6.86pH—25 °C	
Std4	7.00pH—25 °C	
Std5	9.18pH—25 °C	
	9.23pH—25 °C	
	10.01pH—25 °C	
	12.45pH—25 °C	
	Custom Buffer	Custom buffer value. Range = 2.000 pH to 14.000 pH. Custom buffer values are not temperature compensated. Custom buffers should be read at 25 °C.
	No Buffer	Standard is undefined when this option is selected.

Change check standard options

1. Make sure a probe is connected to the meter.
2. Push \leftarrow and select PHC101 Settings.
3. Select Modify Current Settings.

4. Select Check Standards Options and update the settings:

Option	Description
Standard	Sets the temperature compensated buffer value for check standard— <ul style="list-style-type: none"> • 4.01pH—25 °C • 4.65pH—25 °C • 6.86pH—25 °C • 7.00pH—25 °C • 9.16pH—25 °C • 9.23pH—25 °C • 10.01pH—25 °C • 12.45pH—25 °C • Custom The standard value is shown on the Check Standard Options screen. No temperature compensation for custom buffers.
Standard Value	When Standard is set to Custom, enter the standard value using the up/down arrow keys.

5. Select Check Standard Reminder and update the settings:

Option	Description
Reminder Repeat	Sets the time interval for the check standard reminder—Off, 30 minutes, 2 h, 4 h, 8 h, 12 h or 24 h.
Allow Defer	Allows the postponement of check standard reminders—Yes or No.

6. Select Acceptance Criteria and update the settings:

Option	Description
Acceptance Limits	Sets the tolerance limits for check standard—0.005pH (default) to 1.000pH
Cal Expires on Failure	Recalibration required if check standard fails—Yes or No.

7. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.

8. Push **EXIT** until the meter returns to the measurement mode.

Maintenance

Clean the probe

Clean the probe when:

- Drifting/inaccurate readings occur as a result of contamination on the glass sensor or the probe being left dry for extended periods of time.
- Slow stabilization time occurs as a result of contamination on the glass sensor.
- A calibration error occurs as a result of contamination on the glass sensor.

Before a rugged probe can be cleaned, the shroud must be removed (refer to [Remove the shroud](#) on page 10). Install the shroud after the probe is clean (refer to [Install the shroud](#) on page 10).

For general contaminants:

1. Rinse the probe with deionized water and blot dry with a lint-free cloth.
2. Soak the glass bulb for 12 to 16 hours in Hach Electrode Cleaning Solution.
3. Rinse or soak the probe for 1 minute in deionized water.
4. Soak the probe in pH 4 buffer for up to 20 minutes, then rinse with deionized water.
5. Blot dry with a lint-free cloth.

For fats, grease and oils:

1. Soak the glass bulb in a warm detergent solution for up to 2 hours.
2. Rinse or soak the probe for 1 minute in deionized water.
3. Soak the probe in pH 4 buffer for up to 20 minutes, then rinse with deionized water.
4. Blot dry with a lint-free cloth.

Remove the shroud

1. Loosen and remove the locking ring.
2. Slide the shroud and locking ring off the probe.

Install the shroud

1. Put the locking ring on the probe with the threads toward the probe.
2. Slide the shroud on the probe until it is against the locking groove.
3. Hand-tighten the locking ring on the shroud.

Storage

Short-term and long-term storage

For the best probe performance, do not let the reference junction dry out.

1. Rinse the probe with deionized water. Dry the probe with a lint-free cloth.
2. Fill the probe storage cap or soaker bottle half full with Hach Electrode Storage Solution or 3 M potassium chloride (KCl) solution.
3. If a rugged probe, put the probe storage cap on the probe.
4. If a standard probe, put the soaker bottle on the probe and tighten the soaker bottle cap.
5. Make sure that the solution in the storage cap or soaker bottle completely covers the glass bulb and reference junction.

Note: The probe can also be stored in a sample for up to 2 hours if the sample pH is not high.

If the glass bulb becomes dry:

1. Soak the probe tip in the 4.01, 7.00 and 10.01 buffers each for 5 minutes.
2. Rinse the probe with deionized water. Blot dry with a lint-free cloth.
3. Calibrate the probe.

Troubleshooting

Message or symptom	Possible cause	Action
Probe not supported	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website. Refer to the HqD Series meter manual for specific instructions for the meter model.
	HqD meter does not support IntelliCAL [®] probe	Contact a Technical Support Representative.

Message or symptom	Possible cause	Action
Connect a probe or probe requires service	Probe not connected properly	Disconnect, then connect the probe. Tighten the locking nut.
	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website Refer to the HQd Series meter manual.
	Large number of methods stored	Continue to let probe connect, Do not disconnect the probe.
	Damaged probe	Make sure there is connectivity with another probe or meter to confirm isolated issue with probe. Contact a Technical Support Representative.
Standard not recognized error	Tape not removed from the reference junctions	Remove the tape.
Standard not recognized error	Probe storage cap or soaker bottle not removed	Remove the probe storage cap or soaker bottle.
	Incorrect or contaminated buffer solution	Use fresh buffer solution as specified in the method.
pH reading and/or mV reading is same for all solutions	Tape not removed from the reference junctions	Remove the tape.
pH reading and/or mV reading is same for all solutions	Storage cap or soaker bottle not removed	Remove the storage cap or soaker bottle.
	Electrical issue	Contact a Technical Support Representative.
Slow stabilization time	Tape not removed from the reference junctions	Remove the tape.
Slow stabilization time	Contaminated glass sensor	Clean the probe (refer to Clean the probe on page 9).
	Poor contact between reference junction and solution	Shake the probe in the solution from side to side to re-forest the reference junction.
	Probe not prepared for sample	For the best stabilization time, soak the probe in the sample for 10 to 15 minutes before doing a sample measurement.
	Low sample temperature or temperature difference between samples	Check the sample temperature. The lower the temperature or the greater the difference of temperatures between samples, the longer the stabilization time will be.
	Air bubbles around inner reference electrode	Gently tap the probe with hand or shake the probe downward to remove any air bubbles.
Calibration errors	Calibration not done correctly	Recalibrate using freshly prepared pH buffers.
	Contaminated glass sensor	Clean the probe (refer to Clean the probe on page 9).
	Slope exceeds the criteria for % of theoretical (as defined in the method slope limit)	<ol style="list-style-type: none"> 1. Widen the slope limits by changing the PHC101 calibration settings and method. 2. Recalibrate the probe. 3. Run a check standard to check the performance of the probe.

Message or symptom	Possible cause	Action
Drifting/inaccurate readings	Contaminated glass sensor	Clean the probe (refer to Clean the probe on page 9).
	CO ₂ absorption (for low ionic strength or high purity sample)	Use the LIS chamber for LIS/high purity samples to keep sample contamination from occurring.
	Air bubbles around inner reference electrode	Rinse the reference junction holes with deionized water and then gently tap the probe with hand or shake the probe to remove any air bubbles.
	Incorrect storage conditions (discolored, contaminated or dried gel)	Clean or condition the probe and do recalibration. The probe may not operate correctly if the probe has been left dry for a long time. Condition the glass sensor and reference junctions again: <ol style="list-style-type: none"> 1. Soak the probe tip in the 4.01, 7.00 and 10.01 buffers each for 5 minutes 2. Rinse with deionized water. Blot dry with a lint-free cloth 3. Calibrate the probe
	Electromagnetic Forces (EMF) such as voltaic cells, thermoelectric devices, electrical generators, resistors and transformers.	Do not test in areas where EMF is present. For testing in process units (i.e. spot checking), make sure the equipment is grounded.
Out of range	Measurement value is outside of range	Make sure that the sample is within the range of the probe.
Temperature out of range	Temperature value is outside of range	Make sure that the sample temperature is within the range of the probe.
		Make sure that the temperature sensor is working correctly.
	Measured pH buffer temperature is outside range of the probe	Make sure that the standard temperature is within the range of the probe.
		Make sure that the temperature sensor is working correctly.
Check standard temperature value is outside of range	Make sure that the Check Standard temperature is within the range of the probe.	
Out of limits	Measurement value is outside of measurement limits set in the current method	Make sure that the sample is within the limits of the current method.
		Create a new method with expanded limits.
	Check standard value is outside of limits set in the current method	Make sure that the check standard is within the limits of the current method.
		Create another method that expands the acceptable limits.

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Figure 8: Hach Portable Turbidimeter Manual



DOC022.53.80041
2100Q and 2100Qis
 12/2017, Edition 4
User Manual



Specifications

Specifications are subject to change without notice.

Specification	Details
Measurement method	Ratio turbidimetric determination using a primary nephelometric light scatter signal (90°) to the transmitted light scatter signal.
Regulatory	2100Q: Meets EPA Method 180.1
Lamp source	2100Q: Tungsten filament lamp 2100Qis: Light-emitting diode (LED)
Range	0–1000 NTU (FNU)
Accuracy	±2% of reading plus stray light from 0–1000 NTU (FNU)
Repeatability	±1% of reading or 0.01 NTU (FNU), whichever is greater
Resolution	0.01 NTU on lowest range
Stray light	≤ 0.02 NTU (FNU)
Signal averaging	Selectable on or off
Detector	Silicon Photodiode
Reading modes	Normal (Push to Read), Signal Averaging or Rapidly Settling Turbidity™
Calibration options	Single step RapidCal™ for Low-Level Regulatory Reporting from 0–40 NTU (FNU) Full range calibration from 0–1000 NTU (FNU) Calibration to degrees of turbidity
Calibration logger	Records the last 25 successful calibrations
Verification logger	Logs the last 250 successful verifications
Data logger	500 records

Specification	Details
Power requirement	AC 100–240 V, 50/60 Hz (with power or USB/power module) 4 AA alkaline batteries Rechargeable NiMH (for use with USB/power module)
Operating conditions	Temperature: 0 to 50 °C (32 to 122 °F) Relative Humidity: 0–90% at 30 °C, 0–90% at 40 °C, 0–70% at 50 °C, noncondensing
Storage conditions	–40 to 60 °C (–40 to 140 °F), instrument only
Interface	Optional USB
Sample required	15 mL (0.5 oz.)
Sample cells	Round cells 60 x 26 mm (2.36 x 1 in.) borosilicate glass with screw caps
Dimensions	22.9 x 10.7 x 7.7 cm (9.0 x 4.2 x 3.0 in.)
Weight	530 g (1.17 lb) without batteries 620 g (1.37 lb) with four AA alkaline batteries
Meter enclosure rating	IP67 (closed lid, battery and module compartment excluded)
Protection class	Power supply: Class II
Certification	CE certified
Warranty	1 year (EU: 2 years)

General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

Safety information

NOTICE
The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

Use of hazard information

▲ DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

▲ WARNING
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

▲ CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE
Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. If on the instrument, refer to the instruction manual for operation or safety information.
	This symbol indicates that a risk of electrical shock and/or electrocution exists.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005, in conformity with European local and national regulations (EU Directive 2002/95/EC). European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user. Note: For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, products-sourced electronic accessories, and all auxiliary items for proper disposal.

Certification

Canadian Radio Interference-Causing Equipment Regulation, IECIS-003, Class A

Supporting test records reside with the manufacturer.
This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
Cet appareil numérique de classe A répond à toutes les exigences de la réglementation canadienne sur les équipements provoquant des interférences.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

4 English

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

Product overview

The 2100Q and 2100Qis portable turbidimeters measure turbidity from 0 to 1000 NTU (FNU). Primarily for field use, the portable meter operates on four AA batteries. Data can be stored and transferred to a printer, computer or USB storage device.

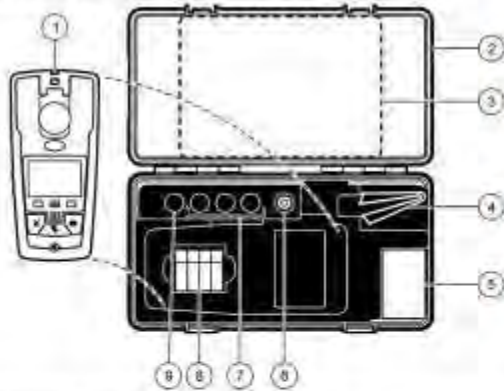
Figure 1 Product overview



Product components

Refer to Figure 2 to make sure that all components have been received. If any of these items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 2 2100Q and 2100QiS components



1 2100Q or 2100QiS turbidimeter	6 Silicone oil
2 Carrying case	7 20, 100 and 600 NTU StabCal calibration standards
3 User manual and Quick reference guide	8 AA alkaline batteries (pk4)
4 Cleaning cloth	9 StabCal 10 NTU verification standard
5 1" sample cell (10 mL) with cap (pk6)	

Installation

CAUTION

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

6 English

Install the battery

WARNING
Explosion hazard. An expired battery can cause hydrogen gas buildup inside the instrument. Replace the battery before it expires. Do not store the instrument for long periods with a battery installed.

WARNING
Potential fire hazard. Use only alkaline or nickel metal hydride batteries (NiMH) in the meter. Other battery types or incorrect installation can cause a fire. Never mix battery types in the meter.

NOTICE
The battery compartment is not waterproof. If the battery compartment becomes wet, remove and dry the batteries and dry the interior of the compartment. Check the battery contacts for corrosion and clean them if necessary.

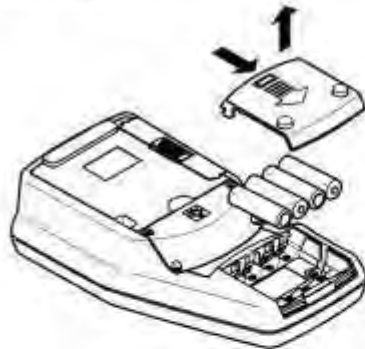
NOTICE
When using nickel metal hydride (NiMH) batteries, the battery icon will not indicate a full charge after freshly charged batteries have been inserted (NiMH batteries are 1.2 V versus 1.5 V for alkaline batteries). Even though the icon does not indicate complete charge, 2300 mAh NiMH batteries will achieve 90% of instrument operation lifetime (before recharge) versus new alkaline batteries.

NOTICE
To avoid potential damage to the meter from battery leakage, remove the meter batteries prior to extended periods of non-use.

The meter can be powered with AA alkaline or rechargeable NiMH batteries. To conserve battery life, the meter will power off after 10 minutes of inactivity, the backlight powers off after 30 seconds. This time can be changed in the Power Management menu.
 Note: Rechargeable batteries will only be recharged with the USB/power module. Refer to the module documentation for further information.
 For battery installation refer to Figure 3.

1. Remove the battery cover.
2. Install 4 AA alkaline or 4 AA nickel metal hydride (NiMH) batteries. Make sure that the batteries are installed in the correct orientation.
3. Replace the battery cover.

Figure 3 Battery installation



User interface and navigation

User interface

Figure 4 Keypad description



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): next 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	

English 7

Display description

The measurement screen shows the turbidity, unit, calibration status, date and time, operator ID (if setup) and sample ID (if setup). Refer to Figure 5.

Figure 5 - Single screen display



1 Operator identification	9 NTU (Nephelometric Turbidity Unit) or FTU (Formazin Turbidity Unit)
2 Sample identification	10 Reading mode: Rapidly Settling Turbidity (Target icon)
3 Stability or display lock indicator	11 Reading mode: Signal Average (X-bar icon)
4 Calibration status indicator (Calibration OK=pass)	12 Time
5 Calibration status indicator (Calibration ?=fail)	13 Date
6 Parameter file	14 Read (contextual: OK, Select)
7 AC power icon	15 Options (contextual)
8 Battery icon	16 Verification calibration

8 - English

1. Select a language from the list. Confirm with **OK**.
2. Push **Done** when the update is complete.

Change the date and time

The date and time can be changed from the Date & Time menu.

1. Push the **SETTINGS** key and select Date & Time.
2. Update the time and date information:

Option	Description
Format	Select one of the formats for the date and time: yyyy-mm-dd 24h yyyy-mm-dd 12h dd-mm-yyyy 24h dd-mm-yyyy 12h mm/dd/yyyy 24h mm/dd/yyyy 12h
Date	Enter the current date
Time	Enter the current time

The current date and time will be shown on the display.

After the date and time setup, the meter is ready to take a reading.

Standard operation

Use a sample ID

The sample ID tag is used to associate readings with a particular sample location. If assigned, stored data will include this ID.

1. Select **Sample ID** in the Settings menu.

Navigation

The meter contains a Settings menu, Reading Options menu, Calibration Options menu and Calibration Verification Options menu to change various options. Use the **UP** and **DOWN** keys to highlight different options. Push the **RIGHT** key to select an option. There are two ways to change options:

1. Select an option from a list: Use the **UP** and **DOWN** keys to select an option. If check boxes are shown, more than one option can be selected. Push the **LEFT** key under Select.
 Note: To deselect check boxes, push the **LEFT** key under Deselect.
2. Enter an option value using the arrow keys: Push the **UP** and **DOWN** keys to enter or change a value.
3. Push the **RIGHT** key to advance to the next space.
4. Push the **RIGHT** key under **OK** to accept the value.

Startup

Turn the meter on and off

Push the **ON/OFF** key to turn on or turn off the meter. If the meter does not turn on, make sure that the batteries, or the module, are properly installed or that the AC power supply is properly connected to an electrical outlet.

Note: The Auto-Shutoff option can also be used to turn off the meter. Refer to Power management on page 72.

Change the language

There are three options to set the language:

- The display language is selected when the meter is powered on for the first time.
- The display language is selected when the power key is pushed and held.
- The language can be changed from the Settings menu.

2. Select, create or delete a sample ID:

Option	Description
Current ID	Select an ID from a list. The current ID will be associated with sample data until a different ID is selected.
Create a New Sample ID	Enter a name for a new sample ID.
Delete Sample ID	Delete an existing sample ID.

Use an operator ID

The operator ID tag associates readings with an individual operator. All stored data will include this ID.

1. Select **Operator ID** in the Settings menu.
2. Select, create or delete an operator ID:

Option	Description
Current ID	Select an ID from a list. The current ID will be associated with sample data until a different ID is selected.
Create a New Operator ID	Enter a name for a new operator ID (maximum 10 names can be entered).
Delete Operator ID	Delete an existing operator ID.

Calibrate the turbidimeter with StabCal® Standards

Note: For best accuracy use the same sample cell or four matched sample cells for all readings during calibration. Insert the sample cell in the instrument cell.

compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.



1. Push the **CALIBRATION** key to enter the Calibration mode. Follow the instructions on the display.
Note: Gently invert each standard before inserting the standard.



2. Insert the 20 NTU StabCal Standard and close the lid.
Note: The standard to be inserted is bordered.



3. Push **Read**. The display shows. Stabilizing and then shows the result.



4. Repeat Step 2 and 3 with the 100 NTU and 500 NTU StabCal Standard.
Note: Push **Done** to complete a 2 point calibration.



5. Push **Done** to review the calibration details.



6. Push **Store** to save the results. After a calibration is complete, the meter automatically goes into the Verify Cal mode. Refer to Calibration verification (Verify Cal) on page 16.

Turbidity measurement

▲ WARNING

Potential explosion and fire hazard. This turbidimeter is designed for water based samples. Do not measure solvent or combustible based samples.

Readings can be taken with the Normal reading mode, Signal Average mode or in the Rapidly Settling Turbidity mode. Refer to Reading modes on page 17 for more information. For accurate turbidity readings use clean sample cells and remove air bubbles (degassing).

Measurement notes

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Use the following measurement notes for proper measurements.

Instrument

- Make sure that the meter is placed on a level, stationary surface during the measurement.
Note: Do not hold the meter in the hand during measurement.
- Always close the sample compartment lid during measurement, calibration and storage.
- Remove sample cell and batteries from the instrument if the instrument is stored for an extended time period (more than a month).
- Keep the sample compartment lid closed to prevent the entry of dust and dirt.

Sample cells

- Always cap the sample cell to prevent spillage of the sample into the instrument.
- Always use clean sample cells in good condition. Dirty, scratched or damaged cells can cause inaccurate readings.
- Make sure that cold samples do not "fog" the sample cell.
- Store sample cells filled with distilled or deionized water and cap tightly.

Measurement

10 English

- Measure samples immediately to prevent temperature changes and settling. Before a measurement is taken, always make sure that the sample is homogeneous throughout.
- Avoid sample dilution when possible.
- Avoid operation in direct sunlight.

Turbidity measurement procedure

Note: Before a measurement is taken, always make sure that the sample is homogeneous throughout.



1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL). Take care to handle the sample cell by the top. Cap the cell.



2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.



3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface. (Apply silicone oil to a sample cell on page 17).



4. Push the **Power** key to turn the meter on. Place the instrument on a flat, steady surface.
Note: Do not hold the instrument while making measurements.



5. Gently invert and then insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. Close the lid.



6. Push **Read**. The display shows. Stabilizing then the turbidity in NTU (FNU). The result is shown and stored automatically. Additional information is available on the manufacturer's website.

Data management

About stored data

The following types of data are stored in the data log:

- Reading Log: stores automatically each time a sample reading is taken (500 records).
- Calibration Log: stores only when **Store** is selected at the end of a calibration (25 records).
- Verify Cal Log: stores only after **Done** is selected at the end of a verification calibration (250 records).

When the data log becomes full, the oldest data point is deleted when more data is added to the log.

View data log

The data log contains Reading Log, Calibration Log and Verify Cal log. All logs can be sorted by date.

1. Push the **DATA MANAGEMENT** key.
2. Select View Data Log to view the stored data.
3. Push **Select** to view additional information.

Option	Description
Reading Log	Reading Log—shows the date, time and reading mode and associated calibration data.
Calibration Log	Calibration Log—shows the date and time of calibration data and additional information about the calibration.
Verify Cal Log	Verify Cal Log—shows the calibration verification date and time and additional information about the verification.
All Logs by Date	The most recent data and additional information is shown. The icons show whether the data is from a reading, calibration or calibration verification and identifies the reading mode, if applicable.

Delete data log

There are two possibilities to delete stored readings in the Data Management menu:

1. Push the **DATA MANAGEMENT** key and select Delete Data Log.

Option	Description
Delete Last Reading	Only the last reading stored can be deleted until a new reading is taken and stored.
Delete All Logs	The entire Reading Log can be deleted at once.

Send stored data

Data can be stored and transferred to a printer, computer or USB storage device. The data will be formatted as an XML file. Install the USB/power module to the meter and to AC power. Refer to the module documentation for more information.

Advanced operation

Display contrast

1. Push the **SETTINGS** key and select Display Contrast.
2. Use the **UP** and **DOWN** key to adjust the contrast of the display and push **OK**.

Power management

Use power management to change the backlight option and the battery saving auto-shutoff option.

Note: Power management is not active when the meter is connected to AC power.

1. Push the **SETTINGS** key and select Power Management.
2. Select which display option to change.

Option	Description
Backlight	The display is illuminated. To maximize battery life, select a time period after which the backlight will automatically power off if no key is pushed: 10 s, 20 s, 30 s, 1 min, 2 min, 5 min. Note: The Backlight key (Figure 4 on page 5) will turn the backlight on and off.
Auto-Shutoff	To maximize battery life, set a time period after which the meter will automatically power off if no key is pushed: 1 min, 2 min, 5 min, 10 min, 30 min, 1 h.

12 English

Set the sound options

The meter can make an audible sound when a key is pushed, when a reading is complete or when the calibration reminder is due.

1. Push **SETTINGS** and select Sounds.
2. Select which events will produce an audible sound. Multiple items can be selected.

Option	Description
Key Press	The meter will make an audible sound whenever a key is pushed.
Reading complete	The meter will make an audible sound whenever a reading is completed.
Reminders	The meter will make an audible sound when a calibration is due.

Security options

The Security Options menu is used to protect the meter setup.

The Setup Date and Time, Delete Data Log, Restoring Factory Defaults and Restore Factory Cal screens are not accessible without a password.

Store the password in a safe and accessible place. If the specified password is forgotten and Security Options is turned on, the operator is locked out of the restricted menus. Contact technical support if the password is lost.

Turn security options on

The security options and the set password options are used together to prevent access to restricted menus:

1. Push the **SETTINGS** key and select Security Options.
2. Select Edit Password and use the **UP** and **DOWN** keys to set a password.
3. Select Security On to enable the password setting. The requirement for the password entry is controlled by setting Security Options on or off.

Note: Set the Security to Off to disable the password setting.

4. Push the **ON/OFF** key to turn off and on the meter to activate the password settings.

View meter information

The instrument information menu shows specific information such as the meter name, model number, software version, serial number and available Operator and Sample IDs. 10 Operator IDs and 100 Sample IDs are available.

1. Push the **SETTINGS** key and select Meter Information.

Calibration

The portable turbidimeter is calibrated with Formazin Primary Standards at the factory. The meter should be calibrated upon receipt for best results. The manufacturer recommends calibration with a primary standard such as StabiCal® Stabilized Standards or with formazin standards every three months.

Note: Set *Cal Reminder Repeat* in the Calibration Options menu for periodic calibration. Verify the calibration once a week.

Calibration options

The calibration options contain Calibration History, Calibration Curves, Cal Reminder Repeat and Restore Factory Calibration.

1. Push the **CALIBRATION** key and then the **UP** and **DOWN** key.

Option	Description
Calibration History	The calibration history shows a list of the times when the meter was calibrated. Select a date and time to view a summary of the calibration data.

English 13

Option	Description
Cal Curve	Select one of the calibration curves for calibration: StabiCal® RapidCal™ (0–40 NTU) StabiCal® (0–1000 NTU) Formazin RapidCal™ (0–40 NTU) Formazin (0–1000 NTU) Degrees (0–100 mg/L) SDVB (0–1000 NTU) Custom (0–1000 NTU)
Cal Reminder Repeat	The meter will make an audible sound when calibration is due. Select one of the following options for time interval and push OK: Off, 1 d, 7 d, 30 d, 60 d, 90 d
Restore Factory Calibration	All user calibrations will be deleted. The original factory calibration is restored.

Table 1 Calibration overview (continued)

Type of calibration	Required standards
SDVB (0–1000 NTU)	Typically deionized or distilled water ¹ 20 NTU 100 NTU 800 NTU
Custom (0–1000 NTU)	Typically deionized or distilled water ¹ Select values

Calibration standard overview

Refer to Table 1 for the calibration standard overview.

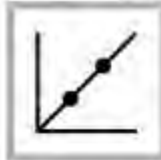
Table 1 Calibration overview

Type of calibration	Required standards
StabiCal® RapidCal™ (0–40 NTU)	– 20 NTU – –
StabiCal® (0–1000 NTU)	– 20 NTU 100 NTU 800 NTU
Formazin RapidCal™ (0–40 NTU)	Typically deionized or distilled water ¹ 20 NTU – –
Formazin (0–1000 NTU)	Typically deionized or distilled water ¹ 20 NTU 100 NTU 800 NTU
Degrees (0–100 mg/L)	Typically deionized or distilled water ¹ 20 NTU 100 NTU –

¹ The water must have a turbidity <0.5 NTU to prepare the calibration standards.

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StabiCal® RapidCal™ calibration



1. Push the **CALIBRATION** key to enter the Calibration mode. Follow the instructions on the display.
Note: Gently invert each standard before inserting the standard.



2. Push the **UP** and **DOWN** key to access Cal Options and then select Cal Curve.



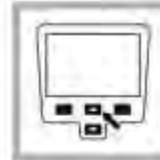
3. Select StabiCal® RapidCal™ from the list and push **OK**.



4. Insert the 20 NTU StabiCal Standard and close the lid.
Note: The standard to be inserted is bordered.



5. Push **Read**. The display shows Stabilizing and then shows the result.



6. Push **Done** to review the calibration details.



7. Push **Store** to save the results.
After a calibration is complete, the meter automatically goes into the Verify Cal mode, refer to Calibration Verification (Verify Cal) on page 15.

English 15

Verification options

The Verification Options contain: Set Verification Standard, Set Acceptance Criteria and Verification Reminder.

1. Push the **Left** key (Verify Cal) and then the **UP** and **DOWN** keys.

Option	Description
Set Verification Standard	To change the verification standard use the UP and DOWN keys to enter a new standard value. Range 0.50–20.0 NTU (Default setting: 10.00 NTU) Range 0–20 NTU for RapidCal™ (0–40 NTU) 0–500 NTU for calibration curves with a range from 0–1000 NTU
Set Acceptance Criteria	Enter the Acceptance Criteria for comparison against the initial calibration verification reading to determine passing or failing. Range 1–50% (Default setting: 10%)
Verification Reminder	Verification Reminder—The meter will make an audible sound when verification is due. Select one of the following options for time interval and push OK/Off : 30 min (Default setting), 2 h, 4 h, 8 h, 24 h. Allow Defer—Push Allow Defer and select Yes or No to postpone the verification due time

Calibration verification (Verify Cal)

The manufacturer recommends a calibration verification once a week. After a calibration is complete, the meter automatically goes into the Verify Cal mode.

Make sure that the sample cell is clean. Oil the sample cell with silicone oil; refer to *Apply silicone oil to a sample cell* on page 17. Check the

standard solution. Prepare a lomrazin standard at the same value and read the value.



1. Push **Verify Cal** to enter the Verify menu.



2. Gently invert the standard. Insert the 10.0 NTU (or other defined value) Verification Standard and close the lid.



3. Push **Read**. The display shows **Stabilizing** and then shows the result and tolerance range.



4. Push **Done** to return to the reading display. Repeat the calibration verification if the verification failed.

Reading modes

- Push the **UP** or **DOWN** key to enter the Reading Options menu.
- Select Reading Mode to select one of the following options:

Option	Description
Normal (Default setting)	The normal mode reads and averages three readings. The result is shown after the reading.
Signal Average 	The Signal Average mode compensates for reading fluctuations caused by drifting of sample particles through the light path. The X-bar icon is shown on the display when signal averaging is on. The Signal Average mode measures 12 times and starts to show the average after three readings. The final result is the average of all 12 readings.
Rapidly Settling Turbidity™ (RST) 	The Rapidly Settling Turbidity (RST) mode calculates and continuously updates the turbidity reading of the sample to a confidence of 95% based on the accumulated trend of the real time measured values. The RST mode is best used on samples that settle rapidly and continuously change in value. The reading is based on a correctly prepared sample that is homogeneous at the beginning of the reading. It is best applied to samples that are greater than 20 NTU. The sample must be mixed thoroughly by inversion immediately before inserting it into the meter. The target icon is shown on the display when the Rapidly Settling Turbidity is on. The Rapidly Settling Turbidity reads and calculates live readings while showing intermediate results.

Apply silicone oil to a sample cell

Sample cells and caps must be extremely clean and free from significant scratches. Apply a thin coating of silicone oil on the outside of the sample cells to mask minor imperfections and scratches that may contribute to light scattering.

Note: Use only the provided silicone oil. This silicone oil has the same refractive index as the sample cell glass.



1. Clean the inside and outside of the cell and caps by washing with a laboratory glass cleaning detergent. Follow with multiple rinses with distilled or demineralized water.



2. Apply a small bead of silicone oil from the top to the bottom of the cell.



3. Use the provided oiling cloth to spread the oil uniformly. Wipe off the excess so that only a thin coat of oil is left. Make sure that the sample cell is almost dry with little or no visible oil.
Note: Store the oiling cloth in a plastic storage bag to keep the cloth clean.

Indexing a single cell

Precise measurements for very low turbidity samples require the use of a single cell for all measurements or optically matching the cells. Use one cell to provide the best precision and repeatability. When one cell is used, an index or orientation mark (other than the factory-placed diamond) can be placed on the cell so it is inserted into the instrument with the same orientation each time.

When using a single cell, make an index or orientation mark on the cell as follows:

1. Fill the clean sample cell to the line with high quality water ($\leq 0.5\text{ NTU}$) and cap immediately. Let the sample cell degas for at least five minutes.
2. Wipe with lint-free cloth. Apply a thin film of silicone oil (Apply silicone oil to a sample cell on page 17).
3. Push the **POWER** key to turn the meter on. Place the instrument on a flat, sturdy surface. **Note:** Do not hold the instrument while making measurement.
4. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark always aligns with the raised orientation mark in front of the cell compartment. Close the lid.
5. Push the **UP** and **DOWN** key to access the Reading Options and then select Indexing Sample Cell. **Note:** The instrument always stays in the last selected reading mode.
6. Push **Read**. The display shows Stabilizing then the turbidity in NTU. Record the cell position in the cell compartment and the reading result.
7. Remove the cell, rotate it slightly approximately $\frac{1}{4}$ of a turn and insert it again into the cell compartment. Close the lid.
8. Push **Read**. Record the cell position in the cell compartment and the reading result.
9. Repeat step 6 until the lowest reading is shown. Place an orientation mark on the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading.

18 English

Maintenance

CAUTION

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

Clean the meter

The meter is designed to be maintenance-free and does not require regular cleaning for normal operation. Exterior surfaces of the meter may be cleaned as necessary.
Note: Do not clean the meter with solvents to avoid damaging the material.

1. Clean the meter with a dust- and lint-free dry or slightly damp cloth. A mild soap solution can also be used for liposoluble contamination.

Store the sample cells

NOTICE

Do not air dry the sample cells.

Note: Always store the sample cells with caps on to prevent the cells from drying.

1. Fill the sample cells with distilled or demineralized water.
2. Cap and store the sample cells.
3. Wipe the outside of the sample cells dry with a soft cloth.

Replace the battery

WARNING

Explosion hazard. An expired battery can cause hydrogen gas buildup inside the instrument. Replace the battery before it expires. Do not store the instrument for long periods with a battery installed.

WARNING

Potential fire hazard. Use only alkaline or nickel metal hydride batteries (NiMH) in the meter. Other battery types or incorrect installation can cause a fire. Never mix battery types in the meter.

For battery replacement refer to **Install the battery** on page 6.

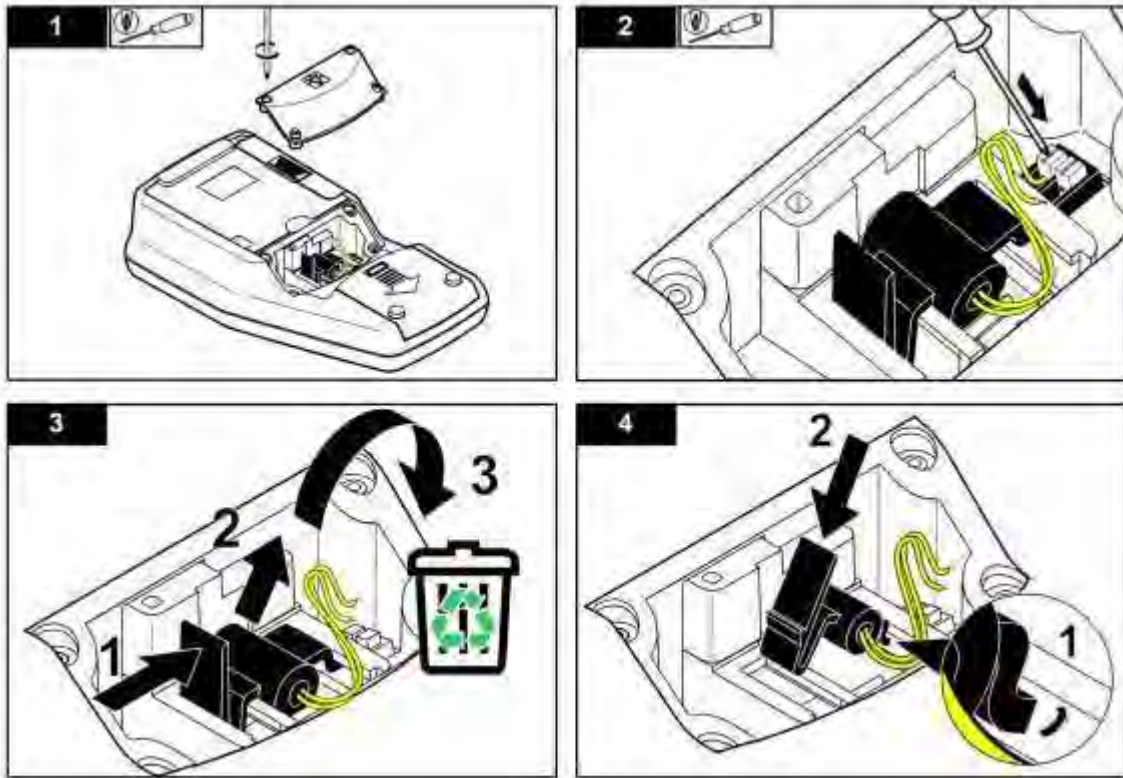
1. Remove the battery cover.
2. Remove the batteries.
3. Install 4 AA alkaline or 4 AA nickel metal hydride (NiMH) batteries. Make sure that the batteries are installed in the correct orientation.
4. Replace the battery cover.

Replace the lamp

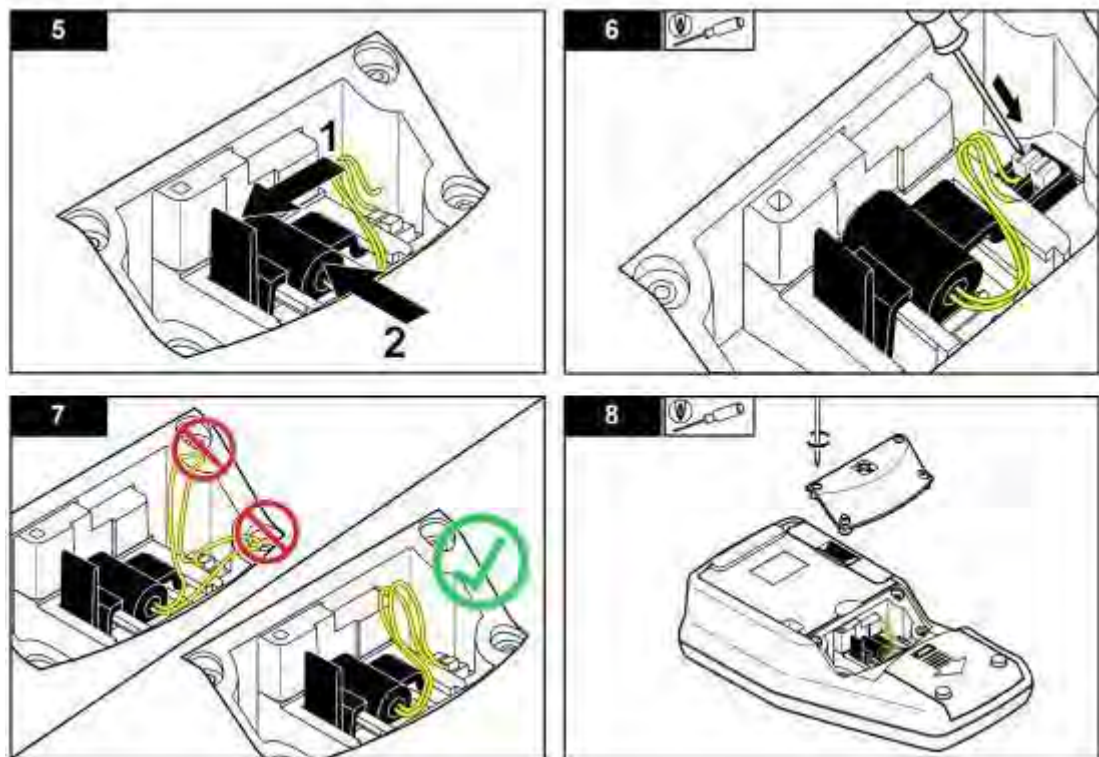
CAUTION

Burn Hazard. Wait until lamp cools down. Contact with the hot lamp can cause burns.

English 19



20 English



English 21

Troubleshooting

Refer to the following table for common problem messages or symptoms, possible causes and corrective actions.

Error/Warning	Description	Solution
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.	<ul style="list-style-type: none"> Insert new batteries. Connect USB/power module if rechargeable batteries are used.
ADC Failure!	Hardware error causing reading to fail.	Repeat the reading.
Detector signal too low!	Insufficient light on the 190° detector.	<ul style="list-style-type: none"> Check for obstructed light path. Check the lamp.
Overrange!	Turbidity too high caused probably by calibrating with RapidCal™ only.	<ul style="list-style-type: none"> Calibrate the upper range. Drain the sample.
Underrange!	The measured absorbance is below the calibration range.	Repeat calibration.
Please check the lamp!	Signals are too low on the 90° and 180° detector.	<p>Z100Q: The lamp is defective. Change the lamp (refer to Replace the lamp on page 19).</p> <p>Z100Qs: Contact technical support.</p>

Error/Warning	Description	Solution
Temperature too high! Switch off instrument.	Temperature has exceeded the meter limits (>60 °C or >140 °F).	Turn off the meter and let it cool down.
RST - Average value!	Solids are settling too slowly. The reading mode is not suitable for this sample.	Select Normal or Signal Average reading mode.
Confidence level is < 95%	The reading mode Rapidly Settling Turbidity did not meet the range of a 95% confidence.	<ul style="list-style-type: none"> Invert the sample several times so that the solids settle. Repeat the reading again. Switch to the Normal reading mode if the sample is stable and does not have settleable solids.
Standard value out of range. Insert standard and push Read.	Used incorrect standard value for the reading.	Insert the appropriate standard and read again.
ID already in use. Enter new ID	The Operator or Sample ID is unavailable as it is already assigned.	Create a new ID.
Error - Security Please set password before activating security	No password is created.	Create a new password.
Please enter at least one character.	Password must contain minimum of one character.	Create a password of at least one character.
Password incorrect. Please retry.	Incorrect password was entered.	Enter the appropriate password.

22 English

Error/Warning	Description	Solution
Please disconnect the USB cable from your computer.	Data storage does not respond while connected to the meter and the computer.	Disconnect the USB cable from the meter and try sending data again.
USB module memory full. Delete data and try again.	Data storage is full.	<ol style="list-style-type: none"> Connect USB/power module to the computer. Download the stored data to the computer. Delete Data Log on the module.
Delete Last Reading Failed!	Error in the data storage.	Turn the meter off and on. If the error message still occurs, contact technical support.
Delete Data Log failed!		
Can't read data set!		
Can't store data!		
Can't store to the Reading Log!		
Can't store to the Verify Cal Log!		
Error storing data!		
Error reading data!		

Replacement parts and accessories

Replacement parts

Description	Quantity	Item no.
StabCal ampoule calibration kit	1	2971205
10 NTU verification standard	100 mL	2861701

² Not available in all regions.

Replacement parts (continued)

Description	Quantity	Item no.
Serorec Oil	15 mL	126938
Insert, molded bottom	1	2971507
Sample cell oiling cloth	1	4707800
1" glass sample cell (10 mL) wrap (Turb)	pkg/6	2434706
Carrying case (includes insert)	1	2971500
Battery set: AA alkaline batteries	pkg/4	1938004
Lamp Assy	1	4653900
Blank module	1	LZV757
Rubber foot set	1	LZV821
Lamp cover (includes screws)	1	LZV822
Battery cover (includes 2 feet)	1	LZV823
Module cover	1	LZV824
Connector cover for USB/power module	1	LZV825
Connector cover for power module	1	LZV826
Lid (includes magnet)	1	LZV827

Accessories


Description	Quantity	Item no.
USB/power module (includes: universal power supply, USB cable, instruction sheet)	1	LZV813 09.00002 ²
Power module (includes: universal power supply, instruction sheet)	1	LZV804 09.00002 ¹

Accessories (continued)

Description	Quantity	Item no.
USB module with USB cable (2x)	1	L2V949.99.000021
StabiCal 0.1 NTU Standard	100 mL	2723342
StabiCal 0.3 NTU Standard	100 mL	2907943
StabiCal 0.5 NTU Standard	100 mL	2898042
StabiCal calibration kit	100 mL	2971210
StabiCal calibration kit	500 mL	2971200
Gelex secondary standards set	1	2464105
Deionized water	4 vials	27217
Filter	0.2 micron	2323810
Formazin	500 ml	246149
Formazin	1000 ml	246142
Sample degassing kit	1	4397500
Sample degassing and filtration kit	1	4397510
Battery, NiMH AA	pk4	2971304

APPENDIX C: Forms and Logbooks

Figure 9: GMCG Field Data Sheet

 2019 Field Data Sheet Green Mountain Conservation Group		GMCG Team Jill: 8 Victoria Office: (603) 319-1830	
PART I – SITE AND FIELD SAMPLER IDENTIFICATION			
Site Code		Date	
Stream Name		Start Time	
Field Samplers			
PART II – WEATHER CONDITIONS <i>Check all that apply</i>			
Sky <input type="checkbox"/> Clear <input type="checkbox"/> Sunny <input type="checkbox"/> Partly Cloudy <input type="checkbox"/> Mostly Cloudy <input type="checkbox"/> Fog <input type="checkbox"/> Hazy		<input type="checkbox"/> Drizzle <input type="checkbox"/> Steady Rain <input type="checkbox"/> Downpour <input type="checkbox"/> Snow <input type="checkbox"/> No Precipitation <input type="checkbox"/> Other _____	
		Air Temperature <input type="checkbox"/> Cold: Less than 4 °C (< 40 °F) <input type="checkbox"/> Cool: 4 – 15.5 °C (40 – 60 °F) <input type="checkbox"/> Warm: 16 – 27 °C (61 – 80 °F) <input type="checkbox"/> Hot: Greater than 27 °C (> 80 °F)	
Wind <input type="checkbox"/> Calm <input type="checkbox"/> Light <input type="checkbox"/> Breezy <input type="checkbox"/> Gusty		Precipitation – Last 24 hours <input type="checkbox"/> None <input type="checkbox"/> Light <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy	
PART III – SITE OBSERVATIONS <i>Check all that apply</i>			
Water Appearance <input type="checkbox"/> Clear <input type="checkbox"/> Milky <input type="checkbox"/> Muddy <input type="checkbox"/> Foamy <input type="checkbox"/> Oily <input type="checkbox"/> Light/Dark Brown <input type="checkbox"/> Greenish <input type="checkbox"/> Other _____		Bottom Appearance <input type="checkbox"/> Silt <input type="checkbox"/> Sand <input type="checkbox"/> Gravel <input type="checkbox"/> Culvert <input type="checkbox"/> Rocky <input type="checkbox"/> Vegetation <input type="checkbox"/> Cannot see bottom <input type="checkbox"/> Other _____	
Water Odor <input type="checkbox"/> None <input type="checkbox"/> Fishy <input type="checkbox"/> Chlorine <input type="checkbox"/> Sewage <input type="checkbox"/> Rotten eggs <input type="checkbox"/> Other _____		Water Flow <input type="checkbox"/> Not flowing <input type="checkbox"/> Slow <input type="checkbox"/> Average Flow <input type="checkbox"/> Fast <input type="checkbox"/> Rapid	
<i>Site Observations (foam, road construction, etc.)</i>			
<i>Wildlife Observations</i>			
<i>Notes</i>			

PART IV – EQUIPMENT INFORMATION AND CALIBRATION			
Meter Set	<input type="checkbox"/> Set # 1: Red Bag		<input type="checkbox"/> Set # 2: Blue Bag
Are both probes calibrated?	<i>LDO Probe</i> <input type="checkbox"/> <input checked="" type="checkbox"/> OK If you see this symbol <input type="checkbox"/> instead, the probe is not calibrated and testing results will not be accurate!	<i>Conductivity Probe</i> <input type="checkbox"/> <input checked="" type="checkbox"/> OK	
PART V – FIELD MEASUREMENTS			
<i>Multi Meter Probes</i> Parameter	<i>LDO Probe</i>		<i>Conduct. Probe</i> Conductivity
	Dissolved Oxygen	Temperature	
Reading # 1	mg/l	%	° C
Reading # 2	mg/l	%	° C
<i>GMCJ office only</i> Average			
Parameter	<i>Turbidity Meter</i> Turbidity	<i>Blue Thermometer</i> Temperature	<i>GMCJ office only</i> pH
Reading # 1	NTU	° C	
Reading # 2	NTU		
<i>GMCJ office only</i> Average			
Depth	<i>LDO and Conduct. probe</i> inches		<i>Turbidity and pH sample</i> inches
PART VI – WATER SAMPLE(S)			
Water samples collected		Water sample info	
<input type="checkbox"/> pH <i>Collected every sampling</i>		Time on bottle(s)	
<i>Additional water samples</i>		Initials on bottle(s)	
<input type="checkbox"/> TP <i>Collected monthly</i> <input type="checkbox"/> TP Rep <i>Collected as directed</i> <input type="checkbox"/> LL <i>Red sites collected monthly</i> <input type="checkbox"/> LL Rep <i>Red sites collected as directed</i>		TP or LL collection depth <input type="checkbox"/> None	
PART VII – VERIFICATION			
<input type="checkbox"/> Check to verify that the RIVERS Protocol was followed to the best of your ability without issue			
Sampler Initials	End Time		
<i>Notes (issues, equipment problems, etc.)</i>			

For Office Use Only: In Office Quality Control Program Coordinator: WQM Director:

Figure 10: SRCC Field Data Sheet

Saco River Basin Water Quality Monitoring Program
2020 field and chemical data sheet

PART I – SITE AND FIELD SAMPLER IDENTIFICATION							
Site Code Number		Site Code Location					
Sample Collection Date		Sample Collection Time	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center;"><u>Begin</u></td> <td style="width: 50%; text-align: center;"><u>Finish</u></td> </tr> <tr> <td style="text-align: center;">a.m.</td> <td style="text-align: center;">a.m.</td> </tr> </table>	<u>Begin</u>	<u>Finish</u>	a.m.	a.m.
<u>Begin</u>	<u>Finish</u>						
a.m.	a.m.						
Field Samplers Names (example – J. Smith)							
PART II – WEATHER CONDITIONS							
Sky <i>(check two)</i> <input type="checkbox"/> Clear <input type="checkbox"/> Sunny <input type="checkbox"/> Partly Cloudy <input type="checkbox"/> Drizzle <input type="checkbox"/> Mostly Cloudy <input type="checkbox"/> Steady Rain <input type="checkbox"/> Fog <input type="checkbox"/> Downpour <input type="checkbox"/> Hazy <input type="checkbox"/> Snow <input type="checkbox"/> No Precipitation		Wind <i>(check one)</i> <input type="checkbox"/> Calm <input type="checkbox"/> Light <input type="checkbox"/> Breezy <input type="checkbox"/> Gusty					
Precipitation <i>(check one and circle one if necessary)</i> <input type="checkbox"/> None <input type="checkbox"/> Past 12 hours - Light Heavy <input type="checkbox"/> Past 24 hours - Light Heavy <input type="checkbox"/> Past 48 hours - Light Heavy <input type="checkbox"/> Past 72 hours - Light Heavy		Air Temperature <i>(check one)</i> <input type="checkbox"/> Less than 4 °C (< 40 °F) COLD <input type="checkbox"/> 4 °C – 15.5 °C (40 °F – 60 °F) COOL <input type="checkbox"/> 16 °C – 27 °C (61 °F – 80 °F) WARM <input type="checkbox"/> Greater than 27 °C (> 80 °F) HOT					
PART III – SITE OBSERVATIONS							
Water Appearance <i>(check the best choice)</i> <input type="checkbox"/> Clear <input type="checkbox"/> Oily <input type="checkbox"/> Milky <input type="checkbox"/> Light/Dark <input type="checkbox"/> Muddy <input type="checkbox"/> Brown <input type="checkbox"/> Foamy <input type="checkbox"/> Greenish <input type="checkbox"/> Other		Bottom Appearance <i>(check the best choice)</i> <input type="checkbox"/> Silt <input type="checkbox"/> Rocky <input type="checkbox"/> Sand <input type="checkbox"/> Vegetation <input type="checkbox"/> Gravel <input type="checkbox"/> Cannot See Bottom					
Water Odor <i>(check the best choice)</i> <input type="checkbox"/> None <input type="checkbox"/> Sewage <input type="checkbox"/> Fishy <input type="checkbox"/> Rotten Eggs <input type="checkbox"/> Chlorine <input type="checkbox"/> Other		Water Flow <i>(check the best choice)</i> <input type="checkbox"/> Not flowing <input type="checkbox"/> Average <input type="checkbox"/> Slow <input type="checkbox"/> Fast <input type="checkbox"/> Rapid					
Wildlife Observations (i.e., birds, fish, insects). If none, indicate so.							
Submersed Aquatic Plants (in the stream) <input type="checkbox"/> None <input type="checkbox"/> Suspect Variable Milfoil *Please take a photo or safely collect a sample <input type="checkbox"/> Other (Please Describe) _____							
Floatable Observations (i.e., debris, foam, leaves) If none, indicate so.							
Surrounding Area Observations (i.e., recent development, road maintenance). If none, indicate so.							

*Saco River Corridor Commission
 (Established 1993)
 Communities Walking Together To Protect Our Rivers*

Site: _____
Date: _____

Saco River Basin Water Quality Monitoring Program
2020 field and chemical data sheet

PART IV – EQUIPMENT INFORMATION AND CALIBRATION				
pH Probe Used (Done in office) 01	YES, this meter has been calibrated within the previous six hours.	<input type="checkbox"/> Check to confirm		
	YES, the calibration log has been completed.	<input type="checkbox"/> Check to confirm		
DO Meter Used 0	YES, this meter has a one year calibration chip which has been confirmed as "ok" on the meter. (if not ok meter will show a "2")	<input type="checkbox"/> Check to confirm		
Turbidimeter Used 0	YES, this meter has been calibrated within the past month and the calibration log has been checked	<input type="checkbox"/> Check to confirm		
Cond. Probe used 0	Yes, this probe has been calibrated within the past week.	<input type="checkbox"/> Check to confirm		
REMEMBER – IF YOU ARE UNABLE TO CONFIRM "YES" FOR EACH ITEM ABOVE, YOUR TESTING RESULTS WILL NOT BE ACCURATE.				
PART V – FIELD MEASUREMENTS				
Parameter	pH	Turbidity	Conductivity	Thermometer Reading
Reading #1	units		µS/cm	_____ ° C
Reading #2	units		µS/cm	
Average of Readings	units		µS/cm	
Depth of Readings	inches	inches	inches	
Parameter	Dissolved Oxygen			Temperature (DO)
Reading #1	mg/l		% sat	° C
Reading #2	mg/l		% sat	° C
Average of Readings	mg/l		% sat	° C
Depth of Readings	inches		inches	inches
Circle all that apply: <input type="checkbox"/> (check if no samples collected)				
<i>Escherichia coli</i>	Total Kjeldahl Nitrogen	Total Phosphorus	Orthophosphate	Alkalinity
Time Samples Collected:	a.m.		Depth of Samples: inches	
PART VI – ADDITIONAL COMMENTS/INFORMATION				
If you encounter any meter issues/problems, be very specific on what happened and any actions you took.				

Check here if Standard Operating Procedures Followed: **Volunteer**
For Office Use Only: **Program Coordinator** **Quality Control**

Saco River Corridor Commission
Established 1973
"Communities Working Together To Protect Our Rivers"

Figure 12: GMCG UNH WRRC Chain of Custody Form

Sample Name		Collected Date	Requested by: Date (Initials)	Date re-requested	Date re-requested	Received by: Date (Initials)	Date received	Date analyzed	Sample Type	Filtered/clarified?	Preservative	Number of lockboxes	Collectors Name	Field Notes	Filter Volume	Filter #	
Additional Sample Information # Available												pH	Temp. (C/F)	Temp. (C/F)	Diss. Oxy. (mg/L)	D.O. (%)	Temperature (C/F)

Figure 13: GMCG/SRCC pH Calibration Log



GMCG TRC
JUL 2021
Office: 1031 5.10.2020

Calibration Logbook: pH Probe

Note: pH probe must be calibrated immediately before use by GMCG staff. Please check the box if calibration was successful and you see the  symbol. If you do not see the  symbol after you have finished calibrating, please try again. Make note of any problems in this log.

Date	Time		Volunteer Name	Standards Used	Comments
		<input type="checkbox"/>			
		<input type="checkbox"/>			
		<input type="checkbox"/>			
		<input type="checkbox"/>			
		<input type="checkbox"/>			
		<input type="checkbox"/>			
		<input type="checkbox"/>			

Figure 14: GMCG/SRCC DO Calibration Log



GMCG Team

Office: (603) 539-1859

Calibration Logbook: Dissolved Oxygen Probe

Note: Dissolved oxygen probe must be calibrated every morning by the first volunteer to sample. Please check the box if calibration was successful and you see the OK symbol. If you do not see the OK symbol after you have finished calibrating, please try again. Make note of any problems in this log and on your field data sheet.

Date	Time	<input checked="" type="checkbox"/> OK	Volunteer Name	Comments
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		
		<input type="checkbox"/>		

APPENDIX D: Annual WQM Work Plans

Table 12: 2019 GMCG Water Quality Monitoring Schedule

GMCG 2019 RIVERS Monitoring Schedule Draft							
Days	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays		
Meter Set # 1 (Red Bag)	GE-1, OL-7, GO-7 7 to 8 a.m.: Tim calibrates, then tests GE-1 (Pine River), then drops equipment off at Burke's by 8:00 for Frank and Robert.	OL-1u, GT-4, GO-5 7 to 8 a.m.: Larry and Nancy calibrate, then test OL-1u (West Branch River) and driver to GT-4 between 7:45 and 8:00.	GT-5, GT-1, GS-1 7:30 to 8:30 a.m.: Jennifer and TBD calibrate, test GT-5 (South River), then meet Beeda at 8 to test GT-1 (Bearcamp River).	GO-1, GO-2, GE-2 7:30 to 8:30 a.m.: Patricia and Dore Ann calibrate, then test GO-1 (Branch River) and GO-2 (Funchman's Brook) and return equipment to GMCG by 8:30.	GM-4, GM-5, GF-3 7:30 to 9 a.m.: TBD and Lucy calibrate, then test GM-5 (Mill Brook), GM-4 (Ferro Brook), then TBD tests GF-3 (Cold Brook) and returns equipment to GMCG.		
Meter Set # 2 (Blue Bag)	8 to 9 a.m.: Frank and Robert test OL-7 (Red Brook) and GO-7 (Cassiper Lake Outflow), then return equipment to GMCG. GE-3, OL-12u, OL-13 7:30 to 8 a.m.: Rich and Robin calibrate and test GE-3 (Cassiper River), then drop equipment off at Burke's. 8 to 9 a.m.: Dave and Nancy meet Kevin at 8:00 at Burke's and test OL-12u (Phillips Brook) and OL-13 (Larwin Brook), then return equipment to GMCG.	8 to 9 a.m.: Norm and Martin test GT-4 (Chocoma) and GO-5 (Bearcamp River), then deliver equipment to The Other Store. GM-1, GM-2, GM-3 7 to 7:30 a.m.: Ralph calibrates, then tests GM-1 (Bonfield Brook). 7:30 to 8:30 a.m.: TBD meets Ralph at 7:30 at GM-1, then tests GM-2 (Pegawket Brook), then delivers to Silver Lake Home Center at 8:30. 8:30 to 9 a.m.: Lynn & Anne F. test GM-3 (Forest Brook), then brings equipment to East Shore Drive.	8:30 to 9 a.m.: Kit meets Beeda at 8:30 at GT-1 (Cold River) with Ronal, Beeda drops equipment off at Watson's General Store for Jill to pick up. OL-4u, OL-6u 8 to 9 a.m.: Karen and Vince calibrate then test OL-4u (Lavel River) and OL-6u (Pace River), then return equipment to GMCG.	8:30 to 9 a.m.: TBD tests GO-2 (South River). GF-1, OL-14u, OL-9u, OL-10 6:30 to 7:30 a.m.: Anne D. calibrates, then tests GF-1 (Danforth Pond outflow), and OL-14u (Square Brook). 7:30 to 9 a.m.: Brian and Carole meet Anne at 7:30 at OL-14u, Brian and Carole test OL-9u (Gold Brook), OL-10 (Judds Pond outflow) and then deliver to GMCG.		GEA-1 7 to 8 a.m.: Mark calibrates and tests GEA-1 (Long Pond Outlet) and leaves equipment at The Mill by 8:00; Jill transfers equipment to GMCG.	
Meter Set Drop Off	Meter Set # 1: Jill drops off at Camp Calumet by 1:30 for Larry. Meter Set # 2: Jill delivers to Ralph.	Meter Set # 1: Jill resupplies at The Other Store, which Jennifer picks up. Meter Set # 2: Jill picks up at home, Karen & Vince pick up at GMCG after 1 p.m.	Meter Set # 1: Patricia and Dore Ann pick up at GMCG in the afternoon. Meter Set # 2: Anne F. picks up at GMCG.	Meter Set # 1: Jill takes home. Meter Set # 2: Jill delivers in Fates Store for Mark.	Meter Set # 1: Jill delivers to Eric on Friday afternoon. Meter Set # 2: Jill delivers to Robin on Friday afternoon.		
2019 RIVERS Testing Dates							
	May	June	July	August	September	October	
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	

Table 13: 2019 SRCC RIVERS Sampling Schedule

2019 Testing Season (Start date 5/16/19; end date 9/23/19)				
Testing Day	Site	Sampling for Lab	Description	
Monday	CC1		Davis Park in Carroll County, NH	
	CC2		Police Station Landing in Carroll Country, NH	
	S1		ME/NH border in Conway, NH	
	MPB22		Below Moose Pond/at Moose Pond Brook	
Tuesday	S2	<i>E. coli</i> or swimmability (3) (6/24), Alk b/w	Westons Beach in Fryeburg	
	SF1		Swan Falls, Fryeburg	
	S3	<i>E. coli</i> or swimmability (3)(6/24) b/w	Canal Bridge Beach in Fryeburg	
	OCS4-B	TNK,ALK, Ortho (1x/mo)	Old Course Downstream of Hemlock Bridge	
	LWP5	<i>E. coli</i> , TP (1x/mo), TKN	Lovewell Pond, Burdich Street, Pepi Lane	
	S6		Woodland Acres campground, Rt. 160 Bridge	
	BMP	<i>E. coli</i> (1) (every week in July)	Burnt Meadow Pond at boat launch	
	Spec 1	<i>E. coli</i> (1)(every week in June and July)	Spec Pond swimming beach	
	LP1	<i>E. coli</i> (3)(every week 6/24-LaborDay)	Long Pond swimming beach	
	S31 RP	Swimmability (3) (6/24) - Labor Day	Rotary Park swimming beach	
	Wednesday	O7	<i>E. coli</i>	ME/NH border in Effingham, NH
		O7-1	<i>E. coli</i>	Covered Bridge off Route 25 in Porter
O8		<i>E. coli</i>	Down river of Kezar Falls village in Parsonsfield	
OS9		<i>E. coli</i>	Cornish Station (Route 5)	
S10		<i>E. coli</i>	Off Route 11 in Standish	
S23		<i>E. coli</i>	Below Hiram Dam Falls in Hiram	
O22		<i>E. coli</i> , TKN, Ortho (1x/mo)	Bridge at Bridge Street - Cornish/Hiram	
S7		<i>E. coli</i>	Camp Hiawatha	
Thursday		LO11-1	TP (1x/mo), Ortho (1x/mo), <i>E. coli</i>	Beside Balch Lake Dam in Newfield
	LO13		Below Shapleigh Pond in Shapleigh	
	SP13-1	<i>E. coli</i>	Shapleigh Pond	
	LO14-1	TP (1x/mo), <i>E. coli</i>	Below Lake Arrowhead Dam	
	LO15	Alkalinity	Below Lake Arrowhead off Route 117 in Limington	
	L016		Little Ossipee River off of Hardscrabble Road, Limington	
	L020	Alkalinity	Off Foss Road in Limerick	
Friday	S17		Bonny Eagle Island in Standish	
	S18		Above Bar Mills Dam in Buxton	
	S19-A	TP (1x/mo), <i>E. coli</i>	Above Skelton Dam in Dayton	
	S20D	TKN, TP (1x/mo)	Rotary Park (dirt road to boat launch)	
	S21	<i>Enterococcus bacteria</i>	Public Boat Launch off Front Street in Saco	
	S22	<i>Enterococcus bacteria</i>	Rumery's Boatyard, Water St., Biddeford	
	S28	TKN, TP (1x/mo), <i>E. coli</i>	Route 5 into Saco, bridge by campground	
	S30	<i>E. coli</i>	Off Irving Street (at the Boat ramp)	

APPENDIX E: SRCC and GMCG Site Descriptions

SRCC sites locations (descriptions and directions)

MONITORED ON MONDAYS

CC1 – Davis Park in Carroll County, NH (monitored since 2005) - From the SRCC office take route 5 North and follow to downtown Fryeburg. Take a left at the light. Go 8.1 miles and take a right on Washington Street. Go 0.2 miles and bear right onto East Side Road. Go over the covered bridge and park on the right in the public parking area. Follow the path to the beach and test here. The site has a sand beach on the shoreline with several trees present.

CC2 – Police Station Landing in Carroll County, NH (monitored since 2005) - From the SRCC office in Cornish take Route 25 East about 1 mile to Rt. 5 North. Stay on Rt. 5 until the light in Fryeburg (about 25 min). Take a left at the light in Fryeburg (Rt. 302). Go about 5 miles to the three-way intersection with a traffic light and turn towards North Conway. Turn right at the Police Station and follow the boat launch signs. Test at the boat launch. There is direct access to the river at this site as there used to be a bridge crossing the river here. There are several trees along the shoreline but the access way has been cleared. A gravel road leads to the river's edge to meet with a set of two granite steps.

S1 – ME/NH Border along Routes 302 and 113 (monitored since 2001) - From the intersection of Routes 5, 113 and 302 in Fryeburg take 302 West/113 North 2.6 miles. Turn right on the gravel road with the sign "Saco Pines Four Seasons Condominiums." Take a right fork off this road (about 150 feet from main highway) follow the woods road about 1200-1400 feet to the parking area. The sampling location is off the dock below the stairs.

MPB22 – Below Moose Pond off Route 160, Denmark (monitored since 2002) - From Cornish take Rt. 5 to Brownfield. Turn left onto Rt. 160 and follow to Denmark. Go over the bridge and the Moose Pond Dam and turn right on Little Pond Road. Stop about 1400 feet from Rt.160. Test downstream of the bridge. Moose Pond Brook was chosen as a sample location as it drains directly into the Saco River.

MONITORED ON TUESDAYS

S2 – Weston's Beach along Route 113, Fryeburg (monitored since 2001) - From the intersection of Routes 5, 113 and 302 in Fryeburg take Route 113 North 0.5 miles to Weston's Beach parking area (across bridge). The sampling location is on the NE end of the parking lot DS at woods line (DS of outhouses and at the end of the bathing beach). The site was originally chosen due to its proximity to large scale agricultural use. The site has a large beach that is extremely popular for recreational activities in the summer and is monitored for safe *E. coli* levels every week during this period.

SF1 – Swan Falls Dam, Fryeburg (monitored since 2016) – From Rt. 302 travelling from the New Hampshire border stay straight onto Rt.5 (Main St.) and turn left onto Swans Falls Road. Follow the road approximately 0.9 miles to the end and follow the boat launch signs to the parking lot at the foot of the dam. Sampling is done at the public boat launch access area below the dam.

S3 - Canal Bridge Beach, Fryeburg (monitored since 2001) – From downtown Fryeburg, travelling North on Rt. 113, take a right on Rt. 5 (Main St.) and travel approximately 4 miles. Take a left into Canal Bridge Campground, there is a brown sign marking the entrance and the campground is located just before the bridge entering Fryeburg Center. Travel 0.15 miles down this road to reach the parking lot and then walk approximately 0.2 miles to reach the public swimming beach. The site has a large beach that is

extremely popular for recreational activities in the summer and is monitored for safe *E. coli* levels every week during this period.

OSC4-B – Old Course downstream of Hemlock Bridge, Fryeburg (monitored since 2007) - From Old River Road and Rt. 5 take a right and then a left onto Frog Ally. Go about a half mile or so and take your first left onto Hemlock Bridge Road. Follow this and park just before the covered bridge on the right. Test downstream of the bridge at the “boat launch.”

LWP5 – Lovewell Pond off of Dearborn Drive, Fryeburg (monitored since 2016) – Traveling South on Rt. 113 from Fryeburg take a right onto Dearborn Drive and travel 4 miles. Take a right at the first driveway (right before the intersection of Moose Rock Road) and travel 0.2 miles to reach the home on the shoreline of the pond. This sample site is monitored as Lovewell Pond drains into the Saco River and the Pond Association has requested we monitor the site.

S6 – Downriver of Brownfield Bog off Route 160 – Brownfield (monitored since 2002) - From Cornish head to Rt. 5 in Brownfield. Take a right on Rt. 160 towards Denmark. Just before the green metal bridge turn left onto Woodland Acres Drive and continue to the public canoe launch area straight toward the shoreline.

BMP – Burnt Meadow Pond Beach off Route 160, Brownfield (monitored since 2016) – From the SRCC office in downtown Cornish take South Hiram Road to Route 160, take a right to go North on Rt. 160 and travel for 9.4 miles until you reach Burnt Meadow Road. Take a right and travel for 2.5 miles until you reach Town Beach Lane, take a right and continue 0.2 miles to reach the Burnt Meadow Pond Beach. The site has a public beach that is popular for recreational activities in the summer and is monitored for safe *E. coli* levels every week during the swimming lesson season at the request of the town of Brownfield.

SPEC1 – Spec Pond Swimming Lessons Beach (monitored since 2019) - From the SRCC office in downtown Cornish travel West on Route 25 for 4.1 miles and take a right onto 160 North. Travel for 125 feet and turn left on School Street. Travel on this road for 1.2 miles. Take a left into the public parking area for “Spectacle Ponds.” This site is monitored for safe *E. coli* levels during the swimming lesson season at the request of the town of Porter.

LP1 – Long Pond at the Parsonsfield Public Beach (monitored since 2018) – From the SRCC office in downtown Cornish travel West on Route 25 for 2.1 miles. Turn left on Pendexter Road and travel for 4.1 miles until you reach “Road between the Ponds” and turn left. Travel for 2 miles, continue past the summer camp, and arrive at the public swimming area. This site is monitored for safe *E. coli* levels during the summer at the request of the town of Parsonsfield, the pond is a very popular spot for swimming and boating.

S31 - Rotary Park in Biddeford (monitored since 2013) - Rotary Park is located at 550 Main Street in Biddeford. Enter the park and go around the Teen Center building. Bear right on a gravel road, and travel approximately ½ mile to the end. You will pass a baseball field and some open fields. The swimming/beach area is at the end of the road and there will be a parking area. The sampling is done in three different locations at the beach labeled 1, 2, and 3, from left to right. Walk approximately 50 feet between each sample and label accordingly. Katahdin will test these samples. If the *E. coli* count comes back high, they will notify us and we will notify the Biddeford Recreation Department. Staff or volunteer members will go back out to Rotary Park and retest as soon as possible. If there is a high *E. coli* count a second time, staff will notify the appropriate town official who will decide if the beach will be closed for the weekend for safety reasons.

MONITORED ON WEDNESDAYS

O7 – ME/NH Border off Huntress Bridge Road (monitored since 2001) - From the SRCC Office in downtown Cornish, follow Route 25 West for approximately 10 miles (just past the ME/NH Border) and take a left onto Huntress Bridge Road. Parking is on the right just over the bridge. The sampling location is on the bank on the upstream side of the bridge.

O7 – 1 - Porter Covered Bridge, off of Route 25, Porter (monitored since 2016) – From the SRCC office in downtown Cornish travel West on Route 25 for 6.7 miles. Turn left on Rt. 160 South and travel for 0.2 miles and turn left on Kezar Mountain Road. In 0.2 miles you will arrive at the Porter covered bridge. The sampling site is located down the bank on the left (upstream) side of the bridge.

O8 – Downriver of Kezar Falls Village off Powerhouse Road (monitored since 2001) - From the SRCC Office follow Route 25 West for approximately 3.2 miles until you come to Garner Avenue. Take a right and follow Garner Avenue for 0.15 miles until you come to Powerhouse Road on the right. Take Powerhouse Road and follow it past the Maine Consumers sign approximately 0.4 miles. Keep to the right and you will end up in a small parking area near the hydro facility. Follow the canoe portage trail to the left down to the main flow of the river approximately 1.5 miles.

OS9 – Baldwin/Cornish Station Bridge along Routes 5 and 117 (monitored since 2001) - From the SRCC Office follow Route 25 East for 0.7 miles and then take a left onto Route 5 North (Bridge Street). Follow Bridge Street for 0.3 miles until you come to the bridge over the Saco River. Parking is available on the Cornish side of the bridge. The sampling site location is at the bottom of the granite walkway along the riprap.

S10 – off Route 11 in Steep Falls (monitored since 2001) – From the SRCC office travel East on Rt. 25, turn Left onto Rt.11 (Sokokis Ave.) at the light in Limington. Travel for 3.5 miles until you go over the Steep Falls Bridge. There is a parking lot on the right directly after the bridge. The sample site is accessed from the parking lot, down the banking with riprap, on the downstream side of the bridge.

S23 – Below Hiram Dam Falls, Hiram (monitored since 2019) – From the SRCC office travel East on Route 25 for 0.5 miles and take a left on Bridge Street. Continue onto River Road for 3.9 miles. Park on the side of the road. You will see caution signs posted by Brookfield Energy for the nearby hydro facility as you approach the shoreline. There is a large beach area below the falls and hydro facility where sampling is completed.

O22 – Past Bridge Street in Cornish to River Road in Hiram (monitored since 2013) - From downtown Cornish, take a left at Bridge Street. Cross the bridge separating the towns of Cornish and Hiram and 200 feet past this bridge, on the left, is a white dry hydrant and a cleared area. Walk down the bank and wear boots to reach the sample site. The Little River, which meanders through the Town of Cornish, runs into the Ossipee River right above our testing location.

S7 - Camp Hiawatha, Porter (monitored since 2019) – Travel East on Route 25 for 0.5 miles and take a left onto Route 5 North for 0.3 miles. Continue straight onto Rt. 177-N / ME-5 N for 1.7 miles. Turn left onto ME-113 N for 4.7 miles. Turn left onto Maple St. / River Rd. for 0.3 miles and continue onto Hiawatha Landing. Travel 0.5 miles to reach Camp Hiawatha. The sample site is all the way at the very far side of the camp. There is a ramp with 4-5 stairs that allows direct access to the river.

MONITORED ON THURSDAYS

LO11 – 1 - Beside Balch Pond Dam, Newfield (monitored since 2015) – From the center of Newfield take Route 11 South toward Bridge St. for 3.3 miles and continue onto ME-110 W for 0.9 miles. Take a slight left onto Garland Rd. and travel for 2.4 miles. Take a right onto Shady Nook Road and travel for 0.5

miles. Turn left onto Acton Ridge Rd and travel for 0.4 miles. The sample site is directly after EH Davis Drive on the right. There is access to the pond next to the dam for sampling.

LO13 – Below Shapleigh Pond off Main Street (monitored since 2001) - Take a right onto Shady Nook Road. Go 2.5 miles and take a right on Bond Spring Road. Go about a half mile and take a right onto Whitten Hill Road. Go another half mile and park at the old Church. There is a path on the Church side of the bridge heading downstream that leads to the water. The sample location is located here. This site has A LOT of poison ivy on the path!

SP13-1 – Shapleigh Pond Boat Launch, Shapleigh (monitored since 2015) – From the center of Newfield travel on Route 11 for 3.4 miles and turn left to stay on Route 11 for another 3.3 miles. Turn right onto Main St. and travel for 0.4 miles and turn left onto Balch Mill Road. Travel for 0.2 miles and you will come to a bridge. The sample location is at the bridge which is located directly above the outflow to the Little Ossipee River.

LO14-1 – Above Lake Arrowhead Dam at the Boat Launch, Limerick (monitored since 2015) – From the center of Limington head west on ME-11 South toward Shaving Hill Rd. for 4 miles. Turn left on Doles Ridge Rd. and travel for 2.6 miles. Turn right onto New Dam Road and travel for 0.8 miles. You will arrive at Ledgemere Dam on the left at a bridge crossing. Park on the side of the road. The site is accessed on the south side of the bridge. This site was chosen as the dam serves as the out flow to the Little Ossipee Flowage.

LO15 – Below Lake Arrowhead off Rt. 117 at the Limington/Waterboro line (monitored since 2001) - From the center of Limington take Route 117 South (Cape Road) for 4.4 miles. Take a right on Doles Ridge Road and proceed for 0.1 miles. There is a dirt pull off area on the left hand side of the road with direct access to the Little Ossipee River. This is the sample location. You will need boots for this site. Warning: Milfoil is present at this site!

LO16 – Off Hardscrabble Road in Limington (monitored since 2019) – From East Limington take Route 25 West and take a left on Hardscrabble Rd. and travel for 1.7 miles until you reach Hubbard Avenue. There is an area to pull off the road directly past Hubbard Ave. on the left side of the road. The Little Ossipee River can be accessed here on the downstream side of the bridge. This site was chosen as an abandoned gravel extraction pit a few miles up the river was opened for use again this year. The gravel pit sits on over 200 acres of conservation land and there was a large public outcry against the pit reopening.

LO20 – Little Ossipee River off of Foss Road, Limerick (monitored since 2016) – From the center of Limerick take Route 5 South for 3.7 miles until you reach Foss Road. Take a right and travel for 3 miles until you reach Waters Way. Travel for another 1,000 feet and reach a small bridge. The sample site is accessed down the bank after crossing the bridge on the downstream side. Pendexter Brook flows directly into the Little Ossipee River at this site all the way from Parsonsfield.

MONITORED ON FRIDAYS

S17 – Bonny Eagle Island Standish (monitored since 2001) - From Cornish take Rt. 25 to the flashing light ½ mile after crossing the Saco River at the Limington Rips. Turn Right on Saco Rd and follow it to a 4-way stop. Turn Right on Cape Rd (also known as Rt. 35A). At the stop sign, turn Right on Rt. 35. After crossing the first bridge, look for a gate on the Right. Park here and follow the path/dirt road to the dam, just upstream from the dam there is a concrete apron and depending on the water level, samples can be taken from here or from the rocks just below.

S18 - Above the Bar Mills Dam in Buxton (monitored since 2001) - From Rt. 112 South turn right on Depot Street, Ray's Garage is on the corner. Follow Depot Street and stay to the left where the roads meet

for 1.4 miles. There is a place to pull off adjacent to the dam across from the intersection of Towle Street. Sampling takes place at this location above the dam. You will need boots for this location.

S19-A – Above Skelton Dam in Buxton (monitored since 2018) – From the center of Hollis travel on Route 202 for 2.1 miles and turn right onto Old Alfred Road. Travel for 0.1 miles and turn right into the parking area. Take the stairs along the pathway down to access the river. Sampling is completed here. This site was chosen for sampling as another nearby site was terminated as the volunteer who lived there moved.

S20-D - Off of South Street on Western edge of Rotary Park, Biddeford (monitored since 2018) – From the intersection of Interstate 95 and South Street travel East on South Street for 1.5 miles until it turns into Main Street. Take a left onto Parkview Court to enter Rotary Park. Travel around the loop and stop in the parking lot. There is a trail exiting the West side of the parking lot, walk on this trail until you reach the shoreline (approximately 0.3 miles) there is an opening between trees and drop off to the water. This is where the sample site is located. This site was chosen as a nearby monitoring site on South Street was terminated when a volunteer moved.

S21 - Public Boat Launch off Front St. in Saco (monitored since 2001) - Go to Main Street in Saco and continue toward Biddeford. At the traffic light, turn left onto Pepperell Square. Continue straight and pass under the railroad. The public boat launch is at the bottom of the hill on the right. Walk out to the end of the dock to take samples.

S22 – Rumery's Boat Yard, Biddeford (monitored since 2016) – Travelling South on Main Street and passing over the Saco River from Saco Island East, take a left onto Water Street. Travel for 0.2 miles and take a right onto Cleaves Street. Rumery's Boat yard is located directly on the left next to the Biddeford Sewage treatment facility. This sample site, along with S21, are the only two monitoring locations in the tidal portion of the Saco River.

S28 – Across Route 5 Bridge from Homestead Campground, Saco (monitored since 2013) – From the intersection of River Road and New County Road travel east for 1.7 miles on New County Road (Rt. 5). Pull over on the left side of the road just before crossing the bridge. The sample site can be accessed down the bank on the downstream side of the bridge.

S30 – Irving Street Boat Launch, Saco (monitored since 2013) - From the intersection of Interstate 95 and Boom Road travel east on Boom Road for 0.9 miles. Merge onto Lincoln St. and continue for 0.4 miles. Turn right onto Market St. for 0.2 miles and then take a left onto Irving Street. Travel to the end of the street until you come to Diamond Park. The sample site is located at the boat launch.

GMCG sites locations (descriptions and directions)

Site locations are described as if the viewer were looking downstream.

OL-1u Ossipee Brook River (West Branch River), Ossipee Lake Road, Ossipee/Freedom Town Line (monitored 2005-present)

This river starts at the south end of Silver Lake and flows into Lily Pond adjacent to the International Paper mill on Route 41. From there it flows south and crosses Ossipee Lake Road, forming the boundary between Freedom and Ossipee. This station is located on the upstream side of Ossipee Lake Road where access is easiest.

OL-2 Bearcamp River (monitored 2003-present)

This river originates in the town of Sandwich and follows Route 113 through the town of Tamworth, crossing under Route 16 south of West Ossipee. It passes the Gitchie Gumie Campground before entering

the main body of Ossipee Lake north of Deer Cove. This station is located upstream of the mouth of the river, just beyond a rope swing, and is accessed by boat from the lake. This site was chosen in 2003 as part of a project to collect samples from the inputs of every tributary into Ossipee Lake.

OL-4u Lovell River, Route 16, Ossipee (monitored 2005-present)

This river originates above Connor Pond in the Ossipee Mountain Range and flows under Route 16 at the Indian Mound Golf Club. It enters the main body of Ossipee Lake south of Deer Cove at the site of a large housing development called The Bluffs. This site was moved here in 2005 from OL-4 to eliminate the influence of lake water.

OL-6u Pine River (monitored 2013-present)

Pine River is one of the lake's major tributaries and has heavy daily recreational use that includes powerboats. It is the location of the only state boat ramp providing access to Ossipee Lake. From that location it flows under Route 25 and passes several clusters of homes before entering the main lake at its southern end, adjacent to the ecologically fragile Ossipee Lake Natural Area. This site is located on Hodson Road in Ossipee. Significant transportation and recreational land uses are just upstream, as is a very large wetland. This site was moved here in 2013 from OL-6 to eliminate the need for boat access.

OL-7 Red Brook (monitored 2003-present)

This brook enters the southeast end of the main body of Ossipee Lake between Long Sands and the Ossipee Lake Natural Area. It flows from the Heath Bog, passing the commercial operations of South African Pulp and Paper Industries. The station is at the outlet of a culvert that carries the brook under Long Sands Road.

OL-9u Cold Brook, Alvino Road, Freedom (monitored 2005-present)

The headwaters of this brook are west of Trout Pond. It runs between Trout Pond and the Jackman Ridge along the Pequawket Trail and passes under the Ossipee Lake Road east of the Pequawket Trail. It subsequently enters the north side of Broad Bay between Camp Huckins and Ossipee Lake Marina. This station is located at the end of Alvino Road, which is off of Marina Road. The brook flows under a footpath through a culvert. This site was moved here in 2005 from OL-9 to eliminate the influence of lake water.

OL-10 Huckins Pond Outflow (monitored 2003-2007)

This brook flows into Danforth Pond from Huckins Pond. Access is across private property at the Danforth Bay Camping Resort. A gravel camp road leads to a boat trailer parking area from which the western bank of this stream is accessed.

OL-12u Phillips Brook, Remle Road, Effingham (monitored 2005-present)

Phillips Brook runs under Route 25 just east of Leavitt Road in Effingham. The brook passes through a concrete box culvert under a utility right of way also known as Abel Boulevard. The station is on the downstream side of the culvert. Flow is low but consistent. The culvert is often partially obstructed by beaver dams. This site was moved to here in 2005 from OL-12 to avoid contamination from lake water.

OL-13 Leavitt Brook, Camp Marist property, Effingham (monitored 2003-present)

This brook starts at Hanson Top and Davis Top in the Green Mountain range. It crosses under Route 25 close to Camp Marist and enters the south end of Leavitt Bay between Leavitt Bay and the channel to Berry Bay on Camp Marist property. The site is located just west of Marist Road, where Abel Boulevard crosses the brook.

OL-14u Square Brook, Ossipee Lake Road, Freedom (monitored 2005-present)

Square Brook runs under Ossipee Lake Road through a corrugated steel culvert east of West Bay Road. This perched culvert has created a pool below it. The sampling station is at the downstream end of the pool,

most easily accessed from the right side of the brook. This site was moved to here in 2005 from OL-14 to avoid contamination from lake water.

GE-1 Pine River, Elm Street, Effingham (monitored 2002-present)

The Pine River flows from the southern boundary of the Ossipee Watershed, through the Pine River State Forest, through several wetlands including Heath Pond Bog and into Ossipee Lake near Ossipee Lake Natural Area. GE-1 is located where the Pine River flows under Elm Street. The site is downstream of a modern bridge with substantial concrete abutments. A dry hydrant access lane leads to the site, which is obviously used regularly by recreational fishermen and beer drinkers. The river is about twenty feet wide. The current is steady enough to bend the subsurface weeds, but there are no surface ripples. Both up and downstream from the site, the river is open to the sky and mostly pines set back from both banks. This site was chosen because it is located downstream of two gravel pits as well as a designated drinking water zone. This site was also easily accessible.

GE-2 South River, Plantation Road, Parsonsfield, ME (monitored 2002-present)

The South River flows from Province Lake and Lords Lake, through several wetlands and into Maine where it joins the Ossipee River. GE-2 is located just below the outlet of Lords Lake on Plantation Road. The testing site is immediately upstream from an aging concrete and steel bridge; the abutments are decaying and have clearly dropped cement into the river but some twenty feet below the actual test site. At the site, the river is about twenty feet wide, perhaps four to five feet deep toward the middle of the stream. The current is strong; there are several small rapids above and below the site. Much of the site gets direct sunlight, but the surrounding trees, mostly deciduous, overhang the river somewhat. There is some evidence of fishing activity. This site was chosen because it is located downstream of the town's transfer station and capped landfill. Potential road run-off is a concern as well. The site was also easily accessible.

GE-3 Ossipee River, Effingham Falls (monitored 2003-present)

The Ossipee River drains Ossipee Lake. GE-3 is located at the point of land just below the Ossipee Lake dam. The flow is rapid, and the water level is largely variable due to dam height and precipitation. Downstream the river turns to a slower moving meandering stream as the channel widens. The bottom is mostly gravel with sparse boulders and cobble. The stream is approximately 20-30 feet wide. Red maple, white pine, and bushes dominate the landscape around the site with a sandy topsoil and a fine sand soil underneath. There are often fishermen here as this is a popular fishing site. Because this is such a popular fishing site there is also unfortunately a lot of trash here. The site is accessed via Ironworks road where the tester parks at the Ossipee Lake Dam, then crosses over the dam. The site is located at the end of the path downstream of the dam on the northern side of the stream. This site was chosen to determine the quality of water as it leaves Ossipee Lake.

GEA-1 Long Pond outlet, Route 153, Eaton (pilot site in 2013)

This site is located in the outlet stream south of Long Pond in Eaton. An unnamed private association road approximately 150 feet northeast of Youngs Road along Route 153 crosses the flow. This site was added to help get a better picture of phosphorus concentrations in the Danforth Pond watershed.

GF-1 Danforth Brook, Ossipee Lake Road, Freedom (monitored 2002-present)

GF-1 is located where Danforth Brook flows under Ossipee Lake Road at the southern end of Danforth Pond. It is a slow moving stream from Danforth Pond to Broad Bay. It is about 15 feet wide by 3-4 feet deep during summer months. The testing site is about 100 feet downstream from the outlet of the pond. There is some outboard boat traffic entering Danforth from Broad Bay (1/day), but mostly canoe and kayak (2-3/day). Agitation exists in Danforth due to boat motors and water skiing. Site is surrounded by dense riparian vegetation. This test site was chosen to determine the impact of road run-off. Additional considerations were its accessibility and the fact that a previous study had been conducted.

GF-3 Cold Brook, Loon Lake inlet, Freedom (monitored 2003-present)

Cold Brook flows through Freedom Village and over a dam, just below GF-2, and into Loon Lake. GF-3 is several hundred yards upstream of the Cold Brook inlet to Loon Lake. The sampling site substrate consists mostly of gravel with minimal aquatic vegetation. A swiftly moving riffle is directly upstream, but the flow is slower at the site. The stream is approximately 5-6 feet wide. The site is surrounded by a mixed hardwood forest of ash, basswood, red maple, white oak, hemlock, and beech with a large amount of large white pines on the eastern side of the river. The herbaceous layer consists mostly of asters, goldenrod, and ferns. There is a thick top soil with plenty of leaf litter. The gravelly beach where sampling occurs is lined by grass. There are few obvious human influences at the site. There is a farmhouse upstream and a cemetery directly next to the site. Various wildlife inhabits the area including beaver and otter. The site is accessed via Maple Road where the tester parks at the cemetery. The site is just over the bank behind the cemetery. There is a path down the bank that goes to the right and the site is a little further to the right from this path at a gravelly beach on the stream situated between two white pines just off shore. This site was chosen because of concern over potential malfunctioning septic systems in Freedom Village.

GM-1 Banfield Brook, Route 113, Madison (monitored 2002-present)

While not in the Ossipee Watershed, this site is in the greater Saco Watershed. The brook comes down from Pea Porridge Pond in Madison and runs under Route 113. There are some houses along the brook's upper reaches in the Eidelweiss development. Banfield is rocky, with generally clear water. It stumbles down over a low concrete ledge ten feet before our testing site. In the summer there are water striders on the surface of the brook. The testing site is on the downstream side of Route 113. This test site was chosen to determine the impact of road run-off, erosion and timber cutting to Pea Porridge Ponds. The stream also flows through the Eidelweiss development, located upstream of the test site.

GM-2 Pequawket Brook, Rt. 113, Madison (monitored 2003, 2006-present)

While not in the Ossipee Watershed, this site is in the greater Saco Watershed. GM-2 is located on the west side of Route 113, about 4 tenths of a mile south of the junction with Route 16. This is the most difficult site to access. It flows from a wetland at the edge of the watershed. There is a steep incline down to the stream. The area surrounding the site is moderately wooded with deciduous trees. A large gravel operation near the stream is buffered only by twenty feet of forest. An abandoned road leads up to the stream embankment. Various wildlife such as beaver and river otter have been noted at the site occasionally. There is some erosion along the banks and some dead fall of trees. Depth of stream varies with the amount of rainfall. The stream has some aquatic growth and is rocky/sandy in areas. This site was chosen because it is downstream of a large gravel operation.

GM-3 Forrest Brook, Rt. 113, Madison (monitored 2004-present)

Forrest Brook, at the test site, has a smooth, slow-moving surface. The site is on the west side of the stream about twenty-five meters downstream from the culvert that carries Route 113 over the stream, and some eight feet down the road. The site is reached by an undistinguished path from the parking lot of the Silver Lake Home Center down to the stream, attempting to avoid the rampant poison ivy that grows in the area. This site was chosen as it is located in the center of Madison within the Ossipee Watershed and is located near two drinking water protection zones.

GM-4 Ferrin Brook, Route 153, Madison (monitored 2013-present)

This site is located just downstream of NH153. Significant amounts of stormwater are shed off of the wide sandy shoulder of NH153 directly into Ferrin Brook, which flows into the south end of Purity Lake. This stream is lower volume than the others, but may transport more NPS pollution.

GM-5 Mill Brook, Route 153, Madison (monitored 2013-present)

This site is located about 600 feet south of where Route 153 passes over the outflow of Purity Lake. This site was added to better understand phosphorus concentrations within the Danforth Pond Watershed.

GO-1 Beech River, Tuftonboro Road, Ossipee (monitored 2002-present)

The Beech River flows from Melvin Pond and Garland Pond in the southern Ossipee Mountains, along the Tuftonboro Road, and into the Pine River. The sampling location is where the river flows underneath the Tuftonboro Road. The stream is approximately 15 feet wide and 1-2 feet deep with a rocky substrate. The stream has a medium flow at the site and is clear with some foam/bubbles on top. There is a large beaver dam upstream of the bridge. Deciduous trees surround the site, including maple, oak, and ash with some hemlock and pine. Towards the end of the summer and into fall there is a thick shrub layer of goldenrod, Queen Anne's lace, and aster. This site was chosen because of accessibility and because it is located upstream of a mill, dump and old tannery.

GO-2 Frenchman Brook, White Pond Road, Ossipee (monitored 2002-present)

This site is located about a ½ mile down White Pond Road just off Granite Road in the section of Ossipee known as Granite. White Pond Rd is a dirt road, maintained by the town. The site is approximately 40 feet upstream of where the stream crosses under White Pond Rd. There is a small pull-off below the brook and across the road is a barely discernible path that leads to a very small clearing on the bank where testing occurs. At the site, the brook is narrow, about 5 feet across and curves both above and below the test area. The brook runs moderately fast with ripples in the center, and generally calm on the sides. The center of the brook is approximately 1 foot deep. Frenchman's Brook flows from Polly's Crossing, through a gravel pit, and into White Pond. This site was chosen because Frenchman Brook runs under Route 16 just upstream of the test site, and there is the potential for road run-off impact. In addition, dumping has previously occurred upstream.

GO-5 Bearcamp River, Whittier Bridge, Ossipee (monitored 2004-present)

GO-5 is located on the Bearcamp River in West Ossipee. The Bearcamp River flows from the Sandwich Range into Bearcamp Pond. Then it drains Bearcamp Pond and flows along Rt. 25 in Tamworth until it flows into Ossipee Lake in Ossipee. The site is just below the Whittier Covered Bridge on Whittier Bridge Rd. Just downstream the river makes a horseshoe bend pointing north. The river is moderately fast moving here, but slow enough so that this is a popular swimming hole in the summer. The bottom is sandy and there is about a 100-foot-wide beach on the north side of the stream where we test, another reason why this is such a popular swimming place. The river is about 30-35 feet wide and towards the middle the river is about 3-4 feet deep, depending on rainfall. There are no aquatic plants due to the sandy nature of the bottom.

GO-7 Ossipee Lake outflow, Ossipee (monitored 2012-present)

This site was added in the Fall of 2012 in order to quantify the upstream inputs into the lower bays of Ossipee Lake. Physical parameter testing and total phosphorus samples will be collected on a year-round monthly basis. This site is located on the sandy southern shore of the main body of Ossipee Lake, where the lake flows out a channel before entering Broad Bay. The site is accessed one of two ways. On foot, one can walk along the Conservation Boardwalk that is accessed on Long Sands Road. The site can be reached by car by turning right at the end of Long Sands Road and driving to the end. The sandy shore is a town owned property. Sampling takes place as far downstream as possible before the "No Trespassing" sign.

GS-1 Cold River, Route 113, Sandwich (monitored 2002-present)

GS-1 is located where the Cold River passes under Route 113 in Sandwich near the Tamworth/Sandwich town line. Cold River drains several streams that flow out of the White Mountain National Forest and the Sandwich Range Wilderness including Flat Mountain Pond. The river is about ten meters wide. GS-1 is downstream from a riffle and has a rocky substrate. The river stands up for its name as this site is usually the coldest in the WQM program and is typically the healthiest site in the program. There is dense riparian vegetation on one side of the river and an upland deciduous forest on the other. This test site was chosen

because of concerns about the gravel pit located upstream of the test site and because the river is situated upstream of Tamworth's drinking wellhead zone.

GT-1 Bearcamp River, Route 113, Tamworth (monitored 2002-present)

The site is located under the bridge where Route 113 crosses the Bearcamp in South Tamworth near the Community School. The Bearcamp drains several streams that flow from Mount Israel in Sandwich. At the sampling site, the Bearcamp is a straight stretch of slow moving tea stained water. The river is 50-60 feet wide with a sandy bottom with scattered cobble and boulder sized rocks. It is about four feet deep at its deepest spot during summer median water level. There is no forest canopy directly at the sampling site and it receives full sunlight with the exception of the portion under the bridge. There are red maples growing about 100 feet on either side of the bridge offering partial shade for much of the river. This site was chosen because of accessibility and because it provided a way for the students at The Community School to get involved with water testing. This site is located downstream of Tamworth's drinking water supply zone.

GT-4 Chocorua River, RT. 41, Tamworth (monitored 2004-present)

The Chocorua River begins in the White Mountain National Forest and eventually makes its way to pass under Route 41 at the Tamworth/West Ossipee line and just west of the Madison line. Monitoring Site GT-4 is at that bridge. A short distance from the site, the Chocorua River joins the Bearcamp River and flows into Ossipee Lake. Site GT-4 itself is a bit precarious. The sampler must affect a straddle with one foot on a log butt and the other on a projection at the base of a 21-foot-long steel retaining wall which is part of the bridge. The actual steel-based bridge is preceded by 20 to 30 feet of 8-foot steel walls on either side. The river exits under the bridge and goes around an opposite 45-degree bend on the other side.

GT-5 Swift River, Tamworth Village, Tamworth (monitored 2005-present)

This site was added in 2005 to the monitoring program at the suggestion of town officials at a Selectmen meeting in the spring of 2005. The site is in the center of the village, downstream from new development and is easily accessible. The site is behind "The Other Store", located on Cleveland Hill Road. There is a rock staircase in the bank of the river that allows easy access into and out of the river. Swift tends to be very clean and very cold most of the year.