



Quality Assurance Project Plan Beaver Lake Watershed Assessment

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List of Abbreviations and Acronyms

BLIA	Beaver Lake Improvement Association
BLWP	Beaver Lake Watershed Partnership
CALM	Consolidated Assessment and Listing Methodology
cm	centimeter
°C	degrees Centigrade
DES	New Hampshire Department of Environmental Services
DO	dissolved oxygen
EMD	Environmental Monitoring Database
fps	feet per second
GIS	Geographic Information Systems
GRANIT	Geographically Referenced Analysis and Information Transfer
LIMS	Laboratory Information Management System
mg/L	milligrams per liter
ml	milliliter
NHRSAT	New Hampshire Rapid Stream Assessment Technique
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QA	Quality Assurance
QC	Quality Control
RPD	relative percent difference
SOP	Standard Operating Procedures
SEA	Students for Environmental Action
STORET	acronym for STORage and RETrieval
TMDL	total maximum daily load
TSA	Technical System Audit
USEPA	United States Environmental Protection Agency
VLAP	Volunteer Lake Assessment Program
VRAP	Volunteer River Assessment Program

3 Distribution List

The following individuals will receive a copy of this final Quality Assurance Project Plan (QAPP). Individuals requesting a copy for informational purposes only will also be listed here. In addition, several people involved in site-specific work, such as the Field Coordinators, will receive the QAPP.

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4 Project and Task Organization

The DES awarded a Watershed Assistance Grant for the development of a Watershed Management Plan for the Beaver Lake watershed. Out of this grant (using Clean Water Act Section 319 money) the Beaver Lake Watershed Partnership was created in 2005. The BLWP includes staff at Pinkerton Academy, local officials from Derry, Chester and Auburn, state officials, volunteer groups, and concerned citizens of the watershed.

The Beaver Lake Watershed Partnership's mission is to create a dynamic watershed management plan that will protect and preserve the valuable resources in this watershed. The watershed includes areas of the Towns of Auburn, Chester, and Derry.

This document is a site-specific QAPP for the Beaver Lake Watershed in New Hampshire. This project is a combined effort of the Beaver Lake Watershed Partnership (BLWP) and Pinkerton Academy (PA). Financial assistance is provided through a Watershed Assistance Grant from the New Hampshire Department of Environmental Services (DES) with Clean Water Act Section 319 funds from the United States Environmental Protection Agency (USEPA). The following is a list of individuals and organizations involved with this project, showing their respective roles and responsibilities. Figure 1 displays the conceptual project organization flow chart. See [Section 3](#) for contact information.

DES Project Manager

Steve Landry, DES

Responsibilities

Overall project management, grant administrative duties, overall QA/QC, volunteer training, field supervision, and data management.

VRAP Coordinator

Jen Drociak, DES

Responsibilities

Volunteer training in water quality sampling, water quality data review and QA.

BLWP QA Officer

Lisa LaValley, Program Coordinator for Pinkerton Academy and member of BLWP

Responsibilities

Student volunteer coordination and supervision, volunteer training, equipment management, QA review of field data, annual review and updating of QAPP.

BLWP Project Manager

Michele L. Tremblay, naturesource communications

Responsibilities

Overall project management, semi-annual reporting, volunteer training.

Field Coordinators

Lisa LaValley, Program Coordinator for Pinkerton Academy

Maureen Granger, Pinkerton Academy Advanced Placement Biology Teacher

Brewster Bartlett, Pinkerton Academy, Students for Environmental Action (SEA) Coordinator

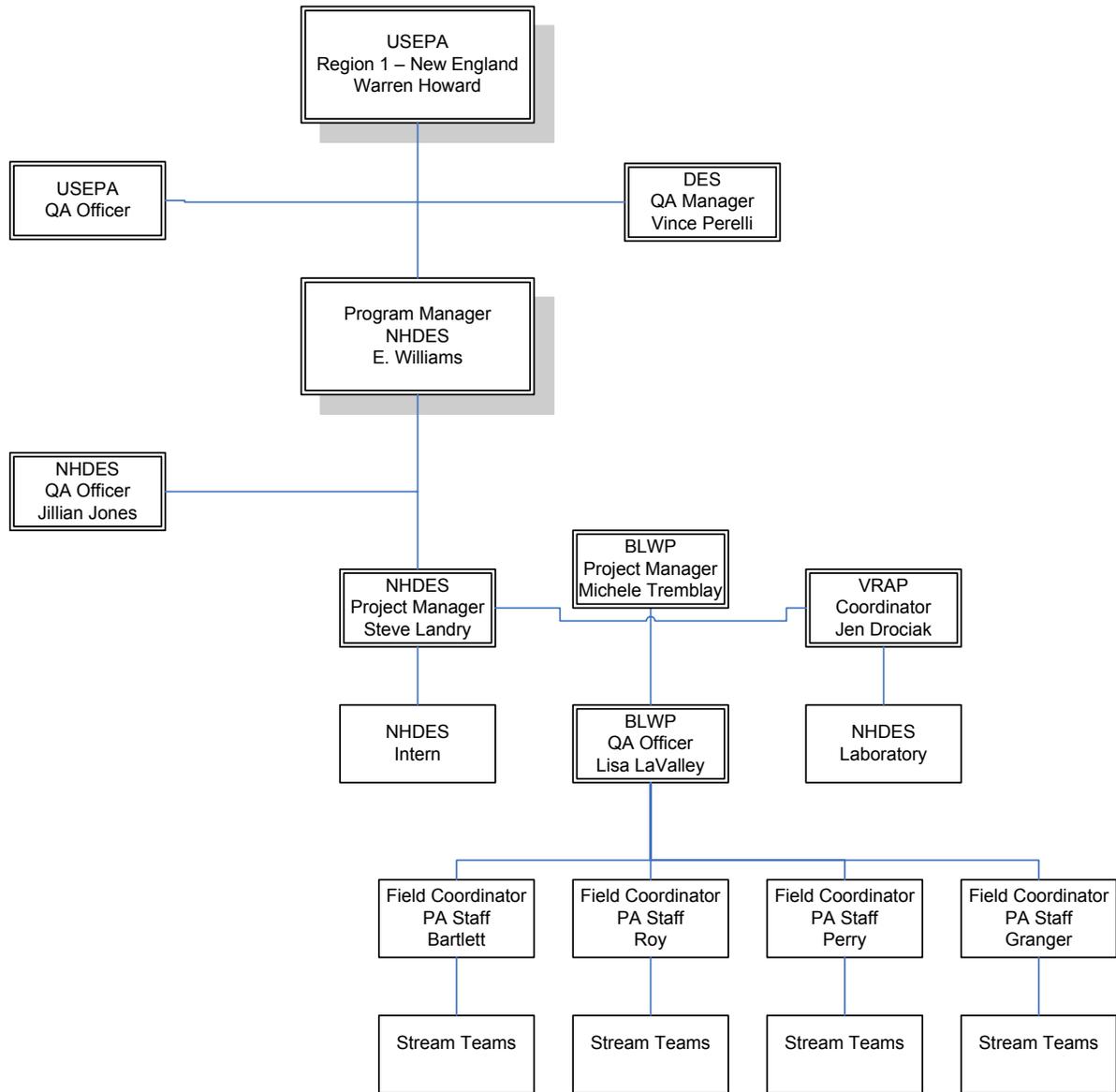
Jen Roy, Pinkerton Academy Field Biology Teacher
 Rachel Perry, Pinkerton Academy Science Teacher

Responsibilities

Organize volunteer stream sampling and supervise students performing field work.

Figure 1: Project Organization Chart

Beaver Lake Watershed Partnership
 Field Data Collection



5 Problem Definition / Background

Beaver Lake is a 140 acre lake located in Derry, NH. The watershed encompassed approximately 10.6 square miles in the towns of Derry, Chester and Auburn (Figure 2). The major tributaries to the lake are Manter Brook, Jenny-Dickey Brook and Cat-O Brook. The water quality of Beaver Lake has been monitored every summer since 1990 through the Volunteer Lake Assessment Program (VLAP). Recent sampling results have indicated that conductivity levels in the lake are increasing from year to year and are higher than the state average. A recent recommendation from the VLAP Reports was to conduct stream surveys to identify potential problem areas in the watershed.

The DES awarded a Watershed Assistance Grant for the development of a Watershed Management Plan for the Beaver Lake watershed. Out of this grant (using Clean Water Act Section 319 money) the Beaver Lake Watershed Partnership was created, which includes staff at Pinkerton Academy, local and state officials, volunteer groups, and concerned citizens of the watershed. Under the grant, the BLWP has developed a study design for water quality monitoring and watershed assessment.

A major objective of the Beaver Lake Watershed Management Plan is to assess the ecological condition of the watershed. The assessment methodologies were developed in consultation with DES and Pinkerton Academy Science Department faculty. To work towards this objective, the following tasks have been identified and will be addressed in this QAPP:

- Recruit student volunteers and assemble Stream Teams to perform fieldwork;
- Conduct training to enable safe, efficient, and reliable field data collection;
- Conduct rapid stream surveys throughout the Beaver Lake watershed; and
- Collect water quality data consistent with DES protocols (in association with the VRAP).

Water quality and stream assessment data collected for this project will be used to document baseline conditions in the watershed. The data also will be used to understand the watershed system as a whole and to educate the region about the watershed. As the program continues into the future, changes in water quality and stream condition over time will be observed and documented. The data will show the overall condition of the watershed and help identify degraded areas with the potential to cause lake impairments, so that future plans for the region may be made based on sound scientific information.

6 Project / Task Description

Planning meetings were held between DES, BLWP and Pinkerton Academy staff to determine appropriate sampling methods. From these meetings, it was decided that trained and supervised volunteers will collect water quality data and conduct rapid field assessments of the streams within the Beaver Lake watershed. The BLWP determined that the most appropriate methods for meeting their objective of assessing the ecological condition of the watershed were the VRAP protocols for volunteer water quality sampling and the New Hampshire Rapid Stream Assessment Technique (NHRSAT) for stream assessments. BLWP is confident that the student volunteers can be effectively trained in these methods and the data obtained will provide meaningful information for use in assessing the entire watershed. The NHRSAT was adapted from the Center for Watershed Protection's *Rapid Watershed Planning Handbook*.

The intent of this project is to initiate a sampling program that can be continued indefinitely in the watershed. The first sampling season is scheduled for 2006; preparations are underway for student recruitment and training. An informational meeting for student recruitment is scheduled for April 18, 2006. Training sessions have been tentatively scheduled for two afternoons in May, 2006. The training will be an annual occurrence. Table 1 depicts the generalized annual timing of the activities detailed in this QAPP. It is anticipated that the BLWP will continue to monitor on their own or with the VRAP after the formal project period ends in December 2007.

Table 1: Annual Project Timeline

Major Tasks	J	F	M	A	M	J	J	A	S	O	N	D
QAPP Preparation and Annual Review	X	X	X	X								X
SOP Preparation and Review		X	X	X								
Volunteer Recruitment and Training	X	X	X	X	X						X	X
VRAP Water Quality Monitoring						X	X	X				
Stream Team Assessments						X	X	X				
Quality Control Checks						X	X	X				
Data Management						X	X	X	X			
Data Report to DES											X	X

This project will involve the following tasks:

Task 1: Preparation of Training Manual for Volunteer Field Data Collection

The field procedures will be performed in two distinct phases: 1) water quality monitoring at fixed locations throughout the watershed, and 2) rapid stream assessments covering the entire watershed (to the extent practical). The water quality monitoring will be performed in accordance with the VRAP protocols. The VRAP protocols are paraphrased, as appropriate, throughout this QAPP.

The water quality monitoring and stream assessment work will be addressed together in this QAPP. That way, roles of the project team are clearly defined and the QA procedures are in one concise place. A training manual will be developed to address the methods that are utilized for both aspects of the sampling. This will make it easier to understand the training. The manual will incorporate methods from the NHRSAT and VRAP protocols, and will succinctly explain how to collect data in the field.

Task 2: Volunteer Recruitment and Training

A meeting was held between DES, certain members of the BLWP, and Pinkerton Academy staff to determine ways to conduct student recruitment and training. Student recruitment will be conducted by first developing an information handout for distribution to students in April, 2006. The program will also

be described to the Student Environmental Action group at their meetings. An informational meeting will be held for interested students in April. The initial target for volunteer recruitment for stream assessments is to assemble at least two stream teams consisting of 2-4 volunteers. The assessment can be conducted with only one team however, if fewer volunteers are recruited. Training will be conducted in cooperation with the DES. Training sessions are described further in [Section 8](#).

Task 3: Water Quality Sampling

The water quality sampling will be performed under the guidance of the VRAP Coordinator. The VRAP has an EPA-approved Programmatic QAPP (DES, 2003) that will be used to provide quality assurance procedures for this project element. Some of the details from that document have been reiterated here. The Volunteer River Assessment Program, Quality Assurance Project Plan approved by EPA in 2003 is on file at DES in Concord, NH.

Sampling stations will be selected from the tributaries to Beaver Lake. Those include Jenny-Dickey Brook, Cat-O Brook, and Manter Brook. Sampling sites will be selected in consideration of representativeness, accessibility and ability for the data to track disturbances in the watershed. The site selection process is further described in [Section 7](#).

In discussing the water quality component with the DES Project Manager, it was suggested that the water quality parameters collected be consistent with the VRAP elements. This will allow the BLWP volunteers additional access to training and equipment resources. Additionally, the data collected through this program will be used to make assessments of the streams water quality through the state's Consolidated Assessment and Listing Methodology (CALM) and can be incorporated into the Environmental Monitoring Database (EMD) used by DES for long term trend analyses.

Water sampling of temperature, pH, specific conductance, and dissolved oxygen will occur throughout the summer months at each site. These parameters will be sampled in accordance with the VRAP protocols in Appendix B. The sampling schedule will be developed in consultation with the VRAP Coordinator. VRAP owns a fixed number of sampling kits, which contain specific water quality monitoring equipment. The kits are loaned to the volunteer groups on an as-needed basis.

The VRAP has a full suite of water chemistry sampling parameters. As a follow-up to the stream assessments described in Task 4 below, volunteer monitors may collect water samples for laboratory analyses specifically for *E. coli* bacteria. Identification of active dry-weather discharges during the stream assessments, for example, may trigger the bacteria sampling. In these cases, the samples will be transported to the DES Laboratory Services Unit by DES personnel or a Field Coordinator. Specific analytical services provided by DES and corresponding standard operating procedures for the bacterial analyses are detailed in the VRAP QAPP. Initially, for this project, the *E. coli* samples will be collected by the DES Project Manager. In the future, volunteers may collect *E. coli* samples in coordination with the DES Project Manager, and DES Laboratory Services, so the associated holding times can be observed.

Task 4: Rapid Stream Assessments

Stream Teams consisting of 2-4 volunteers will survey reaches throughout the watershed. There are approximately twenty-one miles of stream in the watershed. The major tributaries to Beaver Lake include Manter Brook, Jenny-Dickey Brook, and Cat-O Brook. Stream assessments will be conducted to inventory the watershed to identify areas in need of protection or restoration.

The data will be collected according to a modified version of the NHRSAT protocols developed by DES. These protocols incorporate water quality, biological health, and physical inventories for assessing the overall condition of the stream. The modifications to the protocols for this project involve only sampling stream temperature at each segment, rather than additional water quality parameters. Surrounding land

use and riparian conditions will be documented as well. It is recommended that stream segments be defined at significant breaks in habitat type or every 400 feet. Priority areas should be identified for the first round of sampling. Further details on the sampling methods are provided in [Section 11](#).

Ultimately, a stream reference reach will be identified by DES (likely after the first round of assessments). The reference reach is a stream section of comparable dimensions, flow, watershed area, and geology, which is determined to be relatively unaffected by disturbance or pollution. The NHRSAT score of this “pristine” stream reach will give an indication of how the stream reaches of interest would have scored without the effects of disturbance or pollution. The reference reach may be located outside of the Beaver Lake watershed.

Task 5: Data Analysis and Reporting

Data collected in the field will be entered on standardized NHRSAT and VRAP field data sheets, contained in Appendix A and B, respectively. Stream Teams will use the data to score each stream segment that was assessed. The data will be provided to DES. Water quality data will be used by the VRAP and other state agencies to support water body assessments and impairment determinations. Data showing poor water quality conditions (i.e., not meeting state water quality standards) at a VRAP station may indicate potential problems upstream in the watershed. Similarly, the data collected during the stream assessments will facilitate problem identification.

Following each assessment and sampling event, all data will be entered into the EMD maintained by DES (either by the DES Project Manager or the VRAP Coordinator). An interim report of findings will be produced and distributed to DES after the assessments are conducted. A final, year-end report will be produced and distributed in late winter of the following year. Approved data can be utilized by the students and teachers in their curricula.

7 Data Quality Objectives and Criteria

The water quality data collected by volunteers will be used to determine compliance with State water quality standards consistent with the uses detailed in the VRAP QAPP. Data collected under VRAP serve (1) to augment the development of the NH 303(d) list and 305(b) report, provided that the data are collected in accordance with the SOPs provided in their QAPP, (2) as a basis for educating volunteers about the details of water quality, primarily through the development and distribution of annual water quality reports based on the data collected by volunteer monitors, and (3) to increase the amount of data available to the general public (DES, 2003).

The 303(d) list shows all rivers and streams whose status is considered impaired and in need of a total maximum daily load (TMDL) analysis, whereas the 305(b) report provides information on the overall quality of New Hampshire surface waters. Thus, the physical, chemical, and bacteriological characteristics of New Hampshire surface waters are depicted using numerous parameters, including temperature, dissolved oxygen, conductivity, pH, and *E. coli*. These parameters are used to determine whether rivers and streams in New Hampshire meet legislative surface water quality standards, and support designated uses and aquatic life.

Precision and Accuracy

The use of VRAP data inherently requires accurate data collection and documentation. Data are collected during summer months, when rivers and streams typically experience near-limiting ambient conditions (e.g., low stream flow, warm water temperatures). Volunteer monitors will be trained by personnel of the DES Watershed Management Bureau to collect data using calibrated field water quality instrumentation and to collect water samples for laboratory analysis. Personnel from the DES Laboratory Services Unit analyze and report laboratory data. Validated data are compared with state surface water quality

standards to determine whether standards are met. Table 2 illustrates the precision, accuracy and measurement range for the VRAP parameters selected as part of the program.

Table 2: Tributary Water Quality Monitoring Data Objectives

Parameter	Units	Precision	Accuracy	Range
Field Measurements				
Temperature	°C	0.1	± 0.2	-5 to +45
Dissolved Oxygen	mg/L	0.01	± 0.2	0 to 50
DO % saturation	percent	0.1%	± 2%	0 to 500
pH	standard units	0.01	± 0.02	0.00 to 14.00
Conductivity	µhoms/cm	0.01 to 1.0	± 0.5%	0 to 5000
Laboratory Analysis				
<i>E. coli</i> bacteria	Counts/100 mL	1	1	0 to 1,000,000

Note the BLWP may borrow equipment from the VRAP initially, if available; however the BLWP plans on purchasing similar equipment. The performance criteria will likely be the same as listed above; any changes will be noted in subsequent versions of this QAPP.

The NHRSAT data will also be collected during summer months, when rivers and streams typically experience near-limiting ambient conditions. Likewise, Stream Teams will be trained to collect data by DES personnel. Many of the assessment variables associated with the NHRSAT protocols are qualitative. For the subjective assessments such as flow regime, channel alteration and degree of vegetation, for example, each member of the Stream Team will conduct an assessment. At the end of the assessment activities at each reach, the team will compare notes, discuss the parameters and come to a consensus on the subjective scores. Table 3 illustrates the precision, accuracy and measurement range for the quantifiable NHRSAT parameters selected as part of the program.

Duplicate precision (for water quality sampling parameters) is typically analyzed by calculating the relative percent difference (RPD) using the equation referenced in the VRAP procedures. These precision calculations will be performed throughout the sampling season on all duplicate water quality samples.

Table 3: Stream Assessment Data Quality Objectives for Quantifiable Parameters

Parameter ¹	Units	Precision	Accuracy	Range
Location	lat/long	0.001 minute	Less than 15 m	N/A
Channel depth and width	feet	0.1	N/A	N/A
Water velocity	fps	0.1	N/A	N/A
Substrate composition	%	1%	± 5%	0 to 100
Embeddedness	%	25%	± 24%	0 to 100
Temperature	°C	0.1	± 0.2	-5 to +45
Wetted perimeter	%	5%	± 15%	0 to >85
Bank height	feet	1	± 5 feet	0 to >20
Length of eroded bank	feet	1	± 10 feet	0 to >50
Canopy	%	10 to 20%	± 10%	0 to >80
Riparian buffer width	feet	20	± 19 feet	0 to >60
Stormwater outfalls	no.	N/A	N/A	N/A
Macroinvertebrate ID	common name	Insects to order	N/A	N/A
Macroinvertebrate classification	score	N/A	± 15 points	Sensitive to tolerant

1. Subjective assessment parameters are detailed in the attached NHRSAT protocols in Appendix A.

Representativeness

In the BLWP water quality assessments, representativeness depends largely on randomized sampling. Monitoring sites selected for this study will be placed throughout the watershed to ensure adequate representation of the three major tributaries. In selecting the VRAP sites, the project team will be evaluating watershed maps and looking at the hydrology, land use, environmental coverages (surface water discharge points, remediation sites, etc.), and historical water quality data, and then working with the partnership to identify priority monitoring sites in the watershed.

The goal of the stream assessments is to cover the entire watershed. If the stream is wadeable, an assessment will be conducted. In terms of the macroinvertebrate collection, volunteers first examine stream conditions to identify habitats present for invertebrate collection. Twenty stops are performed where organisms are collected. The twenty stops are apportioned according to the substrate type and abundance to ensure all habitat types are covered, and that they are covered relative to their abundance.

The reference reach is a segment of a stable river or stream that has similar valley type and stream morphology as the project reach. Data collected within the reference reach are used to help assess the study area for purposes of river assessment, restoration, stabilization, or enhancement. It is important to select a reference reach that will reflect and be representative of the watershed.

Comparability

Baseline data that are collected will be compared to future data sets and will be used to monitor any changes, or document any trends, that might be occurring in the watershed. One of the ways that the BLWP program ensures comparability is to follow the monitoring protocol established by the State for assessment and analysis. Volunteers also use standardized taxonomic keys to identify macroinvertebrates to the order level. Many of the assessment variables associated with the NHRSAT protocols are qualitative. For the subjective assessments such as flow regime, channel alteration and degree of vegetation, for example, each member of the Stream Team will conduct an assessment. At the end of the assessment activities at each reach, the team will compare notes, discuss the parameters and come to a consensus on the subjective scores. Because the data is being collected in accordance with approved methods from the VRAP and NHRSAT protocols, comparisons can be made with other studies or assessments that were performed using these protocols.

Completeness

There are no legal or compliance uses anticipated for the BLWP data. In addition, there is no fraction of the planned data that must be collected in order to fulfill statistical criteria. It is expected that stream assessments will be completed from the entire watershed, unless unanticipated weather conditions prevent sampling.

When it is found that data do not meet the quality objectives from this section, or do not adhere to the quality control measures described in [Section 14](#), the BLWP QA Officer with support from the DES Project Manager will determine what corrective action must be taken. Incomplete data may lead to the need for re-assessment of particular reach if it is found that the available data are insufficient to meet project goals. When data quality is poor, the Project Manager may choose to have DES staff re-assess or verify the measurements in question, or reject the data with a written explanation.

8 Training Requirements

Training of volunteers is required for water quality and stream assessment data collection, analysis, and data management. The requirements are itemized in Table 4. The BLWP Project Manager and PA Coordinator (QA Officer) maintains a spreadsheet that includes names of trained volunteers and the date

of training for each calendar year (i.e., 2006, etc.). The spreadsheet is developed from the attendance rosters from the individual training sessions. This spreadsheet serves as a certification of training.

Table 4: Summary of Training

Project function	Description of Training	Training Provided by	Training Provided to
Water Quality Monitoring and Sampling	Field instrumentation procedures and water sample collection methods	DES Project Manager, VRAP Coordinator & BLWP Project Manager	Pinkerton Teachers & Volunteer Monitors
Stream Assessments	Field measurements	DES Project Manager, DES personnel & BLWP Project Manager	Pinkerton Teachers & Volunteer Monitors
Macroinvertebrate Identification	Classroom and field demonstrations	DES Project Manager, DES personnel, & BLWP Project Manager	Pinkerton Teachers & Volunteer Monitors

Volunteers will be trained in each aspect of the sampling methods. Session one will cover water quality sampling and stream assessments. Session two will continue to cover stream assessments and will include a field demonstration. Session three, if necessary, will include additional field training and demonstration on a local stream. The training will typically be scheduled for May. For volunteers interested in Stream Team sampling, all three training sessions are required. Volunteers interested in collecting water quality samples at VRAP stations need only attend the first training session.

The water quality sampling training will be conducted by DES VRAP personnel. The VRAP Coordinator will train volunteers prior to the start of the sampling season. At the first training event, an overview of the VRAP will be provided so the Pinkerton Academy staff understand their role in the program. They will be given the Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors (Appendix B) and the testing parameters will be explained and reviewed. DES staff will also conduct the stream assessment training in a separate module that includes topics such as stream geomorphology, macroinvertebrate identification and aquatic and riparian habitat assessment.

Volunteers will be trained to collect samples, take detailed notes, and to maintain and calibrate the equipment. During the training, the volunteers will be trained how to use the DO meter, the pH meter and the conductivity meter, as well as how to gather water samples and record data on the field data sheet. Calibration training will occur prior to field training.

At their first sampling event, the volunteers will go through an additional training process in which they will conduct water quality monitoring at the site while being supervised. The VRAP Coordinator will answer questions and walk the volunteers through any steps they have difficulty with. Proper calibration training is included in this first sampling event. Similarly, the DES Project Manager or other DES staff will accompany the Stream Team volunteers at their first sampling event to ensure the training was effective and the data is collected properly.

The safety of participants is a prime consideration of the program, including ease of access to the sampling sites, ensuring that conditions are optimal for testing, and that participants are comfortable with the tasks required. Volunteers will sign a release form that confirms they know that they are performing sampling tasks, including wading in streams, 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 intent is to have the DES Project Manager on-site during each stream assessment, to the extent practical. Periodically throughout the monitoring season the VRAP Coordinator and/or the DES Project Manager will evaluate the volunteers' effectiveness by testing their proficiency in performing the monitoring and assessment procedures during technical system audits as described in [Section 14](#). Further training will be provided at this point, if necessary.

9 Documents and Records

The BLWP QA Officer will be responsible for ensuring that project personnel have the most current version of the QAPP, including applicable portions of the VRAP QAPP and NHRSA Protocols, training manual and field data forms. Forms for the stream assessments were modeled after the NHRSA. NHRSA field forms are attached in Appendix A. Volunteers will receive field data sheets 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 Pinkerton Academy Field Coordinator at the end of each day. Water quality data collection will be documented in accordance with the forms provided by VRAP (examples in Appendix B). When water samples are collected for laboratory analysis, volunteers will follow documentation and sampling handling procedures detailed in the VRAP QAPP.

Once all fieldwork is completed, information on the field data sheets will be transferred to computer files in the DES office only after the DES Project Manager has inspected and signed off on each individual field data sheet. Although that information will be transferred to computer format, all field data sheets will be scanned and kept on file with the DES Project Manager to ensure that the data are always available in two forms. Copies of the field data will be given to PA and BLWP for use in their curriculum and in development of the Beaver Lake Watershed Plan. This computerized information will be included as part of the BLWP website and will be disseminated to the communities affected by the program. DES staff will keep a complete set of training, education, sampling data and volunteer records archived at the program's office for a minimum of five years.

10 Sampling Process Design (Experimental Design)

Water Quality Monitoring

The water quality sampling will be performed under the guidance of the VRAP Coordinator. The VRAP has an EPA-approved Programmatic QAPP (DES, 2003) that will be used to provide quality assurance procedures for this project element. Sampling stations will be selected from the three main tributaries to Beaver Lake: Jenny-Dickey Brook, Cat-O Brook, and Manter Brook (see Figure 2). Sampling sites will be selected in consideration of representativeness, accessibility, and ability for the data results to track disturbances in the watershed.

The VRAP encourages volunteers to sample on a bi-weekly basis from June through September. Water sampling for temperature, pH, specific conductance, and dissolved oxygen will occur at each station and all stations will be sampled on the same day (VRAP protocols are contained in Appendix B). Volunteers will also record characteristics such as water odor and color during each assessment. Samples will be collected from a bridge or from shore. Field replicates will be conducted on every tenth sample or once per day if less than 10 samples were collected (more details in [Section 14](#)). Sampling will not be performed during heavy rain, or if flow conditions are too high such that sampling is unsafe.

Stream Assessments

There are approximately 21 miles of tributary streams to Beaver Lake. It is the goal of this Project to eventually inventory the entire length of tributaries within the watershed. For this 2-year effort, sites will initially be selected based upon accessibility. Following the NHRSA methods, measurements will be collected at approximately every 400 feet along the stream or at significant changes in stream type or

habitat. For example, if a wetland is encountered, the stream segment will be ended prior to the wetland. Riparian and land use changes will also be taken into consideration when determining where to break a stream segment.

Measurement parameters of interest include streambed geology, physical instream habitat, riparian habitat conditions, biological indicators (macroinvertebrates), streambank erosion indicators, and water quality. Stream Team crews will consist of two to four student volunteers. The teams will initially be accompanied by a DES employee to ensure proper data collection. Stream assessments will be performed in the summer months during periods of moderate to low flow. Low flow conditions are ideal with the exception of those segments of tributaries that have the tendency to go dry during summer conditions (e.g., portions of Jenny-Dickey Brook). The sampling schedule will be developed with this in mind; however the schedule must have a degree of flexibility to account for foul weather and other unanticipated occurrences.

Ultimately, a reference reach will be identified by the DES Project Manager. The reference reach is a section stream of comparable dimensions, flow, watershed area, and geology, which is determined to be relatively unaffected by disturbance or pollution. The NHRSAT score of this “pristine” stream reach will give an indication of how the transects of interest would have scored without the effects of disturbance or pollution. Ideally, the reference reach will be located in the watershed, but it can be located in another undisturbed area of a watershed with similar characteristics such as geology, watershed size, etc. A reference site will be identified after stream assessments are conducted throughout the Beaver Lake watershed. Once selected, Stream Teams under DES supervision will conduct an assessment to generate a reference site score.

Volunteer monitors may collect water samples for *E. coli* analyses from stream segments of interest (e.g., if active dry-weather discharges are identified) as a follow-up to the stream assessments. The sterilized sample collection bottles will be supplied at the beginning of the season through the VRAP personnel. When the sampling has been completed, the samples will be kept cool using coolers and ice. One of the Project Coordinators will return the samples to the DES Laboratory in Concord within 24 hours for analysis. The protocols for laboratory analysis of *E. coli* are on file at the DES Laboratory.

11 Sampling Methods

Refer to the NHRSAT protocols in Appendix A and the DES VRAP Field Protocols for detailed information regarding how samples will be taken, equipment and containers used, sample preservation methods used, and holding times. Tables 5 and 6 provide a summary of the information.

At the VRAP sites (yet to be established), water sampling of temperature, pH, specific conductance, and dissolved oxygen will occur. Volunteer monitors may also collect water samples for laboratory analyses, such as *E. coli* bacteria, in coordination with DES. The parameters and methods are listed in Table 5.

Table 5: Water Quality Parameters and Methods

Parameter	Method or instrument
Field Analysis	
Water Temperature	YSI Model 95
Dissolved oxygen	YSI Model 95
pH	Orion Model 210A Meter
Specific Conductance	YSI Model 30

The procedures for *E. coli* sample collection are shown in Table 6. The samples will be collected in accordance with the procedures detailed in the *Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors* (Appendix B).

Table 6: Method Requirements for *E. coli* sampling

Analytical parameter	Collection method	Sample volume	Container size and type	Preservation requirements	Max. holding time (preparation and analysis)
<i>E. coli</i>	Surface Grab	100 ml	250 ml sterile white polyethylene	chilled to $\leq 10^{\circ}\text{C}$	8 hours

Note: The complete method is listed in the VRAP QAPP.

The NHRSAT protocols incorporate water quality, biological health, and physical inventories for assessing the overall condition of the stream. Surrounding land use and riparian conditions will be documented as well. It is recommended that stream segments be defined at significant breaks in habitat type or every 400 feet. The NHRSAT protocols have been slightly modified for this project. Because water quality data will be collected at various locations in the watershed in conjunction with the VRAP, the only water quality measurement taken during the stream assessments will be water temperature. Volunteers will also record characteristics such as water odor and color during each assessment. The NHRSAT Methods are summarized below. Table 7 lists the parameters and associated methods for the stream assessments.

Transect Data Collection

- Ensure that team members will be able to wade safely at the transect location.
- Establish the transect location with GPS and record latitude and longitude on the field sheet, or store the point with the GPS unit's internal memory.
- Take photographs upstream and downstream to document channel morphology, bank conditions, degree of vegetation, wetted perimeter, etc.
- Begin the site sketch (plan view of channel morphology, meanders, riffles, runs, pools, etc.) noting channel characteristics, buffer width, depositional areas, point bars, and adjacent watershed characteristics (bridges, culverts, homes, lawns, impervious cover, etc.).
- Measure and record water temperature.

Invertebrate Collection

- Prepare for invertebrate processing by filling sorting pans and dividing dishes with stream water.
- Examine stream conditions to identify habitats (i.e., riffle, pool, etc.) present for invertebrate collection. Different organisms are likely to be collected from the different habitats.
- Begin invertebrate collection. Sample a one square meter area in front of the kick-net opening by scrubbing rocks and other debris or by agitating streambed material with hands and/or feet. Perform twenty "stops" with the kick net moving upstream and diagonally across the stream width in a "zig-zag" pattern. Apportion the twenty stops according to the substrate type and abundance.
- Empty contents of the net into pans for sorting, extract organisms with slotted spoons or pipettes, and transfer them to tri-sector dishes for identification.
- Record invertebrate data on the "Streamside Macroinvertebrate Survey" sheet (Appendix A).
- Once a team member has completed sorting, another team member verifies that no macroinvertebrates have been overlooked in the sorting pan, as Quality Control.

Physical measurements

- Perform the in-stream physical measurements after the invertebrate collection is complete, or has progressed upstream, so that the substrate and organisms are not disturbed prior to kick-netting.
- At one-third, one-half, and two-third intervals along the transect reach, measure the wetted perimeter and record as “channel width” on the field sheet.
- At all of the width measurement sites, measure stream depth at one-third, one-half, and two-thirds across the channel and record as “channel depth” on the field sheet.
- Locate pools situated in transect reach. Measure and record depth for at least three pools on field sheet.
- Perform velocity measurements.
- Conduct the Pebble Count and record particle sizes on the pebble count form.
- Complete the “Erosion Classification Scoring Table” and the visual assessment components of the NHR SAT evaluation/scoring form (Appendix A).

Table 7: Stream Assessment Parameters and Methods

Parameter	Assessment Method
In-Stream Physical Habitat	
Location	Hand-held GPS
Channel depth and width	Tape measure and yard stick
Water velocity	Plastic flow ball, tape measure, watch with timer
Substrate composition	Pebble count - modified Wolman Method
Embeddedness of substrate	Visual assessment (%)
Water Temperature	Thermometer
Wetted perimeter	Visual assessment
Pool availability	Visual assessment
Flow regime	Visual assessment
Bank Conditions	
Bank height	Tape measure
Bank Slope	Visual assessment
Length of eroded bank	Tape measure
Degree of bank vegetation	Visual assessment
Bank material (soil)	Visual assessment
Riparian Conditions	
Vegetation type	Visual estimate (categorical)
Canopy	Visual assessment (percent cover)
Adjacent land use	Visual estimate (categorical)
Riparian buffer width	Visual estimate (range of lengths)
Stormwater outfalls	Visual assessment (quantity)
Macroinvertebrates	
Collection	D-frame kick net
Identification	Color ID key, to insect order
Classification	Score according to pollution sensitivity

Many of the assessment variables associated with the NHR SAT protocols are qualitative. For the subjective assessments such as flow regime, channel alteration and degree of vegetation, for example, each member of the Stream Team will conduct an assessment. At the end of the assessment activities at each reach, the team will compare notes, discuss the parameters and come to a consensus on the subjective scores.

12 Sample Handling and Custody

Global Positioning System (GPS) data will be collected at each stream segment and those data will be recorded on field forms and stored in the GPS unit. Each segment will be identified with a unique number which will be stored in the GPS unit and added to each field form to keep track of each site assessment. Photo numbers will be placed in the field notes. A dry erase board and marker will be used at each photo site to identify location, date, time, and any notes. Dry erase board will be visible in each photo. This protocol will facilitate accurate photo file downloads and improve reporting validity.

When physical samples are collected (i.e., *E. coli*), sample containers will be marked with identification labels that will be matched to the identification information on the field data sheets. Samples requiring transport to the DES Laboratory Services Unit in Concord will be contained in a cooler at a temperature of about 4 °C and delivered within eight hours by either the DES Project Manager or Field Coordinator. See Table 6 above for *E. coli* sample handling requirements. Upon arrival at the NHDES laboratory, the person delivering the samples is responsible for completing chain of custody documentation supplied by the NHDES Laboratory Services Unit. Additional sample handling procedures are detailed in Section 10 of the VRAP QAPP.

All samples collected during the pebble count as part of the stream assessments will be measured, tallied and classified in the field at the time of collection. The date and time of collection will be recorded in the field book. One field team member will pick samples, measure them, and call out the measurements, while the other tallies the samples, writes down the measurements according to size and repeats them back for confirmation. It is the responsibility of each team member to make sure the measurements have been properly communicated. Once the sample data have been confirmed and tallied, the sample can be disposed of behind the direction of traverse.

13 Analytical Methods

The analytical methods that will be used for temperature, pH, and dissolved oxygen come from the operation manuals which will be kept with each water quality meter. See Table 5 above in [Section 11](#). The bacterial analyses for this project will be conducted at the DES Laboratory. The analytical method for *E. coli* is included in VRAP QAPP.

Macroinvertebrate samples will be analyzed as follows, in accordance with the NHRSAT protocols for invertebrate collection. First, empty the contents of the net into pans for sorting. Extract organisms with slotted spoons or pipettes and transfer them to a divided container for identification. It is critical to identify as many different organisms as possible while keeping a mental tally of the number of organisms present in each order. Therefore, it is not necessary to transfer every individual into the divided tray but merely representatives from each order, as long as an estimation of their density relative to the entire community can be assessed. Record invertebrate data on the “Streamside Macroinvertebrate Survey” field sheet. On this form, the macroinvertebrate samples are grouped according to their abundance and tolerance to pollution, and a water quality rating and score is calculated for each site.

14 Quality Control

Accuracy of the water quality measurements is ensured by proper calibration of the equipment before sample testing is implemented. Quality control for water quality parameters (dissolved oxygen, pH, conductivity, and temperature) include replicate measurements at each sampling event, training records for samplers, random spot checks and data entry checks by the VRAP Coordinator. Roving crews will perform technical system audits, as further described in the VRAP QAPP.

The volunteer groups will collect duplicate samples and take replicate measurements throughout the sampling period. At least 10% of all samples and measurements will be duplicates and replicates.

For field duplicates, a second sample is collected concomitant with the final sample of any particular sampling day, or every tenth sample, whichever is first for each sampling team. For example, if eight samples are collected for bacterial analysis during a sampling day, a duplicate sample is collected with the eighth sample. However, if 12 samples are collected for bacterial analysis during the day, duplicate samples are collected with the tenth and twelfth samples.

For field measurement replicates, a second measurement is made concomitant with the final sample of any particular sampling day, or every tenth sample, whichever is first for each sampling team. For example, if eight dissolved oxygen measurements are made during a sampling day, two sequential measurements are made for the eighth measurement. However, if 12 dissolved oxygen measurements are made during the day, two sequential measurements are made with the tenth and twelfth measurements.

Duplicate samples are accepted during sampling if (1) each of the two sample collection containers (i.e., sampling buckets) are filled at least one-half of their capacities, and (2) samples are appropriately transferred from each of the buckets to the sample storage containers. Duplicate samples are sometimes collected repeatedly from the same sampling station, since the number of stations is less than the frequency of sampling. See [Section 20](#) for assessment and response actions.

Stream Teams will consist of at least two volunteers and will have supervision at a central location in the watershed. In stream morphology data collection there are no contamination issues. There are no time limits to handling, storing, and transporting samples. Quality control is not quantifiable in most cases, and it becomes a subjective assessment of whether data collected appears reliable and qualifies as a valid representation of what is being measured. For the subjective assessments such as flow regime, channel alteration and degree of vegetation, for example, each member of the Stream Team will conduct an assessment. At the end of the assessment activities at each reach, the team will compare notes, discuss the parameters and come to a consensus on the subjective scores. For the pebble count, a second team member will measure 10% of the sample population to verify measurement accuracy and to ensure that the intermediate axes of those particles have been measured.

There are a few steps that need to be taken to minimize imprecision and to identify any errors that might be present. Roving crews will also perform technical system audits (TSA) of the Stream Teams to ensure data quality. The roving Quality Assurance crew (containing at least one DES staff) will be in the field randomly checking the data collected by the student teams. Any deficiencies will be documented and corrected. An evaluation form for use during the Stream Team TSA process is contained in Appendix A. Students will be made aware of the error and an assessment will be made to determine if retraining is required (as described in [Section 20](#)). When a macroinvertebrate specimen is collected and cannot be identified by the Stream Team, photographs will be taken. The photos will be sent to DES for verification.

15 Instrument and Equipment Testing, Inspection, and Maintenance

Initially, the BLWP will borrow water quality sampling equipment from the VRAP. Equipment for stream assessments (e.g., kick nets, tape measures, etc.) will be purchased. Analytical field meters will eventually be purchased by the BLWP. All field analytical instruments will be inspected for obvious defects, broken parts, etc., prior to the field sampling events, and re-inspected when returned to their storage location at the conclusion of the testing day. Any problems with the meters or equipment are logged for reference in an equipment maintenance logbook stored with the meters and maintained by the BLWP QA Officer. The Field Coordinator will report problems to the DES Project Manager and the VRAP Coordinator for instructions on handling the problem. Similarly, replacements part for the water

quality meters (e.g., DO membranes) will be stored with the meters. Equipment problems will be reported to the DES Project Manager.

Water quality meters will be maintained in accordance with the manufacturers' recommendations and the VRAP protocols (Appendix B).

The hand-held GPS unit must be turned on for a minimum of 15 minutes before collection begins, to ensure the current satellite almanac has been transmitted and received by the unit. The GPS unit will be benchmarked with a position of known geographic location at the beginning and at the end of collection period, and average precision/error can be calculated for points collected. If the error is > 49 feet, then satellite coverage was insufficient at that time.

16 Instrument and Equipment Calibration and Frequency

The water quality meters will be calibrated at the beginning of each day in accordance with the manufacturers' recommendations and the DES VRAP protocols. The pH and dissolved oxygen meters are calibrated at the beginning of each testing day and again on the same day if the same meter is used to obtain more than three samples in a row. Temperature is factory calibrated and is obtained through the use of the DO meter. The conductivity meter will be calibrated to a standard reference solution once per season.

All field instruments are calibrated prior to use according to manufacturer's specifications. Calibration methods for all instruments are summarized in Table 8. Calibration documentation is verified on the VRAP Field Data Sheet (see Appendix B for an example).

Table 8: Calibration Details for Field Water Quality Parameters

Equipment name	Method of calibration	Acceptance criteria	Corrective action
YSI Model 95: DO & temperature	Prior to each measurement, calibrate DO to air saturation. Beginning and end of day check against a zero oxygen standard solution.	$\pm 2\%$ of saturation, relative to initial calibration saturation	Recalibrate. If problem persists, inspect/replace batteries, membrane, and electrolyte. Recalibrate.
Orion Model 210A Meter and Triode Model 91-57BN Electrode: pH	Prior to each measurement, ensure calibration to pH buffer 4.0 and 7.0.	Slope value 92-102%	Recalibrate. If problem persists, inspect batteries, replace buffers, ensure electrode is appropriately filled with filling solution. Recalibrate.
YSI Model 30: Specific Conductance	Daily, prior to use, calibrate to known standard.	$\pm 25 \mu\text{S}/\text{cm}$	Turn off. Inspect/replace batteries. Turn on.

Adapted from VRAP QAPP.

17 Inspection and Acceptance of Supplies and Consumables

All supplies, including instruments and equipment will be checked regularly before use by the BLWP QA Officer and during the random TSAs. Instrumentation reagents such as pH buffers, dissolved oxygen electrolytes, and analytical standards are retained with all water quality instrumentation throughout the sampling season. Acceptance requirements directly relate to the expiration dates stamped on reagent bottles, where reagents are discarded if the expiration data has passed. The VRAP intern, VRAP Coordinator, or QA Officer replenishes all reagents on a biweekly basis. However, volunteer monitors

may request a replenished stock of reagents if the reagents appear discolored or are otherwise contaminated within the biweekly period. All field analytical equipment and appurtenant supplies are inspected and maintained according to methods described in [Sections 15](#) and [16](#), above.

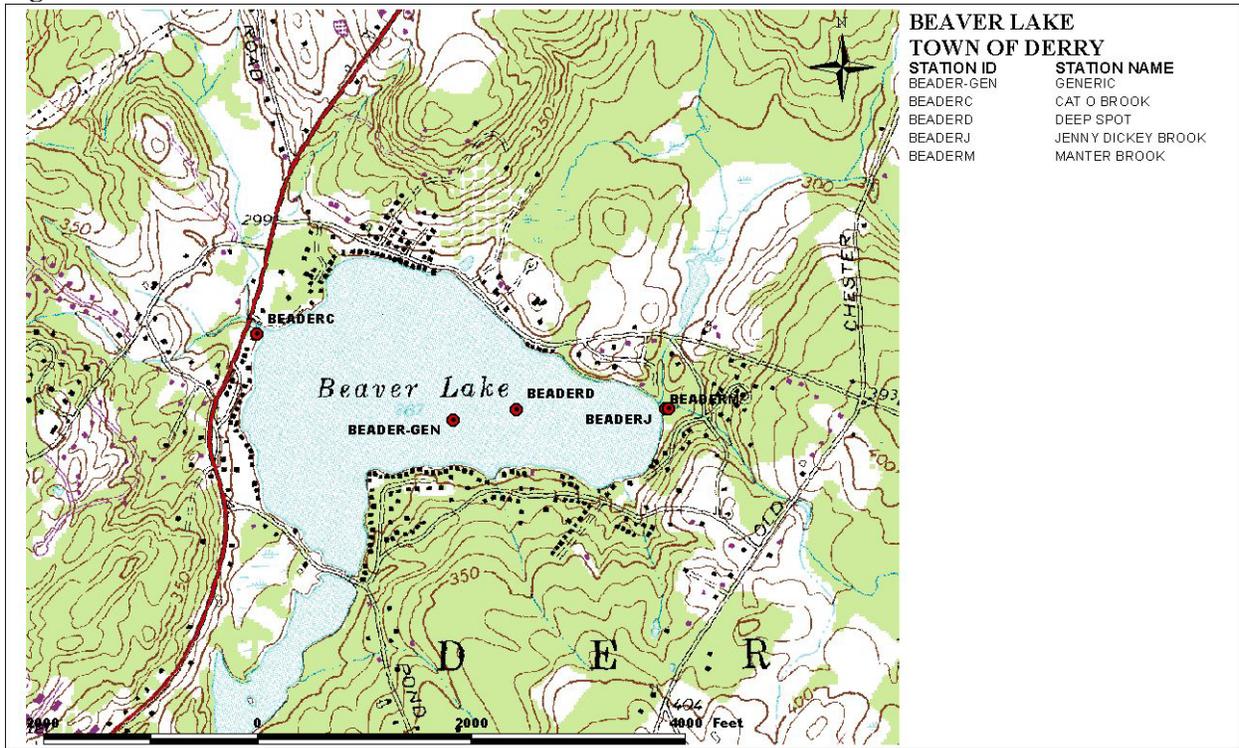
The nets used for collection of macroinvertebrates by the Streams Teams are D-frame kick nets with 500-micron mesh. The nets are replaceable. Nets are inspected for wear and damage prior to each sampling event. The primary contact if there is a problem with the supplies is the DES Project Manager.

18 Non-direct Measurements

Maps of the streams and watershed were created from GIS data obtained from DES and from NH GRANIT sources. These maps will be used to supplement land use observations obtained in the field. In addition, the maps and data coverages will be used to select VRAP sampling sites.

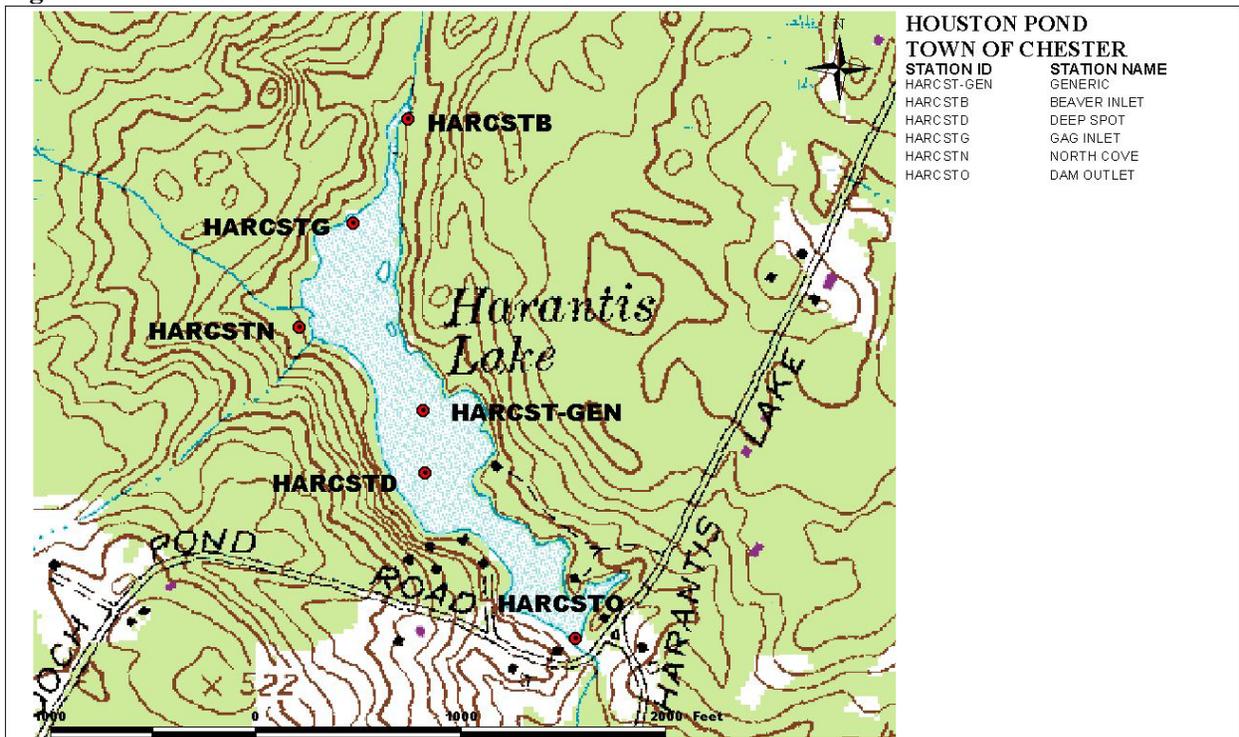
Beaver Lake and Harantis Lake in Chester participate in the VLAP. The reports and associated data from these two lakes will be used to supplement the water quality data collected from the VRAP stations. VLAP sites in Beaver Lake include one station at the mouth of each of the three major tributaries entering Beaver Lake (see Figure 3). Similarly, VLAP stations correspond with inlets to Harantis Lake, also known as Houston Pond (Figure 4). Measurements obtained through VLAP sampling will be referenced to conditions found during the VRAP tributary measurements.

Figure 3: Beaver Lake VLAP Stations



Source: <http://www.des.state.nh.us/wmb/VLAP/2004/sampling/sampling.html>

Figure 4: Harantis Lake VLAP Stations



Source: <http://www.des.state.nh.us/wmb/VLAP/2004/sampling/sampling.html>

19 Data Management

Volunteer monitors are encouraged to use ink to document all field data and information (field measurements, station descriptions, etc.). However, documents completed with pencil or other erasable media are acceptable. Volunteer monitors are also encouraged to correct all recording errors by placing a single horizontal line through the error, recording the new data next to or above the erroneous record(s), and initialing the correction.

Stream Team Data

Field forms will be reviewed by the Field Coordinators then submitted to the DES Project Manager for review. The Stream Teams will use existing field forms to document stream conditions. The NHRSAT forms are attached in Appendix A and include: 1) Stream and Riverbank Erosion Classification Scoring Table, 2) Pebble Count Field Sheet, 3) Streamside Macroinvertebrate Survey, and 4) NHRSAT Scoring Matrix.

All numerical data on the sheets will be entered into a computerized Microsoft Excel spreadsheet for use at DES. The computerized data will be double checked by at least one other person as a form of quality control. Raw data are also extracted from the EMD to support the development of the 303(d) list and 305(b) report.

VRAP Data

Water quality data will be stored in a STORET-compatible database (the EMD) in the DES Watershed Management Bureau. STORET (short for STORage and RETrieval) is a repository for water quality, biological, and physical data and is used by state environmental agencies, USEPA and other federal agencies, universities, private citizens, and many others. Throughout the sampling period, field measurement data are entered into the EMD, after review by the VRAP Coordinator. Station descriptions will accompany the field measurements. Field measurement data are recorded on field data sheets, transmitted to the VRAP Coordinator, and retained in individual file folders for each volunteer group. All data entered into the EMD are cross-checked against the data on the field data sheets by a second staff member to eliminate data entry errors; data entry errors are immediately corrected.

Laboratory Analysis

Laboratory results from the DES laboratory are hand-written in bench books, and are subsequently entered into the Laboratory Information Management System (LIMS) database by laboratory personnel (further details are contained in the VRAP QAPP). Results from all laboratories are submitted to the VRAP Coordinator for review and entry into the DES EMD. Results are subsequently cross-checked against the data on the results sheets to eliminate data entry errors; data entry errors are immediately corrected. QA manuals for laboratory analysis methods are available at the DES laboratory.

Data Entry and Storage

The EMD is maintained on the DES computer network, which is secured through daily back-up procedures. Charts, tables, figures, and descriptive statistics are generated using Microsoft Excel. Raw data are codified accordingly for use in binomial statistical analysis. Raw data are also extracted from the EMD to support the development of the 303(d) list and 305(b) report. The VRAP Coordinator tracks all field and laboratory data collected under VRAP throughout the sampling period. A copy of the field data sheet and station identification form is provided in Appendix B.

NHRSAT Station IDs, coordinates, data and other descriptors will be entered into the EMD. Field sheets and photos will be associated to the Station IDs in the EMD. The raw field sheet data will be scanned and entered onto Excel where it can be queried to make ArcView maps for the watershed that reflect RSAT scores.

20 Assessments and Response Actions

Attention to quality is a primary consideration of the program. The DES Project Manager will formally review the performance of the volunteers and Field Coordinators at times during the sampling season to ensure proper data collection. All personnel associated with the program will ensure that the training manual will be followed closely. Training, calibration, maintenance and laboratory records will be filled out in a timely manner. Refresher courses for the Field Coordinators will be conducted for each new season (in conjunction with volunteer training) and as needed if it is determined that the volunteers are not sampling correctly.

VRAP supports water quality monitoring programs of numerous volunteer groups throughout the state. To ensure data quality, technical systems audits are conducted on the individual volunteer groups at least once during the sampling period for (1) water sample collection, (2) operation of instrumentation, and (3) data documentation, where the VRAP Coordinator, QA Officer, or VRAP intern accompany the volunteer monitors in the field during water sampling. An assessment/audit sheet is used to document the activity (Appendix B). A formal TSA for all activities is not conducted at the onset of the monitoring season, as an initial training session ensures proper use of instrumentation prior to the sampling period.

Planned assessments are not conducted in the DES laboratory for data collected specifically for VRAP. However, proficiency testing, replicate testing, and re-testing of retained samples are among the attributes of the laboratory performance audits that are conducted throughout the year.

Equipment errors may occur and must be accounted for by reporting them to the DES Project Manager or VRAP Coordinator. 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 DES Project Manager. Sites with questionable data will be revisited, if possible or the data will be omitted.

Macroinvertebrate identifications and stream assessment measurements will be verified in the field by the roving QA team during the technical systems audits. An assessment/audit sheet is used to document the activity (Appendix A). Misidentified macroinvertebrates will be noted and corrected on site. Re-training will be required if there are consistent misidentifications in the field. Consistently misidentified macroinvertebrates will be documented and future training sessions will place emphasis on the identification of those organisms. Should problems in accuracy or precision occur, the data related to the problem will be identified and program staff will attempt to identify the origin of the problem and resolve it.

The DES Project Manager is ultimately responsible for oversight of all activities of the data collection process. The BLWP QA Officer will ensure that field team members are performing all data collection as prescribed by the quality assurance project plan. All field activities may be reviewed and project sites may be visited by DES and USEPA quality assurance officers as requested.

21 Reports to Management

Data collected as part of this project will contribute to the annual QA memorandum that is written by the NH VRAP Program at the conclusion of the data collection period (i.e., September/October). This memorandum summarizes the QA activities conducted during that particular year, including:

- Summary of QA/QC objectives;
- Description of training activities;

- Conformance to QAPP requirements/procedures, and descriptions of deviations, if any, from the approved QAPP and approved amendments, if any, to the QAPP;
- Limitations of data;
- Documentation of usable data versus amount of data actually collected;
- List of reasons why data are not usable.
- Summary of conflicts, and subsequent resolution of conflicts, associated with sampling; and
- Use and effectiveness of corrective actions, if corrective actions were taken.

Copies of the memorandum are retained in the VRAP files for reference when preparing the 303(d) list and 305(b) report. Copies are also transmitted to the DES Quality Assurance Manager.

A report will be produced by the VRAP Coordinator and distributed to Project partners by the end of September, or as soon as data have been received from the DES labs. The final report on the program will include all of the accepted 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 and provide a bibliography of resources used. The final report will be completed in December 2007, provided that all data has been received from all labs. Semi-annual and final reports will be submitted to DES.

For the Stream Team data, the following documentation will be presented at the end of data collection and analysis:

- Site sketch showing the limits of each stream reach, and other pertinent information;
- Particle size distribution;
- Erosion;
- Water quality score; and
- Macroinvertebrate identifications and scoring.

A QA memorandum will be produced, separate from the VRAP memo, that details QA activities conducted during that particular year relative to the Stream Teams field work. Copies are also transmitted to the DES Quality Assurance Manager and will be retained at DES Watershed Management Bureau. These QA memos will also describe any changes necessary to QAPP for the following year.

In addition, the grant requires semi-annual progress reports which will be completed by the BLWP Project Manager, and a Final Report, which will be incorporated into the Watershed Management Plan produced under the grant.

22 Data Review, Verification, and Validation

All field and laboratory data will be reviewed by the BLWP QA Officer to determine if the data meet QAPP objectives. The data will be scrutinized in the context of the data quality objectives. A decision will then be made whether to accept, qualify or reject the data. Decisions to reject or qualify data will be made jointly by the DES Project Manager, VRAP Coordinator and BLWP QA Officer.

23 Verification and Validation Methods

The DES Project Manager, VRAP Coordinator and Field Coordinators will perform the following tasks to ensure validity of all data associated with the program.

Replicate Samples

Replicate samples of each meter-tested parameter on site will have their results compared for precision. If an error of greater than 20% is found (VRAP criteria), the program staff will attempt to identify the

problem and correct it. If human error is found to be the issue, re-training will be conducted. 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 DES Project Manager will consult a DES water quality specialist to help resolve the problem.

Data Sheet Verification

Field data sheets will be double-checked in the field by another member of the sampling team. If errors are found, the sampler will be contacted and the errors corrected before computer data entry begins. If consistent errors are found, re-training on the particular issue will occur before the next sampling session.

Stream Team data are submitted to the DES Project Manager and BLWP QA Officer. The DES Project Manager reviews all field data for completeness and makes sure that any questionable data are verified by speaking to the Field Coordinators or Stream Teams directly or reviewing the field logbooks, and noting any unusual or anomalous data in the project files. Any decisions made regarding the usability of data will be ultimately left to the DES Project Manager; however the DES Project Manager may consult with the BLWP QA Officer, project personnel, DES QA staff, or with personnel from USEPA.

When it is found that data do not meet the quality objectives from [Section 7](#), or do not adhere to the quality control measures from [Section 14](#), the Program Manager may determine what corrective action must be taken. Incomplete data may lead to the need for re-assessment of particular reach if it is found that the available data are insufficient to meet project goals. When data quality is poor, the BLWP Project Manager may choose to have DES staff re-assess or verify the measurements in question, or reject the data with a written explanation.

Equipment Inspection

Equipment inspections will occur regularly to ensure that equipment is in proper working order, as detailed in [Section 15](#).

24 Reconciliation with User Requirements

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 tagged and subsequent corrective actions (taken in the next sampling season) will depend on the nature of the incident. Generally, the qualitative observations performed by the Stream Teams will be accepted with proper verification.

In situations where the equipment has been shown to be faulty, it will be replaced or another method will be found. If it is shown that better training is required, the BLWP Project Manager may request additional support from DES and Pinkerton Academy to ensure that training has been completed properly.

Limitations in the Stream Team data will be clearly defined for potential end users in all reports produced. If the project objectives from [Section 7](#) are met, the user requirements have been met. If the project objectives have not been met, corrective actions, as discussed above, will be initiated by the DES Project Manager.

If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the DES and USEPA quality assurance officers for approval.

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Appendix A: NHR SAT Protocols and Field Forms

- NHR SAT Field Protocols
- Stream and Riverbank Erosion Classification Scoring Table
- Pebble Count Field Sheet
- Streamside Macroinvertebrate Survey
- NHR SAT Scoring Matrix
- Macroinvertebrate Color Keys
- NHR SAT Field Sampling Audit Checklist

New Hampshire Rapid Stream Assessment Technique (NHRSAT) Field Protocols



Beginning Transect Data Collection

- Ensure that team members will be able to **wade safely** at the transect location in order to gather data.
- Establish the transect location with **GPS** and record latitude and longitude on the field sheet, or store the point with the GPS unit's internal memory.
- Take **photographs** upstream and downstream to document channel morphology, bank conditions, degree of vegetation, wetted perimeter etc.
- Begin the **site sketch** (plan view of channel morphology, meanders, riffles, runs, pools etc.) noting channel characteristics, buffer width, depositional areas, point bars, and adjacent watershed characteristics (bridges, culverts, homes, lawns, impervious cover etc.).
- Deploy YSI (or similar **multi-parameter/datasonde** unit) and record data in YSI log and on the NHRSAT field sheet¹.

Invertebrate Collection

- **Prepare** for invertebrate processing by filling sorting pans, and divided dishes, with clear water.
- Examine stream conditions to **identify habitats** present for invertebrate collection.
- Begin invertebrate collection. Perform 20 "stops" with the kick net moving upstream and diagonally across the stream width in a "zig-zag" pattern. Disturb a one square meter area in front of the kick-net opening by rubbing rocks and agitating the streambed with hands and/or boots for at least one minute. **Apportion the 20 stops** according to the substrate type and abundance. For example, if rocky substrate dominates, but one-third of the habitat consists of snags and root wads, make 15 stops in rocky habitat and 5 stops (jabs & sweeps) in the snags/root wads. The **length of the NHRSAT transect** is determined by the linear distance required to make 20 well-spaced "stops". For instance, a 3-foot wide stream would require a longer transect than a 30-foot wide stream in order to sufficiently separate the 20 "stops".
- Once 20 stops have been completed, empty contents of the net into pans for **sorting**. Extract organisms with slotted spoons or pipettes and transfer them to a divided container for identification. It is critical to identify as many different organisms as possible while keeping a mental tally of the number of organisms present in each order. Therefore, it is not necessary to transfer every individual into the divided tray but merely representatives from each order, as long as an estimation of their density relative to the entire community can be assessed.
- **Record** invertebrate data on the "Streamside Macroinvertebrate Survey" field sheet.
- Once a team member has completed sorting, another team member should double-check for macroinvertebrates overlooked in the sorting pan, as **Quality Control**.

Physical measurements

- Perform the in-stream **physical measurements** after the invertebrate collection is complete, or has progressed upstream, so that the substrate is not disturbed prior to kick-netting.
- At one-third, one-half, and two-third intervals along the transect reach, measure the **wetted perimeter** and record as "channel width" on the field sheet.
- At all of the width measurement sites, measure **stream depth** at one-third, one-half, and two-thirds across the channel and record as "channel depth" on the field sheet.
- Locate **pools** situated in transect reach. Measure depth and record minimum, maximum and average depths on field sheet.

⊕ Measure out at least a 20' (25' is preferable) segment of stream length to perform **velocity measurements**. Use a neutrally buoyant object and time its passage along the measured length from point-to-point. Make sure that the neutrally buoyant object is placed in the stream/river well above the starting point for timing. This will allow the object to achieve full velocity before timing begins. Do this at least three times and record those times on the field sheet. Be sure to record both the time elapsed, and length traveled, on the field sheet.

⊕ Conduct the **Pebble Count** and record particle sizes on the pebble count form. The pebble count is a 50-particle survey performed by crossing the channel in an upstream direction while “zig-zagging” back and forth up the channel. Select a particle by placing your index finger on the streambed where the front of your foot rests. Separate the fifty selections such that you will cover the entire NHR SAT transect length during the pebble count. Measure across the intermediate axis² of the particle using Vernier calipers or a metric ruler, while another team member records the particle’s size class on the “Pebble Count” field sheet. Use the sum of each of the size classifications to **calculate** the percent of the 50 particles that are sand, and the percent that are boulder, cobble, or coarse gravel. These percentages will be needed for the visual assessment component of NHR SAT.

⊕ Complete the “**Erosion Classification Scoring Table**” and the **visual assessment** components of the NHR SAT evaluation/scoring form.

⊕ It is important to consider that some stream reaches may never achieve an “excellent” rating because of limitations derived from stream type, rather than disturbance or pollution. This fact makes it critical to select a **reference reach to compare with your site**. The reference reach is another stream of comparable dimensions, flow, watershed area, and geology, which is determined to be relatively unaffected by disturbance or pollution. The NHR SAT score of this “pristine” stream reach will give you an indication of how your transect of interest would have scored without the effects of disturbance or pollution.

¹ Optional equipment. The Yellow Springs Instruments (YSI) multi-parameter/datasonde unit is a piece of equipment which allows DO, DO%, conductivity, pH, turbidity, and temperature values to be collected at the site. If a YSI datasonde or similar instrument is not available, a **thermometer must be used to collect temperature data**.

² The “intermediate axis” is the measurement across the particle perpendicular to the longest axis measurement.

Stream and Riverbank Erosion Classification Scoring Table

Erosion Factor	Factor Description and Associated Value						Score Range	Site Score and Comments
Stream or Riverbank Material	Bedrock (1)	Gravel (2)	Clay (3)	Sand (4)			1 to 4	
Bank Height	Low <5ft (1)	Med 5-10ft (2)	High 10-20ft (4)	Very High >20ft (8)			1 to 8	
Bank Slope	Flat >4:1 (1)	Med 4-2:1 (2)	Steep <2:1 (6)	Vertical/Undercut (8)			1 to 8	
Degree of Vegetation	Heavy (1)	Moderate (2)	Sparse (4)	None (7)			1 to 7	
Number of Erosion Indicators	One (1)	Two (2)	Three (3)	Four (4)	Five (5)	Six (6)	1 to 6	
Eroded Bank Length	0 - 10ft (1)	10 - 20ft (2)	20 - 30ft (3)	30 - 40ft (4)	40 - 50ft (5)	50ft. + (6)	1 to 6	
Total Score Range							6 to 39	Erosion Indicators Score

Slope is estimated as 4:1 where 4 equals horizontal units to 1 vertical unit

Erosion Indicators include observed active erosion, seeps and springs, superficial slides, mass wasting and undercut toe.

Flow/Discharge Calculation (cubic feet/second):

Flow = ALC/T Where: A = Average Width (ft) X Average Depth (ft)
 L = Length of Measured Velocity Distance (ft)
 C = Correction Factor of .8 for rocky substrate or .9 for muddy substrate
 T = Time (seconds)

ft ³ /sec

Notes:

New Hampshire Rapid Stream Assessment Technique (NHRSAT) Pebble Count Field Sheet

s=sand (<2mm), g=gravel (2-16mm), cg=coarse gravel (16-64mm), c=cobble (64-256mm), b=boulder (>256mm)

transect																									
size class	s	g	cg	c	b	s	g	cg	c	b	s	g	cg	c	b	s	g	cg	c	b	s	g	cg	c	b
pebble 1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
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49																									
50																									
totals:																									

New Hampshire Rapid Stream Assessment Technique (NHRSAT)

Streamside Macroinvertebrate Survey



Macroinvertebrate Survey	Water Quality Rating																																												
<p>Type of Sampling (check one) Rocky Bottom _____ Muddy Bottom _____</p> <p>Muddy Bottom Sampling Only: Record the number of jabs & sweeps taken in each habitat type.</p> <p>Vegetated bank & root wads _____</p> <p>Snags and logs _____</p> <p>Aquatic vegetation beds _____</p> <p>Silt/sand/gravel substrate _____</p>	<p>Calculate the index value by adding the number of letters found in the three Groups (I, II and III) and multiply by the indicated weighting factor.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 33%; text-align: center;"> Group I _____ (# of R's) x 5.0 total _____ _____ (# of C's) x 5.6 total _____ _____ (# of D's) x 5.3 total _____ Sum of the Index Value for Group I _____ </td> <td style="width: 33%; text-align: center;"> Group II _____ (# of R's) x 3.2 total _____ _____ (# of C's) x 3.4 total _____ _____ (# of D's) x 3.0 total _____ Sum of the Index Value for Group II _____ </td> <td style="width: 33%; text-align: center;"> Group III _____ (# of R's) x 1.2 total _____ _____ (# of C's) x 1.1 total _____ _____ (# of D's) x 1.0 total _____ Sum of the Index Value for Group III _____ </td> </tr> </table>	Group I _____ (# of R's) x 5.0 total _____ _____ (# of C's) x 5.6 total _____ _____ (# of D's) x 5.3 total _____ Sum of the Index Value for Group I _____	Group II _____ (# of R's) x 3.2 total _____ _____ (# of C's) x 3.4 total _____ _____ (# of D's) x 3.0 total _____ Sum of the Index Value for Group II _____	Group III _____ (# of R's) x 1.2 total _____ _____ (# of C's) x 1.1 total _____ _____ (# of D's) x 1.0 total _____ Sum of the Index Value for Group III _____																																									
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Macroinvertebrate Community Count																																													
<p>Identify the macroinvertebrates in the sample and assign them letter codes based upon their abundance: R (rare) = 1-9 organisms; C (common) = 10-99 organisms; and D (dominant) = greater than 100.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 33%; text-align: center;">Group I Sensitive</td> <td style="width: 33%; text-align: center;">Group II Somewhat-Sensitive</td> <td style="width: 33%; text-align: center;">Group III Tolerant</td> </tr> </table> <table style="width: 100%; border: none;"> <tr> <td style="width: 33%;">_____ Mayfly Nymph</td> <td style="width: 33%;">_____ Beetle Larvae</td> <td style="width: 33%;">_____ Aquatic Worms</td> </tr> <tr> <td>_____ Stonefly Nymph</td> <td>_____ Clams</td> <td>_____ Blackfly Larvae</td> </tr> <tr> <td>_____ Water Penny</td> <td>_____ Crane-fly Larvae</td> <td>_____ Leeches</td> </tr> <tr> <td>_____ Hellgrammite</td> <td>_____ Crayfish</td> <td>_____ Midge Larvae</td> </tr> <tr> <td>_____ Riffle Beetle</td> <td>_____ Damselfly Nymph</td> <td>_____ Snails</td> </tr> <tr> <td>_____ Gilled Snail</td> <td>_____ Dragonfly Nymph</td> <td></td> </tr> <tr> <td>_____ Caddisfly Larvae (case builders and freelifving)</td> <td>_____ Scuds</td> <td></td> </tr> <tr> <td></td> <td>_____ Sowbugs</td> <td></td> </tr> <tr> <td></td> <td>_____ Fishfly Larvae</td> <td></td> </tr> <tr> <td></td> <td>_____ Alderfly Larvae</td> <td></td> </tr> <tr> <td></td> <td>_____ Caddisfly Larvae (net-spinners)</td> <td></td> </tr> </table>	Group I Sensitive	Group II Somewhat-Sensitive	Group III Tolerant	_____ Mayfly Nymph	_____ Beetle Larvae	_____ Aquatic Worms	_____ Stonefly Nymph	_____ Clams	_____ Blackfly Larvae	_____ Water Penny	_____ Crane-fly Larvae	_____ Leeches	_____ Hellgrammite	_____ Crayfish	_____ Midge Larvae	_____ Riffle Beetle	_____ Damselfly Nymph	_____ Snails	_____ Gilled Snail	_____ Dragonfly Nymph		_____ Caddisfly Larvae (case builders and freelifving)	_____ Scuds			_____ Sowbugs			_____ Fishfly Larvae			_____ Alderfly Larvae			_____ Caddisfly Larvae (net-spinners)		<h3 style="text-align: center;">Water Quality Score and Assessment</h3> <p>To calculate the Water Quality Score for the stream/river site, add the sum of the Index Values from Groups I, II and III together. The sum of these values equals the water quality score.</p> <p style="text-align: center; font-size: 1.2em;">Water Quality Score _____</p> <p>Compare the Water Quality Score to the following number ranges to determine the quality of the stream/river site.</p> <table style="margin-left: auto; margin-right: auto; border: none;"> <tr> <td style="padding-right: 20px;">Excellent</td> <td style="text-align: right;">> 40</td> </tr> <tr> <td>Good</td> <td style="text-align: right;">30 - 40</td> </tr> <tr> <td>Fair</td> <td style="text-align: right;">15 - 30</td> </tr> <tr> <td>Poor</td> <td style="text-align: right;">< 15</td> </tr> </table>	Excellent	> 40	Good	30 - 40	Fair	15 - 30	Poor	< 15
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Adapted from: *Volunteer Stream Monitoring: A Methods Manual*, USEPA (841-B-97-003), November 1997.

New Hampshire Rapid Stream Assessment Technique (NHRSAT) Scoring Matrix

1: Streambed Geology				
	Excellent	Good	Fair	Poor
Embeddedness ^(P-1)	Riffle embeddedness <25% sand/silt (<35%for large mainstem areas)	25-49% embedded (35-59% for large mainstem areas)	50-75% embedded (60-85% for large mainstem areas)	>75% embedded (>85% embedded for large mainstem areas)
point range	4	3	2	1
Percent Composition ^(P-1)	Percent substrate composition as boulder, cobble and coarse gravel (>50%)	Percent substrate composition as boulder, cobble and coarse gravel (25-50%)	Percent substrate composition as boulder, cobble and coarse gravel (5-24%)	Percent substrate composition as boulder, cobble and coarse gravel (<5%)
point range	4	3	2	1
2: Physical Instream Habitat				
	Excellent	Good	Fair	Poor
Wetted Perimeter ^(V)	Wetted perimeter >85% of bottom channel width (>90%for large mainstem areas)	Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	Wetted perimeter 40-60% of bottom channel width (45-65%for large mainstem areas)	Wetted perimeter <40% of bottom channel width (<45%for large mainstem areas)
point range	4	3	2	1
Pool Availability ^(V)	Large pools generally >24" deep (>48" for large mainstem areas) with good overhead cover/structure	Large pools generally 18 to 24" deep (36-48" for large mainstem areas) with some cover/structure	Large pools generally 12-18" deep (24-36" for large mainstem areas) with little or no cover/structure	Large pools generally <12" deep (<24" for large mainstem areas) devoid of cover/structure
point range	4	3	2	1
Flow Regimes ^(V)	Riffles, runs, pools present. Diverse velocity and depth of flow present	Riffles, runs, pools present. Relatively diverse velocity/depth of flow	Few pools present, riffles/runs dominant. Velocity/depth generally slow/shallow (large mainstem areas, runs/pools dominant with velocity/depth intermediate)	Dominated by one habitat type and one velocity/depth condition
point range	4	3	2	1
Channel Alteration ^(V)	No channel alteration or significant point bar formation or enlargement	Slight increase in point bar formation enlargement or slight amount of channel modification	Moderate increase in point bars and/or in amount of channel modification	Extensive channel alteration or point bar formation/enlargement
point range	4	3	2	1
Streamflow ^(P-2)	Streamflow is greater than 2 cfs	Streamflow is between 1.2 and 2 cfs	Streamflow is between 0.4 and 1.2 cfs	Streamflow is less than 0.4 cfs
point range	4	3	2	1
Temperature ^(P-3)	Summer afternoon water temperature less than 68° F (20°C)	Summer afternoon water temperature 68-74.9° F (20 - 24°C)	Summer afternoon water temperature 75-80° F (24 - 27°C)	Summer afternoon water temperature >80° F (>27°C)
point range	4	3	2	1

3: Riparian Habitat Conditions				
	Excellent	Good	Fair	Poor
Buffer Width/Condition ^(V)	Wide, forested buffer on both sides of channel. Buffer width >18m (60')	Vegetated/forested buffer generally between 12 to 18m (40 to 60') wide along major portion of both banks	Riparian area predominantly wooded but with major localized gaps. Buffer width 6 to 12m (20 to 40')	Riparian area mostly non-woody vegetation. Narrow width riparian area less than 6m (20')
point range	4	3	2	1
Canopy ^(V)	Canopy coverage > 80% shading (60% for large mainstem areas)	Canopy coverage 60-79% shading (45-59% for large mainstem areas)	Canopy coverage 50-60% shading (30-44% for large mainstem areas)	Canopy coverage <50% shading (<30% for large mainstem areas)
point range	4	3	2	1
4: Biological Indicators				
	Excellent	Good	Fair	Poor
Macroinvertebrate Community ^(P-4)	Excellent diversity. Good representation from Group I (sensitive) with stoneflies, mayflies and case building caddisflies typically present. Survey Score is >40	Good overall diversity although stoneflies may be absent. Mayflies and caddisflies may dominate sample. Strong representation from Group II. Survey Score is between 30 and 40	Diminished diversity. Pollution tolerant caddisflies, some mayflies, snails and midges common. Poor representation from Group I. Survey Score is between 15 and 29.9	Poor diversity, generally dominated by midgeflies, aquatic worms and snails. Insects from Groups II and III dominate community. Survey Score is <15
point range	4	3	2	1
5: Streambank Erosion Indicators				
	Excellent	Good	Fair	Poor
Total score obtained from <i>Riverbank Erosion Classification Scoring Table</i> ^(V)	5 to 9.9	10 to 19.9	20 to 30	> 30
point range	4	3	2	1

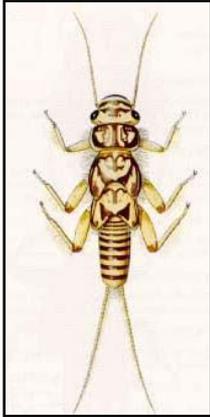
V = Visual Assessment

P = Physical Assessment (P-1 = Modified Wolman Pebble Count; P-2 & P-4 = Procedure from *EPA Volunteer Stream Monitoring: A Methods Manual*; P-3 = YSI 6820/650MDS)

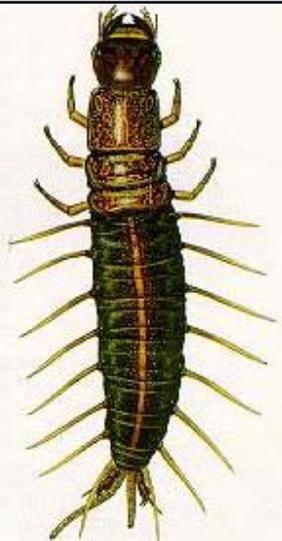
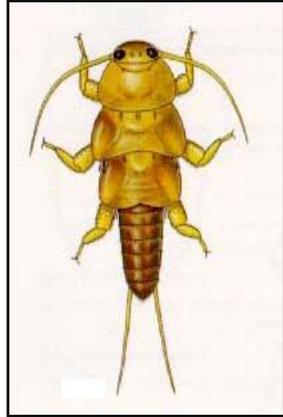
	Excellent	Good	Fair	Poor
Totals				
Combined Site Total				
Stream/River Condition Site Score (site total divided by 12)				

Stream/River Condition Index **Excellent 4.0 - 3.5** **Good 3.49 - 2.5** **Fair 2.49 - 1.5** **Poor 1.49 - 1.0**

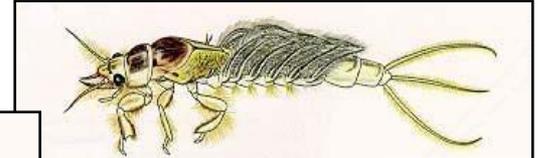
Macroinvertebrates Sensitive to Pollution



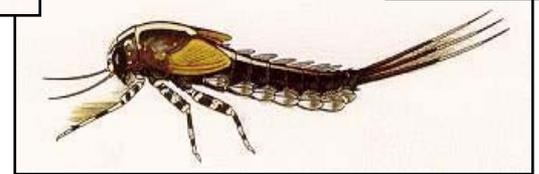
Stonefly Nymphs



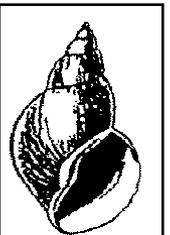
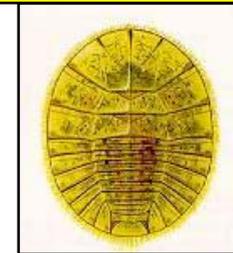
Hellgrammite
(has abdominal gills)



Mayfly Nymphs



Water Penny



Gilled Snail

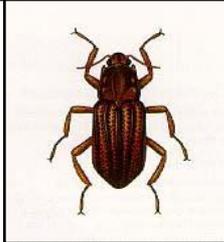
Freeliving Caddisflies



Case-building Caddisflies



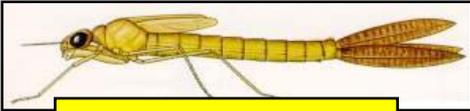
Riffle Beetle Adult



Macroinvertebrates Somewhat Sensitive to Pollution



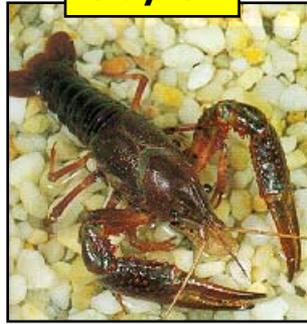
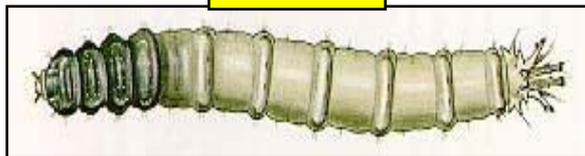
Dragonfly Nymphs



Damselfly Nymphs



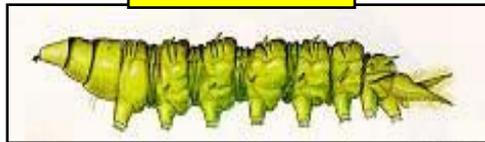
Cranefly



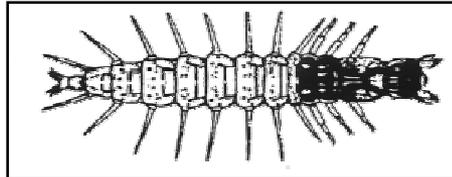
Crayfish



Scuds



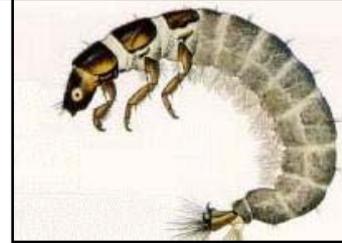
Watersnipe



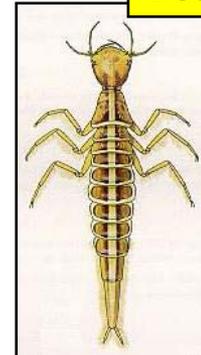
Fishfly
(no abdominal gills)



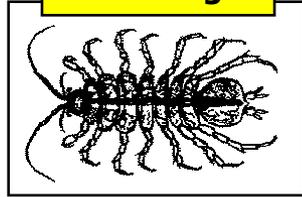
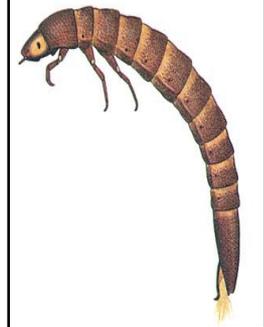
Net-spinning Caddisflies



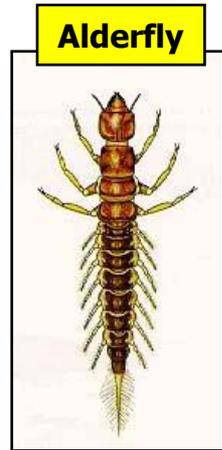
Clams



Beetle Larvae

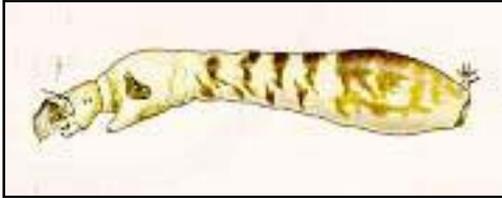


Sowbug



Alderfly

Macroinvertebrates Tolerant to Pollution



Blackfly Larvae

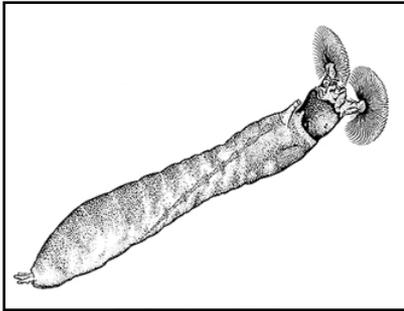
Rat-tailed Maggot



Lunged Snail



Aquatic Worms



Midge Larvae

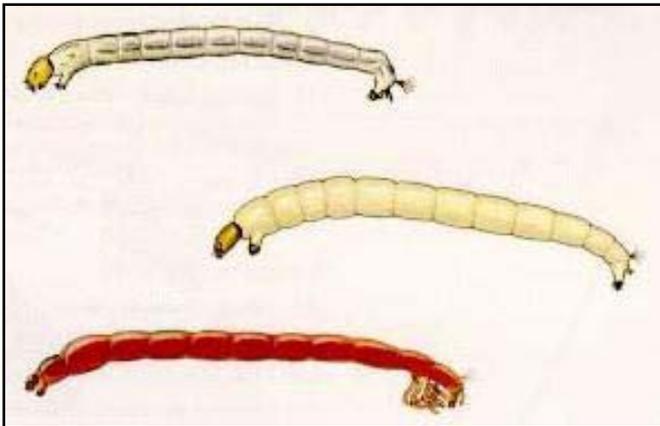
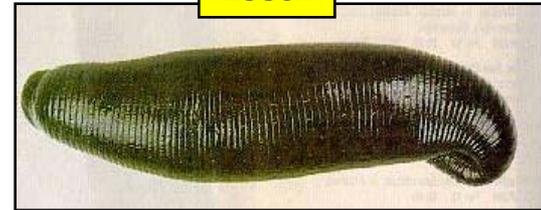
Deer Fly Larvae



Soldier Fly



Leech





NH Rapid Stream Assessment Technique Field Sampling Audit Checklist

Date: _____ Start Time: _____ End Time: _____

Site: _____

Volunteer Monitors Present (First and Last Names): _____

Auditor Present (Print): _____ (Signature): _____

1. Site Information and Documentation		
	Yes	No
A) Site selected based upon the 400' reach-break or distinctive stream-type change criteria		
B) Date, time, location, directions, weather information entered on field sheet		
C) GPS coordinates entered and serial number of GPS unit recorded under "notes" section		
D) If GPS coordinates could not be acquired, does site sketch contain enough detail to geo-reference the site at a later date using remote mapping resources		
E) Photographs taken depicting upstream/downstream perspectives		
F) Photographs taken of major features (stream morphology, erosion indicators, buffers etc.)		
G) Temperature reading recorded under Section 2 of NHRSAT Scoring Matrix		
Audit Pass (If No, provide reason) _____		

2. Macroinvertebrate Collection and Identification		
	Yes	No
A) Kick-net(s) inspected (and cleaned if necessary) prior to use		
B) Kick-net(s) rinsed with stream/river water prior to sample collection		
C) Sorting pans and tri-sector dishes rinsed and then filled with stream/river water		
D) Sorting pans and tri-sector dishes set upon level surface in shaded area		
E) Visual in-stream habitat assessment (riffles, pools, runs etc.) completed prior to sample collection		
F) Twenty "stops" with kick-net(s) apportioned appropriately based upon habitat availability		
G) Minimum 1-minute collection effort at each "stop" with kick net(s)		
H) Second party inspection of kick-net(s) once organisms have been transferred to sorting pans		
I) Macroinvertebrates sorted into pollution tolerance groups in tri-sector dishes		
J) Photograph taken of tri-sector dish (placed on reverse side of identification key) once sorting is complete		
K) Macroinvertebrate Survey and Community Count sections completed on field sheet		
L) Water Quality Rating and Water Quality Score calculations verified by second party		
M) Water Quality Score transferred to NHRSAT Master Field Sheet and Ranking Matrix		
N) Macroinvertebrates carefully returned to stream/river		
O) Kick-net(s), sorting pans, and tri-sector dishes rinsed and inspected prior to storage		
Audit Pass (If No, provide reason) _____		

3. Physical Measurements		
	Yes	No
A) Wetted perimeter/channel width measurements at 1/3, 1/2, and 2/3 along sampling reach		
B) Stream depths recorded at proper locations (corresponding with wetted perimeter measurement sites)		
C) At least three pool depths recorded		
D) Velocity measurement protocols followed accurately		
E) Flow/discharge calculation verified by second party		
F) Fifty “stops” properly distributed along sampling reach during pebble count		
G) Second party verification of 10% of particles selected and recorded during pebble count		
H) Particle distribution calculated and used to complete Section 1: Streambed Geology of scoring matrix		
Audit Pass (If No, provide reason) _____		

4. Erosion Indicators/Visual Assessment/Master Score Sheet and Scoring Matrix		
	Yes	No
A) Consensus among stream team members for scoring wetted perimeter, pool availability, flow regimes, and channel alteration under Section 2 of scoring matrix		
B) Consensus among stream team members for scoring buffer width/condition and canopy under Section 3 of scoring matrix		
C) Scores transferred accurately from field sheets to NHRSAT scoring matrix		
D) Totals for each scoring category (excellent, good, fair, poor) verified by second party		
E) Combined Site Total and Stream/River Condition Site Score verified by second party		
Audit Pass (If No, provide reason) _____		

Appendix B: VRAP Field Protocols and Field Forms

- Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors
- VRAP 2006 Field Data Sheet
- Sampling Station Identification Form
- VRAP Field Sampling Audit Checklist
- VRAP Water Quality Standards

Deviations from the VRAP Protocols include:

1. Volunteers will only collect measurements of the field parameters, including: water temperature, DO, pH, and conductivity. *E. coli* samples may be collected at targeted points as a follow-up to stream assessment work, as described above in this QAPP.

NH Volunteer River Assessment Program

Water Quality Monitoring Field Sampling Protocols

for Volunteer Monitors



New Hampshire Department of Environmental Services

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www.des.nh.gov/wmb/VRAP/

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Introduction



In 1998, the New Hampshire Department of Environmental Services (NHDES) initiated the New Hampshire Volunteer River Assessment Program (VRAP) as a means of expanding public education of water resources in New Hampshire. VRAP promotes awareness and education of the importance of maintaining water quality in rivers and streams. VRAP was created in the wake of the success of the existing New Hampshire Volunteer Lake Assessment Program (VLAP), which provides educational and stewardship opportunities pertaining to lakes and ponds to New Hampshire's residents.

Today, VRAP continues to serve the public by providing water quality monitoring equipment, technical support, and educational programs. In 2005,

VRAP supported twenty-eight volunteer groups on numerous rivers and watersheds throughout the state. These volunteer groups conduct water quality monitoring on an ongoing basis. The work of the VRAP volunteers increases the amount of river water quality information available to local, state and federal governments, which allows for effective financial resource allocation and watershed planning.

This manual is meant to be used as a guide for VRAP monitors. Take this manual with you when you collect samples as a reminder of the proper procedures. Note: If procedures are not followed, the data may not be valid. This manual is *not* a replacement for training or a DES biologist's visit. We look forward to assisting and visiting you at your river every summer.

For More Information

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VRAP Coordinator

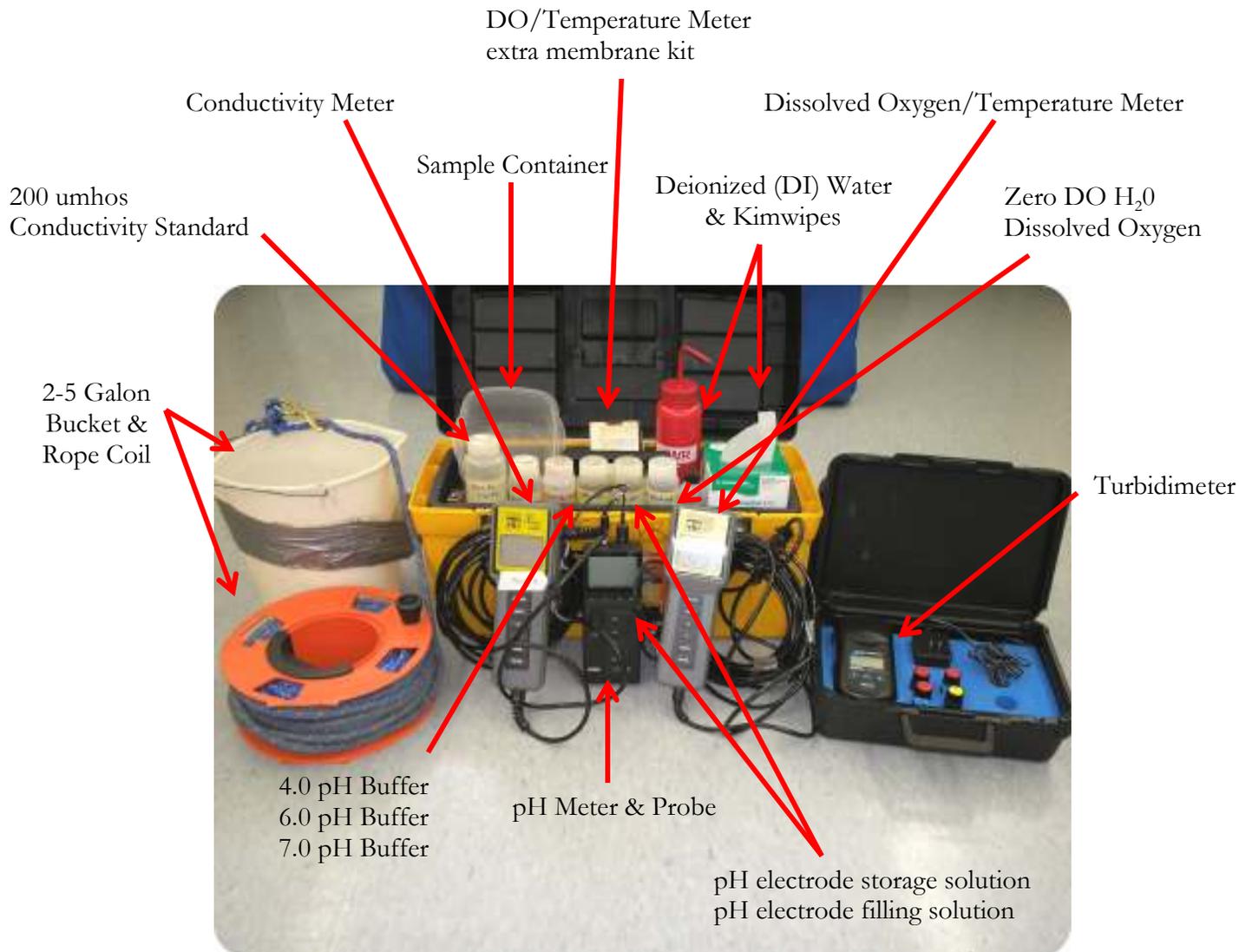
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Equipment & Supplies

Necessary Items



Example of a field kit

Other Necessary Supplies

- ❖ Cooler & Ice Packs (*If sampling for bacteria*)
- ❖ Clipboard & Pencils
(*pencils will write in wet weather*)
- ❖ Batteries (AA and 9V)
- ❖ Masking Tape & Plastic Sample Bottles (*If testing for additional parameters such as TP, TKN, Bacteria, etc*)

Optional Supplies

- ❖ Bug spray
- ❖ Camera
- ❖ Drinking Water & Snack
- ❖ Trash bags
- ❖ Waders/Boots/Shoes that can get wet
- ❖ Warm dry clothes

Before Sampling: Equipment Calibration Procedures

Each meter has a very important calibration procedure, which must be followed to ensure the sampling results are as accurate as possible. If you encounter problems during calibration, refer to the manufacturer's operation manuals in the yellow kit, or contact the VRAP Coordinator.

❖ Dissolved Oxygen/Temperature Meter (*YSI 95 DO/Temp Meter*)

Calibration of the DO/Temp meter is required prior to each individual measurement.

1. Turn on the DO/Temp meter by pressing the **ON/OFF** button. If necessary, press the **MODE** button until dissolved oxygen is displayed in the mg/L or % air saturation.
2. To ensure the probe remains moist inside the DO/Temp meter calibration/storage chamber, pull the probe out and add ten drops of deionized (DI) water to the sponge at the bottom of the calibration/storage chamber. Turn the meter on its side to allow any excess water to drain out of the chamber. *This step will only be necessary once per day, but be sure the sponge in the calibration/storage chamber is moist before storage. Be careful not to over-wet the sponge. Calibrate the meter after excess "puddled" water is drained from the chamber.*



Note: The wet sponge creates a 100% saturated air environment within the chamber for ideal calibration conditions. Ensure that the DO sensor does not contact the wet sponge by inserting the probe only until the rubber seal is flush with the outer edge of the chamber.

3. Unscrew the black protective cage from the end of the probe and without any contact with the membrane surface. Examine the tip (a white disk surrounded by a black circle) for any obvious air bubbles trapped beneath the membrane surface.

If Air Bubbles Are NOT Detected:

4. Replace the protective cage, rinse the probe, and return it to the calibration chamber.
5. **Make sure the meter has been on for 15 minutes before calibrating.** Record the time the dissolved oxygen meter was turned on - on the upper right front page of the VRAP Field Data Sheet.
6. Record the time of the first dissolved oxygen calibration on the upper right front page of the VRAP Field Data Sheet.
7. Press and release both the **DOWN** and **UP** arrow buttons (**DOWN** arrow slightly prior to **UP** arrow) to enter the DO/Temp meter calibration menu. You will see **CAL** in the lower left hand corner when you have successfully entered calibration mode.
8. The screen will prompt you to enter the local altitude in hundreds of feet. Use the **UP** and **DOWN** arrows to adjust the reading appropriately (For example, entering a 12 indicates 1200 feet above sea level) and press **ENTER**.
9. The screen will prompt you to enter the salinity of the sample you will be measuring. Be sure the screen reads zero and press **ENTER**. Then press **ENTER** again and the display should read "SAVE" and then return to normal measurement mode.
10. **Record the calibration value displayed on the screen (typically 98.9%) on the VRAP Field Data Sheet. This number is located in the bottom right hand corner of the screen.** Watch to ensure that this number does not drift (i.e. goes from 98.9% to 96.7% within a few minutes). If drift occurs first check the sponge in the chamber to ensure that it is saturated. Also check the condition of the membrane again and replace if air bubbles are present or the membrane is damaged. The value will vary with altitude.
11. **Leave the meter on until you are finished with all measurements for the day. Calibration must be repeated before each individual measurement. If the meter shuts off, you must wait 15 minutes before calibrating.**
12. In rare cases you may measure the DO concentration of saline (salt) waters. If so, use the conductivity meter to determine the salinity before completing the DO/Temp Meter Calibration procedure. (Use arrow keys to adjust the reading to the appropriate salinity and press **ENTER**).

If Air Bubbles ARE Detected:

1. Thoroughly rinse the sensor tip (gold and silver areas) with DI water.
2. Hold the membrane cap and add 6 to 7 drops of the probe solution (about 1/2 full) that is included in the DO membrane replacement kit.
3. Tap the bottom of the cap with your finger a few times to remove any trapped air bubbles. Caution: Do not touch the membrane surface.
4. Screw the membrane cap tightly onto the probe (to prevent leakage of probe solution). A small amount of probe solution should overflow.

❖ Orion 210A pH Meter

The calibration procedure is required prior to each individual pH measurement.

1. Ensure electrode connections are properly fastened in the appropriate ports.
2. Unscrew the cap on the Electrode Storage Container and remove the end of the pH probe (the screw cap can remain on the electrode). Clean any salty deposits off by rinsing the probe with DI water. Blot dry.
3. If necessary, remove the blue plug from the hole in the side of the probe and refill the electrode with pH electrode filling solution (it may have spilled out). Fill to just below the hole, at least one inch above sample level. Return the blue plug to the hole in the side of the probe for storage and travel between sites. Remove the plug during calibration and sampling.
4. Shake air bubbles from the measurement end (opposite the wires), by gently tapping the outside of the probe against your finger.
5. Press the **POWER** key to turn the meter on. All the features of the display will light up. Then the model number, “210”, will be displayed. Once all power up procedures are complete the meter advances to “MEASURE” mode.



For the first time operation, or if any problems are encountered, it is recommended that the Check Out procedure on page 11 of the Model 210A pH Meter Instruction Manual is carried out before using the meter.

6. Select calibration mode by pressing the **MODE** key until “CALIBRATE” is displayed.

First Standard to Test (7.0 pH Buffer):

7. The last calibration standards, or “buffers”, used will be displayed (7 and 4). Press **YES** to accept this setting. “P1” will be displayed in the lower display field and the standard measurement will be displayed in the main display field. A black arrow will be displayed on the bottom of the screen pointing to 7 indicating that the meter is ready to measure the 7.0 buffer.
8. Rinse the electrode with DI water and blot dry with a Kimwipe.
9. Remove the blue plug from the side of the electrode and immerse the probe into the 7.0 buffer (yellow solution). Allow at least one inch of the pH electrode filling solution volume inside the probe to remain above the sample and standard level during measurement/calibration.
10. When “**READY**” is displayed (Watch for it- it comes and goes quickly!) the electrode is stabilized. Press **YES** while “**READY**” is displayed.



Second Standard to Test (4.0 pH Buffer):

Note: “P2” will be displayed in the lower display field - indicating the meter is ready for the second standard. Make sure “P2” appears before continuing. If it does not appear, keep the electrode in the 7.0 buffer until “READY” appears again and press **YES**. A black arrow will be displayed on the bottom of the screen pointing to 4 indicating that the meter is ready to measure the 4.0 buffer.

10. Remove the electrode from the 7.0 buffer, rinse it with DI water and blot dry with a Kimwipe.

11. Place the electrode in the second (4.0) buffer. When “READY” is displayed press **YES**. WATCH!

12. “SLP” (Slope Value) will appear in the lower display field and the current electrode slope will be displayed in the main field. Record the number on your VRAP Field Data Sheet. An acceptable range for the slope is 92-102%. If you miss the slope, repeat calibration procedure. If you get a slope outside of this range repeat the calibration procedure and check the batteries. If the slope is still outside of the range do not use the meter for that day and notify the VRAP Coordinator immediately.

13. The meter will proceed to the measure mode; “MEASURE” is displayed above the main display field. Remove the electrode from the 4.0 buffer, rinse with DI water and blot dry. The meter is now ready for use.

14. Place the electrode **VERTICALLY** in the storage solution container, being careful not to hit the bottom of the container with the probe and screw the cap on the container. Secure the blue plug in the electrode and set the meter in the kit until you are ready to take a reading (**remember, you will have to press the POWER key twice to restore power if a half hour or more has elapsed between calibration and sampling**).

Rinse the storage solution from the probe before any pH measurements and remember to calibrate between samples.

❖ *LaMotte 2020 Turbidimeter*

1. From the turbidimeter case (black, separate from the VRAP Kit) remove the standard vial marked “1.0 NTU” (if readings at this site tend to be greater than 8, use the “10 NTU” vial and note on data sheet) and carefully wipe off any water, dust and/or fingerprints with a Kimwipe only.

2. Open the lid of the turbidimeter and align the etched arrow on the “1.0 NTU” tube. With the arrow under the meter lid, insert the tube into the chamber and close the lid.

3. Press the **READ** button. A triangle should be displayed in the upper left corner of the display screen.

Note: If the triangle is not displayed, turn the meter off by holding the **READ** button down until the screen reads **OFF**.



Press the **CAL** button while pressing the **READ** button to turn the meter on. If the triangle does not appear, gently repeat this step until it does. This step places the meter into “EPA mode”, which means the meter will automatically round readings to Environmental Protection Agency standards for uniform data reporting.

4. If the displayed value is the same as the 1.0 (or 10.0) NTU Standard, calibration is not necessary at this time. Record 1.0 (or 10.0) on the top left of the field data sheet as the Initial Turbidity Calibration Value.
5. If the displayed value differs from the standard value (1.0 NTU), record the value on the top left of the VRAP Field Data Sheet as the initial Turbidity Calibration Value, and push the **CAL** button until “**CAL**” is displayed. Release the button. The display will flash.
6. Adjust the reading with the up and down buttons, indicated with arrows, until the value of the standard is displayed.
7. Push the **CAL** button again to complete calibration.
8. Hold the **READ** button down until **OFF** is displayed on the screen to turn the meter off.

❖ *YSI 30 Conductivity Meter*

Note: The YSI Model 30/30M looks much like the DO/Temp meter.

1. Turn the meter on by pressing the **ON/OFF** key. The meter will activate all segments of the display screen for a few seconds, followed by a self-test. If the meter is not functioning properly, a continuous error message will be displayed. See Section 9 of the meter manual for a list of error messages.
2. If the “°C” is not flashing on and off, press the **MODE** key until it does. This puts the meter into the temperature compensated mode.
3. Rinse probe with DI water and blot dry with a Kimwipe.
4. Submerge the probe in the 200 μ S conductivity standard solution, and allow to stabilize for two minutes. Be sure there is enough solution to cover the top opening of the probe.
5. Record on the Initial Specific Conductance Calibration Value on the top left of the VRAP Field Data Sheet. Be sure there are no air bubbles on or inside the probe. A reading of 175-225 μ S is acceptable. If the readings are outside of this range you can still take measurements but please contact the VRAP Coordinator as soon as possible.
6. Rinse the probe with DI water, blot dry with a Kimwipe, and return it to the storage chamber.



Quality Assurance & Quality Control

In order for VRAP data to be used in the assessment of New Hampshire's surface waters, the data must meet quality control guidelines as outlined in the VRAP Quality Assurance Project Plan (QAPP). The VRAP QAPP was approved by NHDES and reviewed by EPA in the summer of 2003. The QAPP is reviewed annually and is officially updated and approved every five years. The VRAP Quality Assurance/Quality Control (QA/QC) measures include a six-step approach to ensuring the accuracy of the equipment and consistency in sampling efforts.

1. **Calibration:** All meters are calibrated before the first measurement and after the last one. Prior to each measurement, the pH and dissolved oxygen meters are calibrated.
2. **Replicate Analysis:** A second measurement by each meter is taken from the original sample at one of the stations during the sampling day. The replicate analysis should not be conducted at the same station over and over again, but should be conducted at different stations throughout the monitoring season.
3. **6.0 pH Standard:** A reading of the pH 6.0 buffer is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the 6.0 pH standard check should be conducted at different stations.
4. **Zero Oxygen Standard:** A reading of a zero oxygen solution is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the zero oxygen standard check should be conducted at different stations.
5. **DI Turbidity Blank:** A reading of the DI blank is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the blank check should be conducted at different stations.
6. **Post-Calibration:** At the conclusion of each sampling day, the turbidity and conductivity meters are calibrated.

Sample Collection for Field & Laboratory Analysis

Order of Field Tests

- ❖ Turbidity
- ❖ PH
- ❖ Water Temperature
- ❖ Dissolved Oxygen
- ❖ Air Temperature
- ❖ Specific Conductance

Note: Pour off water for laboratory test(s) before sampling field water quality.

Please label all bottles *prior to filling them* with the date and time of collection, Station Name/Number, collector's initials and the test(s) requested.

You are now ready to travel to your first sampling site. Start with the most downstream sampling location so that monitoring activities do not affect water quality at downstream sites.

BRIDGE SAMPLING:

1. Lower the bucket from the **upstream** side of the bridge into the river and fill the bucket $\frac{1}{2}$ - $\frac{3}{4}$ full of water. Pull the bucket up, swish the water around in the bucket to rinse, and dump the water off the downstream side of the bridge. Repeat this process two more times.



2. Return the bucket to the river on the **upstream** side of the bridge and fill the bucket $\frac{1}{2}$ - $\frac{3}{4}$ full of water as slowly as possible (you may wish to weight one side of the bucket).

3. Pull the bucket up and carry to a safe location (away from the road!) for analyses.

4. If you are collecting samples for analysis of additional parameters, pour water from your bucket into labeled bottles and preserve them properly (in a cooler on ice). Submit the samples to the laboratory within the sample holding time appropriate to each test (for more information, call NHDES Laboratory Services at 271-3445).



OFFSHORE SAMPLING:

1. Carefully wade out into the river until the flowing portion of the water is comfortably within arm's reach. Do not enter the water above your waist, and do not enter the water if there is any concern for your safety. Be sure to have someone on shore that knows where you are. DES highly recommends that volunteers wear an appropriate personal floatation device when working in or near the water.
2. Position yourself facing **upstream** and rinse the bucket in the river three times. **Do not collect the water that is running over your legs/boots.**
3. With the bucket facing **upstream** and held in front of your body, slowly dip the lip of the bucket into the flowing water and allow the bucket to fill. Rivers receive oxygen from the atmosphere through mixing. Just as riffles and rapids increase the oxygen in a river or stream, rushing water over the side of the bucket will add oxygen to the sample and yield inaccurate readings.
4. Carefully return to shore with the bucket $\frac{1}{2}$ - $\frac{3}{4}$ full and place it on the bank for immediate analysis.

DES LABORATORY ANALYSIS

If you are collecting samples for laboratory analysis, wade out into the river and collect water in the bucket. On shore, transfer the water to labeled and prepared bottles (some bottles contain acids that should not be released into the river). Preserve them properly (in a cooler on ice), and submit the samples to the laboratory within the sample holding time appropriate to each test (for more information, call DES Laboratory Services at 271-3445).

4. If the sample is to be analyzed for *E. coli*, wade out into the river, open a labeled, sterilized *E. coli* bottle and turn it upside-down before immersing it in the river. Be careful not to put your fingers or any other material on any surface on the inside of the bottle. Move the bottle from downstream to upstream as you fill the bottle. Dip the bottle into the river in a "U"-shaped scooping motion, turning the bottle right side-up at the bottom of the "U". **Do not collect the water that is running over your legs/boots.**
5. Replace the cap on the bottle and carry the sample to shore. Preserve the bacteria sample properly (in a cooler on ice) and submit the sample to a laboratory within the sample holding time appropriate to the test (usually 6 hours). All samples should be kept on ice.

❖ Sampling Turbidity (*LaMotte 2020 Turbidimeter*)

Note: The Turbidimeter needs to be calibrated twice per sampling date (one prior to the first measurement and once after the last measurement). Please turn the meter off when not in use to conserve battery power.

1. Rinse the plastic sample container with DI water. Then rinse the same container twice with a small amount of river water from the bucket.
2. Pour sample water from the bucket into the plastic sample container (2/3 full) slowly to avoid adding bubbles to the sample.
3. From the Turbidimeter case remove the vial labeled “Sample” or “S” and rinse it out with DI water.
4. Rinse the vial twice with river water from the plastic sample container.



5. Fill the vial with river water by carefully and slowly pouring the water down the side of the sample vial to avoid introducing any bubbles.
6. Wipe any water, dust and/or fingerprints with a Kimwipe. **Note:** Any residue on the vials will interfere with an accurate turbidity reading. Anything other than Kimwipes may scratch the vials, causing inaccurate readings.



7. Open the lid of the Turbidimeter and align the etched arrow on the cleaned (“Sample”) vial with the arrow under the Turbidimeter lid, and 8) Close the lid.



9. Push the **READ** button. A triangle should be displayed in the upper left corner of the display screen.

If the triangle is not displayed, turn the meter off by holding the **READ** button down until the screen reads **OFF**. Press the **CAL** button while pressing the **READ** button to turn the meter on. If the triangle does not appear, gently repeat step this step until it does. This step places the meter into “EPA mode”, which means the meter will automatically round readings to Environmental Protection Agency standards for uniform data reporting.



10. Record the displayed turbidity reading on the VRAP Field Data Sheet.

11. Turn the meter off by holding the **READ** button down until the screen reads “OFF”. Remove the sample vial, empty it and rinse with DI water.

12. At the end of the day, recalibrate the meter and record the 1.0 standard value in the “End of Day Meter Calibration” section on the back of the VRAP Field Data Sheet. Lastly, fill the sample vial with DI water.

❖ Sampling PH (*Orion 210A pH Meter*)

Note: pH meter must be calibrated prior to each pH measurement

1. Remove the probe from the meter (avoid touching the measurement end), rinse with DI water and blot the plastic areas dry with a Kimwipe.

2. Remove the blue plug from the probe and ensure it is clean.

3. Immerse the pH probe into the plastic sample container and remove the blue plug from the side of the electrode. (Press the **POWER** key twice if the display screen has gone blank, this will occur if a half hour or more has elapsed since the last key was pressed.) The meter should be in the “MEASURE” mode. **Important: Do not let the electrode sit on the bottom of the sample container. Submerge the bottom two inches of the electrode and agitate by slowly moving the electrode back and forth in the sample for a minimum of two minutes for the pH reading to stabilize.** Be careful not to submerge/let water into the probe.

3. With the “**READY**” indicator displayed (WATCH!), record the value on the VRAP Field Data Sheet.



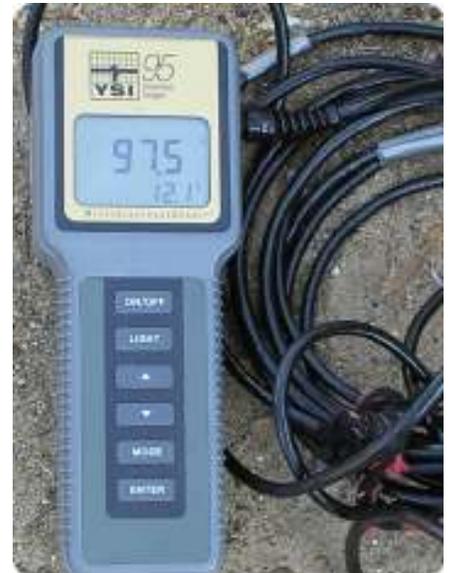
- Rinse the probe with DI water and return it to the storage chamber containing pH electrode storage solution. Make sure the pH electrode storage container is filled about half way with *pH Electrode Storage Solution* and ensure that the electrode is immersed in the storage solution. Be careful not to push the electrode against the bottom of the container as this could damage the electrode.
- Return the meter and the probe to the VRAP Kit. Set the probe upright, and be sure the blue cap is secured in the probe, even with a little masking tape. This will help preserve the equipment.

❖ Sampling Dissolved Oxygen, Water & Air Temperature (*YSI 95 DO/Temp Meter*)

Note: The DO meter must be calibrated prior to each DO measurement.

Dissolved Oxygen (mg/L and % Saturation)

- Remove the DO/Temp probe from the calibration chamber, rinse the probe and cable (approximately 6 inches) with DI water, and blot dry with a Kimwipe.
- Submerge the DO/Temp probe about 2/3 of the way into the large bucket and agitate by slowly moving the probe back and forth in the sample for a minimum of two minutes for the temperature and dissolved oxygen readings to stabilize. Some bouncing will occur due to the probes' sensitivity. Record the temperature (°C) and the DO (mg/L *and* % saturation) on the VRAP Field Data Sheet. (Press the **UP** arrow to shift from mg/L to %sat.)



- Rinse the probe with DI water, blot dry with a Kimwipe and return it to the storage chamber. Wait two minutes and record the dissolved oxygen % saturation on the front of the VRAP Field Data Sheet (Dissolved Oxygen/% saturation in chamber).
- The DO/Temp meter should remain “on” until the last site has been tested and the meter has been calibrated following the last test. If the meter is turned off prior to the end of the sampling day, the meter must be turned on and allowed a 15-minute warm-up period prior to calibration and additional sampling.

Air Temperature

- To determine the air temperature (°C), carefully prop the DO/Temp probe up on top of the meter case (clean surface) and allow the temperature reading to stabilize (this should be done out of the direct sun). **It will only take a minute for the air temperature reading to stabilize. Do not leave the probe out of the chamber longer as it will damage the membrane.** You can also hold it for 30 seconds.
- Rinse the probe with DI water and blot dry with a Kimwipe before returning it to the calibration chamber.

❖ Sampling Specific Conductance (*YSI 30 Conductivity Meter*)

Note: The specific conductance meter needs to be calibrated twice per sampling date (one prior to the first measurement and once after the last measurement. Please turn the meter off when not in use to conserve battery power.

1. Press the **ON/OFF** key to turn the meter on. If the “°C” is not blinking on and off, press the **MODE** key until it does (this puts the meter into the temperature compensated mode). Rinse the probe with DI water and blot dry with a Kimwipe.



2. Immerse the probe in the sample and make sure it is deep enough to cover the hole in the side of the probe. **Do not allow the probe to touch any solid object or the bottom of the bucket while you are taking readings.** It is also important that there are no air bubbles on/in the electrode. To dislodge any bubbles, gently move the electrode through the water before recording the measurement.



3. Agitate by slowly moving the probe back and forth in the sample for a minimum of two minutes for the temperature and conductivity readings to stabilize. Record the conductivity reading on the VRAP Field Data Sheet.



4. Rinse the probe, blot dry with a Kimwipe, and return it to the storage chamber between measurements.
5. At the end of the day, recalibrate the meter and record the 200 *umhos* standard value and error, if occurred, in the “End of Day Meter Calibration” section on the back of the VRAP Field Data Sheet.

End of Day Meter Check & Checklist

❖ Dissolved Oxygen Meter

1. Rinse the DO probe with DI water and blot dry with a Kimwipe.
2. Return the probe to the chamber with wet sponge. Drain any “puddled” water from the chamber.
3. Turn off the meter.

❖ pH Meter

1. Rinse the probe with DI water and blot dry with a Kimwipe.
2. Insert the blue plug into the probe.
3. Return the probe to the storage solution container. Store probe upright.
4. Turn off the meter.

❖ Turbidity Meter (Calibrate at end of day)

1. Place the 1.0 NTU standard into the meter and record the displayed value under “End of Day Meter Calibration” on the back of the VRAP Field Data Sheet.
2. Rinse the probe with DI water and blot dry with a Kimwipe.
3. Rinse the sample vial with DI water for storage.
4. Turn off the meter.

❖ Conductivity Meter (Calibrate at end of day)

1. Rinse the probe with DI water and blot dry with a Kimwipe.
2. Place probe in the 200 μ S standard. Record the displayed value under “End of Day Meter Calibration” on the back of the VRAP Field Data Sheet.
3. Rinse the probe with DI water, blot dry, and return to chamber.
4. Turn off the meter.

❖ VRAP Kit

1. Remove used Kimwipes from the kit.
2. Clean off any dirt and moisture.
3. Record any problems you have encountered on the back of the VRAP Field Data Sheet (under “Comments”) and contact the VRAP Coordinator.

Remember

- ❖ Calibrate the pH and DO meters before each measurement!
- ❖ Do not turn off the DO meter until the end of the day!
- ❖ Run duplicate or replicate samples once a day!
- ❖ Test the pH 6.0 buffer and turbidity DI blank once a day!
- ❖ Rinse everything with DI water - a lot!



NH Volunteer River Assessment Program 2006 Field Data Sheet

For Office Use Only	
Data Entered: _____	
Data QC: _____	
Final Data: _____	

Date: _____ Start Time: _____ End Time (All monitoring activities for the day complete): _____

River: _____ Kit # _____ Volunteer Monitors (First & Last Names): _____

Initial Turbidity Calibration Value: _____
Initial Conductivity Calibration Value (175-225 μ S): _____

Time Dissolved Oxygen Meter Turned On: _____
Time of 1 st Dissolved Oxygen Calibration: _____

DES Station Number	Station Name Or Description	Time Sampled (HHMM) (Military Time)	Turbidity (NTU)	pH Calibration Slope	pH	Water Temp. (°C)	Dissolved Oxygen Calibration Value	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%sat.)	Dissolved Oxygen (%sat in chamber)	Air Temp (°C)	Specific Conductance (μ S)
R	Replicate at (Station Number) _____											

QA/QC Meter Check

Dissolved Oxygen Zero Oxygen Reading (mg/L): _____	(% Sat): _____	Station: _____	Time: _____
6.0 pH Buffer Reading (5.8 – 6.3): _____		Station: _____	Time: _____
DI Blank Turbidity Reading: _____		Station: _____	Time: _____

All fields must be completed in order for this data sheet to be accepted by VRAP. Scribe: _____



Sampling Station Identification Form

Form completed by Daytime phone number Volunteer monitoring group name

Sample type (circle one) VLAP VRAP Complaint Station ID (to be filled in by NHDES) Station name (60 characters max)

Town (not village name) station is in State (circle one) NH ME Canada MA VT Date station established Total water depth at station Water depth units (circle one) in ft cm m

Station type (circle one)

Catch Basin	Estuary	Riverine Impoundment	Wetland - Estuarine, emergent*	Wetland - Palustrine, forested*
Channelized Stream	Lake/Pond	Seep	Wetland - Estuarine, forested*	Wetland - Palustrine, moss-lichen*
Constructed Wetland	Land Runoff	Spring	Wetland - Estuarine, scrub-shrub*	Wetland - Palustrine, scrub - shrub*
Culvert	Pipe	Storm Sewer	Wetland - Lacustrine, emergent*	Wetland - Riverine, emergent*
Drain Manhole	River/Stream	Well	Wetland - Palustrine, emergent*	

*Estuarine = Estuary, Lacustrine = Lake, Palustrine = Wet or Marsh area, Riverine = River

If Station type = Well, please fill in the following:

Well is used for (circle one): Extraction Monitoring Recharge/Injection	Water is used for (circle one): Domestic Commercial Industrial	Type of well (circle one): Bedrock Overburden Unknown
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Name of waterbody (river, stream, lake, etc.) sampling station is on

Station description:

Directions to station:

Date Located: **Please attach a map showing the location of the sampling station.**

If located by GPS: Latitude (Format:DD MM SS.SS) Longitude Datum (circle one or enter) NAD 1927 NAD 1983 WGS 1984 Other:

Elevation information (required only for VRAP): Elevation Units (circle one) ft m Method (circle one) Topo Map GPS Datum (circle one or enter) NGVDD 1929 NAVD 1988 WGS 1984 Other:

Send form and map to: VLAP or VRAP Program (Please specify a program.)
NHDES
P.O. Box 95
Concord, NH 03302-0095



NH Volunteer River Assessment Program Field Sampling Audit Checklist

Date: _____ Start Time: _____ End Time: _____

River: _____

Volunteer Monitors Present (First and Last Names): _____

Auditor Present (Print): _____ (Signature): _____

1. Sampling Procedures		
	Yes	No
A) Sample bucket inspected (and cleaned, if necessary) prior to use		
B) Sample bucket rinsed with river water prior to sample collection		
C) Sample storage containers (e.g., nutrient bottles) properly labeled (date, time, sample site, river name, sampling crew initials, analytical parameter)		
D) Sample collected with minimal disturbance (i.e., bucket gently placed on water surface and allow to fill)		
E) Sample volumes properly poured from bucket into sample containers prior to recording field measurements		
F) Sample(s) stored on ice during transport to laboratory		
G) Field replicates by each meter taken from original sample at one station during the day		
H) "End of Day Meter Calibration" and "End of Day Checklist" properly documented on field data sheet		
Audit Pass (If No, provide reason) _____		

2. YSI 95 Dissolved Oxygen/Temperature Meter		
	Yes	No
A) Appropriate storage of meter during travel/transport		
B) Meter kept turned on until the end of the day		
C) Meter and sensor probe inspected (and cleaned, if necessary) prior to use; sensor probe free of air bubbles		
D) Calibration chamber sponge sufficiently moist/dampened		
E) Calibration to saturation % relative to station elevation		
F) Meter calibrated before each measurement		
F) Temperature equilibration allowed during measurement		
G) Agitation of sensor probe in sample		
H) Dissolved oxygen stabilization allowed during agitation		
I) Replacement of sensor probe in calibration chamber for post-sample check		
J) Appropriate storage of meter after measurement/sampling day		
K) Temperature and dissolved oxygen sampling data properly documented on field data sheet		
Audit Pass (If No, provide reason) _____		

3. Orion Model 210A pH meter & 91-57BN ATC Electrode Probe		
	Yes	No
A) Appropriate storage of meter during travel/transport		
B) Meter and electrode probe and blue plug inspected (and cleaned, if necessary) prior to use; air bubbles removed from end of probe		
C) Probe inspected and pH electrode filling solution just below hole in probe		
D) Calibration to pH 7.0 buffer (before each measurement)		
E) Calibration to pH 4.0 buffer (before each measurement)		
F) Appropriate rinsing of electrode probe after removal from each buffer		
G) Slope calculation within limit (92-102%) (Slope value_____)		
H) Agitation of electrode probe in sample		
I) pH measurement recorded after “ready” indicator is displayed		
J) Appropriate rinsing of electrode probe after removal from sample		
K) Immersion of electrode probe in known buffer (pH 6.0) at one station during sampling day		
L) Appropriate rinsing of electrode probe after removal from known buffer		
M) Appropriate storage of meter after measurement/sampling day		
N) pH calibration and sampling data properly documented on field data sheet		
Audit Pass (If No, provide reason) _____		
4. YSI Model 30 Conductivity Meter		
	Yes	No
A) Appropriate storage of meter during travel/transport		
B) Meter and sensor probe inspected (and cleaned, if necessary) prior to use		
C) Temperature compensation indicator (flashing °C) indicating specific conductance		
D) Calibration performed using 200 umhos conductivity standard		
E) Sensor probe thoroughly rinsed after removal from standard		
F) Agitation of sensor probe in sample		
G) Sensor probe thoroughly rinsed after removal from sample		
H) Meter calibrated at end of each sampling day		
I) Appropriate storage of meter after measurement/sampling day		
J) Specific conductance calibration and sampling data properly documented on field data sheet		
Audit Pass (If No, provide reason) _____		
5. Lamotte Model 2020 Turbidimeter		
	Yes	No
A) Appropriate storage of meter during travel/transport		
B) Meter and vials inspected (and cleaned, if necessary), prior to use		
C) Black triangle displayed, indicating EPA mode		
D) Calibration performed using appropriate standard (1.0 or 10.0 NTU) – dependent on river condition		
E) DI Turbidity Blank recorded at one station during sampling day		
F) Sample vial (“S”) thoroughly rinsed prior to use		
G) Sample vial (“S”) wiped prior to insertion in meter		
H) Sample vial (“S”) inserted into meter appropriately (etched arrow facing user)		
I) Meter calibrated at end of each sampling day		
J) Appropriate storage of meter after measurement/sampling day		
K) Turbidity calibration and sampling data properly documented on field data sheet		
Audit Pass (If No, provide reason) _____		



VRAP Water Quality Standards

Parameter	Class A Standard	Class B Standard												
Chloride (mg/L)	Chronic standard is 230 mg/L Acute standard is 280 mg/L													
Chlorophyll-a (mg/L)	No Numeric Standard													
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Unit</th> <th style="width: 75%;">Category</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">< 3</td> <td style="text-align: center;">Excellent</td> </tr> <tr> <td style="text-align: center;">3 – 7</td> <td style="text-align: center;">Good</td> </tr> <tr> <td style="text-align: center;">7 – 15</td> <td style="text-align: center;">Less than desirable</td> </tr> <tr> <td style="text-align: center;">> 15</td> <td style="text-align: center;">Nuisance</td> </tr> </tbody> </table>		Unit	Category	< 3	Excellent	3 – 7	Good	7 – 15	Less than desirable	> 15	Nuisance		
Unit	Category													
< 3	Excellent													
3 – 7	Good													
7 – 15	Less than desirable													
> 15	Nuisance													
Conductivity/ Specific Conductance (umhos/cm)	No Numeric Standard													
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Unit	Category													
0 – 100	Normal													
101 – 200	Low Impact													
201 – 500	Moderate Impact													
> 501	High Impact													
Dissolved Oxygen (mg/L & %)	6 mg/L 75% Minimum Daily Average; Unless Naturally Occurring	5 mg/L 75% Minimum Daily Average; Unless Naturally Occurring												
E. coli (Counts)	Geometric mean of ≤47 E. coli cts/100 mL based on at least 3 samples obtained over a 60-day period ≤ 153 E. coli cts/100 mL in any 1 sample	Geometric mean of ≤126 E. coli cts/100 mL based on at least 3 samples obtained over a 60-day period ≤ 406 E. coli cts/100 mL in any 1 sample												
pH (Units)	6.5 – 8.0 Unless Naturally Occurring													
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pH (Units)	Category													
<5.0	High Impact													
5.0 – 5.9	Moderate to High Impact													
6.0 – 6.4	Normal; Low Impact													
6.5 – 8.0	Normal;													
6.1 – 8.0	Satisfactory													
Total Phosphorus (mg/L)	No Numeric Standard. As Naturally Occurs													
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< 0.010	Ideal													
0.011 – 0.025	Average													
0.026 – 0.050	More than desirable													
> 0.051	Excessive (potential nuisance concentration)													
Total Kjeldahl Nitrogen (mg/L)	No Numeric Standard. As Naturally Occurs													
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Unit	Category													
< 0.25	Ideal													
0.26 – 0.40	Average													
0.41 – 0.50	More than desirable													
> 0.51	Excessive (potential nuisance concentration)													
Turbidity (NTU)	As Naturally Occurs	Shall not exceed naturally occurring conditions by more than 10 NTU												

New Hampshire Volunteer River Assessment Program

29 Hazen Drive – PO Box 95
Concord, NH 03302-0095
www.des.nh.gov/wmb/vrap