

# *Hudson Basin River Watch*

---

## Guidance Document

*helping to coordinate monitoring of freshwater  
wadeable rivers throughout the watershed*

Revised Draft Summer 2004

**Primary Authors:**

SHARON BEHAR: *River Network*

MARTHA CHEO: *Hudson Basin  
River Watch*

**Collaborators:**

BOB ALPERN, AMY WATERMAN AND  
CHARLIE OLSON: *NYC DEP*

DAVE BURNS: *Dutchess Co. EMC*

CAMILLA CALHOUN: *Earthworks,  
LLC*

ROD CHRISTIE: *Mianus River  
Gorge Preserve*

GEOFF DATES: *River Network*

JEFF MYERS AND ROBERT BODE:  
*NYS DEC Division of Water*

STEVE PENNINGROTH: *Community  
Science Institute, Inc.*

DOUG REED: *Hudson Basin River  
Watch*



*The development of this document was made possible with funds from  
the Hudson River Improvement Fund and  
the New York State Department of Environmental Conservation*

*Copyright © June 2000 by River Network*

**River Network Mission Statement:**

*to help people understand, protect and restore rivers  
and their watersheds*

River Network - River Watch Program  
153 State Street  
Montpelier, VT 05602  
802/223-3840

**Hudson Basin River Watch Mission Statement:**

*to improve the water quality of the Hudson River and all its tributaries through  
education, community involvement, and stewardship*

Hudson Basin River Watch  
3570 Route 29  
East Greenwich, NY 12865  
Doug Reed 518/677-5029  
**[www.hudsonbasin.org](http://www.hudsonbasin.org)**

Permission to copy this document may be obtained by  
contacting Doug Reed at Hudson Basin River Watch.

# TABLE OF CONTENTS

---

---

## ABOUT HBRW

What is HBRW? .....	1
HBRW Regional Coordinators.....	4
School and Citizen Groups.....	6

## OVERVIEW OF MONITORING METHODS

Goals.....	7
How to Use this Guidance Document .....	9
Overview of Tiered Protocols .....	10
Overview of QAQC Guidelines .....	12

## DESIGNING YOUR RIVER STUDY

What is a Study Design? .....	13
Study Design Steps.....	14
Types of Studies .....	18
Study Design Questions and Indicators to Study .....	19
Monitoring Program Cover Sheet .....	28
Study Design Worksheet .....	29
Watershed Inventory Checklist.....	32
NYS River Classification & Water Quality Standards .....	34
NYS DEC Water Quality Reports.....	35
NYS DEC Regional Offices.....	36

<u>SAFETY</u> .....	37
---------------------	----

## PHYSICAL SURVEY

Overview .....	39
Equipment and Materials Needed for Physical Surveys .....	41
Tier 1 Physical / Habitat Survey .....	42
Tiers 2 & 3 Physical Survey / Habitat Assessment.....	44
Site Drawing.....	46
Stream Bottom Survey .....	47
Flow Worksheet .....	48

## BENTHIC MACROINVERTEBRATE (BMI) SAMPLING & ANALYSIS

Overview .....	49
Collecting BMI Samples .....	52
Equipment for BMI Sampling and Analysis .....	54
QAQC.....	54
BMI Sample Sheet .....	58
BMI Data Reporting Sheet.....	59
Analyzing BMI Samples .....	60
Tier 1 Screening Criteria for Non-Impacted Streams .....	61
Tiers 2 & 3 BMI Sorting (& EPT Richness) Worksheet.....	65
Tier 2 Major Group Biotic Index Worksheet.....	68
Tier 2 Major Group Percent Composition and Model Affinity Worksheet.....	69

Tier 2 Major Group Percent Similarity Worksheet.....	71
Tier 3 Family Level Data Sheet.....	74
BMI Data Interpretation.....	76
References for BMI Identification.....	80

**CHEMICAL INDICATORS**

Collecting Water Samples.....	81
Analyzing Water Samples.....	83
QAQC.....	84
Overview of Chemical Sample Analysis Methods.....	87
Chemical Sample Sheet.....	88
Chemical Data Reporting Sheet.....	89
Shelf Life of Reagents.....	90
Chemical Data Interpretation.....	91
Data Analysis Worksheet (Water Quality Standards Survey).....	93
pH.....	95
Alkalinity.....	99
Dissolved Oxygen.....	104
Nitrate-Nitrogen.....	110
Orthophosphate.....	116
Conductivity.....	122
Turbidity.....	124

**REPORTING AND USING DATA**

Data for DEC Use.....	129
Reporting Your Data.....	130
PWL Worksheet.....	131
Stewardship Project Ideas.....	134
Using Data at the Local Level.....	135

**EQUIPMENT LIST**..... 137

# ABOUT HUDSON BASIN RIVER WATCH

---

## What is Hudson Basin River Watch?

Hudson Basin River Watch (HBRW) is a volunteer river monitoring network. The mission is to improve the water quality of the Hudson River and all its tributaries through education, community involvement, and stewardship. The vision is ecological integrity for the whole watershed from Mt. Marcy and the Mohawk River to New York City.

Hudson Basin River Watch objectives are to train volunteers how to identify water quality problems, to monitor the physical, biological, and chemical characteristics of Hudson Basin waters, and to use the information in river restoration and protection efforts.

Hudson Basin River Watch is a project in process. We began as a sole provider of water quality monitoring education for all ages and are now working with many organizations and community leaders in an effort to build a collaborative, responsive and effective volunteer river monitoring network for the Hudson Basin.

Hudson Basin River Watch is a project of the Open Space Institute, Inc., and is funded by New York State Department of Environmental Conservation Hudson River Estuary Program, Hudson River Improvement Fund, and fees for service.

The Hudson River Basin is located in eastern New York State and small parts of New Jersey, Connecticut, Massachusetts, and Vermont (and lies within the 9 Hydrologic Unit Codes 02020001-02020008 and 02030101). It extends from New York City northward approximately 300 river miles to the central Adirondack Mountains and westward approximately 100 miles to the Mohawk River headwaters near Utica. The lower river is one of the most productive estuaries on the eastern seaboard and is tidal for 153 miles north to the Troy Federal Lock and Dam. The Hudson Basin has a diverse population of 4 million people. Approximately 8% of the land use is urban and residential, 25% is agricultural, 62% is forested, and 5% is open water and "other." Primary water uses include irrigation and drinking water supply, commercial transportation, wastewater drainage, wildlife habitat, commercial and sport fishing, and recreation.

## Hudson Basin River Watch Participants

Hudson Basin River Watch started in 1990 in the upper Hudson with several schools, the Adirondack Park Visitors Interpretive Center, and Battenkill Conservancy-NY. Hudson Basin River Watch now serves over 100 schools, volunteer groups, environmental organizations and water resource agencies from the Adirondacks to New York City. The New York District Office of the United States Geological Survey

provided important start-up funding and critical advisory assistance. The Hudson River Improvement Fund contributed significant grant support and valuable assistance. In April 1999 The New York State Department of Environmental Conservation (NYS DEC) Hudson River Estuary Program awarded Hudson Basin River Watch a three-year contract to administer the Citizen Volunteer Water-Quality Monitoring Project throughout the Hudson River Estuary. In March 2000 HBRW signed an addendum to the NYS DEC contract and began a working partnership with Riverkeeper and Stroud Water Research Center to expand volunteer monitoring in the Catskill and Croton regions of the New York City Watershed. In June 2004 NYSDEC awarded HBRW a second long term contract to "Coordinate a Hudson River Estuary Watershed-Wide Volunteer Water Quality Monitoring Program."

Since the first Hudson Basin Volunteer Monitoring Conference in Ossining, NY on May 22, 1997, and a follow-up gathering on March 30, 1999, many other key support organizations have joined the Hudson Basin River Watch Network including: Catskill Center for Conservation and Development, Dutchess County Environmental Management Council, Hudson River Sloop Clearwater, Institute for Ecosystem Studies, Lamont-Doherty Earth Observatory of Columbia University, Riverkeeper, Stroud Water Research Center, Teatown Lake Reservation, Westchester Community Foundation, Westchester County Department of Planning, and many County Soil & Water Conservation Districts. For a complete listing see the following HBRW Steering Committee, Regional Coordinators, Resource Partners, and Monitoring Groups.

## **New York City Watershed and Delaware River Basin**

The land area that catches and drains New York City's water supply includes a large portion of the Hudson River Basin, but also the Delaware River Basin. Because there has been so much interest and activity in protecting New York City's water supply, Hudson Basin River Watch has worked with organizations and supported groups in both the Hudson and Delaware portions of the watershed.

The story of the New York City water supply is an interesting one. It is the largest *unfiltered* drinking water supply in the nation. Over 90% of this water originates high in the Catskill Mountains, more than 100 miles from the city. Beginning in 1909 (and concluding in 1965), New York City constructed six massive reservoirs in the Catskills to catch the abundant rain and snowfall the area receives annually. Each day, the 9 million downstate consumers use 1.3 billion gallons of Catskill Mountain water from both the Hudson and Delaware watersheds. A series of tunnels and two huge aqueducts transport the water by gravity underneath the Hudson River and down to New York City.

In 1997, an historic memorandum of agreement was signed by all interested parties allowing New York City to continue supplying its consumers with unfiltered drinking water despite the Clean Water Act's Surface Water Treatment Rule. This landmark agreement requires the City to invest in many types of water quality improvement

projects and programs within its 1,600 square-mile watershed in the Catskill Mountains. Every five years the USEPA revisits the Filtration Avoidance Determination Waiver that was granted to the City with the intention of reviewing the progress that has been made and to determine if the water quality expectations are still being met.

The Delaware River watershed borders the Hudson River watershed to the west from the Catskill Mountains all the way into northern New Jersey. The main stem of the Delaware is the longest free-flowing river east of the Mississippi. It forms the boundary between New York and Pennsylvania and subsequently between Pennsylvania and New Jersey before emptying into Delaware Bay 330 miles later. From headwaters to its mouth, the Delaware River is approximately 370 miles long, making it the seventeenth longest in the United States.

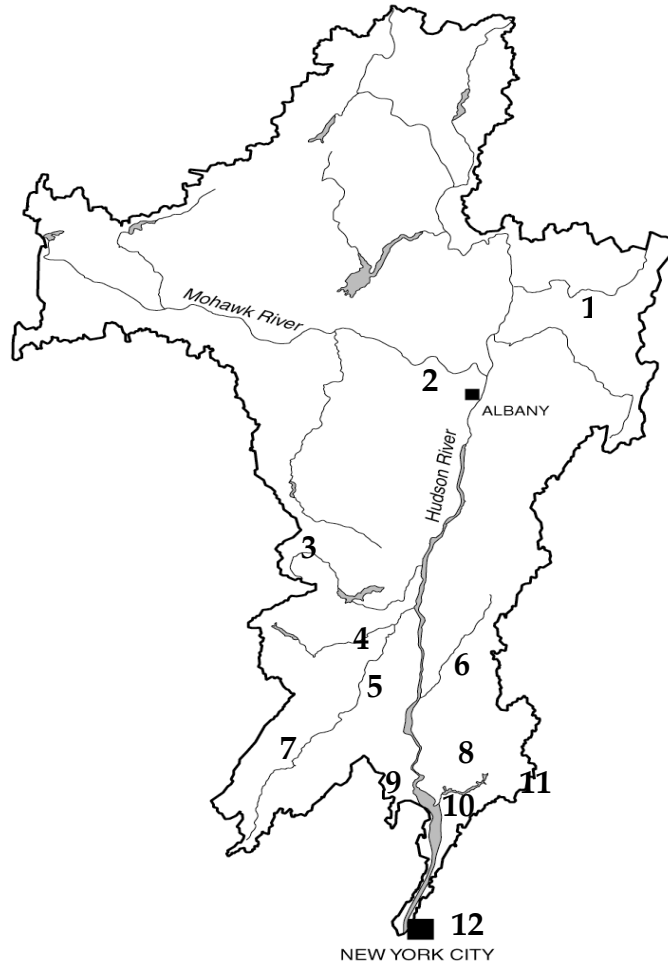
## **Hudson Basin River Watch Organizational Structure**

HBRW consists of a Director, Steering Committee, and Regional Coordinators who train, support and coordinate volunteers. Regional Coordinators review data from their local groups, work with county Water Quality Coordinating Committees and NYSDEC regional offices to follow up on questions, concerns, and verifications, and promote relevant stewardship projects. Groups send data to their Regional Coordinators via the HBRW web site at [www.hudsonbasin.org](http://www.hudsonbasin.org).

Regional Coordinators also communicate and coordinate with each other quarterly, building a whole watershed initiative. The website strengthens this process by facilitating communication and data exchange between groups. The Director provides administrative service and leadership to keep the HBRW network active and connected. The Steering Committee provides technical assistance and keeps HBRW connected to other groups concerned with the ecological integrity of the Hudson River and its watershed.

# Hudson Basin River Watch Regional Coordinators

- 1 Doug Reed**  
HBRW Director and Upper  
Hudson Regional Coordinator  
518-677-5029  
[reed@netheaven.com](mailto:reed@netheaven.com)
- 2 Kelly Nolan**  
Capital District  
Regional Coordinator  
518-372-9606  
[JKN-CMM@worldnet.att.net](mailto:JKN-CMM@worldnet.att.net)
- 3 Aaron Bennett**  
Catskill Center for Conservation  
and Development  
845-586-2611  
[abennett@catskillcenter.org](mailto:abennett@catskillcenter.org)
- 4 Rick Fritschler**  
Ulster County Environmental  
Management Council  
845-687-0267  
[rfrits@aol.com](mailto:rfrits@aol.com)
- 5 Martha Cheo**  
Mid-Hudson Coordinator  
845-256-9316  
[mcheo@hvi.net](mailto:mcheo@hvi.net)
- 6 Dave Burns**  
Dutchess County Environmental  
Management Council  
845-677-5253 x112  
[dburns@co.dutchess.ny.us](mailto:dburns@co.dutchess.ny.us)
- 7 Kevin Sumner**  
Orange County Soil and Water  
Conservation District  
845-343-1873  
[kevin@nymiddleto.fsc.usda.gov](mailto:kevin@nymiddleto.fsc.usda.gov)
- 8 Richard Dima**  
Teatown Lake Reservation  
914-762-2912 x14  
[rdima@teatown.org](mailto:rdima@teatown.org)



- 9 Margie Turrin**  
Lamont Doherty Earth  
Observatory  
Rockland and Westchester  
Counties Coordinator  
845-365-8494  
[mkt@ldeo.columbia.edu](mailto:mkt@ldeo.columbia.edu)
- 10 Rod Christie**  
Mianus River Gorge Preserve  
914-234-3455  
[rodco@optonline.net](mailto:rodco@optonline.net)
- 11 Diana Bregman**  
NY City Regional  
Coordinator  
845-594-5263  
[diana@nycswcd.net](mailto:diana@nycswcd.net)



### ***HBRW Steering Committee and Regional Coordinators***

Doug Reed, HBRW Director and Upper Hudson Regional Coordinator	* Martha Cheo, HBRW Mid-Hudson Coordinator	Nordica Holochuck, NY Sea Grant
* Aaron Bennett, Catskill Center for Conservation and Development	* Rod Christie, Mianus River Gorge Preserve	Chuck Nieder, Hudson River National Estuarine Research Reserve
* Diana Bregman, NY City Regional Coordinator	Scott Cuppett, NY State Department of Environmental Conservation	* Kelly Nolan, Capital District Regional Coordinator
Marilyn Broome, Adirondack Park Visitors Interpretive Center	Barbara Dexter, SUNY Purchase	* Kevin Sumner, Orange County Soil and Water Conservation District
* Dave Burns, Dutchess County Environmental Management Council	* Richard Dima, Teatown Lake Reservation	* Margie Turrin, Lamont Doherty Earth Observatory, Rockland County Coordinator
Camilla Calhoun, Earthworks, LLC	Ward Freeman, U.S. Geological Survey	
	* Rick Fritschler, Ulster County Environmental Management Council	

\* = HBRW Regional Coordinator

### ***HBRW Network Resource Partners***

Adirondack Community College	Keep Rockland Beautiful	Riverkeeper
Adirondack Park Visitors Interpretive Center	Lamont Doherty Earth Observatory	River Network
Battenkill Conservancy-NY	Lower Esopus River Watch	Scenic Hudson
Black Rock Forest Consortium	Marist College	Stony Kill Farm Environmental Education Center
The Boston Foundation	Mohonk Preserve	Stroud Water Research Center
Bronx River Alliance	Mount St. Mary College	Student Conservation Association, SCA Hudson Valley Center for Conservation Service
Catskill Center for Conservation and Development	NYC Department of Environmental Protection	SUNY Albany
Community Science Institute	NY State Cornell Cooperative Extension	SUNY Purchase
Dutchess County Community College	NYSDEC Hudson River Estuary Program and Division of Water	Teatown Lake Reservation
Dutchess County Environmental Management Council	NYS Soil & Water Cons. Districts	Trout Unlimited, Clearwater Chapter
Dutchess Land Conservancy	Albany Co., Dutchess Co., Columbia Co., Essex Co., Greene Co., Orange Co., Putnam Co., Rensselaer Co., Saratoga Co., Schenectady Co., Ulster Co., Warren Co., Washington Co., and New York City	Ulster County Community College
Frost Valley YMCA		Ulster County Environmental Management Council
Hudson River Environmental Society	Olive Natural Heritage Society	US Environmental Protection Agency
Hudson River Improvement Fund of the Hudson River Foundation	Open Space Institute	US Geological Survey
Hudson River National Estuarine Research Reserve	Project WET in NYS	Westchester County Planning Department
Hudson River Sloop Clearwater Institute of Ecosystem Studies		Youth Resource Development Corporation AmeriCorps

## ***School-Based Monitoring Groups***

### **Upper Hudson Region:**

Arlington Memorial High School  
Bolton Central School  
Brittonkill Middle School  
Burr & Burton Seminary  
Darrow School  
Essential School at Albany High  
Glens Falls High School  
Greenwich Central School  
Guilderland High School  
Hadley-Luzerne Central School  
Johnsburg Central School  
Long Lake Central School  
Minerva Central School  
Newcomb Central School  
Niskayuna High School  
Salem Central School  
Schalmont High School  
Schroon Lake Central School  
Schuylerville Central School  
Scotia/Glenville High School  
Warrensburg Central School

### **Mid-Hudson Region:**

Alden Place Elementary  
Arlington High School  
Arlington Middle School  
Bulkeley Middle School  
Chatham High School  
Circleville Elementary School  
Circleville Middle School  
Cornwall High School  
Dover Plains High School  
E.C. Myer Elementary School  
Ellenville Central School  
Henry H. Wells Middle School  
High Meadows School  
Icabod Crane High School  
John Jay High School  
Kingston High School  
LaGrange Middle School  
Linden Avenue Middle School  
Millbrook Junior/Senior High School  
Monhagen Middle School  
Montgomery Elementary School  
Most Precious Blood School  
New Paltz Middle School  
New Windsor Elementary School  
Oakwood Friends School  
Orange-Ulster BOCES  
Pine Bush Elementary School  
Poughkeepsie Day School  
Poughkeepsie High School  
Randolph School  
Rondout Valley High School

Saugerties Central School  
The Alternative Learning Center  
Trinity Pawling High School  
Vassar Road Elementary School  
Wallkill High School  
Wappingers Falls Junior High School  
Warwick Valley High School  
Washingtonville High School  
Valley Central High School

### **Catskill Region:**

Andes Central School  
Charlotte Valley Central School  
Coxsackie-Athens Central School  
Delaware Academy Elementary School  
Delaware County 4H  
Downsville Central School  
Fallsburg Central School  
Gilboa-Conesville Central School  
Hunter-Tannersville Central School  
Livingston Manor Central School  
Margaretville Central School  
Onteora Junior/Senior High School  
Phoenicia Elementary School  
Roxbury Central School  
South Kortright Central School  
Stamford Central School  
Townsend Elementary School  
Tri-Valley Central School  
Windham-Ashland-Jewett Central School  
Woodstock Day School  
Woodstock Elementary School  
Zena Elementary School

### **Lower Hudson Region:**

Automotive High School  
Clarkstown South High School  
Crittenden Middle School  
Croton-Harmon High School  
Dreyfus Intermediate School IS 49  
Edgemont Junior High School  
Fort Hamilton High School  
Fox Lane Middle School  
Horace Greeley High School  
Lakeland Copper Beech Middle School  
Mahopac Middle School  
Manhattan Village Academy  
Metropolitan Montessori School  
Mildred E. Strang Middle School  
New York Harbor School

North Rockland High School  
NYC P.S. 5  
NYC I.S.218  
Ossining High School NYU  
Pearl River High School  
Pleasantville Middle School  
Port Richmond High School  
Putnam/Northern Westchester BOCES  
Rippowam Cisqua Middle School  
R.E. Bell Middle School  
Rockland Country Day School  
Scholastic Academy  
School for Excellence-Morris High School  
School of Environmental Studies  
South Street Seaport  
Tappan Zee High School  
Wagner High School  
Wallerstein Collaborative  
William E. Grady Technical High School  
Yorktown High School

## ***Citizen & College Groups***

Battenkill Conservancy - NY  
Beacon Stream Team  
Broadstreet Hollow Landowner's Association  
Croton Watershed Clean Water Coalition  
Dutchess County Community College  
Environmental Study Team  
Moodna Creek Coalition  
Mountain Top Arboretum  
New York Restoration Project  
Pine Hill Community Center  
Pleasant Valley Conservation Advisory Commission  
Protect the Plattekill Creek  
Rhinebeck Stream Team  
Saw Mill River Coalition  
Sawkill Watershed Alliance  
Schoharie River Center  
Ulster County Community College  
Wallkill River Task Force  
Wappinger Creek Watershed Planning Committee  
Westchester County Dept of Planning  
The Wittenberg Center  
Zen Mountain Monastery

# OVERVIEW OF MONITORING METHODS

---

## Goals

This document was designed in response to goals set by the participants of the first Hudson Basin gathering in May 1997 and by the stated needs of others who were interviewed. It was created to:

- Develop coordination and standardization between all groups involved with monitoring in the basin, whether for educational or resource management purposes, while encouraging and adapting to regional and local differences.
- Improve the ability of groups to compare and use their information.
- Improve the ability of groups to generate data that can be used by New York State Department of Environmental Conservation (NYS DEC) and local communities for management purposes.

This document will help to coordinate HBRW group efforts with the NYS DEC “Waterbody Inventory” (WI) which assesses the quality of the state’s waters. Part of that inventory is the “Priority Waterbody List,” (PWL) which documents information about water bodies with known water quality impacts. Because DEC has limited staff to cover the many miles of rivers in the state, they have called upon HBRW groups and others to provide more information for the WI/PWL. Although DEC does not publish volunteer data directly in the WI/PWL, they would like to use more volunteer data to help document water quality information for the WI/PWL.

## Monitoring Protocols and Quality Assurance Guidelines

The HBRW water quality monitoring protocols are organized into three **TIERS**. The higher the tier, the more involved the protocol. All three tiers can be used for educational purposes. Any water quality information, regardless of the tier, can be used to alert Regional Water Quality Coordinating Councils and DEC Regional offices of possible water quality issues. Groups can also submit their data to help document water quality information for DEC’s statewide water quality assessment efforts (the WI/PWL). The language defining the tiers in this manual corresponds to language used by DEC in the WI/PWL. The higher the tier, the more likely the data will be used to document water quality conditions in the WI/PWL. For more information on the WI/PWL, see the section on “Reporting and Using Data”.

Quality Assurance/Quality Control (QAQC) refers to activities that allow data users to associate a level of confidence to the information provided. The HBRW QAQC Guidelines are organized into three **LEVELS**. As the level of QAQC increases, so does the level of confidence in the information. Information with higher levels of confidence will generally have greater applications for use by local and state government agencies.

Note that although there are three **TIERS** of monitoring protocols and three **LEVELS** of QAQC guidelines, the tiers and levels do not have to correspond with each other. For example, if you use Tier 2 monitoring protocols, you can use Level 3 QAQC guidelines (or vice versa).

### **Monitoring Protocols:**

**Tier 1** is an Introductory Investigation, the primary use of which is educational and provides a general awareness of river water quality.

**Tier 2** is a Preliminary Assessment used to document that a river segment has either “No Known Impacts” and is supportive of aquatic life, or that there are “Suspected” water quality problems that may be impacting water body uses/aquatic life support. Inclusion of “Suspected” water quality problems in the WI/PWL requires verification of those impacts by DEC; this verification may incorporate Tier 3 follow-up by a volunteer group.

**Tier 3** is an In-Depth Assessment used to further evaluate the degree to which a waterbody is able or unable to support aquatic life. DEC will incorporate Tier 3 assessments as “Suspected” or “Known” impacts into its WI/PWL reviews depending on the level of QAQC employed and whether or not there is conflicting information.

Refer to the chart “Overview of Tiered Protocols” for a synopsis of the protocols for each of the tiers. All three tiers include a physical survey/habitat assessment and some level of biological monitoring. Tiers 2 and 3 also include chemical monitoring.

### **QAQC Levels**

**Level A** involves basic QAQC procedures.

**Level B** involves more replication and duplication of sample analysis.

**Level C** involves analysis of samples by outside labs or evaluators.

Refer to the chart “Overview of QAQC Guidelines” for a synopsis of the guidelines for each level of QAQC. More information about QAQC can be found under “Step 4” of the “Designing Your River Study” section of the Guidance Document.

Detailed procedures for both the three tiers of monitoring protocols and the three levels of QAQC are contained in the “Benthic Macroinvertebrate Sampling and Analysis” and “Chemical Indicators” sections of the Guidance Document.

For more information about QAQC, visit the website of Community Science Institute, an organization which worked with HBRW and NYSDEC to evaluate the QAQC of data generated by volunteer monitoring groups through a pilot project conducted in 2001-2002. Through this project, HBRW was able to develop the QAQC protocols found in this edition of the Guidance Document. Visit [www.communityscience.org](http://www.communityscience.org) and click on “Volunteer Monitoring Pilot Project: Final Report” or “Executive Summary.”

## How to Use this Guidance Document

The system of tiered protocols and levels of QAQC balances standardization with flexibility in an effort to meet all HBRW groups' needs. Participants can pick and choose protocols from a menu of options; you don't need to measure every indicator included in a tier, and you can use protocols from more than one tier in the same study. For example, if you're a macroinvertebrate expert but a chemistry novice, you can use the Tier 3 biological protocol with the Tier 2 chemistry protocol. Similarly, participants can choose the level of QAQC that meets their skills and interest.

Your level of expertise is not the only criterium to use in choosing a tier, QAQC level, and parameters to measure. Your group's level of commitment, time and financial resources, will also influence your decisions. And what you measure and which tier and QAQC level you choose depends on what's going on in your part of the watershed and what your goals are. What are the threats to the water quality in your area? What ecological information is important for you to gather? What does your group hope to gain from their experience? Who is going to use your data? All these questions, and more, will determine how you approach the study of your river. You may choose to measure only one indicator or simply perform visual surveys, if that is the key focus in your region.

*The monitoring tiers and QAQC levels described in this document are a framework of suggestions to help you focus your program and connect participants throughout the watershed. If you choose to use other methods or indicators, you are still welcome to be a part of the Hudson Basin network.*

## Where to Start?

**We recommend that you start with a study design**, using the guidance in the "Designing Your River Study" section of this manual. Once you have established a study design, then you can pick and choose which indicators and which monitoring tier and QAQC level best fit your situation.

## Hudson Basin River Watch Overview of Tiered Protocols

	<b>Tier 1 Introductory Investigation</b>	<b>Tier 2 Preliminary Assessment</b>	<b>Tier 3 In-Depth Assessment</b>
<b>DEC Approved Use</b>	The primary use of this investigation is educational, providing a general awareness of river water quality.	Document that a river segment has either “No Known Impacts” and is supportive of aquatic life, or that there are “Suspected” water quality problems that may be impacting uses/aquatic life. Inclusion of “Suspected” water quality problems in the WI/PWL requires verification of those impacts by DEC; this verification may incorporate Tier 3 follow-up by a volunteer group.	Used to further evaluate the degree to which a waterbody is able or unable to support aquatic life. DEC will incorporate these assessments as “Suspected” or “Known” impacts into its WI/PWL reviews depending on the level of QAQC employed and whether or not there is conflicting information.

<b>Physical / Habitat</b>	SITES: <i>Physical/Habitat Survey</i>	<i>Physical Survey/Habitat Assessment</i> : Ranking of habitat factors. OPTIONAL: <i>Stream Bottom Survey</i> : Simplified Wolman pebble count and average of 20 cobble embeddedness. <i>Flow</i> : Float method, 9 velocity trails, 1 cross section.	<i>Physical Survey/Habitat Assessment</i> : Same as Tier 2. <i>Stream Bottom Survey</i> : (for BMI studies) See Tier 2 for description. OPTIONAL: <i>Flow</i> : Same as Tier 2, or flow meter depending on study design.
-------------------------------	---------------------------------------	--	---

### **Benthic Macroinvertebrates (BMI's)**

Sampling Method: 8” x 18” kick net, 800-900 microns (0.8-0.9 mm) mesh, 5 meter long diagonal transect in a riffle, collected in 5 minutes

<i>Screening criteria for non-impacted streams</i> : Live analysis, presence/absence of 5 major groups. Estimate relative abundance.	<i>Live or preserved analysis of 100 organism sub-sample</i> : Identify, sort and count individuals within major groups, sort and count (but not identify) EPT families. Calculate: Organism Density Per Sample, EPT Richness Estimate, Major Group Biotic Index, Major Group Percent Composition and Model Affinity.	<i>Preserved analysis of 100 organism sub-sample</i> : Identify, sort and count individuals within families. Calculate: Organism Density Per Sample, Family EPT Richness, Total Family Richness, Family Biotic Index, Major Group Percent Composition and Model Affinity, EPT/EPT+Chironomidae Ratio, Percent Contribution of the Dominant Family.
--	---	--

## Hudson Basin River Watch – Overview of Tiered Protocols

<b>Chemical Indicators</b>	<b>Tier 1 Introductory Investigation</b>	<b>Tier 2 Preliminary Assessment</b>	<b>Tier 3 In-Depth Assessment</b>
pH	<i>pH paper strips</i> (1-14 by 1) or color comparator	<i>Direct Measurement</i> , Hach pH Testr 2 pocket meter (1-14 by 0.1); or better	Same as Tier 2
DO	None	<i>Modified Winkler Titration</i> , LaMotte microburet (0-20 by 0.2 ppm)	<i>Modified Winkler Titration</i> , Hach digital titrator (0-20 by 0.1 ppm); or <i>Meter</i>
Nitrate-Nitrogen (NO <sub>3</sub> -N)	None	<i>Zinc Reduction</i> , LaMotte color comparator (0, 1, 2, 4, 6, 8, 10, 15 ppm); or <i>Cadmium Reduction</i> , Hach color wheel or LaMotte color comparator	<i>Cadmium Reduction</i> , with standard curve, Hach DR700 or 800 series colorimeter (0-30 by 0.1ppm), DR890 better for lower range (0-5); or spectrophotometer
Orthophosphate (PO <sub>4</sub> )	None	<i>Ascorbic Acid Reduction</i> , Hach color wheel (0-5 by 0.5 ppm)	<i>Ascorbic Acid Reduction</i> , with standard curve, Hach DR700 or 800 series colorimeter (0-2.5 by 0.01 ppm); or spectrophotometer
Total Alkalinity	None	<i>Sulfuric Acid Titration</i> , LaMotte microburet (0-200 by 4.0 ppm)	<i>Sulfuric Acid Double Endpoint Titration</i> , Hach digital titrator (10-4000 by 0.1 ppm)
Conductivity	None	<i>Direct Measurement</i> , conductivity meter (0-1999 microsiemens/cm by 1); or better	Same as Tier 2
Turbidity	None	<i>Direct Measurement</i> , Hach turbidimeter (0-1000 NTU) or Colorimeter (0-1000 FAU)	Same as Tier 2
Bacteria	None	Methods not included in this manual. Contact your Regional Coordinator for suggestions.	

## Overview of QAQC Guidelines

Level	BMI	Chemical
<b>A</b>	<ol style="list-style-type: none"> <li>1. Use 18" x 8" kick net with mesh size 800-900 microns (0.8-0.9 mm). Or mesh size 500-600 microns if collecting data for EPA use.</li> <li>2. Sample is a kick taken along a 5 meter long diagonal transect in a riffle in 5 minutes.</li> <li>3. Clean nets thoroughly of organisms between samples.</li> <li>4. Attach Physical/Habitat survey with sampling spots labeled on sketches.</li> </ol>	<p><u>General:</u></p> <ol style="list-style-type: none"> <li>1. Clean sample bottles and glassware.</li> <li>2. Collect according to procedures in HBRW Guidance Document.</li> <li>3. Make sure reagents are current.</li> <li>4. Analyze samples immediately or preserve according to procedures in HBRW Guidance Document.</li> <li>5. Attach Physical/Habitat survey with collection spots labeled on sketches.</li> </ol> <p><u>Accuracy:</u></p> <ol style="list-style-type: none"> <li>1. Calibrate test kits with blank and standard at beginning of testing. If conducting 10 or more analyses per indicator per day (including duplicates), calibrate with standard at end of testing.</li> <li>2. Calibrate all meters at beginning of each set of 10 analyses (including duplicates), or at each new site, whichever is more frequent.</li> <li>3. Conduct a super-saturation test for dissolved oxygen meters.</li> </ol> <p><u>Precision:</u></p> <ol style="list-style-type: none"> <li>1. Conduct one duplicate analysis for each indicator per sampling day.</li> </ol>
<b>B</b>	<p><u>Same as A plus:</u> Collect and analyze two replicate samples from at least one site per sampling day. Similarity of at least 65% (Tier 3) or 75% (Tier 2) between replicates indicates satisfactory sample collection and analysis.</p>	<p><u>Same as A except:</u> Conduct duplicate analyses for each indicator on 20% of samples or more per sampling day.</p>
<b>C</b>	<p><u>Same as B plus:</u></p> <ol style="list-style-type: none"> <li>1. Samples preserved in alcohol.</li> <li>2. Once per sampling day, outside evaluator verifies analyses of two replicate samples. Goal is at least 65% (Tier 3) or 75% (Tier 2) similarity between evaluator's and volunteer group's results.</li> </ol>	<p><u>Same as B plus:</u> Split one sample for every 20 samples analyzed <u>or</u> split one sample in every 30 day sampling period, whichever is more frequent. Send splits to an ELAP-certified lab for analysis.</p>

Community Science Institute offers outside evaluator services for BMI analysis and ELAP-certified testing for chemical analysis. [www.communityscience.org](http://www.communityscience.org), (607) 257-6606.



# DESIGNING YOUR RIVER STUDY

---

## What is a Study Design?

The process of choosing what, where, how, and when to monitor your river is called a study design. Your study design is the most important step in your whole project. The study design process will help you to decide which tier to use, and what indicators to choose within each tier, for your program to answer the questions and interests you have about your river.

The bottom line of a monitoring study is to make sure that you have a question you are exploring. This chapter will guide you in how to go about picking appropriate questions and then how to design a study that will help you explore that question.

*A study design will help to avoid these common problems:*

- Spending time and money on equipment and procedures that are inappropriate for your purposes
- Looking for the wrong things at the right places or the right things at the wrong places
- Not answering the question you asked, answering a question you did not ask, or, worst of all, not answering a question at all
- Not knowing how to interpret your data, because you didn't have a question or focus when you started your study
- Finding that others are reluctant to use your data, since they do not know how good the data are or how they can be used.

## Who Should Do A Study Design?

We recommend that everyone who has a monitoring program go through a study design process.

Regional or county resource organizations (such as environmental management councils, soil & water conservation districts, planning departments, etc.) are in a great position to design a study for their region. An essential role of an HBRW Regional Coordinator is designing a study for their region.

School groups, town conservation committees, and other citizen groups can develop programs that help implement a part of their Regional Coordinator's study design. Or they can design their own study to best fit their needs.



***A Note for School Teachers:** Even if your primary goal is to teach students hands-on science rather than to gather useful data, the study design process will help you in today's climate of meeting state science standards. Science involves making observations, asking questions, making predictions, and designing experiments to test hypotheses. A study design is all of these things; having one will ensure that your monitoring program is an engaging, inquiry-based science project. The "Study Design Worksheet" at the end of this section is designed specifically to help students apply the scientific method to a watershed study.*

It is important to find out what local agencies and organizations are doing so that you can plug into existing work and prevent "reinventing the wheel." Contact your town, county and state agencies or organizations to find out about existing efforts (soil and water conservation districts, water quality coordinating committees, environmental management councils, Cornell Cooperative Extension, DEC, etc.). In some cases, you may need to use other protocols than what appears in this document, if your local resource agencies have specific data needs that differ.

## **Study Design Steps**

The following section will describe the steps we recommend to create a study design. The "Study Design Worksheet" at the end of this section will help you to compile and record this design.

Step 1 - Watershed Inventory

Step 2 - Why are you monitoring? Define your questions and choose the indicators you will use.

Step 3 - Define your data uses and users. Which tier do they fit into?

Step 4 - Choose the level of QAQC that best fits your data use goals.

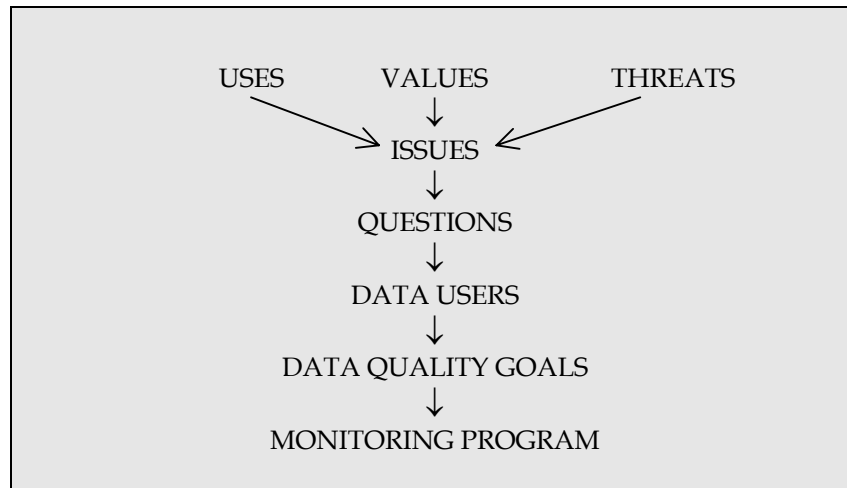
Step 5 - Where will you monitor?

Step 6 - When will you monitor?

Step 7 - Who will do what tasks?

## Watershed Inventory

The purpose of a watershed inventory is to learn about the current uses, values and threats to the water resources of your watershed. This will help you identify key issues that your study questions can focus on.



There are many different ways to perform a watershed inventory. Below are some ideas for the kinds of information you might want to gather in an inventory. A more complete list of information to gather, a “Watershed Inventory Checklist,” is included at the end of this section. This checklist also provides suggestions for where you can obtain sources of information you’ll need to conduct a watershed inventory.

In general, there are two ways to gather information: 1) Research and interviews to find existing information, and 2) Field inventory to document what’s actually happening out in the watershed.

### 1. Research:

The following are some of the important research items to include in your watershed inventory:

- Use maps and aerial photos to:
  - o Delineate watershed and obtain basic watershed information.
  - o Calculate percentage for different land uses and how they have changed over time.
  - o Record the location of specific uses, values and threats that you learn about through your research.
  - o In urban or developed areas, map where the storm water outfalls are. You can obtain storm water watershed maps from your public works department.

- Get copies of existing reports that include your river.  
DEC information about surface waterbodies in the state is available from the Rotating Intensive Basin Studies (RIBS) Reports, Biological Assessment Reports, the Waterbody Inventory and Priority Waterbody List (WI/PWL), the 305(b) Report, and the 303(d) List (see the description of NYS DEC Water Quality Reports and how to order them at the end of this section). If DEC doesn't have much information documented about your river or river segment, don't be discouraged; in fact, DEC encourages HBRW groups to monitor sites and rivers for which there is a lack of information or poor documentation. If your river isn't listed in the PWL as an impaired waterbody, you may want to conduct a preliminary study to see if it should be. Or if your river is listed as an impaired waterbody, your study could try to verify the information or improve the level documentation that appears in the PWL. In addition to DEC reports, find out if any county or local agencies have completed river basin plans, watershed assessments, special studies, etc., so you can coordinate your efforts with theirs.
- Find out the legal classification of and designated uses associated with your river. Find out the NY State classification of your river to determine what the designated use of your river segment is. For each designated use, specific water quality criteria are set. Find the criteria that are set for your river segments. There is a brief overview of the NY State classifications and standards in this manual, but it is important to obtain a copy that has more detail. Contact your regional DEC office.
- Identify your river's special attributes and uses and what threatens them.  
What are the existing river uses? What is special about the river (its values) and where are these special attributes located? What and where are the activities that threaten these river uses and values? Have any of these activities been determined to be causing problems?

<b>Uses</b>	
• Swimming	• Fishing
• Irrigation	• Public water supply
• Waste assimilation	• Canoeing/Kayaking
<b>Values</b>	
• Aquatic life habitat	• Flood storage
• Scenic quality	• Wildlife habitat
• Unique natural features	• Ecosystem functions
<b>Threats/Problems</b>	
• Channel alterations	• Pollution discharges
• Sedimentation	• Polluted runoff
• Combined sewer overflows	• Loss of habitat
• Conflicts among uses	• Flow alterations
• Loss of riparian vegetation	

*Examples of Uses, Values, and Threats*

- Survey people in your watershed to identify river uses, special attributes, and problems.
- Know what municipalities govern your watershed and find out about land use ordinances and past, present and future zoning.
- Find out if there is a Natural Resource Inventory completed for any or all portions of your watershed. Contact your county environmental management council or planning department.
- Research any flora or fauna studies that might provide indications of land use changes or ecological health. Contact the NY Natural Heritage Program, local Audubon societies, other conservation groups, garden clubs, etc. Ask about vegetation surveys, bird surveys, lake studies, and studies of native, endangered and invasive species.

## 2. Field Inventory:

No matter how much information you dig up in your research and interviews, the best way to really know what's going on in your watershed is to get out into the field and make first-hand observations. Use your maps and researched information as a guide. Check out key features in your watershed. You might want to start at the headwaters and finish at the mouth of your river, noticing how natural characteristics and human land uses change from up to downstream. Verify the uses, values and threats you learned about in your research and interviews. No doubt you'll witness other ways the waterbody is being used, valued and threatened. Use part III, "Are your watershed uses & values threatened?" in the "Watershed Inventory Checklist" as a guide for identifying possible problematic areas and issues. Note the locations of key observations by marking them directly on your maps.



**A Note for School Teachers:** *If for the sake of logistics, convenience, access and/or safety, you have already selected a site (e.g. the stream in the schoolyard so you don't have to depend on buses), then your study design process will be a bit different than what is outlined in this manual. You have already determined Step 5 "Where will you monitor" before you have completed Step 1 "Watershed Inventory." Part of the purpose of the watershed inventory is to help you determine where to monitor, based on issues and questions that come up as a result of the inventory. However, if you already have a site, the watershed inventory is still an important part of the study design process. The more students know about the watershed upstream from their site, the better they will be able to come up with questions and hypotheses for their study.*

*The Watershed Inventory will help you guide your students through the watershed inventory process. Your HBRW Regional Coordinator may be able to help gather the materials your students will need to complete the Watershed Inventory (maps, aerial photos, existing studies, etc.). The Regional Coordinator may also be able to help you plan a "watershed tour" to take your students around the watershed by bus or other vehicle. At each predetermined stop, students can make observations about natural features and human land uses. This type of field trip will give them a broader perspective of the river and concrete experiences that will help them make inferences about the potential impact of various land uses on water quality. If you are not able to take your students on such a trip, a slide show is perhaps the best substitute.*

## Why are you monitoring? Define your questions and choose the indicators you will use.

Your watershed inventory will yield a lot of useful information that you can use to design your study. Some questions you come up with may be able to be answered with further research, and some might entail monitoring. Pick a list of questions that interest you and then assess which ones meet your organization's goals or class purpose and which of these you can answer in your program. Then you can choose the indicators that are best suited for answering your chosen question(s).

No matter what you study, a physical assessment is essential for helping you analyze your data regarding selected indicators. You may decide to design a monitoring program that focuses solely on observing and recording physical characteristics, such as surrounding land uses, bank erosion, degree of shading, and presence of pipes emptying into the water. Certain problems, such as sediment, may be better documented by frequent observations than by infrequent (though precise) measurements.

## Types of Studies

Depending on the questions you want to ask, this manual describes five kinds of water quality studies:

1. Water Quality Standard Survey: determines whether a river meets selected state water quality standards for its designated uses.
2. River Characterization: establishes a profile of a river along its length.
3. Trend Analysis: provides baseline information about how a river changes over time.
4. Impact or Improvement Assessment: measures the impact on a river of a particular human alteration or land use, or the improvement from a remediation activity.
5. Ecological Study: determines the effect that natural variation of river or watershed features has on different parameters, or answers a multitude of other questions.

Refer to the table "Study Design Questions & Indicators to Study" on the next page for a sample list of some of the questions that might interest you in the Hudson Basin, and the indicators you would measure to address each type of question. The questions are listed by type of water quality study. The list of questions for the "Impact/Improvement Assessment" section of the chart are based on common impacts in the Hudson River Watershed and the improvement activities that are used to address them.

## Study Design Questions & Indicators to Study

TYPE OF STUDY	SAMPLE STUDY DESIGN QUESTIONS	INDICATORS TO STUDY <i>(Do physical survey/habitat assessment for all studies)</i>
<b>Water Quality Standards Survey</b> Sample at one or more sites over a long period of time.	<ul style="list-style-type: none"> <li>▪ Is the waterbody supportive of its uses/values? If not, at what level are they impaired?</li> <li>▪ Does the segment meet water quality standards for the indicator measured?</li> </ul>	Choose indicators specific to the designated uses of your site. For swimming, measure fecal coliform bacteria. For all classifications C and above, aquatic life is a “use” - measure Benthic Macroinvertebrates (BMI’s).
<b>River Characterization</b> Sample at several sites over a short period of time.	<ul style="list-style-type: none"> <li>▪ How do factors (BMI’ s, dissolved oxygen, phosphorus, etc.) change from headwaters to mouth?</li> <li>▪ Where in the watershed are the uses/values impaired at this time?</li> </ul>	Choose the indicator(s) of most concern.
<b>Trend Analysis</b> Sample at one or more sites over a long period of time.	<ul style="list-style-type: none"> <li>▪ How do factors change over time (monthly, seasonally, over several years, etc.)?</li> <li>▪ Do uses/values tend to be more threatened at certain times of the year?</li> </ul>	Choose the indicator(s) of most concern.
<b>Impact/Improvement Assessment</b> Sample just up and downstream of the suspected impact over a short period of time; also at a recovery site further downstream.	<ul style="list-style-type: none"> <li>▪ Is there pesticide runoff or groundwater leaching from the <i>apple orchard</i> that is having an impact?</li> <li>▪ Are best management practices on the orchard improving the water quality?</li> </ul>	BMI, pH, dissolved oxygen, conductivity; send samples to a lab to measure specific pesticides.
	<ul style="list-style-type: none"> <li>▪ Does cow manure from the <i>dairy farm</i> have an impact?</li> <li>▪ Are best management practices on the dairy farm improving the water quality?</li> <li>▪ Does the <i>sewage treatment plant/septic system</i> have an impact?</li> <li>▪ Is the sewage treatment plant upgrade improving the water quality?</li> </ul>	Phosphate & nitrate (if slow moving stream or tributary to a lake), dissolved oxygen, bacteria, BMI.
	<ul style="list-style-type: none"> <li>▪ Is the <i>construction site</i> or <i>gravel mine</i> causing erosion/sedimentation or harming BMI habitat?</li> <li>▪ Are erosion/drainage control measures, detention ponds decreasing sedimentation?</li> </ul>	BMI, embeddedness, turbidity; document storm events.

## Study Design Questions & Indicators to Study

TYPE OF STUDY	SAMPLE STUDY DESIGN QUESTIONS	INDICATORS TO STUDY <i>(Do physical survey/habitat assessment for all studies)</i>
<b>Impact/Improvement Assessment</b> (Continued)	<ul style="list-style-type: none"> <li>▪ Is the <i>lack of riparian vegetation</i> or <i>forestry operation</i> causing increased runoff, erosion/sedimentation, high temperatures/low oxygen, degraded habitat?</li> <li>▪ Are the re-vegetation project and buffer strips improving the water quality and habitat?</li> </ul>	BMI, embeddedness, turbidity, temperature, dissolved oxygen; document storm events.
	<ul style="list-style-type: none"> <li>▪ Is storm water runoff from the <i>developed area</i> having an impact?</li> <li>▪ Are the storm water BMP' s improving the water quality?</li> </ul>	Same as above plus phosphate & nitrate, conductivity, bacteria.
	<ul style="list-style-type: none"> <li>▪ Is the <i>golf course</i> impacting the stream?</li> <li>▪ Are the BMP' s to reduce nutrient runoff improving the water quality?</li> </ul>	Phosphate & nitrate (if slow moving stream or tributary to a lake).
	<ul style="list-style-type: none"> <li>▪ Is there leaching from the <i>landfill</i> that is impacting the water quality?</li> <li>▪ Are drainage control measures, detention ponds improving the water quality?</li> </ul>	BMI, pH, dissolved oxygen, conductivity.
<b>Ecological Study</b> These types of questions will help you better understand the river ecosystem and the dynamics that occur; they will influence the results of other studies.	<u>Dissolved oxygen &amp; temperature questions:</u> <ul style="list-style-type: none"> <li>▪ Do oxygen and temperature vary daily or seasonally?</li> <li>▪ Do low flow/high temperature conditions in the summer support trout?</li> </ul>	<u>Dissolved oxygen, temperature:</u> <ul style="list-style-type: none"> <li>▪ Sample at different times of day or year; in different seasons, sample at same time of day.</li> <li>▪ Sample in summer: sample in morning most important, could also sample in afternoon for comparison.</li> </ul>
	<u>BMI questions:</u> <ul style="list-style-type: none"> <li>▪ Do BMIs change with different substrate types?</li> <li>▪ What habitat limitations might be affecting the BMI community?</li> <li>▪ How does the BMI community at a site change seasonally?</li> <li>▪ What is the composition of functional feeding groups? Do they change with habitat differences/seasonally?</li> <li>▪ Does the BMI community respond as the river continuum concept would predict?</li> <li>▪ Do BMI densities increase with nutrient increases?</li> <li>▪ How well does the sub-sample represent the whole sample?</li> </ul>	<u>BMI, stream bottom survey:</u> <ul style="list-style-type: none"> <li>▪ Sample at different substrate types.</li> <li>▪ Sample at different habitat conditions.</li> <li>▪ Sample in different seasons; perhaps before and after emergences.</li> <li>▪ Analyze feeding groups; sample at different habitat conditions/seasons.</li> <li>▪ Sample at different locations along the river continuum.</li> <li>▪ Sample at sites prone to nutrient increases; measure nitrate and phosphate.</li> <li>▪ Sort and identify the entire sample in addition to a random sub-sample and compare.</li> </ul>



## Define your data uses and users. Which tier do they fit into?

Many of the questions above can fit into more than one tier. You will need to decide how rigorous an analysis you want. From this, you'll be able to choose a tier. Each tier has recommended protocols for the indicators you choose. In general, the higher the tier, the more rigorous the analysis.

To be able to choose the tier appropriate for your study, it is important to identify how you want to use your data and who will use it. Each tier in this guidance manual relates to different data uses.

### Data Use by Individuals

Perhaps the most valuable use of your data is to share it with land and business owners in your watershed. They are the true "resource managers" – they make the small-scale land use decisions that affect your watershed daily. If you find a problem, suggest methods and offer resources on how to improve the situation rather than simply pointing a finger.

### Data Use by DEC

HBRW has worked with DEC to ensure that the protocols in this manual are designed to yield data that DEC can use for their watershed management efforts. Groups can report their results directly to their DEC Regional officers to alert them of potential water quality issues. Groups can also submit their results to DEC to be considered for incorporation into the WI/PWL, DEC's statewide water quality assessment effort. Groups can do this by filling out a WI/PWL Worksheet. We recommend that groups work with their Regional Water Quality Coordinating Councils when filling out WI/PWL worksheets. A sample copy of the WI/PWL Worksheet appears in this manual in the section entitled "Reporting and Using Data."

All three tiers can be used to report data to DEC for their use in updating the WI/PWL. However, the higher the tier, the more likely the data can be used to document water quality conditions:

**Tier 1** is an Introductory Investigation, the primary use of which is educational and provides a general awareness of river water quality.

**Tier 2** is a Preliminary Assessment used to document that a river segment has either "No Known Impacts" and is supportive of aquatic life, or that there are "Suspected" water quality problems that may be impacting water body uses/aquatic life support. Inclusion of "Suspected" water quality problems in

the WI/PWL requires verification of those impacts by DEC; this verification may incorporate Tier 3 follow-up by a volunteer group.

**Tier 3** is an In-Depth Assessment used to further evaluate the degree to which a waterbody is able or unable to support aquatic life. DEC will incorporate Tier 3 assessments as “Suspected” or “Known” impacts into its WI/PWL reviews depending on the level of QAQC employed and whether or not there is conflicting information.

## **Data Use by Local Agencies/Organizations**

If any regional, county or more local agencies/organizations are involved in watershed management efforts that involve your river, they may be very interested in your data. Check with them to determine the tier that fits best for their purposes. In some cases, you may need to use other protocols than what appears in this document if your local resource agencies have specific data needs that differ.

## **Data Use by Local Town or City Officials**

Share your data with your local town or city officials. Municipal planning boards have the most control over local land uses that occur in your watershed; they should know about your efforts to monitor your river. Even if your data does not indicate problems, a presentation to your municipal planning board can educate them about the importance of healthy watersheds and make a pitch to them to help prevent future potential problems.

## Choose the level of quality assurance/quality control that best fits your data use goals.

Quality assurance and quality control (QAQC) procedures provide information that permits data users to evaluate the scientific credibility of volunteer data. The more that volunteer water quality data are able to meet specific QAQC standards, the more the data are likely to be used in environmental management decisions.

Quality assurance (QA) information describes the system of procedures that volunteers use to collect and analyze the samples and produce the data, such as how a sampling site was located, how samples were preserved, which laboratory methods were used to analyze samples, how data were archived and reported. In order to provide quality assurance, it is necessary to document your methods, not just your data results. Use the “Monitoring Program Cover Sheet” that appears at the end of this section to provide data users with a birds-eye view of your monitoring program and to keep track of all your various data sheets. Only one cover sheet needs to be filled out, at the end of your monitoring project. Use the “BMI Sample Sheet” (in the BMI section) and “Chemical Sample Sheet” (in the chemical section) to document your BMI and chemical methods. These sheets need to be filled out for each sample collected.

Quality control (QC) information is actual test data that show how reliable the results of the analyses are. Reliability is evaluated by accuracy, precision and representativeness. *Accuracy* refers to how close the results are to the true value of the parameter being measured. It can be affected by factors such as how skilled volunteers are at identifying BMI's, how well their water samples are preserved prior to analysis, how clean their glassware is, whether their reagents have expired, and how well their instruments are calibrated. *Precision* refers to how reproducible the results are if the analysis is repeated. It can be evaluated by collecting and analyzing two replicate BMI samples from the same site, and conducting duplicate chemical tests on the same water sample. *Representativeness* refers to how faithfully measurements depict the true environmental conditions and populations of the waterbody being evaluated. It can be evaluated by habitat descriptions and sampling methods, timing and locations. The various physical, BMI and chemical data reporting sheets in this Guidance Document are designed to provide QC information as you report your data results.

A summary table of QAQC guidelines can be found on page 13 in the “Overview of Monitoring Methods” section of this manual. These guidelines are designed to provide feedback to groups that will help them adjust their methods to increase the scientific credibility of their data. The level of QAQC you choose will depend on your group's study design goals, abilities, time and resources. Each successive level of QAQC builds on and incorporates the previous level. Level A consists of documenting a basic system of assuring data quality. Level B adds “internal” controls on data quality (procedures that can be completed by your volunteer group) that further enhance the credibility of the data. At level C, volunteers obtain feedback from outside evaluators in order to corroborate the accuracy and precision of their data (“external” controls).

## Where Will You Monitor?

For a River Characterization, sampling sites should include a variety of locations representing the range of conditions in the watershed.

A Water Quality Standards Survey allows you the flexibility to have one site or many. Try to choose sites that reflect the uses and values that are indicated for the classification of your river.

For a Trend Analysis, you can also sample at one or more sites, depending on whether you want to investigate how the river changes over time at one site or over a longer portion of its length.

For an Impact Assessment, three sites should be chosen to “bracket” the impact:

- a) a reference or control site immediately upstream of any potential impact;
- b) an impact site immediately downstream of the alteration (at the point where the impact is completely integrated with the water);
- c) a recovery site downstream of the impact (where the water has at least partially recovered from the impact).

It is very important that all the sites be as similar as possible in every respect except for the impact being assessed.



***A Note for School Teachers:** You might want to start with considering what sites you can get to or access safely, and design a study around those sites, as mentioned in the “Watershed Inventory” section of this chapter.*

## When will you monitor?

Some studies require a short duration but high intensity of sampling, while others require a long duration of low intensity sampling. Ecological studies will fall into either category, depending on the nature of the question you're asking. Choose the type of study that fits your group's schedule, resources and abilities.

### **Short Duration/High Intensity:**

River Characterization: Establishing a profile of a river will require sampling several sites over a short period of time. Sample multiple sites along the length of the river in one or two days. It is best if you can repeat the process at least a couple more times within one or two weeks time, so that you end up sampling each site multiple times over a short period of time.

Impact/Improvement Assessment: To determine if a human activity has impacted or improved a river, sample your sites all in the same day, during a time when the potential impact/improvement is expected to occur. As with a River Characterization, it is best if you can repeat the process at least a couple more times within one week's time, so you end up sampling each site multiple times over a short period of time.

### **Long Duration/Low Intensity:**

For these types of studies, it is important to collect samples at the same time of day each time you sample, because there may be natural daily fluctuations of certain indicators, such as dissolved oxygen, that will influence your data results.

Water Quality Standards Survey: To determine if a waterbody supports its intended uses, it is best to sample over a long period of time. In general, monthly sampling for at least a year is recommended. If you are only able to sample one or two times a year, your results may be combined with others for a more complete picture of how the river is meeting expected standards over the course of the year. The timing and duration of your study will depend on the use you are evaluating. If you are trying to determine if a waterbody is suitable for swimming, you would only need to sample it during the summer swimming season.

Trend Analysis: To gather baseline data on how a river changes over time, sample monthly for a year or more, seasonally for a few years or more, or annually over several years.

### **The effect of storms:**

Weather changes, particularly storms with significant rainfall, may drastically alter conditions in a river. In short duration studies (River Characterization and Impact/Improvement Assessment), you'll want to collect all your samples under similar weather conditions for a fair comparison. Long duration studies will naturally pick up varied weather conditions. It is important to note weather conditions every time you sample.

For some studies, you may want to time your sampling specifically around storm events. For example, if you are assessing the impact of a sewage treatment plant that you suspect overflows during storms, you would want to sample above and below its outfall before and after storm events. For many questions having to do with sedimentation and erosion, it is also important to sample around storm events, because that is when much of the erosion and sediment loading occurs.

Storm sampling can be tricky. During and shortly following a storm, the flow rate (and water level) in a river rises. At some point shortly after the storm ceases, the flow rate reaches its peak and then starts to decline back towards its baseline level. To sample a storm event, ideally you sample during the rise, at the peak, and during the fall. However, your sampling schedule will depend on the goals of your study, the hydrologic nature of the watershed, and safety concerns. In general, more pollutants and sediment are carried in the rise of the flow and thus the rise is usually more intensively sampled. However, there may be some cases where more materials are carried in the fall of the flow. A storm drainage system using a retention basin might not contribute material to the river until after the peak of the flow because the basin delays the release of water.

A further complication is possible: though there may be increased pollution loading into a river during high flows, actual concentrations may be lower due to dilution.

If you plan to conduct storm sampling, you will have to create a way to inform your sampling team about appropriate timing for sampling each event. In many cases, sampling may not be possible due to safety (high flow rates) or convenience issues.

### **Benthic Macroinvertebrate Sampling:**

NYS DEC samples macroinvertebrates from July through September, when populations tend to be under the highest stress of the year due to low flows and high temperatures. In an ideal world, HBRW groups would do the same. However, if you are a school group, you will probably sample in May and/or October. This is fine. The most important thing to keep in mind is to sample the same time each year if you are going to compare data over several years. Also, if you sample in the fall, try to do it before leaf drop to save yourself from the cumbersome task of sorting through all the debris.

## Who Will Do What Tasks?

How will you organize your sampling? If you are a teacher, will you organize your students into teams for each indicator, or will all students measure every indicator? If you are a community program, will you have volunteers collect samples and bring them to a central place to be processed? If so, who will run the tests?

Quite often there are different volunteers who run each test in the lab, rather than every person doing each test in the field. For benthic macroinvertebrates, community groups often invite the volunteers back for evening sessions picking and sorting the organisms. Sometimes you can ask a college class to do this for you, or to take your samples and identify them in further detail.

Regardless, it is a good exercise to decide how each task in your program will be accomplished. The more people that are involved in your program, the greater the visibility and ownership for your organization, and the more interest there is in the river.



***A Final Note for School Teachers:** School programs can be limited by when and where they can sample. When designing your study, be aware of these limitations and gear your study goals accordingly. You will most likely flip back and forth between what you are interested in knowing and your limitations, before you arrive at a study that works for your situation. Smaller groups of students (e.g. environmental clubs) often continue the study and work with community volunteers to explore more specific questions. Also remember that studies evolve with time. Each year, you will make adjustments to refine your program. In our experience, it takes three years for a new program to run smoothly.*

Required for  
all groups

# Monitoring Program Cover Sheet

Name of Group/Program \_\_\_\_\_ River/Stream \_\_\_\_\_

Location (county, USGS Quadrangle(s)) \_\_\_\_\_ Date \_\_\_\_\_

Type of study: \_\_\_ Water Quality Standards Survey \_\_\_ River Characterization  
(check all \_\_\_ Trend Analysis \_\_\_ Impact or Improvement Assessment  
that apply) \_\_\_ Ecological Study \_\_\_ Other \_\_\_\_\_

What is the purpose of your study?

Describe sampling sites and other study details below (attach another sheet if needed):

Site name	Site description/location	Dates sampled	Indicators analyzed	HBRW Tier	QAQC level

Describe your group, ages and experience of those carrying out tasks:

Indicate total number of each:

\_\_\_ sampling sites \_\_\_ sampling days  
\_\_\_ BMI samples collected \_\_\_ chemical samples collected

Indicate total number of each that are attached:

\_\_\_ Physical/Habitat Survey Sheets (one per site per season)  
\_\_\_ Stream Bottom Survey Sheets (Tier 3: one per BMI site sampled; Tiers 1-2: optional)  
\_\_\_ Flow Data Sheets (one for each chemical sample collected, if possible)  
\_\_\_ BMI Sample Sheets (one for each BMI sample)  
\_\_\_ BMI Data Reporting Sheets (one for each BMI sample & replicate)  
\_\_\_ Chemical Sample Sheets (one for each chemical sample)  
\_\_\_ Chemical Data Reporting Sheets (one for up to chemical samples, including duplicates)

Remarks:

Name, phone & email of contact person: \_\_\_\_\_



## Study Design Worksheet

**Observation and/or Problem** (Discovered in your watershed inventory)

**Study Question** (What question(s) do you want to answer with your monitoring program?)

**Hypothesis** (A testable explanation)

**Prediction** (If the hypothesis is true, then you would predict that.....)

### Experimental Design

1. Describe how you will test your hypothesis.
  
  
  
  
  
  
  
  
  
  
2. Define your data uses and users – which tier do they fit into?

3. For each indicator that you will need to measure, describe the monitoring methods and QAQC procedures you plan to use.

Indicator	Monitoring Methods (Tier 1, 2, or 3?)	QAQC Procedures (Level A, B, or C?)

4. Where and when will you carry out the necessary tasks?

5. Who will do what tasks?

# Study Design Worksheet - Example

## Observation and/or Problem

*Wappinger Lake is eutrophic*

## Study Question

*Where are the high nutrient levels coming from?*

## Hypothesis

*Route 9 storm drains contribute more to the problem than the watershed upstream of the lake.*

## Prediction

*Nutrient loading from Route 9 storm drains is greater than nutrient loading in the creek just upstream from the lake.*

## Experimental Design

### 1. Describe how you will test your hypothesis.

*Measure phosphate & nitrate concentrations and flow of water coming from Route 9 storm drains and in creek just above lake. Calculate loading values (loading = concentration x flow) and compare.*

### 2. Define your data uses and users - which tier do they fit into?

*Dutchess County Environmental Management Council and Wappinger Creek Watershed Planning Committee. They will accept either Tier 2 or Tier 3 data.*

### 3. For each indicator that you will need to measure, describe methods, including QAQC.

Indicator	Monitoring Methods (Tier 1, 2, or 3?)	QAQC Procedures (Level A, B, or C?)
$NO_3-N$	Zinc reduction color comparator (Tier 2)	<p>Level C:</p> <p>Calibrate Nitrate test kit with blank and standard before testing sample.</p> <p>Analyze one duplicate for each indicator each day.</p> <p>Split one sample for each day of sampling and send to an ELAP-certified lab for analysis. (Skip the split for a sampling day if it is within 30 days of a previous one).</p> <p>Thoroughly wash all sampling bottles and glassware.</p> <p>Make sure all reagents are current.</p> <p>Collect a grab sample from main current or a composite sample from cross section of the stream.</p> <p>Because analysis will not be done right away in the field, follow procedure for preserving the sample for later analysis.</p> <p>Use known <math>PO_4</math> standards to develop calibration curve for DR890 colorimeter.</p>
$PO_4$	DR890 colorimeter (Tier 3)	
flow	<p>Extrapolate flow of creek from USGS data.</p> <p>Measure flow from pipes with a known volume container and a stop watch.</p>	

### 4. Where and when will you carry out the necessary tasks?

*The day after a rainstorm of at least 1 inch. Sample at storm drain pipes and from creek at road crossing upstream from lake. Sample 5 rainstorms over the course of a season.*

### 5. Who will do what tasks?

*Because storm sampling is important for this study, students will not be able to do the sampling unless they can walk there from the school (need prior notice to arrange a field trip). However, teachers can still carry out this study with students. Take them on a field trip of the watershed, the creek, and the lake to learn about and observe the situation. If possible, recruit and train a parent and student willing to take samples the day after the next rainstorm. Otherwise, a teacher or community volunteer can do the sampling. Students can analyze the samples in the classroom.*

# Watershed Inventory Checklist

I. What and where is your watershed?	Useful tools/resources:
<ol style="list-style-type: none"> <li>1. Define the watershed that will be the focus of your monitoring program (name of river/watershed).</li> <li>2. Pathway to the Hudson (or Atlantic Ocean).</li> <li>3. Headwaters (note highest elevations).</li> <li>4. Mouth (note elevation).</li> <li>5. Other topographical features.</li> <li>6. Length of the main stream/river.</li> <li>7. Major tributaries/sub-basins in the watershed.</li> <li>8. Major wetlands &amp; lakes in the watershed.</li> <li>9. If your study will not cover the entire watershed, describe the area that your study will focus on (if you know).</li> <li>10. Number of square miles in your watershed (you may need to delineate your watershed's boundary to determine this. If you already have sampling sites chosen, delineate just the watershed area defined by your most downstream site).</li> <li>11. Towns/cities/counties/states within the watershed.</li> <li>12. Weather patterns (especially annual rainfall and seasonal rainfall patterns) in your watershed.</li> </ol>	<ul style="list-style-type: none"> <li>▪ Topographic maps available from USGS Information Service, Box 25286, Denver, CO 80225 (<a href="http://mapping.usgs.gov">http://mapping.usgs.gov</a>), from county soil and water conservation districts, or <a href="http://www.topozone.com">www.topozone.com</a>.</li> <li>▪ Road maps of your area.</li> <li>▪ "Delineating the Boundaries of Your Watershed," in the <i>Streamkeepers Field Guide</i>, available from the Adopt-A-Stream Foundation, Everett, WA, (425) 316-8592.</li> <li>▪ GIS maps may be available from county water quality committees, environmental management councils, or planning departments.</li> <li>▪ National and local weather service.</li> </ul>

II. How is your watershed used and valued?	Useful tools/resources/contacts:
<ol style="list-style-type: none"> <li>1. NYS DEC classification of your river segment(s).</li> <li>2. Sewage treatment plants or other major SPDES permits.</li> </ol>	<ul style="list-style-type: none"> <li>▪ State stream classification maps and charts, state water quality standards, and SPDES permit information available from DEC regional offices.</li> </ul>
<ol style="list-style-type: none"> <li>3. Estimates of how much of your watershed area is urban, rural and forested.</li> <li>4. Zoning in the watershed.</li> <li>5. Recent trends in land use changes.</li> <li>6. Recent trends in population growth or decline.</li> </ol>	<ul style="list-style-type: none"> <li>▪ Aerial photos available from county planning departments, USDA Farm Service Agency offices, or <a href="http://www.nysgis.state.ny.us">www.nysgis.state.ny.us</a>.</li> <li>▪ Zoning maps and information from local town halls.</li> <li>▪ GIS land use maps may be available from county environmental management councils or planning departments.</li> <li>▪ Procedures on how to estimate land use percentages from aerial photos: Activity 8 in <i>SWEAP</i> curriculum, available from the Institute of Ecosystem Studies, 845-677-5359.</li> <li>▪ Population statistics from county planning departments.</li> </ul>
<ol style="list-style-type: none"> <li>7. Major sources of drinking water (aquifers, reservoirs, etc.).</li> </ol>	<ul style="list-style-type: none"> <li>▪ Maps and information from county health departments, water agencies, and/or environmental management councils.</li> </ul>
<ol style="list-style-type: none"> <li>8. Key fish species and fishing areas.</li> </ol>	<ul style="list-style-type: none"> <li>▪ DEC regional fisheries offices.</li> <li>▪ Survey local fishermen.</li> <li>▪ Native Fish Conservancy (<a href="http://www.nativefish.org">www.nativefish.org</a>).</li> <li>▪ Trout Unlimited.</li> </ul>
<ol style="list-style-type: none"> <li>9. Key wildlife habitats and species.</li> </ol>	<ul style="list-style-type: none"> <li>▪ NY Natural Heritage Program, 518-783-3926.</li> <li>▪ Hudson River Estuary Biodiversity Coordinator, 845-256-3061.</li> <li>▪ Local chapters of The Nature Conservancy, Audubon Society, and other wildlife conservation organizations.</li> </ul>

9. Key wildlife habitats and species, continued.	<ul style="list-style-type: none"> <li>▪ The wildlife technicians in DEC regional offices.</li> <li>▪ Hudsonia, Ltd., 845-876-7200.</li> <li>▪ Metropolitan Conservation Alliance, 914-925-9175.</li> </ul>
10. Swimming areas. 11. Other recreational uses and areas. 12. Important scenic areas.	<ul style="list-style-type: none"> <li>▪ Information from county health departments on officially regulated public swimming areas.</li> <li>▪ Survey local residents about unofficial swimming areas, other recreational uses, and scenic values of your watershed.</li> <li>▪ Town, county and state parks and recreation departments.</li> <li>▪ Local hiking groups, sporting clubs, and other environmental organizations.</li> <li>▪ Scenic Hudson, 845-473-4440).</li> <li>▪ Greenway Council for the Hudson River Valley, 518-473-3835.</li> <li>▪ Department of State Scenic Areas of Statewide Importance Program, 518-474-5290.</li> <li>▪ NYS Department of Transportation Scenic By-Ways Program, 518-457-4460.</li> </ul>
13. Predominant agricultural activities.	<ul style="list-style-type: none"> <li>▪ County soil and water conservation districts.</li> <li>▪ County Cornell Cooperative Extension offices.</li> <li>▪ Local chapters of the NY Farm Bureau.</li> </ul>
14. Other watershed uses & values.	<ul style="list-style-type: none"> <li>▪ Survey local residents.</li> </ul>

<b>III. Are your watershed uses &amp; values threatened?</b>	<b>Useful tools/resources:</b>
<ol style="list-style-type: none"> <li>1. Areas of riparian habitat loss.</li> <li>2. Potential impacts from non-point source pollution, such as stream bank erosion, urban and agricultural runoff, storm drain pipes, septic problems, etc.</li> <li>3. Potential impacts from point source pollution.</li> <li>4. Potential flood hazard areas.</li> <li>5. Areas where the flow and channel of the river has been altered (e.g. dams, dikes, extensive culverting, etc.).</li> <li>6. Other threats.</li> </ol>	<ul style="list-style-type: none"> <li>▪ NYS 305(b) Report, Priority Waterbodies List for your portion of the Hudson Basin, and any other studies more specific to your watershed, available from NYS DEC Division of Water, (518) 457-7130.</li> <li>▪ Maps of storm drain pipe locations are sometimes available from town or county public works.</li> <li>▪ Records of SPDES permit violations available from your local DEC regional office.</li> <li>▪ Maps of floodplain management zones available from town hall or county planning.</li> <li>▪ Information from surveying local residents.</li> <li>▪ OBSERVATIONS MADE THROUGH A WATERSHED FIELD INVENTORY: field check as many of the potential impact areas you discover when researching, and use your field inventory to find any other potential threats not gleaned from existing information, interviews, or surveys.</li> </ul>

<b>IV. Are there watershed protection activities underway in your watershed?</b>	<b>Useful contacts:</b>
<ol style="list-style-type: none"> <li>1. Groups formed to do watershed watching, stream monitoring, or watershed management planning.</li> <li>2. Best management practices (urban or agricultural) that have been implemented or planned.</li> </ol>	<ul style="list-style-type: none"> <li>▪ County soil and water conservation districts.</li> <li>▪ County environmental management councils.</li> <li>▪ County planning departments.</li> <li>▪ County Cornell Cooperative Extension offices.</li> <li>▪ Local environmental organizations.</li> </ul>
<ol style="list-style-type: none"> <li>3. Land conservation projects.</li> </ol>	<ul style="list-style-type: none"> <li>▪ Local land conservation organizations.</li> <li>▪ Scenic Hudson, 845-473-4440.</li> </ul>
<ol style="list-style-type: none"> <li>4. Local town or county ordinances that protect waterways through buffer zones, erosion control regulations, etc.</li> </ol>	<ul style="list-style-type: none"> <li>▪ Town halls.</li> <li>▪ Town conservation commissions.</li> <li>▪ County planning departments.</li> </ul>

## New York State River Classifications

(For more complete info, see *NY State Codes, Rules and Regulations Title 6, Chapter X, Parts 700-705*)

- Class A** Drinking, cooking, contact recreation (swimming), fishing, fish propagation and survival (aquatic life). (For information on Class AA-Special, Class A-Special and Class AA, see NY State publication above).
- Class B** Primary and secondary contact recreation, fishing, fish propagation and survival (aquatic life).
- Class C** Fishing, fish propagation and survival (aquatic life). Can be suitable for contact recreation, but may be limited.
- Class D** Fishing. Cannot support fish propagation due to natural conditions such as streambed and flow. Suitable for fish survival. Contact recreation may be limited.

## New York State Water Quality Standards (for surface freshwater)

Parameter	Class	Standard	Guideline for a Healthy Stream
pH	A,B,C	Between 6.5-8.5	See standards.
	D	Between 6.0-9.0	
DO	A, B, C	Trout spawning (TS) $\geq 7.0$ mg/L Trout waters (T) never $< 5.0$ mg/L, daily ave. 6.0 Non-trout, never $< 4.0$ mg/L, daily ave 5.0	
	D	$\geq 3.0$ mg/L	
Temperature		No standard	Trout, $\leq 70^{\circ}\text{F}$ (21.1 $^{\circ}\text{C}$ ) Non-trout, $<80^{\circ}\text{F}$ (26.7 $^{\circ}\text{C}$ )
Orthophosphate as $\text{PO}_4$ (divide by 3 for orthophosphate as P)		“None that will result in growths of algae, weeds, and slime that will impair uses”  No numerical standard	$> 0.15$ mg/L impact likely $> 0.3$ mg/L impact certain  (especially if slow moving area or upstream from lake)
Nitrate-nitrogen ( $\text{NO}_3\text{-N}$ )	A	$\leq 10$ mg/L	Natural levels generally $< 1$ mg/L
	B, C, D	“None that will result in growths of algae, weeds, and slime that will impair uses”	
Ammonia-nitrogen ( $\text{NH}_3\text{-N}$ )		No standard	Not to exceed 0.10 mg/L
Alkalinity		No Standard	0-5 mg/L endangered or critical 5-10 mg/L highly sensitive 10-20 mg/L sensitive 20 mg/L not sensitive
Chloride	A	$\leq 250$ mg/L	Natural levels generally $<50$ mg/L
	B, C, D	No standard	
Conductivity	Freshwater	No standard	Generally 150-500 uS/cm, salt water much higher
Fecal Coliforms	A, B, C, D	Monthly geometric mean of at least 5 samples $\leq 200$ colonies/100 ml	See standards.
Total Coliforms	A, B, C, D	Monthly median value from at least 5 samples $\leq 2,400$ colonies/100ml; and $>20\%$ of the samples, from at least 5 samples $\leq 5,000$ colonies/100ml	
Turbidity	A, B, C, D	“No increase that will cause a substantial visible contrast to natural conditions”	
Suspended and settleable solids	A, B, C, D	“None from sewage, industrial wastes or other wastes that cause deposition or impair the waters for their best usages”	

**New York State Department of Environmental Conservation (NYSDEC)  
Water Quality Reports**

Use these reports to gather information about your river. To obtain them contact:  
NY State Department of Environmental Conservation, Division of Water, 625 Broadway, Albany,  
NY 12233. Phone: 518-402- 8233 Email: [dowinfo@gw.dec.state.ny.us](mailto:dowinfo@gw.dec.state.ny.us)

The data and information in the RIBS Reports are used to update...

WI/PWL information for the entire state is summarized and compiled to generate...

A subset of waterbodies identified as **not** supporting designated uses makes up...

**Rotating Integrated Basin Studies (RIBS) Reports**

*Water Quality Reports for Individual Large Drainage Areas of NY State.*  
These reports summarize the results of the DEC Division of Water RIBS ambient surface water monitoring program. The RIBS Sampling Program incorporates the chemical analysis of water and bottom sediment, and the biological monitoring of aquatic communities and analysis of tissue samples, ambient toxicity testing, fisheries evaluations and other monitoring activities to produce an integrated assessment of water quality. The RIBS Program conducts intensive monitoring in about 20% of the state in each year, with coverage of the entire state within a 5-year period.

► **Waterbody Inventory and Priority Waterbodies List (WI/PWL)**

*Summary Reports of Water Quality Assessment Information for Large Drainage Areas.*  
These reports provide an inventory of waterbodies in the state, and summarize background information, water quality conditions, the degree to which the waterbodies support designated uses, and progress toward the identification of problems, sources and improvements. While RIBS documents are data reports, the WI/PWL Reports provide more of a water quality *scorecard*. The assessment information contained in the WI/PWL is based on input from sources from both within and outside DEC.

► **The Section 305(b) New York State Water Quality Report**

*Biennial Report to USEPA Describing the Current State of New York Waters.*  
Section 305(b) of the federal Clean Water Act requires each state to assess and report on the health of their waters every two years. The 305(b) report is the principal means by which the U.S. EPA evaluates the degree to which waters support appropriate uses (such as drinking, swimming, and aquatic life), and progress the state is making in achieving its water quality goals.

► **The New York State Section 303(d) List**

*A Biennial List of Problem Waters in New York State.*  
Section 303(d) of the Federal Clean Water Act requires states to develop and submit to EPA a list of waters for which technology-based pollution controls are not stringent enough to attain or maintain compliance with applicable state water quality standards. This list identifies waters as priorities for total maximum daily load (TMDL) development, a strategy to reduce specific pollutant loadings and restore water uses.

**Biological Assessment Reports**

These reports present the results of macroinvertebrate sampling conducted by the DEC Stream Biomonitoring Unit on individual wadeable streams. The streams are usually selected for study because of known or suspected issues of interest to DEC Regional staff.

## NYS DEC Regional Offices

<b>REGION</b>	<b>AREA COVERED</b>	<b>OFFICE LOCATION</b>	<b>PHONE</b>
Region 2	New York City	Long Island City	718-482-4933
Region 3	Rockland/Westchester Counties north up to and including Ulster/Dutchess Counties	Tarrytown	845-332-1835
Region 4	Greene/Columbia to Rensselaer County and including the Mohawk River west to and including Montgomery County	Schenectady	518-357-2380
Region 5	Upper Hudson River	Warrensburg	518-623-1200
Region 6	Mohawk River in Herkimer/Oneida Counties	Utica	315-793-2747
Hudson River Estuary	Troy Dam to New York City	New Paltz	845-256-3029



# SAFETY

---

Collecting and analyzing all types of samples requires certain precautions and safety measures. Here are some recommended safety procedures:

- Collect samples with a partner. Let someone know where you are going and when you expect to return. Bring a cell phone with you if possible.
- *If you are in doubt as to your ability to safely collect a sample, don't do it!* Be aware of your own physical limitations and the difficulty of collecting samples at certain locations under certain conditions. Don't collect under difficult conditions or severe weather.
- Bring a basic first aid kit, and get emergency contacts and information about any medical conditions for all the people in your group.
- Be careful when pulling off on the side of the road and leaving your car, so as not to endanger yourself or create a traffic hazard. If you are sampling or working alongside a roadway or on a bridge, wear orange vests or other bright, reflective clothing. If sampling on a bridge, also look for boaters, swimmers, etc. before you drop your sampler over the side of the bridge. Don't lean too far over the railing!
- Consider leaving your wallet and keys in or around your car so you won't lose them in the river.
- Bring a stick or pole along for balance when climbing down steep banks or wading.
- Watch out for poison ivy – it likes stream banks!
- High flows can turn even the most placid water into a raging torrent. Don't attempt to collect a sample if you feel the least bit of risk. *Avoid dangerous situations.* If there is an upstream dam that periodically releases water, the water level may rise swiftly. Be aware of the timing of such releases and avoid getting caught in the middle of the stream during a release. Inform the dam operators of your collection. If there is a conflict, ask if the release can be changed to accommodate you.
- Collecting samples requires wading. *Wear waders or at least sturdy soled shoes!* Bring a towel and a dry, warm change of clothes. If any of the people wading in the stream are not strong swimmers, the use of a personal floatation device is strongly recommended.
- If sampling below a wastewater treatment plant, or in waters known to be polluted, wear rubber gloves and wash your hands after exposure.
- If the stream bed is soft and mucky, test it with a pole or stick before putting your full weight on it.
- Use latex gloves and protective eyewear when working with all chemicals and pay special attention to the information included with your reagents.
- Make sure to dispose of waste correctly. **The cadmium in the Tier 3 nitrate test has to be disposed of as a hazardous waste.** Make sure to read the material safety data sheets (MSDS) that come with all of your reagents.
- Don't trespass on private property. Obtain prior permission of the landowner.



# PHYSICAL SURVEY

---

## Overview

The physical survey is an essential component of any monitoring program. In fact, simply performing and documenting a physical survey can be an excellent monitoring project. You can perform a physical survey as background information to help design a monitoring program, as the core part of your program, or to obtain information for better understanding your chemical and biological monitoring results.

The physical surveys in this document provide you with a focused way to look at:

- weather conditions
- water appearance
- stream banks and channel
- habitat characteristics: riffles & pools (flow pattern), stream bottom composition, embeddedness, velocity, shelter for fish
- flow (volume and velocity of water in the stream)
- riparian zone
- land use around your site

A physical survey should be conducted at each monitoring site for a 200' segment that extends up and downstream from your sampling site (your sampling site bisects the 200' segment). Consider the entire 200' segment when evaluating the various factors that describe the physical habitat quality. For the factors of substrate size and embeddedness, however, evaluate only your specific BMI collection site – the riffle area in which you actually collect BMI's.

Tier 1 provides a simple "Physical/Habitat Survey." Tiers 2 and 3 involve a more detailed "Physical Survey/Habitat Assessment" that ranks the site on a scale from "excellent" to "poor." Not only does this help you evaluate your site, it also enables you to compare qualitatively different sites.

All tiers include a "Site Drawing" that helps you document features visually. It is important to indicate on your drawing the exact location of where you collected your samples. Photographs are also a great way to document the physical features of your site. Note on your site drawing where your photographs were taken.

An additional field survey to evaluate the stream bottom habitat is recommended for Tier 3 BMI studies (optional for Tier 2). A procedure for measuring flow is also provided. The rationale for both of these are described in more detail below.

## How Often Should I Complete a Physical Survey?

The entire physical survey should be conducted every time you collect a BMI sample. For chemical monitoring, complete the first page of the Tier 2/3 survey (or the first half of the first page of the Tier 1 survey) every time you collect a water sample, and complete the entire physical survey for each site at least once per year. You may want

to complete the entire physical survey more often, such as once per season, or when there are noticeable changes from the last time you surveyed the site.

## **A Context for Analyzing Results**

The characteristics you observe in the physical survey provide an important context for the other indicators you measure. Chemical and biological data about a stream are useless without some key pieces of information. The entire physical survey should be conducted every time you collect a BMI sample because it documents habitat characteristics that may have a significant impact on the BMI community. A difference in BMI findings between two sites might be caused by a difference in habitats between sites rather than a difference in water quality.

The first page of the Tier 2/3 survey (or the first half of the first page of the Tier 1 survey) should be conducted every time you collect a water sample because it documents information about weather, water level, and water appearance that may change frequently and have a significant influence on river water quality. Other items covered by the rest of the physical survey are important to document at least annually as they will help you interpret your chemical monitoring results. For example, the presence of a storm drain pipe might explain elevated levels of certain indicators, or the absence of shade trees along the river banks might explain low levels of dissolved oxygen during the summer.

## **Use in Study Design**

You can use the physical survey to develop your monitoring program study design. You might select sites for chemical monitoring based on the presence of particular land uses or human impacts discovered in a physical survey. If you are assessing the impact of water quality on macroinvertebrates in your watershed, you could use the habitat assessment to make sure you choose sites that are as similar as possible in basic habitat features so you know that water quality differences, not habitat differences, are impacting the macroinvertebrate community. If your question involves studying what type of macroinvertebrates live in different habitats, then you could use the habitat assessment to help you choose sites of varying habitat.

## **Stream Bottom Survey**

The stream bottom survey provides step-by-step instructions for examining two key factors determining macroinvertebrate habitat: substrate size and cobble embeddedness. *Substrate* refers to the materials on the stream bottom. The sizes of stream bottom materials at a site will determine what types of macroinvertebrates live there. For example, crayfish prefer to hide beneath large boulders and aquatic worms burrow in fine silt. *Cobbles*, the rocks between 2 and 10 inches in diameter, are the most optimal for benthic macroinvertebrates. When cobbles on the stream bottom are covered up with silt and sand, they are *embedded*. The more cobbles are embedded, the less habitat is available to the macroinvertebrates that live in the spaces beneath the cobbles. Embeddedness also hinders trout egg laying and survival. It is recommended that a stream bottom survey be completed every time a Tier 3 BMI sample is collected.

The survey is optional for Tier 2. Conduct this survey at your specific BMI collection site – the riffle area in which you collect organisms (it is not meant to be a general evaluation of the 200' segment). If possible, conduct the stream bottom survey BEFORE you collect BMI's, because you will disturb the stream bottom during collection.

## Measuring Flow

The "Flow Worksheet" for Tiers 2 & 3 provides step-by-step instructions for obtaining an estimate measurement of the flow, or discharge, of your river at your site. Flow is the volume of water that moves past a site in a certain amount of time. Calculating flow involves measuring the cross sectional area and velocity of your river. The method in the Guidance Document uses a float to measure velocity. An orange works well in most rivers. For small creeks, a ping pong ball might work better.

For greater accuracy and precision (but at much greater expense), you can use a flow meter. If you are not able to measure flow, you may be able to obtain discharge data about your river from the U.S. Geological Survey's website [www.usgs.gov](http://www.usgs.gov).

Knowing the flow of your river helps you better understand your data results, particularly that of your chemical monitoring. High flows from storm events might cause an increase in the concentration of certain indicators, from non-point pollution carried by storm water runoff. High flows might, however, have the opposite effect, diluting concentrations of pollutants. Low flows resulting from drought times might tell a different story for your findings. For example, finding high bacteria counts during a low flow period of no storms might indicate input from a point source of pollution.

**An Important Note:** Many of the observations that comprise a physical survey involve making estimates. To keep the estimations consistent between sites, have the same people estimate for each site.

## Equipment and Materials Needed for Physical Surveys

Waders

Thermometer

Tape measure (30 meter preferable) or string marked in 1-meter increments

Meter stick

An orange or other float

Stopwatch

Clipboard

Camera

U.S.G.S. topographic map is helpful

Flow meter may be necessary, depending on your study design

# Physical/Habitat Survey

Assess a 200 foot segment up and downstream from your sample site.

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

Survey Site \_\_\_\_\_ Survey Date & Time \_\_\_\_\_

Name of person(s) completing survey \_\_\_\_\_

**Weather:** Today \_\_\_\_\_ **Temperature:** Air \_\_\_\_\_ °C  
 Past 2 days \_\_\_\_\_ Water \_\_\_\_\_ °C

**Stream Width:** The stream is on average \_\_\_\_\_ meters wide and \_\_\_\_\_ meters deep.

**Water Level:** Compared to the height of the stream channel, the water level seems relatively: \_\_\_\_\_ high \_\_\_\_\_ medium \_\_\_\_\_ low

**Water Appearance/Odor**

- clear       tea-brown       milky       other       unusual odor  
 foam       multi-color       muddy      (describe):      (describe):

**Velocity:** Average time it takes to flow 3 meters: a) 3 meters / \_\_\_\_\_ sec = v1 \_\_\_\_\_  
 (0.45-0.75 m/sec is optimal for BMI collection sites) b) 3 meters / \_\_\_\_\_ sec = v2 \_\_\_\_\_  
**AVERAGE:** \_\_\_\_\_ m/sec

**Habitat Features:**

The site has:	Many	Some	Few or None
Riffles (fast areas, <2' deep)			
Runs (fast areas, >2' deep)			
Pools (slow areas, >2' deep)			
Glides (slow areas, <2' deep)			
Shelter for fish (logs, stumps, and/or undercut banks)			
Patches of aquatic plants			

**Substrate Size:** (evaluate the riffle area where you will collect your BMI's)

Rank the substrate sizes from most common (1) to least common (6)

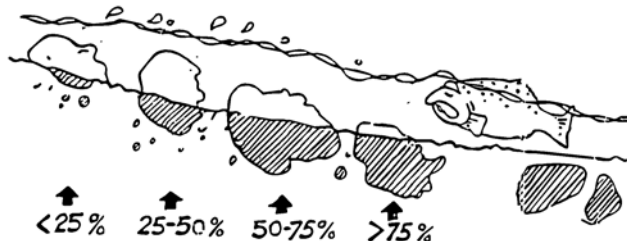
Silt/Clay/Mud (makes the water cloudy if disturbed)	Sand (up to 0.1")	Gravel (0.1-2")	Cobbles (2-10")	Boulders (>10")	Bedrock (solid rock covering the stream bottom)

**Cobble Embeddedness:** (evaluate the riffle area where you will collect your BMI's)

Pick up several cobbles (if present) to estimate the average embeddedness of your site:

Average Embeddedness: \_\_\_\_\_ %

(50% embeddedness indicates doubtful habitat for many macroinvertebrates, trout and egg survival)



**Natural Vegetation** extends beyond the banks for: \_\_\_\_\_ < 6 yards    \_\_\_ 6-12 yards  
 (if the 2 banks are different, evaluate the worst side)    \_\_\_\_\_ 12-35 yards    \_\_\_ > 35 yards

**Stream Banks:**

They are:	In no or few areas	In some areas	In many areas
Covered with vegetation			
Eroding			
Mowed			
Artificially protected			

**Human Impacts and Land Uses:** (check what applies)

- |   |                                     |                                   |                                   |                                 |
|---|-------------------------------------|-----------------------------------|-----------------------------------|---------------------------------|
| <input type="checkbox"/> Stream channel altered       | <input type="checkbox"/> Dams       | <input type="checkbox"/> Stores   | <input type="checkbox"/> Industry | <input type="checkbox"/> Other: |
| <input type="checkbox"/> Storm drain pipes            | <input type="checkbox"/> Farms      | <input type="checkbox"/> Culverts | <input type="checkbox"/> Houses   |                                 |
| <input type="checkbox"/> Sewage treatment plant pipes | <input type="checkbox"/> Recreation | <input type="checkbox"/> Mining   | <input type="checkbox"/> Logging  |                                 |
|   | <input type="checkbox"/> Garbage    | <input type="checkbox"/> Roads    |                                   |                                 |

**Describe how they may be impacting the stream:**

---

**Site Drawing:** Attach data sheet located on page 46.

## Physical Survey / Habitat Assessment

Assess a 200 foot segment up & downstream from your sample site

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_  
 Survey Site \_\_\_\_\_ Survey Date & Time \_\_\_\_\_  
 Name of person(s) completing survey \_\_\_\_\_

**Weather:** Today \_\_\_\_\_ **Temperature:** Air \_\_\_\_\_ °C  
 Past 2 days \_\_\_\_\_ Water \_\_\_\_\_ °C

<i>Sampling Site Type</i> (Select one from each row)									
<b>Stream Size</b>	Headwater Tributaries			Creeks and Streams			Larger Rivers		
<b>Gradient</b>	FAST (primarily riffle)			VARIED (pools and riffles)			SLOW (low gradient)		
<b>Surrounding Land Use</b>	Forested		Agricultural		Residential			Urban	
	dense	sparse	pasture-land	crop-land	rural	village	suburban	Residential	commercial/industrial

**Stream Width:** The stream is on average \_\_\_\_\_ meters wide and \_\_\_\_\_ meters deep.

**Water Level:** Compared to the height of the stream channel, the water level seems relatively:     high     medium     low

**Water Appearance/Odor:**

**Turbidity** substantially greater than natural conditions:     Yes     No

Describe \_\_\_\_\_

**Oily film, grease globules,** or unusual odor or color present     Yes     No

Describe: \_\_\_\_\_

**Algae or Weed Growth:** Substantially greater than natural conditions:     Yes     No

Describe \_\_\_\_\_

**Upstream Dam:**     Yes     No    How far upstream: \_\_\_\_\_

**Average Velocity of Sampling Site:**

Average time it takes to flow 3 meters:

0.45 – 0.75 m/sec is optimal for BMI collection

a) 3 m / \_\_\_\_\_ sec = v1 \_\_\_\_\_

b) 3 m / \_\_\_\_\_ sec = v2 \_\_\_\_\_

**AVERAGE:** \_\_\_\_\_ m/sec

**Average Depth of Sampling Site:** \_\_\_\_\_ meters



**Assessment Factors:** Circle the box that best applies for each assessment factor.

Assessment Factor	Excellent	Good	Fair	Poor
<b>Riffle size</b>	Well-developed riffle, as wide as stream & as long as 2x stream width	Riffle as wide as stream but riffle length less than 2x stream width	Riffle not as wide as stream and length less than 2x stream width	Riffles or run virtually nonexistent
<b>Substrate size</b> (at BMI collection site)	Cobble predominates; boulders, gravel common	Cobble less abundant; boulders and gravel common	Gravel, boulders or bedrock prevalent; some cobble	Large boulders and bedrock or sand & silt prevalent; cobble lacking
<b>Shelter for fish</b>	Snags, submerged logs, undercut banks, or other stable habitat are found in over 50% of the site	Snags, submerged logs, undercut banks, or other stable habitat are found in 30-50% of the site	Snags, submerged logs, undercut banks, or other stable habitat are found in 10-30% of the site	Snags, submerged logs, undercut banks, or other stable habitat are found in less than 10% of the site
<b>Embeddedness</b> (at BMI collection site)	Rocks in stream <25% embedded; very little sand, silt, or mud	Rocks 25-50% embedded; can easily turn over rocks	Rocks 50-75% embedded and firmly stuck in sediments	Rocks >75% embedded; bottom mostly sand, silt, or mud
<b>Flow pattern</b> (deep is > 2 ft)	All 4 patterns present: slow/deep, fast/shallow, fast/deep, slow/shallow	Only 3 of 4 flow patterns present	Only 2 of 4 flow patterns present	Dominated by 1 flow pattern
<b>Channel alteration</b>	Stream straightening, dredging, artificial embankments, dams or bridge abutments absent or minimal; stream with meandering pattern	Some stream straightening, dredging, artificial embankments, or dams present, usually near bridge abutments; no recent channel alteration	Artificial embankments present to some extent on both banks; and 40-80% of stream site straightened, dredged, or otherwise altered	Banks shored with gabion or cement; over 80% of the stream site straightened and disrupted
<b>Stream bank cover and stability *</b>	Banks stable; no evidence of erosion; bank covered by vegetation or rock	Moderately stable; small areas of erosion; most of bank covered by vegetation or rock	Largely unstable; almost half of bank has areas of erosion or is not covered by vegetation or rock	Unstable, eroded; less than half of bank covered by vegetation or rock, or rock slumping into creek
<b>Disruption of riparian bank coverage*</b> (land bordering stream bank)	Mature trees and vegetation; most growing naturally; no disturbance by forestry, grazing, or mowing	Trees, woody plants, soft green plants dominate; some disruption but not affecting full plant growth potential	Obvious disruption; patches of bare soil, cultivated fields or closely cropped vegetation are the norm	Not much natural vegetation left or it has been removed to 3" or less in height
<b>Width of riparian vegetation zone*</b>	More than 35 yards wide; human activities have not impacted zone	Zone 12-35 yards wide; marginal impact from human activities	Zone 6-12 yards wide; impact from human activities evident	Zone less than 6 yards wide; lots of nearby human activities
<b>Litter</b>	No litter (metal or plastic) in area	Very little litter; accidentally dropped	Litter fairly common; purposely dropped	Lots of litter present; obviously dumped

\*if the two banks are very different, assess the worst side

Given the assessment above, how would you rate your habitat overall? \_\_\_\_\_

Describe how land uses / human activities may be impacting the stream.

## *Site Drawing:*

Draw a “bird’s-eye” sketch of your 200’ long river segment up and downstream from your sampling site, recording:

1. Your sampling sites – include where you collected chemical and BMI samples, and measured velocity and cross section area.
2. Direction of water flow – indicate with arrows.
3. Location and orientation of any photos taken.
4. In-stream habitat – riffles, pools, runs, large woody debris, boulders, organic material, aquatic plants, overhanging vegetation, etc.
5. Streambanks – steep & gently sloping areas, naturally vegetated, bare, eroding, clear-cut, or mowed areas, artificially protected areas, etc.
6. Channel – wide & narrow areas, meanders, shaded & exposed areas, unnatural alterations, dams, culverts, etc.
7. Human land uses – roads, houses, driveways, parking lots, storm drain pipes, sewage pipes, factories, farms, livestock crossings, recreational use, logging, etc.

***Sampling Site Description:*** Describe exactly where you collected chemical and BMI samples and measured velocity and cross section area:

# Stream Bottom Survey

Evaluate your specific BMI collection site (riffle area)

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

Survey Site \_\_\_\_\_ Survey Date & Time \_\_\_\_\_

Name of person(s) completing survey \_\_\_\_\_

1. Set up 2-4 transects across the stream, in riffle habitats.
2. Starting at the water's edge, take one step at a time toward the opposite bank. With each step, reach over the toe of your wader with your forefinger without looking down and feel the substrate material closest to your large toe (could be mud or sand; does not have to be a rock). Pick it up (if possible), measure its size, and mark a tally in the appropriate column in the "Substrate Size Table" below.
3. If the substrate is a cobble, be careful as you pick it up out of the stream bottom so you can estimate how much it is covered up by silt or sand. Feel with your fingers for the edge of the cobble where it emerges from the silt or sand, and keep your fingers on that edge as you pick it up. Often there will be a "bathtub ring" line on the cobble where the level of the silt or sand was. There is also often algae growing on the top surface of the cobble down to that line. Estimate the percentage that the cobble is embedded and check the appropriate box in the "Cobble Embeddedness Table" below.
4. Continue until you have sampled approximately 50 substrate sizes and 20 cobbles.
5. In the "Substrate Size Table," total the tallies for each substrate type and record these numbers in the second row. Calculate the percentage of each substrate size by dividing the number of tallies by the total number (this should be approximately 50) and multiplying by 100.

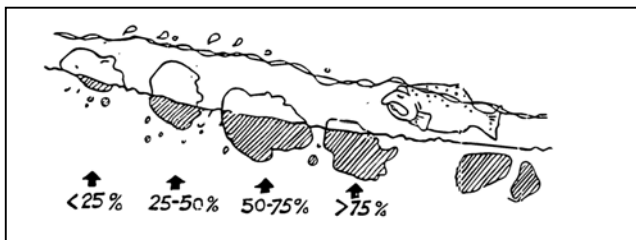
*Substrate Size Table*

Substrate Type	Silt/Clay/Mud (makes the water cloudy if disturbed)	Sand (up to 0.1")	Gravel (0.1-2")	Cobbles (2-10")	Boulders (>10")	Bedrock (solid rock covers stream bottom)
Tallies						
# of Tallies						
Percentage						

*Cobble Embeddedness Table*

Cobble #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0-25%																				
25-50%																				
50-75%																				
75-100%																				

50% embeddedness indicates doubtful habitat for many macroinvertebrates, trout, and egg survival



Based on your results, estimate the average embeddedness of the whole site:

**Average Embeddedness:** \_\_\_\_\_ %  
(record on physical survey/habitat assessment form)

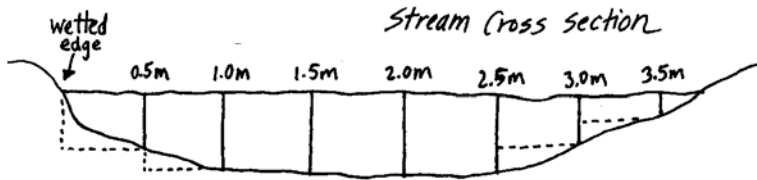
# Flow Worksheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_ Site \_\_\_\_\_

Name of person(s) measuring flow \_\_\_\_\_ Date & Time \_\_\_\_\_

### Area of the Stream's Cross-Section:

1. Stretch a tape measure from wetted edge to wetted edge.
2. At 0.5 meter intervals, across the entire width of the stream, measure the depth (in meters) and record in the table at right. (If stream is more than 10.5m wide, measure in 1m intervals).
3. Each segment you measured is like a small rectangle (see diagram below). The area of each rectangle equals its depth times its width. Since the width of each rectangle is 0.5 meter, the area of each rectangle is 0.5 times its depth, in square meters.



interval (m)	depth (m)	interval (m)	depth (m)
wetted edge	0	5.5	
0.5		6.0	
1.0		6.5	
1.5		7.0	
2.0		7.5	
2.5		8.0	
3.0		8.5	
3.5		9.0	
4.0		9.5	
4.5		10.0	
5.0		10.5	

4. The total cross section area of the stream is estimated by adding up the areas of all the rectangles. This is the same as adding up all the depths you measured and multiplying by 0.5. Record your total cross section area estimate in the box at right. (If measured at 1m intervals, simply add the depths).

Sum of depths

x .5 =

**Total Cross Section Area**

### Velocity of the Stream's Water:

1. Record the distance of the marked course in the space below.
2. Record the number of seconds it takes the float to travel the marked course. Do this 9 times (3 times on the left side of the stream, 3 times in the center, and 3 times on the right side) and record the average time.
3. Calculate the average velocity by dividing the distance of the course by the average time. Convert to underwater velocity by multiplying by 0.85.

(  m /  sec ) X 0.85 =  m/sec

Left side	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
Center	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
Right side	<input type="text"/>
	<input type="text"/>
	<input type="text"/>
SUM:	<input type="text"/>
Avg. Time: (sum/9)	<input type="text"/> sec.

### Flow:

The flow, or discharge of the stream, is the volume of water that moves past a site in a certain amount of time. Calculate the flow by multiplying the total cross section area by the average underwater velocity.

m/sec x  m<sup>2</sup> =  m<sup>3</sup>/sec x 35.32 =  ft<sup>3</sup>/sec

# BENTHIC MACROINVERTEBRATE SAMPLING AND ANALYSIS

---

## Overview

The following is a brief overview of Benthic Macroinvertebrate (BMI) sampling and analysis. The sampling procedure is the same for each tier but the analysis procedures vary. More detailed instructions and worksheets start at the end of this section.

## Sampling

The sampling (collection) methods are different from previous versions of the Guidance Document; they have been changed to reflect DEC's collection methods. Because the analysis methods in the Guidance Document are from DEC, it is best to use DEC's collection methods. Their analysis metrics are scientifically derived from data collected using their collection methods.

Macroinvertebrates are collected from a riffle site using an 18" x 8" rectangular net, mesh size 800-900 microns (0.8 -0.9 mm). Note that the EPA recommends a smaller mesh size of 500-600 microns. The NYSDEC recommends a larger 800-900 micron mesh net because they feel a 500-600 micron net catches too many of the smaller midges and debris that are difficult to identify and sort through. If you are collecting data for EPA use, use the smaller mesh size.

The procedure involves sampling a diagonal transect of the stream bottom in the riffle, kicking by foot along the transect, for 5 meters in 5 minutes. For QAQC Levels B and C, two replicate samples are collected for at least one site.

## Analysis

The following is a brief overview of the analysis procedures for each tier. The next section of the manual provides more detailed directions. If two replicate samples are collected, analyze each separately and then calculate a percent similarity.

### Tier 1 Summary

### BMI

Streamside, qualitative survey of live samples. Used for an introductory investigation of a watershed. Results can suggest if a stream is "non-impacted," but follow-up is needed for documentation. The simple physical/habitat survey is essential.

#### *Method:*

Live samples are assessed for the presence of four orders of relatively pollution sensitive stream organisms, and the absence (or sparseness) of worms, which tend to be very pollution tolerant. The four pollution sensitive orders are mayflies, stoneflies, caddisflies and beetles. There is a caveat that netspinner caddisflies (a

relatively pollution tolerant family) do not dominate the sample, and dobsonflies or fishflies may be substituted for beetles. The presence of the four orders, with an absence or scarcity of worms, indicates a non-impacted stream. This method is not for quantitative analysis.

## Tier 2 Summary

**BMI**

Quantitative survey of either live or preserved samples using identification to order, or major group. Used to identify preliminary warning signs that water quality standards are not being met and ecosystem health is threatened.

The “Physical Survey/Habitat Assessment” is essential for your study. It is more complex than Tier 1 and also used for Tier 3. Samples can be analyzed live or preserved; preserved samples lend themselves to a more accurate analysis.

### **Method:**

After samples are collected they are either preserved or analyzed live.

A sub-sample of 100 organisms (or the entire sample) is picked and sorted into major groups. These are identified and counted to calculate certain metrics, which are values that can be compared on a numerical scale to determine a corresponding level of impact to stream health.

Organism Density Per Sample (preserved samples only): An estimate of the total number of individuals in the entire sample (not just the sub-sample) based on the number of organisms picked from a certain number of squares in a tray marked with a grid. Density varies considerably from stream to stream. In general, however, density will increase with the addition of organic matter (which happens naturally in a river system as one moves downstream) and/or improvements in habitat conditions. Density will decrease with siltation, low pH, and toxic substances.

EPT Richness Estimate: An estimate of the number of different kinds of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) The EPT's tend to be particularly sensitive to pollution. Therefore, less impacted streams generally have a higher EPT Richness. The EPT Richness can be a useful indicator of stream health and a way to compare two or more different sites. In Tier 2, the EPT Richness you measure is an estimate because you do not identify the taxa to the family level; instead you simply distinguish between different taxa within each of the three major groups.

Major Group Biotic Index: This metric takes into account pollution tolerance values that are specifically assigned to each major group of organisms, along with the number, or density of organisms found in each major group. Different types of macroinvertebrates have a different tolerance to pollution. By counting the number of different types you collect and multiplying by the pollution tolerance of each, it is possible to arrive at a biotic index. In general, the more pollution intolerant organisms you find, the higher the biotic index, and the less impacted your stream.

Major Group Percent Composition: Percent Composition is not a single metric that refers to a certain level of impact. It is calculated for each major group by dividing

the number or density of organisms in each major group by the total number of organisms in the sub-sample and then multiplying by 100 to convert to percentage. The relative Percent Composition of organisms in major groups will change with different sites, habitats, and different water qualities. Calculating Percent Composition gives you a good picture of the community at a particular site. You can use this to compare two different sites or to see how the community at a site changes over time. A higher Percent Composition of pollution tolerant organisms suggests more impact than a higher Percent Composition of pollution sensitive organisms.

Major Group Percent Model Affinity: Percent Composition values are compared to a model community established by the NYSDEC for an un-impacted stream. The model is based on a typical summertime community, so this metric will probably not be useful if you sample in the early spring or late fall.

### Tier 3 Summary

### BMI

Quantitative survey of preserved samples using identification to family level of the mayfly, stonefly and caddisfly orders. Used to evaluate the degree to which a waterbody is able or unable to support aquatic life. May be able to document “suspected” or “known” impacts.

#### *Method:*

Tier 3 analysis is similar to but more in-depth than Tier 2, with some additions and modifications. These are described below:

1. Samples **MUST BE PRESERVED**.
2. In addition to the “Physical Survey/Habitat Assessment,” a separate “Stream Bottom Survey” is also used.
3. All organisms are identified to family level (not just sorted as like/different).
4. The metrics recommended are listed below (choose ones that fit your needs):

Organism Density Per Sample (same as Tier 2).

Family EPT Richness: Similar to Tier 2, but no longer an estimate because organisms are identified to the family level.

Total Family Richness: An actual count of the number of families in the sample. It is a rough measure of the diversity of the macroinvertebrate community. In general, the greater the number of families (higher richness), the less impacted the stream.

Family Biotic Index: The biotic index can be calculated more accurately using family values. Within the mayfly, stonefly and caddisfly orders, there is large variation of pollution tolerance values. Identification to the family level takes this variation into account. For example, a study of Morris Brook in New Hampshire showed improvement of the BMI community after best management practices were implemented on a dairy farm. This improvement was most clearly seen at the family level.

Major Group Percent Composition (same as Tier 2).

Major Group Percent Model Affinity (same as Tier 2).

EPT/ EPT+Chironomidae Ratio: This is a measure of the ratio of the number of intolerant EPT orders to the generally tolerant Diptera family Chironomidae (midges). The closer this ratio is to a value of 1, the less impacted the stream.

Percent Contribution of the Dominant Family: This is the percentage of the sample made up of the most abundant family. A sample dominated (>50%) by one family may indicate an environmental impact.

## Collecting Benthic Macroinvertebrate Samples

Two replicate samples are collected in a riffle with a substrate of rock, cobble, gravel and sand. The DEC defines a riffle as an area that is shallow enough for the surface to be broken by the substrate. Depth should be less than one meter. Current speed should be between 0.45 and 0.75 meters/second. If your site is too deep or very muddy, please check with your Regional Coordinator or local resource provider to help you develop an appropriate alternative collection method using an artificial substrate or other method.

Each replicate sample is collected by disturbing the stream bottom by foot along a diagonal 5 meter transect, for 5 minutes. The samples are either preserved or analyzed live depending on the tier you choose.

The net used for this collection is Nitex cloth mounted on a metal frame attached to a wooden or aluminum pole. The opening measures 18" x 8". *The mesh size for the net must be no smaller than 800 microns (0.8 mm) and no larger than 900 microns (0.9 mm).* If you are collecting data for EPA use, use a mesh size of 500-600 microns.

### Step by Step Procedure

- Step 1:** Assemble collection equipment and supplies (see below)
- Step 2:** Go to your site and identify a riffle for collection. It should have a velocity somewhere between 0.40 and 0.75 meters/second and be shallow enough for the surface to be broken by the substrate (less than one meter).
- Step 3:** Measure a 200' segment that contains the riffle habitat from which the sample will be collected.
- Step 4:** Conduct physical survey (choose the level appropriate to your study) for this 200' segment.
- Step 5:** Wade into the riffle and look for an appropriate spot to place the net. There should be at least 5 meters of riffle upstream of the net, in a diagonal direction.



- Step 6:** Have one person place and hold the net on the river bottom at the collection spot, with the opening of the net facing upstream.
- Step 7:** Have another person stand 0.5 meter directly upstream from the net opening and disturb the stream bottom by foot for 30 seconds so that organisms are dislodged and carried by the current into the net. Use a shuffling motion, disturbing the substrate a few inches down. Avoid kicking the substrate into the net.
- Step 8:** When you've finished at the first spot, carefully lift the net out of the river, walk upstream 0.5 meter in a diagonal direction, and repeat. *Leave the sample in the net.* Continue until a total of 5 meters are sampled along a diagonal transect as wide as the net. This should be completed in a total of 5 minutes. The resulting collection of organisms in your net is one replicate sample.
- Step 9:** If there is a lot of fine sediment in your sample, try to remove as much as possible. This can be done easily with a sieve bucket by placing your sample in the bucket, submerging the bucket partially in the stream, and swirling. If you don't have a sieve bucket, submerge your net partially in the stream and gently swirl to rinse sediments out of the net (be careful not to lose any of your sample).
- Step 10:** Bring the sample to shore and transfer the contents of the net (and sieve bucket, if you used one) to a 4"-6" deep white tray with water for live analysis or a wide mouth glass jar of 90% ethyl alcohol for preservation. Thoroughly clean the net of all organisms. For preserved samples, make sure the sample is completely submerged in alcohol (not exposed to air). Tightly cap the jar and label with the site name or number, date, replicate, and sampler names. Your sample will keep until you are ready for analysis.
- Step 11:** Fill out the "Sampling Protocol" section of the "BMI Sample Sheet."
- Step 12:** Repeat steps 5-11 for your second replicate (two replicate samples are required for QAQC levels B and C). Make sure the net is thoroughly cleaned of organisms before you collect the second replicate.



***A Note For School Teachers:*** Here is an example of how you might organize students for collecting BMI's (you will need 4 nets): Divide a group of 8 students into 2 teams of 4 students. Each team is responsible to collect one replicate sample. Send the 2 teams to different parts of the riffle. Divide each team into 2 pairs. Each pair collects half of the 5 meter transect. Combine collections from the 2 pairs in each team but keep the 2 replicate samples separate. If you have more than 8 students out at the stream at a time, have other students carry out other tasks, such as the physical survey and other aspects of your study.

## Equipment for Benthic Macroinvertebrate Sampling and Analysis

		<u>Essential Items</u>	<u>Purpose</u>
		<input type="checkbox"/> BMI Sample Sheets and appropriate physical survey sheets	For permanent record of collection
		<input type="checkbox"/> Clipboard	To hold field sheet
		<input type="checkbox"/> Collection net: 18"x8" w/ 0.8-0.9 mm mesh size	To catch dislodged organisms during collection
		<input type="checkbox"/> Forceps	To pick critters off net and sieve bucket
		<input type="checkbox"/> 4"-6" deep white trays	To observe live samples for picking
		<input type="checkbox"/> Small white containers/ice cube trays	To sort live critters into groups
		<input type="checkbox"/> Float (orange or fishing bobber)	To measure current velocity
		<input type="checkbox"/> Stop watch	To measure current velocity
		<input type="checkbox"/> Tape measure (50' minimum) or 50' string marked in 10' sections	To measure segment length, width, and velocity
Essential for tiers 2 and 3 only	}	<input type="checkbox"/> 1 qt. Mason jars w/ rubber seal lids	To hold preserved samples
		<input type="checkbox"/> 90% de-natured ethyl alcohol	To preserve samples
		<input type="checkbox"/> Labeling tape and pencils	To label sample containers
		<u>Other Recommended Items</u>	<u>Purpose</u>
		<input type="checkbox"/> Waders or high boots	To keep your feet dry
		<input type="checkbox"/> Field magnifiers	To identify critters streamside
		<input type="checkbox"/> Sieve bucket (#30 mesh)	To collect and transfer samples for preservation
		<input type="checkbox"/> USGS topographic map	To help locate collection sites
		<input type="checkbox"/> 5-gallon bucket	All purpose container
		<input type="checkbox"/> Life jackets	For safety in deeper water

## QAQC

Quality Assurance/Quality Control (QAQC) refers to activities that allow data users to associate a level of confidence to the information provided. The HBRW QAQC Guidelines are organized into three levels, A, B, and C. As the level of QAQC increases (C being the highest), so does the level of confidence in the information. Information with higher levels of confidence will generally have greater applications for use by local and state government agencies.

The left hand column of the QAQC guidelines chart in the "Overview of Monitoring Protocols" section of this manual provides QAQC guidelines for BMI monitoring. These guidelines refer to net mesh size and procedures for collecting and analyzing samples. Detailed procedures for collecting samples are found in the section entitled "Collecting Benthic Macroinvertebrate Samples" above.

## Sample Collection

For all levels of QAQC, it is important to use a mesh size between 800 and 900 microns (0.5-0.9 mm). Any smaller, and you will be collecting fine sediment that will be difficult to sort through. Any larger, and you will not catch a representative sample of organisms in your river - you will lose the smaller critters that are important in evaluating the BMI community. If you are collecting data for EPA use, use a mesh size of 500-600 microns.

For all levels of QAQC, it is also important to collect samples in a riffle habitat, defined as an area that is shallow enough for the surface to be broken by the substrate, less than 1 meter deep, with a velocity somewhere between 0.40 and 0.75 meters/second. The procedures for evaluating your findings are based on BMI communities that are found in riffle habitats. If you want to sample a deeper, slower or faster habitat, consult with your HBRW Regional Coordinator for guidelines on how to do this.

For all levels of QAQC, your sample should be a composite of a 5-meter-long diagonal transect of the stream bottom, collected in 5 minutes. This should provide you with a sample of over 100 organisms. If for some reason your sampling does not produce 100 organisms, go back and sample again, making sure you follow the collecting procedures outlined in this manual. You can try sampling a different riffle. You need a minimum of 100 organisms to evaluate the BMI community in your river according to the procedures in this manual.

## Physical/Habitat Survey

For all levels of QAQC, fill out the “Physical Survey/Habitat Assessment” form every time you collect a BMI sample. The habitat of the river greatly affects the nature of the BMI community. Without habitat information, your BMI data is less valuable. It is also important to complete a site drawing (part of the physical survey) to record features visually and document the location of your specific collection site(s). If you prefer to document features visually with photographs (very convenient these days with the availability of digital cameras), a site map is still important for documenting the specific location of your collection site(s).

For Tier 3 studies, fill out the “Stream Bottom Survey” form as well. This provides you with more specific information about the most important element of BMI habitat in the stream.

## BMI Identification

There are several references listed at the end of this BMI section that will help you identify macroinvertebrates. We recommend using a combination of picture keys and dichotomous keys. It is also helpful to build up a “library” of voucher specimens to help you verify your identifications. These are real BMI specimens that have been positively identified by an expert and preserved in a 90% ethyl alcohol solution.

Many of the details you need to look at to distinguish between major groups of organisms are small, such as number of legs or tails, or whether gills are present, etc. At

least a 10X hand lens is helpful. A 40X dissecting scope is even better, and necessary for Tier 3 analysis, which requires identification to the family level. A lighted magnifier lamp is a really useful tool for either level, during the initial sorting of organisms. The magnifier clamps to a table and can be positioned right over your tray of organisms. It helps you find every last critter in the tray or grid square, which is crucial for making your sub-sample a truly random representation of your whole sample.

## **Replicate Samples**

For QAQC Levels B and C, it is important to collect and analyze two replicate BMI samples from at least one of your collecting sites per sampling day. This will provide a measure of how precise or reproducible your data are. The two replicates should be collected from the same riffle if possible. If not, they should be collected from two similar riffles in close proximity to each other. Each replicate sample should be collected like any other sample - a composite of a 5-meter-long diagonal transect of the stream bottom, and yielding at least 100 organisms.

The two replicates should be analyzed separately and then the percent similarity between the results of the replicates should be calculated (method explained in the instructions for each tier). For Tier 2 analysis, a similarity of 75% or greater between the replicates indicates satisfactory sample collection and analysis. For Tier 3 analysis, the replicates should be 65% similar.

## **Analysis By Outside Evaluator**

For QAQC Level C, samples should be preserved in alcohol and an outside evaluator must verify the analyses of two replicate samples per sampling day. The outside evaluator should pick his or her own sub-sample from each replicate. Thus before sending the samples to the outside evaluator, mix your sub-sample back into the entire sample (do this for each replicate).

For Tier 2, a similarity of 75% or greater between the outside evaluator's and volunteer group's results indicates satisfactory sample collection and analysis. For Tier 3, the results should be 65% similar.

In some cases, HBRW Regional Coordinators can serve as outside evaluators of BMI samples. One of HBRW's Resource Partners, Community Science Institute, also provides outside evaluator services. Go to [www.communityscience.org](http://www.communityscience.org) or call Steve Penningroth at (607) 257-6606 for more information.

## **Reporting Sheets**

The "BMI Sample Sheet" is designed to help you document that you completed all these QAQC procedures. It also asks you to record an estimate of the number of organisms in each sample that your group feels confident they positively identified, the number they feel tentative about, and the number they were not able to identify. Fill out a "BMI Sample Sheet" each time you collect and analyze a BMI sample.

Use the “BMI Data Reporting Sheet” to record your results. It provides space to record results for two replicate samples and percent similarity between them. For Tier 3 studies, results can be recorded and reported using the “BMI Family Level Data Sheet” instead.

Required for all Tiers

## Benthic Macroinvertebrate Sample Sheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

Sampling Site \_\_\_\_\_ Sampling Date & Time \_\_\_\_\_ Replicate \_\_\_\_\_

Name of person(s) collecting sample \_\_\_\_\_

### Sampling Protocol:

QAQC Level A	QAQC Level B & C
<input type="checkbox"/> Used 18" x 8" net with mesh size between 0.8-0.9 mm	<input type="checkbox"/> Checked all boxes under A
<input type="checkbox"/> Sampled in a riffle 0.45-0.75 m/sec and > 1 meter deep	<input type="checkbox"/> Two replicates collected from at least one site per sampling day (required for B and C)
<input type="checkbox"/> Sampled 5-meter-long diagonal transect in 5 minutes	<input type="checkbox"/> Whole replicate samples preserved in alcohol (required for C)
<input type="checkbox"/> Nets thoroughly cleaned of organisms between samples	
<input type="checkbox"/> Physical/habitat survey attached	
<input type="checkbox"/> Sampling spots labeled on sketches in physical survey	

Describe sampling methods if different from above (indicate mesh size if not 0.8-0.9 mm):

### Sample Analysis Protocol:

Selected and analyzed a sub-sample (Tiers 2 & 3)

Total number of organisms in sub-sample (minimum of 100 organisms recommended) \_\_\_\_\_

Describe procedure for selecting sub-sample:

Equipment used for ID: (circle) none \_\_\_X magnifier \_\_\_X dissecting scope (indicate power)

Author & title of reference used to identify macroinvertebrates \_\_\_\_\_

Voucher specimens used (optional)  List of specimens attached

Number and percent of organisms in sub-sample that you believe you have:

Positively identified \_\_\_\_\_ number \_\_\_\_\_% of total

Tentatively identified \_\_\_\_\_ number \_\_\_\_\_% of total

Not identified \_\_\_\_\_ number \_\_\_\_\_% of total

BMI Data Reporting Sheet attached  Raw BMI worksheets attached

Name of person(s) analyzing sample \_\_\_\_\_ Date analyzed \_\_\_\_\_

Name, phone & email of person completing Sample Sheet \_\_\_\_\_

\_\_\_\_\_ Date completed \_\_\_\_\_

QAQC Level C only:

Name & phone of outside evaluator \_\_\_\_\_

Outside lab's results attached (raw data and Percent Similarity Worksheet)

# Benthic Macroinvertebrate Data Reporting Sheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

Site \_\_\_\_\_ Sampling Date \_\_\_\_\_

TIER 1    Replicate 1:             non-impacted     "possible" impact  
                  Replicate 2:             non-impacted     "possible" impact

TIER 2 OR TIER 3 (CIRCLE ONE)

**Major Group  
Percent Composition**

	Replicate	
	1	2
Mayfly		
Stonefly		
Caddisfly		
Midge		
Beetle		
Worms		
Others		

Replicate	1	2
-----------	---	---

**EPT Richness**

Score		
Level of Impact		

**Family Richness (Tier 3)**

Score		
Level of Impact		

**Biotic Index**    Family    Major Group (circle one)

Score		
Level of Impact		

**Percent Model Affinity**

Score		
Level of Impact		

	Replicate	1	2
<b>Organism Density/Sample</b> (preserved samples)			
<b>EPT/EPT+Chironomidae Ratio</b> (Tier 3)			
<b>Percent Composition of the Dominant Family</b> (Tier 3)			
Name of dominant family:			

PERCENT SIMILARITY

<b>Between replicates</b>	
---------------------------	--

<b>Between volunteer and outside evaluator results</b>	Rep 1	Rep 2

COMMENTS

Name, phone & email of person completing this sheet \_\_\_\_\_

# Analyzing Benthic Macroinvertebrate Samples

Tier 1

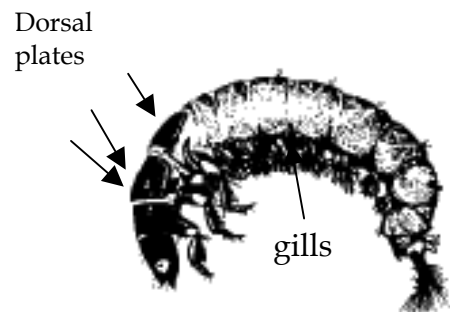
BMI

## Streamside Analysis

### Procedure

1. Place the sample in a large white tub with a few inches of water (enough to cover all the items in your sample). If you have a large amount of debris, you might shake each piece thoroughly under the water to dislodge the organisms, and then remove it from the tray. Take time to look at your sample without disturbing it for at least 5 minutes – you will begin to notice the widest variety of organisms if you keep the water still.
2. Collect an assortment of the organisms you find, using forceps, and sort them into white ice cube trays or petri dishes (putting likes with likes).  
BE SURE TO LOOK FOR ALL SIZES OF ORGANISMS – NOT JUST THE BIG, INTERESTING ONES!
3. Complete the worksheet “Screening Criteria for Non-Impacted Streams” by checking the sample for the presence or absence of the 5 major groups: mayflies, stoneflies, caddisflies, beetles OR dobsonflies/fishflies, and worms.
  - a. Check the mayfly (Ephemeroptera) box only if you can distinguish at least three different kinds (no need to identify them).
  - b. Check the stonefly (Plecoptera) box if they are present.
  - c. Check the caddisfly (Trichoptera) box only if the Common Netspinner Caddisfly (Family Hydropsychidae) does NOT dominate the sample. This means that Common Netspinners should not comprise more than 50% of your sample. See below for how to identify them.
  - d. Check the beetle or dobsonfly/fishfly (Coleoptera or Corydalidae) box if any of the three are present.
  - e. Check the worm (Oligochaeta) box if they are absent or sparse.
4. Repeat steps 1-3 for your second replicate (two replicate samples are required for QAQC Levels B and C).
5. Record your results on the “BMI Data Reporting Sheet.”

**Common Netspinner Caddisfly** larvae usually have a curved body 10-16 mm long when mature, sometimes larger. Their two distinguishing characteristics are:  
1) The three segments of the body where the legs are attached (thoracic segments) have well-developed plates on the top (dorsal) side.  
2) The segments below the legs (abdominal segments) have branched, hairy gills on the bottom (ventral) side.





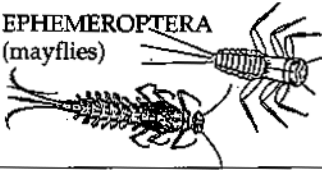
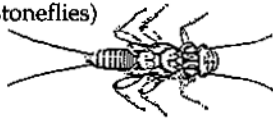



## Benthic Macroinvertebrate Screening Criteria for Non-Impacted Streams

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

Site \_\_\_\_\_ Replicate \_\_\_\_\_ Sampling Date \_\_\_\_\_

Name of person(s) conducting analysis \_\_\_\_\_

Make a check in each box where your stream site meets the criteria. If your stream site does not meet a certain criteria, explain why in the "Description" box.

BMI Order	Criteria	put a (✓) if criteria is met	Description
<b>EPHEMEROPTERA</b> (mayflies) 	must be numerous at least 3 species present		
<b>PLECOPTERA</b> (stoneflies) 	must be present		
<b>TRICHOPTERA</b> (caddisflies) 	must be present, but sample not dominated by netspinners (Hydropsychidae)		
<b>COLEOPTERA</b> (beetles) 	must be present or dobsonflies or fishflies (Corydalidae)		
<b>OLIGOCHAETA</b> (worms) 	must be absent or sparse		

The stream site is:

- Non-Impacted** - all 5 boxes are checked
- Possible Impact** - at least one box is not checked (needs further study to confirm)

### Analysis with a Preserved Sample

Note that each replicate is preserved and analyzed separately.

#### **Procedure**

1. Mark a shallow (1" or less) white tray into 12 equal size squares with a permanent marker. Fill tray with water.
2. Pour the first replicate sample into a 30 mm sieve, pouring off the alcohol.
3. Rinse the macroinvertebrates in the sieve with water.
4. Place the sample in the tray and spread out evenly.
5. Randomly choose a square and pick all the organisms in that square. As you pick them, sort them using petri plates. Use a lighted magnifier if possible.
6. Pick at least 1/4 of the squares in the tray.
7. If you do not have at least 100 organisms after picking the first 3 squares, continue picking a square at a time, until you have at least 100 organisms. This is your "sub-sample." Note: Pick the entire square once you start – do not pick 1/2 a square!
8. Go to the instructions below, "Steps for Both Live and Preserved Samples."

### Analysis With a Live Sample:

Note that each replicate is analyzed separately.

#### **Procedure**

Using live samples for analysis is not as accurate a method as preserving a sample. Perform the analysis immediately, using the following steps:

1. Place the first replicate sample in a large white tub with enough water to cover all the items in your sample. If you have a large amount of debris, you might shake each piece thoroughly under the water to dislodge the organisms, and then remove it from the tray.
2. Use a smaller container to scoop out a portion of the sample and pour into a shallow (1" or less) white tray. Let the debris settle and collect all the organisms you see in the tray. Sort them in white ice cube trays or petri dishes (putting likes with likes). Use a lighted magnifier if possible.
3. When you have collected all the organisms in the shallow tray, dump the contents of the tray into a bucket and repeat step 2. Continue until you have collected at least 100 organisms. This is your "sub-sample."
4. SCOOP OUT PORTIONS OF YOUR SAMPLE AS RANDOMLY AS POSSIBLE. LOOK FOR ALL SIZES OF ORGANISMS – NOT JUST THE BIG, FAST ONES!
5. Go to the instructions below, "Steps for Both Live and Preserved Samples."

## Steps for Both Live and Preserved Samples:

### **Procedure**

1. Once you have at least a 100 organism sub-sample (or have picked the entire sample), review the sorting that you have done and organize the categories more accurately.
2. Identify and sort organisms in your sub-sample to the order (or major group) level. Use a dichotomous key in addition to the "BMI Sorting Worksheet" to ensure proper identification (see references at the end of this section). Use at least a 10X hand lens. A 40X dissecting scope is even better.
3. Within each order, try to distinguish between different taxa, putting likes with likes, and sort organisms accordingly. The "BMI Sorting Worksheet" provides some examples of taxa commonly found in the Hudson Basin that are relatively easy to identify. For taxa not pictured, make up your own description (e.g. furry-gilled, mottled color, etc.) and write it in the "other" box for the appropriate order.
4. Count the number of organisms you have for each taxa and record on the "BMI Sorting Worksheet" by marking a tally in the appropriate box next to the picture (or your own description) of each taxa.
5. To calculate an EPT Richness Estimate, add up the number of different mayfly, caddisfly and stonefly taxa found. Count the number of boxes that have tallies, NOT the tallies. Record the EPT Richness estimate in the box at the bottom right hand corner of the first page of the "BMI Sorting (& EPT Richness) Worksheet." Compare to the values listed there that indicate different levels of impact. Record your results on the "BMI Data Reporting Sheet."
6. Calculate an estimate of the Organism Density of your whole sample (preserved samples only). Use the boxes at the bottom of page 3 of the "BMI Sorting Worksheet." Multiply the number of organisms in your sub-sample by the total number of grid squares in the tray. Then divide by the number of grid squares you picked to get your sub-sample.
7. Calculate the Major Group Biotic Index, using the corresponding worksheet (more detailed instructions are found on the worksheet). Record the number of organisms found in each major group in the first column. Multiply these values by each major group's assigned biotic index (found in the second column). Sum up all the resulting products and divide by the number of organisms in your sub-sample. Compare your result to the values on the bottom of the worksheet that indicate different levels of impact. Record your result on the "BMI Data Reporting Sheet."

NOTE: Netspinner caddisflies (Family Hydropsychidae) have a higher tolerance value than other caddisflies. See Tier 1 instructions for how to identify this family of caddisflies. Also, gilled snails have a much lower tolerance value than other snails. Gilled snails have an operculum, a hard shell-like material covering their shell opening. Other snails do not. Gilled snails depend on dissolved

oxygen in the water to breathe, whereas other snails come to the surface of the water to breathe air.

8. Calculate the Major Group Percent Composition by using the corresponding worksheet (more detailed instructions are found on the worksheet). Record the number of organisms found in each major group in the first column. Divide each value by the total number of organisms in your sub-sample. Multiply these values by 100 to convert to percentages. Record your results in the “BMI Data Reporting Sheet.”
9. Calculate the Percent Model Affinity by using the same worksheet as in step 8. Compare your Percent Composition results to the percentages of a model, unimpacted community established by the DEC. For each major group, record in the last column on the worksheet the absolute differences between your sample result and the model community. Sum up the differences, divide the sum by 0.5, and subtract that number from 100. Compare the resulting Percent Model Affinity score to the values on the bottom of the worksheet that indicate different levels of impact. Note that Percent Model Affinity is relevant only to summertime BMI communities (see discussion in “BMI Data Interpretation – Some Guidelines” section).
10. Fill out the “Sample Analysis Protocol” section of the “BMI Sample Sheet” (the “Sampling Protocol” section should already have been completed when the sample was collected). Complete a separate “BMI Sample Sheet” for each replicate.
12. Repeat the entire process again to analyze the second replicate sample (two replicate samples required for QAQC Levels B and C).
13. Calculate a Percent Similarity between the two replicates using the “BMI Percent Similarity Worksheet” (more detailed instructions are on the worksheet). For each major group, compare the Percent Composition in the first replicate with that of the second replicate. Find the lesser of the two values. The sum all of these lesser values is the Percent Similarity of the two replicate samples. A Percent Similarity of 75% or greater is the goal for Tier 2. If you are far from this goal, try collecting another replicate sample in your collection area, if possible (and if weather conditions have not changed too much since you collected the first samples).
14. For QAQC Level C, have an outside evaluator analyze your samples (see QAQC discussion earlier in this section). For each replicate, calculate the Percent Similarity between your results and the evaluators, using the “BMI Percent Similarity Worksheet.”
15. Record your results on the “BMI Data Reporting Sheet.”

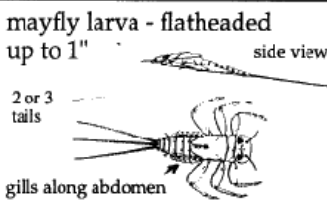
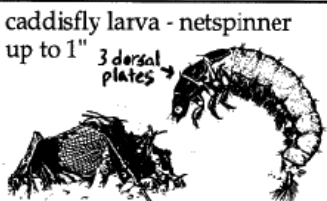
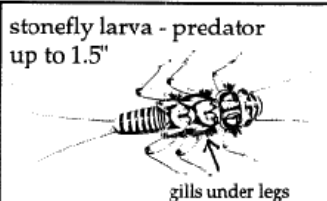
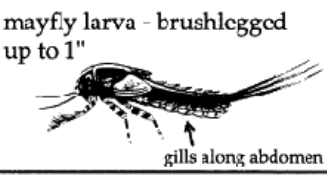
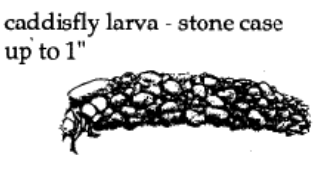
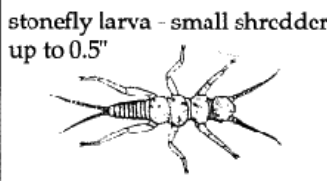
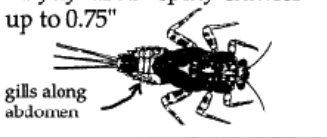
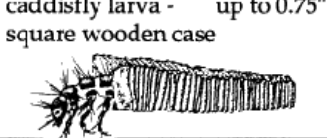
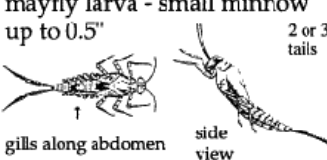
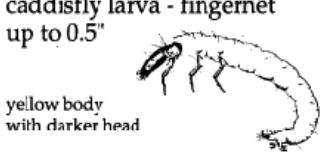
## Benthic Macroinvertebrate Sorting (& EPT Richness) Worksheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

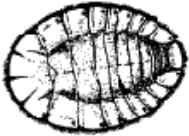
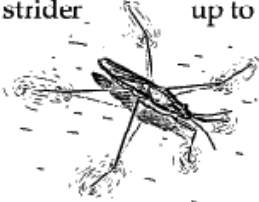





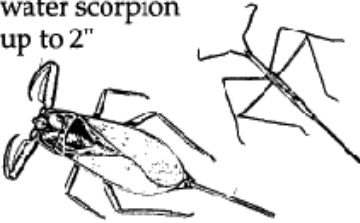



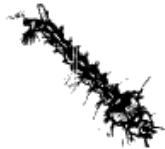
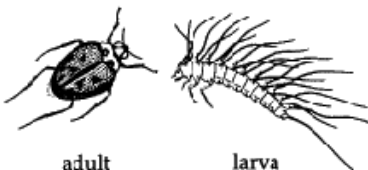


Site \_\_\_\_\_ Replicate \_\_\_\_\_ Sampling Date \_\_\_\_\_

Name of person(s) conducting analysis \_\_\_\_\_





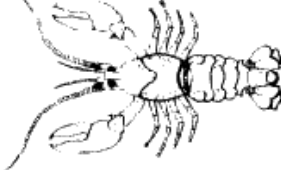














1. Sort and identify organisms to the level of order (stoneflies, caddisflies, beetles, true bugs, etc.). Within each order, try to distinguish different taxa and sort organisms accordingly.
2. Count the number of organisms of each taxa and mark a tally in the appropriate box next to the picture of the taxa. For taxa not pictured, make up your own description, write it in the "other" box for the appropriate order, and indicate with a tally the number of organisms found for that taxa.
3. To calculate an EPT Richness estimate, add up the number of different mayfly, caddisfly and stonefly taxa found. Count the number of boxes that have tallies, NOT the number of tallies. Record the EPT Richness estimate in the box at the bottom right hand corner of the page.
4. Use the data from this sheet to fill out the "Percent Composition" and "Biotic Index" worksheets.
5. For preserved samples, use chart at the bottom of page 3 to estimate organism density of the entire sample (# of bugs picked) X (total # of squares in the grid)/(# of squares picked to get sub-sample).

MAYFLY LARVAE	CADDISFLY LARVAE	STONEFLY LARVAE
<p>mayfly larva - flatheaded up to 1"</p>  <p>side view 2 or 3 tails gills along abdomen</p>	<p>caddisfly larva - netspinner up to 1"</p>  <p>3 dorsal plates</p>	<p>stonefly larva - predator up to 1.5"</p>  <p>gills under legs</p>
<p>mayfly larva - brushlegged up to 1"</p>  <p>gills along abdomen</p>	<p>caddisfly larva - stone case up to 1"</p> 	<p>stonefly larva - small shredder up to 0.5"</p> 
<p>mayfly larva - spiny crawler up to 0.75"</p>  <p>gills along abdomen</p>	<p>caddisfly larva - up to 0.75" square wooden case</p> 	<p>stonefly larva - other</p>
<p>mayfly larva - small minnow up to 0.5"</p>  <p>gills along abdomen 2 or 3 tails side view</p>	<p>caddisfly larva - fingernet up to 0.5"</p>  <p>yellow body with darker head</p>	
<p>mayfly larva - other</p>	<p>caddisfly larva - other</p>	<p><b>EPT RICHNESS:</b></p> <p>&gt;7 = non-impacted 3-7 = slightly impacted 1-2 = moderately impacted 0 = severely impacted</p>

# Benthic Macroinvertebrate Sorting Worksheet

<p>water penny beetle larva up to 0.5"</p> 	<p>water strider up to 1.5"</p> 	<p>midge larva up to 0.5"</p> 
<p>riffle beetle 0.25-0.5"</p>  <p>adult larva</p>	<p>giant water bug up to 1.5"</p> 	<p>blackfly larva up to 0.5"</p> 
<p>predacious diving beetle</p>  <p>adult up to 1" larva up to 2"</p>	<p>water scorpion up to 2"</p> 	<p>crane fly larva up to 4"</p> 
<p>whirligig beetle</p>  <p>adult up to 1.0" larva up to 1.5"</p>	<p>backswimmer up to 1"</p> 	<p>mosquito larva up to 0.5"</p> 
<p>crawling water beetle 0.25-0.5"</p>  <p>adult larva</p>	<p>water boatman up to 1"</p> 	<p>watersnipe fly larva up to 0.75"</p> 
<p>other beetles</p>	<p>other true bugs</p>	<p>other true flies</p>

Note: Size does not include tails

snail - flat spiral 	scud  up to 0.5"	dragonfly larva - clubtail up to 1.25" 
snail - left opening 	crayfish  up to 6"	dragonfly larva - skimmer up to 1.5" 
snail - right opening 	aquatic sowbug  up to 0.75"	dragonfly larva - darter up to 2" 
fingernail clam  up to 0.5"	other crustaceans	damsel fly larva up to 1.25" 
other mollusks	<b>Aquatic Worms</b>	3 oar-shaped tails (gills) 
<b>Dobsonflies, Fishflies, &amp; Alderflies</b>	aquatic earthworm  up to 2"	damsel fly larva up to 1.25" 
dobsonfly larva  up to 4" gill tufts at base of each "hair"	flatworm (planarian)  up to 0.75"	3 tails (gills); middle one shorter
fishfly larva  up to 1.5" no gills	leech  up to 2"	other dragonflies/damselflies
alderfly larva  up to 1"	other worms	<b>TAXA RICHNESS:</b> (the total number of different kinds of macroinvertebrates)

Organism Density Estimate For Entire Sample

# bugs picked	X	total # squares in grid	÷	# squares picked	=	Organism Density
---------------	---	-------------------------	---	------------------	---	------------------

## Benthic Macroinvertebrate Major Group Biotic Index Worksheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_  
 Site \_\_\_\_\_ Replicate \_\_\_\_\_ Sampling Date \_\_\_\_\_  
 Name of person(s) conducting analysis \_\_\_\_\_

Major group	A # of Organisms in Sub-sample	B Assigned Biotic Index	C Biotic Value for Group
Stoneflies		1	
Mayflies		2	
All Caddisflies except net spinner		2	
Gilled Snails		3	
Dobsonflies, Fishflies, Alderflies		4	
Dragonflies		4	
Crane Flies		4	
Watersnipe Flies		4	
Water Penny Beetle Larvae		4	
Whirligig Beetles		4	
Other Beetles		5	
Net Spinner Caddisflies		5	
Black Flies		5	
Midges		6	
Damselflies		6	
Water Mites		6	
Crayfish		6	
Clams		6	
Scuds		7	
Other Snails (not gilled)		7	
Leeches		7	
Sowbugs		8	
Aquatic Worms		9	
<b>TOTALS</b>	D		E

**Instructions:** (Try to pick at least 100 organisms.) Using the "BMI Sorting Worksheet," count the number of organisms for each major group identified in your sub-sample and record in column A. Sum the total of column A and record in D. Multiply the number of organisms in each major group by the assigned biotic index value (column B) and record in column C. Sum the total of column C and record in E. For the Biotic Index Score, divide E by D.

$$\text{Biotic Index Score} = \frac{E \text{ (total biotic value)}}{D \text{ (total \# organisms in your sub-sample)}} = \boxed{\phantom{000}}$$

<b>Biotic Index:</b>	0-4.50 non-impacted	4.51-5.50 slightly impacted	5.51-7.00 moderately impacted	7.01-10 severely impacted
----------------------	------------------------	--------------------------------	----------------------------------	------------------------------



## Benthic Macroinvertebrate Major Group Percent Composition & Model Affinity Worksheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_  
 Site \_\_\_\_\_ Replicate \_\_\_\_\_ Sampling Date \_\_\_\_\_  
 Name of person(s) conducting analysis \_\_\_\_\_

$$\text{Percent Composition} = \frac{\text{\# individuals of major group}}{\text{total \# individuals in sub-sample}} \times 100$$

Major group	# Individuals of major group	Total # of all organisms in sub-sample	Percent Composition	NYSDEC Model Community	Absolute Difference
Mayfly	÷	x 100 =		40%	
Stonefly	÷	x 100 =		5%	
Caddisfly	÷	x 100 =		10%	
Midge	÷	x 100 =		20%	
Beetle	÷	x 100 =		10%	
Worms	÷	x 100 =		5%	
Others	÷	x 100 =		10%	
<b>TOTAL</b>				SUM =	

$$100 - (\text{sum of absolute differences } \boxed{\phantom{000}} \times 0.5) = \text{Percent Model Affinity } \boxed{\phantom{000}}$$

**Steps:**

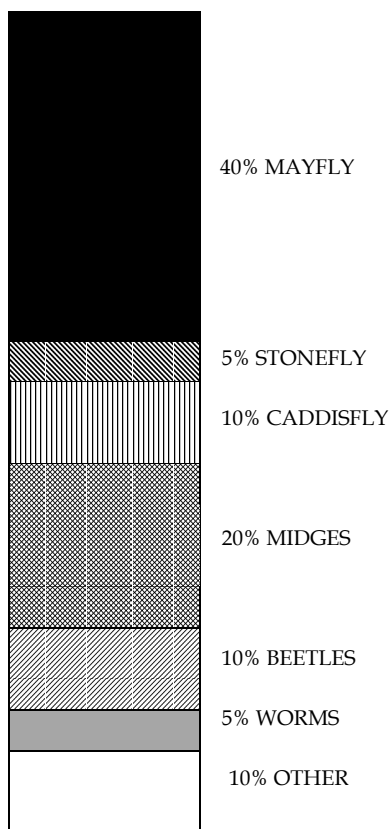
1. Try to pick at least 100 organisms or 1/4 of your sample. This is your sub-sample.
2. Fill in the number of individuals you have identified in each group from your sub-sample using the "BMI Sorting Worksheet."
3. Sum the total number of organisms in your sub-sample.
4. For each major group, divide the number of individuals for that group by the total number in your sub-sample. Multiply by 100 to calculate percent composition.
5. Calculate the absolute difference (subtract the lower percent from the higher percent) between the NYSDEC model community and the sample Percent Composition. Note this model is based on a *summertime* BMI community (see text).
6. Sum these absolute differences.
7. Multiply the sum by 0.5 and subtract this number from 100 to find the Percent Model Affinity. Note that impact level is only relevant to *summer* sampling.
8. For a visual comparison, graph the percent composition in the "Graphing Percent Composition Worksheet."

Level of Impact: <ul style="list-style-type: none"> <li>&gt; 64 non-impacted</li> <li>50-64 slightly impacted</li> <li>35-49 moderately impacted</li> <li>&lt;35 severely impacted</li> </ul>
---

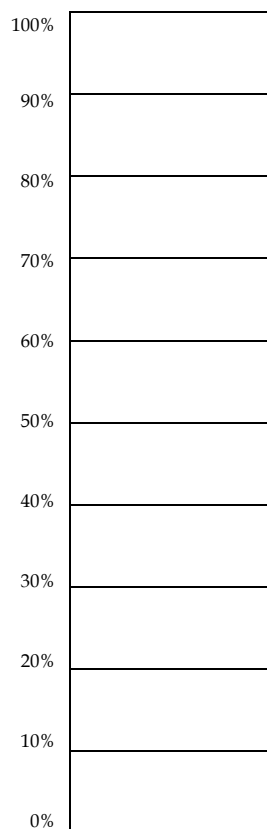
# Graphing Percent Composition Worksheet

Attach this graph to the appropriate Percent Composition Worksheet

NY "model community"



Your Sample:  
(color in appropriate %'s)



### BMI Major Group Percent Similarity Worksheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_ Site \_\_\_\_\_  
 Sampling Date \_\_\_\_\_ Name of person(s) conducting analysis \_\_\_\_\_

Major Group	Replicate 1 (or volunteer group results)	Replicate 2 (or outside evaluator's results)	Lesser of 2 Values
Stonefly			
Mayfly			
All Caddisfly except netspinner			
Gilled Snail			
Dobsonfly, Fishfly, Alderfly			
Dragonfly			
Crane Fly			
Watersnipe Fly			
Water Penny Beetle Larvae			
Whirligig Beetle			
Other Beetles			
Net Spinner Caddisfly			
Black Fly			
Midge			
Damselfly			
Water Mites			
Crayfish			
Clam			
Scud			
Other Snails (not Gilled)			
Leech			
Sowbug			
Aquatic Worm			
<b>SUM</b>	100%	100%	

**Percent Similarity**

**Instructions:**

1. Determine the percent composition of each major group in each replicate and record in the second and third columns, accordingly. Each column must add up to 100.
2. For each major group, compare the percent composition of the first replicate with that of the second replicate. Find the lesser of the two values, and record in the fourth column.
3. Sum all of the lesser values to get the percent similarity of the two samples. A percent similarity of 75% or greater is the goal for Tier 2.

**For Comparing Outside Evaluator and Volunteer Group Analyses:** Use the same procedure above for each replicate being compared. Use the second column for your group's results and the third column for the outside evaluator's results. Check the box below and indicate for which replicate this percent similarity was calculated.

This Percent Similarity is between volunteer group and outside evaluator's results.  
 It is calculated for Replicate # \_\_\_\_\_

This tier uses similar procedures for Tier 2, "Analysis with a Preserved Sample," except that organisms are identified to the family level and additional metrics are calculated.

### **Procedure**

After you have identified the major groups in the sample using the directions for Tier 2 "Analysis with a Preserved Sample" above, follow the steps below.

1. Use a picture key (such as the one from River Network's *Living Waters*) to identify as many of the families as you can.
2. Place any organisms you cannot identify into an "unknown" compartment.
3. Use a family level dichotomous key (see references) to identify the rest of the organisms to the family level. You will need a 40X dissecting scope.
4. Count and record the number of organisms in each family on the "Benthic Macroinvertebrate Family Level Data Sheet."

NOTE: HBRW has an electronic Microsoft Excel spreadsheet version of this worksheet that performs all the calculations automatically. Contact your Regional Coordinator for a copy. The instructions below tell you how to calculate the metrics by hand. We recommend you save yourself the trouble, get the electronic version, and use these instructions just as a reference for knowing how the metrics are calculated. When you request the electronic spreadsheet, ask also for the instructions on how to use it.

5. Repeat for second replicate (2 replicates required for QAQC levels B and C).
6. Calculate the metrics below on each replicate. If your time is limited, you can choose those metrics that best apply to your study design.
7. Record all your results on the second page of the "BMI Family Level Data Sheet" or on the "BMI Data Reporting Sheet."
8. Fill out the "Sample Analysis Protocol" section of the "BMI Sample Sheet" (the "Sampling Protocol" section should already have been completed when the sample was collected). Complete a separate "BMI Sample Sheet" for each replicate.
9. Calculate a Percent Similarity between the two replicates using the "BMI Family Level Data Sheet." For each family, compare the Percent Composition in the first replicate with that of the second replicate. Record the lesser of the two values in the (L) column. Then find the sum all of these lesser values. This sum is the Percent Similarity of the two replicate samples. A Percent Similarity of 65% or greater is the goal for Tier 3. If you are far from this goal, try collecting another replicate sample in your collection area, if possible (and if weather conditions have not changed much since you collected the first samples).

10. For QAQC level C, have an outside evaluator analyze your samples (see QAQC discussion earlier in this section). For each replicate, calculate the Percent Similarity between your results and the evaluator's results, using a separate copy of the "BMI Family Level Data Sheet" for each comparison. Use the "Replicate 1" column for your group's results and the "Replicate 2" column for the evaluator's results. Record your result in the bottom of the data sheet. Check the box to indicate that the information on the data sheet refers to a comparison with an outside evaluator's results and write in the replicate number that is being compared.
11. Results from your complete analysis can be submitted on the "BMI Family Level Data Sheet" or the "BMI Data Reporting Sheet."

## **Recommended Metrics**

Organism Density Per Sample: Multiply the number of organisms in your sub-sample (which is the same as the total density (total D)) by the total number of squares in the tray. Divide by the number of squares in the tray you picked to get your sub-sample.

EPT Family Richness: Add the total number of mayfly, stonefly and caddisfly families. Include families you were not able to identify, from the "Other" rows. (This will be the total of "Subtotal E," "Subtotal P," and "Subtotal T").

Total Family Richness: Add up the total number of macroinvertebrate families represented in the sample.

Family Biotic Index: Multiply the density (D) for each family by the pollution tolerance (T). Add the results for all the families and divide by the total number of organisms you picked for your sub-sample (total D).

Major Group Percent Composition and Percent Model Affinity: See Tier 2 instructions.

EPT/EPT + Chironomidae Ratio: Divide the Family EPT Richness value by the sum of the Family EPT Richness value and the number of organisms picked in the Chironomidae family (D Chironomidae).

Percent Composition of the Dominant Family: Identify the family in the sample with the most organisms picked. Divide the number of organisms picked in this family (D) by the total number of organisms in the sub-sample (total D) and multiply by 100 to convert to percent.

## Benthic Macroinvertebrate Family Level Data Sheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

Site \_\_\_\_\_ Sampling Date \_\_\_\_\_

Name of person(s) conducting analysis \_\_\_\_\_

T= Family Tolerance Value

D= Density (# of organisms found in sub-sample)

TxD=Product of Tolerance Value X Density

%C= Percent Composition

L= lesser of two %C values (for calculating Percent Similarity between replicates)

Families in Major Groups	T	Replicate 1			Replicate 2			L
		D	TxD	%C	D	TxD	%C	
<b>EPHEMEROPTERA (E)</b>								
Baetidae	6							
Baetiscidae	4							
Caenidae	6							
Ephemerellidae	2							
Ephemeridae	4							
Heptageniidae	3							
Leptophlebiidae	4							
Metretopodidae	2							
Oligoneuriidae	2							
Polymitarcylidae	2							
Potomanthidae	4							
Siphonuridae	7							
Tricorythidae	4							
Isonychiidae	2							
Other								
Subtotal E								
<b>PLECOPTERA (P)</b>								
Capniidae	3							
Chloroperlidae	0							
Leuctridae	0							
Nemouridae	2							
Peltoperlidae	0							
Perlidae	3							
Perlodidae	2							
Pteronarcyidae	0							
Taeniopterygidae	2							
Other								
Subtotal P								
<b>MEGALOPTERA (M)</b>								
Corydalidae	4							
Sialidae	4							
Other								
Subtotal M								
<b>LEPIDOPTERA (L)</b>								
Pyralidae	5							
Other								
Subtotal L								

Families in Major Groups	T	Replicate 1			Replicate 2			L
		D	TxD	%C	D	TxD	%C	
<b>TRICHOPTERA (T)</b>								
Brachycentridae	2							
Glossosomatidae	1							
Helicopsychidae	3							
Hydropsychidae	5							
Hydroptilidae	6							
Lepidostomatidae	1							
Leptoceridae	4							
Limnephilidae	4							
Molannidae	6							
Odontoceridae	0							
Philopotamidae	3							
Phryganeidae	4							
Polycentropodidae	6							
Psychomyiidae	2							
Rhyacophilidae	1							
Sericostomatidae	3							
Other								
Subtotal T								
<b>DIPTERA (D)</b>								
Anthericidae	4							
Blephariceridae	0							
Ceratopogonidae	6							
Chironomidae	6							
Tipulidae	4							
Empididae	6							
Simuliidae	5							
Tabanidae	5							
Other								
Subtotal D								
<b>ISOPODA (I)</b>								
Asellidae	8							
Other								
Subtotal I								

# Benthic Macroinvertebrate Family Level Data Sheet

Families in Major Groups	Replicate 1				Replicate 2				L
	T	D	TxD	%C	D	TxD	%C		
<b>COLEOPTERA (C)</b>									
Dryopidae	5								
Elmidae	5								
Gyrinidae	4								
Haliplidae	5								
Psephenidae	4								
Other									
Subtotal C									
<b>ODONATA (O)</b>									
Aeshnidae	5								
Calopterygidae	6								
Coenagrionidae	8								
Cordulegastridae	3								
Corduliidae	2								
Gomphidae	4								
Lestidae	9								
Libellulidae	2								
Macromiidae	2								
Other									
Subtotal E									
<b>AMPHIPODA (A)</b>									
Crangonyctidae	6								
Gammaridae	6								
Talitridae	8								
Other									
Subtotal A									

Families in Major Groups	Replicate 1				Replicate 2				L
	T	D	TxD	%C	D	TxD	%C		
<b>DECAPODA (DE)</b>									
Cambaridae	6								
Astacidae	6								
Other									
Subtotal DE									
<b>OTHER</b>									
Oligochaeta	9								
Hirudinea	7								
Gastropoda	7								
Pelecypoda	6								
Turbellaria	6								
Nemertea	8								
Other									
Subtotal Other									
<b>TOTALS</b>									

**Organism Density/Sample**

Total D x Total # squares picked  
# squares in tray

Rep 1	Rep 2

**EPT Family Richness**

Total # EPT families

Rep 1	Rep 2

>7 non-impacted      1-2 moderately impacted  
3-7 slightly impacted      0 severely impacted

**Total Family Richness**

Total # families

Rep 1	Rep 2

>13 non-impacted      7-9 moderately impacted  
10-13 slightly impacted      <7 severely impacted

**Family Biotic Index**  
(Total T x D) ÷ Total D

Rep 1	Rep 2

0-4.5 non-impacted  
4.51-5.50 slightly impacted  
5.51-7.00 moderately impacted  
7.01-10.00 severely impacted

**Percent Model Affinity**  
Use Tier 2 worksheet

Rep 1	Rep 2

**EPT/EPT + Chironomidae Ratio**

Total # EPT families

---

Total # EPT families + D value for Chironomidae

>0.65 non-impacted

Rep 1	Rep 2

**Percent Contribution of the Dominant Family**  
The family with the largest %C value

Family	Rep 1 %C	Rep 2 %C

**Percent Similarity**

Sum of the lesser values (L)

Goal for Tier 3 is 65%

If using to compare volunteer and outside evaluator results, check here  and indicate replicate # \_\_\_\_\_

(Use Rep 1 column for volunteer results and Rep 2 column for outside evaluator results)

# Benthic Macroinvertebrate Data Interpretation

How you approach interpretation depends on your study question and the tier that you used. Interpretation mostly involves more than a simple “yes or no, impacted or not?” type of response. Have fun trying to tell the story of what you find – use the physical/habitat survey information to try to explain your data. You will generate more questions that will become great guides for future studies. Also, remember to save and use each year’s data. The story of your river will begin to unfold with more depth as you begin to compare each year. The “Data Analysis Worksheet - Water Quality Standard Survey” (found in the “Chemical Indicators” section) provides an example of one way to analyze results from a Water Quality Standard Survey (both benthic macroinvertebrates and chemical indicators).

## Tier 1

This is a basic screening tier that tests for presence/absence of 5 major groups of invertebrates. This screening can test for a non-impacted community. If a site does not meet these criteria, you cannot necessarily conclude that it is impacted; further study is recommended. The DEC is interested in knowing areas with non-impacted river communities as well as areas that require further study.

### Questions to ask when reviewing the data:

- a) How might the habitat (in particular the bottom composition and embeddedness) affect the benthic community?
- b) Does any single taxon appear to dominate the sample (>50% of individuals visible in the field)?
- c) If so, what might be causing this? If not, does the sample appear to have a relatively balanced composition?

A note about springtime sampling: DEC has found “worm blooms” in creeks in May and June. Sometimes as much as 90% of a sample will be worms. These worms are in the order Tubificida, family Naidiae, usually the genus Nais. They are not indicators of poor water quality. Groups sampling in the spring should be aware of this. These worms are extremely small, often just 1-2 mm in length, so if your group does not pick organisms this small out of their samples, worm blooms may not be a concern.

## Tier 2

For this tier you will have a number of metrics to use to tell the story of the water quality of your river. The Major Group Biotic Index, EPT Richness Estimate, and Percent Model Affinity provide a more detailed assessment of impact than Tier 1, from non-impacted to severely impacted. Percent Composition and Organism Density allow for a more rich understanding of the dynamics of the macroinvertebrate community.

Organism Density Per Sample: Density varies considerably from stream to stream. It’s best to compare results with a specific reference site. In general, however, density will



increase with the addition of organic matter (which happens naturally in a river system as one moves downstream) and/or improvements in habitat conditions. Density will decrease with siltation, low pH, and toxic substances.

Percent Composition: Look for a large increase/decrease of any major group and note whether the increase/decrease is occurring with a pollution tolerant or intolerant group. As an example, a large increase of the percentage of midges might indicate an impacted site. Non-impacted sites have a healthy percentage of the pollution tolerant organisms, but they should not be in the majority. (See note about springtime sampling and worm blooms in Tier 1 section above).

Percent Model Affinity: Use this metric to compare your results to DEC's "model" (healthy) BMI community. The further your results stray from the "model," the more impacted your site. Note, however, that this "model" community was established based on DEC's summertime sampling. If you sample in the winter, spring or fall, this metric might not be relevant. For example, in the fall, you might find more than 5% stoneflies and less than 40% mayflies. This does not mean your site is impacted.

EPT Richness: In general, an EPT Richness greater than 7 reflects a healthy site. Note, however, that EPT Richness is very dependant on habitat; for small headwater streams, the EPT Richness will be very low because there is not a large amount of species diversity present in these streams. Also, some of the EPT species may be very small. Your EPT Richness will be lower than it should be if you overlook them while sorting and identifying.

Biotic Index: DEC considers a biotic index of 4.5 or less to indicate a non-impacted site. The Major Group Biotic Index is a less rigorous assessment of stream health than the EPT Richness because it does not consider the variation in pollution tolerance among EPT families – all the mayflies are given the same tolerance values, for example. You may find that your EPT Richness value indicates a higher level of impact than your Biotic Index value. If this happens to you and your sample has an abundance of only one or two EPT species, you may want to take the extra step of trying to identify those species to family level to determine their pollution tolerance.

The interesting part of interpreting this data is that not all of the metrics you study will always be consistent with each other – exploring the reasons for your findings makes for a fun and interesting study. Remember that streams are complex ecosystems, and many natural and human-caused factors may influence your results.

### Tier 3

This tier uses a similar approach to Tier 2, but involves more metrics and a more detailed view. Since each metric describes a different aspect of the BMI community, it's good to calculate them all. However, you may find that some are more meaningful than others when you interpret the results. When reporting your results, you might just use the ones that relate most directly to your study question.

Organism Density Per Sample: (same as Tier 2)

EPT and Total Family Richness: Generally, the more families, especially the more EPT families, the better the water quality or the better the habitat. However, some pristine headwater streams may be naturally low in richness, due to a relative lack of food and generally lower abundance of organisms. In general, a non-impacted site should have more than 7 identified EPT families and more than 13 total families (including EPT families). No EPT families or less than 7 total families indicates a severely impacted site.

Family Biotic Index: This analysis is based on the relative tolerance of the BMI families to organic pollution such as sewage and animal manure. The values were developed by Hilsenhoff and modified by the DEC Biomonitoring unit to fit New York State BMI communities. The more tolerant the organism, the higher their tolerance value. The higher the index value, the more impacted the stream. A value of 4.5 or less indicates a non-impacted stream. A value over 7.00 indicates a severely impacted stream.

Major Group Percent Composition and Percent Model Affinity: (same as Tier 2)

EPT/EPT+Chironomidae Ratio: EPT/EPT+Chironomidae is a measure of the ratio of the abundance of the intolerant EPT orders to the generally tolerant Diptera family Chironomidae. The results should lie between 0 and 1. An unimpacted stream will have fewer Chironomidae relative to EPTs than an impacted stream. The more Chironomidae organisms present, the smaller the ratio will be. Thus the closer the ratio is to 1, the less impacted the stream. DEC's guidelines are as follows:

>0.65 = Reference condition (non-impacted)

>0.55 = Minimal change from reference condition

>0.45 = Moderate change from reference condition

Percent Contribution of the Dominant Family:

If the most common family represents more than 50% of the total number of organisms, it is said to dominate the sample. In general, unimpacted streams should have diverse assemblages of macroinvertebrates. If one family dominates the sample, it may indicate an environmental impact. A sample dominated by a pollution tolerant family indicates greater impact than one dominated by a pollution sensitive family.

Biological Assessment Profile:

The NYS DEC has developed a Biological Assessment Profile that provides an overall river water quality assessment based on four BMI metrics: Family Richness, EPT Richness, Family Biotic Index, and Percent Model Affinity. It converts each metric's score to a 0-10 water quality scale and calculates their mean. The mean score identifies the water quality as non-impacted, slightly impacted, moderately impacted, or severely impacted. There is an Microsoft Excel program that automatically calculates the Biological Assessment Profile. Contact your HBRW Regional Coordinator for more information.

# Presenting Your Data

Displaying your data is an essential part of being able to interpret it. Examples of graphs you might want to make are included in this section, which describes ways to use the metrics for analyzing different types of studies:

## For Water Quality Standards Survey (one site):

What level of impact does the EPT Richness, Family Richness (Tier 3), Biotic Index and Percent Model Affinity indicate for your site? What might explain your results?

How does the Percent Composition of your site compare to the NYS DEC “model” community? What might explain these differences? (habitat, stream reach, water quality, time of year, weather, etc.). Graph the Percent Composition and compare it to a model community for New York State.

(For Tier 3): Does the EPT/EPT+Chironomidae Ratio indicate a potential impact? Is there a family that dominates the sample? What is the pollution tolerance of that family? What is the overall Biological Assessment Profile of the site?

Remember that for all DEC stream classifications above D, aquatic life is considered a “use.” If the BMI community is impacted, then a designated use is impaired. See the section entitled “Data Reporting – Tying it all Together” for more information about how you can use your results to document a level of impairment for the DEC Priority Waterbodies List.

## For Impact/Improvement Assessment:

How did the benthic macroinvertebrate community change above and below the impact/improvement? What might explain these differences if any? How similar are the habitats?

- Graph Percent Composition of major groups for the upstream, downstream, and recovery sites.
- Create a table that allows you to compare the EPT Richness, Biotic Index, Percent Model Affinity (and Family Richness, EPT/EPT+Chironomidae Ratio, Percent Contribution of the Dominant Family, and the Biological Assessment Profile for Tier 3) for the three sites on a given date.

## For River Characterization Survey:

How does the benthic macroinvertebrate community change from upstream to downstream? What might explain these changes?

- Graph Percent Composition of major groups arranged from upstream to downstream sites for each sampling date.
- Create a table that allows you to compare the EPT Richness, Biotic Index, Percent Model Affinity (and Family Richness, EPT/EPT+Chironomidae Ratio, Percent Contribution of the Dominant Family and the Biological Assessment Profile for Tier 3) for each site on a given date.

### For Trend Analysis:

How did the benthic macroinvertebrate community change over time? What might explain these differences if any? How have the habitats changed?

- Graph Percent Composition of major groups for the different seasons and years of your study.
- Create a table that allows you to compare the EPT Richness, Biotic Index, Percent Model Affinity (and Family Richness, EPT/EPT+Chironomidae Ratio, Percent Contribution of the Dominant Family, and the Biological Assessment Profile for Tier 3) for different seasons and years.

## **References for Benthic Macroinvertebrate Identification**

[www.dec.state.ny.us/website/dow/stream/index.htm](http://www.dec.state.ny.us/website/dow/stream/index.htm) This website is an excellent tool; it has great photographs of different BMI families.

*Living Waters*, by Geoff Dates and Jack Byrne. A more in-depth guide to using BMIs for river monitoring. Has handy picture keys as well as family and major group dichotomous keys. Available from River Network (802) 223-3840.

*Aquatic Entomology*, by W. Patrick McCafferty. Has family level dichotomous keys, great illustrations, and brief descriptions of each family. User-friendly because it provides common names of families which are easier to use in conversation with most of us who are not aquatic entomologists.

*A Guide to Common Freshwater Invertebrates of North America*, by Reese Voshell. For family level identification.

*The Streamkeeper's Field Guide*, by Tom Murdoch, Martha Cheo, and Kate O'Laughlin. Includes background information about BMIs in general, an EPT picture key, and a major group dichotomous key. Great bug cartoons!

*Guide to Freshwater Animals Without Backbones*, by Arlene de Strulle and Tora Johnson. Handy pocket guide with a well-illustrated major group dichotomous key and good background information on each of the major groups. Available from the Catskill Center for Conservation and Development, (845) 586-2611.

*Save Our Streams Monitor's Guide to Aquatic Macroinvertebrates*, by Loren Larkin Kellogg. Another handy pocket guide with a major group dichotomous key and good background information on each of the major groups. Available from the Izaak Walton League of America, (301) 548-0150

# CHEMICAL INDICATORS

---

This section contains the protocols for the sampling and analysis for a variety of indicators. Choose those indicators that are important for your study. Generally, chemical indicators give a “snapshot” of the river. They tell us what is in the water at the place and time it was measured. They do not give us information about what happened in the past or why something is happening now.

## Collecting Water Samples

The way you collect your sample can have a tremendous influence on your results. It's important to collect samples so that they are representative of the water you're monitoring. That means that they should be collected in places that are typical of the site you're sampling and that your sampling procedure should not introduce more of the indicator you are measuring into your sample than is actually in the water. For example, if you're collecting a sample to measure turbidity, you should not stir up the bottom where you're sampling, this might add additional sediment into the bottle and will give a higher measure of turbidity than is actually in the river. It is also important to collect all your samples in exactly the same way, so that you can accurately compare your results. It is essential, therefore, that all sample collectors follow the same sampling procedures outlined below. To sample for dissolved oxygen, follow the procedures in the “Dissolved Oxygen” section of this manual. Note that the collection method and sampling container are different from the other indicators.

## Water Sample Containers and Sample Volume

Collect water samples in high density polyethylene (HDPE) or polypropylene (PP) bottles or disposable "whirl-pak" bags. If you are using Tier 2, a 500 ml bottle is more than enough volume to analyze every indicator listed in this Guidance Document; if you are using Tier 3, you may need a little more than 500 ml to analyze every indicator (not including dissolved oxygen, which is collected separately). Refer to the sample volume information in the chart “Overview of Chemical Sample Analysis Methods” following this section to determine the amount of water you need to run the tests for the indicators you plan to analyze. The sample volumes listed in the chart will provide you with enough sample for analyzing one duplicate per sample as well as some room for error.

All sample bottles should be washed with non-phosphate soap, scrubbed with a bristle brush, rinsed with warm tap water until soap disappears (about 6 times) and then rinsed 3 times with de-ionized water. (De-ionized is more pure than distilled water and thus better to use for final rinsing). For a Tier 3 sample that will be analyzed for orthophosphate, ***your sample bottle should be washed with acid instead of soap*** to ensure you remove possible contamination that could affect your results. Or you can acid-wash a separate, smaller sampling bottle or use a whirl-pak bag to collect just the orthophosphate sample.

Before you sample, label your containers with the following information:

Stream _____ Site _____ Date _____ Time _____
Name of Collector _____

## Where and How to Sample

In general, sample away from the riverbank in the main current where mixing is at a maximum. The main current is not necessarily in the middle of the river; it could be closer to one bank than the other. Avoid sampling stagnant water near the shoreline.

For Tiers 1 and 2, collect one “grab” sample at mid-depth (mid-way down between the surface and the bottom of the river). In shallow stretches, wade into the main current carefully to collect the sample.

For Tier 3, a “composite” sample is recommended, but not required. A composite sample ensures a better representation of the river water (if the river is less than 10 feet wide, a composite sample is not necessary). For wadeable rivers, the composite sample should be taken at mid-depth across the profile of the river in 2-5 areas, depending on how wide the river is. Use your best judgement to collect enough samples to obtain a well-mixed sample. Rinse a clean bucket with stream water before beginning the sample collection. As each sample is collected, pour them into the bucket and swirl to thoroughly mix the composite before pouring it into a sample bottle.

For dissolved oxygen, do not collect composite samples. Use one grab sample per duplicate analysis, for both Tiers 2 and 3. Follow the instructions in the “Dissolved Oxygen” section of this manual.

If the river is non-wadeable, use a boat, or select a site where there is a bridge over the river from which you can suspend a water sampler. The “Equipment” section of manual lists a dissolved oxygen/ temperature sampler that can be used to collect samples for dissolved oxygen as well as other parameters (under “Parameter: General”). You could also make your own water sampler by attaching your sample bottle to an extension pole. If sampling from a bridge, stay clear from the piers, where stagnant water can collect.

If you are collecting a composite sample in a non-wadeable river, the sample should not only consist of 2-5 samples across the profile of the river, but also of 3 samples along the depth of the water column. At each area along the profile, collect water just under the surface, mid-way down, and near the bottom (not stirring up sediment).

## Step by Step Sampling Procedure

- 1) If you are wading: Approach the sampling spot from downstream. Try to disturb as little bottom sediment as possible and be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side.

If you are collecting a sample by boat: Approach the sampling spot from downstream. Carefully reach over the side and collect the water sample on the upstream side of the boat.

- 2) Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.
- 3) Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down and plunge it into the water, facing upstream. Hold the bottle mid-way between the surface and bottom.
- 4) Turn the bottle underwater into the current and away from you. In slow-moving river reaches, push the bottle underneath the surface and away from you in an upstream direction.
- 5) Empty the bottle and repeat step 4. (This will remove any rinse water left over from washing the container.)
- 6) Fill the bottle completely and recap the bottle carefully – remember, don't touch the inside!
- 8) Fill out a physical survey field sheet every time you sample.
- 9) If you plan to collect samples and analyze at a later date, be aware of the sample preservation procedures and maximum holding times for each indicator. This information appears in the chart "Overview of Chemical Sample Analysis Methods" following this section.

## Analyzing Water Samples

The protocols for analysis differ with each indicator and HBRW tier. The following section of this manual provides detailed protocol instructions, listed by indicator and tier. The chart entitled "Overview of Chemical Sample Analysis Methods" provides an overview, including sample volume required, holding time and preservation methods, analysis methods, test apparatus, and test range, increments, and accuracy. Sample volumes listed will provide you with enough for one duplicate analysis per sample as well as some room for error. Holding time & preservation methods should be followed if you are not going to analyze samples immediately; otherwise your results may not be accurate. The test apparatus listed is only a recommendation; any apparatus that uses the test method listed and provides the range, increments and accuracy listed can be used. For example, for Tier 3 dissolved oxygen, a Hach kit with digital titrator does not have to be used if you have a different apparatus to perform a Modified Winkler Titration that yields results within a 0-20 mg/L range and in 0.01 increments. Test range, increments, and accuracy are all given in the same column. The first number given is range, the second number is increments, and the third number refers to accuracy. For example, with orthophosphate Tier 3 Hach color wheel, the range is 0-5 mg/L, the increment measured is 0.1, and the accuracy is 10%. This means that the test

can measure from 0 to 5 mg/L of orthophosphate in increments of 0.1, 0.2, 0.3, etc. up to 5.0. The accuracy reported by Hach Company is 10% of your reading. Thus if you get a reading of 2 mg/L, the real value could be anywhere between 10% less than 2 (1.8), or 10% more than 2 (2.2). Some accuracy values are percentages, others are simply concentration values.

A Note on Units: Many indicators are measured in milligrams per liter (mg/L), which is the same as parts per million (ppm).

## QAQC

Quality Assurance/Quality Control (QAQC) refers to activities that allow data users to associate a level of confidence to the information provided. The HBRW QAQC Guidelines are organized into three levels, A, B, and C. As the level of QAQC increases (C being the highest), so does the level of confidence in the information. Information with higher levels of confidence will generally have greater applications for use by local and state government agencies.

The right hand column of the QAQC guidelines chart on page 13 provides QAQC guidelines for chemical monitoring. These guidelines refer to procedures for cleaning sample bottles and glassware, collecting samples, holding and preserving samples, maintaining reagents, calibrating equipment, and analyzing duplicate and split samples. The procedures for cleaning sample bottles and glassware and collecting samples are found in the previous section entitled "Collecting Water Samples." The procedures for holding and preserving samples are found in the chart "Overview of Chemical Sample Analysis Methods" following this section. The procedures for calibrating equipment, analyzing duplicate and split samples, and maintaining reagents are below. Make sure you follow all these procedures to ensure accurate test results.

It is also important to fill out the first page of the "Physical Survey/Habitat Assessment" form every time you collect a water sample for analysis. (For Tier 1, fill out the first half of the first page of the "Physical/Habitat Survey" form). This form provides documentation on weather, water level, and water appearance. These are key factors which may influence how you interpret your testing results.

The "Chemical Sample Sheet" at the end of this section has a checklist to help you document that you completed all these QAQC procedures. Fill one out each time you collect and analyze a water sample.

Use the "Chemical Data Reporting Sheet" at the end of this section to record your testing results. It provides space to record results for up to 5 water samples. Make sure you record the site name and sampling date (or a sample number) in the space provided at top of the appropriate column so you can keep track of which results correspond to which samples. The "Chemical Data Reporting Sheet" also provides space to record results from calibrating your equipment and analyzing duplicate and split samples (see instructions below). If it is more convenient to revise the data reporting sheet to better fit your study design, feel free to do so.



## Calibrating Equipment

Calibration refers to procedures that ensure that your equipment is reading results accurately. Calibration often involves conducting a test with a blank, usually de-ionized water, and conducting a test with a standard of known concentration. Meters usually have built-in calibration corrections that occur when you test them with blanks and standards. Test kits do not. Record your calibration results on the “Chemical Data Reporting Sheet.” Record the result you obtain from testing the blank in the “Blank” column in the “Calibration” section. Record the concentration of the known standard in the “Actual Value” column. Record the result you obtain when testing the standard in the “Your Result” column.

If your test kit yields a result different than zero for a blank and far off from a known standard concentration, try the test again, checking your procedures. Make sure your glassware is clean, your reagents have not expired, and your blank and standards are not contaminated. Your results do not have to be exactly on the mark; there is an expected margin of error for the equipment recommended in this Guidance Document. This margin of error is based on the accuracy of the test method found in the chart “Overview of Chemical Sample Analysis Methods.” Recommended standard concentrations and expected margins of error are included in the detailed instructions for each indicator.

Calibrate your test kits with a blank and standard at the beginning of your day of testing. If you conduct 10 or more analyses per indicator in a day (including duplicate analyses), conduct one more test with the standard at the end of the day, as a final QAQC check. Record this result under the “End of Testing” column on the “Chemical Data Reporting Sheet.”

Calibrate your meters at the beginning of your day of testing. If you conduct more than 10 analyses per day (including duplicates), re-calibrate your meters before continuing beyond the first 10 analyses. If you switch sites and/or turn your meters off between analyses, re-calibrate at each new site and/or whenever you turn the meters back on. For dissolved oxygen meters, conduct a super-saturation test as your calibration (follow instructions that come with the meter).

A colorimeter or spectrophotometer is recommended for Tier 3 nitrate-nitrogen and orthophosphate. These instruments should be calibrated with a 5 (or more) point standard curve. See instructions in the nitrate-nitrogen and orthophosphate sections of this manual. On the “Chemical Data Reporting Sheet,” indicate in the “Calibration” section that a standard curve was used and attach curve results.

## Duplicate Samples

Analyzing a duplicate sample simply means that you repeat a test on a sample of water after conducting an initial test. Use water from the same sample container as the initial sample tested. Duplicates help you assess the precision of your work; i.e., how reproducible the results are if the analysis is repeated. For QAQC Level A, analyze at least one duplicate per indicator per sampling day. If you are testing the same indicator

on several samples (from several sites, for example), then you only have to conduct a duplicate on one of those samples (one per indicator). For QAQC Levels B & C, conduct duplicate analyses for each indicator on at least 20% of your samples per sampling day. If you are only analyzing 5 samples, 20% amounts to one sample. In this case, the number of duplicates recommended for QAQC Levels B & C would be the same as for QAQC Level A. Record your duplicate results under the “Dup.” columns on the “Chemical Data Reporting Sheet.”

## **Split Samples**

Split samples are an “external” QAQC check on the accuracy of your work. Conducting a split sample means you pour half of a collected sample into a separate bottle and send it off to another party for analysis. QAQC Level C recommends you analyze one split sample for every 20 samples analyzed or one split sample in every 30 day sampling period, whichever is more frequent. Splits should be sent to an ELAP certified lab for analysis. One of HBRW’s Resource Partners, Community Science Institute, can provide ELAP certified lab analysis of split samples for volunteer groups at a reasonable cost. Go to [www.communityscience.org](http://www.communityscience.org) or call Steve Penningroth at (607) 257-6606 for more information. There is space on the “Chemical Data Reporting Sheet” to record split sample results. Make sure you record the site name and sampling date (or a sample number) in the space provided at the top of the column labeled “Split.”

## **Reagents**

It is important that you keep your reagents up to date. Expired reagents may not yield accurate results. Become familiar with the codes that the chemical companies use on their labels to document dates of manufacture and/or expiration. Usually a “lot number” appears on a label corresponding to a manufacture date. Hach Company lot numbers consist of 4 digits. The first digit is the year and the next 3 digits are the day of the year. Thus 3032 means the reagent was manufactured on February 1, 2003. LaMotte Company lot numbers consist of 3 digits. The first two digits are the week and the third digit is the year. Thus 502 means the reagent was manufactured in the middle of December 2002. The companies are changing some labels to print the actual expiration date right on the reagent containers. A table at the end of this section provides the shelf life of reagents required by the equipment recommended in this Guidance Document. The shelf life listed for each reagent assumes proper storage in a cool, dark, dry place at 10-30°C, with no exposure to heat, light and humidity.

## Overview of Chemical Sample Analysis Methods

Indicator	Tier	Sample Volume	Sample Holding Time & Preservation	Analysis Methods	Test Apparatus	Range, Increments, and Accuracy
pH	1	100 ml	24 hours cooled to 4°C	Direct measurement OR Wide Range Indicator	paper strips OR LaMotte color comparator	0-14 pH units by 1 OR 3-10.5 pH units by 0.5; $\pm 0.5$
	2, 3			Direct measurement	Hach pH Testr 2 or other meter	0-14 pH units by 0.1; $\pm 0.1$
Dissolved Oxygen	2	60 ml	"Fix" with first 3 reagents immediately in field; store in dark and analyze within 8 hours.	Modified Winkler Titration	LaMotte microburet	0-20 mg/L by 0.2; $\pm 5\%$
	3	60 or 300 ml	Same as Tier 2	Modified Winkler Titration	Hach digital titrator	0-20 mg/L by 0.01; $\pm 1$ digit on titrator
Nitrate-Nitrogen	2	25 ml	48 hours cooled to 4°C	Zinc Reduction	LaMotte color comparator	0-15 mg/L by 1, 2, 4, 6, 8, 10, 15; $\pm 10\%$
	3	50 ml	Samples can be held for up to 28 days if acidified with sulfuric acid to pH2. Samples collected < 28 days apart can be analyzed at the same time using the same standard curve.	Cadmium Reduction with 5 point standard curve for extrapolating concentration from absorbance	Hach DR890 colorimeter OR spectrophotometer	0-2 or 1-10 mg/L by 0.01; $\pm 0.2^*$
Ortho-phosphate	2	25 ml	48 hours cooled to 4°C	Ascorbic Acid Reduction	Hach color wheel	0-5 mg/L by 0.1; $\pm 10\%$
	3	50 ml	Same as Nitrate-Nitrogen Tier 3, except the 28 day holding time only applies if samples are analyzed for total P.	Ascorbic Acid Reduction with 5 point standard curve as in Nitrate-Nitrogen Tier 3.	Hach DR890 colorimeter OR spectrophotometer	0-0.2 or 0.2-1.0 mg/L by 0.01; $\pm 0.05^*$
Alkalinity	2	25 ml	14 days cooled to 4°C	Sulfuric Acid Titration	LaMotte microburet	0-200 mg/L by 4; $\pm 20\%$ 0-720 mg/L by 0.1; $\pm 1$ digit on titrator
	3	250 ml		Double Endpoint Titration	Hach digital titrator	
Conductivity	2-3	50-100 ml	28 days cooled to 4°C	Direct measurement	conductivity meter	0-1999 microsiemens/cm by 1; $\pm 20\%$
Turbidity	2-3	50 ml	48 hours cooled to 4°C	Direct measurement	nephelometer OR Hach DR800 colorimeter	0-1000 NTU by 0.01; $\pm 2\%$ OR 0-1000 FAU by 0.01; $\pm 2$ FAU

\* This is Hach's reported accuracy of the instrument when reading concentrations. The accuracy of the test should be greater if a standard curve is used.

# Chemical Sample Sheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_  
 Site \_\_\_\_\_ Sampling Date \_\_\_\_\_ Sampling Time \_\_\_\_\_ Sample # \_\_\_\_\_  
 Name of person(s) collecting sample \_\_\_\_\_  
 Name of person(s) analyzing sample \_\_\_\_\_ Date analyzed \_\_\_\_\_

**QAQC Checks** (if your methods are different than below, please describe on separate sheet)

- First part of Physical Survey Data Sheet attached for this date:
  - First page of Tier 2/3 Physical Survey Data Sheet OR
  - First half of first page of Tier 1 Physical Survey Data Sheet
- Site drawing attached, with location of sampling site marked (from this or previous date)
- Sample bottles and glassware washed according to procedures in Guidance Document.
- Sample collected according to procedures in Guidance Document:
  - Grab sample in main current OR
  - Composite sample (describe method) \_\_\_\_\_
- Reagents used were not expired
- Sample analyzed immediately or preserved according to procedures in Guidance Document
- Test kits calibrated with blank and standard at beginning of testing, and with standard at end of testing if 10 or more analyses per indicator per day (including duplicates)
- Meters calibrated at beginning of each set of 10 samples or at each new site
- Duplicates analyzed for each indicator per sampling day (QAQC Level A) OR
- Duplicates analyzed for each indicator on 20% of samples per sampling day (QAQC Level B)
- One out of 20 samples or one sample per 30 days split and sent to ELAP lab (QAQC Level C)

**Documentation of Test Methods**

Indicator	Analysis Method	Test Apparatus	Test Range & Increments

Name, phone & email of person completing Sample Sheet \_\_\_\_\_  
 \_\_\_\_\_ Date completed \_\_\_\_\_

**QAQC Level C:**

Name & phone of ELAP lab that analyzed splits \_\_\_\_\_  
 Lab results attached

## Chemical Data Reporting Sheet

School/Group \_\_\_\_\_ River/Stream \_\_\_\_\_

Name of person(s) analyzing samples \_\_\_\_\_ Date analyzed \_\_\_\_\_

Indicator	Calibration*			Sample Results (write in site & date, or sample #, in spaces below, for up to 5 samples)										Standard	Split*
	Blank	Standard												End of Testing*	
		Actual Value	Your Result	Result	Dup.*	Result	Dup.*	Result	Dup.*	Result	Dup.*	Result	Dup.*	Your Result	ELAP Result
Temperature °C	n/a	n/a	n/a												
pH	n/a														
Alkalinity (mg/L CaCO <sub>3</sub> )															
Dissolved Oxygen (mg/L)	n/a	super-sat. test for meters													
% Saturation	n/a	n/a	n/a												
Nitrate-N* (mg/L)															
Orthophosphate* as PO <sub>4</sub> (mg/L)															
Conductivity (uS/cm)															
Other															
Other															

\* Calibrate with blank & standard at start of testing. If 10 or more analyses per indicator per day (including duplicates), calibrate with standard at end of testing.  
 For QAQC Level A, analyze at least 1 duplicate per indicator per day. For QAQC Levels B & C, analyze at least 1 duplicate per 20% of samples per day.  
 For Tier 3 Nitrate-N and Orthophosphate, indicate under calibration that standard curve was used. Attach curve results.  
 For QAQC Level C, split one sample for every 20 samples analyzed or one in every 30 day period; send to ELAP lab.

Name, phone & email of person completing this sheet \_\_\_\_\_ Date completed \_\_\_\_\_

## Shelf Life of Reagents

This chart assumes reagents are kept cool and dry. Avoid leaving reagents out in hot, humid conditions. Consult source companies for more info.

Indicator	Company	Description	Catalog #	Shelf Life
pH	Hach	pH 4 buffer 500 ml	22834-49	4 years
		pH 7 buffer 500 ml	22835-49	2 years
		pH 10 buffer 500 ml	22836-49	1 year
Conductivity	Hach	1000 uS/cm NaCl standard 100 ml	14400-42	5 years
Nitrate-Nitrogen	LaMotte	Tablet #1 for Zn reduction	2799-H	3 years
		Tablet #2 for Zn reduction	NN-3703-H	3 years
	Hach	Nitraver 5 for 5 ml sample	14035-99	2 years
		Nitraver 5 for 10 ml sample	21061-69	3 years
		100 ppm NO <sub>3</sub> -N standard 2 ml ampules (20)*	1947-20	4 years
		5 ppm NO <sub>3</sub> -N standard 10 ml ampules (16)*	25578-10	4 years
10 ppm NO <sub>3</sub> -N standard, 500 ml bottle*	307-49	4 years		
Ortho-phosphate	Hach	Phosver 3 for 5 ml sample	2209-99	5 years
		Phosver 3 for 10 ml sample	21060-69	3 years
		50 ppm PO <sub>4</sub> standard 10 ml ampules (16) *	171-10	5 years
		1 ppm PO <sub>4</sub> standard, 500 ml bottle*	2569-49	4 years
Alkalinity	LaMotte	Titration reagent	4493DR-H	2 years
		BCG-MR tablets	T-2311-H	18 months
	Hach	0.16N Sulfuric acid titration cartridge	14388-01	18 months
		50 ppm CaCO <sub>3</sub> standard	21277-16	12 months
Dissolved Oxygen	LaMotte	Manganous sulfate	4167-G	3 years
		Alkaline iodide azide	7166-G	3 years
		Sulfuric acid	6141WT-G	3 years
		Sodium thiosulfate	4169-H	1 year
		Starch indicator	4170WT-G	18 months
	Hach	Manganous sulfate	1071-66	5 years
		Alkaline iodide azide	1072-66	3 years
		Sulfamic acid	20762-66	5 years
		0.2 N Sodium thiosulfate cartridge	22675-01	2 years
Starch indicator	349-32	5 years		
Turbidity	Hach	4000 NTU stock solution	2461-42	2 years

\*For N and P ampule and bottled standards, once ampules and bottles are opened, the shelf life no longer applies. Ampule standards should be discarded. Bottled standards should be used with discretion. How long they keep depends on storage conditions and whether they're contaminated with use. Hach Company says if you're having problems and a bottle has been opened for over 30 days, discard the standard.

# Chemical Data Interpretation

Data interpretation is the most important part of your monitoring program. Quite often due to time constraints and other factors, programs end up with many data sheets accumulating in the drawer. Here are a few ways to look at your data to begin to tell the story of your watershed. Keep the data you collect over time; the story will begin to unfold with each sampling event.

Start by making a simple table so that you can view your results in one place, rather than flipping through multiple sheets. Then look at your physical surveys. Briefly describe how the physical and habitat conditions of your site may have contributed to your results. Pay careful attention to flow, weather, and time of year. Note these observations on your data table.

Below are some ways to approach and organize your thinking:

- Review your study design question. Display your data in graphs that will help you to assess the information you gathered. Does your data answer your question? What story does it tell about your question? What gaps are there in your information?
- Compare your results to the NYS DEC water quality standards and guidelines. Do any indicators violate standards? The guidelines?
- Compare sites. Graph each indicator on a separate graph with your sites in order of upstream to downstream. Are there any trends? Throughout the years, are any sites consistently higher or lower than other sites?
- Graph each site over time. Do you see any changes? Do seasonal patterns appear?

## Follow-up Study

Discuss these questions as a way of deciding what the next steps are:

- What further questions arose from analyzing your results?
- Are there any areas to check more carefully in the future?
- Are there any more detailed studies you would like to conduct?

The “Data Analysis Worksheet – Water Quality Standards Survey” provides an example of one way to analyze results from a water quality standards survey.

## Advanced Analysis: Loading

Loading is a concept that is gaining importance for rivers. Loading is the amount of a pollutant that passes by a point in the stream per unit of time.

Currently, the U.S. EPA is working with states to incorporate loading into their management and regulatory systems. States may have to adopt a total maximum daily load (TMDL) for each of their rivers. In other words, they will have to limit the accumulated total of a load throughout the day for selected pollutants.

Loading could be important to consider in your data analysis, depending on your study design. Loading can help you factor out the effect of stream flow on pollutant concentrations. As an example, consider an impact assessment study of a horse ranch conducted by Millbrook High School students in November 1998. There was a 3-fold increase in the phosphate concentration as you moved from the upstream to the downstream site (indicating an impact). However, the impact of the ranch became even more apparent by calculating loading values. There was a 7-fold increase in flow as you moved from the upstream to the downstream site. This means there must have been a 21-fold difference in phosphate loading!

You can calculate the loading for the indicators you measured by using the equation below:

$$\text{LOADING (grams/day)} = \text{CONCENTRATION (mg/L)} \times \text{FLOW (m}^3\text{/sec)} \times 86,400 *$$

\*(there are 86,400 seconds in 1 day)

To calculate flow, see the "Flow" worksheet in the "Physical Survey" section of this manual.

*Rationale for the formula used to calculate loading:*

$$\text{LOADING} = \text{MASS/TIME}$$

$$\text{CONCENTRATION} = \text{MASS/VOLUME}$$

$$\text{FLOW} = \text{VOLUME/TIME}$$

$$\text{so LOADING} = \text{CONCENTRATION} \times \text{FLOW}$$

$$\frac{(\text{Concentration})\text{mg}}{\text{liter}} \times (\text{FLOW}) \frac{\text{m}^3}{\text{sec}} \times \left( \frac{1000\text{liter}}{1\text{m}^3} \times \frac{1\text{gram}}{1000\text{mg}} \times \frac{86,400\text{sec}}{1\text{day}} \right) =$$

$$\text{CONCENTRATION} \times \text{FLOW} \times 86,400 = \text{LOADING in grams/day}$$



## Data Analysis Worksheet - Water Quality Standards Survey

Name(s) \_\_\_\_\_  
School/Group \_\_\_\_\_ Date \_\_\_\_\_  
Stream \_\_\_\_\_ Site \_\_\_\_\_

According to your data, does the stream violate DEC water quality standards according to the classification of your stream site? Describe.

Does the stream exceed guidelines for a healthy stream? Describe.

Are any of the designated uses of the stream site (drinking water, swimming, aquatic life, etc.) impaired? Indicate the level of impact. (Remember that "aquatic life" is a use. Consider what your benthic data tells you about the level of impairment for this use).

Are any other uses, such as recreation or aesthetics, impaired? To what extent?

## **Data Analysis Worksheet – Water Quality Standards Survey (continued)**

What might be causing the impairments? Include type of pollutant/impact and possible sources. Consider how the physical/habitat conditions may have influenced your water chemistry and macroinvertebrate results.

What else does your data tell you about your stream?

List some ideas for follow-up, such as further questions to study, protection or restoration actions, stewardship projects, etc.

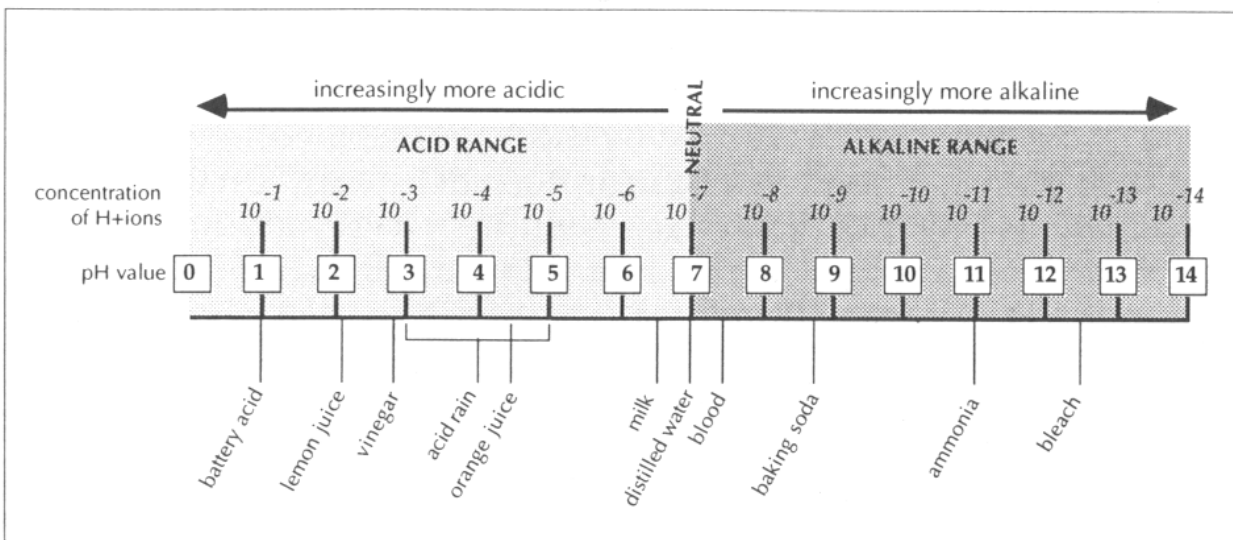


## Background

**What is pH?** pH is a measure of the acidity of a solution. Acids produce hydrogen ions (H<sup>+</sup>) and bases produce hydroxide ions (OH<sup>-</sup>) in solution. Water molecules ionize (break apart) and produce hydrogen and hydroxide ions in equal numbers. When another compound enters the water, the ions of water and the ions of the compound react with each other leaving an unequal number of hydrogen and hydroxide ions. If the solution has more hydrogen ions, it is acidic; if it has more hydroxide ions, it is basic.

**Why Measure pH?** Many fish and invertebrates are sensitive to high (above 8.6) and low (below 6.5) pH levels. Recently, because of air pollution, precipitation in the Northeast US tends to have low pH. This is called "acid rain." At low pH's the bones of fish may become soft and the fish are unable to lay eggs successfully. Fish gills become clogged with mucus and the fish has difficulty getting oxygen into its bloodstream.

**pH Scale Diagram**



**Levels:** Optimal Range for most life: 6.5-8.2  
 NYS DEC Standard for Class A, B, C waters: 6.5-8.5

## Analysis

### Tier 1

### pH

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat. #
Direct reading (or Wide Range Indicator)	VWR paper strips (or LaMotte color comparator)	1-14 (or 3-10.5)	1 (or 0.5) pH units	± 0.5 (color comparator)	VWR #EM-9590-3 (or LaMotte #5858)

### Procedure

The procedure below is for pH paper strips. The most accurate paper strips are pH strips, universal range, EM CholorpHast (company and catalog number listed above). You can also use a color comparator kit (one example listed above).

#### Test a known standard

1. Wash a beaker with non-phosphate soap and rinse three times with de-ionized water.
2. Pour a small amount of a pH 4, 7, or 10 buffer solution into the beaker. Record the value of the buffer in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet."
3. Dip paper strip into beaker and wait a minute. Compare color of strip to pH chart and record result in the "Your Result" column in the "Calibration" section of the "Chemical Data Reporting Sheet."

#### Test a sample

4. Rinse beaker three times with de-ionized water. Pour a little of your sample into the beaker.
5. Dip paper strip into beaker and wait a minute. Compare color of strip to pH chart and record result in the appropriate "Result" column of the "Chemical Data Reporting Sheet."

#### Test a duplicate

6. Repeat steps 4-5 with more of your sample. Use sample from the same collecting bottle. Record result in the appropriate "Dup." column of the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).

#### When you have finished testing

7. If you have conducted 10 or more analyses per day (including duplicates), test with your buffer solution one more time. Record your result in the "End of Testing" column on the "Chemical Data Reporting Sheet."

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat. #
Direct Measurement	Hach pH Testr 2 or other meter	0-14 pH	0.1	± 0.1	Hach #27235-00

## Procedure

The instructions below assume you are using the Hach pH Testr 2. If you are using a different meter, make sure you check the instructions that come with your instrument and amend these procedures accordingly.

### Prepare for testing

1. Before you begin, condition the electrode. Remove cap from the bottom of the meter and immerse the electrode in pH buffer solution or tap water for at least 30 minutes. DO NOT use de-ionized water.
2. Wash a beaker with non-phosphate soap, then rinse three times with de-ionized water.

### Calibrate the meter

3. Calibrate the meter according to instructions that come with the instrument. It is best to use a buffer that is close to the expected pH value of your river. If you use a buffer that is significantly higher or lower pH than your sample, the calibration might bias your results. For most rivers, a pH 7 buffer is appropriate. You might want to try a pH 4 buffer if you know your river has limited buffering capacity and thus is heavily influenced by acid rain.
4. Record the value of the buffer you use in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet." Record your result from measuring the buffer in the "Your Result" column. Your result should be within the expected margin of error of +/- 0.1 pH units.

### Test a sample

5. Rinse the beaker and electrode three times with de-ionized water. Pour sample into the beaker about 2 inches deep.
6. Immerse the electrode ½ - 1 inch into the water sample. Stir once and then hold meter still to let the reading stabilize. (See note below).\*
7. Record the pH value under the appropriate "Result" column on the "Chemical Data Reporting Sheet."

### Test a duplicate

8. Rinse the beaker and electrode 3 times with de-ionized water. Use same sample bottle to pour another sample into the beaker about 2 inches deep.
9. Repeat steps 6 & 7. Record result in the appropriate "Dup." column on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC

Levels B & C).

**Test more samples**

10. Repeat steps 5-7 (and 8-9 if doing more duplicates). If the meter has to be turned back on, or if you have moved to another site, re-calibrate the meter before conducting more tests. Also re-calibrate once you have tested 10 samples (including duplicates), if you plan on continuing testing. Use the "End of Testing" column on the "Chemical Data Reporting Sheet" to record the result of re-calibration.

**When you are finished testing**

11. Make sure you remember to turn the meter off so your battery won't be dead for the next sampling!
12. When storing the meter, keep the electrode moist by placing a cloth soaked in 7.0 pH buffer solution or clean tap water in the protective cap. Do not use de-ionized water - this may leach metals from the electrode.

\* Samples around the neutral point will take longer to stabilize. If the reading gradually rises a few tenths of a pH unit, wait for the reading to stabilize. If the reading continues to rise a whole pH unit, or fails to stabilize, the electrode may need cleaning. Soak it for 1 hour in pH 4 buffer, then 1 hour in pH 10 buffer, then 1 hour in pH 7 buffer. If the reading is still not stabilizing after this treatment, it is probably time to replace the electrode.



## Background

*What is Alkalinity?* Alkalinity is a measure of the capacity of water to neutralize (or buffer) inputs of acids. A river's alkalinity is dependent on the type of soil and bedrock through which it flows. Therefore, it can vary greatly from watershed to watershed naturally. The lower the alkalinity the lower the ability to buffer. Alkalinity is measured in milligrams per liter of calcium carbonate.

*Why Measure Alkalinity?* Alkalinity is important because it protects against pH changes from acid inputs and thus affects the waters' ability to support life. Human caused inputs of acid into a river are mainly acid deposition (rain, snow, and dry particles), wastewater discharges, industrial discharges, and acid mine drainage.

*Levels (Alkalinity as CaCO<sub>3</sub>):*

- Acidified: 0
- Critical: 0-2 mg/L
- Endangered: 2-5 mg/L
- Highly sensitive: 5-10 mg/L
- Sensitive: 10-20 mg/L
- Not sensitive: 20 or higher mg/L

## Analysis

### Tier 2 Alkalinity

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat. #
Sulfuric Acid Titration	LaMotte microburet	0-200 mg/L	4 mg/L	± 20%	LaMotte #4491-DR

## Procedure

### Prepare for testing

1. Wash ALL glassware with non-phosphate soap, then rinse three times with de-ionized water.

### Test a blank

2. Fill glass titration tube with de-ionized water to the 5 ml line.
3. Add one BCG-MR tablet to the tube and swirl to mix.
4. Depress the plunger of the titrator (looks like a syringe) to expel air.
5. Insert titrator into the plastic fitting of alkalinity reagent B bottle.
6. To fill titrator, invert the bottle and slowly withdraw the plunger until the bottom of the plunger is opposite the zero mark on the scale.

**NOTE:** A small air bubble may appear in the titrator. Expel the bubble by partially filling the titrator and pumping the reagent back into the inverted bottle. Repeat this pumping action until bubble disappears.

7. WITHOUT DEPRESSING PLUNGER, turn the bottle right side-up and remove titrator. Insert the tip of titrator into the opening of the titrator tube cap as shown in kit directions.
8. SLOWLY depress plunger to dispense one drop of the reagent. Gently swirl tube to mix.
9. The blank should turn from blue to purple-red with the color change holding, after this one drop. Record a "0" in the "Blank" column in the "Calibration" section of the "Chemical Data Reporting Sheet."

#### **Test a known standard**

10. Empty titration tube, rinse 3 times with de-ionized water, and fill to the 5 ml line with your standard. Use a standard between 50-200 mg/L CaCO<sub>3</sub>. Record the value of your known standard in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet."
11. Refill titrator with alkalinity reagent B to the zero mark and insert into tube as in steps 5-7.
12. SLOWLY depress plunger to dispense one drop of the reagent. Gently swirl tube to mix.
13. Continue adding individual units of alkalinity reagent until the standard turns from blue to purple-red with the color change holding.
14. The alkalinity of your standard is read directly from the scale on the titrator. Your value corresponds to the point where the bottom of the plunger lines up on the scale. Record the results as mg/L CaCO<sub>3</sub> in the "Your Result" column in the "Calibration" section on the "Chemical Data Reporting Sheet." Your result should fall within an expected margin of error of +/- 20%. **NOTE:** If no color change occurs by the time the plunger tip reaches the bottom of the scale, refill the titrator to the zero mark and continue titrating. Record your final result as the sum of both titration amounts.

#### **Test a sample**

15. Empty titration tube, rinse 3 times with de-ionized water, and fill to the 5 ml line with your sample.
16. Repeat steps 11-13 above.
17. Record your result in the appropriate "Result" column on the "Chemical Data Reporting Sheet."

#### **Test a duplicate**

18. Empty titration tube, rinse 3 times with de-ionized water, and use the same sample bottle to fill to the 5 ml line with your sample.
19. Repeat steps 11-13 above.
20. Record your result in the appropriate "Dup." column on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).



### When you have finished testing

21. If you have conducted 10 or more analyses per day (including duplicates), test your known standard one more time. Record your result in the "End of Testing" column on the "Chemical Data Reporting Sheet."
22. When you are finished with all testing, discard any extra reagent from the titrator into your waste container; DO NOT put back into the original reagent bottle.

## Tier 3

## Alkalinity

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat. #
Double Endpoint Titration	Hach digital titrator* and pH meter	0-720 mg/L	0.1 mg/L	± 1 digit on titrator (± 1% if over 100 digits)	Hach #20637

\*You can use the same titrator as is used in the Tier 3 Dissolved Oxygen test

**Summary of Method:** Titration with sulfuric acid is performed using a digital titrator and pH meter. (River Network adaptation of method used by the University of Massachusetts Acid Rain Monitoring Program.) First, a 100 ml sample is poured into a beaker and the pH is recorded. Sulfuric acid is added until the pH reaches 4.5. The amount of sulfuric acid added is recorded. Additional sulfuric acid is added until the pH is 4.2. This is recorded as well. An equation is applied to determine total alkalinity as mg/L CaCO<sub>3</sub>.

### Procedure

#### Prepare for testing

1. Wash ALL glassware with non-phosphate soap, then rinse 3 times with de-ionized water.
2. Familiarize yourself with how to operate the pH meter (see instructions in pH section). Calibrate the meter.

#### Test a blank

3. Follow steps 5-14 below using de-ionized water as a blank sample. Your result should be very close to zero. Record a "0" in the "Blank" column in the "Calibration" section of the "Chemical Data Reporting Sheet."

#### Test a known standard

4. Use a standard between 50-200 mg/L CaCO<sub>3</sub>. Record the value of your known standard in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet." Follow steps 5-14 below to test the standard. Record the results as mg/L CaCO<sub>3</sub> in the "Your Result" column. Your result should fall within an expected margin of error of +/- 1 digit on the titrator (or

1% for more than 100 digits).

### Test a sample

5. Bring water sample to room temperature. (Let sit for 1 hour with the cap on). Measure 100 ml of the water sample and pour immediately into the 250 ml beaker with a magnetic stirrer or stir manually.
6. Rinse the pH electrode well with de-ionized water. Place the electrode into the sample and stir. Read and record the temperature and pH in the appropriate columns on the data sheet. Rinse the electrode well with de-ionized water.
7. Insert a clean delivery tube into the 0.16N Sulfuric Acid titration cartridge and attach the cartridge to the titrator body.
8. Over a sink, hold the titrator with the cartridge tip pointing up. Carefully turn the delivery knob to eject all of the air and a few drops of titrant. Check for air bubbles in the tube. Reset counter to 0 and wipe the tip.
9. If the pH of the sample is less than 4.5, skip to step 14 below.
10. Insert the delivery tube into the beaker containing the sample. Turn the delivery knob while stirring the beaker continuously until the pH meter reads 4.5. The pH can change quite suddenly, so add drops slowly. Be sure to allow the meter to stabilize as you add the acid. Record the number of digits used to achieve this pH on the lab sheet. Do not reset counter. If you overshoot by adding too much acid, skip to step 14 below.
11. Continue adding acid (titrating) to a pH of 4.2 and record the total number of digits.
12. Apply the following equation to calculate alkalinity:  
Alkalinity (as mg/L CaCO<sub>3</sub>) = (2a-b) X 0.1  
a = digits of titrant required to get to pH 4.5  
b = total number of digits of titrant required to get to pH 4.2 (which includes digits required to get to pH 4.5)  
0.1= digit multiplier for a 0.16N titration cartridge and a 100 ml sample
13. Record the results as mg/L CaCO<sub>3</sub> in the appropriate "Result" column on the "Chemical Data Reporting Sheet."
14. If the pH of your water sample prior to titration is less than 4.5 or if you overshoot 4.5, proceed as follows:
  - a. Insert the delivery tube into the beaker containing the sample.
  - b. Turn the delivery knob while swirling the beaker until the pH meter reads exactly 0.3 pH units less than the initial pH of the sample.
  - c. Read and record the number of digits used to achieve this pH.
  - d. Apply the equation as in step 11, but "a" = 0 and "b" = the number of digits required to reduce the initial pH exactly 0.3 pH units.
  - e. Record the results as mg/L CaCO<sub>3</sub> in the appropriate "Result"

column on the "Chemical Data Reporting Sheet."

NOTE: If the alkalinity is high, you may want to switch to the 1.6 N sulfuric acid for titration after your first sampling. The more concentrated acid allows you to use less of it, but you can continue to use the 0.16 N solution and still get the same final results. If you do switch, the digit multiplier for the equation will be 1.0 (instead of 0.1).

#### **Test a duplicate**

15. Rinse beaker, electrode and graduated cylinder 3 times with de-ionized water.
16. Use same sample bottle to pour 100 ml into the 250 ml beaker.
17. Repeat steps 5-14. Record the results as mg/L CaCO<sub>3</sub> in the appropriate "Dup." column on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).

#### **When you have finished testing**

18. If you have conducted 10 or more analyses per day (including duplicates), test with your known standard one more time. OR, as an alternative accuracy check, follow the procedure described below. Record your result in the "End of Testing" column on the "Chemical Data Reporting Sheet."

#### **To Perform an Accuracy Check**

1. Snap off a 0.5N Alkalinity Voluette Ampule Standard. This is a standard solution that has a known alkalinity.
2. Perform the alkalinity test using this standard:
  - a) Pipet 0.1 ml of the standard to the finished sample from above.
  - b) Titrate this with more sulfuric acid until the pH returns to 4.2.
  - c) Record the number of digits needed.
  - d) Repeat steps a-c twice more.
3. Each 0.1 ml addition of standard should require 250 additional digits of 0.16N sulfuric acid titrant. Compare your results with this number. If the number of digits you got was very different, explore reasons for this difference.



## Background

**What is Dissolved Oxygen?** Dissolved oxygen (DO) is a measure of the concentration of oxygen gas that is dissolved in the water. The main ways it enters water are through turbulence and plant photosynthesis. DO is measured in milligrams per liter (mg/L) which is the same as parts per million (ppm).

**Why Measure Dissolved Oxygen?** Oxygen is essential for all living things. Certain macroinvertebrates, such as most mayflies, caddisflies, and stoneflies, and certain fish, such as trout, require dissolved oxygen levels of at least 6 mg/L. The most oxygen that can be dissolved in water is about 14 mg/L.

When a stream warms up, it loses its ability to hold dissolved oxygen. Other factors such as excess algae or suspended sediment can also lower oxygen levels.

Water can hold a maximum amount of dissolved oxygen at different temperatures (saturation). In our analysis we will calculate the concentration of DO and the percent oxygen saturation. The percent saturation is the amount of DO that is dissolved in the water compared to the optimal amount that you'd expect the water to hold at its given temperature.

Recording the time of day is essential for DO measurements, as the amount will fluctuate throughout the course of a day due to fluctuations in plant photosynthetic activity and water temperatures.

### Concentrations:

NYS DEC Water Quality Standards:

Class A-S: 6.0 mg/L

All other class A and B,C:

Trout Spawning (TS): 7.0 mg/L

Trout Waters (T): 5.0, daily average 6.0

Non-trout: 4.0, daily average 5.0

Class D: 3.0 mg/L

## Analysis

### Tier 2

### Dissolved Oxygen

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat. #
Modified Winkler Titration	LaMotte microburet	1-20 mg/L	1 mg/L	± 5%	LaMotte #5860

## Procedure

### Collect a water sample

1. Wash ALL glassware with non-phosphate soap, then rinse 3 times with de-ionized water.
2. Carefully wade into the stream. Stand so that you are facing one of the banks. Take and record the temperature of the water.
3. Remove the cap of the sample bottle. Slowly lower the sample bottle into the water so that the top of the bottle is pointing UPSTREAM, until the lower lip of the opening is just submerged. Allow the water to fill the bottle very gradually, avoiding any turbulence (this would add oxygen to the sample). When the water level in the bottle has stabilized (it will not be full because the bottle is tilted), SLOWLY turn the bottle upright and fill completely. Keep the bottle under water and allow it to overflow for 2 or 3 minutes to ensure that no air bubbles are trapped in the sample.
4. Cap the bottle while it is still submerged. Examine your sample for air bubbles. If you see any, pour out the sample and try again. (You want to sample oxygen that is DISSOLVED in the water, not oxygen that was in the bottle from the air.)

### Immediately "fix" the sample

5. Add 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide Azide to the sample.
6. Cap the bottle and mix by inverting several times.
7. The brown precipitate indicates that oxygen is present. Allow the sample to stand until the precipitate settles below the shoulder of the bottle.
8. Add 8 drops of Sulfuric Acid to the sample. Cap the bottle and mix until the precipitate and reagent have totally dissolved. The sample will be clear yellow to amber brown if it contains oxygen.
9. Titrate immediately or store in a cool dark place for no longer than 8 hours before continuing.

### Titrate the sample

10. Fill the titration tube (not the titrator, which looks like a syringe) to the 20 ml line with the sample. Cap the tube.
11. Depress plunger of the titrator and insert into the Sodium Thiosulfate

bottle.

12. Invert the bottle and slowly withdraw the plunger until the bottom of the plunger is opposite the zero mark on the scale. If small air bubbles appear in the titrator, expel them by partially filling the titrator and pumping the solution back into the reagent container. Repeat until bubble disappears.
13. Turn the bottle upright and remove the titrator. If the sample is a very pale yellow, go to step 17.
14. Insert the tip of the titrator into the titration tube cap.
15. Slowly depress the plunger to dispense one drop at a time of the titrating solution. After each drop, gently swirl the tube during the titration to mix the contents. Continue until the yellow-brown color changes to pale yellow.
16. Carefully remove the titrator and cap. Do not disturb the titrator plunger.
17. Add 8 drops of Starch Indicator solution. The sample should turn blue.
18. Cap the titration tube and re-insert the titrator. Continue titrating until the blue color disappears and the solution becomes colorless.
19. Record the result where the titrator plunger tip meets the scale. Record as mg/L DO in the appropriate "Result" column on the "Chemical Data Reporting Sheet."
20. Use the oxygen saturation chart to calculate percent saturation and record on the "Chemical Data Reporting Sheet."

**Test a duplicate**

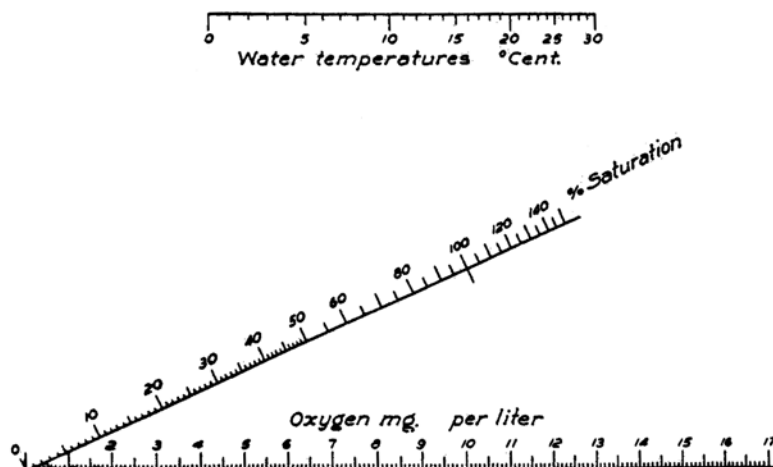
21. Rinse ALL glassware 3 times with de-ionized water.
22. Repeat steps 2-20 and record your results in the appropriate "Dup." columns on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).

**When you are finished testing**

23. If you have conducted 10 or more analyses per day (including duplicates), test your known standard one more time. Record your result in the "End of Testing" column on the "Chemical Data Reporting Sheet."

## Percent Saturation Chart

Instructions: To calculate percent saturation, find the mg/L of oxygen on the lower line and the water temperature on the upper line. Use a straight edge to line up the two readings and record where the straight edge intersects the percent saturation line.



**A note about percent saturation:** It is possible to get more than 100% saturation. The sample can be supersaturated in cold water that has a lot of turbulence or in an area where there are a lot of plants or algae on a sunny day (due to photosynthetic activity).

### Tier 3

### Dissolved Oxygen

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat.#
Modified Winkler Titration (or direct measurement)	Hach digital titrator* (or meter)	0-20 mg/L	0.01 mg/L	± 1 digit on titrator (± 1% if over 100 digits)	Hach #20631-00

\*You can use the same titrator as is used in the Tier 3 Alkalinity test

**Summary of Method:** A sample is collected in a 300 ml BOD bottle and “fixed” in the field using manganous sulfate, alkaline iodide azide, and sulfamic acid. These react with the sample turning it yellow. A starch indicator is then added to turn the solution blue. Sodium thiosulfate is added incrementally which will turn the solution clear. The amount it takes to turn the solution clear is proportional to the amount of DO in the sample.

### Procedure

The procedure below is for the Modified Winkler Titration with the Hach digital titrator. You may also use a meter. If you do use a meter, conduct a super-saturation test as a calibration. Record your result in the “Your Result” column in the

test as a calibration. Record your result in the "Your Result" column in the "Calibration" section of the "Chemical Data Reporting Sheet."

### Collect a Water Sample

1. Wash ALL glassware with non-phosphate soap, then rinse three times with de-ionized water.
2. Carefully wade into the stream. Stand so that you are facing one of the banks. Take and record the temperature of the water.
3. Remove the cap of the BOD bottle. Slowly lower the BOD bottle into the water so that the top of the bottle is pointing upstream, until the lower lip of the opening is just submerged. Allow the water to fill the bottle very gradually, avoiding any turbulence (this would add oxygen to the sample). When the water level in the bottle has stabilized (it will not be full because the bottle is tilted), slowly turn the bottle upright and fill completely. Keep the bottle under water and allow it to overflow for 2 or 3 minutes to ensure that no air bubbles are trapped in the sample.
4. Cap the bottle while it is still submerged. Examine your sample for air bubbles. If you see any pour out the sample and try again. (You want to sample to oxygen that is DISSOLVED in the water, not oxygen that was in the bottle from the air).

### Analyze the Water Sample

5. "Fix" the sample immediately
  - a) Remove the stopper and add the contents of one Manganous Sulfate powder pillow and one Alkaline Iodide Azide powder pillow.
  - b) Immediately insert the stopper so air is not trapped in the bottle and invert several times to mix. This solution is caustic, wear gloves or rinse your hands if you get any on them. An orange-brown flocculent precipitate will form if oxygen is present.
  - c) Wait a few minutes until the floc in the solution has settled. Again invert the bottle several times and wait until the floc has settled. This ensures complete reaction of the sample and reagents.
  - d) Remove the stopper from one of the samples and add the contents of one sulfamic acid powder pillow. Immediately insert the stopper so air is not trapped in the bottle, and invert several times to mix. The floc will dissolve and leave a yellow color if oxygen is present. If particles are present, shake, turn upside-down a few more times, or use a magnetic stirrer to dissolve as much as possible.
  - e) The oxygen is now fixed and can be stored in the dark for up to 8 hours.

#### **If you want to finish the test later in the lab:**

Cap the bottle firmly and seal it by pouring a small amount of water into the flared lip area. Place the bottle in a cooler in an upright position. Label the bottle with site and date or sample #. Transport the bottle in a dark place in an upright position with the stopper firmly in place. Maximum holding time is 8 hours.



6. Insert the 0.2N sodium thiosulfate cartridge into the digital titrator and insert a clean delivery tube into the cartridge.
7. Over a sink, hold the titrator with the cartridge tip pointing up. Turn the delivery knob to eject air and a few drops of titrant. Reset the counter to 0 and wipe the tip.
8. Measure 100 ml (using the graduated cylinder) of the sample volume from the "fixed" sample in the 300 ml BOD bottle and pour into a 250 ml Erlenmeyer flask. Place on a sheet of white paper to clearly see the color of the liquid.
9. Place the delivery tube tip into the solution and swirl the flask while turning the delivery knob. Keep turning the knob until the solution turns a pale yellow color.
10. Add two FULL eyedroppers of Starch Indicator solution and swirl to mix the solution. This will turn the solution dark blue. Continue titrating until the liquid turns clear. Record the number of digits showing on the titrator counter. (Tip: to make sure that you have titrated all your sample, add one more digit to the sample when it appears to turn clear. If you see no additional color change, then subtract one digit from your final count). Use the equation below to calculate mg/L of DO:  
$$\text{mg/L DO} = \text{digits required} \times 0.02$$

(0.02 is the correct digit multiplier for the 0.2N concentration of the sodium thiosulfate cartridge)
11. Calculate percent saturation using the oxygen saturation graph above.
12. Record the concentration and the percent saturation in the appropriate "Result" columns on the "Chemical Data Reporting Sheet."

**Test a duplicate**

13. Rinse ALL glassware three times with de-ionized water. Repeat steps 2-11 and record your results in the appropriate "Dup." columns on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).

**When you are finished testing**

14. If using a meter, and you have conducted 10 or more analyses per day (including duplicates), conduct a super-saturation test one more time. Record your result in the "End of Testing" column on the "Chemical Data Reporting Sheet."



## Nitrate - Nitrogen

### Background

**What is Nitrate?** Nitrate ( $\text{NO}_3^-$ ) is the form of nitrogen that is an essential nutrient for plants and animals as a building block for proteins. Nitrate is measured in milligrams per liter (mg/L). In freshwater ecosystems the limiting nutrient is phosphorus, in saltwater ecosystems, nitrate nitrogen is the nutrient in shortest supply.

**Why Measure Nitrate?** Nitrates are an essential nutrient and found naturally in unpolluted streams and ponds due to the process of plant and animal growth and decay. However, excess nitrates can cause great increases in plant growth and adversely affect the health of aquatic animals and humans. Some effects include: unstable dissolved oxygen, higher water temperatures, changes in habitat. The health impacts for humans of excess nitrates in our drinking water can result in blood poisoning in infants, hypertension in children, and gastric cancers in adults.

**Levels:** (measured as nitrate-nitrogen,  $\text{NO}_3\text{-N}$ )

Typical natural levels for freshwater: < 1 mg/L

Recommended level for trout: < 0.06 mg/L

Sewage treatment plant effluent: ~ 30 mg/L

NYS DEC Water Quality Standards:

Class A: 10 mg/L

Classes B,C,D: "None that will result in growths of algae, weeds, and slime that will impair uses."

### Analysis

#### Tier 2

#### Nitrate-Nitrogen

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat.#
Zinc Reduction	LaMotte color comparator	0-15 mg/L	0, 1, 2, 4, 6, 8, 10, 15	$\pm 10\%$	LaMotte #3354

### Procedure

#### Prepare for testing

1. Wash ALL glassware with non-phosphate soap, then rinse three times with de-ionized water.

#### Test a blank

2. Fill the test tube to the 5 ml line with de-ionized water.
3. Add one Nitrate #1 tablet to the test tube.
4. Cap and mix until tablet disintegrates.
5. Add one Nitrate #2 CTA tablet to the test tube.

6. Cap and mix until tablet disintegrates.
7. Wait 5 minutes.
8. Insert Nitrate-Nitrogen Octa-Slide Bar into the Octa-Slide Viewer.
9. Insert test tube into Octa-Slide Viewer.
10. The water in the test tube should be colorless, matching with zero on the Octa-Slide Viewer. Record a "0" in the "Blank" column in the "Calibration" section of the "Chemical Data Reporting Sheet."

**Test a known standard**

11. Rinse glassware three times with de-ionized water.
12. Fill the test tube to the 5 ml line with your standard. Use standard between 1-10 mg/L Nitrate-Nitrogen. Record the value of your known standard in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet."
13. Follow steps 3-9 above to test the standard.
14. Match color in the test tube to a color standard on the Octa-Slide Viewer. Record the results as mg/L NO<sub>3</sub>-N in the "Your Result" column in the "Calibration" section of the "Chemical Data Reporting Sheet." Your result should fall within an expected margin of error of +/- 10%.

**Test a sample**

15. Rinse glassware 3 times with de-ionized water.
16. Fill the test tube to the 5 ml line with your sample.
17. Repeat steps 3-9 above.
18. Match sample color to a color standard on the Octa-Slide Viewer. Record your result as mg/L NO<sub>3</sub>-N in the appropriate "Result" column on the "Chemical Data Reporting Sheet."

**Test a duplicate**

19. Rinse glassware 3 times with de-ionized water.
20. Fill the test tube to the 5 ml line with your sample, using same sample bottle.
21. Repeat steps 3-9 above.
22. Match sample color to a color standard on the Octa-Slide Viewer. Record your result as mg/L NO<sub>3</sub>-N in the appropriate "Dup." column on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).

**When you are finished testing**

23. If you have conducted 10 or more analyses per day (including duplicates), test your known standard one more time. Record your result in the "End of Testing" column on the "Chemical Data Reporting Sheet."

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat.#
Cadmium Reduction	Hach DR890 colorimeter, or spectrophotometer	Depends on standard curve; 0-2 or 1-10 mg/L	0.01	$\pm 0.2$ *	Hach 48470-00

\* This value is Hach's reported accuracy of the instrument when reading concentrations. The accuracy of the test should be greater if the procedure below is followed (using a standard curve).

**THIS TEST GENERATES CADMIUM WASTE WHICH IS TOXIC AND SHOULD BE DISPOSED OF SEPARATELY!!** *There is an alternative NO<sub>3</sub>-N test that the Hach DR890 colorimeter can perform that does not generate cadmium waste -- the Chromotropic Acid Method. However, HBRW has not fully explored the accuracy of this method. Feel free to try it out and let us know if you obtain satisfactory results. (Instructions can be found in the Hach DR890 manual).*

**Summary of Method:** Nitrates are measured using the cadmium reduction method with a colorimeter.

First, a standard curve is created using known concentrations of standards. This curve is used to convert absorbance readings of field samples into mg/L of nitrate-nitrogen. Then the reagent is added to field samples and their absorbance is read using a colorimeter or a spectrophotometer. The concentration of each sample is found by plotting absorbance on the standard curve and recording the corresponding concentration in mg/L.

## Procedure

### Prepare Standard Nitrate-Nitrogen Concentrations for Standard Curve

Prepare standard concentrations within the range of your samples. Below are two charts, one for a low range of 0-2 mg/L and a higher range 0-10 mg/L. If you have concentrations that are higher, make higher concentration standards for your curve.

1. Wash ALL glassware with non-phosphate soap, then rinse three times with de-ionized water.
2. Choose range: 0-2 or 0-10 mg/L.
3. Make a stock of nitrate-nitrogen solution appropriate to the range:
  - a. *0-2 mg/L:* Prepare a 2 mg/L stock solution. Empty one 2 ml ampule of nitrate-nitrogen standard solution (100 mg/L) into a 100 ml volumetric flask\*. Add de-ionized water until the final volume reads 100 ml. This gives you a final stock concentration of 2 mg/L nitrate-nitrogen. Mix well before pouring into sample cell to analyze.
  - b. *0-10 mg/L:* Prepare a 10 mg/L stock solution. Empty five 2 ml

ampules of nitrate-nitrogen standard solution (100 mg/L) into a 100 ml volumetric flask\*. Add de-ionized water until the final volume reads 100 ml. This gives you a final stock concentration of 10 mg/L nitrate-nitrogen. Mix well before pouring into sample cell to analyze.

The equation to calculate the final concentration of your stock solution from the 2 ml ampules is:

$$V1 \times C1 = V2 \times C2$$

(V=volume; C=concentration)

Example: (5 ampules)(2ml)(100mg/L) = (100 ml)(X)  
 $X = 10 \text{ mg/L}$

\*Volumetric flasks are important to use for mixing standards because of their precision.

- Set out six 10 ml sample cells. Use calibrated volumetric pipets to transfer corresponding volumes of nitrate stock solution to each cell as in the appropriate chart below. Before using each pipet the first time, clear it by filling once with the stock solution and forcing it out. (Do not use your mouth; use a pipet bulb.)

	<b>Standard Concentration (mg/L NO<sub>3</sub>-N)</b>	<b>Volume (ml) of 2mg/L NO<sub>3</sub>-N Stock Solution</b>
0-2 mg/L range	0.0	0
	0.4	2
	0.8	4
	1.2	6
	1.6	8
	2.0	10

	<b>Standard Concentration (mg/L NO<sub>3</sub>-N)</b>	<b>Volume (ml) of 10 mg/L NO<sub>3</sub>-N Stock Solution</b>
0-10 mg/L range	0.0	0
	2.0	2
	4.0	4
	6.0	6
	8.0	8
	10.0	10

The equation to calculate your own standards is  $A = BC/D$

- A: volume of stock solution needed
- B: desired concentration of standard
- C: volume of standard
- D: concentration of stock solution

- Fill the remainder of each sample cell with de-ionized water to the 10 ml line. Swirl to mix.

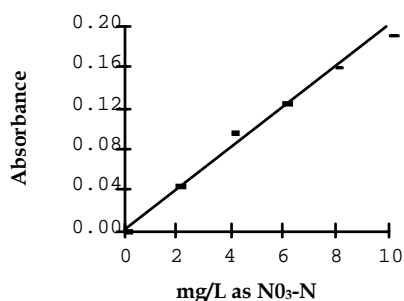
## Measure Nitrate-Nitrogen of Standards and Samples

1. Measure 10 ml of each sample and your standards into different sample cells.
2. Prepare the colorimeter for the appropriate range nitrate-nitrogen test using the instructions that come with the instrument and adjust the colorimeter to read for absorbance.
3. **Use of gloves is recommended for this part of the test.** Add NitraVer5 pillows one at a time to your standards and samples as follows:
  - a. Add the contents of one NitraVer 5 pillow to the standard or sample. Cover with parafilm (very tightly) or a Teflon screw cap. **This powder contains cadmium, be very careful NOT to breathe it.**
  - b. Shake vigorously for one minute (be exact!!) Unoxidized particles of cadmium metal will remain in the sample and settle to the bottom of the tube. Shaking time and technique influence your results. Be consistent with each standard and sample.
  - c. Wait five minutes to proceed. The DR 890 colorimeter has a timer programmed into its function. See instrument instructions.
4. Add the contents of one NitraVer5 pillow to your 0.0 standard. This is your blank; use it to zero the colorimeter for all your standards and samples.
5. Read the absorbance of each standard and sample as follows:
  - a. Wipe the sample cell with a kimwipe.
  - b. Insert sample cell correctly into the colorimeter and cover.
  - c. Read the absorbance by pressing the READ key and record.

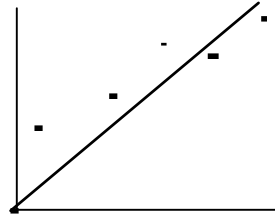
## Prepare a Calibration Curve and Convert Absorbance to mg/L

1. Make an absorbance versus concentration graph on graph paper:
  - a. Draw the y-axis (vertical) and label it "absorbance." Mark this axis in increments from 0 to the top of the graph paper (the more spread out your graph, the more accurate).
  - b. Draw the x-axis (horizontal) and label it: "concentration: mg/L as NO<sub>3</sub>-N." Mark this axis with the concentration of the standards.
2. Plot the absorbance of the standard concentrations on the graph.
3. Draw a "best fit" straight line through these points. The line should touch (or almost touch) each point. If not, the results are not valid. If just one point is far off the line, run that standard again. If more than one point is very far from the line, re-do the entire set of standards. Adjust for shaking time and method if necessary. See below for examples of a standard curve.

## Nitrate-Nitrogen Standard Curve



Acceptable



Not Acceptable

4. Convert the absorbance readings of each river sample to mg/L: locate the absorbance on the y-axis, read horizontally over to the curve, and then down to read the concentration in mg/L as NO<sub>3</sub>-N.
5. Record the concentrations of your samples in the appropriate "Result" columns on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C). Record the concentrations of your duplicates in the appropriate "Dup." columns on the "Chemical Data Reporting Sheet."
6. Write "standard curve" across all three columns of the "Calibration" section of the "Chemical Data Reporting Sheet" and attach your curve results.

## Disposal

**Rinse the unoxidized cadmium metal from the test tubes into a clearly marked container for toxic waste pickup.** Arrangements should be made with toxic materials handlers for safe disposal.

## An Additional Quality Control Check for the DR890 Colorimeter

Use the "DR/Check ABS Secondary Standards" available from Hach Company to easily verify the performance of the DR890 Colorimeter. They are reusable gel standards consisting of a blank and one standard each for low, mid and high range absorbance values. They are listed in the "Equipment" section of this manual under "Parameter: NO<sub>3</sub>-N and PO<sub>4</sub>-P."



## Background

**What is Orthophosphate?** In aquatic ecosystems, phosphorous occurs mainly in the form of phosphate. Phosphates ( $\text{PO}_4^{-3}$ ) are a plant nutrient found in phosphate containing rocks, soil, and animal wastes. High levels of phosphates can also be found in detergents, cattle feedlot runoff and human sewage effluent. Phosphate is measured in milligrams per liter. Phosphates come in two primary forms: organic and inorganic. Organic phosphate is bound in plants and animals and is not available for plants. Inorganic, or orthophosphate, also known as reactive phosphorous, is the form that is available and required by plants.

**Why Measure Orthophosphate?** In most fresh waters, phosphate is the nutrient in shortest supply and therefore limits the growth of plants. Any human addition of phosphorus can cause great increases in aquatic plant growth which may result in higher water temperatures, unstable dissolved oxygen, changes in habitat and ultimately a decrease in aquatic life.

**Special Considerations:** To analyze the most accurate concentration of phosphorus in your river system, measuring total phosphorus is the best approach. This involves an additional step to the procedures below (digesting your sample with acid). The protocols below test for orthophosphate, the amount available in the water column. This concentration underestimates the total amount of phosphorus in your system. Please contact HBRW if you are interested in testing for total phosphorus.

When testing for orthophosphate, be careful to report your measurement with the appropriate units. You can report it "as  $\text{PO}_4$ " (as phosphate) or "as P" (as phosphorus).

If your kit measures orthophosphate "as  $\text{PO}_4$ ," then you must divide your amount by 3 if you want to report your result "as P." (Phosphorus as the element P has 1/3 the molecular weight of the phosphate  $\text{PO}_4$  compound.)

### Concentrations:

Wastewater: 5-30 mg/L

NYS DEC Standards: For all classes,

"None that will result in growths of algae, weeds, and slime that will impair uses" (no numerical standard).

Guidelines for phosphorus "as  $\text{PO}_4$ ":

Above 0.15 mg/L: impact likely; above 0.3 mg/L: impact certain  
(especially upstream from a pond/lake or slow moving area where algal blooms may be prevalent)



## Analysis

### Tier 2

### Orthophosphate

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat.#
Ascorbic Acid Reduction	Hach color wheel	Use low range: 0-5 mg/L*	0.1	± 10%	Hach #2248-00

\* If your sample range is higher than 5 mg/L, follow instructions that come with the Hach kit to conduct the high range test.

## Procedure

### Prepare for testing

1. Wash ALL glassware with non-phosphate soap, then rinse 3 times with de-ionized water.

### Test a blank

2. Fill the test tubes to the lowest (5 ml) line with deionized water.
3. Open one PhosVer 3 Phosphate Reagent package and add the contents to one of the tubes.
4. Swirl to mix. Wait at least 1 minute, but no longer than 5 minutes, for color to develop.
5. Put the treated tube into the right opening of the color wheel and the untreated tube into the left opening.
6. Hold the color wheel up to a light source and view through the openings in front. Rotate the disc to obtain a color match.
7. The treated tube should match up with zero. Record a "0" in the "Blank" column in the "Calibration" section of the "Chemical Data Reporting Sheet."

### Test a known standard

8. Rinse glassware 3 times with de-ionized water.
9. Fill the test tubes to the lowest (5 ml) line with a known standard. Use a standard between 0.5-3.0 mg/L PO<sub>4</sub>. Record the value of your known standard in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet."
10. Repeat steps 3-6 above.
11. Divide the reading by 10 to obtain the mg/L PO<sub>4</sub>. Record your result in the "Your Result" column in the "Calibration" section of the "Chemical Data Reporting Sheet." Your result should fall within an expected margin of error of +/- 10% of your reading.

### Test a sample

12. Rinse glassware three times with de-ionized water.
13. Fill the test tubes to the lowest (5 ml) line with your sample.
14. Repeat steps 3-6 above. (If your sample range is higher than 5 mg/L, follow instructions that come with the kit to conduct the high range test, 0-50 mg/L. You also need to conduct your standard test again,

- using a standard concentration within the range of your sample).
- Divide the reading by 10 to obtain the mg/L PO<sub>4</sub>. Record your result as mg/L PO<sub>4</sub> in the appropriate "Result" column on the "Chemical Data Reporting Sheet."

**Test a duplicate**

- Rinse glassware 3 times with de-ionized water.
- Fill the test tubes to the lowest (5 ml) line with your sample, using same sample bottle.
- Repeat steps 3-6 above.
- Divide the reading by 10 to obtain the mg/L PO<sub>4</sub>. Record your result as mg/L PO<sub>4</sub> in the appropriate "Dup." column on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).

**When you are finished testing**

- If you have conducted 10 or more analyses per day (including duplicates), test your known standard one more time. Record your result in the "End of Testing" column on the "Chemical Data Reporting Sheet."

**Tier 3 Orthophosphate**

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat.#
Ascorbic Acid Reduction	Hach DR 890 colorimeter, or spectrophotometer	Depends on standard curve; 0-0.2 or 0.2-1.0 mg/L	0.01	± 0.05 *	Hach #48470-00

\* This value is Hach’s reported accuracy of the instrument when reading concentrations. The accuracy of the test should be greater if the procedure below is followed (using a standard curve).

**Summary of Method:** Orthophosphate is measured using the ascorbic acid reduction method with a colorimeter. First, a standard curve is created using known concentrations of standards. This curve is used to convert absorbance readings of field samples into mg/L of orthophosphate. Then the reagent is added to field samples and their absorbance is read using a colorimeter, or a spectrophotometer . The concentration of each sample is found by plotting absorbance on the standard curve and recording the corresponding concentration in mg/L.

**Procedure**

**Prepare Standard Phosphate Concentrations for Standard Curve**

Prepare standard concentrations within the range of your samples. Below are two charts: one for a range of 0-0.2 mg/L as P, the other with a higher range of 0-1.0 mg/L as P. If you have a

higher concentration, make higher concentration standards for your curve. (This will require getting a more concentrated stock solution.)

1. Wash ALL glassware WITHOUT soap, using 6N HCl and then rinse with de-ionized water 3 times.
2. Choose a range appropriate for your studies, 0-0.02 or 0-1.0 mg/L as P.
3. Make a stock of phosphate solution appropriate to the range:
  - a. 0-0.2 mg/L as P: Prepare a 0.25 mg/L stock solution. Using a calibrated volumetric pipet, dispense 25 ml of phosphate solution (1 mg/L as P) into a 100 ml volumetric flask\*. Add de-ionized water until the final volume reads 100 ml. This gives you a final stock concentration of 0.25 mg/L as P. Mix well before pouring into sample cell to analyze.
  - b. 0-1.0 mg/L as P: Pour about 30 ml of the phosphate solution (1 mg/L as P) into a 50 ml beaker.

The equation to calculate final concentration of your stock solution from the 1 mg/L standard solution is:

$$V1 \times C1 = V2 \times C2$$

(V=volume; C=concentration)

Example: (25ml)(1mg/L as P) = (100 ml)(X)

$$X = 0.25 \text{ mg/L as P}$$

\*Volumetric flasks are important to use for mixing standards because of their precision.

4. Set out six 10 ml sample cells. Use calibrated volumetric pipets to transfer corresponding volumes of phosphate stock solution to cells as in the appropriate chart below. Before using each pipet the first time, clear it by filling once with the standard solution and forcing it out. (Do not use your mouth; use a pipet tube.)

	<b>Standard Concentration (mg/L as P)</b>	<b>Volume (ml) of 0.25 mg/L as P Stock Solution</b>
	0.00	0
0-0.2	0.025	1
mg/L as	0.05	2
P range	0.1	4
	0.15	6
	0.20	8

	<b>Standard Concentration (mg/L as P)</b>	<b>Volume (ml) of 1.0 mg/L as P Stock Solution</b>
0-1.0	0.0	0
mg/L as	0.2	2
P range	0.4	4
	0.8	8
	1.0	10

The equation to calculate your own standards is

$$A = BC/D$$

- A: volume of stock solution needed
- B: desired concentration of standard
- C: volume of standard
- D: concentration of stock solution

5. Fill the remainder of each flask or test tube with de-ionized water to the 10 ml line (be precise). Swirl to mix.

### Measure Phosphate of Standards and Samples

1. Measure 10 ml of each sample and your standards into different sample cells.
2. Prepare the colorimeter using the instructions that come with the instrument and adjust it to read for absorbance.
3. Add PhosVer 3 pillows one at a time to your standard concentrations and samples as follows (start with your standard concentrations):
  - a) Add the contents of one PhosVer 3 pillow to the standard or sample. Cover with parafilm (very tightly) or a Teflon screw cap.
  - b) Shake for fifteen seconds.
  - c) Wait 2 minutes to proceed. The DR 800 series colorimeter has a timer programmed into its function. See instrument instructions.
4. Add the contents of one PhosVer3 pillow to your 0.0 standard. This is your blank; use it to zero the colorimeter for all your standards and samples.
5. Read the ABSORBANCE of each standard and sample as follows:
  - a) Wipe the sample cell with a kimwipe.
  - b) Insert sample cell correctly into the colorimeter and cover.
  - c) Read the absorbance by pressing the READ key and record.

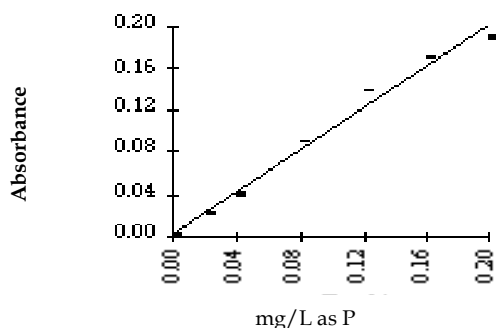
**NOTE:** If your samples have high turbidity, it may affect the results. Measure and record the absorbance of a sample without reagent added (shake the sample well before measuring). Subtract this value from the absorbance readings you obtain for each sample you measure with reagent. This will factor out the effect of sample turbidity on your results.

### Prepare a Calibration Curve and Convert Absorbance to mg/L

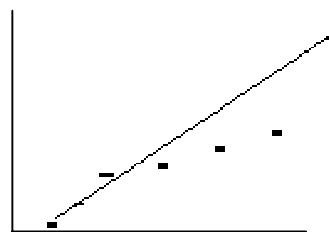
1. Make an absorbance versus concentration graph on graph paper:
  - a. Draw the y-axis (vertical) and label it "absorbance." Mark this axis in increments from 0 to the top of the graph paper (the more spread out your graph, the more accurate).
  - b. Draw the x-axis (horizontal) and label it "concentration: mg/L as P." Mark this axis with the concentration of the standards.

- Plot the absorbance of the standard concentrations on the graph.
- Draw a "best fit" straight line through these points. The line should touch (or almost touch) each of the points. If it does not, the results of this procedure are not valid. If just one point is far off the line, run that standard again. Run the entire set of standards again if more than one point is far from the line. See examples of standard curves below.

### Phosphorus Standard Curve



Acceptable



Not Acceptable

- Convert absorbance of each field sample reading to mg/L: Locate the absorbance on the y-axis, read horizontally over to the curve, and then down to read the concentration in mg/L as P. NOTE: The detection limit for this test is 0.01 mg/L. Report any results less than 0.01 mg/L as "<0.01." Round off all results to the nearest hundredth.
- Record the concentrations of your samples in the appropriate "Result" columns on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C). Record the concentrations of your duplicates in the appropriate "Dup." columns on the "Chemical Data Reporting Sheet."
- Write "standard curve" across all three columns of the "Calibration" section of the "Chemical Data Reporting Sheet" and attach your curve results.

**Important Note:** If you have samples that have a higher concentration than any of your standards, make a standard that is a higher concentration to extend your graph.

### An Additional Quality Control Check for the DR890 Colorimeter

Use the "DR/Check ABS Secondary Standards" available from Hach Company to easily verify the performance of the DR890 Colorimeter. They are reusable gel standards consisting of a blank and one standard each for low, mid and high range absorbance values. They are listed in the "Equipment" section of this manual under "Parameter: NO<sub>3</sub>-N and PO<sub>4</sub>-P."



## Background

**What is Conductivity?** Conductivity is a measure of the ability of water to pass an electrical current. Conductivity is affected primarily by the geology of the area through which the water flows and the presence of naturally occurring electrolytes, such as salts. It is measured as micromhos/centimeter ( $\mu\text{mhos/cm}$ ) or microsiemens per centimeter ( $\mu\text{S/cm}$ ).

**Why measure Conductivity?** Each river tends to have a relatively consistent range of conductivity that, once established, can be used as a baseline for comparison with regular measurements of conductivity. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a river. A failing septic system, heavy metals, chloride, phosphates and nitrates would all raise the conductivity while an oil spill would lower it.

**Levels:** The conductivity of freshwater rivers ranges greatly from 50-1,500  $\mu\text{S/cm}$ . Estuaries have a higher conductivity than freshwater due to their salinity.

## Analysis

### Tiers 2-3

### Conductivity

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat.#
Measured directly	Conductivity meter	0-1999 micro-siemens/cm	1	$\pm 20\%$	No particular brand to recommend at this time

Note: Conductivity values are affected by the temperature of the solution being measured. Your conductivity meter should have an automatic temperature compensation feature that compensates for temperature variations during calibration and measurement procedures. However, for optimum accuracy, it is often best to make sure that calibration standards and sample solutions are at the same temperature, preferably 25°C. See the instructions of your instrument for more information.

## Procedure

### Prepare for testing

1. Wash all glassware with non-phosphate soap, then rinse 3 times with de-ionized water.

**Calibrate the meter**

2. Calibrate the meter according to instructions that come with the instrument. Use a conductivity standard between 50-500 microsiemens/cm.
3. Record the value of the standard you use in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet." Record your result from measuring the standard in the "Your Result" column.

**Test a sample**

4. Rinse glassware and electrode 3 times with de-ionized water.
5. Analyze sample according to instructions that come with the instrument.
6. Record the conductivity value under the appropriate "Result" column on the "Chemical Data Reporting Sheet."

**Test a duplicate**

7. Rinse glassware and electrode 3 times with de-ionized water.
8. Repeat test with another sample from the same container.
9. Record result in the appropriate "Dup." column on the "Chemical Data Reporting Sheet." Analyze one duplicate per day (QAQC Level A) or one duplicate per 20% of samples per day (QAQC Levels B & C).

**Test more samples**

10. Rinse glassware and electrode 3 times with de-ionized water.
11. Repeat test with more samples. If the meter has to be turned back on, or if you have moved to another site, re-calibrate the meter before conducting more tests. Also re-calibrate once you have tested 10 samples (including duplicates), if you plan on continuing testing. Use the "End of Testing" column on the "Chemical Data Reporting Sheet" to record the result of re-calibration.

**When you have finished testing**

12. Make sure you remember to turn the meter off.
13. Store the meter and care for the electrode according to instructions that come with the instrument.



## Background

**What is Turbidity?** Turbidity is a measure of the scattering of light by particles suspended in water. Turbidity is one way to measure water clarity. It is expressed in terms of nephelometric units (NTU's) as it is measured by a nephelometer or turbidimeter.

**Why measure Turbidity?** Turbidity is important as an indicator of suspended sediment and its effects on sedimentation over time and distance. Elevated turbidity can affect the river ecosystem in a number of ways, including higher water temperatures, reducing available oxygen. Suspended materials can clog fish gills and provide a place for harmful microorganisms to breed and carry attached pollutants. Particle settling can decrease the amount and type of habitat available for aquatic macroinvertebrates.

**Levels:** Background turbidity levels vary from < 1.0 NTU to > 50 in larger rivers after a rainfall.

NYS DEC Standards: For all classes, "no increase that will cause a substantial visible contrast to natural conditions."

## Analysis

### Tiers 2-3 Turbidity

Analysis Method	Test Apparatus	Range	Increments	Accuracy	Company/Cat.#
Direct measurement OR Absorptometric Method*	Hach 2100P portable turbidimeter OR Hach DR890 colorimeter*	0-1000 NTU OR 0-1000 FAU	0.01	± 2% plus stray light (< 0.02 NTU) OR ± 2 FAU	Hach #46500-00 OR Hach #48470-00

\* This method cannot be used to report findings to the EPA because it measures turbidity in FAU's, not NTU's. However, it can be used to determine if there is an increase in turbidity that causes "a substantial visible contrast to natural conditions," which is currently all that New York State has as a standard for turbidity.

## Procedure - Turbidimeter

### Choose and orient the sample cell

Select one of the three sample cells provided with the meter. Use this cell for all of the samples. Each side of this sample cell may have different optical properties that will



yield different turbidity readings. To correct for this, test each cell by rotating it 45 degrees and recording the turbidity reading after each rotation. Place a mark on the side that yields the lowest turbidity reading. Each time you use this cell to measure a sample, place it in the meter with this mark aligned with the raised mark on the meter. Follow the directions in the manual to find the proper orientation of all three sample cells.

### **Calibrate the meter**

The meter is calibrated at the factory when it is new. After your first sampling season, you should re-calibrate the meter at the beginning of every season. To calibrate, use formazin solution.

1. Make up formazin dilutions of 800, 100, and 20 NTU using the 4000 NTU stock solution as described in the Hach manual (provided with the meter).
2. Calibrate the meter using steps in the Hach manual.
3. Keep a record of the dates that you calibrate the meter.
4. Write “calibrated” across all three columns of the “Calibration” section of the “Chemical Data Reporting Sheet.”

### **Determine the true value of the Gelex Standards**

At the beginning of every sampling season, after calibrating the meter, determine the NTU value of the Gelex standards again. The next time you use the meter in the same sampling season, you do not have to re-calibrate it, but you must determine the NTU value of the Gelex standards. These are used every time you use the meter to check if it has drifted from its calibration.

1. Measure the turbidity of each of the three Gelex standards, following the procedure in the Hach manual.
2. Record these values IN PENCIL in the white diamonds on each standard.

### **Test a sample**

1. Check the calibration of the meter by measuring the NTUs of the Gelex standards. If they are off by more than 5% from the values you marked after the last calibration you will need to re-calibrate the meter using the calibration procedure outlined above.
2. Allow sample to come to room temperature.
3. Prepare the sample cell by applying a thin coating of silicone oil with a soft, lint-free cloth. (This masks any scratches, which the meter would read as turbidity).
4. GENTLY turn over the sample bottle several times to mix the sample. Do not shake the sample – air bubbles are read by the meter as turbidity.

5. Gently and slowly fill a sample cell to the fill line (15 ml) with a portion of the sample. If you must handle the sample cell, handle it only at the top to avoid smudging the lower part of the cell (which the meter would read as turbidity). Cap the cell.
6. Check the sample in the cell for air bubbles and condensation. If there are air bubbles, uncap it and let it sit for a few moments before measuring. If the air bubbles persist, try refilling the sample cell more slowly. If they still persist, use the degassing kit to remove them. If condensation forms on the outside of the cell, wipe it off with a Kimwipe or lint-free cloth. If it immediately reforms, allow the sample to come to room temperature.
7. Set the meter to "auto range" (see page 28 of the Hach manual).
8. Insert the sample cell into the turbidimeter and line up the orientation mark on the cell with the raised tab on the meter. Record the reading in the appropriate "Result" column of the "Chemical Data Reporting Sheet." Remove the sample cell from the meter and pour it out.
9. Rinse the sample cell 3 times with de-ionized water and shake out remaining water drops inside the cell.

#### **Test a duplicate**

10. Repeat steps 4-9 using a sample from the same bottle. Record the reading in the appropriate "Dup." column of the "Chemical Data Reporting Sheet."

#### **Test more samples**

11. Repeat steps 4-9 (and 10 if testing more duplicates). If the meter has to be turned back on, or if you have moved to another site, check the calibration of the meter by measuring the NTU's of the Gelex standards. If they are off by more than 5% from the values you marked after the last calibration you will need to re-calibrate the meter using the calibration procedure outlined above. Also determine the NTU value of the Gelex standards once you have tested 10 samples (including duplicates), if you plan on continuing testing. Make a note such as "Gelex OK" in the "End of Testing" column on the "Chemical Data Reporting Sheet."

#### **When you are finished testing**

12. Remove the sample cell from the meter and remember to turn it off.

**NOTE:** If the turbidity of the sample is above 40 NTU, it must be diluted and read again. Follow the instructions in the Hach manual to do this.

## Procedure - Colorimeter

The Hach DR700 or 800 series colorimeters have been calibrated using formazin, the primary standard for turbidity. Check the accuracy of your instrument by measuring the turbidity of a known 200 FAU formazin solution as if it were an unknown sample:

1. Prepare the colorimeter for the turbidity test using the instrument's instructions.
2. Fill a sample cell with 10 ml of deionized water. Wipe this blank with a Kimwipe.
3. Zero the instrument by placing your blank into the cell holder, covering it with the instrument cap, and pressing ZERO.
4. Fill a sample cell with 10 ml of your 200 FAU standard. Wipe the standard with a Kimwipe. Record 200 in the "Actual Value" column in the "Calibration" section of the "Chemical Data Reporting Sheet."
5. Read the turbidity of your standard by placing it into the cell holder, covering it with the instrument cap, and pressing READ. Record your result from measuring the standard in the "Your Result" column in the "Calibration" section of the "Chemical Data Reporting Sheet."
6. If the value of the known solution does not read 200 FAU, the colorimeter's built in calibration curve needs adjusting. Follow the instructions in the instrument's manual to adjust the curve.

To measure the turbidity of your unknown river samples, repeat the same procedure above, using your blank to zero the instrument and your unknown samples instead of the known standard.



# REPORTING AND USING DATA

---

## Data for DEC Use

DEC incorporates information from monitoring groups into the "Waterbody Inventory/Priority Waterbody List" (WI/PWL). The WI/PWL is an inventory database of water quality information for all waterbodies in New York State. The PWL is a subset of the database that is limited to segments with well-documented water quality issues and problems. Data is not published in the WI/PWL; information regarding uses supported by data and reviewed through the PWL update process is incorporated.

Waterbodies listed in the WI/PWL are described by their "severity of use impairment." The severity of water quality problems depends on the how much the known water quality impacts are affecting a waterbody's uses:

### PWL Severity of Use Impairment

**PRECLUDED:** *Frequent/persistent* water quality/quantity conditions and/or associated habitat degradation *prevent all aspects* of the waterbody use.

**IMPAIRED:** *Occasional* water quality/quantity conditions and/or habitat characteristics *periodically prevent* the use of the waterbody, or *limit some aspects* of the uses. Or *frequent* water quality/quantity conditions and/or habitat degradation *discourage* the use of the waterbody.

**STRESSED:** Waterbody uses are not significantly limited but *occasional* water quality/quantity conditions and/or habitat *degradation periodically discourage* the use of the waterbody.

**THREATENED:** Water quality currently supports waterbody uses and the ecosystem exhibits no obvious signs of stress. However, *existing or changing land use patterns* may result in restricted use or ecosystem disruption, *monitoring data reveals increasing contamination*, or support of *specific/distinctive use(s)* makes the waterbody more susceptible to threats.

Aquatic life is considered a waterbody use for all class A-C waters. If a condition affects the macroinvertebrate community in a class A-C waterbody, a waterbody use is impacted. The four levels of use impairment in the PWL described above roughly correspond to the four levels of impact used in the Biotic Index and EPT Richness metrics from the BMI analyses in this manual:

PWL Severity of Water Quality Problem	Biotic Index/EPT Richness Level of Impact
Precluded	Severely Impacted
Impaired	Moderately Impacted
Stressed/Threatened	Slightly Impacted
No Known Impact	No Impact

The PWL identifies three possible levels of problem documentation:

**PWL Level of Problem Documentation**

**KNOWN:** Water quality studies have been completed by DEC and conclude that the use of the waterbody is restricted to the degree indicated by the listed severity.

**SUSPECTED:** Reasonably strong evidence, supported by best professional judgment of DEC staff, suggests the use of the waterbody is restricted/impacted. However, water quality studies that establish an impairment have not been completed by DEC or there is conflicting information.

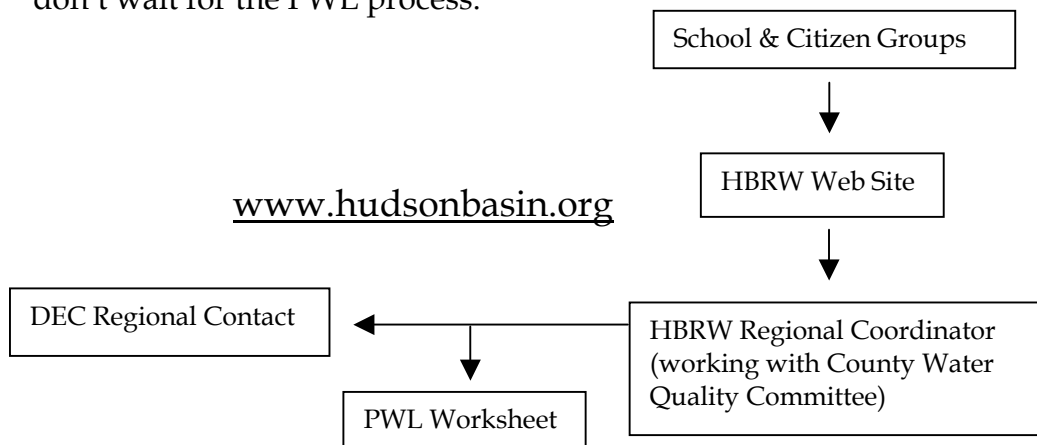
**POSSIBLE:** Anecdotal evidence, public perception and/or specific citizen complaints indicate that the use of the waterbody may be restricted. Land use or other activities in the watershed are such that the use of the waterbody could be affected. However, there is currently very little, if any, documentation of an actual water quality problem.

These levels of problem documentation roughly correspond to the tiers in this manual (see Step 3, "Define Your Data Uses and Users," in the "Designing Your River Study" section of this manual for more information).

Tier 1 studies might suggest "possible" impacts that need further verification. Tier 2 studies can document "suspected" impacts, if confirmed by Tier 3 methods or DEC. Tier 3 studies can document "known" impacts, depending on the level of QAQC employed and whether or not there is conflicting information.

## Reporting Your Data

Data flows from HBRW groups to DEC via the HBRW Regional Coordinators and County Water Quality Committees. Groups can input their data into the HBRW web site, and/or send their data to their HBRW Regional Coordinator. HBRW Regional Coordinators review the data, perhaps ask groups for clarification, and use it to fill out DEC's PWL Worksheet (included at the end of this section). The HBRW Regional Coordinator should work closely with their County Water Quality Committee and DEC regional contact to follow up on questions, concerns, and verifications. If there is an immediate problem that needs to be addressed, notify your DEC regional contact - don't wait for the PWL process.



NYSDEC - DIVISION OF WATER  
**WATERBODY INVENTORY and  
 PRIORITY WATERBODIES LIST (PWL) WORKSHEET**

Date \_\_\_\_\_

**WATERBODY LOCATION INFORMATION**

Segment ID \_\_\_\_\_

- |   |   |
|---|---|
| 1. Waterbody Name _____                               | 9. Waterbody Classification _____         |
| 2. Waterbody Type _____                               | 10. County (primary) _____                |
| 3. Water Index Number (WIN) _____                     | 10a. Additional Counties _____            |
| 4. Drainage Basin and Sub-basin _____                 |   |
| 5. Hydrologic (Watershed) Unit Code _____ / _____     | 11. NYSDEC Region _____                   |
| 6. Flow Category (if river segment) _____             | 12. Quad Map _____                        |
| 7. Affected Length/Area _____ Units (mi, acres) _____ | 12a. Quad Num __ - __ - __ More Quads? __ |
| 8. Describe Waterbody Segment _____                   |   |

(see *Waterbody Inventory*, if available)

**WATER QUALITY PROBLEM INFORMATION**

13. Use Impairment/Severity of Water Quality Problem *Select all that apply*

**Waterbody Uses**

Indicate precluded, impaired, stressed or threatened (P,I,S,T)

**Problem Documentation**

Known Suspected Possible

Water Supply (Class A, AA, GA)	_____	_____	_____	_____
Shellfishing (Class SA)	_____	_____	_____	_____
Public Bathing (Class B, SB or above)	_____	_____	_____	_____
Fishing Consumption	_____	_____	_____	_____
Aquatic Life (Class C, SC or above)	_____	_____	_____	_____
Recreation	_____	_____	_____	_____
Natural Resources Habitat/Hydrology	_____	_____	_____	_____
Aesthetics	_____	_____	_____	_____

14. Type of Pollutant(s) Select all that apply. Indicate as *known* (K), *suspected* (S), or *possible* (P). **Circle Major pollutant t (i.e., those contributing to most severe use impacts/impairment); others are considered Minor.**

**CHEMICAL CAUSES**

- |                     |                        |                             |
|---------------------|------------------------|-----------------------------|
| _____ Nutrients     | _____ Metals           | _____ Pesticides            |
| _____ Ammonia       | _____ Acid/Base (pH)   | _____ Priority Organics     |
| _____ Chlorine      | _____ Salts            | _____ Non-Priority Organics |
| _____ Unknown Toxic | _____ Other Inorganics | _____ Oil and Grease        |

**BIOLOGICAL CAUSES**

- |                 |                       |                          |
|-----------------|-----------------------|--------------------------|
| _____ Pathogens | _____ Problem Species | _____ Species Alteration |
|-----------------|-----------------------|--------------------------|

**PHYSICAL CAUSES**

- |                          |                        |                                     |
|--------------------------|------------------------|-------------------------------------|
| _____ D.O./Oxygen Demand | _____ Thermal Changes  | _____ Restricted Passage            |
| _____ Siltation/Sediment | _____ Water Level/Flow | _____ Aesthetics (float, odor, etc) |

\_\_\_\_\_ **OTHER CAUSES** \_\_\_\_\_





**RESOLUTION/MANAGEMENT INFORMATION** Private citizens need not complete.

**18. Resolvability** Select one

- Needs Verification/Study (see *Status of Problem Verification/Study*)
- Strategy Exists, Funding/Resources Needed
- Strategy Being Implemented
- Problem Not Resolvable (technical/economic)
- Problem Not Resolvable (natural condition)
- Problem Thought to be Abated
- Problem Abated, Waterbody Deleted from PWL
- No Known Use Impairment

**19. Status of Problem Verification/Study** Select one

- Waterbody Nominated, but Problem Not Verified
- Problem Verified/Documented, Cause Unknown
- Cause of Problem Identified, Source Unknown
- Source of Problem Identified, Management Strategy Needed
- Management Strategy has been Developed

**20. Lead Agency/Office:** \_\_\_\_\_ **21. Resolution Potential** (High, Med, Low): \_\_\_\_\_

**22. TMDL Note**

Impaired Waterbody, TMDL Development Required

High Priority for TMDL Development

Multiple Segment/Categorical TMDL Waters

Acid Rain Waters

Fish Consumption Waters

Restricted Shellfishing Waters.

Water Requiring Re-evaluation

Impaired Waterbody, TMDL Development NOT Required

TMDL Complete, being Implemented

Impairment Due to *Pollution*, Not *Pollutant(s)*

Other Controls More Appropriate than TMDL.

## Stewardship Project Ideas

Once you've gotten to know your watershed, learned about your river's uses, values and threats, and examined its physical habitat, benthic macroinvertebrate community and/or water quality, there are many activities you can do to protect and/or improve your river's health. The following list of possible stewardship projects are just suggestions to get you inspired. If you come up with other ideas, please share them with your HBRW Regional Coordinator so we can pass them on to others.

- *Conduct a river clean-up* to pick up trash along the banks of a section of your river. Contact Scenic Hudson (845-473-4440) to coordinate with their "Great Hudson River Sweep" event that they hold every spring.
- *Label storm drains* in your neighborhood that drain into your river. Stencils or decals with messages such as "Dump No Waste, Drains to River" may be available from your county Soil and Water Conservation District, Environmental Management Council, or Planning Department.
- *Produce a brochure* describing your river and its watershed, explaining what people can do to help protect it. Contact your HBRW Regional Coordinator for examples of existing public information brochures.
- *Organize a community "Stream Team"* to do regular shoreline surveys along a length of your river to keep an eye on potential problems that might threaten your river's health.
- *Build an interpretive trail* along your river to provide local residents with an opportunity to learn more about its natural and cultural history while hiking along its shoreline.
- *Survey local residents and businesses* in your watershed to find out if they carry out river-friendly practices, such as proper septic system maintenance, natural lawn and garden care, water conservation, and use of non-toxic household products. Collect information about how to adopt these practices and provide them to your community members.
- *Plant native riparian trees, shrubs and herbaceous plants* in areas along your stream where the banks are bare and eroding. Contact your local Soil and Water Conservation District for technical advice and plant sources.
- *Put up river identification signs* at road crossings or public parks to let the public know of your river and that there are people out there who care about its well-being. (You'll need permission from the agency that maintains the road or park). Hold an art contest for choosing the design to encourage greater involvement in the project.
- *Organize a "Test Your Water Day"* in your town where community residents can bring in samples of their drinking water or samples from their backyard ponds and streams for you to test. Make it a part of a regular, well-attended community event to increase your chances of a good turnout.

- *Keep track of new developments* in your town to make sure they are following required DEC and local government regulations for managing storm water runoff.
- *Make presentations at public meetings*, to town boards and planning boards, to encourage them to consider healthy rivers and clean water in their permitting decisions.

## Using Data at the Local Level

Remember that often the most effective use of your data can be at the local level. Share your data with the leaders and landowners of the towns, cities and/or counties that comprise your watershed; they are the true resource managers. Schedule a time for your group to make a presentation at a town meeting so you can share what you've learned about your river with members of your community. Municipal planning boards make land use decisions on a regular basis that may affect your river. Presenting information to your planning board can help encourage them to consider your river's protection when they make decisions about developments in the watershed.



# EQUIPMENT LIST

Tier	Company	Item	Catalog #	*Each \$
<b>Parameter: Alkalinity</b>				
2	LaMotte	total alkalinity microburet kit & reagents	4491-DR	21.10
3	Hach	alkalinity digital titrator kit & reagents	20637-00	153.90
3	Hach	alkalinity standard, 50 mg/L CaCO <sub>3</sub> , 946 ml	21277-16	38.60

## Parameter: Conductivity

2, 3	Hach	conductivity standard, 1000 microsiemens/cm, 100ml	14400-42	7.20
2, 3		conductivity meter, no particular brand to recommend		

## Parameter: Nitrate-Nitrogen (NO<sub>3</sub>-N)

2	LaMotte	zinc reduction kit & reagents	3354	39.95
3	Hach	nitrate reagents for DR/890 (contains cadmium)	21061-69	22.00
3	Hach	nitrate reagents for DR/890 (cadmium free)	26053-45	45.36
2, 3	Hach	nitrate standard, 100 mg/L NO <sub>3</sub> -N, 20 2-ml ampules	1947-20	20.25
2, 3	Hach	nitrate standard, 5 mg/L NO <sub>3</sub> -N, 16 10-ml ampules	25578-10	32.80
2, 3	Hach	nitrate standard, 10 mg/L NO <sub>3</sub> -N, 500 ml	307-49	11.85

## Parameter: Orthophosphate (PO<sub>4</sub>)

2	Hach	orthophosphate color wheel kit & reagents	2248-00	54.50
3	Hach	orthophosphate reagents for DR890	21060-69	20.00
2, 3	Hach	phosphate standard, 50 mg/L PO <sub>4</sub> , 16 10-ml ampules	171-10	30.25
2, 3	Hach	phosphate standard, 1 mg/L PO <sub>4</sub> (1 mg/L as P), 500 ml	2569-49	13.80

## Parameter: NO<sub>3</sub>-N and PO<sub>4</sub>-P

3	Hach	DR/890 Colorimeter	48470-00	749.00
3	Hach	sample cells, 10 ml, pkg 6 (you may need 2-3 pkgs)	24276-06	15.50
3	Hach	DR/Check ABS Secondary Standards	27639-00	97.00
3	Hach	TenSette Pipet, 1 to 10 ml	19700-10	154.00
3	Hach	volumetric flask, 100 ml, class A	14574-42	20.00
3	Hach	HCl, 6N, 500 ml	884-49	11.30
3	Hach	kimwipes	20970-00	3.25

## Parameter: Oxygen, Dissolved

2	LaMotte	oxygen microburet kit & reagents	5860	37.00
3	Hach	oxygen digital titrator kit & reagents	20631-00	190.75

## Parameter: pH

1	VWR	pH strips	EM-9590-3	
1	LaMotte	pH wide range test kit & reagent	5858	
2, 3	Hach	pH Testr 2	27235-00	79.00
2, 3	Hach	pH 7 buffer, 500 ml	22835-49	6.75

## Parameter: Turbidity

2,3	Hach	2100 Portable Turbidimeter & standards	46500-00	775.00
-----	------	--	----------	--------

Tier	Company	Item	Catalog #	Each \$
------	---------	------	-----------	---------

**Parameter: BMI**

1, 2, 3	WildCo	net, 18" wide, 800-900 micron	425-A50	151.00
2, 3	Ben Meadows	forceps, curved-fine point	300235	3.26
2, 3	Herbach & Rademan	lighted magnifier	MG-104	69.95
2, 3	VWR Scientific	lamp for lighted magnifier	36935-121	
2, 3	VWR Scientific	sieve, #28 U.S. standard	57320-646	28.40
2, 3	VWR Scientific	white trays, 18"x13"x3/4"	62686-363	7.01
2, 3	VWR Scientific	labeling tape, white	36425-023	2.03
2, 3	VWR Scientific	petri plates, 4 compartment, case 500	25380-069	148.07
2, 3	VWR Scientific	glass vials (for preserving), poly-seal caps, case 500	66021-533	133.45
2, 3	VWR Scientific	Ethyl alcohol, 95%, 4 L (VWR or local Hardware Store)	mk701808	77.50
OPT	Ben Meadows	multiplate samplers	244284	26.00
OPT	Brock Optical	The Magiscope, 20x magnification, with "Lumorod"	model 70	119.00
OPT	Brock Optical	field case for Magiscope		24.00
OPT	QC Services	dissecting scope, 56X, built-in light source	MCB10	600.00
OPT	CT Valley Biological	magnifying specimen box, 1"	AP36	0.84
OPT	CT Valley Biological	magnifying specimen box, 1.5"	AP37	1.68
OPT	CT Valley Biological	folding pocket magnifier	AP38	2.40
OPT	CT Valley Biological	mini aquarium	A2118	15.00
OPT	CT Valley Biological	deep well projection slides	AP120	45.00
OPT	Nylon Net	seine, 3/16" mesh, 10'x4'	AS3164	23.20
OPT	WildCo	sieve bucket	190-E20	65.30

**Parameter: General**

1, 2, 3	Ben Meadows	tape measure, 100"/30m	122632	30.25
1, 2, 3	Dick's Sporting Goods	hip waders		19.99
1, 2, 3	Hach	thermometer, (alcohol filled) 20-105°C, armored	1877-01	12.50
2, 3	Hach	goggles, safety, vented	25507-00	5.00
2, 3	Hach	wash bottle, 500 ml (for DI water and ETOH)	620-11	4.25
2, 3	Hach	bottles, 250 ml, pkg 12 (for sampling and waste)	14724-56	30.00
2, 3	LaMotte	bottles, 60 ml, with squeeze top	0688	2.00
OPT	VWR Scientific	gloves, neoprene, shoulder length, for deep water	EW9-430	27.48
OPT	Hach	gloves, nitrile, forearm length, for cold water sampling	24101	4.00
2, 3	Hach	gloves, latex, medium	25904-02	24.00
2, 3	Hach	de-ionized water, 4 L	272-56	16.10
2, 3	LaMotte	DO/temperature sampler	3-0026	99.00
2, 3	Radio Shack	batteries for pH meter	23-115	

OPT = Optional

\*Prices are not current

---

Company Phone Numbers

Ben Meadows 800-241-6401  
 Brock Optical 800-780-9111  
 Chemetrics 800-356-3072  
 CT Valley Biological 800-628-7748  
 Dick's Sporting Goods 845-297-4767  
 Hach 800-227-4224

Herbach & Rademan 800-848-8001  
 LaMotte 800-344-3100  
 Nylon Net 800-238-7529  
 VWR Scientific 800-932-5000  
 WildCo 800-799-8301

---