New Hampshire Volunteer River Assessment Program
2006 Pennichuck Brook Water Quality Report

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State of New Hampshire
Department of Environmental Services
Water Division
Watershed Management Bureau
P.O. Box 95
29 Hazen Drive
Concord, New Hampshire 03302-0095
www.des.nh.gov

Thomas S. Burack
Commissioner

Harry T. Stewart
Director
Water Division

Prepared By:

Ted Walsh
Jen Drociak
Katie Zink

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Cover Photo: Volunteers collect a water sample in the Pennichuck Brook watershed

TABLE OF CONTENTS

List of Figures and Tables

List of Appendices

ACKNOWLEDGEMENTS

The New Hampshire Department of Environmental Services Volunteer River Assessment Program extends sincere thanks to the volunteers of the Pennichuck Brook VRAP Group and the Nashua Regional Planning Commission for their efforts during 2006. This report was created solely from the data collected by the volunteers listed below. Their time and dedication is an expression of their genuine concern for local water resources and has significantly contributed to our knowledge of river and stream water quality in New Hampshire.

2006 Pennichuck Brook Watershed Water Quality Monitors

Brendan O'Shaughnessey

Paul Johnson

Rob Polys

Minda Henderson

1.0 INTRODUCTION

1.1. Purpose of Report

Each year the New Hampshire Volunteer River Assessment Program (VRAP) prepares and distributes a water quality report for each volunteer river monitoring group that is based solely on the water quality data collected by that group during a specific year. The reports summarize and interpret the data, particularly as they relate to New Hampshire's surface water quality standards, and serve as a teaching tool and guidance document for future monitoring activities by the individual volunteer groups.

1.2. Report Format

Each report includes the following:

- **Volunteer River Assessment Program (VRAP) Overview**

  This section includes a description of the history of VRAP, the technical support, training and guidance provided by NHDES, and how data is transmitted to the volunteers and used in surface water quality assessments.

- **Monitoring Program Description**

  This section provides a description of the volunteer group's monitoring program including monitoring objectives as well as a table and map showing sample station locations.

- **Results and Recommendations**

  Water quality data collected during the year are summarized on a parameter-by-parameter basis using (1) a data summary table that includes the number of samples collected, data ranges, the number of samples meeting New Hampshire water quality standards, and the number of samples adequate for water quality assessments at each station, (2) a discussion of the data, (3) a river graph showing the range of measured values at each station and (4) a list of applicable recommendations.

  Sample results reported as less than the detection limit were assumed equal to one-half the detection limit on the river graphs. This approach simplifies the understanding of the parameter of interest, and specifically helps one to visualize how the river or watershed is functioning from upstream to downstream. In addition, this format allows the reader to better understand potential pollution areas and target those areas for additional sampling or environmental enhancements. Where applicable, the river graph also shows New Hampshire surface water quality standards or levels of concern for comparison purposes.

- **Appendix A – Water Quality Data**

  This appendix includes a spreadsheet detailing the data results and additional information such data results which do not meet New Hampshire surface water quality standards, and data that is unusable for assessment purposes due to quality control requirements.

- **Appendix B – Interpreting VRAP Water Quality Parameters**

  This appendix includes a brief description of water quality parameters typically sampled by VRAP volunteers and their importance, as well as applicable state water quality criteria or levels of concern.

- **Appendix C – Glossary of River Ecology Terms**

  This appendix contains a list of terms commonly used when discussing river ecology and water quality.

- **Appendix D – Native Shoreland/Riparian Buffer Plantings for New Hampshire**

  This appendix contains a table of over ninety suggested native shoreland/riparian buffer plantings for New Hampshire. The table contains common name(s), Latin name, height, growth rate, rooting, light preference, soil preference, and associated wildlife and food value of each tree, shrub, and groundcover/herbaceous perennial species.

2.0 PROGRAM OVERVIEW

2.1 Past, Present, and Future

In 1998, the New Hampshire Department of Environmental Services established the New Hampshire Volunteer River Assessment Program (VRAP) to promote awareness and education of the importance of maintaining water quality in New Hampshire's rivers and streams. VRAP aims to educate people about river and stream water quality and ecology and to improve water quality monitoring coverage for the protection of water resources. The water quality data collected by VRAP volunteers provides both NHDES and the program participants with invaluable information on the fluctuating conditions in rivers and streams and helps determine where improvements, restoration, or preservation may benefit the river and the communities it supports.

Today, VRAP continues to serve the public by providing services such as technical assistance, training in water quality monitoring protocols, quality assurance/quality control procedures, educational outreach, GIS assistance, and water quality reports. In 2006, VRAP supported 28 volunteer groups on numerous stream and river watersheds throughout the state. During 2006, VRAP volunteers monitored 298 river and stream stations providing over 9,000 water quality parameter measurements useable for Clean Water Act mandated water quality assessments.

2.2 Technical Support

VRAP lends and maintains water quality monitoring kits for volunteer groups throughout the state. The kits contain electronic meters and supplies for "in-the-field" measurements of water temperature, dissolved oxygen, pH, specific conductance (conductivity), and turbidity. These are the core parameters typically measured by volunteers. However, other water quality parameters, such as nutrients (total phosphorus, total Kjeldahl nitrogen, nitrate), metals, chloride and bacteria (*Escherichia coli*), can also be studied by volunteer groups. VRAP can provide limited to funds to assist groups in laboratory analysis. However due to limited VRAP funds, we encourage VRAP groups to pursue other fundraising activities such as association membership fees, special events, in-kind services (non-monetary contributions from individuals and organizations), and grant writing to assist in laboratory fees or the purchase of water quality monitoring equipment.

VRAP typically recommends sampling every other week during the summer, and volunteer groups are encouraged to organize a long-term sampling program in order to begin to determine trends in river conditions. Each year volunteers design and arrange a sampling schedule in cooperation with NHDES staff. Project designs are created through a review and discussion of existing water quality information, such as known and perceived problem areas or locations of exceptional water quality. The interests, priorities, and resources of the partnership determine monitoring locations, parameters, and frequency.

Water quality measurements repeated over time create a picture of the fluctuating conditions in rivers and streams and help to determine what trends in water quality may be occurring. Water quality results are also used to determine if a river is meeting surface water quality standards. Volunteer monitoring results, meeting NHDES Quality Assurance and Quality Control (QA/QC) requirements, supplement the efforts of NHDES to assess the condition of New Hampshire surface waters. The New Hampshire Surface Water Quality Regulations are available on-line at www.des.nh.gov/rules/desadmin_list.htm#waterq or by calling (603) 271-1975.

2.3 Training and Guidance

Each VRAP volunteer attends an annual training session to receive a demonstration of monitoring protocols and sampling techniques. Training sessions are an opportunity for volunteers to receive an updated version of monitoring techniques. During the training, volunteers have an opportunity for hands-on use of the VRAP equipment and may also receive instruction in the collection of samples for laboratory analysis. Training is accomplished in approximately two hours, after which volunteers are certified in the care, calibration, and use of the VRAP equipment. In some cases, veteran group coordinators can attend a "train the trainer" session. In these trainings the group coordinator receives an update in sampling protocols and techniques and will then train the individual volunteers of their respective group.

VRAP groups conduct sampling according to a prearranged monitoring schedule and VRAP protocols. NHDES staff from the VRAP program aim to visit each group annually during a scheduled sampling events to verify that volunteers successfully follow the VRAP protocols. If necessary, volunteers are re-trained during the visit, and the group's monitoring coordinator is notified of the result of the verification visit. VRAP groups forward water quality results to NHDES for incorporation into an annual report and state water quality assessment activities.

2.4 Data Usage

2.4.1 Annual VRAP Water Quality Reports

All data collected by volunteers are summarized in annual VRAP water quality reports that are prepared and distributed after the conclusion of the sampling period (typically fall or winter). Each volunteer group receives copies of the report. The volunteers can use the reports and data as a means of understanding the details of water quality, guiding future sampling efforts, or determining restoration activities.

2.4.2 New Hampshire Surface Water Quality Assessments

Along with data collected from other water quality programs, specifically the State Ambient River Monitoring Program (ARMP), applicable volunteer data are used to support periodic NHDES surface water quality assessments. VRAP data are entered into NHDES's Environmental Monitoring Database (EMD) and are ultimately uploaded to the Environmental Protection Agency's database. Assessment results and the methodology used to assess surface waters are published by NHDES every two years (i.e., Section 305(b) Water Quality Reports) as required by the federal Clean Water Act. The reader is encouraged to log on to the NHDES web page to review the assessment methodology and list of impaired waters www.des.nh.gov/wmb/swqa/.

2.5 Quality Assurance/Quality Control

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

- **Calibration:** Prior to each measurement, the pH and DO meters must be calibrated. Conductivity and turbidity meters are checked against a known standard before the first measurement and after the last one.

- **Replicate Analysis:** A second measurement by each meter is taken from the original sample at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the replicate analysis should be conducted at different stations. Replicates should be measured within 15 minutes of the original measurements.

- **6.0 pH Standard:** A reading of the pH 6.0 buffer is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the 6.0 pH standard check should be conducted at different stations.

- **Zero Oxygen Solution:** A reading of a zero oxygen solution is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the zero oxygen standard check should be conducted at different stations.

- **DI (De-Ionized) Turbidity Blank**: A reading of the DI blank is recorded at one of the stations during the sampling day. If the same sampling schedule is used throughout the monitoring season, the blank check should be conducted at different stations.

- **End of the Day Conductivity and Turbidity Meter Check:** At the conclusion of each sampling day, the conductivity and turbidity meters are re-checked against a known standard.

2.1.1 Measurement Performance Criteria

Precision is calculated for field and laboratory measurements through measurement replicates (instrumental variability) and is calculated for each sampling day. The use of VRAP data for assessment purposes is contingent on compliance with a parameter-specific relative percent difference (RPD) as derived from equation 1, below. Any data exceeding the limits of the individual measures are disqualified from surface water quality assessments. Table 1 shows typical parameters studied under VRAP and the associated quality control procedures.

(Equation 1)

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100 \ \%$$

where x_1 is the original sample and x_2 is the replicate sample

Table 1. Field Analytical Quality Controls

Water Quality Parameter	QC Check	QC Acceptance Limit	Corrective Action	Person Responsible for Corrective Action	Data Quality Indicator
Temperature	Measurement Replicate	RPD < 10% or Absolute Difference <0.8 C.	Repeat Measurement	Volunteer Monitors	Precision
Dissolved Oxygen	Measurement Replicate	RPD < 10%	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Known Buffer (Zero O_2 Sol.)	RPD < 10% or Absolute Difference <0.4 mg/L	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Relative Accuracy
pH	Measurement Replicate	RPD < 10% or Absolute Difference <0.3 pH units	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Known Buffer (pH = 6.0)	± 0.1 std units	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Accuracy
Specific Conductance	Measurement Replicate	RPD < 10% or Absolute Difference <5µS/cm	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Method Blank (Zero Air Reading)	± 5.0 µS/cm	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Accuracy
Turbidity	Measurement Replicate	RPD < 10% or Absolute Difference <0.5 NTU	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Precision
	Method Blank (DI Water)	± 0.1 NTU	Recalibrate Instrument, Repeat Measurement	Volunteer Monitors	Accuracy
Laboratory Parameters	Measurement Replicate	RPD < 20% or Absolute Difference less than ½ the mean value of the parameter in NHDES's Environmental Monitoring Database	Repeat Measurement	Volunteer Monitors	Precision

3.0 METHODS

During the summer of 2005, volunteers from the Pennichuck Brook VRAP Group and the Nashua Regional Planning Commission began water quality monitoring in the Pennichuck Brook watershed. The goal of this effort was to provide water quality data from the Pennichuck River relative to surface water quality standards and to allow for the assessment of the river for support of aquatic life. The Pennichuck Brook watershed is an important source of drinking water for the greater Nashua area. The establishment of a long-term monitoring program will allow for an understanding of the river's dynamics, or variations on a station-by-station and year-to-year basis. The data can also serve as a baseline from which to determine any water pollution problems in the river and/or watershed. The Volunteer River Assessment Program has provided field training, equipment, and technical assistance.

During 2006, trained volunteers from the Pennichuck Brook VRAP Group monitored water quality at nine stations in the Pennichuck Brook watershed (Figure 1, Table 2). In addition, one station on Witches Brook in Hollis (08-WCH) was monitored by VRAP staff using a multiparameter datalogger and a water temperature datalogger.

Stations IDs are designated using a number indicating the relative position of the station and a three letter code to identify the waterbody name. The higher the station number the more upstream the station is in the watershed.

Pennichuck Brook and all its tributaries and impoundments and all their tributaries, in the towns of Hollis, Milford, Amherst, Merrimack, and the city of Nashua, from the outlet of Pennichuck Pond to the crest of the Supply Pond dam, are considered Class A waters. All other portions of the Pennichuck Brook watershed are designated as Class B waters. These classifications are used to apply the appropriate water quality standards.

Water quality monitoring was conducted from June through October. In-situ measurements of water temperature, air temperature, dissolved oxygen, pH, turbidity and specific conductance were taken using handheld meters provided by NHDES. Samples for *E.coli* and nutrients were taken using bottles supplied by the either Chem Serve or the NHDES laboratory and were stored on ice during transport from the field to the lab. Table 3 summarizes the parameters measured, laboratory standard methods, and equipment used.

Table 2. Sampling Stations for the Pennichuck Brook Watershed, NHDES VRAP, 2006

Station ID	Class	Waterbody Name	Location	Town	Elevation* (Ft.)
08-WCH	**A**	Witches Brook	Silver Lake Road	Hollis	200
02-WCH	**A**	Witches Brook	Ames Road Bridge off Route 122	Hollis	200
01-XWB	**A**	Unamed Tributary To Witches Brook	End of Northern Boulevard	Amherst	200
01-WCH	**A**	Witches Brook	South Merrimack Road Bridge	Hollis	200
09-XPB	**A**	Unamed Tributary To Pennichuck Brook	Route 101A Bridge	Hollis	200
12-PEN	**B**	Pennichuck Brook	Nevins Road Bridge	Hollis	200
01-MUD	**B**	Muddy Brook	Fraley Road Bridge	Hollis	200
10-PEN	**A**	Pennichuck Brook	Railroad Bridge	Hollis	200
09-PEN	**A**	Holt Pond	Holt Pond Dam	Nashua	200
01-BFB	**B**	Boire Field Brook	Tinker Road	Nashua	200

*Elevations have been rounded off to 100-foot increments for calibration of dissolved oxygen meter

Figure 1. Pennichuck Brook Watershed and Monitoring Stations 2006

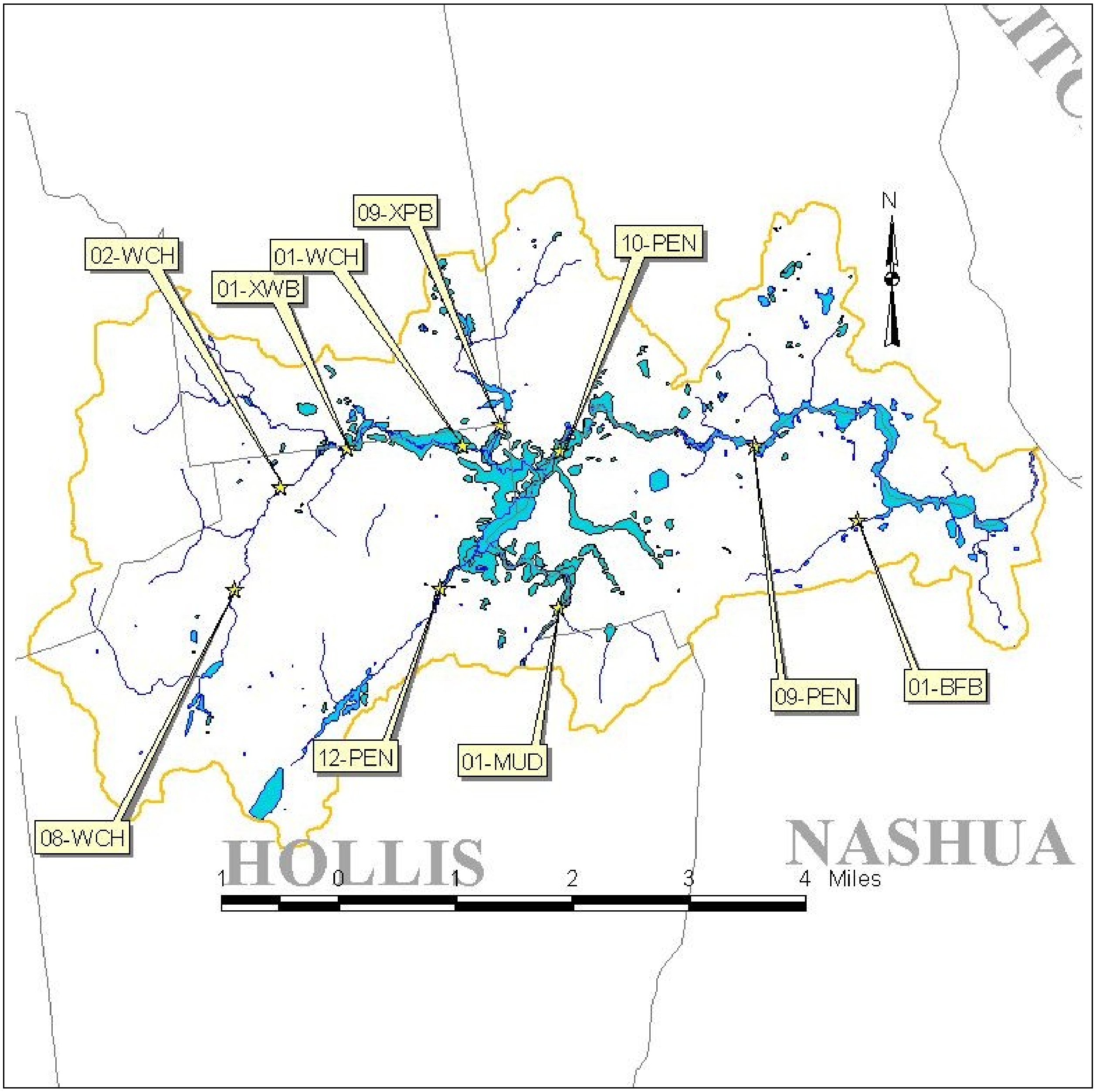


Table 3. Sampling and Analysis Methods

Parameter	Sample Type	Standard Method	Equipment Used	Laboratory
Temperature	In-Situ	SM 2550	YSI 95	------
	Datalogger	SM 2550	Onset HOBO Water Temp Pro	------
Dissolved Oxygen	In-Situ	SM 4500 O G	YSI 95	------
	Datalogger	SM 4500 O G	YSI XLM 6000	------
pH	In-Situ	SM 4500 H+	Orion 210A+	------
	Datalogger	SM 4500 H+	YSI XLM 6000	------
Turbidity	In-Situ	EPA 180.1	LaMotte 2020	------
Specific Conductance	In-Situ	SM 2510	YSI 30	------
	Datalogger	SM 2510	YSI XLM 6000	------
E.coli	Bottle (Sterile)	EPA 1103.1	------	Nashua WWTF
Total Phosphorus	Bottle (w/ Preservative)	EPA 365.2	------	Chem Serve
Total Kjeldahl Nitrogen	Bottle (w/ Preservative)	EPA 351.3	------	Chem Serve
Ammonia-N	Bottle (w/ Preservative)	EPA 350.2	------	Chem Serve
Orthophosphate, Phosphorous	Bottle (w/ Preservative)	EPA 365.2	------	Chem Serve
Nitrate	Bottle (w/ Preservative)	SW 9056	------	Chem Serve

4.0 RESULTS AND RECOMMENDATIONS

4.1 Dissolved Oxygen

Between two and seven measurements were taken in the field for dissolved oxygen concentration at 10 stations in the Pennichuck Brook watershed (Table 4). Of the 67 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

The Class A New Hampshire surface water quality standard for dissolved oxygen is a minimum concentration of 6.0 mg/L **and** a minimum daily average saturation of 75 %. The Class B New Hampshire surface water quality standard for dissolved oxygen includes a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 % saturation. In other words, there are criteria for both concentration and saturation that must be met before the river can be assessed as meeting dissolved oxygen standards. Table 4 reports only dissolved oxygen concentration as more detailed analysis is required to determine if instantaneous dissolved oxygen saturation measurements are above or below water quality standards.

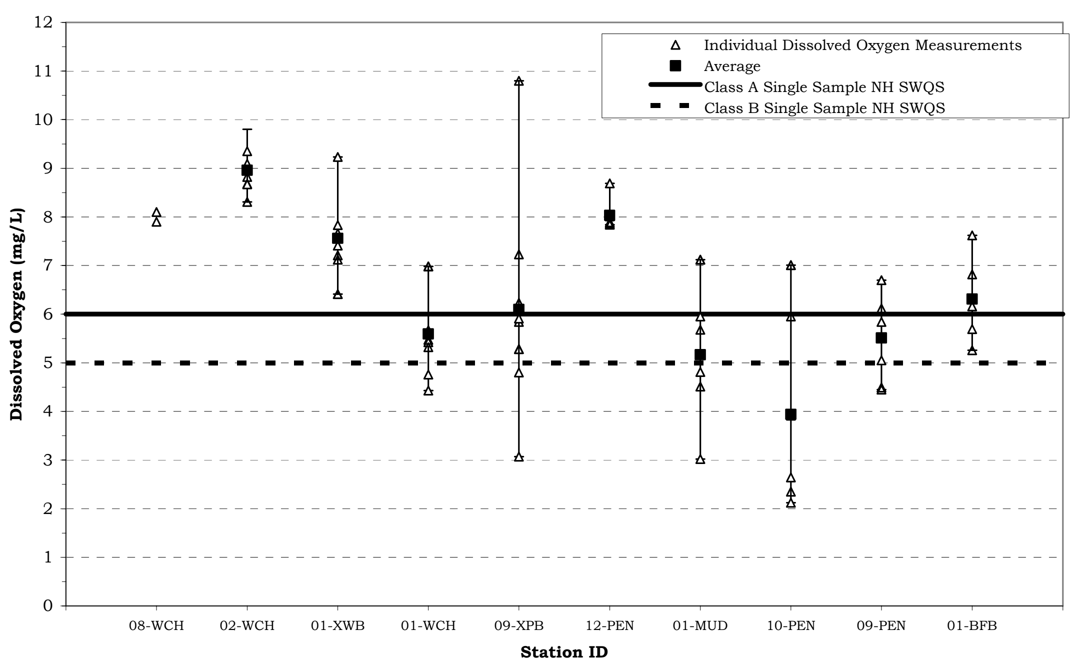
Table 4. Dissolved Oxygen (mg/L) Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
08-WCH	**A**	2	7.90 - 8.10	0	2
02-WCH	**A**	7	8.31 - 9.80	0	7
01-XWB	**A**	8	6.41 - 9.23	0	8
01-WCH	**A**	8	4.43 - 6.98	6	8
09-XPB	**A**	9	3.07 - 10.80	6	9
12-PEN	**B**	7	7.84 - 8.69	0	7
01-MUD	**B**	7	3.02 - 7.12	3	7
10-PEN	**A**	7	2.12 - 7.01	6	7
09-PEN	**A**	7	4.45 - 6.70	5	7
01-BFB	**B**	5	5.26 - 7.62	0	5
Total	_____	**67**	_____	**26**	**67**

Dissolved oxygen concentration levels were variable with the average ranging from 3.94 mg/L to 8.96 mg/L (Figure 2). Stations 01-WCH, 09-XPB, 01-MUD, 10-PEN and 09-PEN had dissolved oxygen levels on multiple occasions that were below the appropriate water quality standard. Stations 08-WCH, 02-WCH, 01-XWB, 12-PEN, and 01-BFB were above the standard on all occasions. Levels of dissolved oxygen sustained above the standards are considered adequate for the support of aquatic life and other desirable water quality conditions.

Stations where the instantaneous dissolved oxygen standard was not met could potentially have a dissolved oxygen problem and further investigation is warranted. It should be noted however, that low dissolved oxygen levels may be the result of natural conditions (e.g., the presence of wetlands or stagnant water caused by a beaver dam).

Figure 2. Dissolved Oxygen Statistics for the Pennichuck Brook Watershed
February 23 - October 31, 2006 NHDES VRAP



Figures 3 and 4 illustrate the results of dissolved oxygen concentration and saturation levels obtained at station 08-WCH using a submersible datalogger that was deployed from August 9 through August 14. The meter was programmed to take dissolved oxygen readings every 15 minutes. Data from this meter is generally analyzed in 24 hour sections. During this deployment four full 24-hour periods were measured. The daily average of dissolved oxygen percent saturation was above the Class B standard of 75 %. Dissolved oxygen concentration levels were also above the standard at all times.

Figures 3 and 4 also depict the typical cyclical variations in dissolved oxygen measurements one would expect to see during a 24-hour period in the summer. In general, dissolved oxygen levels are lowest in the early morning when there is low photosynthetic activity and a peak in respiration from organisms throughout the water column. This is the time of least oxygen production and greatest carbon dioxide emission. Peak dissolved oxygen levels occur when photosynthetic activity is at its peak. The greater the amount of photosynthetic activity the greater the production of oxygen as a byproduct of photosynthesis.

Figure 3. Dissolved Oxygen Saturation Statistics for Witches Brook August 9 - 14, 2006, NHDES VRAP

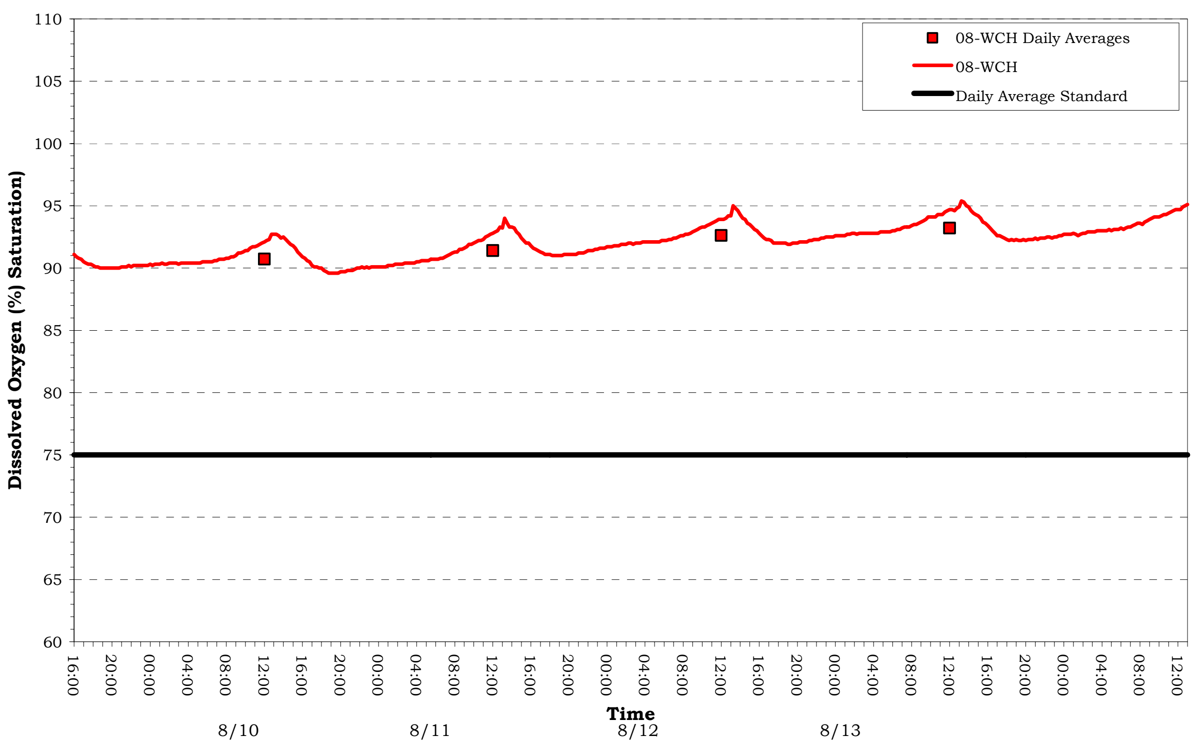
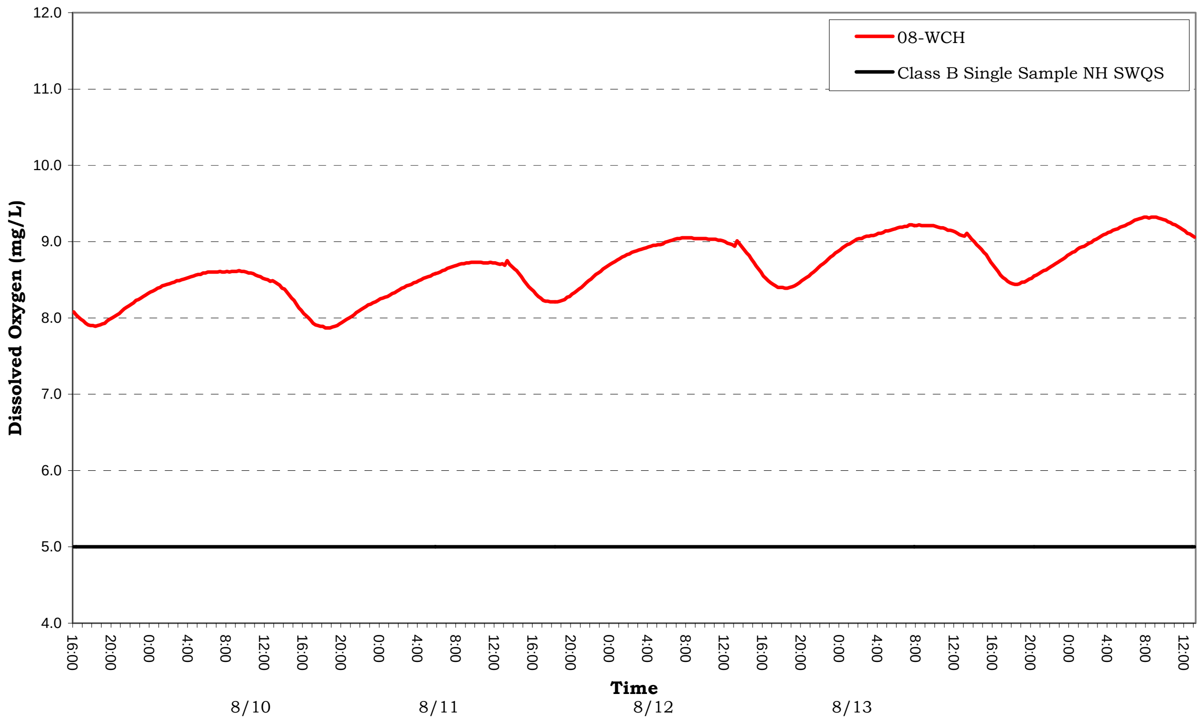


Figure 4. Dissolved Oxygen Concentration Statistics Witches Brook August 9 - 14, 2006, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.
- If possible, take measurements between 5 a.m. and 10 a.m., which is when dissolved oxygen is usually the lowest, and between 2 p.m. and 7 p.m. when dissolved oxygen is usually the highest. In general, dissolved oxygen levels are lowest in the early morning when there is low photosynthetic activity and a peak in respiration from organisms throughout the water column. This is the time of least oxygen production and greatest carbon dioxide emission. Peak dissolved oxygen levels occur when photosynthetic activity is at its peak. The greater the amount of photosynthetic activity the greater the production of oxygen as a byproduct of photosynthesis.
- Next year incorporate the use of in-situ dataloggers to automatically record dissolved oxygen saturation levels during a period of several days. This will allow for the calculation of the daily average for dissolved oxygen per cent saturation. Dataloggers can be put in the water for a period of several days and collect data at specific time intervals (e.g. every 15 minutes). The use of these instruments is dependent upon availability, and requires coordination with NHDES.

4.2 pH

Between two and eight measurements were taken in the field for pH at 10 stations in the Pennichuck Brook watershed [Table 5]. Of the 65 measurements taken, 63 met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

The Class A and B New Hampshire surface water quality standard is 6.5 - 8.0, unless naturally occurring.

Table 5. pH Data Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (standard units)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
08-WCH	**A**	2	6.20 - 6.45	2	2
02-WCH	**A**	7	5.51 - 6.24	7	7
01-XWB	**A**	7	5.47 - 6.41	7	7
01-WCH	**A**	7	5.47 - 6.13	7	7
09-XPB	**A**	8	5.43 - 6.21	8	8
12-PEN	**A**	7	6.03 - 6.38	7	7
01-MUD	**B**	7	5.97 - 6.41	7	7
10-PEN	**B**	6	5.41 - 6.32	6	6
09-PEN	**A**	7	5.54 - 6.51	7	6
01-BFB	**B**	7	6.04 - 6.73	4	6
Total	_____	**65**	_____	**62**	**63**

With the exception of four measurements, all other pH measurements were below the minimum New Hampshire surface water quality standard (Figure 3). Lower pH measurements are likely the result of natural conditions such as the soils, geology, or the presence of wetlands in the area. Rain and snow falling in New Hampshire is relatively acidic, which can also affect pH levels; after the spring melt or significant rain events, surface waters will generally have a lower pH.

Figure 5. pH Statistics for the Pennichuck Brook Watershed
June 13 - October 31, 2006 NHDES VRAP

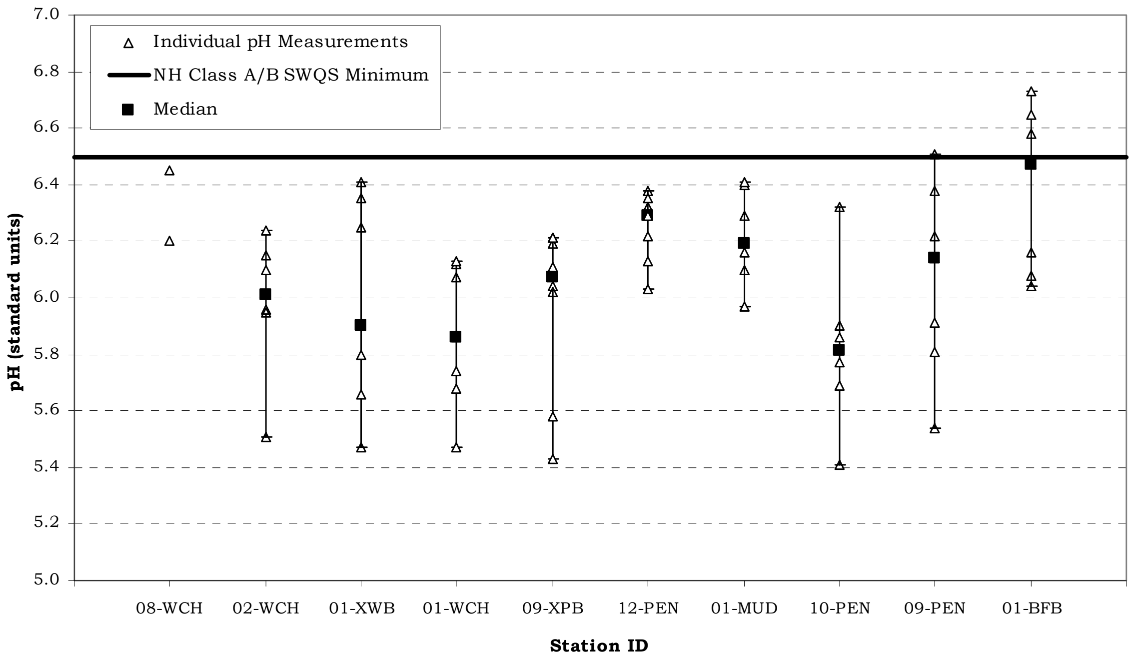
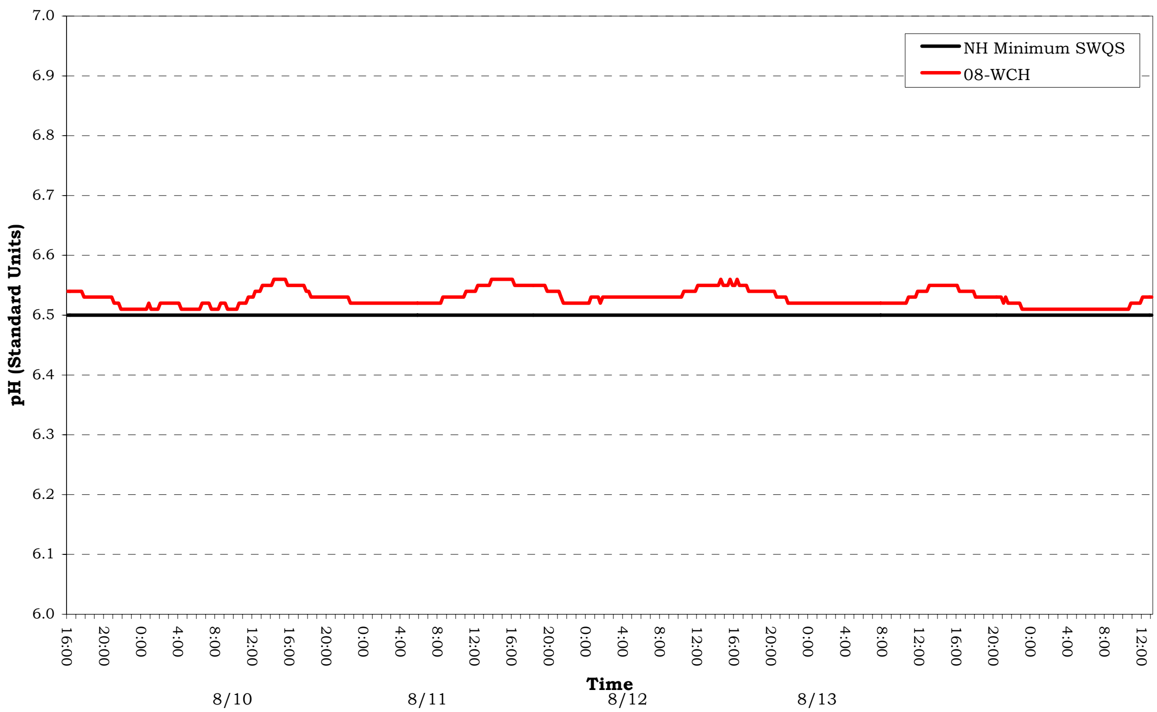


Figure 6 illustrates the results of pH measurements obtained at station 08-WCH using a submersible datalogger that was deployed from August 9 through August 14. The meter was programmed to take pH readings every 15 minutes over a multiple day period. During this deployment four full 24-hour periods were measured. On all occasions during the deployment, the pH at station 08-WCH met water quality standards.

Figure 6. pH Statistics for Witches Brook
August 9 - 14, 2006, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.
- Consider sampling for pH in some of the tributaries and wetland areas that are influencing the pH of stations with measurements below state standards. Site conditions are considered along with pH measurements because of the narrative portion of the pH standard. RSA 485-A:8 states that pH of Class B waters *shall be between 6.5 and 8.0, except when due to natural causes*. Wetlands can lower the pH of a river naturally by releasing tannic and humic acids from decaying plant material. If the sampling location is influenced by wetlands or other natural conditions, then the low pH measurements are not considered a violation of water quality standards. It is important to note that the New Hampshire water quality standard for pH is fairly conservative, thus pH levels slightly below the standard are not necessarily harmful to aquatic life. In this case, additional information about factors influencing pH levels is needed.

4.3 Turbidity

Between seven and nine measurements were taken in the field for turbidity at nine stations in the Pennichuck Brook watershed [Table 6]. Of the 70 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

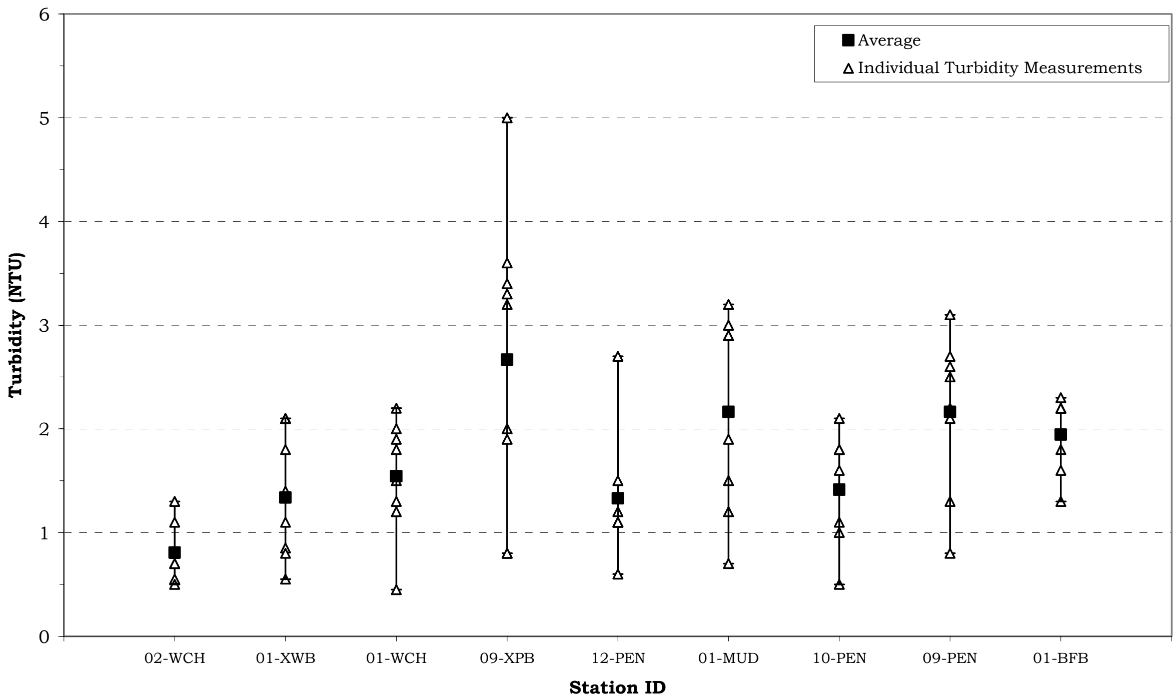
New Hampshire Surface Water Quality Standards state that turbidity of Class A waters *shall be as naturally occurring*. The Class B New Hampshire surface water quality standard for turbidity is less than 10 NTU above background.

Table 6. Turbidity Data Summary - Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (NTU)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
02-WCH	**A**	8	0.50 - 1.30	0	8
01-XWB	**A**	8	0.55 - 2.10	0	8
01-WCH	**A**	8	0.45 - 2.20	0	8
09-XPB	**A**	9	0.80 - 5.00	0	9
12-PEN	**A**	7	0.60 - 2.70	0	7
01-MUD	**A**	8	0.70 - 3.20	0	8
10-PEN	**B**	7	0.50 - 2.10	0	7
09-PEN	**A**	8	0.80 - 3.10	0	8
01-BFB	**B**	7	1.30 - 2.30	0	7
Total	_____	**70**	_____	**0**	**70**

Turbidity levels were low on all occasions and at all stations with the average ranging from 0.8 NTU to 2.7 NTU (Figure 7). Although clean waters are associated with low turbidity there is a high degree of natural variability involved. Precipitation often contributes to increased turbidity by flushing sediment, organic matter and other materials from the surrounding landscape into surface waters. However, human activities, such as removal of vegetation near surface waters and disruption of nearby soils, can lead to dramatic increases in turbidity levels. In general it is typical to see a rise in turbidity in more developed areas due to increased runoff.

Figure 7. Turbidity Statistics for the Pennichuck Brook Watershed
June 13 - October 31, 2006 NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.
- Collect samples during wet weather. This will help us to understand how the river responds to runoff and sedimentation.
- If a higher than normal turbidity measurement occurs, volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated turbidity levels. In addition, take good field notes and photographs. If human activity is suspected or verified as the source of elevated turbidity levels, volunteers should contact NHDES.

4.4 Specific Conductance

Between four and ten measurements were taken in the field for specific conductance at 10 stations in the Pennichuck Brook watershed [Table 7]. Of the 77 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

New Hampshire surface water quality standards do not contain numeric limits for specific conductance.

Table 7. Specific Conductance Data Summary - Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (µS/cm)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
08-WCH	**A**	4	107.3 - 109.4	Not Applicable	4
02-WCH	**A**	8	75.5 - 146.7	N/A	8
01-XWB	**A**	8	86.4 - 152.4	N/A	8
01-WCH	**A**	9	98.6 - 179.6	N/A	9
09-XPB	**A**	10	115.1 - 300.4	N/A	10
12-PEN	**B**	9	103.4 - 211.4	N/A	9
01-MUD	**B**	9	113.2 - 153.5	N/A	9
10-PEN	**A**	7	103.2 - 184.6	N/A	7
09-PEN	**A**	8	108.0 - 296.0	N/A	8
01-BFB	**B**	5	302.1 - 548	N/A	5
Total	_____	**77**	_____	**N/A**	**77**

Specific conductance levels showed low to moderate impact with the average ranging from 120.3 µS/cm to 421.4 µS/cm (Figure 8). Boire Field Brook had consistently higher specific conductance levels than other stations in the watershed. Higher specific conductance levels can be indicative of pollution from sources such as urban/agricultural runoff, road salt, failed septic systems, or groundwater pollution. The variable specific conductance levels in the Pennichuck Brook watershed indicate low pollutant levels at some stations and potentially higher at others.

Figure 8. Specific Conductance Statistics for the Pennichuck Brook Watershed
June 13 - October 31, 2006 NHDES VRAP

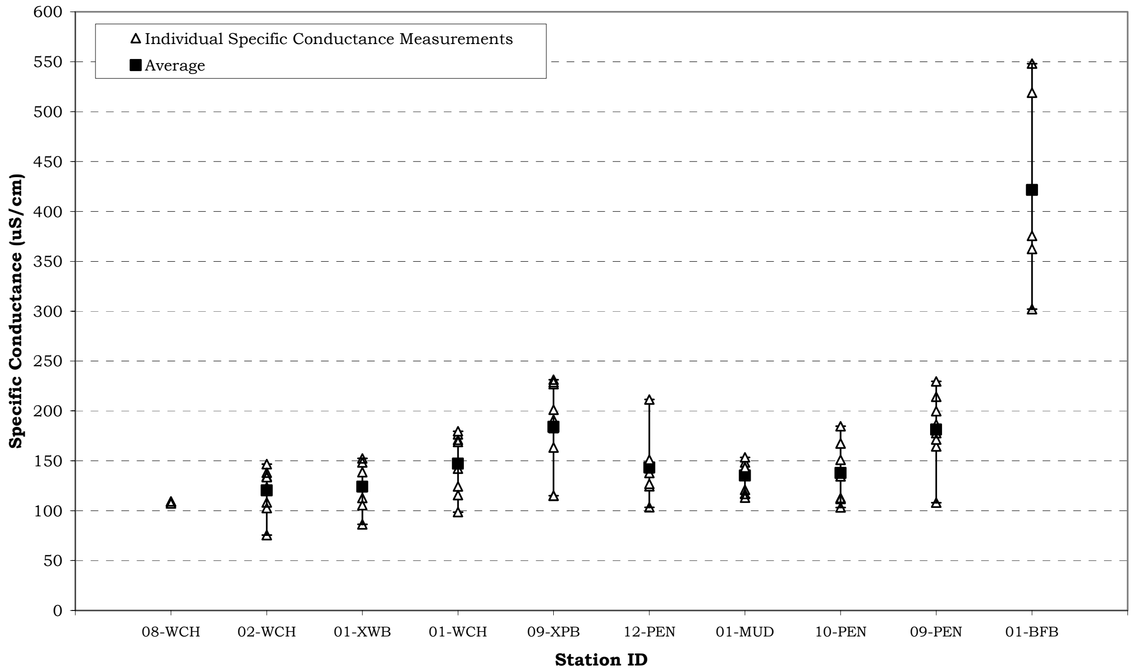
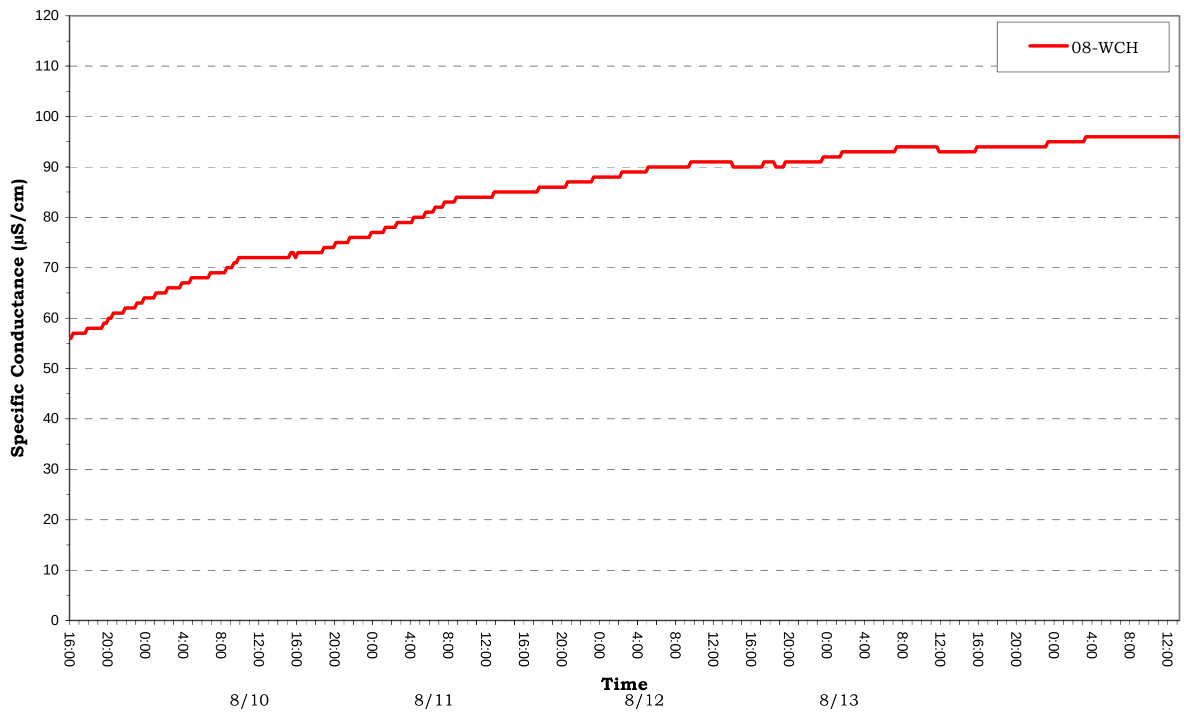


Figure 9 illustrates the results of specific conductance measurements obtained at station 08-WCH using a submersible datalogger that was deployed from August 9 through August 14. The meter was programmed to take specific conductance readings every 15 minutes. Specific conductance levels were consistently low ranging from 57 µS/cm to 96 µS/cm.

Figure 9. Specific Conductance Statistics for Witches Brook
August 9 - 14, 2006, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.
- Consider collecting chloride samples at the same time that specific conductance is measured. During the late winter/early spring snowmelt, higher conductivity levels are often seen due to elevated concentrations of chloride in the runoff. Conductivity levels are very closely correlated to chloride levels. Simultaneously measuring chloride and conductivity will allow for a better understanding of their relationship.

4.5 Water Temperature

Between two and 10 measurements were taken in the field for water temperature at 10 stations in the Pennichuck Brook watershed [Table 8].Of the 79 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

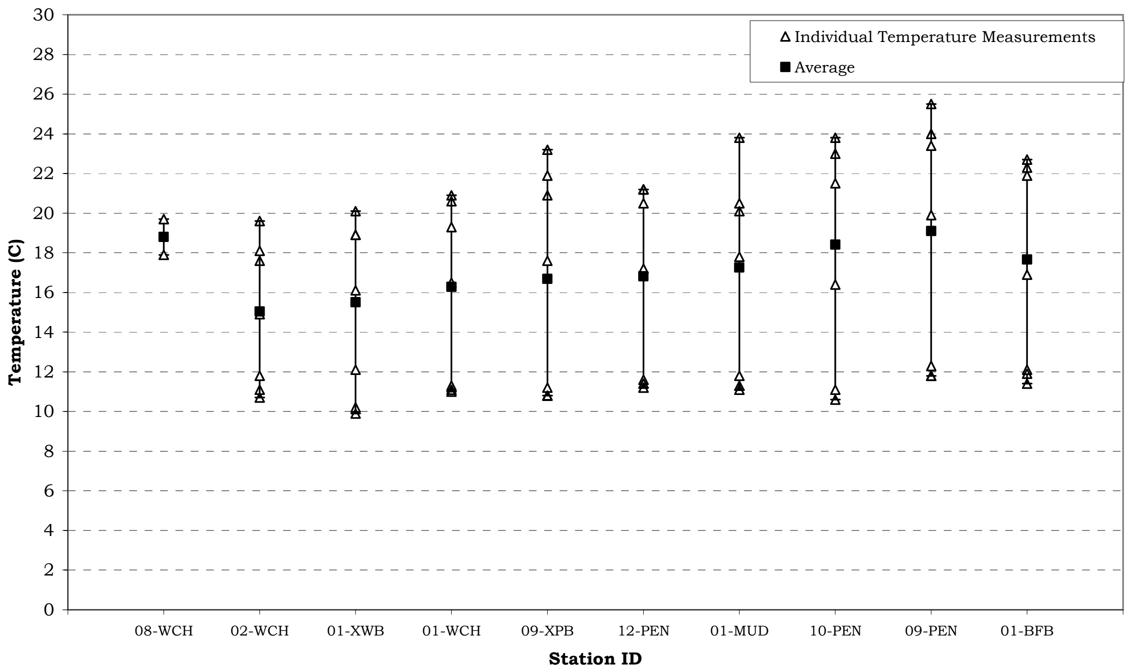
Although there is currently no numerical water quality criteria for water temperature, NHDES is in the process of collecting biological and water temperature data that will contribute to the development of a procedure for assessing rivers and stream based on water temperature and its corresponding impact to the biological integrity of the waterbody.

Table 8. Water Temperature Data Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (°C)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
08-WCH	**A**	2	17.9 - 19.7	Not Applicable	2
02-WCH	**A**	8	10.7 - 19.6	N/A	8
01-XWB	**A**	8	9.9 - 20.1	N/A	8
01-WCH	**A**	9	11.0 - 20.9	N/A	9
09-XPB	**A**	10	10.8 - 23.2	N/A	10
12-PEN	**B**	9	11.2 - 21.2	N/A	9
01-MUD	**B**	9	11.1 - 23.8	N/A	9
10-PEN	**A**	7	10.6 - 23.8	N/A	7
09-PEN	**A**	8	11.8 - 25.5	N/A	8
01-BFB	**B**	8	11.4 - 22.7	N/A	8
Total	_____	**78**	_____	**N/A**	**78**

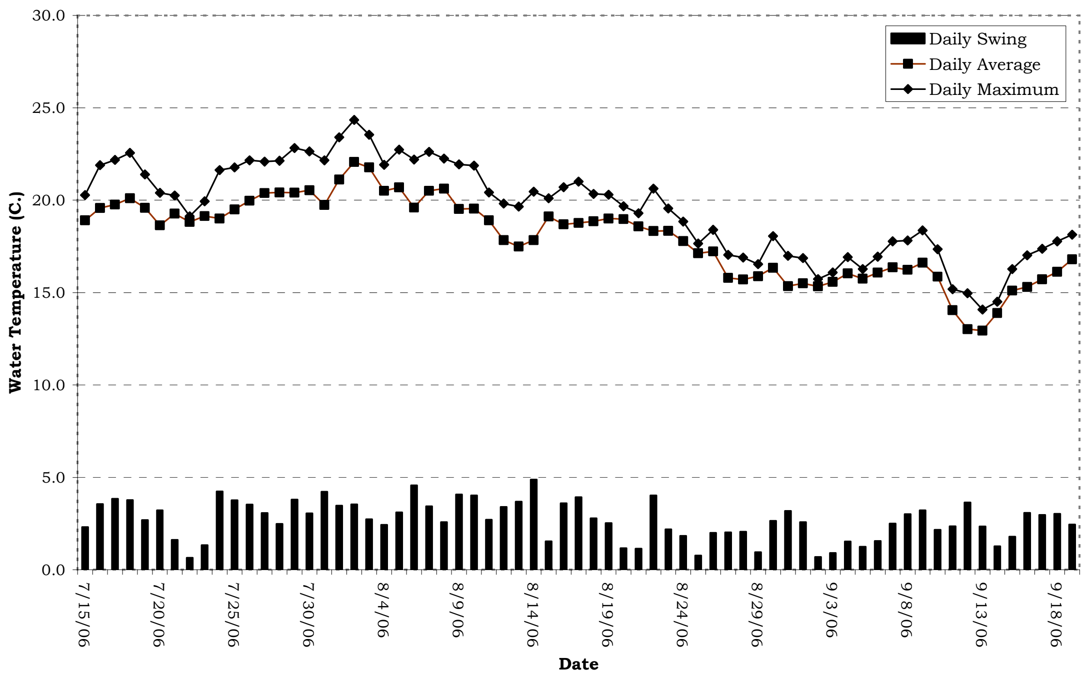
Figure 10 shows the results of instantaneous water temperature measurements taken in the Pennichuck Brook watershed. The average water temperature varied from 15.0°C. to 19.0 °C.

Figure 10. Water Temperature Statistics for the Pennichuck Brook Watershed
June 13 - October 31, 2006 NHDES VRAP



From July 15 to September 19 VRAP staff deployed a submersible water temperature datalogger at station 08-WCH. The datalogger was programmed to record water temperature once an hour during the deployment time. Figure 11 shows the results of water temperature during the deployment time in terms of the daily maximum temperature, the daily average temperature and the swing between the daily maximum and daily minimum. The monthly average water temperature for the month of August was 18.6 C.

Figure 11. Water Temperature Statistics for Witches Brook (08-WCH)
July 15 - September 19, 2006, NHDES, VRAP



Water temperature is a critical parameter for aquatic life and has an impact on other water quality parameters such as dissolved oxygen concentrations, and the activity of bacteria in the water. Water temperature controls the metabolic and reproductive processes of aquatic species and can determine which fish and macroinvertabrate species can survive in a given river or stream.

A number of factors can have an impact on water temperature including the quantity and maturity of riparian vegetation along the shoreline, the rate of flow, the percent of impervious surfaces contributing stormwater, thermal discharges, impoundments and the influence of groundwater.

Recommendations

- Continue collecting water temperature data via both instantaneous reading and long-term deployment of dataloggers.

4.6 *Escherichia coli*/Bacteria

Either two or three samples were taken for *Escherichia coli* (*E. coli*) at nine stations in the Pennichuck Brook watershed (Table 9). Of the 26 samples taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

Class A New Hampshire surface water quality standards for *E.coli* are as follows:

<153 cts/100 ml, based on any single sample, or
<47 cts/100 ml, based on a geometric mean calculated from three samples collected within a 60-day period.

The Class B New Hampshire surface water quality standards for *E.coli* are as follows:

<406 cts/100 ml, based on any single sample, or
<126 cts/100 ml, based on a geometric mean calculated from three samples collected within a 60-day period.

Table 9. *E.coli* Data Summary - Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (cts/100ml)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01-XWB	**A**	3	<2 - 12	0	3
02-WCH	**A**	3	<2 - <4	0	3
01-WCH	**A**	3	2 - <4	0	3
09-XPB	**A**	3	<2 - 10	0	3
12-PEN	**A**	3	<2 - <4	0	3
01-MUD	**A**	3	<2 - <4	0	3
10-PEN	**B**	3	4 - 10	0	3
09-PEN	**A**	2	<2 - 2	0	2
01-BFB	**B**	3	<2 - <4	0	3
Total	_____	**26**	_____	**0**	**26**

All bacteria measurements met the relevant New Hampshire surface water quality standard (Figure 13). In order to fully determine whether a waterbody is meeting surface water standards for *E.coli* a geometric mean must be calculated. A geometric mean is calculated using three samples collected within a 60-day period. A geometric mean was calculated at eight of the stations and all were below the relevant Class A or B water quality standard (Table 10).

Figure 12. ***Escherichia coli*** **Statistics for the Pennichuck Brook Watershed**
June 21 - September 26, 2005 NHDES VRAP

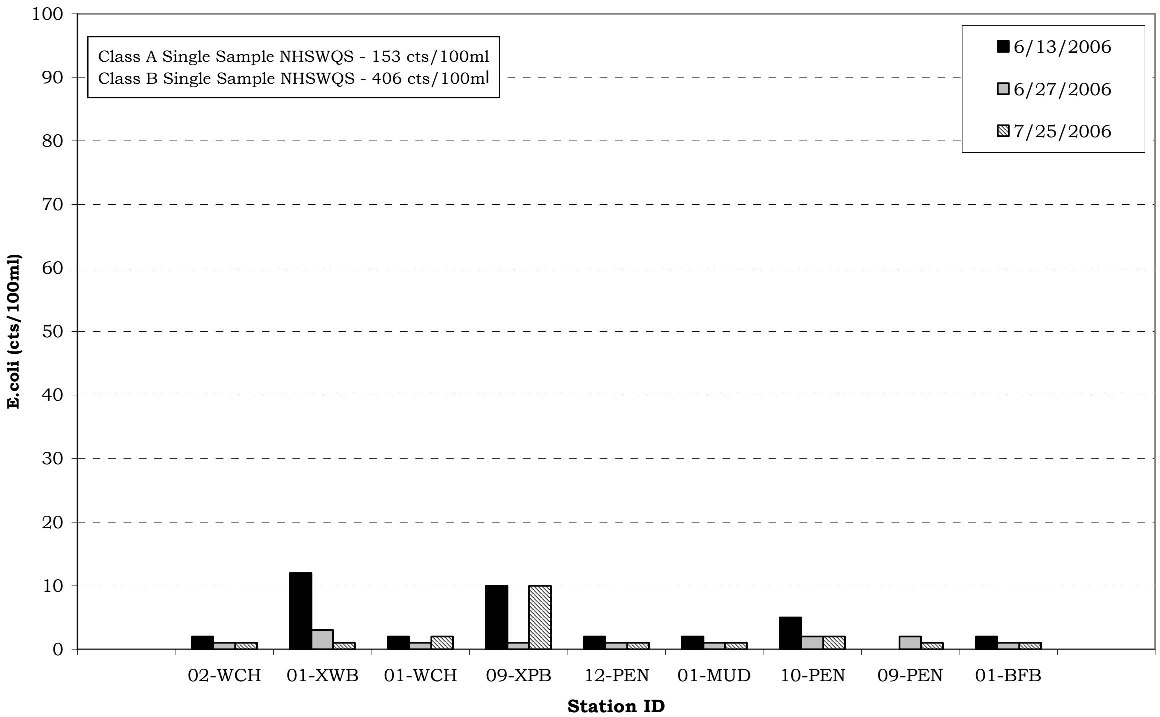


Table 10. *E.coli* Geometric Mean Data – Pennichuck Brook Watershed, 2006

Station ID	Geometric Means Calculated	Geometric Mean 7/13/06-7/25/06	Geometric Means Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01-XWB	1	3	0	1
02-WCH	1	1	0	1
01-WCH	1	3	0	1
09-XPB	1	5	0	1
12-PEN	1	1	0	1
01-MUD	1	1	0	1
10-PEN	1	5	0	1
01-BFB	1	1	0	1
Total	**8**	_____	**0**	**8**

Several factors can contribute to elevated *E. coli* levels, including, but not limited to rain storms, low river flows, the presence of wildlife, and the presence of septic systems along the river.

The E.coli levels measured in the Pennichuck Brook watershed during 2006 were much lower than would be normally expected in this watershed given the prevelance of development, impervious surfaces, and wetlands. E.coli levels were much higher during 2005 and more in line with what would be expected in the Pennichuck Brook watershed.

Recommendations

- Continue collecting three samples within any 60-day period during the summer to allow for determination of geometric means.
- Collect split samples to send to the NHDES laboratory for quality control purposes.
- Continue to document river conditions and station characteristics (including the presence of wildlife in the area during sampling).
- At stations with particularly high bacteria levels volunteers can investigate further by moving upstream and taking additional measurements. This will facilitate isolating the location of the cause of the elevated bacteria levels. Those sampling should also look for any potential sources of bacteria such as emission pipes, failed septic systems, farm animals, pet waste, wildlife and waterfowl.

4.7 Total Phosphorus

Either three or four samples were taken for total phosphorus at nine stations in the Pennichuck Brook watershed (Table 11). Of the 35 samples taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

There is no numeric standard for total phosphorus for Class A or B waters. The narrative standard states that "unless naturally occurring, shall contain no phosphorus in such concentrations that would impair any existing or designated uses." The NHDES "level of concern" for total phosphorous is 0.05 mg/L.

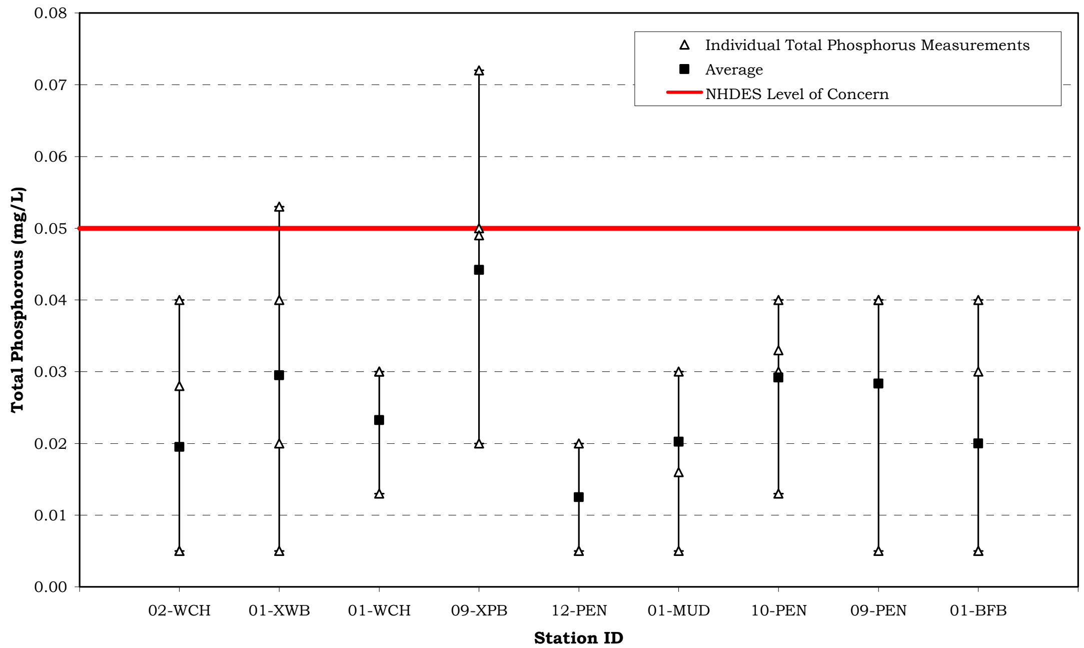
Table 11. Total Phosphorus Data Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (mg/l)	Acceptable Samples Exceeding NHDES Level of Concern	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01-XWB	**A**	4	< 0.010 - 0.053	1	4
02-WCH	**A**	4	0.005 - 0.040	0	4
01-WCH	**A**	4	0.013 - 0.030	0	4
09-XPB	**A**	4	0.020 - 0.072	2	4
12-PEN	**B**	4	< 0.010 - 0.020	0	4
01-MUD	**B**	4	< 0.020 - 0.030	0	4
10-PEN	**A**	4	0.013 - 0.040	0	4
09-PEN	**A**	3	0.005 - 0.040	0	3
01-BFB	**B**	4	0.005 - 0.040	0	4
Total	____	**35**	____	**3**	**35**

Seven of the stations were below the NHDES "level of concern" for total phosphorous on all occasions. Station 01-XWB had one measurement above the "level of concern" and station 09-XPB had two. (Figure 14). Under undisturbed natural conditions phosphorous is at very low levels in aquatic ecosystems. Of the three nutrients critical for aquatic plant growth; potassium, nitrogen, and phosphorous, it is usually phosphorous that is the limiting factor to plant growth. When the supply of phosphorous is increased due to human activity, algae respond with significant growth.

A major source of excessive phosphorous concentrations in aquatic ecosystems can be wastewater treatment facilities, as sewage typically contains relatively high levels of phosphorus detergents. However, fertilizers used on lawns and agricultural areas can also contribute significant amounts of phosphorus.

Figure 13. Total Phosphorous Statistics for the Pennichuck Brook Watershed
June 13 - August 8, 2006, NHDES VRAP



Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

4.8 Orthophosphate

Either three or four measurements were taken for orthophosphate at nine stations in the Pennichuck Brook watershed [Table 12]. Of the 34 measurements taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

There is no numeric standard for phosphorus for Class A or B waters. The narrative standard states that "unless naturally occurring, shall contain no phosphorus in such concentrations that would impair any existing or designated uses."

Table 12. Orthophosphate Data Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01-XWB	**A**	4	< 0.010	Not Applicable	4
02-WCH	**A**	3	< 0.010	N/A	3
01-WCH	**A**	4	< 0.010	N/A	4
09-XPB	**A**	4	< 0.010	N/A	4
12-PEN	**B**	4	< 0.010	N/A	4
01-MUD	**B**	4	< 0.010	N/A	4
10-PEN	**A**	4	< 0.010	N/A	4
09-PEN	**A**	3	< 0.010	N/A	3
01-BFB	**B**	4	< 0.010	N/A	4
Total	____	**34**	____	**N/A**	**34**

Orthoposphate concentrations were below the laboratory detection limit at all stations and on all occasions. Under undisturbed natural conditions phosphorous is at very low levels in aquatic ecosystems. Of the three nutrients critical for aquatic plant growth; potassium, nitrogen, and phosphorous, it is usually phosphorous that is the limiting factor to plant growth. When the supply of phosphorous is increased due to human activity, algae respond with significant growth. Orthophosphate is the most stable kind of phosphate, and is the form of phosphorous used by plants.

Natural processes produce orthophosphate, but major man-influenced sources include: partially treated and untreated sewage, runoff from agricultural sites, and application of some lawn fertilizers.

Recommendations

- Given the low levels of orthophosphate, total phosphate can be used as the indicator for phosphorous levels in the Pennichuck Brook watershed. Stations with excessive total phosphorous levels could also be tested for orthophosphate to help determine the source..

4.9 Total Kjeldahl Nitrogen

Either three or four samples were collected for total kjeldahl nitrogen (TKN) in the Pennichuck Brook watershed (Table 13). Of the 35 samples collected, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

There is no numeric standard for TKN for Class A or B waters. The narrative standard states that "unless naturally occurring, shall contain no nitrogen in such concentrations that would impair any existing or designated uses."

Table 13. Total Kjeldahl Nitrogen Data Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01-XWB	**A**	4	< 0.250	Not Applicable	4
02-WCH	**A**	4	< 0.250	N/A	4
01-WCH	**A**	4	< 0.250	N/A	4
09-XPB	**A**	4	< 0.250 - 12.5	N/A	4
12-PEN	**B**	4	< 0.250	N/A	4
01-MUD	**B**	4	< 0.250 - 3.85	N/A	4
10-PEN	**A**	4	< 0.250	N/A	4
09-PEN	**A**	3	< 0.250	N/A	3
01-BFB	**B**	4	< 0.250 – 3.05	N/A	4
Total	_____	**35**	_____	**N/A**	**35**

Six of the stations were below the laboratory detection limit for TKN on all occasions. Station 09-XPB had two measurements above the detection limit and stations 01-MUD and 01-BFB had one measurement above the detection limit. Those measurements above the detection limit were elevated and the TKN measurement at station 09-XPB on 6/13/06 was significantly elevated.

TKN is unoxidized nitrogen and a measurement of the combined concentration of organic nitrogen and ammonia. Nitrogen is naturally occurring in soil in organic forms from decomposing plant and animal matter. Bacteria in the soil then convert nitrogen to nitrate, a nitrogen-oxygen chemical unit. Primary sources which can cause increased nitrate levels are human sewage, livestock manure, and agricultural fertilizers. Higher TKN values may also be indicative of high production rates, algal growth and decomposing organics.

Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

- Consider monitoring for chlorophyll-a. High concentrations of nutrients will lead to an increase in algal growth. Because algae is a plant and contains chlorophyll-a, the concentration of chlorophyll-a found in the water will give an estimation of the concentration of algae. NHDES uses chlorophyll-a as an indicator in the assessment of surface water for primary contact recreation.

- Shoreline investigations should be conducted to look for potential sources of high nitrogen levels. Land use practices that would incorporate the use of fertilizers should be documented.

4.10 Nitrate (NO_3)

Four samples were collected for nitrate at nine stations in the Pennichuck Brook watershed (Table 14). Of the 36 samples taken, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

There is no numeric standard for nitrate for Class A or B waters. The narrative standard states that "unless naturally occurring, shall contain no nitrogen in such concentrations that would impair any existing or designated uses."

Table 14. Nitrate Data Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01-XWB	**A**	4	< 1	Not Applicable	4
02-WCH	**A**	4	< 1	N/A	4
01-WCH	**A**	4	< 1	N/A	4
09-XPB	**A**	4	< 1	N/A	4
12-PEN	**B**	4	< 1	N/A	4
01-MUD	**B**	4	< 1	N/A	4
10-PEN	**A**	4	< 1	N/A	4
09-PEN	**A**	4	< 1	N/A	4
01-BFB	**B**	4	< 1	N/A	4
Total	____	**36**	____	**N/A**	**36**

Nitrate concentrations were below the laboratory detection limit at all stations on most occasions.

Nitrogen is naturally occurring in soil in organic forms from decomposing plant and animal matter. Bacteria in the soil then convert nitrogen to nitrate, a nitrogen-oxygen chemical unit. Primary sources which can cause increased nitrate levels are human sewage, livestock manure, and agricultural fertilizers. Sources of nitrogen include fertilizer, failing septic systems, and animal wastes.

Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

4.11 Ammonia (NH_3)

Either three or four samples were collected for ammonia at nine stations in the Pennichuck Brook watershed (Table 15). Of the 36 samples collected, all met quality assurance/quality control (QA/QC) requirements and are usable for New Hampshire's 2008 surface water quality report to the US Environmental Protection Agency.

Class A and B New Hampshire surface water quality standards for ammonia are dependant on pH.

Table 15. Ammonia Data Summary – Pennichuck Brook Watershed, 2006

Station ID	Class	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class A/B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01-XWB	**A**	4	< 0.100 - 0.227	0	4
02-WCH	**A**	4	<0.100	0	4
01-WCH	**A**	4	< 0.100 - 0.450	0	4
09-XPB	**A**	4	< 0.100 - 0.277	0	4
12-PEN	**B**	4	< 0.100 - 0.450	0	4
01-MUD	**B**	4	< 0.100	0	4
10-PEN	**A**	4	< 0.100 - 0.680	0	4
09-PEN	**A**	3	<0.100	0	3
01-BFB	**B**	4	<0.100 - 0.420	0	4
Total	____	**35**	____	**0**	**35**

Ammonia concentrations were below the laboratory detection limit on all occasions at three stations (02-WCH, 01-MUD, and 09-PEN). All of the remaining stations had at least one measurement above the laboratory detection limit. None of the measurements exceeded the pH dependant freshwater chronic criteria for ammonia.

Elevated levels of ammonia indicated relatively recent pollution since it is readily oxidized into nitrate or nitrite under aerobic conditions. More chronic forms of excessive nitrogen would be detected by testing for nitrate, nitrite or in some circumstances TKN.

Potential sources of ammonia include discharge from waterwater treatments plants, failing septic systems, and runoff from livestock farms.

Recommendations

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on.

APPENDIX A

2006 Pennichuck Brook Watershed Water Quality Data

2006 PENNICHUCK BROOK WATERSHED VRAP DATA

(blue)	Measurements not meeting New Hampshire surface water quality standards
(pink)	Total Phosphorous measurements exceeding NHDES level of concern
(diagonal line)	Measurements not meeting NHDES quality assurance/quality control standards

a Data collected by NHDES staff during deployment of dataloggers

b Designated wild trout/cold water fishery. Additional dissolved oxygen standard apply.

08-WCH, Witches Brook, Silver Lake Road, Hollis - Class A

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Specific Conductance (uS/cm)
Standard	**NA**	**>6.0 [b]**	**>75% Daily Average [b]**	**NA**	**NA**	**6.5-8.0**	**NA**
8/9/06[a]	13:35	7.90	86.3	19.7	20.5	6.20	109.0
8/14/06[a]	13:19	8.10	85.5	17.9	21.0	6.45	107.3

02-WCH, Witches Brook, Ames Road Bridge off Route 122, Hollis - Class A

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	**NA**	**>6.0 [b]**	**>75% Daily Average [b]**	**NA**	**NA**	**6.5-8.0**	**<10 NTU above backgrd**	**NA**	**<153**	**<47**	**Narrative**	**Narrative**	**Narrative**	**Narrative**	**pH Dependent**
6/13/06	10:25	9.35	92.5	14.9	17.0	5.51	0.5	75.5	2		0.028	< 0.01	< 0.250	< 1	< 0.100
6/27/06	10:05	8.68	91.7	18.1	21.5	5.96	0.7	102.6	1		< 0.010	< 0.01	< 0.250	< 1	< 0.100
7/25/06	09:15	9.09	93.1	16.5	19.9	6.10	1.3	134.4	1	1	< 0.010		< 0.250	< 1	< 0.100
8/8/06	09:15	8.67	90.5	17.6	21.6	6.24	0.7	146.7			0.040	< 0.01	< 0.250	< 1	< 0.100
9/5/06	10:00	8.82	82.1	19.6	21.4		1.1	133.6							
10/19/06	10:35	9.80	90.5	11.8	12.1	6.15	0.6	75.5							
10/27/06	10:25			11.1	11.2	5.95	0.8	138.1							
10/31/06	10:35	8.31	75.7	10.7	11.9	6.01	0.8	108.3							

01-XWB, Unnamed Tributary to Witches Brook, End of Northern Blvd., Amherst - Class A

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	NA	>6.0	>75% Daily Average	NA	NA	6.5-8.0	<10 NTU above backgrd	NA	<153	<47	Narrative	Narrative	Narrative	Narrative	pH Dependent
6/13/06	10:00	9.23	93.7	16.1	19.4	5.47	0.6	86.4	12		0.053	< 0.010	< 0.250	< 1	0.227
6/27/06	09:32	7.66	82.6	18.9	23.4	5.66	0.9	105.6	3		< 0.010	< 0.010	< 0.250	< 1	< 0.100
7/25/06	09:00	7.83	82.8	17.9	21.6	5.90	1.8	138.7	1	3	0.020	< 0.010	< 0.250	< 1	< 0.100
8/8/06	08:55	7.41	80.0	18.9	20.9	~~5.80~~	1.4	148.3			0.040	< 0.010	< 0.250	< 1	< 0.100
9/5/06	09:20	7.21	66.3	20.1	20.1		0.8	125.1							
10/19/06	10:00	7.59	70.1	12.1	11.8	6.25	1.1	123.5							
10/27/06	10:00	6.41	68.3	10.2	11.0	6.41	2.1	112.7							
10/31/06	10:00	7.12	67.6	9.9	11.6	6.35	2.1	152.4							

01-WCH, Witches Brook, South Merrimack Road Bridge, Hollis - Class A

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	NA	>6.0 [b]	>75% Daily Average [b]	NA	NA	6.5-8.0	<10 NTU above backgrd	NA	<153	<47	Narrative	Narrative	Narrative	Narrative	pH Dependent
6/13/06	07:55	4.43	46.1	16.5	17.2	5.47	0.5	98.6	2		0.013	< 0.010	< 0.250	< 1	0.249
6/27/06	09:05	4.76	52.3	19.3	21.3	5.68	1.3	124.4	2		0.030	< 0.010	< 0.250	< 1	< 0.100
7/25/06	08:40	5.42	59.4	19.6	21.2	5.74	2.0	176.5	4	3	0.030	< 0.010	~~< 0.250~~	< 1	~~0.450~~
8/8/06	08:37	5.67	63.7	20.9	26.7	~~5.86~~	1.9	179.6			0.020	< 0.010	< 0.250	< 1	< 0.100
9/5/06	08:45	6.68	61.4	20.6	17.5		1.8	168.9							
10/19/06	09:20	6.98	64.3	11.3	11.4	6.07	2.2	170.9							
10/27/06	09:20	5.32	56.1	11.1	11.0	6.12	1.5	142.1							
10/31/06	09:15	5.47	51.4	11.0	11.5	6.13	1.2	115.6							

09-XPB, Unnamed Tributary to Pennichuck Brook, Route 101A Bridge, Hollis - Class A

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	**NA**	**>6.0**	**>75% Daily Average**	**NA**	**NA**	**6.5-8.0**	**<10 NTU above backgrd**	**NA**	**<153**	**<47**	**Narrative**	**Narrative**	**Narrative**	**Narrative**	**pH Dependent**
6/13/06	08:25	3.07	32.3	17.6	19.0	5.43	1.9	182.8	10		0.072	< 0.010	12.5	< 1	0.227
6/27/06	08:45	4.80	54.8	21.9	25.3	5.58	3.6	201.1	1		0.050	< 0.010	< 0.250	< 1	< 0.100
6/27/06	08:45										0.049		0.800		0.090
7/25/06	08:15	5.84	68.2	22.9	21.6	6.04	3.4	226.8	10	5	0.030	< 0.010	< 0.250	< 1	< 0.100
8/8/06	08:10	5.72	67.5	23.2	21.4	6.19	5.0	228.7			0.020	< 0.010	< 0.250	< 1	< 0.100
9/5/06	08:15	5.28	48.2	20.9	17.3		3.2	231.3							
10/19/06	08:50	7.23	70.3	11.2	10.9	6.02	2.0	191.3							
10/27/06	08:40	6.23	66.3	10.8	11.0	6.21	0.8	115.1							
10/29/06	08:40	10.80	66.3	10.8	11.0	6.21	0.8	115.1							
10/31/06	08:40	5.91	54.9	10.9	10.6	6.11	3.3	163.4							

12-PEN, Pennichuck Brook, Nevins Road Bridge, Hollis - Class B

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	**NA**	**>5.0**	**>75% Daily Average**	**NA**	**NA**	**6.5-8.0**	**<10 NTU above backgrd**	**NA**	**<406**	**<126**	**Narrative**	**Narrative**	**Narrative**	**Narrative**	**pH Dependent**
6/13/06	11:10	8.69	90.2	17.2	18.1	6.03	0.6	124.5	2		< 0.010	< 0.010	< 0.250	< 1	< 0.100
6/27/06	10:45	8.01	89.3	20.5	22.0	6.13	1.1	126.8	1		< 0.010	< 0.010	< 0.250	< 1	< 0.100
7/25/06	09:35	7.89	87.4	20.2	20.6	6.35	1.5	137.8	1	1	0.020	< 0.010	< 0.250	< 1	0.450
8/8/06	09:30	8.01	89.4	21.2	98.3	6.22	1.1	142.4			0.020	< 0.010	< 0.250	< 1	< 0.100
9/5/06	10:40	7.92	73.3	21.2	22.9		2.7	211.4							
10/19/06	11:00	7.84	72.4	11.6		6.32		103.4							
10/27/06	10:55			11.2	11.3	6.38	1.2	148.2							
10/31/06	11:00	7.87	72.4	11.4	12.6	6.29	1.1	151.1							

01-MUD, Muddy Brook, Fraley Road Bridge, Hollis - Class B

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	**NA**	**>5.0**	**>75% Daily Average**	**NA**	**NA**	**6.5-8.0**	**<10 NTU above backgrd**	**NA**	**<406**	**<126**	**Narrative**	**Narrative**	**Narrative**	**Narrative**	**pH Dependent**
6/13/06	11:30	5.95	62.7	17.8	18.1	5.97	0.7	113.2	2		0.016	< 0.010	3.850	< 1	< 0.100
6/27/06	11:00	4.81	53.3	20.5	21.8	6.19	1.9	148.3	1		< 0.020	< 0.010	< 0.250	< 1	< 0.100
7/25/06	10:05	3.02	35.5	21.7	23.0	6.16	2.9	153.5	1	1	0.030	< 0.010	< 0.250	< 1	< 0.100
8/8/06	10:10	4.51	53.4	23.8	22.8	6.40	3.0	143.5			0.030	< 0.010	< 0.250	< 1	< 0.100
9/5/06	11:00	5.08	46.6	20.1	21.6		3.2	142.2							
10/19/06	11:25	7.12	69.1	11.8		6.10	1.2	121.0							
10/27/06	11:15			11.3	11.8	6.29	1.5	116.8							
10/31/06	11:25	5.68	52.2	11.1	12.4	6.41	2.9	143.2							

10-PEN, Pennichuck Brook, Railroad Bridge, Hollis - Class A

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	**NA**	**>6.0**	**>75% Daily Average**	**NA**	**NA**	**6.5-8.0**	**<10 NTU above backgrd**	**NA**	**<153**	**<47**	**Narrative**	**Narrative**	**Narrative**	**Narrative**	**pH Dependent**
6/13/06	09:10	3.91	41.8	16.4	19.9	5.41	0.5	111.9	10		0.013	< 0.010	< 0.250	< 1	0.227
6/27/06	08:10	2.64	29.9	21.5	22.5	5.77	1.6	134.4	4		0.040	< 0.010	< 0.250	< 1	< 0.100
6/27/06	08:15										0.033		0.500		
7/25/06	08:00	2.12	24.3	22.5	23.3	5.69	1.8	151.0			0.030	< 0.010	< 0.250	< 1	< 0.100
8/8/06	07:45	2.35	27.9	23.0	21.6	5.86	2.1	167.4	4	5	0.030	< 0.010	< 0.250	< 1	0.680
9/5/06	07:55	3.61	42.8	23.8	16.8		1.8	184.6							
10/19/06	08:05	7.01	66.8	11.1	10.6	5.90	1.0	112.6							
10/27/06	08:10	5.95	61.4	10.6	10.8	6.32	1.1	103.2							

09-PEN, Pennichuck Brook, Holt Pond Dam, Nashua - Class A

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	**NA**	**>6.0**	**>75% Daily Average**	**NA**	**NA**	**6.5-8.0**	**<10 NTU above backgrd**	**NA**	**<406**	**<47**	**Narrative**	**Narrative**	**Narrative**	**Narrative**	**pH Dependent**
6/13/06	12:10	5.84	64.7	19.9	20.1	5.54	1.3	108.0			< 0.010				< 0.100
6/27/06	11:25	5.05	59.3	23.4	24.0	5.91	2.6	164.5	2		0.040	< 0.01	< 0.250	< 1	< 0.100
7/25/06	10:35	4.45	53.0	24.1	24.5	5.81	3.1	171.3	< 2		0.040	< 0.01	< 0.250	< 1	< 0.100
8/8/06	10:40	6.70	81.7	25.5	24.8	6.14	2.7	199.6				< 0.01	< 0.250	< 1	
9/5/06	11:25	6.12	56.3	24.0	23.1		2.1	229.6						< 1	
10/19/06	12:05	5.92	55.9	12.3		6.22	0.8	186.3							
10/27/06	11:40			11.8	12.1	6.51	2.2	214.2							
10/31/06	11:50	4.49	41.8	11.8	12.7	6.38	2.5	177.6							

01-BFB, Boire Field Brook, Tinker Road, Nashua - Class B

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Turbidity (NTUs)	Specific Conductance (uS/cm)	*E. coli* (CTS/100 mL)	*E.coli* Geometric Mean	Total Phosphorus (mg/L)	Phosphorous, Orthophosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate (mg/L)	Ammonia NH3+ (mg/L)
Standard	**NA**	**>5.0**	**>75% Daily Average**	**NA**	**NA**	**6.5-8.0**	**<10 NTU above backgrd**	**NA**	**<153**	**<47**	**Narrative**	**Narrative**	**Narrative**	**Narrative**	**pH Dependent**
6/13/06	11:50	7.62	78.3	16.9	18.1	6.58	2.2	548.0	2		< 0.010	< 0.01	< 0.250	< 1	< 0.100
6/27/06	11:49			21.9	23.0	6.65	2.2	519.0	1		< 0.010	< 0.01	< 0.250	< 1	< 0.100
7/25/06	11:00	5.69	65.3	22.1	24.6	6.47	2.3	375.5	1	1	0.040	< 0.01	< 0.250	< 1	0.420
8/8/06	11:00	6.16	70.9	22.3	24.1	6.73					0.030	< 0.01	3.050	< 1	< 0.100
9/5/06	11:45	6.82	64.7	22.7	22.4		1.6	362.4							
10/19/06	12:20		69.6	12.1		6.04	2.2								
10/27/06	12:10			11.9	12.0	6.08	1.8	302.1							
10/31/06	12:10	5.26	48.9	11.4	13.1	6.16	1.3								