New Hampshire Volunteer River Assessment Program
2006 Wildcat Brook Tributaries & Ellis River
Water Quality Report

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

January 2007

NHDES- WD-07-24

New Hampshire Volunteer River Assessment Program 2006 Wildcat Brook & Ellis River Water Quality Report

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January 2007

Photo: Station 00K-WLD: The confluence of Thorn Hill Brook and the Wildcat Brook

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ACKNOWLEDGEMENTS

The New Hampshire Department of Environmental Services Volunteer River Assessment Program extends sincere thanks to the volunteers of the Jackson VRAP Group and the Jackson Conservation Commission for their efforts. 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.

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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 or by NHDES staff at the request of the 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 hand-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.

2.5.1 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 2003, the Jackson Conservation Commission, in conjunction with the NHDES Volunteer River Assessment Program began a water quality monitoring program on surface waters in the town of Jackson including Great Brook, Wildcat Brook, the Ellis River, and their tributaries. A water quality monitoring program was initiated by the suggestion of the Jackson Planning Board in considering recommendations in the town's master plan. The goal of this effort was to provide water quality data from the rivers and streams in the town of Jackson relative to surface water quality standards and to allow for the assessment of the river for support of aquatic life and primary contact recreation (swimming). 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, financial assistance for laboratory costs, and technical assistance.

During 2006, the Jackson VRAP group decided to forego instantaneous measurement and to instead use multiparameter dataloggers to collect water quality measurements. Two separate datalogger deployments were completed at a total of six stations. The first deployment included one station on Wildcat Brook and two stations on the Ellis River. These stations corresponded with locations where volunteers had collected instantaneous readings in past years. The second deployment was done in response to concerns about high specific conductance levels in some tributaries to the Wildcat Brook. As part of the investigation into the high specific conductance levels, VRAP staff also collected instantaneous readings in the area of concern. Table 2 lists the locations of the stations monitored in 2006 both by multiparameter dataloggers and instantaneous measurements. Figure 1 depicts those stations monitored on Wildcat Brook and the Ellis River with multiparamter dataloggers. Figure 2 depicts stations that were sampled with multiparameter dataloggers and/or instantaneous measurements while investigating high specific conductance levels in the Wildcat Brook watershed.

Stations IDs are designated using a three letter code to identify the waterbody name plus a number indicating the relative position of the station. The higher the station number the more upstream the station is in the watershed. All stations monitored in 2006 are designated as Class B waters.

Laboratory samples for *E.coli*, total phosphorus, and chloride were taken using sterile and/or preserved bottles supplied by 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 -Wildcat Brook Tributaries & Ellis River, VRAP, 2006

Station ID	Waterbody Name	Location	Town	Elevation*(Ft.)
07-ELL	Ellis River	Ellis River: Route 16, Downstream of Rocky Branch	Jackson	1000
01-WLD	Wildcat Brook	Wildcat Brook: Route 16A Bridge	Jackson	800
00P-WLD	Wildcat Brook	100 Feet Upstream from Thorn Hill Brook	Jackson	800
04-TRB	Thorn Hill Brook	Route 16A Bridge	Jackson	800
03-TRB	Thorn Hill Brook	100 Feet Upstream from Unnamed Salt Pile Tributary	Jackson	800
03-THT	Unnamed Tributary to Thorn Hill Brook	Inlet to Culvert Under Route 16A	Jackson	800
02-THT	Unnamed Tributary to Thorn Hill Brook	Downstream Side of Culvert Under Route 16	Jackson	800
01-THT	Unnamed Tributary to Thorn Hill Brook	25 Feet Above Confluence with Thorn Hill Brook	Jackson	800
02-TRB	Thorn Hill Brook	Just Upstream From Outlet of Fire Pond	Jackson	800
01K-TRB	Thorn Hill Brook	Fire Pond Inlet	Jackson	800
01F-TRB	Thorn Hill Brook	Fire Pond Outlet	Jackson	800
01-TRB	Thorn Hill Brook	10 Feet Upstream of Confluence w/ Wildcat Brook	Jackson	800
00K-WLD	Wildcat Brook	Wildcat Brook: 100 Feet Downstream from Thorn Hill Brook	Jackson	800
03-ELL	Ellis River	Ellis River: Jackson/Bartlett Town Line	Jackson	800

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

Figure 1. Wildcat Brook and Ellis River Monitoring Stations 2006

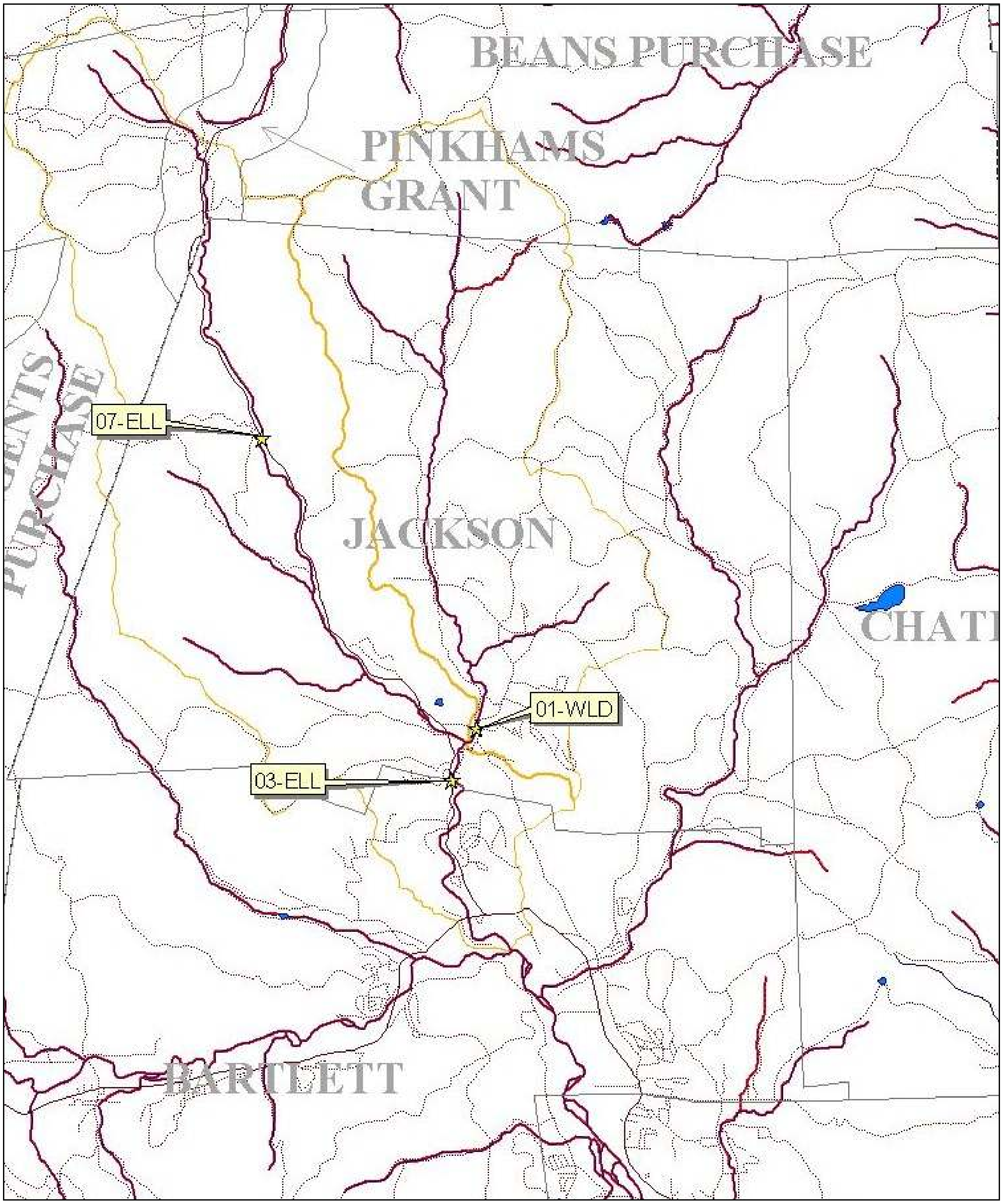


Figure 2. Wildcat Brook Watershed Specific Conductance Monitoring Stations 2006

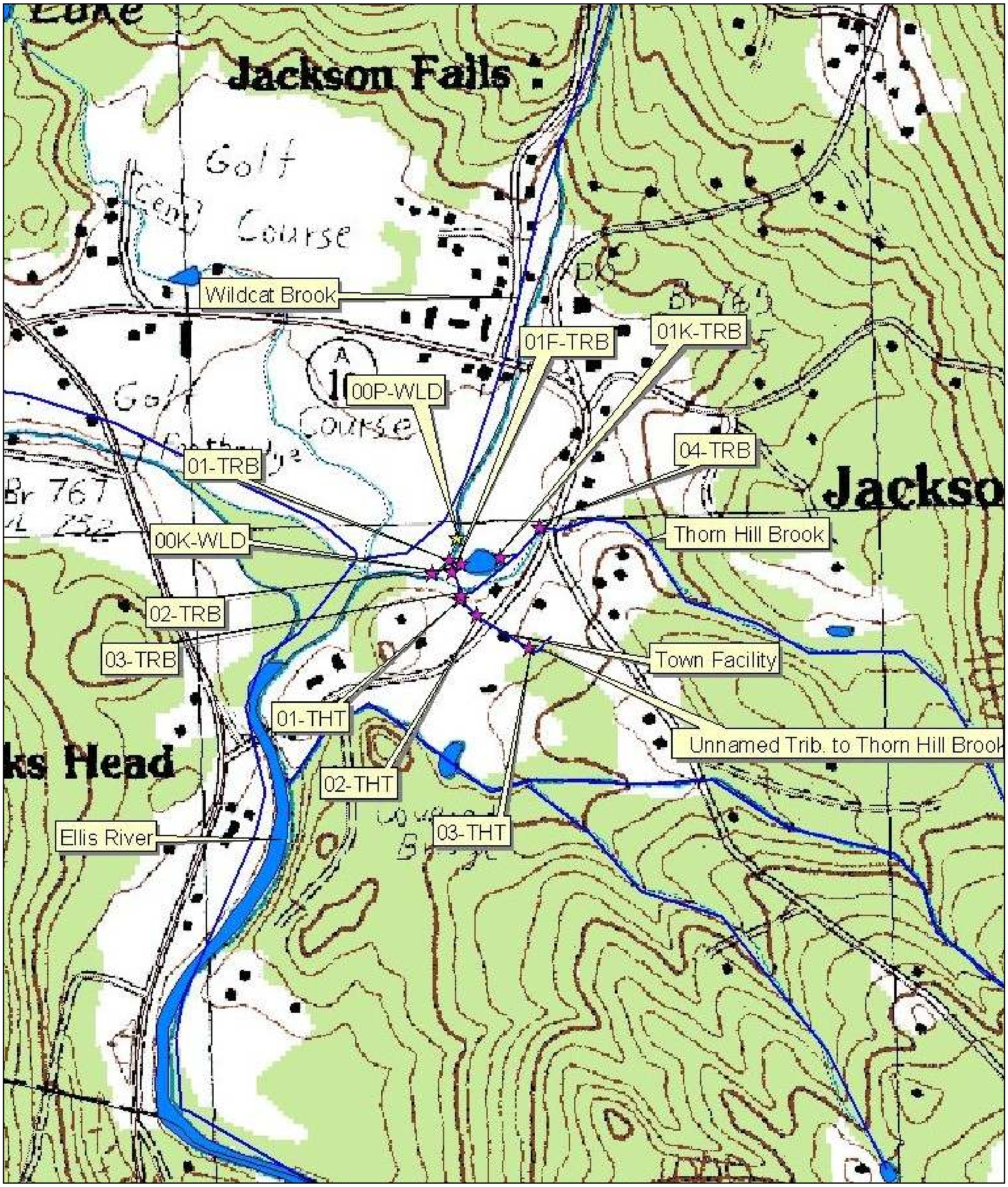


Table 3. Sampling and Analysis Methods

Parameter	Sample Type	Standard Method	Equipment Used	Laboratory
Temperature	In-Situ	SM 2550	YSI 85	------
	Datalogger	SM 2550	YSI XLM 6000	------
Dissolved Oxygen	In-Situ	SM 4500 O G	YSI 85	------
	Datalogger	SM 4500 O G	YSI XLM 6000	------
pH	In-Situ	SM 4500 H+	Oakton 9	------
	Datalogger	SM 4500 H+	YSI XLM 6000	------
Turbidity	In-Situ	EPA 180.1	LaMotte 2020e	------
Specific Conductance	In-Situ	SM 2510	YSI 30	------
	Datalogger	SM 2510	YSI XLM 6000	------
E.coli	Bottle (Sterile)	SM 19 9213 D3	------	NHDES
Total Phosphorus	Bottle (Preserved)	EPA 365.3	------	NHDES
Chloride	Bottle	EPA 325.2	------	NHDES

4.0 RESULTS AND RECOMMENDATIONS

4.1 Dissolved Oxygen

Two measurements were taken in the field for dissolved oxygen concentration at one station on Wildcat Brook and two stations on the Ellis River in Jackson. (Table 4). These measurements were taken during the deployment and retrieval of multiparameter dataloggers. Of the six 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.

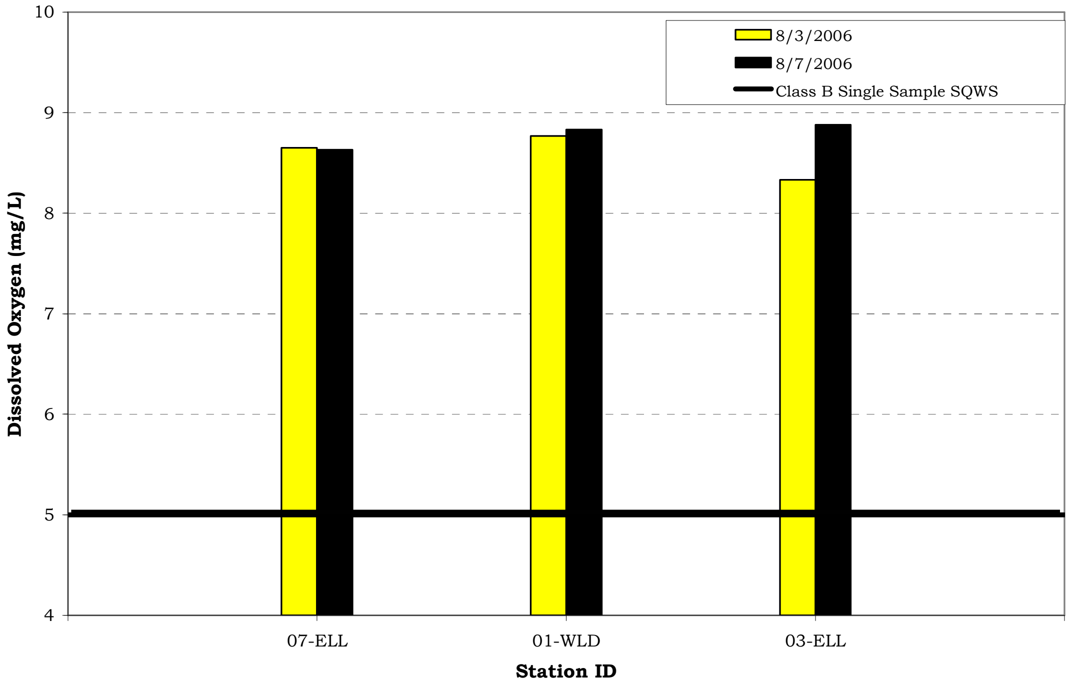
The Class B New Hampshire surface water quality standard for dissolved oxygen includes a minimum concentration of 5.0 mg/L **and** a minimum daily average of 75 percent of saturation. In other words, there are criteria for both concentration and saturation that must be met before the river can be assessed 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) Data Summary – Wildcat Brook & Ellis River, 2006

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
07-ELL	2	8.63-8.65	0	2
01-WLD	2	8.77-8.33	0	2
03-ELL	2	8.33-8.88	0	2
Total	**6**	____	**0**	**6**

Dissolved oxygen concentration levels were well above New Hampshire surface water quality standards at all stations and on all occasions (Figure 3). The average concentration of dissolved oxygen was consistently above the Class B standard at all stations ranging from 8.61 mg/L to 8.80 mg/L. Levels of dissolved oxygen sustained above the standards are considered adequate for the support of aquatic life and other desirable water quality conditions.

Figure 3. Dissolved Oxygen Statistics - Wildcat Brook/Ellis River
August 3 and August 7, 2006, NHDES VRAP



Figures 4 and 5 illustrate the results of dissolved oxygen concentration and saturation levels obtained at one station on Wildcat Brook and two stations on the Ellis River using submersible dataloggers that were deployed from August 3 through August 7. The meters were programmed to take dissolved oxygen readings every 15 minutes. Data from these meters is generally analyzed in 24 hour sections. During this deployment three full 24-hour periods were measured.

The daily average of dissolved oxygen % saturation was above the Class B standard of 75 % at all stations and on all days. Dissolved oxygen concentration levels were also above the standard at all stations and at all times.

Figures 4 and 5 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 4. Dissolved Oxygen Saturation Statistics - Wildcat Brook/Ellis River
August 3 - 7, 2006, NHDES VRAP

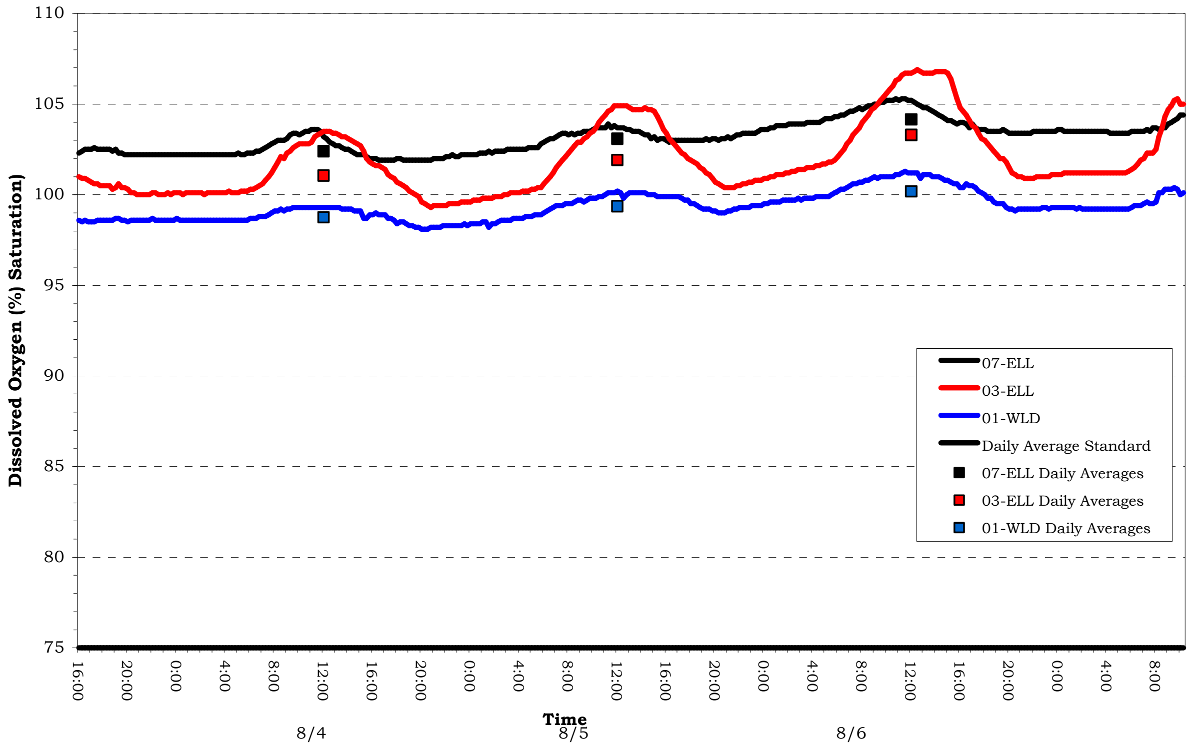
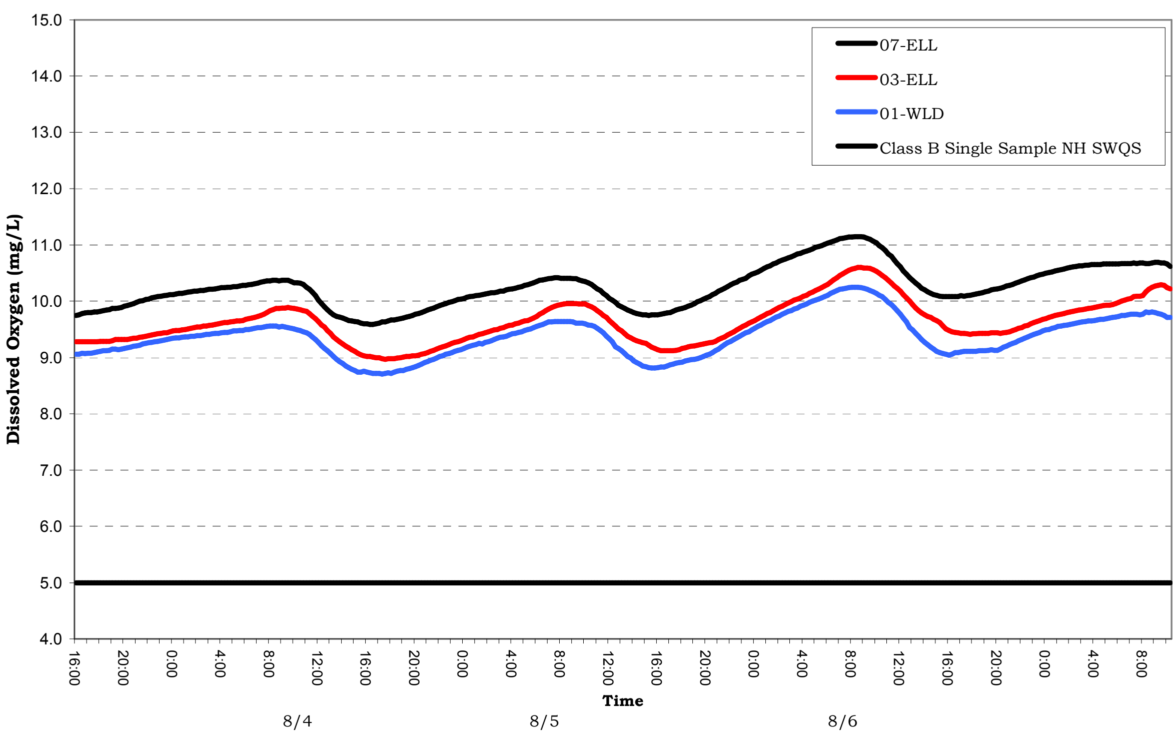


Figure 5. Dissolved Oxygen Concentration Statistics - Wildcat Brook/Ellis River
August 3 - 7, 2006, NHDES VRAP



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.
- Continue to 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 percent 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

Two measurements were taken in the field for pH at one station on Wildcat Brook, three stations on Wildcat Brook tributaries, and two stations on the Ellis River (Table 5]. These measurements were taken during the deployment and retrieval of multiparameter dataloggers. Of the 12 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 B New Hampshire surface water quality standard is 6.5 - 8.0, unless naturally occurring.

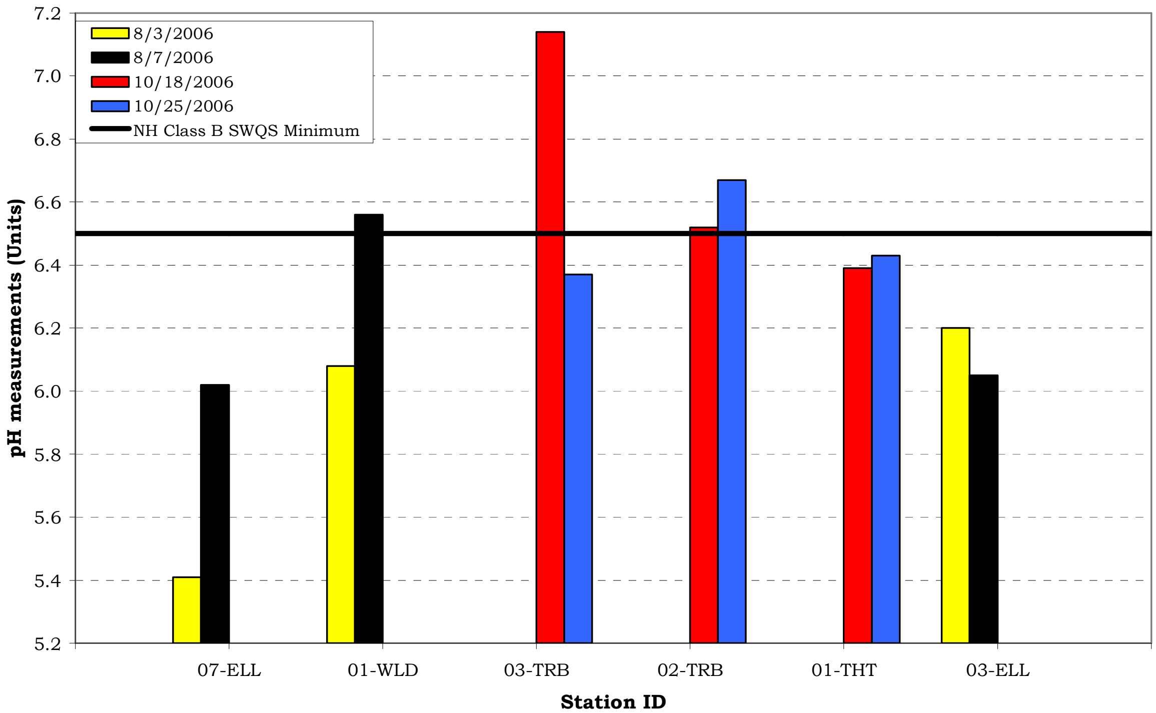
Table 5. pH Data Summary - Wildcat Brook & Ellis River, 2006

Station ID	Samples Collected	Data Range (standard units)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
07-ELL	2	5.41-6.02	2	2
01-WLD	2	6.08 - 6.56	1	2
03-TRB	2	6.37 - 7.14	1	2
02-TRB	2	6.52 - 6.67	0	2
01-THT	2	6.39 - 6.43	2	2
03-ELL	2	6.05 - 6.20	1	2
Total	**12**	____	**7**	**12**

A majority of the pH measurements were below the minimum New Hampshire Class B surface water quality standard (Figure 6).

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 6. pH Statistics -Wildcat Brook/Ellis River
August and October, 2006, NHDES VRAP



Figures 7 and 8 illustrate the results of pH measurements obtained at six stations in the Ellis River and Wildcat Brook watersheds using submersible multiparameter dataloggers. The meters were programmed to take pH readings every 15 minutes over a multiple day period. In general the daily minimum is used to determine the waterbodies are meeting surface water quality standards.

During the first datalogger deployment depicted in Figure 7, station 03-ELL met surface water quality standards on all occasions, while station 07-ELL fell below the minimum surface water quality standard on all occasions. Station 01-WLD fluctuated above and below the minimum surface water quality standard, with most measurements below the standard.

During the second deployment depicted in Figure 8, all three stations (03-TRB, 01-THT, and 02-TRB) had pH measurements that fluctuated above and below the minimum pH water quality standard. Stations 03-TRB and 01-TRB on Thorn Hill Brook are very close to each other (100 feet) and they bracket where the unnamed tributary station 01-THT enters Thorn Hill Brook. During the datalogger deployment it appears that the unnamed tributary to Thorn Hill Brook is influencing the pH at the downstream station 01-TRB.

Figure 7. pH Statistics - Wildcat Brook/Ellis River
August 3 - 7, 2006, NHDES VRAP

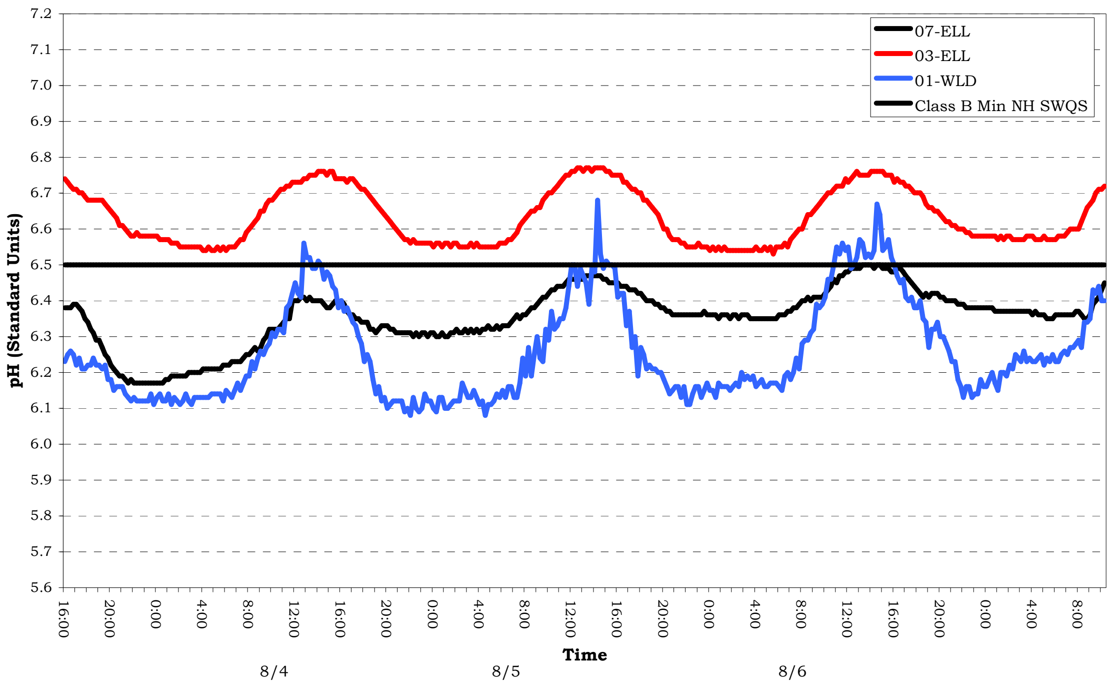
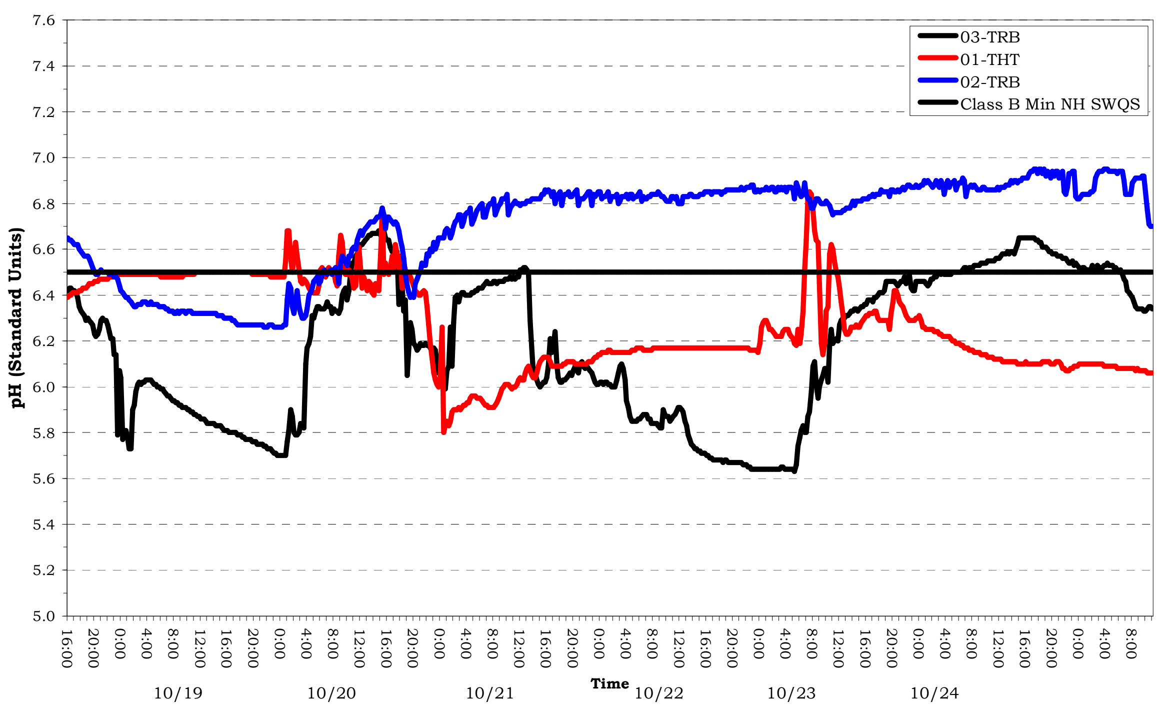


Figure 8. pH Statistics - Wildcat River & Tributaries
October 18 - 25, 2006, NHDES VRAP



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 Specific Conductance/Chloride

Between one and three measurements were taken in the field for specific conductance at 13 stations in the Ellis River watershed [Table 6]. These measurements were taken during the deployment and retrieval of multiparameter dataloggers. Of the 23 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 6. Specific Conductance Summary - Wildcat Brook & Ellis River, 2006

Station ID	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
07-ELL	2	31 - 36.4	Not Applicable	2
01-WLD	2	25.4 - 27.8	N/A	2
00P-WLD	1	29.2	N/A	1
04-TRB	1	101.4	N/A	1
03-TRB	1	102.4	N/A	1
03-THT	2	57400 - 75200	N/A	2
02-THT	2	23360 - 26000	N/A	2
01-THT	1	17330	N/A	1
02-TRB	2	490 - 9800	N/A	2
01F-TRB	3	101.1 - 115.3	N/A	3
01-TRB	2	479 - 1600	N/A	2
00K-WLD	2	32.4 - 64	N/A	2
03-ELL	2	35.4 - 45.6	N/A	2
Total	**23**	_____	**N/A**	**23**

Specific conductance levels were low at those stations on Wildcat Brook and the Ellis River. They were also low at those stations on Thorn Hill Brook upstream of the unnamed tributary to Thorn Hill Brook. Specific conductance levels were extremely high in the unnamed tributary to Thorn Hill Brook and these high levels were impacting Thorn Hill Brook below the confluence. Despite the high conductivity levels in Thorn Hill Brook at the confluence with Wildcat Brook, it does not appear to be having a significant impact on Wildcat Brook. This is due to the higher volume of water in Wildcat Brook which is thus able to ameliorate the high conductivity levels via dilution.

Higher specific conductance levels can be indicative of pollution from sources such as urban/agricultural runoff, road salt, failed septic systems, or groundwater pollution.

Figure 9 illustrates the results of specific conductance measurements obtained at one station on Wildcat Brook and two stations on the Ellis River using submersible dataloggers that were deployed from August 3 through August 7. The meters were programmed to take specific conductance readings every 15 minutes.

Specific conductance levels were low at all three stations (07-ELL, 01-WLD, 03-ELL) and consistent with the instantaneous measurements. The low specific conductance at these stations indicate low pollutant levels.

Figure 9. Specific Conductance Statistics - Wildcat Brook/Ellis Riverr
August 3 - 7, 2006, NHDES VRAP

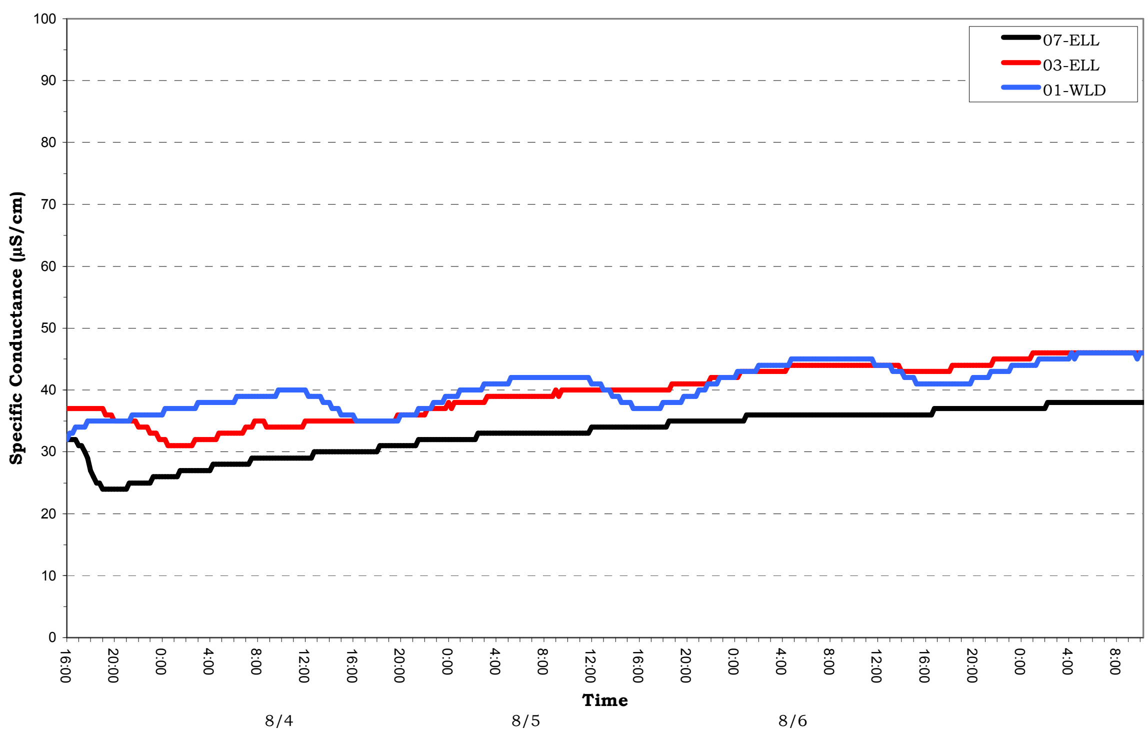
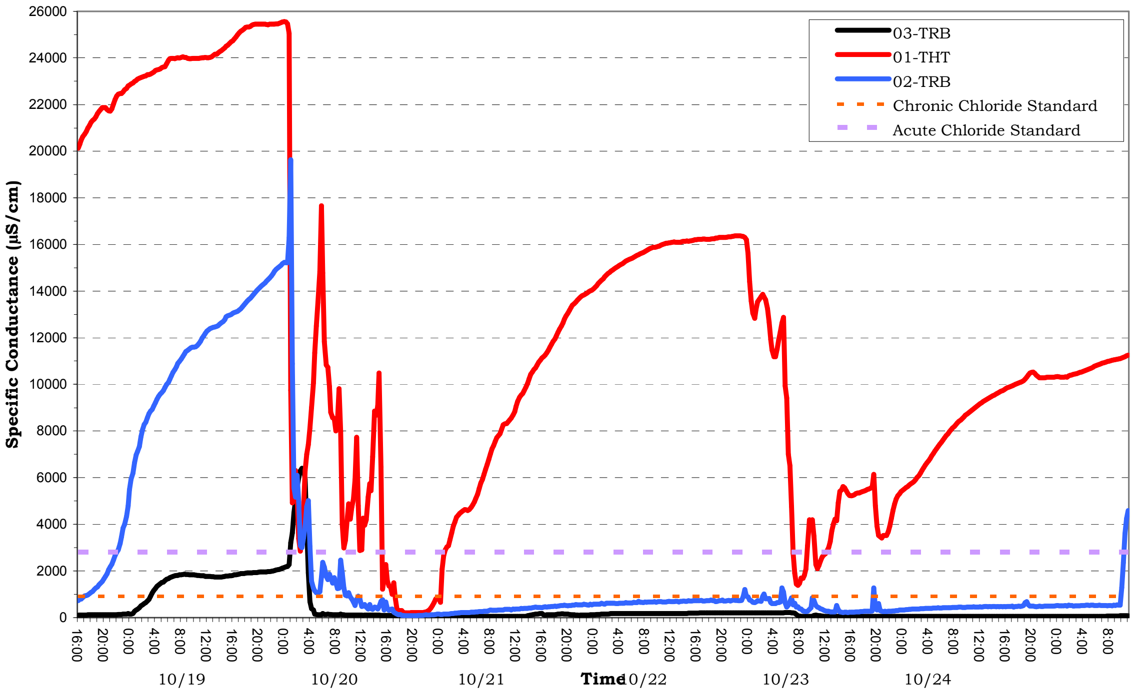


Figure 10 illustrates the results of specific conductance measurements obtained at two stations on Thorn Hill Brook and one stations on an unnamed tributary to Thorn Hill Brook that were deployed from October 18 through October 25. The meters were programmed to take specific conductance readings every 15 minutes.

Figure 10. Specific Conductance Statistics for the Thorn Hill Brook Watershed
October 18 - 25, 2006, NHDES VRAP



All three stations (03- THT, 01-TRB, and 02-TRB) had extremely high specific conductance levels. The town of Jackson's salt and sand pile is located upstream of the stations on the unnamed tributary to Thorn Hill Brook. It is likely that this salt pile is the primary reason for the high specific conductance levels.

Although NHDES does not have a formal water quality standard for specific conductance, data collected by NHDES and VRAP volunteers indicate that there is a very close relationship between specific conductance and chloride for which there is a formal standard. Figure 11 depicts a regression model between chloride and specific conductance from data collected by NHDES. The regression model depicts the very tight relationship between specific conductance and chloride. This correlation allows NHDES to estimate at what specific conductance value the chloride standard is exceeded.

The Class B New Hampshire surface water quality standard for chloride and corresponding specific conductance levels are as follows:

	Chloride	Specific Conductance
Freshwater chronic	230 mg/l	900 µS/cm
Freshwater acute	860 mg/l	2300 µS/cm

During the retrieval of the dataloggers NHDES collected three chloride samples on October 25 simultaneously with specific conductance (Table 7).

Table 7. Chloride Data Summary - Wildcat Brook Tributaries, 2006

Station ID	Samples Collected	Chloride (mg/l)	Specific Conductance (µS/cm)	Acceptable Samples Not Meeting Chloride Standard	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
03-TRB	1	3700	11090	1	1
02-TRB	1	1800	5390	1	1
01-THT	1	7500	22690	1	1
Total	**3**	_____		**3**	**3**

The datalogger measurements depicted in Figure 10 and the chloride samples shown in Table 7 indicate that at all three stations chloride levels exceed the chronic standard and at stations 03-TRB and 01-THT the acute standards was also exceeded. This data indicates a significant chloride impairment at those stations monitored in the Thorn Hill Brook watershed.

Although chloride can originate from natural sources, most of the chloride that enters the environment is associated with the storage and application of road salt. Road salt readily dissolves and enters aquatic environments in ionic forms. As such, chloride-containing compounds commonly enter surface water, soil, and groundwater during late-spring snowmelt (since the ground is frozen during much of the late winter and early spring). Chloride ions are conservative, which means they are not degraded in the environment and tend to remain in solution, once dissolved. Chloride ions that enter ground water can ultimately be expected to reach surface water and, therefore, influence aquatic environments and humans. Additional human sources of chloride can come from fertilizers, septic systems, and water softening systems.

Recommendations

- Further investigation should be conducted to confirm the source of the high specific conductance levels in the Thorn Hill Brook watershed. Where possible steps should be initiated to reduce or eliminate the sources of these high levels.

- Continue sampling at all stations in order to develop a long-term data set to better understand trends as time goes on. This will be particularly important if steps are taken to reduce chloride loading and will allow for the monitoring of any subsequent reductions that occur.

- Continue collecting chloride samples at the same time that specific conductance is measured.

- Continue the use of dataloggers to determine specific conductance levels during rain events, snowmelt, and baseline dry weather conditions.

4.4 Water Temperature

Two measurements were taken in the field for water temperature at one station on Wildcat Brook and two stations on the Ellis River [Table 8]. Of the six 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.

In addition to the instantaneous measurements, from August 3 through August 7, submersible dataloggers were deployed at one station on Wildcat Brook and two stations on the Ellis River and recorded water temperature data every 15 minutes.

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 – Wildcat Brook & Ellis River, 2006

Station ID	Samples Collected	Data Range (C)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
07-ELL	2	17.6 - 17.8	Not Applicable	2
01-WLD	2	17.8 - 19.2	N/A	2
03-ELL	2	17.2 - 19.3	N/A	2
Total	**6**	_____	**N/A**	**6**

Figure 11 shows the results of instantaneous water temperature measurements taken at two stations on the Ellis River and one station on Wildcat Brook. The average water temperature varied from 17.7 °C. to 18.5 °C.

Figure 12 shows the results of water temperature obtained at one station on the Wild River and two stations on the Ellis River using submersible dataloggers. During the deployment three full 24 hour period were analyzed.

Figure 11. Water Temperature Statistics for the Wildcat Brook/Ellis River
August 3 and August 7, 2006, NHDES VRAP

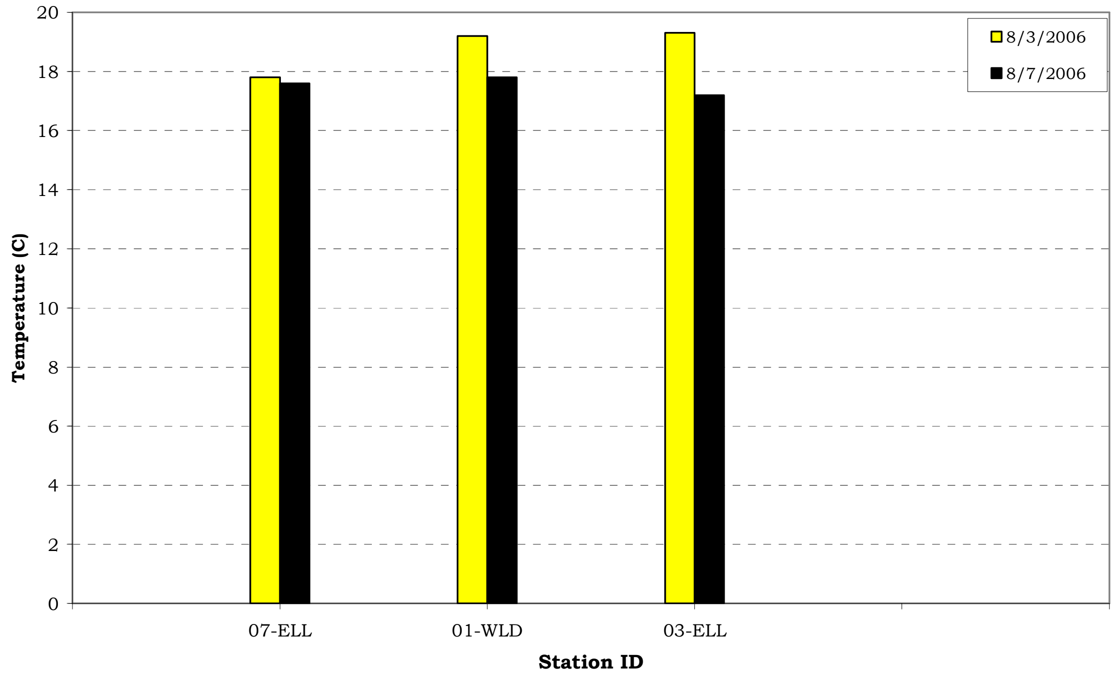
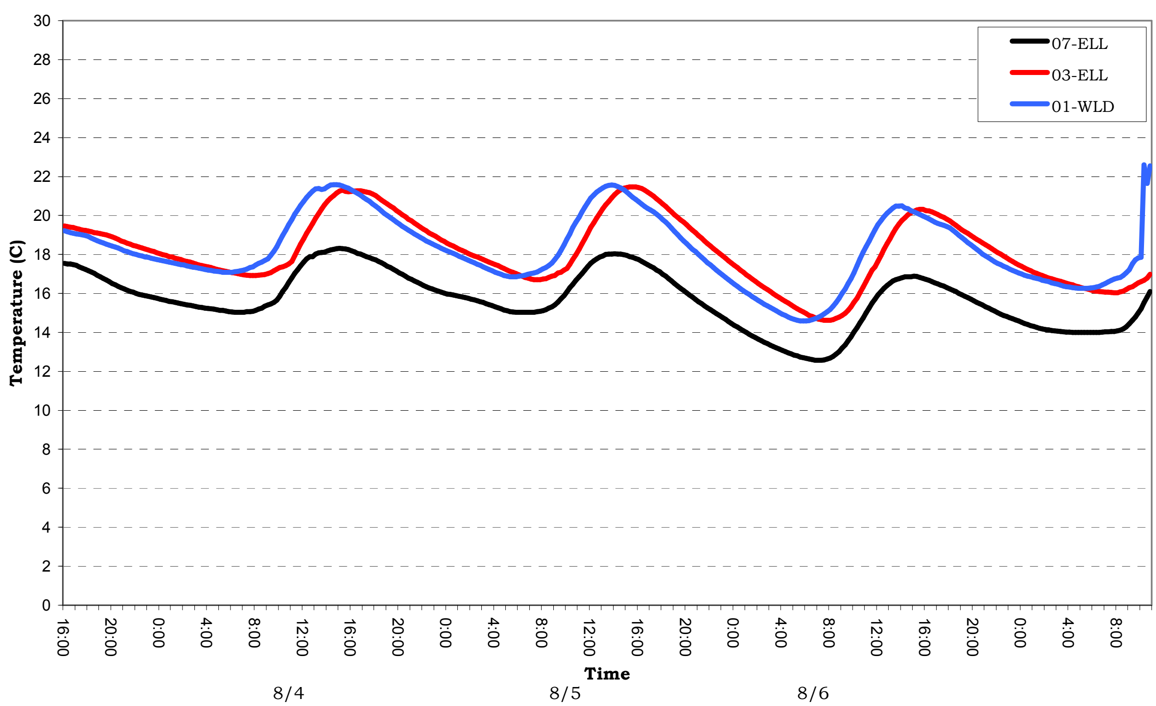


Figure 12. Water Temperature Statistics - Wildcat Brook/Ellis River
August 3 - 7, 2006, NHDES VRAP



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 instantaneous readings and consider long-term deployment of NHDES temperature dataloggers.

4.5 *Escherichia coli*/Bacteria

One sample was taken for *Escherichia coli* (*E. coli*) at two stations on Thorn Hill Brook in Jackson. The stations correspond to the inlet (01K-TB) and outlet (01F-TRB) of the Jackson Fire Pond (Table 9). Both samples 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 B New Hampshire surface water quality standards for *E.coli* are as follows:

$\leq$406 cts/100 ml, based on any single sample, or
$\leq$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 - Fire Pond Inlet/Outlet, 2006

Station ID	Samples Collected	Data Range (cts/100 ml)	Acceptable Samples Not Meeting NH Class B Standards	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01K-TRB	1	250	0	1
01F-TRB	1	20	0	1
Total	**2**	_____	**0**	**2**

Both stations were below the single sample New Hampshire water quality standard for *E.coli*. Station 01K-TRB had higher levels of *E.coli* than 01F-TRB so it appears that on this day bacteria levels were higher coming into the pond than exiting. 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. Since only one sample was collected a geometric mean could not be calculated.

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.

Recommendations

- Collect three samples within any 60-day period during the summer to allow for determination of geometric means.
- 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.

4.5 Total Phosphorus

One sample was taken for total phosphorus at two stations on Thorn Hill Brook in Jackson. The stations correspond to the inlet (01K-TB) and outlet (01F-TRB) of the Jackson Fire Pond (Table 10). Both samples 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 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 phosphorus is 0.05 mg/L.

Table 10. Total Phosphorus Data Summary – Fire Pond Inlet/Outlet, 2006

Station ID	Samples Collected	Data Range (mg/l)	Acceptable Samples Exceeding NHDES Level of Concern	Number of Usable Samples for 2008 NH Surface Water Quality Assessment
01K-TRB	1	0.010	0	1
01F-TRB	1	0.024	0	1
Total	**2**	_____	**0**	**2**

Total phosphorus levels were below the NHDES "level of concern" at both stations. Station 01F-TRB had higher levels of total phosphorus than 01K-TRB so it appears that on this day total phosphorus levels were higher exiting the pond than entering.

Under undisturbed natural conditions phosphorus is at very low levels in aquatic ecosystems. Of the three nutrients critical for aquatic plant growth; potassium, nitrogen, and phosphorus, it is usually phosphorus that is the limiting factor to plant growth. When the supply of phosphorus is increased due to human activity, algae respond with significant growth.

A major source of excessive phosphorus 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.

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 Wildcat Brook & Ellis River Water Quality Data

2006 WILDCAT BROOK/ELLIS RIVER VRAP DATA

Measurements not meeting New Hampshire surface water quality standards
Measurements not meeting NHDES quality assurance/quality control standards

[A] Chronic Standard
[B] Acute Standard

07-ELL, Ellis River, Route 16 Downstream of Rocky Branch, Jackson

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Specific Conductance (µS/cm)
Standard	NA	>5.0	>75% Daily Average	Narrative	NA	6.5-8.0	NA
8/3/06	12:25	8.65	90.8	17.8	19.4	5.41	31.0
8/7/06	13:21	8.63	90.4	17.6		6.02	36.4

01-WLD, Wildcat Brook, Route 16A Bridge, Jackson

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Specific Conductance (µS/cm)
Standard	NA	>5.0	>75% Daily Average	Narrative	NA	6.5-8.0	NA
8/3/06	13:07	8.77	94.8	19.2		6.08	25.4
8/7/06	12:05	8.83	92.8	17.8	22.0	6.56	27.8

00P-WLD, 100 Feet Upstream of Thorn Hill Brook, Jackson

Date	Specific Conductance (µS/cm)
Standard	NA
10/18/06	29.2

04-TRB, Route 16A Bridge, Jackson

Date	Time of Sample	Specific Conductance (µS/cm)
Standard	NA	NA
10/18/06	13:00	101.4

03-TRB, 10 Feet Upstream from Unnamed Salt Pile Tributary, Jackson

Date	Time of Sample	Water Temp. (°C)	pH	Specific Conductance (µS/cm)	Chloride (mg/L)
Standard	NA	Narrative	6.5-8.0	NA	<230[A]/860[B]
10/18/06	13:01	8.8	7.14	102.4	
10/25/06	11:11	7.0	6.37	11090	3700

03-THT, Inlet to Culvert Under Route 16A, Jackson

Date	Specific Conductance (µS/cm)
Standard	NA
8/7/06	75200
10/18/06	57400

02-THT, Downstream Side of Culvert Route 16, Jackson

Date	Time of Sample	Specific Conductance (µS/cm)
Standard	NA	NA
8/7/06	13:25	26000
10/18/06	13:45	23360

01-THT, 25 Feet Above Confluence with Thorn Hill Brook, Jackson

Date	Time of Sample	Water Temp. (°C)	pH	Specific Conductance (µS/cm)	Chloride (mg/L)
Standard	NA	Narrative	6.5-8.0	NA	<230[A]/860[B]
10/18/06	12:59	9.6	6.39	17330	
10/25/06	11:26	7.6	6.43	22690	7500

02-TRB, Just Upstream of Outlet to Fire Pond, Jackson

Date	Time of Sample	Water Temp. (°C)	pH	Specific Conductance (µS/cm)	Chloride (mg/L)
Standard	NA	Narrative	6.5-8.0	NA	<230[A]/860[B]
8/7/06	13:00			9800	
10/18/06	12:54	9.3	6.52	490	
10/25/06	11:33	7.1	6.67	5390	1800

01K-TRB, Fire Pond Inlet, Jackson

Date	Time of Sample	Specific Conductance (µS/cm)	Total Phosphorus (mg/L)	*E.Coli* (cts/100 ml)
Standard	NA	NA	Narrative	<406
8/7/06	11:22	115.3	0.010	250
10/18/06	13:10	101.1		

01F-TRB, Fire Pond Outlet, Jackson

Date	Time of Sample	Specific Conductance (µS/cm)	Total Phosphorus (mg/L)	*E.Coli* (cts/100 ml)
Standard	NA	NA	Narrative	<406
8/7/06	11:22	115.3	0.024	20
10/18/06	13:10	106.1		

01-TRB, 10 Feet Upstream of Confluence with Wildcat Brook, Jackson

Date	Time of Sample	Specific Conductance (µS/cm)
Standard	NA	NA
8/7/06	13:10	1600
10/18/06	13:35	479

00K-WLD, 100 Feet Downstream from Thorn Hill Brook, Jackson

Date	Time of Sample	Specific Conductance (µS/cm)
Standard	NA	NA
8/7/06	13:05	64.0
10/18/06	13:40	32.4

03-ELL, Ellis River, Jackson/Bartlett Town Line, Jackson

Date	Time of Sample	DO (mg/L)	DO (% sat.)	Water Temp. (°C)	Air Temp. (°C)	pH	Specific Conductance (µS/cm)
Standard	NA	>5.0	>75% Daily Average	Narrative	NA	6.5-8.0	NA
8/3/06	11:11	8.33	90.0	19.3		6.20	35.4
8/7/06	10:50	8.88	92.3	17.2		6.05	45.6