

2006

**Volunteer Biological  
Stream Data Collection Report  
for the Ossipee Watershed**



R-WD-06-42

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Stream Data Collection Report  
for the Ossipee Watershed**

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## **ACKNOWLEDGEMENTS**

The data presented in this report was collected entirely by volunteers of the Green Mountain Conservation Group (GMCG). DES would like to thank all of the individuals who participated in the 2006 Volunteer Biomonitoring Assessment Program:

Jamie Riel & the Tamworth Learning Circle  
Justin Chapman & the Sandwich Elementary School  
Liz Ahearn, Center Tuftonboro  
Emelyn Albert, Effingham  
Sylvia Carney, Freedom  
Anne Garland, Jackson  
Ned Hatfield, Freedom  
Kate Horam, Preston UK  
Julie Horam, Preston UK  
Frank Lucas, Freedom  
Elena Piekut, Effingham  
Lee Pollock, Madison  
John Shipman, Freedom  
Tara Schroeder, GMCG Director  
Henry Spencer, Effingham  
Theresa Swanick, Freedom  
Maynard Thomson, Freedom  
Kate Yarrison, Tamworth

### **DES Staff Assistance**

Elizabeth Durfee  
Miles Waniga  
Sally Soule

## 2006 Ossipee Watershed Annual VBAP Report

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## **1. INTRODUCTION**

The New Hampshire Department of Environmental Services (DES) is continuously conducting stream surveys to determine the health of aquatic communities. As part of these efforts the DES is working to develop a screening protocol for 1<sup>st</sup> through 4<sup>th</sup> order streams that is appropriate for volunteers and untrained professionals to evaluate biological condition. The goals are to supplement biological data collected by the DES, educate the public about water quality issues as interpreted through biological assessments, build a constituency of citizens to practice sound water quality management at a local level, and build public support for water quality protection.

Since 2004, the DES has coordinated efforts with several local organizations to develop the Volunteer Biological Assessment Program (VBAP). In 2006, the DES worked with the Green Mountain Conservation Group (GMCG), a non-profit charitable organization concerned with natural resource conservation in the Ossipee Watershed, to; (1) determine the level of volunteer interest and ability to collect biological data (2) evaluate the effectiveness of the VBAP protocol and associated biotic index, and (3) initiate and complete biological sampling of macroinvertebrates in several streams within the Ossipee watershed.

Throughout September, the DES biomonitoring program, GMCG staff, and volunteers sampled 11 sites throughout the Ossipee watershed (Map 1.1). The Ossipee watershed is a part of the greater Saco River basin. It contains 82 lakes and ponds which cover approximately 9,400 acres contained within 13 towns in Carroll and Grafton County. Tributaries located in the Ossipee watershed flow into the Saco River and terminate in the Atlantic Ocean. All sites were located within the Ossipee watershed except Banfield Brook which is a part of the larger Saco watershed. Banfield Brook, was chosen by the GMCG to monitor potential impacts associated with local development.

Macroinvertebrates, which vary in their ability to tolerate pollutants and are useful water quality indicators, were identified and counted by volunteers. In doing so, they were able to complete screening level investigations of the general condition of aquatic communities based on the types and quantity of macroinvertebrates present. Physical, biological, and chemical data were collected at each site and are included in the subsequent sections of this report.

## **2. METHODS**

### **2.1 Sampling sites and data collection**

All sites were accessible, wadeable, a minimum of 50 yards upstream from major human influences on the stream, approximately 50 to 200 feet in length, and contained appropriate sampling habitat (at least 1 riffle with mixed cobble substrate). Sampling was scheduled throughout September and required 2 to 4 hours per site. The number of volunteers sampling was recorded at each site.

Prior to any sampling, a training session was held and consisted of three major components; (1) macroinvertebrate sampling (2) macroinvertebrate identification, and (3) biotic index computation. Volunteers were also trained to collect and record supplementary data which consisted of basic physical and chemical parameters.

## 2.2 Macroinvertebrate sampling

Before collecting macroinvertebrates, site information was recorded and a representative sample reach was identified (50 to 200 feet in length) and sketched on the Volunteer Biomonitoring Habitat Data Sheet (Appendix 2.1). Volunteers were careful not to walk in the stream to avoid disturbing biological communities. After site information was recorded and sampling locations were identified, macroinvertebrates were collected by placing a 500 micron mesh kicknet perpendicular to stream flow and firmly against the streambed with the opening of the net faced upstream to promote macroinvertebrate collection. Another person stood upstream of the net and disturbed the sample area (1/5 m<sup>2</sup>) for a total of 60 seconds (30 second hand-scrub followed by a 30 second kick). Subsequently, the kicknet was carefully lifted out of the water and the same process was repeated four additional times with each sample collected further upstream. Collectively, active sampling time approximated 5 minutes within 1m<sup>2</sup> area at each sampling station (i.e. stream).

Once the collection process was complete, the contents of the net were transferred into a container fitted with 500 micron wire mesh and all organisms remaining on the net were carefully removed and added to the sample. The sample was mixed for approximately 15 seconds and divided into 4 approximately equal portions. One portion of the sample was randomly selected for sorting and transferred to a separate tray(s). The remaining sample was kept in the wire mesh pan and submersed in a plastic basin with water to prevent the sample from drying.

## 2.3 Macroinvertebrate sorting and identification

Volunteers removed macroinvertebrates from the selected portion of the sample with spoons, forceps, or pipettes for 1 hour and placed them into separate containers. If the first portion of the sample was completely sorted before 1 hour of sorting time had elapsed, an additional portion was selected. After sorting, specimens were identified to various coarse taxonomic groups (Table 1). The number of people sorting, cumulative sorting effort (1 hour x # people sorting), and approximate fraction of the total sample sorted were recorded.

**Table 1.** The Order and common name of aquatic macroinvertebrates identified in the VBAP.

Order	Common Name	Tolerance value
Ephemeroptera	Mayfly nymph	3
Plecoptera	Stonefly nymph	1
Trichoptera	Caddisfly larvae	4
Odonata	Dragonfly nymph	3
	Damselfly nymph	7
Diptera	Black fly larvae	7
	Midge larvae	6
	Most true flies	4
Megaloptera	Alderfly	4
	Fishfly or helgrammite	0
Coleoptera	Riffle beetle	4
	Water penny	4
	Beetle and beetle-like	7
Others	Crayfish	6
	Snails	7
	Aquatic worms	8
	Scuds	8
	Sowbugs	7
	Clams and mussels	8

The number of macroinvertebrates within each taxonomic group and the total number of individuals sorted was calculated and recorded on the Volunteer Biomonitoring Macroinvertebrate Data Sheet (Appendix 2.2). Quality control (QC) samples were taken at 10 percent of the sites to evaluate the ability of volunteers to identify and enumerate macroinvertebrates. All of the sorted organisms included in the QC sample were preserved and identified by a trained biologist.

## **2.4 Biotic index and accessory metric computation**

Biotic scores were computed using the Biotic Index Calculation Worksheet (Appendix 2.3). Biotic scores are based on tolerance values assigned to individual taxonomic groups, which range from 0 to 10. More tolerant groups have higher tolerance values and less tolerant groups have lower values. Taxonomic-specific biotic scores were computed by multiplying the number of individuals by their respective tolerance value. The final biotic score was calculated by summing the taxonomic-specific biotic scores and dividing the sum by the total number of individuals identified. Final biotic scores correspond to three interim narrative categories: excellent (0 to 3.5), good (3.5 to 4.8), or fairly poor (greater than 4.8).

Additionally, an estimated abundance, diversity index (H), and the percentage of EPT individuals were calculated for each sample. Abundance is a standardized calculation which predicts the total number of organisms within a sample. Diversity, the variety of organisms within a sample, was measured with the Shannon-Weiner index. The values (H) increase with variety. The percentage of EPT individuals refers to the total percentage of Ephemeroptera (mayfly nymphs), Plecoptera (stonefly nymphs), and Trichoptera (caddisfly larvae) in a sample. Generally, the percent of EPT individuals increases with water quality.

## **2.5 Supplementary data**

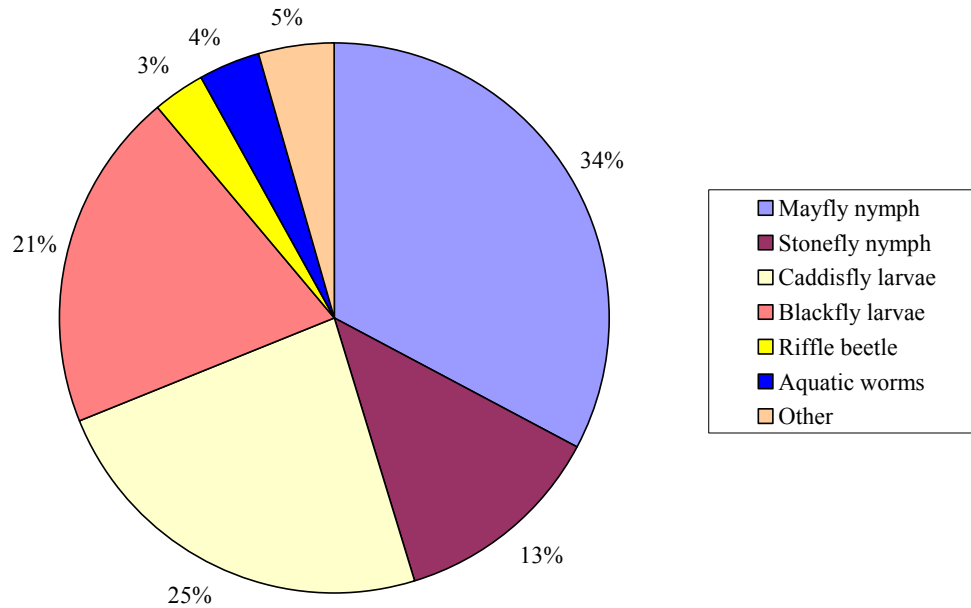
The water chemistry and physical parameters of the stream were also recorded on the Volunteer Biomonitoring Physical/Chemical Data Sheet (Appendix 2.4). Basic water chemistry data was collected using a YSI 556 multi-parameter submersible water quality probe and included pH, dissolved oxygen, conductivity, and temperature.

## **3. RESULTS AND DISCUSSION**

When the data from all sites were combined, mayfly nymphs were the most abundant macroinvertebrate group (34 percent of all individuals; Figure 1) and dominated at 8 of the 11 VBAP sites. The Lovell and Swift River were dominated by black fly larvae, while at Banfield Brook caddisfly larvae was the dominant taxonomic group. Together mayfly and stonefly nymphs, black fly larvae, and caddisfly larvae accounted for 93 percent of the macroinvertebrates collected at the sample sites, whereas the riffle beetles, aquatic worms, and other organisms accounted for approximately 12 percent of the sample. Damselflies, alderflies, crayfish, and sowbugs were absent from all samples.



**Figure 1:** The macroinvertebrate taxonomic composition of all sample sites in September 2006 using VBAP protocol.



The average biotic score for the sampled streams was 3.92 and ranged from 3.09 to 5.00. There were 2 streams with biotic scores greater than 4.8 (fairly poor), 5 streams with scores between 3.5 and 4.8 (good), and 4 streams with scores less than 3.5 (excellent) (Table 2).

**Table 2:** The biotic score and associated narrative quality of streams sampled in September 2006 for the VBAP where Biotic Index Scores 0 to 3.5 are excellent, 3.5 to 4.8 are good, greater than 4.8 are fairly poor.

Site Number	Stream name, town	Biotic score	VBAP narrative category
1	Banfield Brook, Madison	4.66	good
2	Beech River, Ossipee	3.09	excellent
3	Forrest Brook, Madison	3.51	good
4	Swift River, Tamworth	5.00	fairly poor
5	South River, Parsonsfield	4.00	good
6	Mill Brook, Tamworth	3.88	good
7	Cold River, Sandwich	3.29	excellent
8	Bearcamp River, Tamworth	4.38	good
9	Lovell River, Ossipee	4.90	fairly poor
10	Cold Brook, Freedom	3.27	excellent
11	Pond Brook, Sandwich	3.13	excellent

The average pH of the sample sites was 6.53 and ranged from 5.74 to 8.05 (Table 3). The pH at 8 of the sites was outside NH state water quality criteria. These may be the result of the natural admission of humic acids into the streams or inaccuracy of the pH meter. The average dissolved oxygen at the sample sites was 9.97 (mg/l) and ranged from 8.00 mg/l (South River) to 11.90 mg/l (Cold River). The average percent dissolved oxygen at sample sites was 97 percent and ranged from 79 to 111 percent. The dissolved oxygen levels at all sites met Class A New Hampshire water quality criteria. The average water temperature was 14 degrees Celsius and is typical for September. The average conductivity at the sample sites was 68  $\mu$ S/cm and ranged from 24  $\mu$ S/cm to 206  $\mu$ S/cm. However, all of the parameters obtained at sampling sites are just single samples and may not accurately represent the stream.

**Table 3:** pH (units), dissolved oxygen (mg/l; percent), temperature (°C), and conductivity (µS/cm) of sites sampled in September 2006 for the VBAP.

Site number	Stream name	pH (units)	Dissolved oxygen (mg/l)	Percent dissolved oxygen (%)	Temperature (°C)	Conductivity (µS/cm)
1	Banfield Brook	8.05	9.91	96.8	14.28	206
2	Beech River	6.40	10.34	102.9	15.18	43
3	Forrest Brook	5.98	10.06	96.3	13.40	59
4	Swift River	6.56	10.21	99.9	14.36	41
5	South River	6.38	8.00	79.0	14.81	51
6	Mill Brook	6.31	8.99	90.2	15.50	46
7	Cold River	6.47	11.90	111.1	12.26	24
8	Bearcamp River	7.05	10.80	107.2	13.47	42
9	Lovell River	6.12	9.97	98.2	14.70	35
10	Cold Brook	6.82	8.54	90.3	18.00	86
11	Pond Brook	5.74	10.97	102.5	12.30	29
<b>Average</b>		<b>6.53</b>	<b>9.97</b>	<b>97.3</b>	<b>14.50</b>	<b>68</b>

Estimated macroinvertebrate abundance ranged from 272 to 1372 individuals (Table 4). Mill Brook had the lowest abundance, whereas the Swift River had the highest estimated number of individuals in the sample. The diversity values (H) ranged from 1.35 to 1.88, varied little across sites, and was constrained by a fixed number of taxonomic groups. The percentage of EPT individuals ranged from 48 to 89. The Swift River and Lovell River had the lowest, whereas the Beech River and Pond Brook had the highest percentage of EPT individuals (Table 4).

**Table 4:** Estimated proportion of the sample sorted, total number of individuals sorted, macroinvertebrate abundance (approximate total number of individuals in entire sample), diversity values (H), and percentage of EPT individuals of the sites sampled in September 2006 for the VBAP.

Site Number	Stream name	Estimated proportion of the sample sorted	Total number of individuals sorted	Abundance	H	EPT (percent)
1	Banfield Brook	.25	204	816	1.59	58
2	Beech River	.20	177	708	1.50	88
3	Forrest Brook	.20	260	1040	1.71	76
4	Swift River	.23	343	1372	1.45	48
5	South River	.19	244	976	1.69	68
6	Mill Brook	.23	68	272	1.88	60
7	Cold River	.23	122	488	1.60	84
8	Bearcamp River	.23	241	964	1.41	61
9	Lovell River	.24	229	916	1.54	52
10	Cold Brook	.16	249	996	1.35	89
11	Pond Brook	.25	169	676	1.42	88

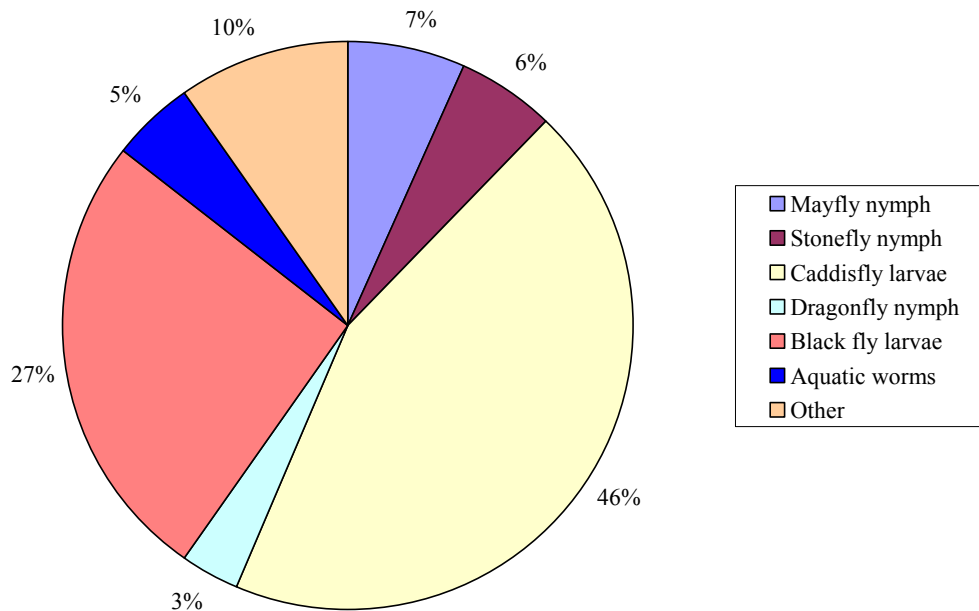
### 3.1 Banfield Brook, Madison

Banfield Brook is found just outside of the Ossipee Watershed and is a tributary of Pea Porridge Pond and Middle Pea Porridge Pond. The brook runs through the Edelweiss residential community and eventually under Route 113. We sampled approximately 100 feet upstream from the bridge crossing. The riparian zone was greater than 500 feet on the left bank and slightly less on the right. The canopy covered more than 75 percent of the brook and consisted of approximately 60 percent deciduous trees. There was slight erosion on the left bank of the stream and frequent areas of erosion with minor impacts to the streambed on the right. The site

consisted mostly of slow steady runs with few riffles and frequent woody debris. Sand and gravel were the dominant substrate and were 0 to 25 percent embedded. Algae and aquatic plants were present, but not abundant. The average width of the reach was approximately 10 feet and average depth was 0.30 feet.

Two-hundred and four organisms were identified (Table 5). The sample consisted mainly of caddisfly (46 percent) and black fly larvae (27 percent), which accounted for more than 70 percent of the total sample (Figure 2). Compared to all sites, Banfield Brook had the greatest percent of caddisfly and dragonfly larvae. Similar percentages of mayfly (7 percent) and stonefly nymphs (6 percent), and aquatic worms (5 percent) were found in the sample. There were smaller percentages of midge larvae, helgrammites, and riffle beetles. The biotic score was 4.66. The macroinvertebrate community composition was indicative of a stream in ‘good’ condition. However, further examination of the data may suggest otherwise. Here, the percentage of EPT individuals was 58 percent, which was low in comparison to other sites. Additionally, the pH was 8.05 and conductivity was 206 ( $\mu\text{S}/\text{cm}$ ), which were higher here than at any of the other sampling sites.

**Figure 2:** The macroinvertebrate taxonomic composition of Banfield Brook, Madison on 1 September 2006 using VBAP protocol



**Table 5:** The macroinvertebrate taxonomic composition of Banfield Brook, Madison on 1 September 2006 using the VBAP protocol.

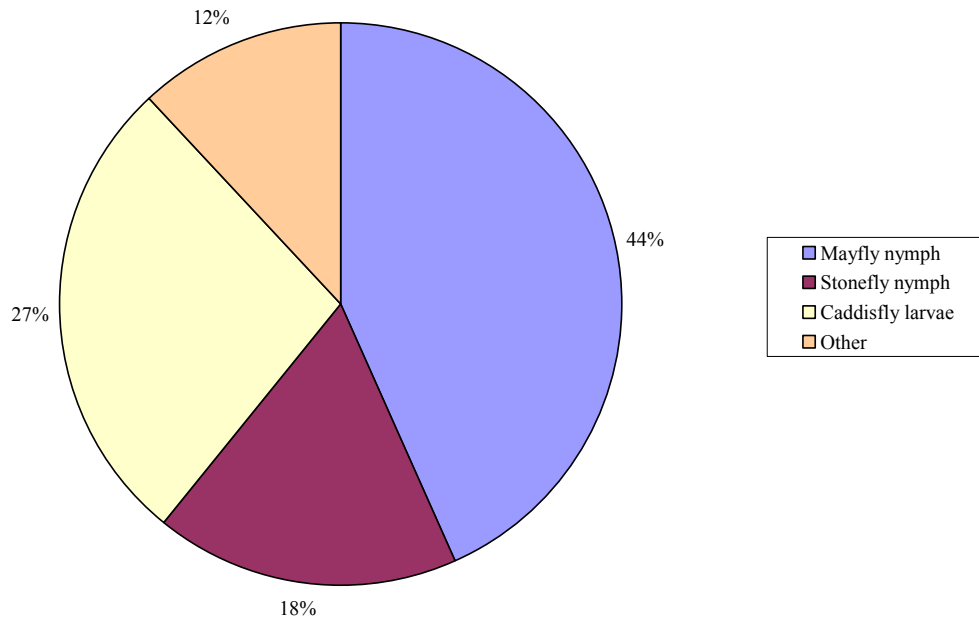
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	14	3	42		
Plecoptera	Stonefly nymph	12	1	12		
Tricoptera	Caddisfly larvae	93	4	372		
Odonata	Dragonfly nymph	7	3	21		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	55	7	385		
	Midge larvae	2	6	12		
	Most true flies	1	4	4		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	5	0	0		
Coleoptera	Riffle beetle	4	4	16		
	Water penny	0	4	0		
	Beetle & beetle-like	1	7	7		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	10	8	80		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
<b>TOTALS</b>		<b>204</b>		<b>951</b>	<b>4.66</b>	<b>good</b>

### 3.2 Beech River, Ossipee

The Beech River flows from Melvin and Garland Pond along Tuftonboro Road and eventually into the Pine River. Samples were collected upstream of the bridge crossing on Dore Street. The riparian width was 20 to 100 feet on both banks and consisted of trees, shrubs, grasses, and non-woody plants. The canopy covered more than 75 percent of the stream and was comprised mostly of deciduous trees. The left bank appeared to be relatively undisturbed, whereas the right bank had some minor areas of erosion. The sample reach consisted mostly of riffles with a few runs. The stream substrates consisted mostly of cobbles with a few boulders and were 0 to 25 percent embedded by fine sediment. There was occasional woody debris. Algae and moss were present at the site, but not abundant. The average width of the reach was 20 feet and the average depth was 1.25 feet.

There were 177 organisms identified a majority of which were mayflies (44 percent), (Table 6; Figure 3). Twenty-seven percent of the sample consisted of caddisfly larvae and 18 percent were stonefly nymphs. The remainder of the sample (12 percent) consisted of dragonfly nymphs, black fly larvae, true flies, helgrammites, beetles, and aquatic worms. This site had one of the lowest percentages of black fly larvae. The biotic score was 3.09 and the percentage of EPT individuals was 88 percent. Taken together at the screening level, these results suggest the Beech River contains a macroinvertebrate community indicative of a high quality stream.

**Figure 3:** The macroinvertebrate taxonomic composition of the Beech River, Ossipee on 4 September 2006 using VBAP protocol



**Table 6:** The macroinvertebrate taxonomic composition of the Beech River, Ossipee on 4 September 2006 using the VBAP protocol.

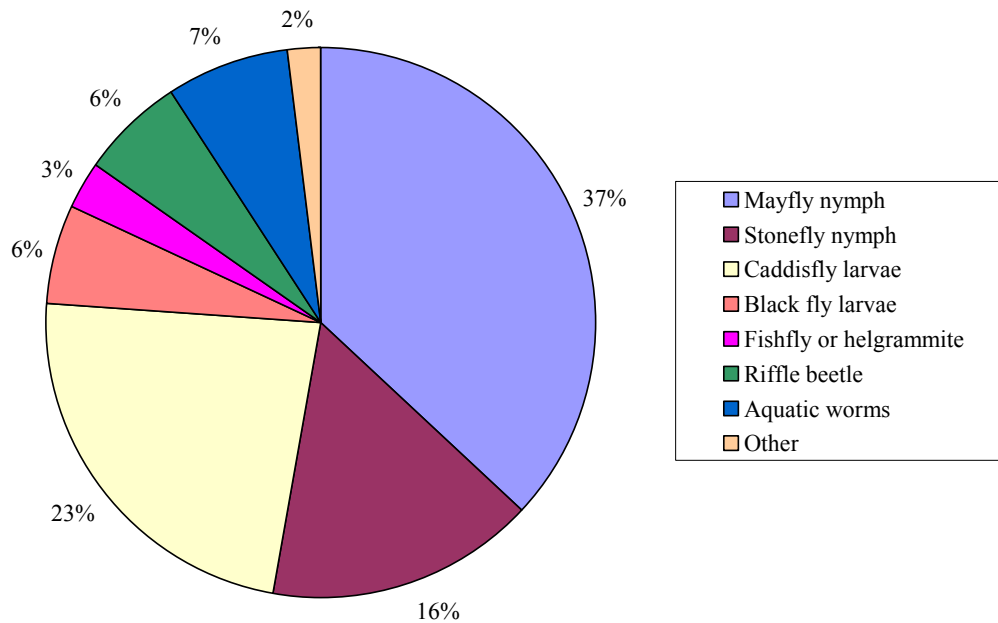
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	77	3	231		
Plecoptera	Stonefly nymph	31	1	31		
Tricoptera	Caddisfly larvae	48	4	192		
Odonata	Dragonfly nymph	2	3	6		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	4	7	28		
	Midge larvae	0	6	0		
	Most true flies	4	4	16		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	4	0	0		
Coleoptera	Riffle beetle	3	4	12		
	Water penny	0	4	0		
	Beetle & beetle-like	1	7	7		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	3	8	24		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
<b>TOTALS</b>		<b>177</b>		<b>547</b>	<b>3.09</b>	<b>excellent</b>

### 3.3 Forrest Brook, Madison

Forrest Brook begins approximately 3 miles east of and runs directly through the town of Madison and eventually drains into Silver Lake. The sampling site was located approximately 2 miles east of Silver Lake immediately upstream of a bridge crossing next to the Silver Lake Home Center and a gas station on East Madison Road. The riparian zone consisted mostly of deciduous trees and was 100 to 500 feet wide on the left and 0 to 20 feet wide on the right bank. The canopy covered more than 75 percent of the stream. There were some areas of erosion on both banks, but no noticeable impacts to the streambed. The water was slightly reddish-orange. The sampling reach included frequent riffles and runs, with fewer pools. The streambed consisted of mostly gravel with fewer cobbles which were 50 to 75 percent embedded. Woody debris was frequently encountered throughout the stream reach. Moss and aquatic plants were found at the site, but were not abundant. The average width of Forrest Brook was 20 feet and the average depth was 1 foot.

Two-hundred and sixty organisms were identified in the selected sample. Thirty-seven percent were mayfly nymphs and 23 percent were caddisfly larvae (Table 7; Figure 4.) Another 16 percent of the sample consisted of stonefly nymphs, while the remaining quarter consisted of a variety of organisms, but mainly black fly larvae, riffle beetles, and aquatic worms. Forrest Brook had the greatest number of aquatic worms (7 percent). The biotic score was 3.50 and the percentage of EPT individuals was 76 percent and suggests the macroinvertebrate community is indicative of 'good' quality streams.

**Figure 4:** The macroinvertebrate taxonomic composition of Forrest Brook, Madison on 5 September 2006 using the VBAP protocol.



**Table 7:** The macroinvertebrate taxonomic composition of Forrest Brook, Tamworth on 5 September 2006 using the VBAP protocol.

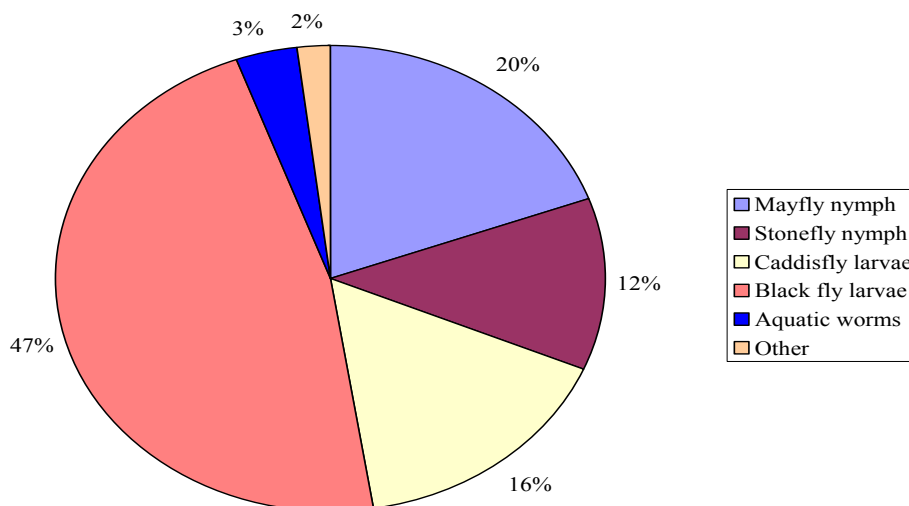
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	96	3	288		
Plecoptera	Stonefly nymph	41	1	41		
Tricoptera	Caddisfly larvae	61	4	244		
Odonata	Dragonfly nymph	2	3	6		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	15	7	105		
	Midge larvae	0	6	0		
	Most true flies	3	4	12		
Megaloptera	Alderfly	0	4	0		
	Fishfly or hellgrammite	7	0	0		
Coleoptera	Riffle beetle	16	4	64		
	Water penny	0	4	0		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	19	8	152		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
<b>TOTALS</b>		<b>260</b>		<b>912</b>	<b>3.51</b>	<b>good</b>

### 3.4 Swift River, Tamworth

The Swift River starts in the town of Tamworth and meanders next to Route 113A flowing into the Bearcamp River, which leads into Ossipee Lake. The sampling site was located upstream of the bridge crossing in Tamworth village. The Hemenway State Forest is approximately 4 miles upstream from the site. There was less than 20 feet of riparian zone on both banks. Canopy cover was less than 10 percent which consisted only of deciduous trees. The left bank had frequent areas of erosion with minor impacts to the streambed, while the right bank had concrete blocks placed along the bank to prevent erosion. The stream stretch consisted mostly of riffles with a few pools and runs. The streambed consisted mainly of large cobbles which were 0 to 25 percent embedded with fine sediment. Occasional woody debris and moss were found at the site, but were not abundant. The average width of the reach was 40 to 50 feet and the average depth was 0.5 to 1.0 feet.

Three-hundred and forty-three organisms were found at this site which was the highest number of individuals identified from the 11 sampled sites. Additionally, the greatest percentage of black fly larvae (47 percent) was found at the Swift River site, and accounted for nearly half of the total sample (Table 8; Figure 5). The remainder of the sample consisted mainly of mayfly (20 percent) and stonefly nymphs (12 percent), and caddisfly larvae (16 percent) with low quantities of true flies, hellgrammites, beetles, and aquatic worms. The biotic score was 5.00, which was the overall highest score. The percentage of EPT individuals was 48 percent which, was the lowest. The macroinvertebrate community was indicative of a stream with ‘fairly poor’ water quality. However, the river appeared to be in acceptable condition. The data may reflect a bias towards the selection of black fly larvae (tolerance value of 7), whereas tiny mayfly nymphs may have been overlooked (tolerance value of 3). Together, these may explain the “fairly poor” narrative rating. These data represent a screening sample and are not applicable to formal water quality assessments. Further investigation is warranted.

**Figure 5:** The macroinvertebrate taxonomic composition of the Swift River, Tamworth on 6 September 2006 using the VBAP protocol.



**Table 8:** The macroinvertebrate taxonomic composition of the Swift River, Tamworth on 6 September 2006 using the VBAP protocol.

Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	67	3	201		
Plecoptera	Stonefly nymph	41	1	41		
Tricoptera	Caddisfly larvae	55	4	220		
Odonata	Dragonfly nymph	0	3	0		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	161	7	1127		
	Midge larvae	0	6	0		
	Most true flies	2	4	8		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	1	0	0		
Coleoptera	Riffle beetle	2	4	8		
	Water penny	0	4	0		
	Beetle & beetle-like	2	7	14		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	12	8	96		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
<b>TOTALS</b>		<b>343</b>		<b>1715</b>	<b>5.00</b>	<b>Fairly poor</b>

### 3.5 South River, Parsonsfield

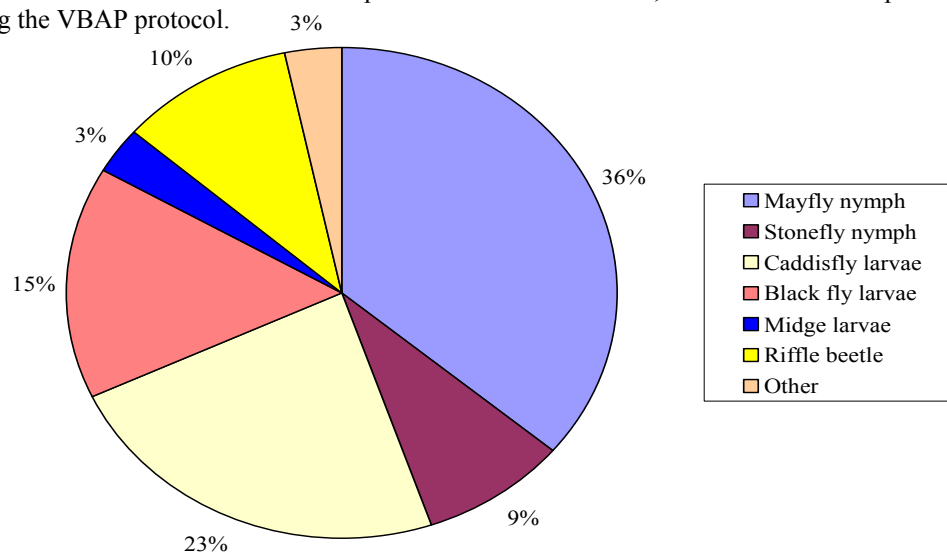
The South River begins in the town of Effingham, NH at Province Lake and leads into Lords Pond and eventually into the Ossipee River in the State of Maine. The sampling site was located upstream of the Plantation Road bridge crossing, approximately 2 miles east of the New Hampshire/Maine state border. The site's riparian zone was 20 to 100 feet wide on both banks



and consisted of a mix of trees, shrubs, and grasses. The canopy cover was less than 10 percent and was comprised almost entirely of deciduous trees. Neither bank appeared to suffer from erosion. There were approximately equal portions of riffle, pool, and run habitats. Woody debris was frequently encountered throughout the stream reach. Algae, moss, and plants were also present, but not abundant. The stream bottom was a sandy, cobble mixture which was 25 to 50 percent embedded by fine sediment. The average width of the stream reach was 25 feet and the average depth was 0.75 feet.

Two-hundred forty-four organisms were identified of which 36 percent were mayfly nymphs, 23 percent were caddisfly larvae, 15 percent were black fly larvae, and 9 percent were stonefly nymphs (Table 9; Figure 6). The biotic score for the South River was 4.00 and percentage of EPT individuals was 68 percent. The macroinvertebrate composition at the South River was indicative of a river in ‘good’ condition.

**Figure 6:** The macroinvertebrate taxonomic composition of the South River, Parsonsfield on 7 September 2006 using the VBAP protocol.



**Table 9:** The macroinvertebrate taxonomic composition of the South River, Parsonsfield on 7 September 2006 using the VBAP protocol.

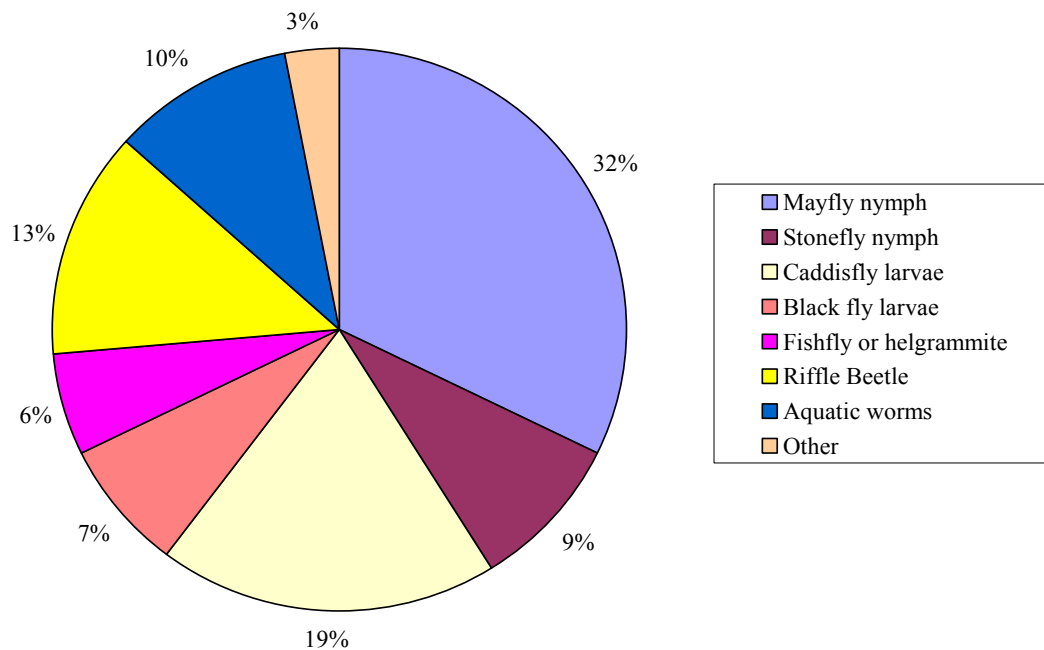
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	88	3	264		
Plecoptera	Stonefly nymph	21	1	21		
Tricoptera	Caddisfly larvae	57	4	228		
Odonata	Dragonfly nymph	0	3	0		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	37	7	259		
	Midge larvae	8	6	48		
	Most true flies	0	4	0		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	1	0	0		
Coleoptera	Riffle beetle	25	4	100		
	Water penny	0	4	0		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	4	8	32		
	Scuds	3	8	24		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
<b>TOTALS</b>		<b>244</b>		<b>976</b>	<b>4.00</b>	<b>good</b>

### 3.6 Mill Brook, Tamworth

Mill Brook flows from the White Mountain National Forest and the Sandwich Range Wilderness through Tamworth until it joins with the Swift River and flows into the Bearcamp River. The sampling site was located on Bunker Hill Road upstream of the one-land bridge. The riparian zone on both banks extended for 20 to 100 feet and consisted of trees, shrubs, grasses, and non-woody vegetation. The canopy cover was greater than 75 percent and consisted of a mixture of deciduous and coniferous trees. There was slight erosion on the left bank, whereas the right bank had boulders placed along the bank to minimize further erosion. The water was reddish-orange in color. The sampling stretch consisted of a few small riffles and runs. Cobbles were the predominant substrate and were 25 to 50 percent embedded by fine sediment. There was occasional woody debris throughout the stream. Algae, moss, and aquatic plants were present, but were not abundant. The average width of the stream was 17 feet and the average depth was 1 feet.

Only 68 macroinvertebrates were identified at Mill Brook, most of which were mayfly nymphs (32 percent) and caddisfly larvae (19 percent), (Table 10; Figure 7). There were also portions of stonefly nymphs (9 percent), black fly larvae (7 percent), helgrammites (6 percent), riffle beetles (13 percent), and aquatic worms (10 percent) found in the sample. The biotic score was 3.88 and the percentage of EPT individuals was 60 percent. The macroinvertebrate community at Mill Brook was indicative of a stream with ‘good’ water quality.

**Figure 7:** The macroinvertebrate taxonomic composition of Mill Brook, Tamworth on 8 September 2006 using VBAP protocol.



**Table 10:** The macroinvertebrate taxonomic composition of Mill Brook, Tamworth on 8 September 2006 using the VBAP protocol.

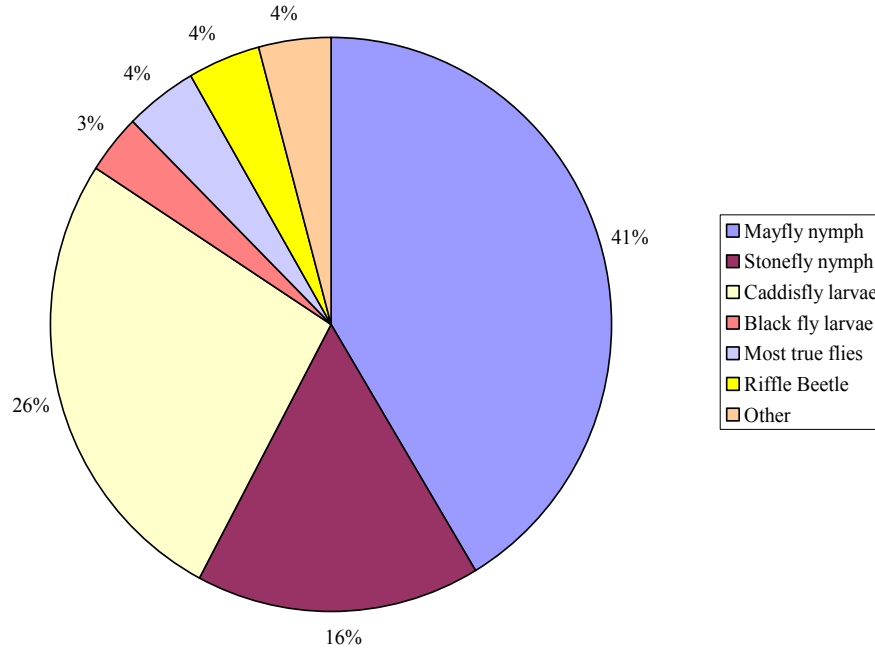
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	22	3	66		
Plecoptera	Stonefly nymph	6	1	6		
Tricoptera	Caddisfly larvae	13	4	52		
Odonata	Dragonfly nymph	0	3	0		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	5	7	35		
	Midge larvae	1	6	6		
	Most true flies	0	4	0		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	4	0	0		
Coleoptera	Riffle beetle	9	4	36		
	Water penny	0	4	0		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	7	8	56		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	1	7	7		
<b>TOTALS</b>		<b>68</b>		<b>264</b>	<b>3.88</b>	<b>good</b>

### 3.7 Cold River, Sandwich

The Cold River starts in the White Mountain National Forest, NH and flows through Sandwich where it eventually joins Meadow Brook and flows into the Bearcamp River. The sampling site was located upstream of a bridge crossing on Route 113, approximately 1.5 miles west of Tamworth. The area was forested and used commercially with a gravel pit located approximately 500 feet upstream of the site. The riparian zone on the left bank of the stream was 0 to 20 feet wide, whereas the right bank was 100 to 500 feet wide. Both banks were comprised of a mixture of trees, shrubs, and grasses. The stream had a relatively open canopy, with less than 10 percent of the stream covered by deciduous trees. The left bank had frequent areas of erosion, with minor impacts to the streambed and the right bank had no noticeable erosion. The streambed was comprised predominantly of cobbles which were 0 to 25 percent embedded. The stream stretch consisted of a couple of riffles and runs with occasional woody debris. The average width of the stream reach was 65 feet and the average depth was 0.60 feet.

Out of the 122 macroinvertebrates identified at the Cold River, 41 percent were mayfly nymphs, 26 percent were caddisfly larvae, and 16 percent were stonefly nymphs (Table 11; Figure 8). The rest of the sample consisted of relatively similar but smaller percentages of black fly larvae (27 percent), true flies, riffle beetles, and aquatic worms with even smaller percentages of helgrammites, water pennies, and snails. The biotic score was 3.29 and the percentage of EPT individuals was 84 percent. The macroinvertebrate community was indicative of a stream with 'excellent' water quality.

**Figure 8:** The macroinvertebrate taxonomic composition of the Cold River, Sandwich on 11 September 2006 using VBAP protocol.



**Table 11:** The macroinvertebrate taxonomic composition of the Cold River, Sandwich on 11 September 2006 using the VBAP protocol.

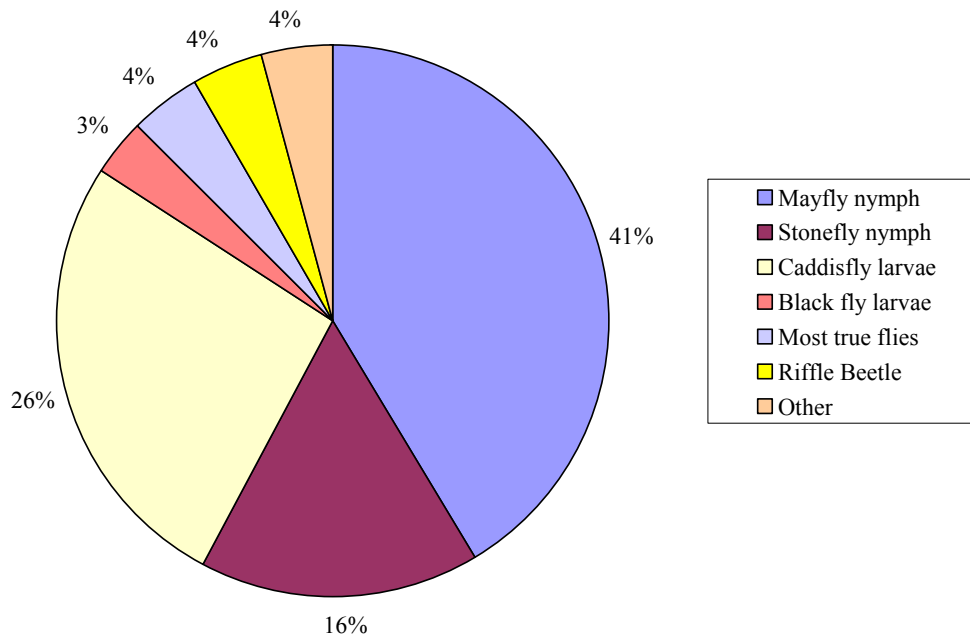
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	50	3	150		
Plecoptera	Stonefly nymph	20	1	20		
Tricoptera	Caddisfly larvae	32	4	128		
Odonata	Dragonfly nymph	0	3	0		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	4	7	28		
	Midge larvae	0	6	0		
	Most true flies	5	4	20		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	1	0	0		
Coleoptera	Riffle beetle	5	4	20		
	Water penny	1	4	4		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	1	7	7		
	Aquatic Worms	3	8	24		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
<b>TOTALS</b>		<b>122</b>		<b>401</b>	<b>3.29</b>	<b>excellent</b>

### 3.8 Bearcamp River, Tamworth

The Bearcamp River represents the primary tributary flowing into Ossipee Lake. Route 25 closely borders the majority of the river. The sampling site was located off of Route 113 approximately 4 miles south of the town of Tamworth. The left bank's riparian zone was 20 to 100 feet wide. The right bank was narrower. The vegetation on both sides of the river was comprised of trees, shrubs, grasses, and non-woody plants. The stream was relatively open and covered primarily by deciduous trees. There was no evidence of erosion on the left bank, and some areas of erosion, but no noticeable impacts to the streambed on the right. The sampling reach consisted of mostly riffles with fewer runs, and no pools. The streambed consisted primarily of gravel, cobbles, and boulders that were 25 to 50 percent embedded in fine sediment. Algae and moss were found in the stream and water was slightly reddish-orange. The average width of the stream reach was 43 feet and the average depth was 1 foot.

Two-hundred and forty-one aquatic organisms were identified in the sample collected from the Bearcamp River (Table 12). Mayfly nymphs (44 percent) and black fly larvae (32 percent) accounted for approximately 75 percent of the entire sample (Figure 9). There were lower percentages of caddisfly larvae (26 percent) and stonefly nymphs (16 percent). The remainder of the sample consisted of true flies (4 percent), riffle beetles (4 percent), and other organisms (4 percent). The biotic score was 4.38 and the percentage of EPT individuals was 61 percent. The macroinvertebrate community in the Bearcamp River was indicative of a stream with 'good' water quality.

**Figure 9:** The macroinvertebrate taxonomic composition of the Bearcamp River, Tamworth on 12 September 2006 using VBAP protocol.



**Table 12:** The macroinvertebrate taxonomic composition of the Bearcamp River, Tamworth on 12 September 2006 using the VBAP protocol.

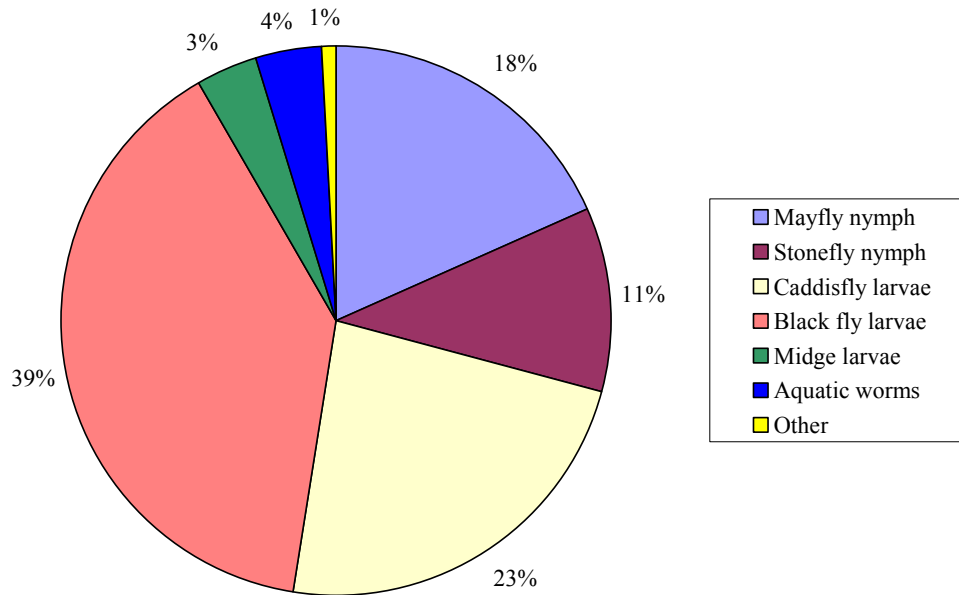
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	105	3	315		
Plecoptera	Stonefly nymph	21	1	21		
Tricoptera	Caddisfly larvae	21	4	84		
Odonata	Dragonfly nymph	0	3	0		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	77	7	539		
	Midge larvae	0	6	0		
	Most true flies	4	4	16		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	0	0	0		
Coleoptera	Riffle beetle	6	4	24		
	Water penny	0	4	0		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	7	8	56		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
TOTALS		241		1055	4.38	good

### 3.9 Lovell River, Ossipee

The Lovell River originates near Connor Pond in the Ossipee Mountain Range and flows under Route 16 at the Indian Mound Golf Club. It enters Ossipee Lake south of Deer Cove at a housing development. The sampling site was located immediately upstream of the Route 16 bridge crossing. The riparian zone was less than 20 feet wide on the left bank and 20 to 100 feet wide on the right which consisted mainly of trees and non-woody plants. The river was 40 to 75 percent covered by predominantly deciduous trees. There were frequent areas of erosion, with minor impacts to the streambed on both banks. The site was comprised of a large riffle with occasional woody debris, algae, and moss. The streambed was comprised mostly of gravel with a few cobbles and was 0 to 25 percent embedded by fine sediment. The average width of the stream reach was 35 feet and the average width was 1 foot.

Two-hundred and twenty-nine macroinvertebrates were identified and counted at Lovell River site (Table 13). The site was dominated by black fly larvae (39 percent), caddisfly larvae (23 percent), and mayfly nymphs (18 percent) (Figure 10). The remaining 7 percent of the sample consisted of midge larvae (3 percent) and aquatic worms (4 percent). The biotic score was 4.90 and the percentage of EPT individuals was 52 percent. These data suggest the macroinvertebrate community composition was indicative of a site with ‘fairly poor’ water quality. However, the Lovell River appeared to be in good condition. As stated earlier, the data may reflect a bias towards the selection of more visible black fly larvae (tolerance value of 7), whereas tiny mayfly nymphs may have been overlooked (tolerance value of 3). Together, these may explain the placement of the sites in the ‘fairly poor’ narrative category. These data represent a single sample and are not applicable to formal water quality assessments. Additional sampling is recommended to confirm or refute the results obtained in 2006.

**Figure 10:** The macroinvertebrate taxonomic composition of the Lovell River, Ossipee on 18 September 2006 using the VBAP protocol.



**Table 13:** The macroinvertebrate taxonomic composition of the Lovell River, Ossipee sample on 18 September 2006 using the VBAP protocol.

Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	42	3	126		
Plecoptera	Stonefly nymph	25	1	25		
Tricoptera	Caddisfly larvae	53	4	212		
Odonata	Dragonfly nymph	0	3	0		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	90	7	630		
	Midge larvae	8	6	48		
	Most true flies	0	4	0		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	0	0	0		
Coleoptera	Riffle beetle	2	4	8		
	Water penny	0	4	0		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	9	8	72		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
	<b>TOTALS</b>		<b>229</b>		<b>1121</b>	<b>4.90</b>

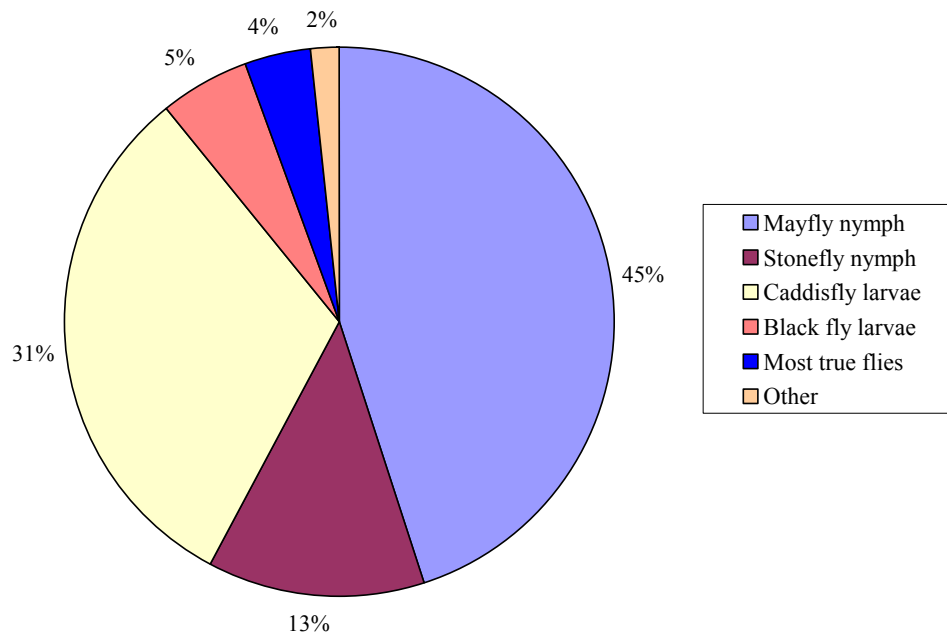
### 3.10 Cold Brook, Freedom

Cold Brook starts just south of the Eaton town line and runs through Freedom and eventually into Loon Lake. The sampling site was located on Old Portland Road across from a bed and breakfast lodge. Both riparian zones at the site consisted of a diverse vegetative community and greater than 500 feet wide. The canopy was comprised of approximately 65 percent deciduous

trees and covered 10 to 40 percent of the stream. There was slight erosion on both banks. The sampling site consisted of riffles and runs, with no pools. The streambed consisted of mostly cobbles which were 0 to 25 percent embedded by fine sediment. There was occasional debris, algae, and moss in the brook. The average width of the stream was 14 feet and the average depth was 0.6 feet.

Two-hundred and forty-nine aquatic organisms were identified in the Cold Brook. Mayfly nymphs (45 percent) and caddisfly larvae (31 percent) accounted for just over 75 percent of the total sample (Table 14; Figure 11). The remainder of the sample consisted of black fly larvae (5 percent), true flies (4 percent), and other organisms (2 percent). The biotic score was 3.27 and the percentage of EPT individuals was 89 percent. The macroinvertebrate composition in Cold Brook was indicative of streams with ‘excellent’ water quality.

**Figure 11:** The macroinvertebrate taxonomic composition of Cold Brook, Freedom on 18 September 2006 using VBAP protocol.





**Table 14:** The macroinvertebrate taxonomic composition of Cold Brook, Freedom on 18 September 2006 using the VBAP protocol.

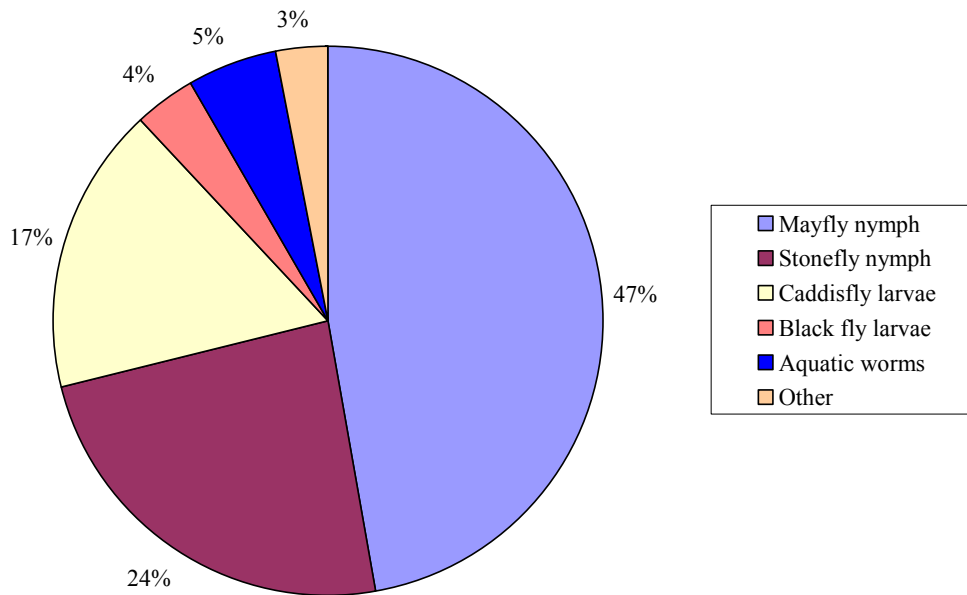
Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	112	3	336		
Plecoptera	Stonefly nymph	32	1	32		
Tricoptera	Caddisfly larvae	78	4	312		
Odonata	Dragonfly nymph	0	3	0		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	13	7	91		
	Midge larvae	0	6	0		
	Most true flies	10	4	40		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	3	0	0		
Coleoptera	Riffle beetle	1	4	0		
	Water penny	0	4	4		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic worms	0	8	0		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and mussels	0	7	0		
<b>TOTALS</b>		<b>249</b>		<b>815</b>	<b>3.27</b>	<b>excellent</b>

### 3.11 Pond Brook, Sandwich

Pond Brook flows out of Flat Mountain Ponds in the White Mountain National Forest and the Sandwich Range Wilderness. The sampling site was located approximately 3 miles north of North Sandwich immediately upstream of the bridge crossing on Route 113. The riparian zone of both banks was diverse and 100 to 500 feet wide. The stream was relatively open, with less than a 10 percent canopy. Both banks appeared to have no noticeable erosion. The sample reach consisted mostly of riffles with few, small runs and pools. The brook had large boulders, and cobbles which were slightly embedded by fine sediment. There was occasional woody debris and algae throughout the site. The average width of the stream stretch was 30 feet and the average depth was 0.80 feet.

One-hundred sixty-nine organisms were sorted and identified at this site (Table 15). Nearly half of the macroinvertebrate sample consisted of mayfly nymphs (47 percent), many of which were extremely small (Figure 12). Stonefly nymphs (24 percent) comprised the second greatest portion of the sample followed by caddisfly larvae (17 percent). The remainder of the sample (12 percent) consisted of black fly larvae (4 percent), aquatic worms (5 percent), and other organisms (3 percent). The biotic score was 3.11 and the percentage of EPT individuals was 88 percent. The macroinvertebrate community in Pond Brook was indicative of streams with ‘excellent’ water quality.

**Figure 12:** The macroinvertebrate taxonomic community of Pond Brook, Sandwich on 21 September 2006.



**Table 15:** The macroinvertebrate taxonomic composition of Pond Brook, Sandwich on 21 September 2006 using the VBAP protocol.

Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	80	3	240		
Plecoptera	Stonefly nymph	40	1	40		
Tricoptera	Caddisfly larvae	29	4	116		
Odonata	Dragonfly nymph	1	3	3		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	2	7	14		
	Midge larvae	6	6	36		
	Most true flies	1	4	4		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	1	0	0		
Coleoptera	Riffle beetle	0	4	0		
	Water penny	0	4	0		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic Worms	9	8	72		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and Mussels	0	7	0		
<b>TOTALS</b>		<b>169</b>		<b>525</b>	<b>3.11</b>	<b>excellent</b>

### 3.12 Quality Assurance / Quality Control

The VBAP protocols calls for an enumeration and identification check to be performed on 10% of the samples collected. For the Ossipee Watershed project 11 sites were sampled and 1 site (QC sample) chosen for assessing enumeration and identification accuracy. The DES verified the macroinvertebrate identification and enumeration for Pond Brook (Table 16). The results of the QC sample proved comparable to the original processed by the volunteers (compare to Table 15). The total number of individuals enumerated differed by 4% (169 - original vs. 162 - QC sample). Similarly, the taxonomic composition was similar with 9 taxa found in the original sample and 8 taxa in the QC sample. The largest difference was from the aquatic worm taxonomic group, yet only differed by only 9 individuals between the original and QC sample. The site biotic scores were similar between the original and QC samples at 3.11 and 3.02, respectively. The results place both samples in the ‘excellent’ narrative category.

Table 16: The macroinvertebrate taxonomic composition of the QC sample for Pond Brook, Sandwich on 21 September 2006 using the VBAP protocol.

Order	Common Name	Number of Individuals	Group Tolerance Value	Group Biotic Score	Site Biotic Score	VBAP Narrative Category
Ephemeroptera	Mayfly nymph	78	3	234		
Plecoptera	Stonefly nymph	38	1	38		
Tricoptera	Caddisfly larvae	27	4	108		
Odonata	Dragonfly nymph	1	3	3		
	Damselfly nymph	0	7	0		
Diptera	Black fly larvae	6	7	42		
	Midge larvae	10	6	60		
	Most true flies	1	4	4		
Megaloptera	Alderfly	0	4	0		
	Fishfly or helgrammite	1	0	0		
Coleoptera	Riffle beetle	0	4	0		
	Water penny	0	4	0		
	Beetle & beetle-like	0	7	0		
Others	Crayfish	0	6	0		
	Snails	0	7	0		
	Aquatic Worms	0	8	0		
	Scuds	0	8	0		
	Sowbugs	0	7	0		
	Clams and Mussels	0	7	0		
<b>TOTALS</b>		<b>162</b>		<b>489</b>	<b>3.02</b>	<b>excellent</b>

## 4. SUMMARY AND FUTUTRE RECOMMENDATIONS

The documentation by volunteers of the macroinvertebrate communities using the VBAP protocol during summer 2006 in the Ossipee watershed represented an initial ‘screening’ of the status of aquatic communities. The sampling efforts included 11 sites in the Ossipee watershed. The VBAP protocol was designed by the DES to provide volunteers and water quality professionals without formal training in biological sampling an avenue to complete “coarse” level investigations of the types and quantities of macroinvertebrates living in streams and rivers. Macroinvertebrates are widely used as indicators of water quality that integrate the effects of multiple pollutants over time. It is important to recognize that the results obtained from the VBAP protocol are not intended to represent formal water quality assessments, but rather, a basic indicator of aquatic community condition.

The VBAP protocol also provided volunteers with an opportunity to become familiar with aquatic fauna in the streams and rivers in the Ossipee watershed. The collection of macroinvertebrates using the VBAP protocol, in addition to the usual chemical parameters collected by the GMCG, proved to be a fairly simple, yet an informative method for identifying sites in excellent, good, or fairly poor condition. With adequate training volunteers became familiar with the most common macroinvertebrate types and their respective tolerance to pollution. Common suggestions by volunteers for improvement of the VBAP protocol were an increase in volunteer participation, the number of sampling sites, and the availability of macroinvertebrate identification resources. However, as the program continues to develop, many of these associated drawbacks will be alleviated. Most volunteers felt additional experience, through continued sampling, would alleviate many of the minor problems encountered during the initial efforts in 2006.

The results obtained by volunteers using the VBAP protocol indicated that the majority of sites sampled appeared to be in relatively “good” condition. Four of the streams fell into the “excellent” category and only two were in the “fairly poor” category. Most of the communities were dominated by less tolerant macroinvertebrates, such as the mayfly and stonefly nymphs. Other streams were dominated by moderately pollutant tolerant organisms, such as black fly larvae and some types of caddisfly larvae.

The index appeared to appropriately categorize most sampling sites into coarse narrative rating categories (excellent, good or fairly poor). However, the index may have been affected by sorting biases towards the selection of larger macroinvertebrate individuals. For example organisms sorted in samples from the Swift and Lovell River sites were both dominated by black fly larvae. As a relatively easily distinguished taxa that coincidentally also has a relatively high tolerance value, volunteers could have overlooked less obvious and less tolerant taxa resulting in the ‘fairly poor’ narrative rating for these sites. Previous experience in both the Swift and Lovell Rivers by DES staff has shown them to be in good condition. While the biotic index provided a method for relative comparisons of the sites sampled, the tolerance values and narrative categories are still under development and must be calibrated to a set of reference sites before statewide application is possible. The data collected provides a baseline to compare future VBAP sampling efforts against and highlights the general lack of major impacts to the macroinvertebrate communities at the points where samples were collected.

While the sampling efforts were effective at documenting the status of the macroinvertebrate communities at a coarse level it is important to recognize that the project represented a cooperative effort between the GMCG and the DES to pilot the VBAP protocol. Increasing interest by volunteer water quality sampling organizations has been shown in using biological sampling techniques to estimate the potential impacts of pollution to aquatic communities. For this reason, the DES Biomonitoring program developed the VBAP protocol and is continually refining the training provided to volunteers, field sampling techniques, and biotic index applicability. Ultimately, a final training and field protocol manual will be produced for use across the state.

## 5. APPENDIX

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### Pictures of study area:

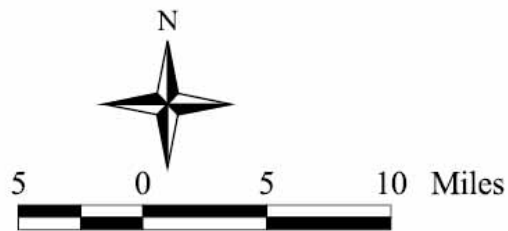
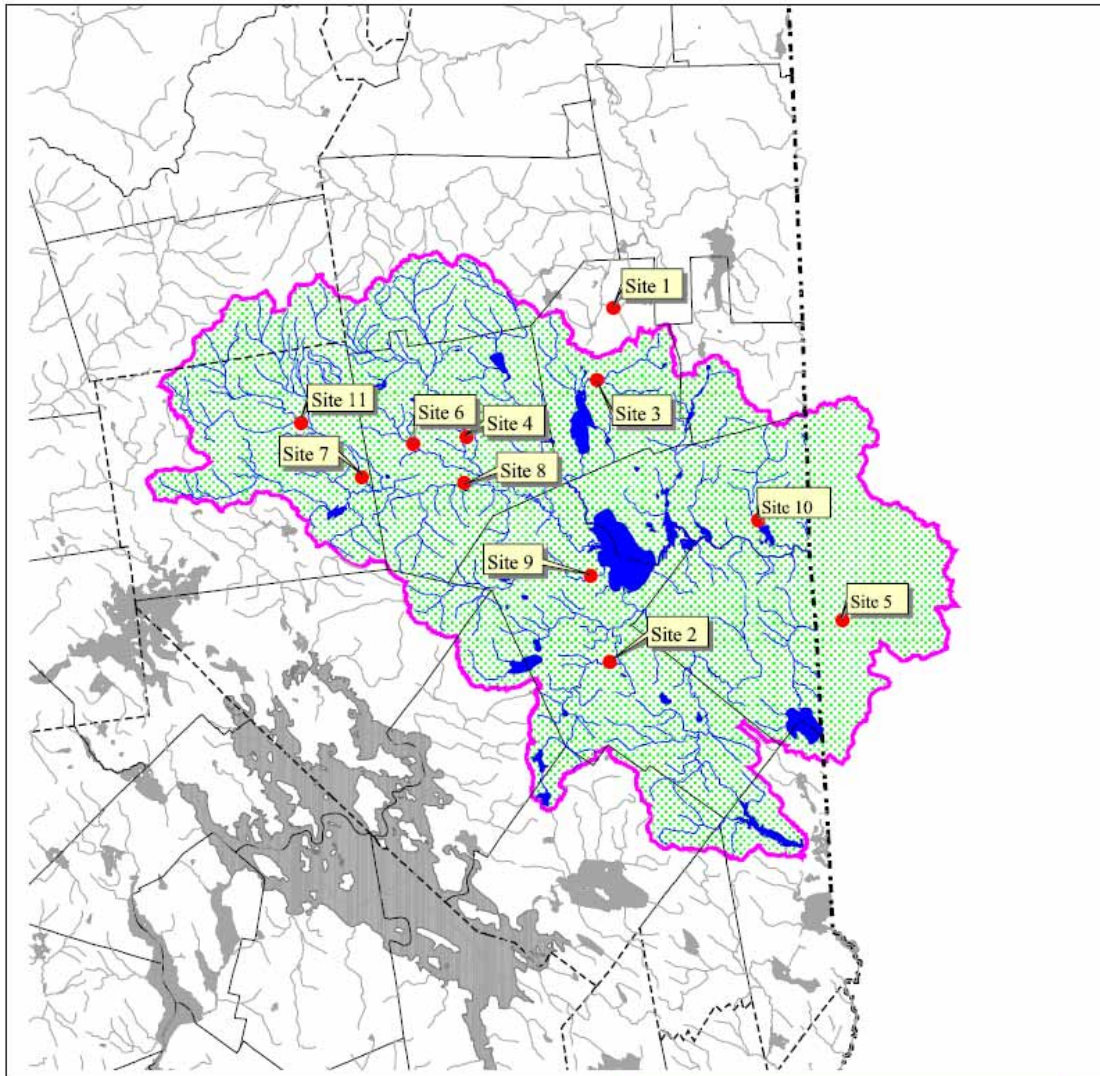
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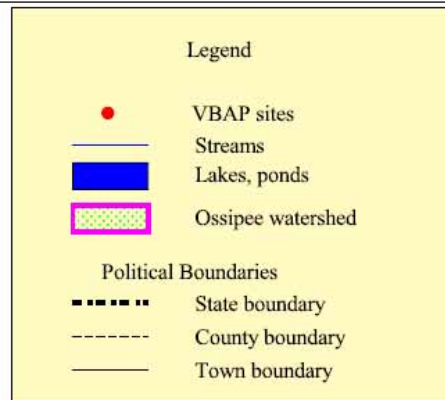
# Map 1

## 2006 Ossipee Watershed Volunteer Biomonitoring Assessment Program Sites



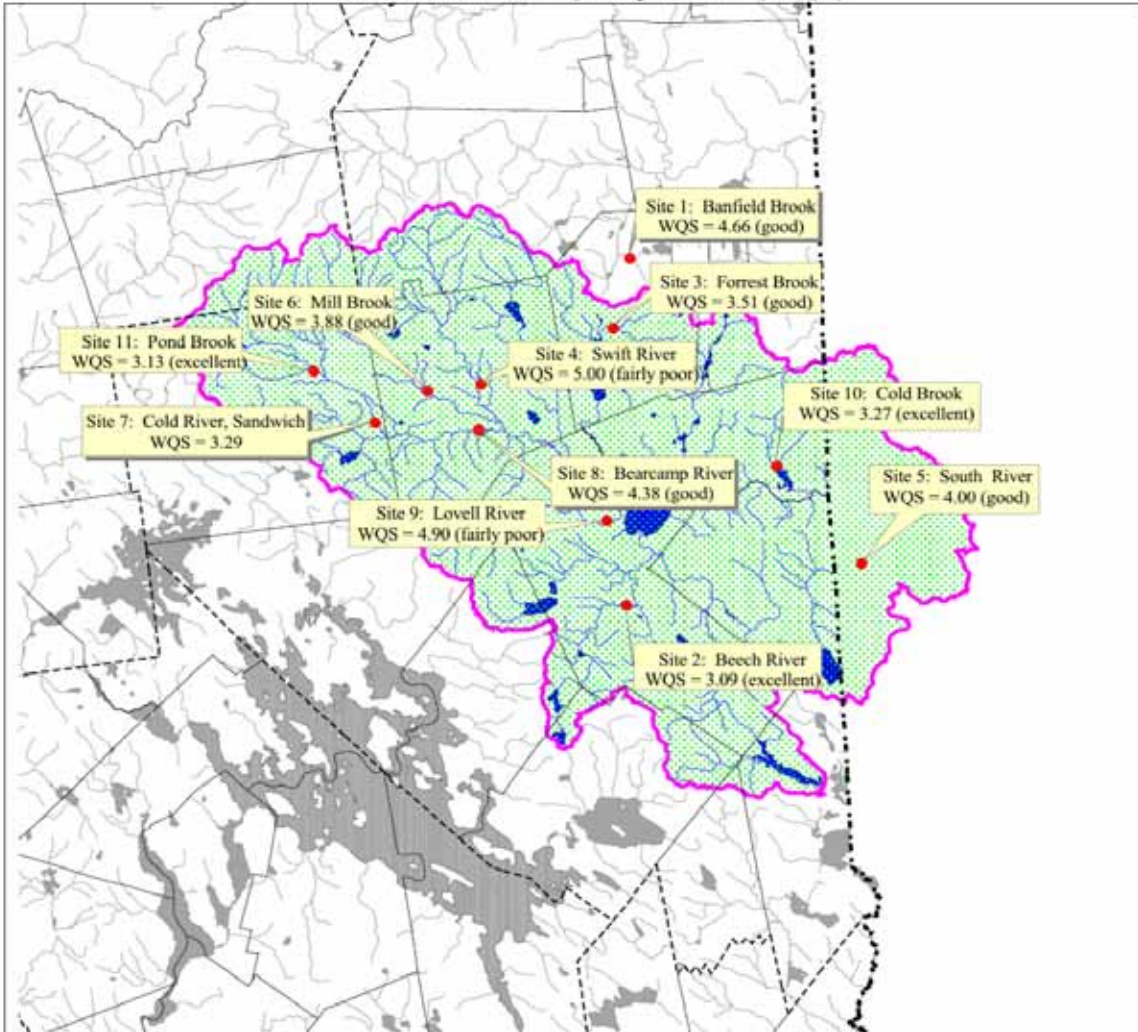
The coverages presented in this program are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. The Department is not responsible for the use or interpretation of this information, nor for any inaccuracies.

Map Prepared October 16, 2006.



# Map 2

## 2006 Ossipee Watershed Volunteer Biomonitoring Assessment Program Sites and Water Quality Scores (WQS)

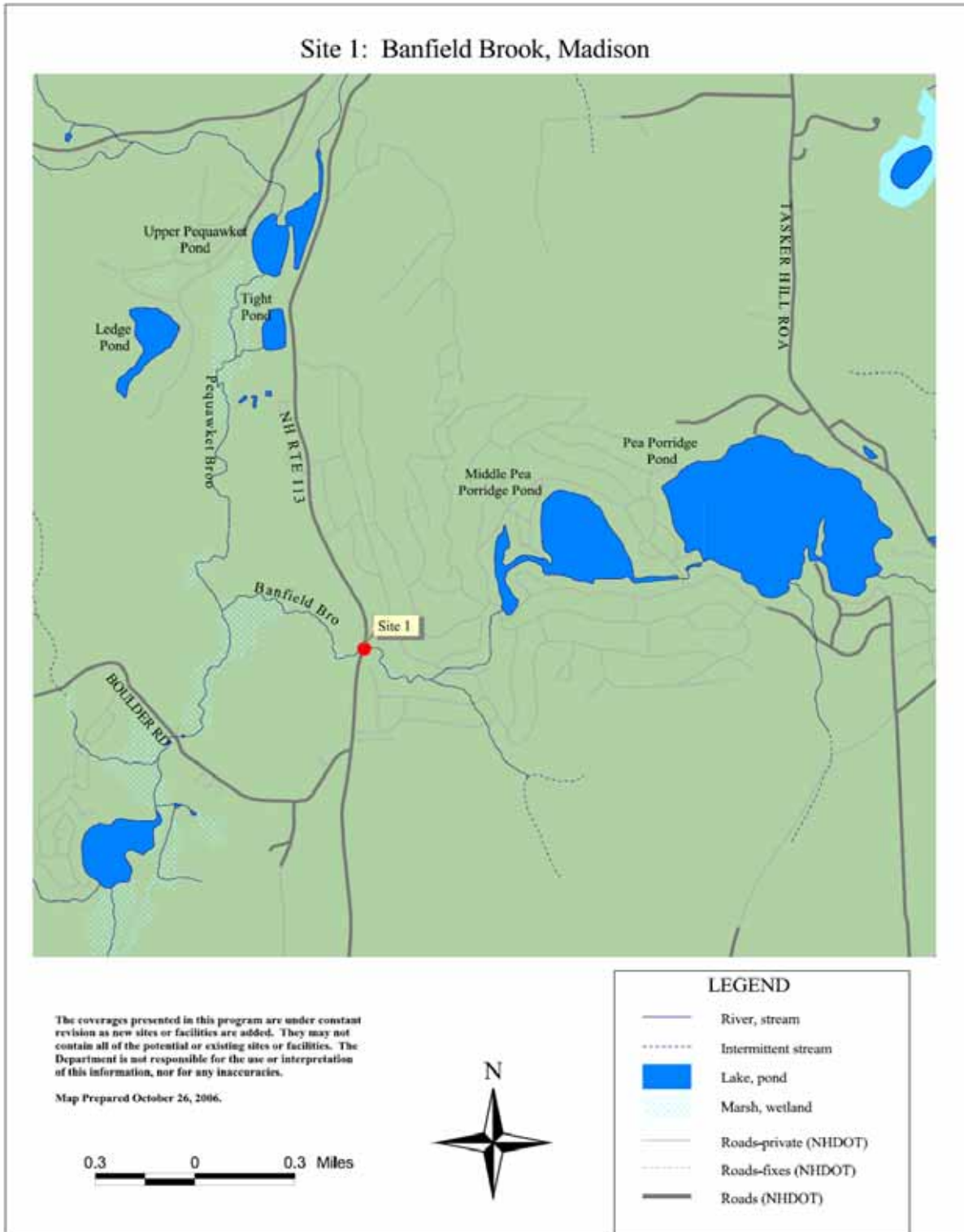


The coverages presented in this program are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. The Department is not responsible for the use or interpretation of this information, nor for any inaccuracies.

Map Prepared October 16, 2006.

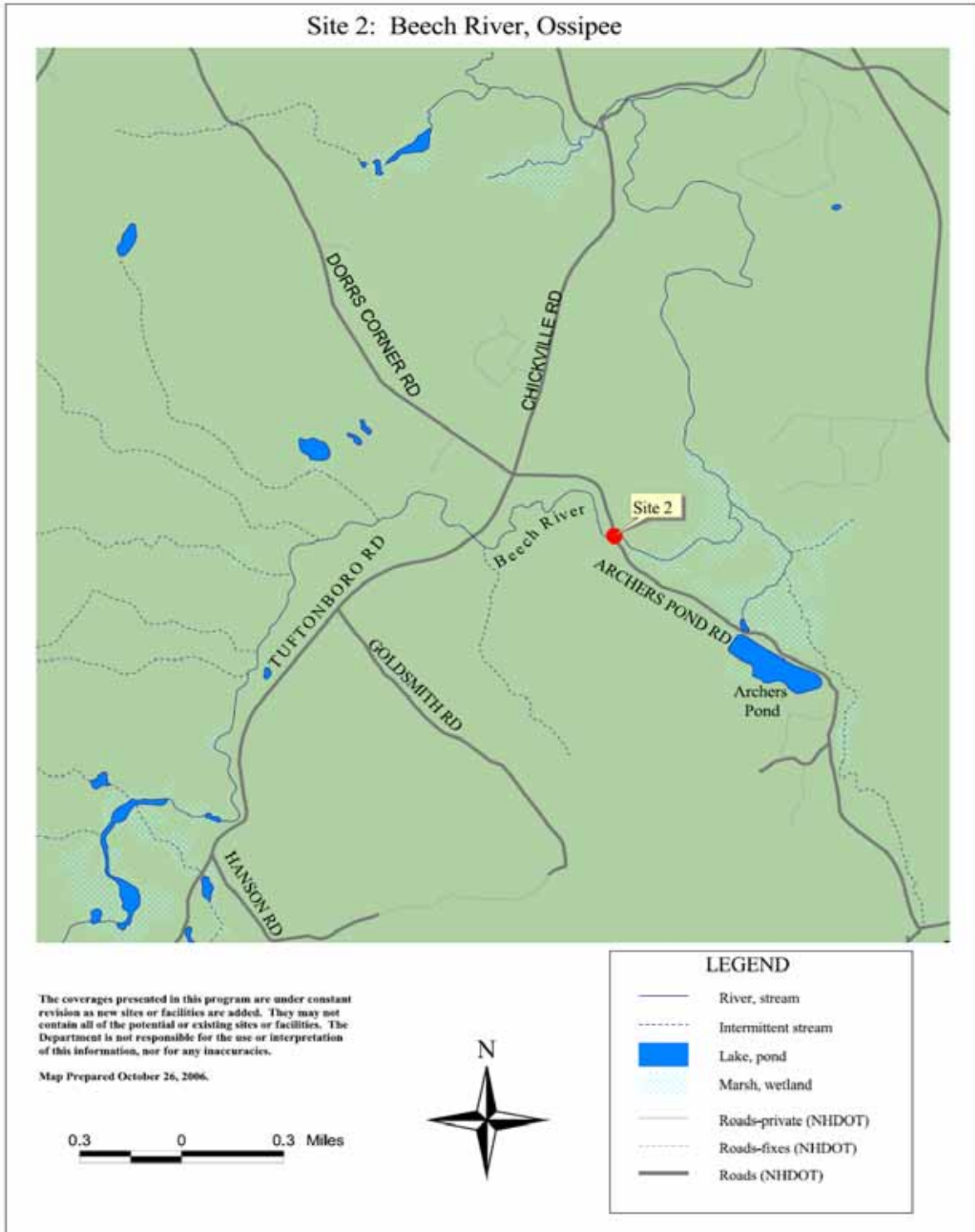


# Map 3





# Map 4



# Map 5

## Site 3: Forrest Brook, Madison



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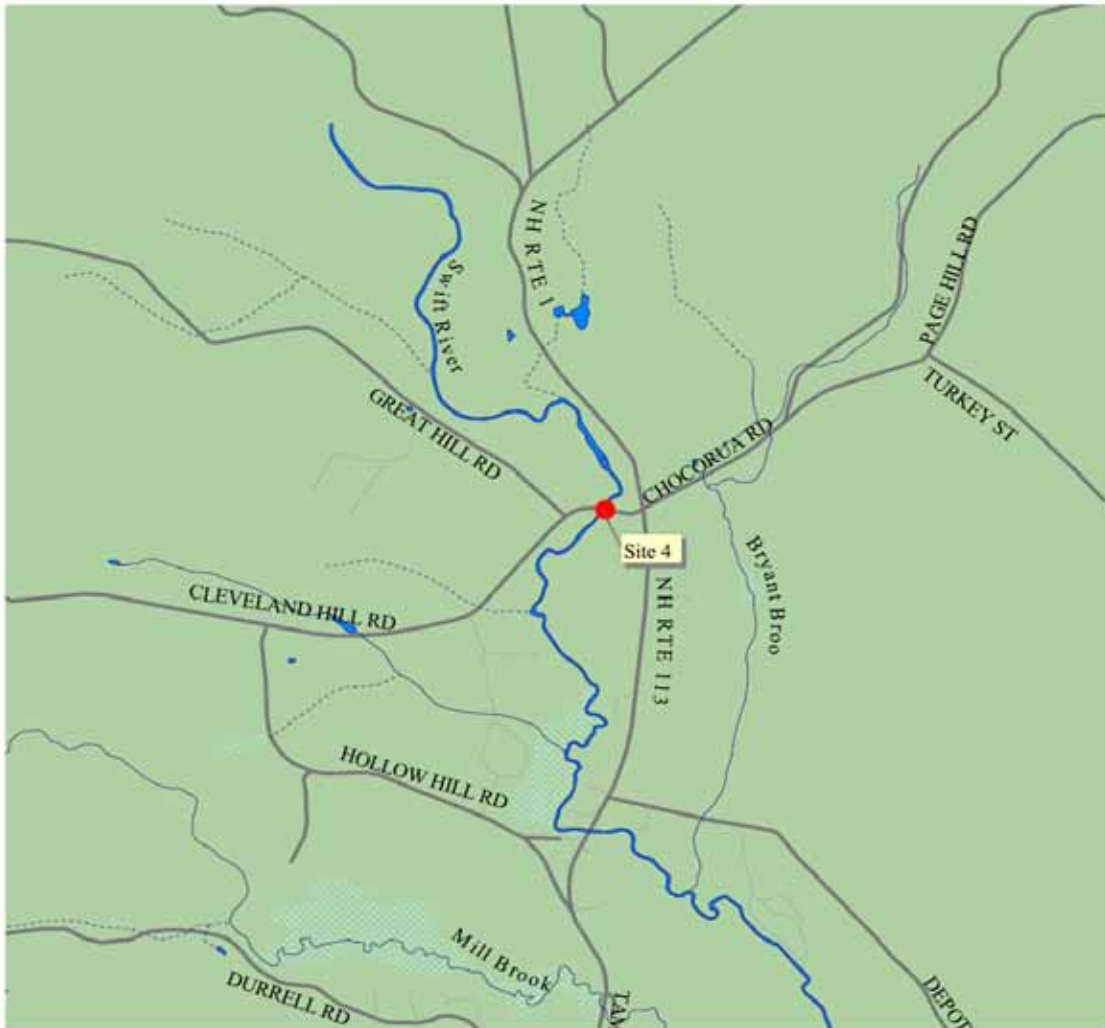
Map Prepared October 26, 2006.



LEGEND	
	River, stream
	Intermittent stream
	Lake, pond
	Marsh, wetland
	Roads-private (NHDOT)
	Roads-fixes (NHDOT)
	Roads (NHDOT)

# Map 6

## Site 4: Swift River, Tamworth



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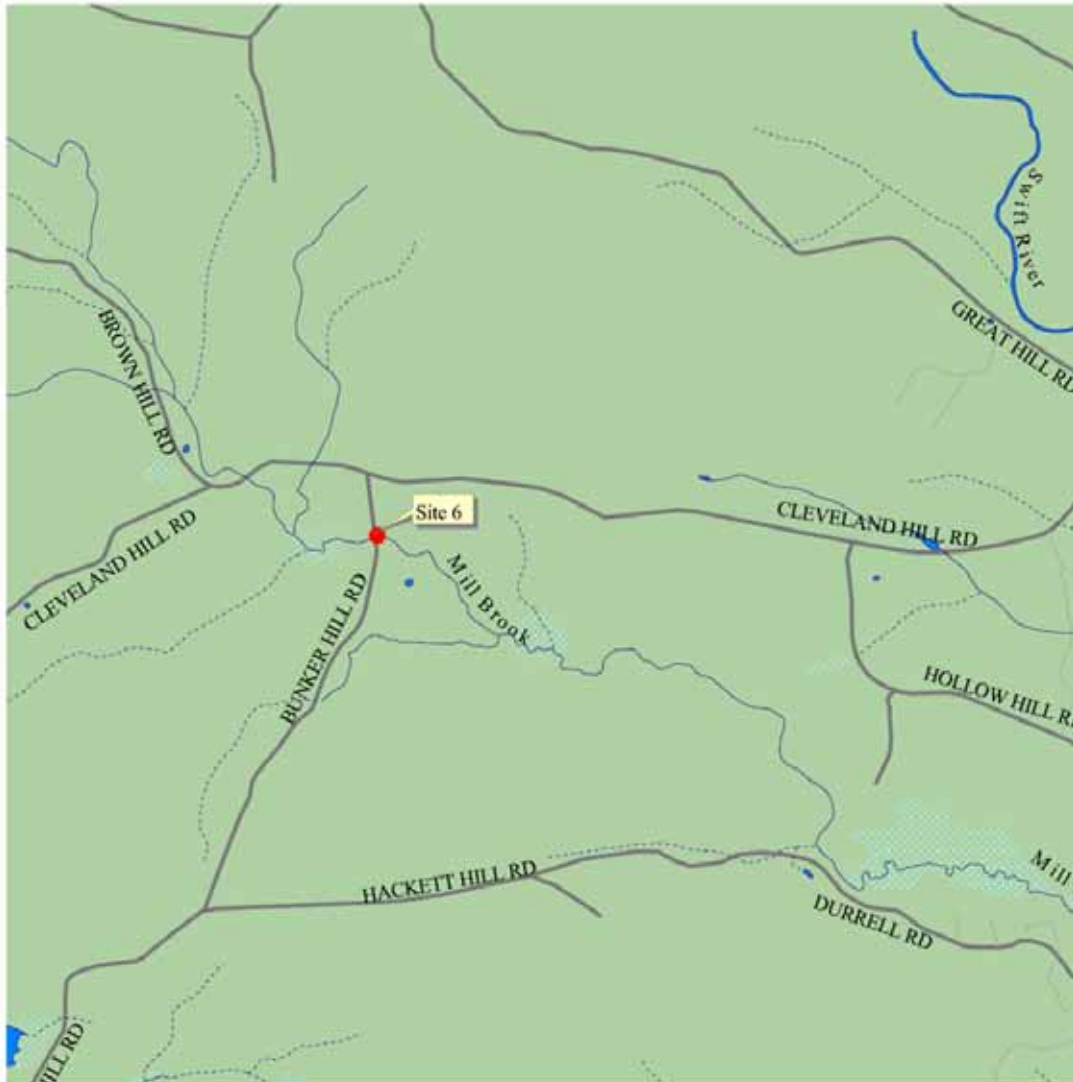
Map Prepared October 26, 2006.



LEGEND	
	River, stream
	Intermittent stream
	Lake, pond
	Marsh, wetland
	Roads-private (NHDOT)
	Roads-fixes (NHDOT)
	Roads (NHDOT)

# Map 8

## Site 6: Mill Brook, Tamworth





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Map Prepared October 26, 2006.

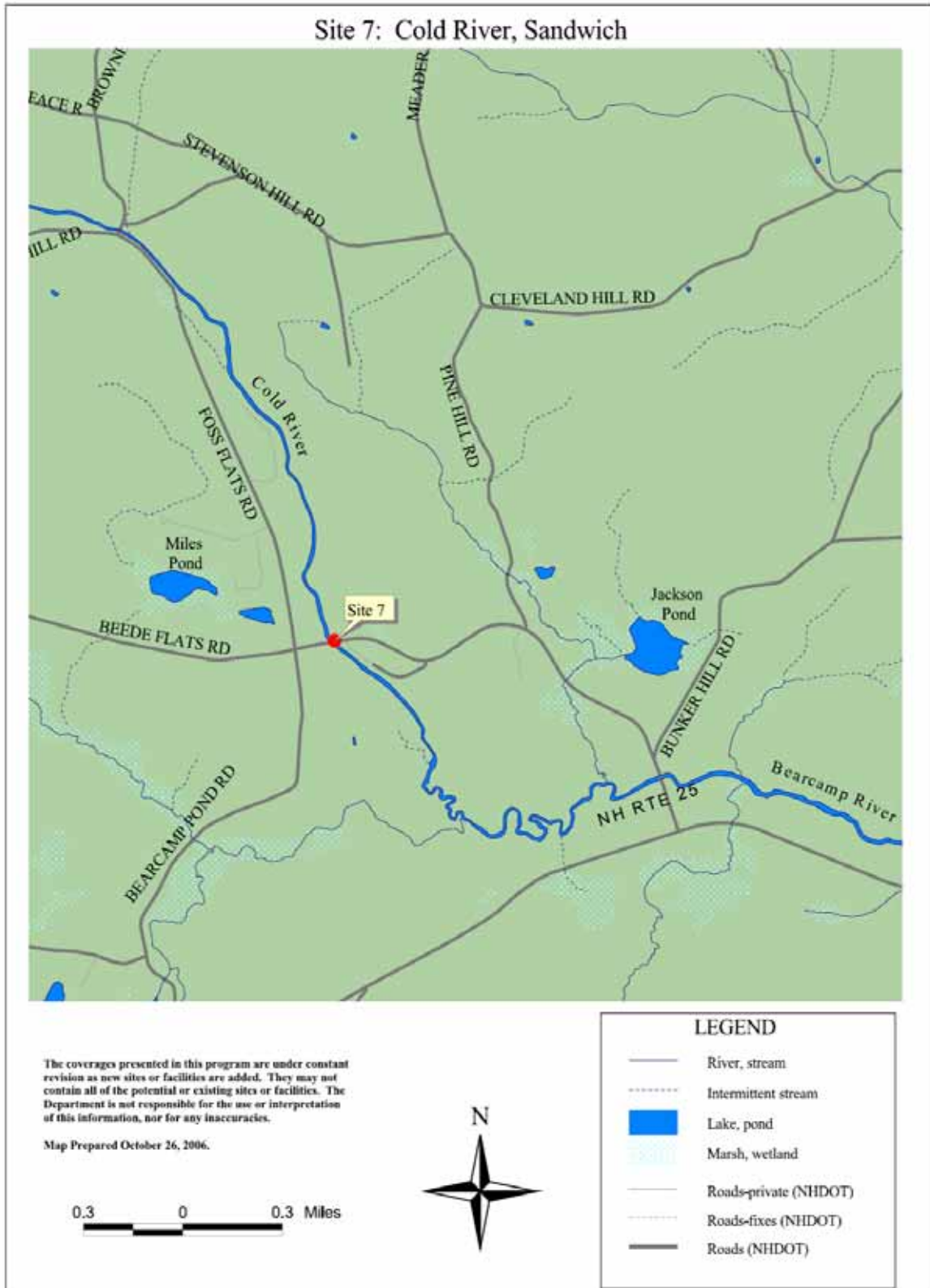
0.3 0 0.3 Miles



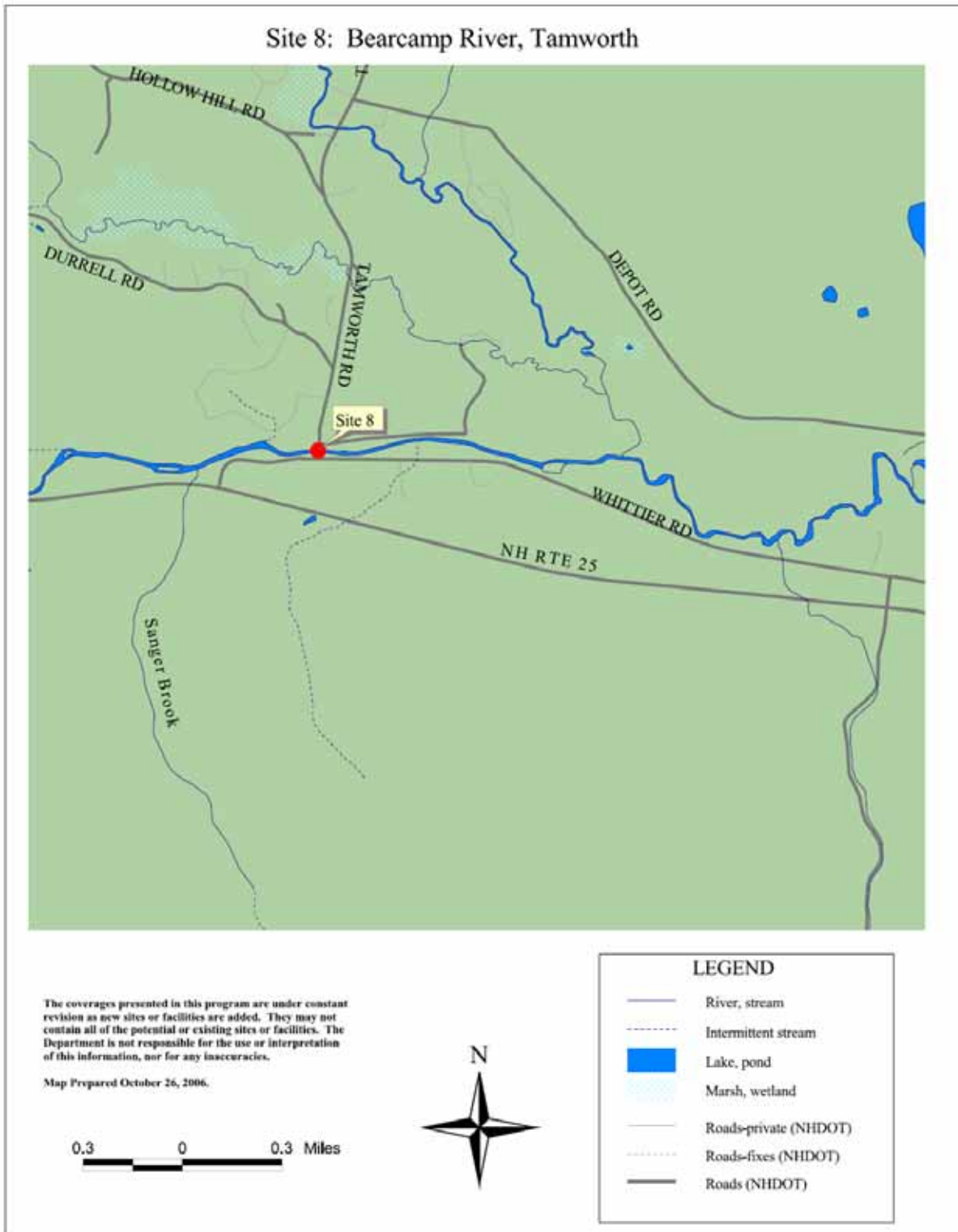
### LEGEND

-  River, stream
-  Intermittent stream
-  Lake, pond
-  Marsh, wetland
-  Roads-private (NHDOT)
-  Roads-fixes (NHDOT)
-  Roads (NHDOT)

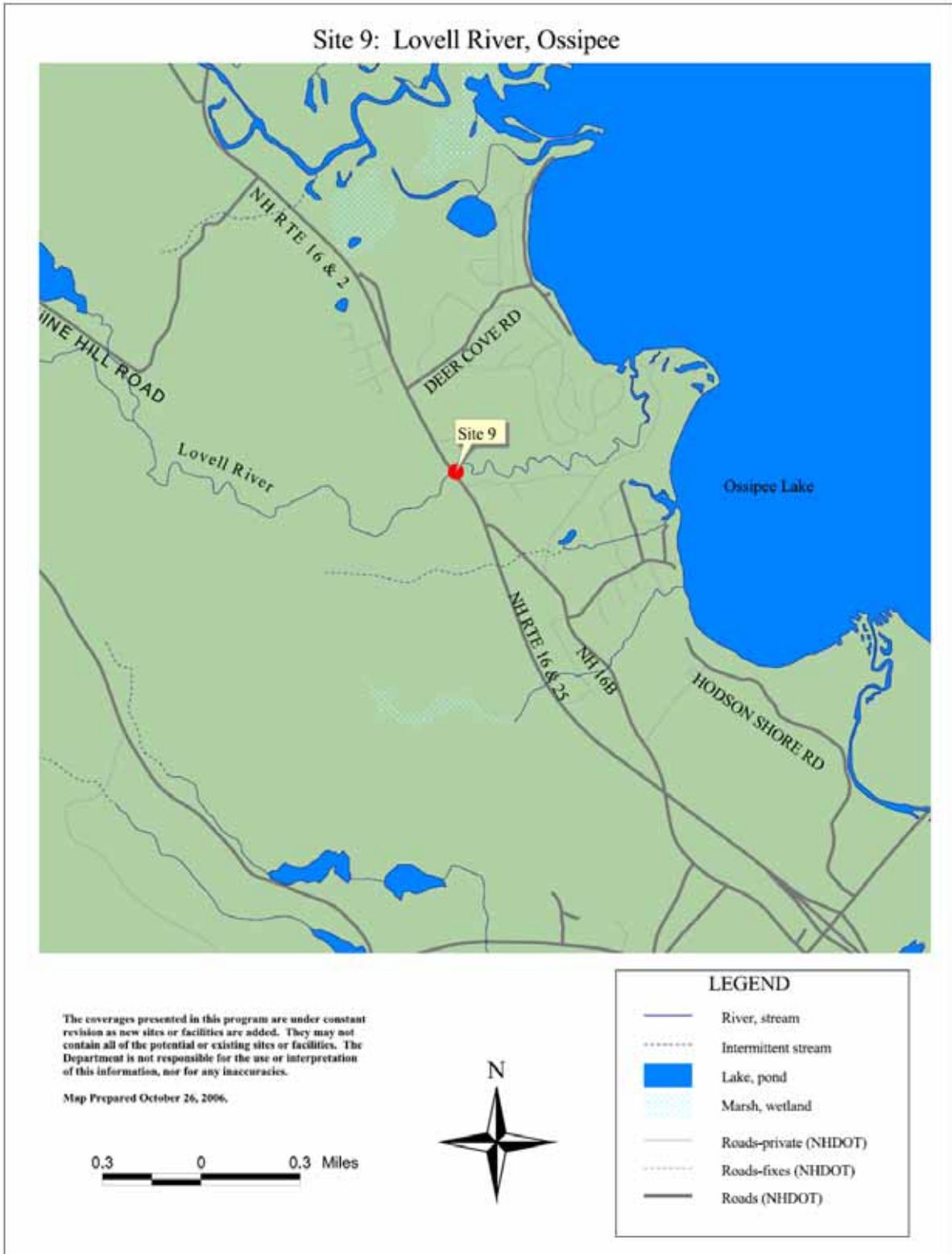
# Map 9



# Map 10

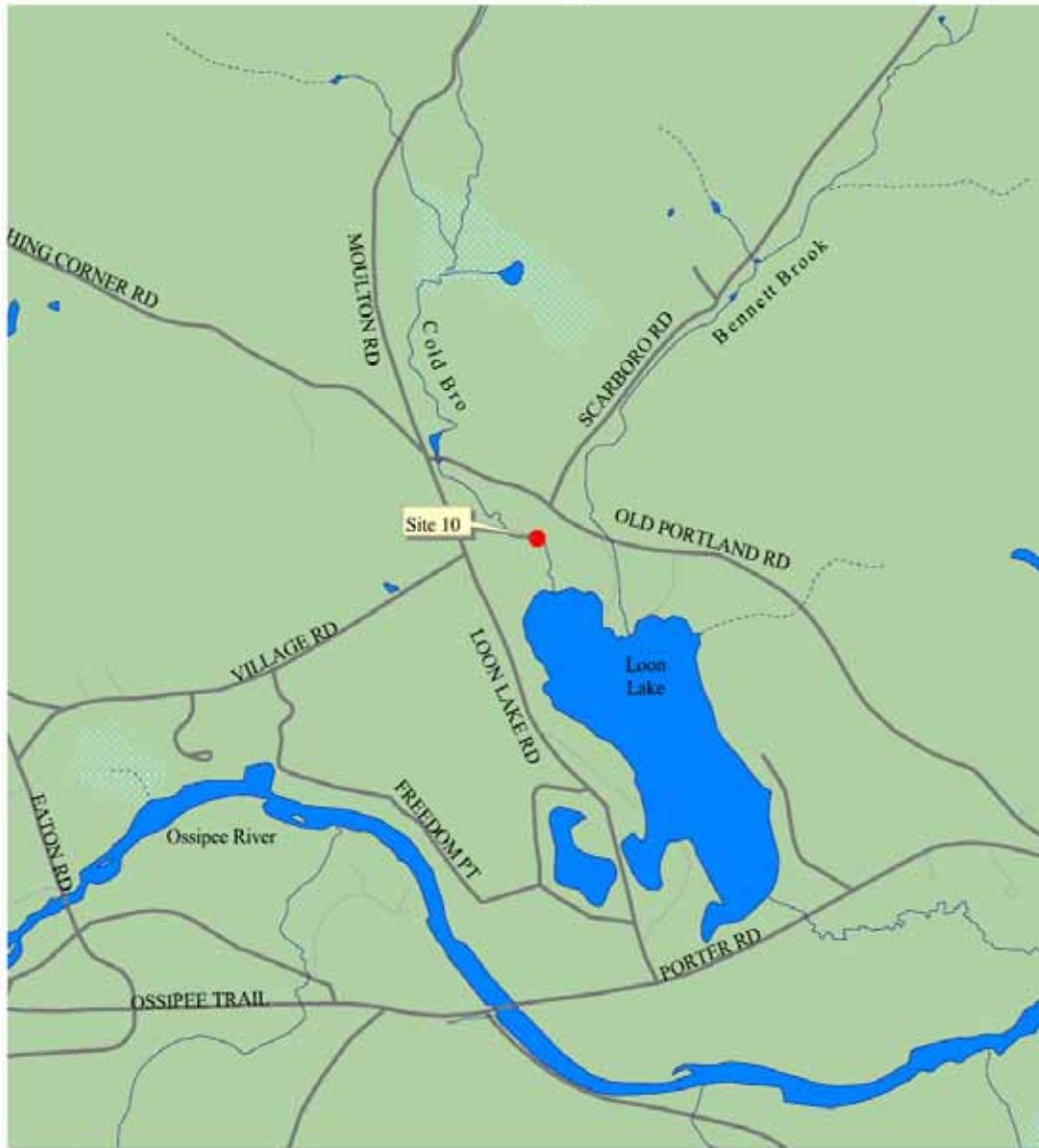


# Map 11



# Map 12

## Site 10: Cold Brook, Freedom



The coverages presented in this program are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. The Department is not responsible for the use or interpretation of this information, nor for any inaccuracies.

Map Prepared October 26, 2006.



### LEGEND

- River, stream
- Intermittent stream
- Lake, pond
- Marsh, wetland
- Roads-private (NHDOT)
- Roads-fixes (NHDOT)
- Roads (NHDOT)



# Map 13

## Site 11: Pond Brook




The coverages presented in this program are under constant revision as new sites or facilities are added. They may not contain all of the potential or existing sites or facilities. The Department is not responsible for the use or interpretation of this information, nor for any inaccuracies.

Map Prepared October 26, 2006.

0.3 0 0.3 Miles



### LEGEND

-  River, stream
-  Intermittent stream
-  Lake, pond
-  Marsh, wetland
-  Roads-private (NHDOT)
-  Roads-fixes (NHDOT)
-  Roads (NHDOT)

Picture 1

Site 1: Banfield Brook, Madison, NH



Picture 2

Site 2: Beech River, Ossipee, NH



Picture 3

Site 3: Forest Brook, Madison, NH



Picture 4

Site 4: Swift River, Tamworth, NH



Picture 5

Site 5: South River, Parsonsfield, ME



Picture 6

Site 6: Mill Brook, Tamworth, NH



Picture 7

Site 7: Cold River, Sandwich, NH



Picture 8

Site 8: Bearcamp River, Tamworth, NH



Picture 9

Site 9: Lovell River, Ossipee, NH



Picture 10

Site 10: Cold Brook, Freedom, NH



Picture 11


Site 11: Pond Brook, Sandwich, NH







## B. Sample Volunteer Biomonitoring Biological Water Quality Score Sheet – Biotic Index Calculation Worksheet

Site Number	3	Stream Name	Cohas Brook	Town	Manchester		
Volunteer Group	Merrimack Grp.						
Staff Present	John Doe, Jane Doe			Date	7/2/03		Replicate Number

The invertebrate Groups below have different sensitivities to pollution. These sensitivities have both a narrative and numeric ranking as summarized here. Calculate the Final Biotic Score by multiplying the Tolerance Value by the Totals Found. Sum each row in the Biotic Score column and place this value in the Total Biotic Score line. Calculate Final Biotic Score according to calculation below. This is your Biological Water Quality Score.

Group	Tolerance Value	*	Totals Found	=	Biotic Score
<b>Ephemeroptera</b> Mayfly Nymph	3	*	23	=	69
<b>Plecoptera</b> Stonefly Nymph	1	*	56	=	56
<b>Trichoptera</b> Caddisfly Larvae	4	*	25	=	100
<b>Odonata</b> Dragonfly Nymph	3	*	0	=	0
Damselfly Nymph	7	*	0	=	0
<b>Diptera</b> Black fly larvae	7	*	0	=	0
Midge larvae	6	*	8	=	48
Most True Flies	4	*	3	=	12
<b>Megaloptera</b> Alderfly	4	*	0	=	0
Fishfly or Helgrammite	0	*	1	=	0
<b>Coleoptera</b> Riffle Beetle	4	*	6	=	24
Water Penny	4	*	2	=	8
Beetle & Beetle-like	7	*	3	=	21
<b>Others</b> Crayfish	6	*	0	=	0
Snails	7	*	0	=	0
Aquatic Worms	8	*	2	=	16
Scuds	8	*	0	=	0
Sowbugs	7	*	0	=	0
Clams	8	*	0	=	0

**Total Biotic Score** 436

$$\text{Final Biotic Score} = \frac{\text{Total Biotic Score}}{\text{Total \# Individuals Counted for all Groups}}$$

$$\text{Final Biotic Score} = \frac{436}{115} = 3.8$$

Circle the Water Quality Score that corresponds to the Final Biotic Score.

Water Quality Score	
0 - 3.5	Excellent
>3.5 - 4.8	Good
>4.8	Fairly Poor

\*\*This is your Biological Water Quality Score\*\*  
Enter this Score on the Site Sheet.

### C. Sample Volunteer Biomonitoring Physical/Chemical Data Sheet

200'

End of reach

Record depth = 1 ft 6 in

Record width = 7.9 ft

Middle of reach

Record depth = 1 ft 9 in

Record width = 10.0 ft

Start of reach

Record depth = 1 ft 3 in

Record width = 12.1 ft

Average depth =  $\frac{\text{sum}}{3} = \frac{4'6''}{3} = 1 \text{ ft } 6 \text{ in}$

Average width =  $\frac{\text{sum}}{3} = \frac{30.0}{3} = 10.0 \text{ ft}$

\*All chemical samples should be taken in an undisturbed area before performing all other in-stream sampling activities.

\*These are the 4 required parameters. Others may be taken.

Chemical Parameter	Date	Value	Meter #
pH	7/2/03	6.8	16A
Dissolved Oxygen	7/2/03	8.2 mg/L	15B
Temperature	7/2/03	20.1 °C	10A
Conductivity	7/2/03	30 μS/cm	16C



## D. Volunteer Biomonitoring Habitat Data Sheet

Site Number \_\_\_\_\_ Stream Name \_\_\_\_\_ Town \_\_\_\_\_

Volunteer Group \_\_\_\_\_ Staff Present \_\_\_\_\_

Latitude \_\_\_\_\_ Longitude \_\_\_\_\_ Date \_\_\_\_\_

Directions to the site:

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Weather:	Past 3 days	Today
Heavy rain/ downpour		
Steady rain		
Intermittent rain		
Overcast/ cloudy		
Clear/Sunny		
Air Temperature °F		

**Surrounding Land Use** (estimate % of each if multiple surrounding land uses):

- Forest
- Field/Pasture
- Agricultural
- Residential
- Commercial
- Industrial
- Other \_\_\_\_\_

**Riparian Vegetation** (dominant vegetative type):

- Trees
- Shrubs
- Grasses
- Herbaceous (non-woody, green and leaf-like)

Width of Riparian Zone:

-Left Bank    \_\_\_\_\_ 0-20'    \_\_\_\_\_ 20-100'    \_\_\_\_\_ 100-500'    \_\_\_\_\_ >500'  
 -Right Bank    \_\_\_\_\_ 0-20'    \_\_\_\_\_ 20-100'    \_\_\_\_\_ 100-500'    \_\_\_\_\_ >500'

**Canopy Cover:**

\_\_\_\_\_ open    \_\_\_\_\_ <10%    \_\_\_\_\_ 10-40%    \_\_\_\_\_ 40-75%    \_\_\_\_\_ >75%  
 % of tree type (deciduous/coniferous) \_\_\_\_\_

**Eroded or Disturbed Banks:**

**Left Bank**

- \_\_\_\_\_ None noticeable
- \_\_\_\_\_ Slight (some areas of erosion, but no noticeable impacts to streambed)
- \_\_\_\_\_ Moderate (frequent areas of erosion, with minor impacts to streambed)
- \_\_\_\_\_ Heavy (erosion impacts streambed)

**Right Bank**

- \_\_\_\_\_ None noticeable
- \_\_\_\_\_ Slight (some areas of erosion, but no noticeable impacts to streambed)
- \_\_\_\_\_ Moderate (frequent areas of erosion, with minor impacts to streambed)
- \_\_\_\_\_ Heavy (erosion impacts streambed)

**Flow** (estimate requires general idea of water levels during sampling period):

- Low (below average level for the time of the year)
- Moderate (approximate seasonal average)
- High (above average level for the time of the year)

**Frequency of habitat type within Reach** (Chose most prevalent habitat type):

\_\_\_\_\_ Riffles \_\_\_\_\_ Pools \_\_\_\_\_ Run/Glide

**Water Color:**

- Clear
- Green
- Reddish/orange
- Cloudy
- Muddy

**Presence Logs or Woody Debris:**

\_\_\_\_\_ None \_\_\_\_\_ Occasional (present but not frequently encountered)  
\_\_\_\_\_ Common (present and frequently encountered)

**Stream Substrate** (Describe the substrate at the sampling site):

- Clay (hard, slippery, muddy)
- Silt (smooth, fluffy, easily suspended in water)
- Sand (smaller than marble and gritty)
- Gravel (marble to tennis ball)
- Cobble (tennis ball to basketball)
- Boulder (basketball size or larger)
- Bedrock (solid surface)

**Embeddedness:**

- Cobble and boulder particles are 0-25% surrounded by sediment (sand, silt).
- Cobble and boulder particles are 25-50% surrounded by sediment (sand, silt).
- Cobble and boulder particles are 50-75% surrounded by sediment (sand, silt).
- Cobble and boulder particles are more than 75% surrounded by sediment (sand, silt).

**Aquatic Vegetation:**

- Algae (no stems, leaves or roots)
- Moss (small plant with stems, leaves and roots, often found in mat-like structures)
- Plants

**Comment Section** (Note any unusual items such as water smell, streamside activities, garbage, storm water inputs, drainage pipes, etc.):

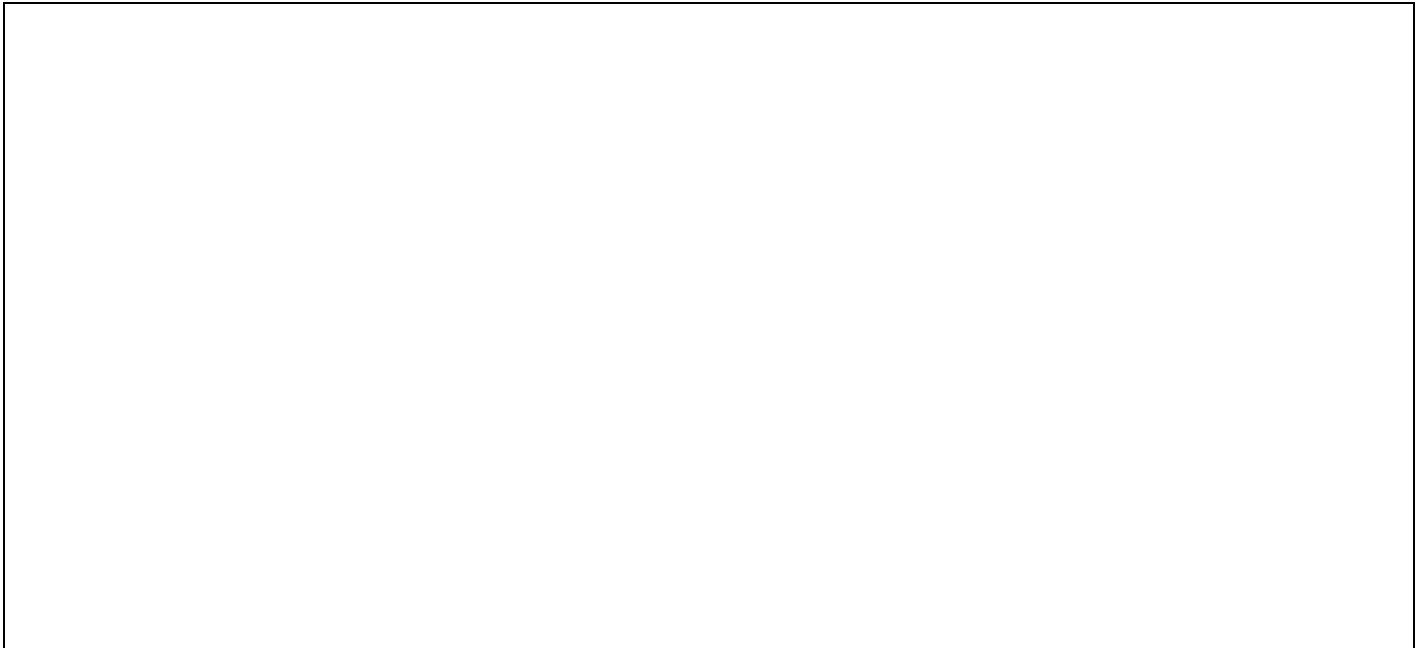
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**Site Sketch:**



Features to Include in Site Drawing

- Direction of flow
- ~ Riffle
- = Run
- O Pool
- × Location of each sample

Also include:

Distance from road/bridge  
Woody debris/trees, Pipes,  
Any anthropogenic or unusual features

