EXECUTIVE SUMMARY

Thank you for your continued hard work sampling **Phillips Pond, Sandown** this year! Your monitoring group sampled the deep spot **five** times this year and has done so for many years. As you know, conducting multiple sampling events each year enables DES to more accurately detect water quality changes. Keep up the great work!

2010 RESULTS

- Table 1 depicts the minimum and maximum ranges for water quality parameters collected at **Phillips Pond** in 2010. Highlighted cells depict values or ranges that are considered outside the mean range for New Hampshire lakes and ponds. *For a description of each parameter and water quality ranges, please refer to the Data Interpretation section of this report.*

Table 1. 2010 Chemical and Biological Data Summary

Station Name	Transparency (meters) (min-max)		Chorophyll-a (mg/m^3) (min-max)	Dissolved Oxygen (mg/L) (min-max)	Conductivity (uMhos/cm) (min-max)	Total Phosphorus (ug/L) (min-max)	Turbidity (NTUs) (min-max)	pH (min-max)	Acid Neutralizing Capacity (mg/L) (min-max)	Chloride (mg/L) (min-max)	E. coli (cts/100 mL) (min-max)
	NVS	VS									
EPILIMNION	1.50 – 2.28	2.0 – 2.5	**2.35 – 21.8***	5.5 – 8.5	**159.7 – 187.7**	**14 – 24***	**0.82 – 1.47***	6.76 – 6.98	7.8 – 12.9	**29 – 39**	n/a
HYPOLIMNION	n/a		n/a	**1.6 – 2.3**	**161.0 – 186.2**	**14 – 23◊**	**1.00 – 3.57◊**	6.28 – 6.77	n/a	n/a	n/a
INLET	n/a		n/a	n/a	**185.0 – 206.0**	**28 – 60◊**	**0.96 – 3.59◊**	6.40 – 6.82	n/a	**24 – 33**	n/a
METACOMET INLET	n/a		n/a	n/a	**155.9 – 170.6**	**18 – 44**	0.58 – 1.29	6.10 – 6.44	n/a	**24 – 41**	n/a
OUTLET	n/a		n/a	n/a	**170.7 – 181.7**	21 – 29	1.12 – 1.33	6.20 – 6.31	n/a	**24 - 37**	n/a

* Suspected algal bloom in May increased chlorophyll-a concentrations, and epilimnetic turbidity and phosphorus concentrations.
◊ Suspected sediment contamination in hypolimnion and Inlet samples increased phosphorus concentrations.

DATA INTERPRETATION

- **TRANSPARENCY**

Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by algae and sediment in the water, as well as the natural color of the water. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

Transparency may also be measured using a viewscope, a cylindrical tube, designed to decrease surface water properties that may cause difficulty in viewing the Secchi disk. A comparison of transparency readings collected with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days.

Water Clarity (meters)	Category
< 2	Poor
2-4.5	Good
> 4.5	Exceptional

Typically, as chlorophyll-a concentrations increase in a waterbody, transparency decreases, and vice versa. Also, high intensity rainfall events can cause sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts should continually be made to stabilize stream banks, pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the pond. Guides to best management practices that can be implemented to reduce, and possibly even eliminate, nonpoint source pollutants, are available from DES upon request.

- **CHLOROPHYLL-A**

Chlorophyll-a, a pigment found in plants, is an indicator of algal or cyanobacteria abundance. Algae are typically microscopic plants that are naturally found in the lake ecosystem. The measurement of chlorophyll-a in the water gives biologists an estimation of the algal concentration or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m^3.**

Chlorophyll-a (mg/m^3)	Category
0-5	Good
5.1-15	More than desirable
> 15	Nuisance amounts (indicative of algal or cyanobacteria blooms)

While algae are naturally present in all waterbodies, an excessive or increasing amount of any type is not welcomed. Phosphorus is the nutrient that algae

typically depend upon for growth in New Hampshire lakes and ponds. Algal concentrations increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase. Increased Chlorophyll-a concentrations can also affect water clarity, causing Secchi-disk transparency to decrease (worsen) and turbidity to increase (worsen). Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

- **PHYTOPLANKTON**

Phytoplankton populations undergo a natural succession during the growing season. Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession. Diatoms and golden-brown algae populations are typical in New Hampshire's less productive lakes and ponds.

Table 2 lists the phytoplankton (algae) and/or cyanobacteria observed in **2010**. Specifically, this table lists the three most dominant phytoplankton and/or cyanobacteria observed and their relative dominance in the sample.

Table 2. Dominant Phytoplankton/Cyanobacteria (August 2010)

Division	Genus	% Dominance
Chrysophyta	Dinobryon	74.0
Bacillariophyta	Tabellaria	17.0
Pyrrophyta	Ceratium	6.0

- **TOTAL PHOSPHORUS**

Phosphorus is typically the limiting nutrient for vascular plant and algal growth in New Hampshire's lakes and ponds. Excessive phosphorus in a pond can lead to increased plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

Total Phosphorus (µg/L)	Category
1-10	Low (good)
11-20	Average
21-40	High
> 40	Excessive

Elevated epilimnetic phosphorus concentrations are often a result phosphorus-enriched stormwater runoff following a significant rain event. Elevated hypolimnetic phosphorus concentrations are often caused by the anchor or Kemmerer Bottle disturbing the lake bottom sediment while sampling and/or the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the lake bottom is disturbed, phosphorus rich sediment is

released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottle.

Elevated tributary phosphorus concentrations are often a result of stormwater runoff following a significant rain event. These events can cause watershed wetland systems to release phosphorus-enriched water, and/or carry phosphorus laden watershed runoff to tributaries. Phosphorus sources in the watershed can include fertilizers, agricultural runoff, failing or marginal septic systems, road runoff, and watershed development. Efforts should be made in the watershed to reduce impervious surfaces and limit phosphorus sources such as fertilizer use, septic influences, agricultural impacts, and sediment/erosion control.

- **CONDUCTIVITY**

Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The soft waters of New Hampshire have traditionally low conductivity values, generally less than 50 uMhos/cm. However, specific categories of good and bad levels cannot be constructed for conductivity because variations in watershed geology can result in natural fluctuations in conductivity. The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**.

Generally, values in New Hampshire lakes exceeding **100 uMhos/cm** indicate cultural, meaning human, disturbances. An increasing conductivity trend typically indicates point source and/or non-point sources of pollution are occurring within the watershed. These sources include failed or marginally functioning septic systems, agricultural runoff, and road runoff which contains road salt during the spring snow-melt. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could also contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

It appears that de-icing materials applied to nearby roadways during the winter months are influencing the conductivity in the pond. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).
Therefore, we recommend that the **epilimnion** (upper layer) and **tributaries** continue to be sampled for chloride next year to help establish a baseline of data.

- **pH**

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the state surface waters are slightly acidic.

pH	Category
< 5.0	Acidified
5.0-5.4	Critical
5.5-6.0	Endangered
6.1-8.0	Satisfactory

The hypolimnetic (lower layer) pH is often ***lower (more acidic)*** than in the epilimnion (upper layer). This increase in acidity near the bottom is likely due to the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the state's abundance of granite bedrock and acid deposition received from snowmelt, rainfall, and atmospheric particulates, there is little that can be feasibly done to effectively increase pond pH. The pH at the deep spot, however, is sufficient to support aquatic life.

- **ACID NEUTRALIZING CAPACITY**

Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.9 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs.

ANC (mg/L)	Category
< 0	Acidified
0-2	Extremely Vulnerable
2.1-10	Moderately Vulnerable
10.1-25	Low Vulnerability
> 25	Not Vulnerable

- **TURBIDITY**

Turbidity in the water is caused by suspended matter (such as clay, silt and algae) that cause light to be scattered and absorbed, not transmitted in straight lines through water. Water clarity is highly influenced by turbidity. High turbidity readings are often found in water adjacent to construction sites. Also, improper sampling techniques (such as hitting the bottom sediments with the Kemmerer bottle or sampling a tributary with little flow) may also cause high turbidity readings. The Class B standard for a water quality violation is 10 NTUs over the lake background level.

Turbidity (NTUs)	Category
< 0.1	Minimum
22.0	Maximum
1.0	Median

Elevated turbidity levels at the deep spot (epilimnion, metalimnion, hypolimnion) are often a result of stormwater runoff, algal or cyanobacteria blooms, and/or lake bottom disturbance either from the Kemmerer bottle,

anchor or powerful motor boats. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

Elevated turbidity levels in tributaries are often a result of stormwater runoff or sampling a tributary with little to no flow. Rainfall creates runoff that washes sediment and organic materials into tributaries causing turbid conditions.

Low tributary flow can lead to bottom sediment contamination during sample collection. Please be careful to observe tributary flow conditions and only sample when sufficient flow is present.

- **DISSOLVED OXYGEN**

The presence of dissolved oxygen is vital to bottom-dwelling organisms as well as fish and amphibians. If the concentration of dissolved oxygen is low, typically less than 5 mg/L, species intolerant, meaning sensitive, to this situation, such as trout, will be forced to move up closer to the surface where there is more dissolved oxygen but the water column is generally warmer, and the species may not survive.

Temperature is also a factor in the dissolved oxygen concentration. Water can hold more oxygen at colder temperatures than at warmer temperatures. Therefore, a lake will typically have a higher concentration of dissolved oxygen during the winter, spring, and fall than during the summer.

Dissolved Oxygen (mg/L)	Category
0-5	Low
5.1-8.0	Average
8.0-10.0	High (usually indicative of an algal or cyanobacteria bloom)

The dissolved oxygen concentration was ***lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)*** during the annual biologist visit. As stratified ponds age, and as the summer progresses, oxygen typically becomes ***depleted*** in the hypolimnion by the process of decomposition. Specifically, the reduction of hypolimnetic oxygen is primarily a result of biological organisms using oxygen to break down organic matter, both in the water column and particularly at the bottom of the pond where the water meets the sediment. When the hypolimnetic oxygen concentration is depleted to less than 1 mg/L, the phosphorus that is normally bound up in the sediment may be re-released into the water column, a process referred to as ***internal phosphorus loading***.

- **E. COLI**

E. coli are normal bacteria found in the large intestine of humans and other warm-blooded animals. *E.coli* are used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful

disease-causing organisms **may** also be present. *Please refer to the "Other Monitoring Parameters" section of the report for a more detailed explanation.*

E. coli (cts/100 mL)	Category
0-88	< State Standard for public beaches
> 88	> State Standard for public beaches
> 406	> State Standard for Class B surface waters

If beach monitoring results were above the state standard, we recommend that your group continue *E.coli* sampling at this station next year. If the results continue to be ***elevated***, we will recommend that your group conduct a series of tests on a weekend during heavy beach use and also immediately after a rain event. This additional sampling may help us determine the source of the bacteria. We also recommend that your group consider joining the DES Beach Inspection Program to monitor the public beach on a routine basis for *E. coli* and cyanobacteria.

If non-beach monitoring results were above the state standard for Class B surface waters, we recommend that your monitoring group conduct rain event sampling and bracket sampling next year in this area. This additional sampling may help us determine the source of the bacteria.

- **CHLORIDE**

The chloride ion (Cl^-) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. *Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.*

If your monitoring results were **> 4 mg/L and < 100 mg/L**, we recommend that your monitoring group continue to conduct chloride sampling in the epilimnion at the deep spot. This will establish a baseline of data that will assist your monitoring group and DES to determine lake quality trends in the future.

If you monitoring results were **> 100 mg/L and < 230 mg/L**, we recommend that your monitoring group conduct chloride sampling in the epilimnion at the deep spot and in the tributaries near salted roadways, particularly in the spring, during snow-melt and rain events during the summer. This will establish a baseline of data that will assist your monitoring group and DES to determine lake quality trends in the future.

If you monitoring results were **> 230 mg/L or 860 mg/L**, we recommend that your monitoring group continue to conduct chloride sampling at the deep spot and in the tributaries near salted roadways, particularly in the spring soon after

snow-melt and after rain events during the summer. Specifically, we recommend that the epilimnion, metalimnion, and hypolimnion be sampled to determine if a **chemocline**, a formation of lake layers controlled by what is dissolved in the water rather the temperature of the water, exists in the water column.

In addition, if your group is concerned about salt use on a particular roadway, we recommend contacting the town road agent or the Department of Transportation to discuss the implementation of a low-salt area near the lake and/or its major tributaries. We also recommend that your group work with watershed residents to reduce the application of chloride containing de-icing agents to driveways and walkways.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your pond, the biologist conducted a sampling procedures assessment audit for your monitoring group. Specifically, the biologist observed the performance of your monitoring group and completed an assessment audit sheet to document the volunteer monitors' ability to follow the proper field sampling procedures, as outlined in the VLAP Monitor's Field Manual. This assessment is used to identify any aspects of sample collection in which volunteer monitors failed to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this year! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if your group followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting samples and submitting them to the laboratory this year! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-03-42.pdf.

Iron Bacteria in Surface Water, DES fact sheet WD-BB-18, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-18.pdf.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, DES fact sheet WD-BB-9, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/bb/documents/bb-9.pdf.

*NH Stormwater Management Manual Volume 1: Stormwater and Antidegradation, DES fact sheet WD-08-20A, (*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20a.pdf

NH Stormwater Management Manual Volume 2: Post-Construction Best Management Practices Selection and Design, DES fact sheet WD-08-20B, *(*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf

NH Stormwater Management Manual Volume 3: Erosion and Sediment Controls During Construction, DES fact sheet WD-08-20C, *(*603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20c.pdf

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, DES fact sheet WD-SP-2, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-2.pdf.

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/organization/commissioner/pip/factsheets/wmb/documents/wmb-4.pdf.

Vegetation Maintenance Within the Protected Shoreland, DES fact sheet WD-SP-5, (603) 271-2975 or http://des.nh.gov/organization/commissioner/pip/factsheets/sp/documents/sp-5.pdf