New Hampshire Volunteer Lake Assessment Program

2005 Interim Report for Clough Pond Loudon

NHDES
Water Division
Watershed Management Bureau
29 Hazen Drive
Concord, NH 03301

NEW HAMPSHIRE DEPARTMENT OF **Environmental Services**

Acknowledgements

The New Hampshire Volunteer Lake Assessment Program (VLAP) is a collaborative effort that depends on many people. Because of the help and support of so many individuals and groups, VLAP continues to be a success.

The VLAP Coordinator and Limnology Center Director would like to extend their greatest thanks to each of the volunteer monitors! Specifically, we thank the volunteer monitors for spending countless hours sampling and transporting samples and equipment to and from their final destination. We would also like to thank the volunteers for their continued support and enthusiasm for the program. Volunteer monitors help DES biologists keep tabs on the quality of many lakes and ponds throughout the state. Volunteer monitors keep a close eye on their lake or pond and are the key individuals that help protect the quality of these resources.

As with every year, the coordinators of VLAP would like to extend a huge thank you to each of the Biology Section interns and staff who worked relentlessly this summer to analyze samples, participate in field work, and provide technical assistance to VLAP. In particular, we would like to recognize Biology Section Interns Kendra Gurney, Jess Durrett, Matt Richards, Meryl Richards, and Alicia Lane for conducting annual biologist visits this season and for managing data in the laboratory. We would also like to recognize Sara Sumner (former long-time VLAP Intern and now DES Beach Program Coordinator) and Amy Smagula (DES Exotic Species Coordinator) for spending numerous hours analyzing VLAP plankton samples, and Scott Ashley (DES Biology Section Database Coordinator) and Andrew Cornwell (DES Watershed Management Bureau Data Specialist) for assisting the VLAP Coordinator with data management.

The coordinators of VLAP would also like to recognize the staff and interns of the Lake Sunapee Protective Association (LSPA), Colby-Sawyer College (CSC), and the Sunapee Satellite Laboratory in New London for supporting VLAP monitoring efforts in this area of the state. The CSC-LSPA Satellite Laboratory, under the management of Bonnie Lewis, continued to loan out equipment to volunteer monitors and also continued to process samples that were collected in an extremely professional and timely manner.

We also would like to thank the DES Laboratory Services, who handle a constant influx of total phosphorus and *E.coli* samples from VLAP, yet continue to deliver results quickly to the volunteers.

And finally, we want to extend a special thanks to the volunteer monitors that appear on the report cover this year! They are (in clockwise order from the top right hand-side of the photo) Dr. Larry Coleman (Pool Pond, Rindge) and Tom Vogel and Maynard Wheeler (Eastman Pond, Grantham). The VLAP sign (top left) photo is from Highland Lake, Stoddard.

VLAP Lakes and Volunteer Monitors
2005 Sampling Season

Angle Pond, Sandown	Brant Sayre
Armington Lake, Piermont	Mike Poole, Grita Taylor, Linda Michaelson, Ray TaFrate
Ashuelot Pond, Washington	Don Damm, Erin Zanni
Ayers Pond, Barrington	Ron and Diane St. Jean, Michael Cavanagh
Baptist Pond, Springfield	Perry Hodges, Cynthia Hayes, John Trachy, Sylvia Garfield
Baxter Lake, Farmington	Priscilla Crevelli, Joyce Goodberry, Jim O'Connell
Bearcamp Pond, Sandwich	Emily Green-Colozzi, Gail Colozzi, Bob Green
Beaver Lake, Derry	Bob Madden, Tim Pellegrino
Berry Bay, Ossipee	Susan Marks
Blaisdell Lake, Sutton	Bill Hallahan, Michael Gudefin, Bruce Ellsworth
Broad Bay, Ossipee	Paul Clausen, Susan Marks
Canaan Street Lake, Canaan	Dan Fleetham, Rob Schaeffer
Canobie Lake, Windham	Dick Hannon and Bill Schroeder
Captain's Pond, Salem	Bob Haidaic, Maureen Cartier
Center Pond, Stoddard	Glenn Webber
Chalk Pond, Newbury	Dennis Varley
Chase Pond, Wilmot	Wayne Hayes
Chestnut Pond, Epsom	Martha Chase, Beth and Barry Arseneau
Clement Pond, Hopkinton	Marianne, Rich and Amy Sharpe
Clough Pond, Loudon	Curt Darling, Gizmo the dog
Cobbetts Pond, Windham	Al Schommer, Vicky Mason, Eric Meyer, Leo Scalan
Cole Pond, Andover	Wayne Nichol, Rod Theobald
Contention Pond, Hillsboro	Tom and Tammy McLure
Contoocook Lake, Jaffrey	Ted Covert, Kim Cochrane, Elizabeth Titus
Crescent Lake, Acworth	Tim Perry, Bob Kroupa, Mark Wilson, Jerry Bushway, Stan Rastallis
Crystal Lake, Gilmanton	Marty and Jean Martin
Crystal Lake, Manchester	Ken Cardin, Art Grindle
Danforth Pond, Lower, Freedom	Lauren Bergeron
Deering Lake, Deering	Bob Compton, Peter Kaplan, Joe and Peggy Lauzon
Dorrs Pond, Manchester	Art Grindle
Dutchman Pond, Springfield	Tina Rivera, Jen Fletcher
Eastman Pond, Grantham	Charlie McCarthy, Tom Vogel, Russ Johnson, Maynard Wheeler, Larry and Lois White
Forest Lake, Dalton/Whitefield	Rick Wright
Forest Lake, Winchester	Pat Johnson
French Pond, Haverhill	Don Rundstrom
French Pond, Henniker	Mike French
Frost Pond, Jaffrey	Jack Donnelly, Leslie Whone
Gilmore Pond, Jaffrey	Mike and Val Lichter
Gould Pond, Hillsboro	Walter Henderson, Ken Warren
Governor's Lake, Raymond	Ken Pothier
Granite Lake, Nelson/Stoddard	Tom and Ian Newcombe, Eve Sharkey
Great Pond, Kingston	Dave Ingalls, Skip Clark, Larry Smith, John Booth, Craig Eldridge

Gregg Lake, Antrim	Jim Franco, Bob Southall
Halfmoon Lake, Barnstead	George Fitzpatrick, Bill Dugan, M. Fedichick, Mike Bennett, Norm Boisvert
Halfmoon Pond, Washington	Carol and Mike Andrews
Harantis Lake, Chester	Jo Columbus
Harrisville Pond, Harrisville	Harry Wolhandler
Harvey Lake, Northwood	Karen Smith, Doris Entwisle
Hermit Lake, Sanbornton	Marie Wescott, Jackson
Highland Lake, Andover	Len Davis, Robert Welch, Frank Baker
Highland Lake, Stoddard/Washington	Jeff and Helen Berry, William Bearce, Mike Jubert
Hills Pond, Alton	John Harrington, Pam Couronis, Mike McDavitt
Island Pond, Stoddard	Don Flemming, Geoff Molina
Island Pond, Washington	Jean and Heather Kluk, Steve and Debbie Vinciguerra
Island Pond, Big, Derry	Herb Lippold, Dale Anderson, Dick Jones, Art Bowen, Barry Reed
Jenness Pond, Northwood	Jim Bapple, Earl Klaubert, Ron Covey
Katherine, Lake, Piermont	Charlie Muntz, George and Joyce Tompkins, Helga Mueller
Kezar Lake, North Sutton	Steve and Leslie Enroth, Ken
Kilton Pond, Grafton	John and Jan Bidwell, Lou Cerundolo
Knowles Pond, Northfield	Alan and Cindy Leach
Kolelemook Lake, Springfield	Thomas Duling, Ed Belfield, A. Wheeler
Laurel Lake, Fitzwilliam	Barbara Green, Craig Heatley, Craig Heatly Jr. Marjorie Aukstikalnis, Phyllis Lurvey, Mary Ann Perry, Perry Nadeau, Dana Wasserbauer
Leavitt Bay, Ossipee	Susan Marks
Ledge Pond, Sunapee	Marilyn Johnson, Nancy, Susan and Chuck Crickman, Michael Hogan
Lees Pond, Moultonboro	Karin and Beverly Nelson
Long Pond, Lempster	Al Grotheer, Nola Garrits
Loon Lake, Plymouth/Rumney	Dick and Aloise Stewart
Loon Pond, Gilmanton	Richard Hillsgrove
Lower Beech Pond, Tuftonboro	Marty and Rita Martel, Jim Minieri, Warren Amundsen
Marsh Pond, Chichester	Deb Soule, LeeAnn Valotto, Mark Marchand
Martin Meadow Pond, Lancaster	Martin, Helen, and Tyler Driscoll
Mascoma Lake, Enfield	Roger Barnes, Austin Flint, Jim Martel, Erland Schulson, George Crowe, Francis and Henry Miles, Mike Umberger, Bill Martin, Bob Sletten, Lee Hammond
Lake Massasecum, Bradford	Dave Currier, M. Prime, Robert Toppi, Tom Marshall
Maxwell Pond, Manchester	Art Grindle
May Pond, Washington	Mike Morrison
McQuesten Pond, Manchester	Art Grindle
Meetinghouse Pond, Marlboro	Ernest and Ethan Linders
Melendy Pond, Brookline	Steve Fitzgerald, Jay Chrystal, Ken Turkington, Harold Briggs
Messer Pond, New London	David Webster, John Harris
Mill Pond, Stratham	Pat Elwell
Millen Pond, Washington	Fred Douglas, Dennis O'Malley, Ed Collins, John and Elizabeth Brighten
Mitigation Wetlands, Brentwood	Albert Garlo

Lake Monomonac, Rindge	Lorraine Gauthier, Mindy Grady, Mark Senecal, Carlton Grady, Art Florelli
Mountain Lake, North, Haverhill	Don Drew
Mountain Lake, South, Haverhill	Don Drew
Mountainview Lake, Sunapee	Eleanor Thompson and Dick Whynall
New Pond, Canterbury	Ken and Ginny Dow, Brendan Hearn
Northwood Lake, Northwood	Alan Hand, Jack Gardner
Nubanusit Lake, Nelson	Dave Birchenough, Maurice Legace
Nutts Pond, Manchester	Art Grindle
Onway Lake, Raymond	Jonathan Wood, Michelle McManus
Lake Ossipee, Ossipee	Howard Bouve
Otter Pond, New London/Sunapee	Gerry and Elizabeth Shelby, S. Greenbalm
Otternick Pond, Hudson	Mike Cunningham, Ed Mercer, Donna Abbott
Partridge Lake, Littleton	Dayton Goudie
Pawtuckaway Lake, Nottingham	Scott and Jack Hodgson, Joyce and Chris Rowe, Jim Kelly, Willard Urban, Therese Thompson, Bud Bonser, Tony Scianna, Dan Hajjar, Dwight and Ellie Crow
Pea Porridge Pond, Big, Madison	Paul Mattatal, Bob Borchers, Ralph Lutjen, Joe Lee, Rich Sholtanis, Chet Gevida, Heidi Gervino
Pea Porridge Pond, Mid, Madison	Paul Mattatal, Bob Borchers, Ralph Lutjen, Joe Lee, Rich Sholtanis
Pearly Pond, Rindge	Phil Folsom, Bob Scribner, Dick Isakson
Pemigewasset Lake, Meredith	Paul and Roberta Flaherty
Pequawcket Pond, Conway	Rick Else
Perkins Pond, Sunapee	Gary Szalucka, Robin Saunders
Pillsbury Lake, Webster	M.J. Turcott, Pat Adams, Donna McWilliams
Pine Island Pond, Manchester	Art Grindle, Merrill Lewis, Jen Drociak
Pine River Pond, Wakefield	Baron Fryer, Lewis Royal, Carl True, Jack Dahlstrom, Jim Miller, Ron Duke, Barry Fryer
Pleasant Lake, Deerfield	Joe and Michael Farrelly, Tony Spinazolla
Pleasant Lake, New London	Terrence Dancy, Dick Kellom, Peter Dunning
Pleasant Pond, Francestown	Catherine Eby, Ann and Levi Clark
Pool Pond, Rindge	Dan and Kevin Mathieu, Larry Coleman, Dave Kilmer
Post Pond, Lyme	Putnam Blodgett
Potanipo, Lake, Brookline	Jay Chrystal, Stephen, Benjamin and Abigail Fitzgerald, Ken and Julie Turkington
Powwow Pond, East Kingston	Larry Smith, Scott Urwick
Pratt Pond, New Ipswich	Dwayne White, Nancy Redling
Province Lake, Effingham	Steve Craig, Janet Murfey, Norm Dudziak
Rand Pond, Goshen	Bernie Cutter, Dick Ambler
Reservoir Pond, Lyme	Lee Larson
Robinson Pond, Hudson	Rob Richtarek, Pete and Austin Heller, Brynn Campbell, Bob and L. Robbins
Rock Pond, Windham	Sue Burgess
Rockwood Pond, Fitzwilliam	Coni Porter, Frank Bateman, Bill Bazley, Val Busler
Rockybound Pond, Croydon	Catherine Stroomer, Don Hanlon, Liz Lee, Barry Wade

Round Pond, Little, Wakefield	Richard Mageary, Tom D'Entremont John Varone, Richard Hoage
Russell Reservoir, Harrisville	Bob Sturgis
Rust Pond, Wolfeboro	Ed Webb, Keith Simpson
Sand Pond, Marlow	Emily Bomely, Jaye Aldrich
Scobie Pond, Francestown	Jill and Chuck Rolph
Seavey Pond, Windham	Michelle and Nicole Repetto, Lisa and Shira Linowes, Steve, Melissa, Danielle Murphy, Maureen Richards
Sebbins Pond, Bedford	Louis Pinard
Shellcamp Pond, Gilmanton	Bob Bussey
Showell Pond, Sandown	Fred and Carole Riley, Jim Buckley, Frances Gagnon, Frances and Carol Sienkiewicz, June Lillihill, Ann McCully, Greg Buffington
Silver Lake, Harrisville	Jen Grimaud, Dave Quimby, Roger Williams, and Chet Hurd
Skatutakee Lake, Harrisville	Judy Patton, Howard Clark, Larry Merrifield, Ken and Susan Brown, Margaret DeWitt
Snake River, New Hampton	Janan Hayes
Sondogardy Pond, Northfield	Mark St. Cyr
Spofford Lake, Chesterfield	Fred Szmit, Bill Hanrahan, Fred Turner
Stevens Pond, Manchester	Art Grindle
Stinson Lake, Rumney	Patty Lawson, Les Gilbert
Stocker Pond, Grantham	Pat Woolson
Stone Pond, Marlborough	Ernest and Ethan Linders
Sunapee Lake, Sunapee	John Dowd and Family, Kristen Begor and Family, Chris and Tom McKee, N. Eldredge, Joe Goodnough and Sue Williamson, Bob Cross, Kathy and Jim Nichol, Deane Geddes, The Gardner Family, Midge Eliassen, Clare Bensley, Dick and Betsy Katz, The Robb Family. Dick and Sue Eaton, Bill Hall, Ken and Liz Tentarelli, Tanya and Todd McIntire, Glenda Cottrill, Shelby Blunt, Baker Hill Golf Course, Jack Sheehan, Jack Hambley, Bob Turcotte, Edythe Anderson
Sunapee Lake, Little, New London	Jack Sheehan, Robert Scott
Suncook Pond, Upper, Barnstead	Carol Barrett
Suncook Pond, Lower, Barnstead	Carol Barrett
Sunrise Lake, Middleton	Warren Bartlett, Joe Curtin, Lou and Carol Vita, Mike DelloIacono, Frank O'Toole
Sunset Lake, Alton	Carol and John Harrington, Mike McDavitt, Pam Couronis
Swanzey Lake, Swanzey	Ron and Anne Bedaw
Tarleton Lake, Piermont	Helga Mueller, George and Joyce Tompkins
Thorndike Pond, Jaffrey	Bill Jackson, Bob Chamberlain
Todd Lake, Newbury	Norman Lehouiller, Bob Doherty
Tolman Pond, Nelson	Ian Hyman, Karen Tolman
Tom Pond, Warner	John Hamilton
Tucker Pond, Salisbury	Tom Duffy
Warren Lake, Alstead	Kate Morgan, Rosemarie Dowling, Julie Hogan, Alex Bishop
Waukeena Lake, Danbury	Don and Kenneth Hartford
Lake Waukewan, Meredith	Boo Gershun, Don Thompson, Shasta, Chaos

Webster Lake, Franklin	Ruth and Earl Rutier, Gwen Hall, Laurie Salame, Bill Lincoln, Dan Conahan, Richard Chandler
White Oak Pond, Holderness	Galen Beach, Nancy Voorhis
Wicwas Lake, Meredith	David and Marjorie Thorpe
Lake Winnepocket, Webster	Jere Buckley, Warren Emley
Lake Winnisquam, Laconia/Belmont	Dick Tardiff, Dave McLaughlin, Harvey Beetle
Lake Winona, New Hampton	Lee Gardinier, Claudette Picklesimer, Bob Farrington

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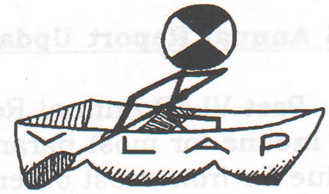
Introduction



The 2005 VLAP Sampling Season

The Volunteer Lake Assessment Program (VLAP) celebrated its twentieth anniversary in 2005. A new volunteer participation record was set this season as a total of 161 lakes were sampled by volunteers throughout the state. In addition, approximately 450 volunteer monitors participated in the program!

DES would like to extend a special welcome to those volunteer monitoring groups that joined VLAP for the first time this year; these volunteers represent the following waterbodies: Sandown Pond in Sanbornton; Martin Meadow Pond in Lancaster; Otternick Pond in Hudson; Angle Pond in Sandown; Contention Pond in Hillsboro; Lake Pemigewasset in Meredith; and French Pond in Haverhill.

And, we welcome back our friends and new monitors at Pequawket Pond in Conway, Gregg Lake in Antrim, and the Brentwood Mitigation Wetlands in Brentwood, who rejoined VLAP during the 2005 season.

2005 Weather Conditions in New Hampshire

The Summer of 2005 was a summer of extremes. As many of you may remember, May and June were marked by numerous rainy days. The rain that fell during this period was often very intense and caused a great deal of sediment and nutrient loading into waterbodies throughout the state. As a result, many of you reported much less than average transparency readings in May, June, and even July.

July was hot and humid and most lakes heated up rapidly. The nutrient-enriched warm water created ideal conditions for algae (microscopic plant) and a greater abundance of aquatic plants (macrophytes), including bladderwort in many lakes and ponds. August was relatively warm and dry which caused tributaries to dry and deeper transparency readings were measured at most deep spots.

2005 Program Updates

During the annual biologist visit, the biologist may have helped you take Secchi Disk transparency readings with and without the use of a viewscope (a white plastic PVC pipe with a clear plexiglass end). The purpose of this exercise was to determine if the viewscope made it easier to view the Secchi Disk by reducing the amount of glare and wave action on the water surface. Readings with and without the viewscope were collected at different times of day under different weather conditions at many lakes. While the data are still being analyzed, it appears that, under certain conditions, the viewscope does increase the depth to which the Secchi Disk can been seen. Unfortunately, since the majority of the groups participating VLAP have never used a viewscope before, switching to using viewscope would make it difficult to compare transparency data collected without a viewscope in the past. Stay tuned for the 2006 newsletter in which the use of a viewscope in VLAP sampling will be discussed in greater detail.

2005 Annual Report Updates

Past VLAP Annual Reports have compared individual VLAP lake data to calculated state **means** for most parameters. However, since **means** can be affected by **outlier data** (a value far from most others in a set of data), it is more appropriate to compare your lake data to calculated state **medians** for each parameter. A **median** is a value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50% percentile). **Medians** are not typically affected by outlier data. You may notice that the comparison lines on the chlorophyll and transparency graphs have been moved down because the statewide results for these parameters was skewed due to atypically high chlorophyll and deep transparency readings. The comparison lines on the phosphorus graphs have remained unchanged as the median statewide values have been used for comparison purposes for many years.

Also, an additional reference line, referred to as the **"Similar Median"** line, is included on the chlorophyll, transparency, and total phosphorus graphs this year. Using data collected from all of the state's public lakes and ponds through the DES Lake Survey Program, we are now able to compare data collected from your lake or pond to data collected from "similar" lakes or ponds in the state. Specifically, lakes and ponds in New Hampshire have been grouped into ten different categories based on maximum depth and lake volume. While this is a simple classification scheme, it can be useful in comparing the quliaty of your lake to waterbodies of similar depth and volume. To find out what group your lake or pond is in and what the basic statistics are that describe the data for that group, refer to Appendix F.

Concluding Remarks

Please read the "Observations and Recommendations" and "Data Quality Assessment & Quality Control" sections of your report carefully, and pay special attention to the recommendations that we have made to improve the quality or your lake as well as your current sampling program.

In Appendix D, you will find this year's Special Topic Article "Lake Foam – Natural or Caused by Laundry Detergent?" While lake foam is typically a natural occurrence, it can indicate that laundry detergent, as well as other household pollutants, may be leaching into surface waters and eventually into your lake. You will learn how to test lake foam to better determine what is causing it.

We realize that there is a lot of information to digest in the following pages. If you have any questions regarding your 2005 report, please feel free to call us.

See you soon!

Sincerely,

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Data Interpretation: Graphs and Tables

Observation: A sample or data point.

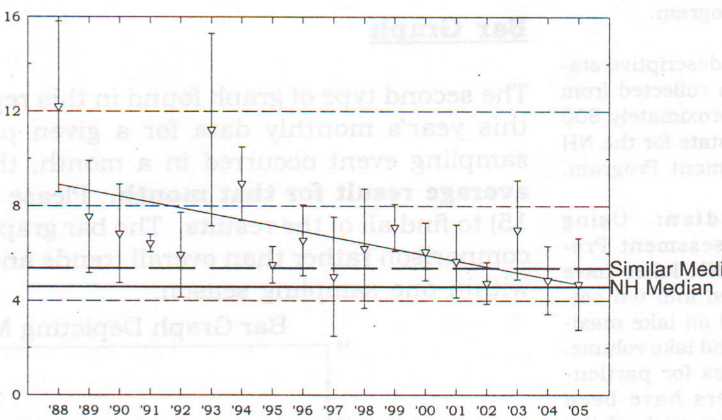
There are two types of graphs in Appendix A, a line graph and bar graph. Each graph conveys much more to the reader than a table or verbal description, so it is important to be able to interpret it correctly. It must be stressed that a fewer number of **observations** causes a corresponding decline in the reliability of the information (the more data the better!).

Line Graph

Mean: Average. To calculate the mean, the reading or concentration for a particular parameter on each sampling event is added together, which results in a total for the season. The season total is then divided by the number of sampling events during the season, which results in an average concentration or reading per sample event.

The line graph summarizes sampling results for the years you have collected data (see sample line graph below). The graph shows the **mean** for a given year as an up-turned or down-turned triangle. The triangle points in the direction of more desirable values. For example, chlorophyll-a and total phosphorus have downward triangles, indicating lower values are better, while transparency has upward triangles, signifying higher values are more desirable.

Line Graph Depicting Historical Data



Standard deviation: A statistic measuring the spread of the data around the mean.

Range: Difference between the high and low values.

A measure of the spread of the data around the mean, or **standard deviation**, is shown as the vertical lines extending up and down from the mean. Standard deviation is similar to **range** except standard deviation is a more exact measure of variation. In this case, the lines indicating standard deviation on your graphs illustrate the amount of variation in the results for a particular test for all the times you sampled in that year. For example, if all the chlorophyll readings came back with similar results each time you sampled this year, then the amount of deviation from the average would be small. If there was a wide range of chlorophyll concentrations in the lake, then the deviation would be large.

Regression Line: A statistical tool used to predict trends in data.

Trends in the yearly data can be discerned by looking at the **regression line** and noting its direction and degree of slant (see example next page). If the line is slanted downward (like this "\"), it indicates an improving trend in chlorophyll-a and total phosphorus but a declining trend in transparency values. If the line is sloped the opposite way (like this "/"), it depicts a worsening trend in chlorophyll-a and phosphorus, but an improving trend in transparency values. The steeper the regression line's slope the stronger the trend. A horizontal regression line indicates the parameter presented is stable, neither improving nor worsening over time.

Skew:A measurment of consistency, or more precisely, the lack of consistency.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50% percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

Outlier: A value far from most others in a set of data.

NH Median: A descriptive statistic for data collected from all of the approximately 800 lakes in the state through the NH Lake Assessment Program.

NH Mean: A descriptive statistic for data collected from all of the approximately 800 lakes in the state for the NH Lake Assessment Program.

Similar Median: Using NH Lake Assessment Program data, NH lakes have been classified into ten categories based on lake maximum depth and lake volume. Median values for particular parameters have been determined for each of the ten groups.

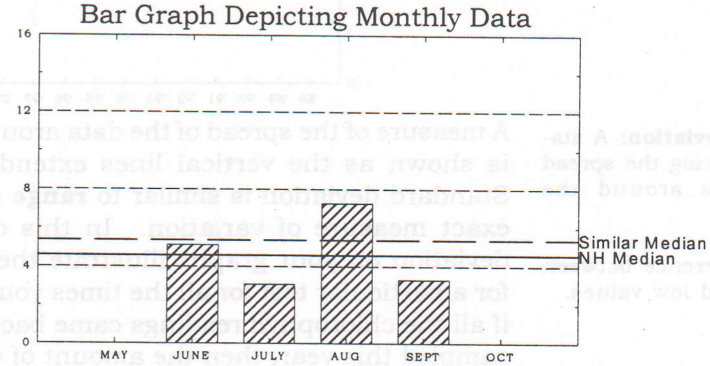
Caution is warranted when drawing absolute conclusions from annual data if the lake data set is small. Don't panic if the line graph shows a parameter worsening—check your raw data first. Look for years with one extremely high or low sampling point; this could **skew** the trend line. Remember, you need many years of data before trends become apparent, and ten years before they are considered statistically significant. After your lake or pond has been monitored through VLAP for at least 10 consecutive years, we will analyze the in-lake data with a simple statistical test. Specifically, a linear regression analysis will be used to determine if there has been an increase or decrease of the annual mean for chlorophyll-a, Secchi-disk transparency, and total phosphorus in your lake/pond since monitoring began.

The last element in the line graph are two reference lines. One reference line represents the **New Hampshire Median** for that particular parameter. The data from your lake can be compared to the **New Hampshire Median** to get an idea of how your lake quality compares to all of the lakes and ponds in the state as a whole. The second reference line on the graph represents the **Similar Median** (short for Similar Lake Median) for that particular parameter. Using the **Similar Median**, the data from your lake can be compared to median values for similar lakes and ponds, based on lake volume and maximum depth. This simple classification scheme can be useful in better characterizing the quality of your lake.

Bar Graph

The second type of graph found in this report is the bar graph. It represents this year's monthly data for a given parameter. When more than one sampling event occurred in a month, the plotted value will represent **an average result for that month.** Please check your raw data report (Table 15) to find all of the results. The bar graph emphasizes individual values for comparison rather than overall trends and allows for easy data comparisons within one sampling season.

Bar Graph Depicting Monthly Data



Tables

Tables in Appendix B summarize data collected during 2005 and previous years. Maximum, minimum, and mean values are given for each station by sampling year for most tests, where applicable.

Lake Maps

Bathymetric map: A map which shows the topography of the lake's bottom; contours depict lake depths.

A **bathymetric map** in Appendix C shows the depth contours of your lake. A station map in Appendix C shows the name and location of the tributary and deep spot samples collected from your lake. Tributary names for major inlets and outlets are labeled on the map, and should be referred to when labeling sample bottles and studying the data in Appendix B. If stations are missing, please make corrections and send the map to the VLAP Coordinator.

Interpreting Data

Lake aging: Natural process by which a lake fills-in over time.

Watershed: The land that drains to a particular water body; often described as a funnel.

Eutrophication: Lake aging accelerated by increased nutrient input exceeding the natural supply.

Fertility: Capacity to sustain plant growth.

Biological Production: Total amount or weight of living plants and animals.

Limiting nutrient: Nutrient that in small increases can cause larger changes in biological production

Oligo: Little.

Trophic: Food.

Oligotrophic: Low biological production and nutrients; highest lake classification.

Eutrophic: High biological production, nutrient rich; lowest lake classification.

Cultural eutrophication: When increased nutrient input and debris into a lake is caused by human activity.

Impervious: Impenetrable.

Epilimnetic: Upper water layer.

Hypolimnetic: Lower water layer.

Anoxia: No oxygen present.

Like all of us, lakes age over time. **Lake aging** is the natural process by which a lake fills in over geologic time. They fill-in with erosional materials carried in by the tributary streams, with materials deposited directly through the air, and with materials produced in the lake itself. From the time that a lake is created, the aging or filling-in process begins. Although many New Hampshire lakes have the same chronological age, they change and fill-in at different rates because of differences in runoff and **watershed** characteristics. Lakes can fill-in more quickly than natural due to human impacts. **Eutrophication** is the process of increased nutrient input to a lake exceeding the natural supply. The **fertility** of the watershed, which is dependent upon land use and geology, determines the rate of lake aging. Increased lake fertilization results in an increase in **biological production**.

The key chemical in the eutrophication process is the nutrient phosphorus. Phosphorus is the **limiting nutrient** in New Hampshire lakes; the greater the phosphorus concentration in a lake, the greater the biological production. Biological production can be measured in terms of plant growth, algal growth, decreased transparency, and an overall decrease in lake quality.

It is very important to understand the meaning of biological production when referring to lakes. We often think of biological production as something good. For example, a productive garden yields an abundance of vegetables. But, when speaking about lake productivity, usually the low biological production associated with a clear, **oligotrophic** lake is the ideal condition. Fisherman, on the other hand, may prefer a productive lake, especially if they are fishing for warm water species, such as bass. Warm water species thrive in productive lakes because of the abundance of food and presence of plants used for protection and spawning. Excessive plant growth and algae blooms are present in a *highly* productive, **eutrophic** lake.

When eutrophication is caused by human activity it is termed **cultural eutrophication**. This accelerated aging results from watershed activities that increase nutrient loading or the deposition of other debris, such as fertilizing, converting forest or pasture to cropland, and creating **impervious** areas such as rooftops, parking lots, and driveways. Studies in New Hampshire have shown that phosphorus exports from agricultural lands is at least 5 times greater than from forested lands, and in urban areas may be more than 10 times greater. Other contributers to cultural eutrophication include lechate from septic systems, bathing in or near the lake, sediment erosion into the lake, dumping or burning leaves and trees in or near a lake, and feeding ducks.

As you interpret the data on the following pages, pay close attention to the trends. Look for increases or decreases in the **epilimnetic** and **hypolimnetic** phosphorus. If you observe an increase in hypolimnetic phosphorus as the summer progresses, a process called internal phosphorus loading is occurring. This means phosphorus that was tied up in the lake floor sediments is now available to enter the water column. **Anoxia** initiates this process by creating a chemical change in the sediment that allows the phosphorus to separate from iron and aluminum compounds.

Transparency: Water clarity.

Chlorophyll-a: Green pigment found in plants; used to measure the amount of algae in a lake.

Turbidity: The amount of suspended particles in water, such as clay, silt, and algae that cause light to be scattered and absorbed, not transmitted in straight lines through the water.

Non-point pollution: Pollution originating in the watershed, often entering the water body via surface runoff or groundwater.

Epilimnion: Upper water layer.

Metalimnion: Middle water layer (a.k.a. thermocline.)

Hypolimnion: Bottom water layer.

Tributary: Stream, inlet.

What if there was an increase in epilimnetic phosphorus? As you look at the data from the inlets, notice if this year's data show an increase in phosphorus from a particular inlet. If the increase is large, the new source of phosphorus should be investigated. Investigations may include a watershed walk or bracketing the brook for further sampling.

Correlations between **transparency** and **chlorophyll-a** are important. If the chlorophyll-a increased and the Secchi disk transparency decreased, increased algae populations are affecting the water clarity. If the chlorophyll-a has not increased, but the transparency has undergone a decline, the reduced transparency could be attributed to an increase of suspended particles **(turbidity)** caused by stream inputs, motorboat activity, shoreline construction, or disturbances of bottom sediments. In shallow lakes less than 15 feet in depth, the wind creates enough energy to produce wave action and bottom currents that disturb the bottom sediment which results in high turbidity.

Conductivity, acid neutralizing capacity (ANC), and pH should also be examined. Conductivity is a good indicator of disturbance or **non-point sources** of pollution. The lower the pH or ANC value for your lake the more vulnerable it is to acid precipitation. A marked increase or decrease in any parameter should be investigated.

All of the data might seem overwhelming to you at the start. First, take a look at the in-lake data. The tables in Appendix B will list in-lake data either as **Epilimnion, Metalimnion,** or **Hypolimnion.** The number of layers formed in a given year is dependent upon lake depth and seasonal temperatures; if your lake has two layers, only epilimnetic and hypolimnetic data will be displayed, or epilimnetic data only if the lake is too shallow to form layers. Follow the trends within each layer and note any changes for each parameter.

Then examine the **tributary** data. Look at each inlet, one at a time. Some will likely reflect good conditions (low total phosphorus, low conductivity, and pH between 6.0 and 7.0). Others might reflect poor tributary quality, sending off a warning light (high total phosphorus, high conductivity, or low pH). List the possible problems you identified from your data and prioritize them according to your association's goals. Keep in mind that weather patterns during the sampling season will strongly affect the lake quality. High-impact rainfall or large amounts of snow-melt can result in nutrient-rich and sediment-laden runoff to the lake. On the other hand, a dry season will have an absence of such runoff, potentially resulting in low energy runoff and less nutrients to feed algae and plant growth and greater water clarity.

Weather patterns should be carefully considered when assessing lake changes from year to year, and even within a sampling season. Large variations in sample results may be observed from month to month when comparing a wet summer month to a dry month.

Biological: Living plants or organisms.

Chemical: Parameters related to the chemistry of water.

Physical: Parameters that can be perceived using the senses, such as Secchi Disk transparency.

To provide an understanding of how your water body compares to other New Hampshire lakes the following table summarizes key **biological, chemical, and physical** parameters for all the state's lakes surveyed since 1976.

Characteristics of New Hampshire Lakes and Ponds

Summer Epilimnetic Values

Parameter	#*	Min	Max	Mean	Median
pH (units)	780	4.3	9.3	**6.5	6.6
Alkalinity (mg/L)	781	-3	85.9	6.6	4.9
Total Phosphorus (ug/L)	772	<1	121	-	12
Conductivity (umhos/cm)	768	13.1	696	59.4	40.0
Chloride (mg/L)	742	<2	198	-	4
Chlorophyll-a (mg/m3)	776	0.19	143.8	7.16	4.58
Secchi Disk (m)***	663	0.40	13	3.7	3.2

** = the number of lake stations sampled*

*** = average pH reading; not average of hydrogen ion concentration*

**** = does not include "visible on bottom" readings*

Finally, refer to the Observations and Recommendations section of this report, which discusses the basic trend data and also lists some suggestions for future sampling. Then, formulate a management plan and call us for guidance. Once you have identified your and/or your association's concerns, we will work with you to modify the current sampling program to address these goals. You may also be eligible to be involved in the New Hampshire Clean Lakes Program (NHCLP) which provides more detailed watershed diagnostic tests and recommends Best Managment Programs (BMPs) to reduce pollutants to the lake. The NHCLP can lead to watershed management programs through the Local Initatives Grants offered by DES.

Monitoring Parameters

Biological Parameters

Algal Abundance

Algae are photosynthetic plants that contain chlorophyll but do not have true roots, stems, or leaves (a.k.a. "phytoplankton"). They do, however, grow in many forms such as aggregates of cells (colonies), in strands (filaments), or as microscopic single cells. They may also be found growing on objects, like rocks or vascular plants, in the bottom sand or free-floating in the water column.

Photosynthesis: Producing carbohydrates with the aid of sunlight.

Food chain: Arrangement of organisms in a community according to the order of predation.

Oxygenated: Holding oxygen in solution.

Regardless of their form, these primitive plants carry out **photosynthesis** and accomplish two very important roles in the process. First, inorganic material is converted to organic matter. These tiny plants then form the base of a lake **food chain**. Microscopic animals (zooplankton) graze upon algae like cows graze on grass in a field. Fish also feed on the algae along with other aquatic organisms. Second, the water is **oxygenated**, aiding the chemical balance and biological health of the lake system.

Algae require light, nutrients, and certain temperatures to thrive. All of these factors are constantly changing in a lake from day to day, season to season, and year to year. Therefore, algae populations and the abundance of individual species of algae naturally fluctuate with weather changes or changes in lake quality.

Chlorophyll-a: A green pigment found in algae.

Oligotrophic: Low biological production.

Eutrophic: High biological production; nutrient rich.

VLAP uses the measure of **chlorophyll-a** as an indicator of the algae abundance. Because algae is a plant and contains the green pigment chlorophyll, the concentration of chlorophyll found in the water gives us an estimation of the concentration of algae. If the chlorophyll-a concentration increases, this indicates an increase in the algal population. Generally, a chlorophyll-a concentration of less than 5 mg/m^3 typically indicates water quality conditions that are representative of **oligotrophic** lakes, while a chlorophyll-a concentration greater than 15 mg/m^3 indicates **eutrophic** conditions. A chlorophyll concentration greater than 10 mg/m^3 generally indicates an algae bloom (excessive reproduction of algae).

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50% percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

Outlier: A value far from most others in a set of data.

The **median** chlorophyll concentration for New Hampshire lakes is **4.58 mg/m^3** (the **mean** is **7.16 mg/m^3**). Figure 1 (Appendix A) and Table 1 (Appendix B) present the mean chlorophyll-a concentration for each year of participation in VLAP. Table 1 also presents the minimum and maximum values recorded for the same years.

Chlorophyll-a (mg/m3)	
0-5	Good
5.1-15	More than desirable
>15	Nuisance amounts

Phytoplankton

Phytoplankton: Microscopic algae drifting through the water column.

Plankton net: Fine mesh net used to collect microscopic plants and animals.

Periphyton: An assemblage of microorganisms (plants and animals) firmly attached to and growing upon solid surfaces such as the bottom of a lake or stream, rocks, logs, and structures.

Succession: The decline of dominant species of algae over a period of time as another species increases and becomes dominant.

The type of **phytoplankton** present in a lake can be used as an indicator of general lake quality. The most direct way to obtain phytoplankton information involves collection of a sample with a **plankton net**, measurement of the quantity of phytoplankton contained in the sample, and identification of the species present using a microscope. An abundance of cyanobacteria, such as *Anabaena, Aphanizomenon, Oscillatoria,* or *Microcystis* may indicate excessive phosphorus concentration or that the lake ecology is out of balance. On the other hand, diatoms such as *Asterionella, Melosira,* and *Tabellaria* or golden-brown algae such as *Dinobryon* or *Chrysosphaerella* are typical phytoplankton of New Hampshire's less productive lakes. In shallow warm waters with minimal wave action (such as a cove), filamentous green algae may grow in a form that looks like a mass of green cotton candy. **Periphyton** may grow on rocks or vegetation, causing these to be slippery.

Phytoplankton populations undergo a natural **succession** during the growing season. Many factors influence this succession: amount of light, availability of nutrients, temperature of the water, and the amount of grazing occurring from zooplankton. As shown in the diagram on the next page, it is natural for diatoms to be the dominant species in the spring and then green algae in the early summer, while cyanobacteria may dominate in mid to late summer. The plankton samples from your lake will show different dominant species, depending on when the samples were taken. Phytoplankton are identified in Table 2 in Appendix B. Phytoplankton groups and species are listed below.

Phytoplankton Groups and Species Common to New Hampshire Lakes and Ponds

<u>Greens</u>

Actinastrum	*Eudorina*	*Pandorina*	*Spirogyra*
Arthrodesmus	*Kirchneriella*	*Pediastrum*	*Staurastrum*
Dictyosphaerium	*Micractinium*	*Scenedesmus*	*Stigeoclonium*
Elakotothrix	*Mougeotia*	*Sphaerocystis*	*Ulothrix*

<u>Diatoms</u>

Asterionella	*Melosira*	*Rhizosolenia*	*Synedra*
Cyclotella	*Pleurosigma*	*Surirella*	*Tabellaria*
Fragilaria			

<u>Dinoflagellates</u>

Ceratium	*Peridinium*	*Gymnodinium*

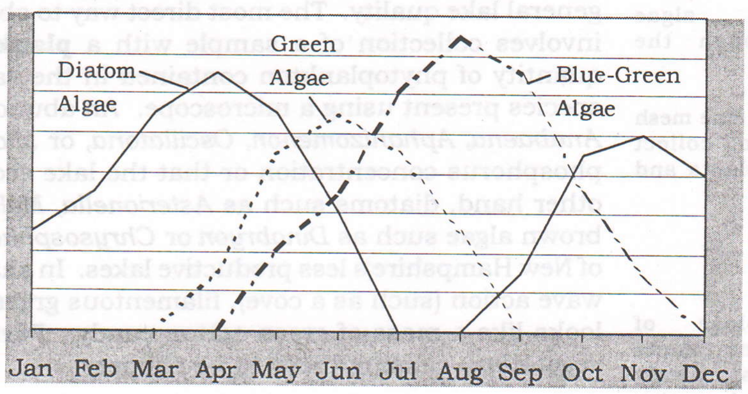
<u>Cyanobacteria (formerly known as blue-green algae)</u>

Anabaena	*Chroococcus*	*Gloeotrichia*	*Microcystis*
Aphanizomenon	*Coelosphaerium*	*Lyngbya*	*Oscillatoria*
Aphanocapsa			

<u>Golden-Browns</u>

Chrysosphaerella	*Mallomonas*	*Synura*	*Uroglenopsis*
Dinobryon			

A Typical Seasonal Succession of Lake Algae



Cyanobacteria

Cyanobacteria: Bacterial microorganisms that photosynthesize and may produce chemicals toxic to other organisms, including humans. They have the ability to produce their own nitrogren. They have the ability to produce gases to move vertically through the water column. Some have structures that fall to the sediment when environmental conditions in the water column are not condusive for growth and can regenerate when water column conditions are more favorable.

Zooplankton: Small, usually microscopic animals found in lakes and reservoirs that possess limited means of propulsion. Consequently, animals belonging to this class drift along with the currents.

Cyanobacteria are bacterial microorganisms that photosynthesize. Many species of cyanobacteria may accumulate to form surface water "blooms". They produce a blue-green pigment but may impart a green, blue, or pink color to the water. Cyanobacteria are some of the earliest inhabitants of our waters, and they are naturally occurring in all of our lakes. However, research indicates that their abundance increases as the phosphorus in a lake increase. They are part of the aquatic food web and can be eaten by various grazers in the lake ecosystem, such as **zooplankton** and mussels.

Although they are most often seen when floating near the surface, many cyanobacteria species spend a portion of their life cycle on the bottom of the lake during the winter months. As spring provides more light and warmer temperatures, cyanobacteria move up the water column and eventually rise toward the surface where they can form dense blooms or scums, often seen in mid to late summer and, weather permitting, sometimes well into the fall.

Some cyanobacteria produce toxins that adversely affect livestock, domestic animals, and humans. According to the World Health Organization (WHO), toxic cyanobacteria are found worldwide in both inland and coastal waters. The first reports of toxic cyanobacteria in New Hampshire occurred in the 1960s and 1970s. During the summer of 1999, several dogs died after ingesting toxic cyanobacteria from a bloom in Lake Champlain in Vermont. The WHO has documented acute impacts to humans from cyanobacteria from the U.S. and around the world as far back as 1931. While most human health impacts have resulted from ingestion of contaminated drinking water, cases of illnesses have also been attributed to swimming in waters infested with cyanobacteria.

The possible effects of cyanobacteria on the "health" of New Hampshire lakes and their natural inhabitants, such as fish and other aquatic life, are under study at this time. The Center for Freshwater Biology (CFB) at the University of New Hampshire (UNH) is currently examining the potential impacts of these toxins upon the lake food web. The potential human health hazards via exposure through drinking water and/or during recreational water activities are also a concern to the CFB and DES.

Neurotoxin: Nerve toxins.

Hepotoxins: Liver toxins.

Dermatoxins: Toxins that cause skin irritations.

Cyanobacteria occur in all lakes, everywhere. There are many types of cyanobacteria in New Hampshire lakes. Most cyanobacteria do not have the ability to produce toxins. In New Hampshire, there are several common cyanobacteria that include: *Gleotrichia, Merismopeida, Anabaena, Oscillatoria, Coelospharium, Lyngba and Microcystis*. *Anabaena* and *Aphanizomenon* produce **neurotoxins** that interfere with the nerve function and have almost immediate effects when ingested. *Microcystis* and *Oscillatoria* are best known for producing **hepatotoxins** known as microcystins. *Oscillatoria* and *Lyngbya* produce **dermatotoxins**, which cause skin rashes.

Both DES and UNH have extensive lake monitoring programs. Generally, the water quality of New Hampshire's lakes is very good. However, DES strongly advises against using lake water for consumption, since neither in-home water treatment systems nor boiling the water will eliminate cyanobacteria toxins if they are present.

If you observe a well-established potential cyanobacteria bloom or scum in the water, please comply with the following:

- Do not wade or swim in the water!
- Do not drink the water or let children drink the water!
- Do not let pets or livestock into the water!

Exposure to toxic cyanobacteria scums may cause various symptoms, including nausea, vomiting, diarrhea, mild fever, skin rashes, eye and nose irritations, and general malaise. If anyone comes in contact with a blue-green algae bloom or scum, they should rinse off with fresh water as soon as possible.

If you observe a Cyanobacteria scum, please call DES at 271-3414. DES will sample the scum and determine if it contains cyanobacteria that are associated with toxic production. An advisory will be posted on the immediate shoreline indicating that the area may not be suitable for swimming. DES will notify the town health officer, beach manager, and/or property owner, and the New Hampshire Department of Health and Human Services. DES will continue to monitor the water and will notify the appropriate parties regarding the results of the testing. When monitoring indicates that cyanobacteria are no longer present at levels that could harm humans or animals, the advisory will be removed.

Secchi Disk Transparency

The Secchi disk is a 20 centimeter disk with alternating black and white quadrants. It has been used since the mid-1800s to measure the transparency of water. The Secchi disk is named after the Italian professor P.A. Secchi whose early studies established the experimental procedures for using the disk. The disk is used to measure the depth that a person can see into the water. Transparency, a measure of the water clarity, is affected by the amount of algae, color, and particulate matter within a lake. In addition, the transparency reading may be affected by wave action, sunlight, and the eyesight of the volunteer monitor. Therefore, we recommend that two or three monitors take a Secchi disk reading, and then these readings should be averaged. In general, a transparency greater than 4.5 meters indicates oligotrophic conditions, while a transparency of less than 2 meters is indicative of eutrophic conditions.

The **median** transparency for New Hampshire lakes is **3.2 meters** (one meter equals 3 feet, 4 inches) and the **mean** transparency is **3.7meters**. Figure 2 in Appendix A presents a comparison of the transparency values for each of the VLAP monitoring years, while Table 3 of Appendix B shows the minimum, maximum, and mean values for all years of participation.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50% percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

Outlier: A value far from most others in a set of data.

Water Clarity (Transparency) Ranges for Lakes and Ponds

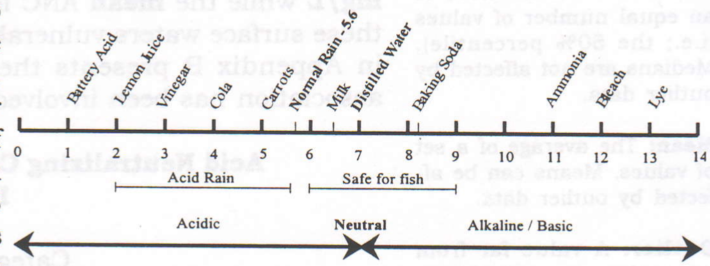
Category	Water Clarity (m)
Poor	<2
Good	2-4.5
Exceptional	>4.5

Chemical Parameters

pH

pH is measured on a logarithmic scale of 0 to 14. The lower the pH the more acidic the solution, due to higher concentrations of hydrogen ions. Acid rain typically has a pH of 3.5 to 5.5 due to pollutants added from the air. In contrast, the **median** pH for New Hampshire lakes is **6.6**.

pH Scale



Lake pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.0 severely limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal.

Thermally stratified: Water layered by temperature differences. During the summer, cooler, more dense water is typically found closer to the lake bottom, while warmer, less dense water is found closer to the lake surface.

Bacteria: Tiny organisms that break down dead matter.

Phytoplankton: Microscopic algae drifting through the water column.

Many lakes exhibit lower pH values in the deeper waters than nearer the surface. This effect is greatest in the bottom waters of a **thermally stratified** lake. Decomposition carried out by **bacteria** in the lake bottom causes the pH to drop, while photosynthesis by **phytoplankton** in the upper layers can cause the pH to increase. Tannic and humic acids released to the water by decaying plants can create more acidic waters in areas influenced by wetlands. After the acidic spring-time snow melt or a significant rain event, surface waters may have a lower pH than deeper waters and may take several weeks to recover. (Snowmelt and rainfall typcially have pH values of 4 or lower.)

Table 4 in Appendix B presents the in-lake and tributary true mean pH data.

pH Ranges for New Hampshire Lakes and Ponds

Category	pH (units)
Critical (toxic to most fish)	<5
Endangered (toxic to some aquatic organisms)	5-6
Satisfactory	>6

Acid Neutralizing Capacity

Buffering capacity or Acid Neutralizing Capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. The higher the ANC the greater the ability of the water to neutralize acids. This concept can be compared to a person taking an antacid, to neutralize stomach acid indigestion. Low ANC lakes are not well buffered. These lakes are often adversely affected by acidic inputs.

Historically, New Hampshire has had naturally low ANC waters because of the prevalence of granite bedrock. Granite contains only a small amount of buffereing elements, unlike limestone which contains a large amoung of buffereing elements. The **median** ANC for New Hampshire lakes is **4.9 mg/L** while the **mean** ANC is **6.6 mg/L**. This relatively low value makes these surface waters vulnerable to the effects of acid precipitation. Table 5 in Appendix B presents the mean epilimnetic ANC for each year your association has been involved in this program.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50% percentile). Medians are not affected by outlier data.

Mean: The average of a set of values. Means can be affected by outlier data.

Outlier: A value far from most others in a set of data.

Acid Neutralizing Capacity Ranges for New Hampshire Lakes and Ponds

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

Conductivity

Conductivity is the numerical expression of the ability of water to carry an electrical current. It is determined primarily by the number of **ionic particles** present. The soft waters of New Hampshire have traditionally had low conductivity values. High conductivity may indicate pollution from such sources as road salting, faulty septic systems, or urban/agricultural runoff.

Ionic particle(s): An atom or group of atoms carrying an electrical charge

Specific categories of good and bad levels cannot be constructed for conductivity, because variations in watershed geology can result in natural fluctuations in conductivity. However, values in New Hampshire lakes exceeding 100 umhos/cm generally indicate cultural (man-made) sources of ions. The conductivity should remain fairly constant for a given lake throughout the year. Any major changes over a short period of time may indicate **erosion** resulting from heavy rain or a large flush of runoff from a problem site. Conductivity less than 50 umhos/cm is typical of oligotrophic lakes. Conductivity greater than 100 umhos/cm is more typical of lakes with greater human impacts.

Erosion: Soil materials worn away by the action of water or wind.

The **median** conductivity for New Hampshire lakes is **40.0 umhos/cm** while the **mean** conductivity is **59.4 umhos/cm**. Table 6 in Appendix B presents mean conductivity values for tributaries and in-lake data.

Phosphorus

Phosphorus is the most important water quality parameter measured in our lakes. It is this nutrient that limits the algae's ability to grow and reproduce. Limiting phosphorus in a lake will result in lower or reduced, natural algae concentration. Increased phosphorus levels encourage excessive plant growth and **algal blooms.** Phosphorus occurs in many forms in a lake and is absorbed by algae, becoming part of a living cell. When the algae cell dies the phosphorus is still organically bound, even as the dead cells settle to the lake bottom.

Algal blooms: Over-population of algae.

Phosphorus sources around a lake include septic systems, animal waste, lawn fertilizer, road and construction erosion, natural wetlands, and atmospheric deposition.

An in-lake epilimnetic (upper layer) phosphorus concentration of less than 10 ug/L indicates oligotrophic conditions, while a concentration greater than 20 ug/L in the epilimnion is indicative of eutrophic conditions. The **median** phosphorus concentration in the epilimnion layer of New Hampshire lakes is **12 ug/L**. The **median** phosphorus concentration in the hypolimnion (lower layer) is **14 ug/L**.

Median: A value in an ordered set of values below and above which there is an equal number of values (i.e.; the 50% percentile). Medians are not affected by outlier data.

Figure 3 in Appendix A shows the epilimnetic and hypolimnetic total phosphorus values for 2005 and the historical data. Table 8 in Appendix B presents mean total phosphorus data for in-lake and tributary data.

Total Phosphorus Ranges for New Hampshire Lakes and Ponds (Epilimnetic)

Category	TP (ug/L)
Ideal	<10
Average	11-20
More than desirable	21-40
Excessive	>40

Dissolved Oxygen and Temperature

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, species intolerant (meaning sensitive) to this situation, such as trout, will be forced to move up closer to the surface (where the water column is generally warmer) and 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 in the summer.

Thermal stratification: Water layering by temperature.

ppm: Parts per million; equal to mg/L.

Internal phosphorus loading: Addition of phosphorus to the hypolimnion from the lake sediments due to a chemical change initiated by low oxygen conditions.

Thermocline: Barrier between warm surface layer (epilimnion) and cold deep layer (hypolimnion) where a rapid decrease in water temperature occurs with increasing depth.

At least once during this summer, a DES biologist measured the dissolved oxygen and temperature at set intervals from the bottom of the lake to the surface. These measurements allow us to determine the extent of **thermal stratification** as well as the lake oxygen content. Many of the more productive lakes experience a drop in dissolved oxygen in the deeper waters as the summer progresses. Bacteria in the lake sediments decompose the dead organic matter that settles out, a process that depletes oxygen in the bottom waters. Since more productive lakes tend to have organic-rich sediments there will be greater decomposition on the bottom of such lakes, potentially creating a severe dissolved oxygen deficit (less than 1 **ppm**). This low oxygen condition can then trigger phosphorus that is normally bound to the sediment to be released into the water (**internal phosphorus loading**).

Dissolved oxygen percent saturation shows the percentage of oxygen that is dissolved in the water at a particular depth. Typically, the deeper the reading the lower the percent saturation. A high reading at or slightly above the **thermocline** may be due to a layer of algae, producing oxygen during photosynthesis. Colder waters are able to hold more dissolved oxygen than warmer waters, and generally, the deeper the water the colder the temperature. As a result, a reading of 9 mg/L of oxygen at the surface will yield a higher percent saturation than a reading of 9 mg/L of oxygen at 25 meters, because of the difference in water temperture. Table 9 in Appendix B illustrates the Dissolved Oxygen/Temperture profile(s) for 2005, and Table 10 shows historical hypolimnetic dissolved oxygen readings.

Chloride

The chloride ion (Cl^-) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Higher-than-normal chloride concentrations in fresh water, due to sodium chloride (table salt) that is used on foods and present in body wastes, can indicate sewage pollution. The use of highway deicing salts can also introduce chlorides to surface water or groundwater.

In New Hampshire, the application of road salt for winter accident prevention is a large source of chloride to the environment, which is increasing over time due to the expansion of road networks and increased vehicle traffic. Road salt (most often sodium chloride) readily dissolves and enters aquatic environments in ionic forms. 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. As such, chloride-containing compounds commonly enter surface water, soil, and ground water during late-spring snowmelt (since the ground is frozen during much of the late winter and early spring).

Chloride ions are conservative, which means that 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.

Acute toxicity: An adverse effect such as mortality or debilitation caused by an exposure of 96 hours or less to a toxic substance (i.e; short period of time).

Chronic toxicity: An adverse effect such as reduced reproductive success or growth, or poor survival of sensitive life stages, which occurs as a result of prolonged exposure to a toxic substance (i.e; long period of time).

Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. Among the species tested, freshwater aquatic plants and invertebrates tend to be the most sensitive to chloride. 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.

Chloride levels in drinking water would be unpalatable before they became toxic. The maximum contaminant level for drinking water is 250 mg/L and the recommend action level is less than 100 mg/L.

The chloride content in New Hampshire lakes is naturally low **(median = 4 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.

Other Parameters

Turbidity

Turbidity in water is caused by suspended matter, such as clay, silt, and algae that cause light to be scattered and absorbed, not transmittted in straight lines through the water. Secchi disk transparency, and therefore water clarity, is strongly influenced by turbidity. High turbidity readings are often found in water adjacent to construction sites; during rain events unstable soil erodes and causes turbid water downstream. Also, improper sampling techniques (hitting the bottom of the lake with the Kemmerer bottle or stirring up the stream bottom when collecting tributary samples) may also cause high turbidity readings. The New Hampshire **median** for lake turbidity is **1.0 NTU**. Table 11 in Appendix B lists turbidity data for 2005.

Statistical Summary of Turbidity Values for New Hampshire Lakes and Ponds

Category	Value (NTU)
Minimum	<0.1
Maximum	22.0
Median	1.0

Bacteria

Surface waters contain a variety of microorganisms including bacteria, fungi, protozoa, and algae. Most of these occur naturally and have little or no impact on human health. Health risks associated with water contact occur generally when there is contamination from human sources. Warm blooded animals such as ducks, beaver, geese, and pets can also contribute bacteria to surface waters. Contamination arises most commonly from sources of fecal waste such as failing or poorly designed septic systems, leaky sewage pipes, nonpoint source runoff from wildlife habitat areas, or inputs from wastewater treatment plant outflows within a watershed. Swim beaches with heavy use, shallow swim areas, and/or poor water circulation also have commonly reported bacteria problems. Therefore, water used for swimming should be monitored for indicators of possible fecal contamination. Contamination is typically short-lived, since most bacteria cannot survive long in cold water; their natural environment is the gut of warm blooded animals. A recent study has shown that *E. coli* can live fairly long periods of time in the sediments.

Specific types of bacteria, called indicator organisms, are the basis of bacteriological monitoring, because their presence indicates that sources of fecal contamination exist.

Pathogens: Disease-causing organisms.

Indicators estimate the presence and quantity of things that cannot be meaured easily by themselves. We measure these sewage or fecal indicators rather than the **pathogens** themselves to estimate sewage or fecal contamination and, therefore, the possible risk of disease associated with using the water.

New Hampshire closely follows the bacteria standards recommended by the U.S. Environmental Protection Agency (EPA). Following a 1988 EPA report recommending the use of *E. coli* as a standard for public water supplies and human contact, DES followed suit by adopting *Escherichia coil* (*E. coli*) as the new indicator organism. The standards for Class B waters specify that no more than 406 *E. coli* counts/100 mL, or a geometric mean based on at least 3 samples obtained over a 60 day period be greater than 126 *E. coli* counts/100 mL. Designated public beach areas have more stringent standards: 88 *E. coli* counts/100 mL in any one sample, or a geometric mean of three samples over 60 days of 47 *E. coli* counts/100 mL. Table 12 shows bacteria (*E. coli*) results for 2005 and for previous sampling seasons.

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **CLOUGH POND, LOUDON,** the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the pond this season! Your monitoring group sampled **three** times this season and has done so for many years! As you know, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the pond has been monitored through the program.

  Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives 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.**

  The current year data (the top graph) show that the chlorophyll-a concentration ***decreased greatly*** from **June** to **July** and then ***increased greatly*** from **July** to **August**. The chlorophyll-a concentration on **each sampling event** was ***greater than*** the state median and similar lake median (for more information about the similar lake median, refer to Appendix F).

  The chlorophyll concentration on the **August** sampling event **(14.3 ug/L)** was the ***highest*** chlorophyll concentration that has been measured at the deep spot since monitoring began in 1989 and suggests that an algal bloom may have been occurring.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a ***variable, but overall increasing (meaning worsening),*** in-lake chlorophyll-a trend since monitoring began. The 2005 annual mean is the ***highest*** annual mean since monitoring began.

After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all ponds, an excessive or increasing amount of any type is not welcomed. In freshwater ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and pond quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the pond has been monitored through the program.

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

The current year data (the top graph) show that the in-lake transparency ***remained relatively stable*** from **June** to **July** and then ***increased*** from **July** to **August**. The transparency on **each sampling event** was ***greater than*** the state median and similar lake median (refer to Appendix F for more information about the similar lake median).

As previously discussed, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into ponds and streams, thus 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 designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amount of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the pond has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a pond can lead to increases in 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.**

The current year data for the epilimnion and hypolimnion show that the phosphorus concentration on the **June** sampling event was ***much greater than*** the state median and similar lake median. Please note that the pond is typically sampled once per summer for phosphorus due to a limited lake association sampling budget.

The turbidity and total phosphorus concentration in the hypolimnion (lower layer) sample was ***elevated*** on the **June** sampling event and the turbidity was also ***elevated*** on the **July** and **August** sampling events. Historically, the turbidity and phosphorus levels have been ***elevated*** in the hypolimnion on most sampling events. This suggests that the lake bottom is composed of a thick layer of organic material that is easily disturbed. The presence of a thick organic layer on the lake bottom (which is likely comprised of decomposed plants and algae, and also sediment) would also explain the lower dissolved oxygen concentration near the pond bottom.

Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows a ***fluctuating***, but overall ***increasing (meaning worsening)***, phosphorus trend since monitoring initially began in **1989**.

Please keep in mind that these trends are based on limited data as the pond was not sampled during 1996 through 2000 and has only been sampled per year for phosphorus during 2002 through 2005.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

Table 2 (Appendix B) lists the current and historical phytoplankton species observed in the pond. Specifically, this table lists the three most dominant phytoplankton species observed in the sample and their relative abundance in the sample.

The dominant phytoplankton species observed in the **July** sample were ***Dinobryon* (golden-brown), *Chrysosphaerella* (golden-brown)**, and ***Peridinium* (diatom).**

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 are typical in New Hampshire's less productive lakes and ponds.

- **Table 2: Cyanobacteria**

A **small amount** of the cyanobacterium ***Anabaena*** was observed in the **July** plankton sample. ***This species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.*** (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased (this is often caused by rain events) and favorable environmental conditions occur (such as a period of sunny, warm weather).

The presence of cyanobacteria serves as a reminder of the lake's/pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the pond by eliminating fertilizer use on lawns, keeping the pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the pond. If a fall bloom occurs, please collect a sample (any clean jar or bottle will be suitable) and contact the VLAP Coordinator.

- **Table 4: pH**

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

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 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 surface waters in the state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spot this season ranged from **6.20** in the hypolimnion to **6.90** in the epilimnion, which means that the water is ***slightly acidic*** near the lake bottom and ***approximately neutral*** near the lake surface.

It is important to point out that the pH in the hypolimnion (lower layer) was ***lower (more acidic)*** than in the epilimnion (upper layer). This increase in acidity near the lake bottom is likely due the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the presence of granite bedrock in the state and acid deposition (from snowmelt, rainfall, and atmospheric particulates) in New Hampshire, there is not much that can be done to effectively increase pond pH.

- **Table 5: Acid Neutralizing Capacity**

Table 5 (Appendix B) presents the current year and historical epilimnetic ANC for each year the pond has been monitored through VLAP.

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. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was **6.1 mg/L** this season, which is ***slightly greater than*** the state median. In addition, this indicates that the lake/pond is ***moderately vulnerable*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**

Table 6 (Appendix B) presents the current and historical conductivity values for tributaries and in-lake data. 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 median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean annual conductivity in the epilimnion at the deep spot this season was **76.50 uMhos/cm**, which is ***greater than*** the state median.

The conductivity has ***increased*** in the pond and tributaries since monitoring began. Typically, sources of increased conductivity are due to human activity. These activities include 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 contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

We recommend that your monitoring group conduct a shoreline conductivity survey of the lake and the **Inlet tributary** to help pinpoint the sources of ***elevated*** conductivity.

To learn how to conduct a shoreline or tributary conductivity survey, please refer to the 2004 "Special Topic Article" or contact the VLAP Coordinator.

It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the lake/pond. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the **epilimnion** (upper layer) and the **Inlet** be sampled for chloride next season. This sampling may help us pinpoint what areas of the watershed which are contributing to the increasing in-lake conductivity.

Please note that there will be an additional cost for each of the chloride samples and that these samples must be analyzed at the DES laboratory in Concord. In addition, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

- **Table 8: Total Phosphorus**

Table 8 (Appendix B) presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration was ***elevated*** in the **Inlet** and **Outlet** sample on the ***July*** sampling event ***(29 and 25 ug/L, respectively)***. The turbidity of these samples was also ***elevated (3.52 and 7.06 NTUs, respectively).*** These stations have had a history of ***elevated and fluctuating*** total phosphorus and turbidity concentrations which suggests that erosion is occurring in the watershed. We recommend that your monitoring group conduct a stream survey and storm event sampling along the **Inlet** so that we can determine what may be causing the elevated levels.

For a detailed explanation on how to conduct rain event sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2005 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was greater than **100%** saturation at **4, 7,** and **8 meters** at the deep spot on the **July** sampling event. Wave action from wind can also dissolve atmospheric oxygen into the upper layers of the water column. Layers of algae can also increase the dissolved oxygen in the water column, since oxygen is a by-product of photosynthesis. Considering that the depth of the photic zone (depth to which sunlight can penetrate into the water column) was approximately **4.2** meters on this date (as shown by the Secchi-disk transparency), and that the metalimnion (the layer of rapid decrease in water temperature and increase in water density – a place where algae are often found) was located between approximately **6** and **10** meters, we suspect that an abundance of algae in the metalimnion caused the oxygen super saturation.

  During this season, and many past sampling seasons, the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (lower layer) than in the epilimnion (upper layer). These data suggest that the process of ***internal phosphorus loading*** is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion **(as it was this season and in many past seasons)**, the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column. Since an internal source of phosphorus in the lake/pond may be present, it is even more important that watershed residents act proactively to minimize phosphorus loading from the watershed.

  The DES biologist visit has conducted the temperature/dissolved oxygen profile in **June or July** since monitoring began. We recommend that the annual biologist visit for the 2006 sampling season be scheduled during **August** so that we can determine if oxygen is depleted in the hypolimnion ***later*** in the sampling season.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historical data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  As discussed previously, the turbidity of the **epilimnion, Inlet,** and **Outlet** samples was ***elevated*** on the **June** sampling event. This suggests that a rainstorm may have recently contributed sediment-laden stormwater runoff to the lake and/or an algal bloom had occurred in the lake.

- **Table 12: Bacteria (*E.coli*)**
  Table 12 lists only the historical data for bacteria (*E.coli*) testing. (Please note that Table 12 now lists the maximum and minimum results for all past sampling seasons.) *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is 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.

  It should be noted that bacteria sampling was not conducted this year. If residents are concerned about sources of bacteria such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high, when beach use is heavy, or immediately after rain events.

- **Table 14: Current Year Biological and Chemical Raw Data**
  This table lists the most current sampling season results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw" (meaning unprocessed) data. The results are sorted by station, depth zone (epilimnion, metalimnion, and hypolimnion) and parameter.

- **Table 15: Station Table**
  As of the Spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past (and are most familiar with), an EMD station name also exists for each VLAP sampling location. For each station sampled at your lake or pond, Table 15 identifies what EMD station

name corresponds to the station names you have used in the past and will continue to use in the future.

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 while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors 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 fail to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the 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 season! 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 the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of 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 season! 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

Acid Deposition Impacting New Hampshire's Ecosystems, NHDES Fact Sheet ARD-32, (603) 271-2975 or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES Booklet WD-03-42, (603) 271-2975.

Best Management Practices for Well Drilling Operations, NHDES Fact Sheet WD-WSEB-21-4, (603) 271-2975 or www.des.nh.gov/factsheets/ws/ws-21-4.htm.

Biodegradable Soaps and Water Quality, NHDES Fact Sheet BB-54, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-54.htm.

Canada Geese Facts and Management Options, NHDES Fact Sheet BB-53, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-53.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet WMB-10, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, NHDES Fact Sheet WD-SP-1, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-1.htm.

Freshwater Jellyfish In New Hampshire, NHDES Fact Sheet WD-BB-5, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-51/htm.

Impacts of Development Upon Stormwater Runoff, NHDES Fact Sheet WD-WQE-7, (603) 271-2975 or www.des.state.nh.us/factsheets/wqe/wqe-7.htm.

IPM: An Alternative to Pesticides, NHDES Fact Sheet WD-SP-3, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-3.htm.

Iron Bacteria in Surface Water, NHDES Fact Sheet WD-BB-18, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-18.htm.

Lake Foam, NHDES Fact Sheet WD-BB-4, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-5.htm.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, NHDES Fact Sheet WD-BB-9, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters NHDES Fact Sheet WD-WMB-16, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-17.htm.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, NHDES Fact Sheet WD-SP-2, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, NHDES Fact Sheet WD-WMB-4, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, NHDES Fact Sheet WD-BB-15, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act, NHDES Fact Sheet SP-4, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-4.htm.

Soil Erosion and Sediment Control on Construction Sites, NHDES Fact Sheet WQE-6, (603) 271-2975 or www.des.state.nh.us/factsheets/wqe/wqe-6.htm.

Through the Looking Glass: A Field Guide to Aquatic Plants, North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

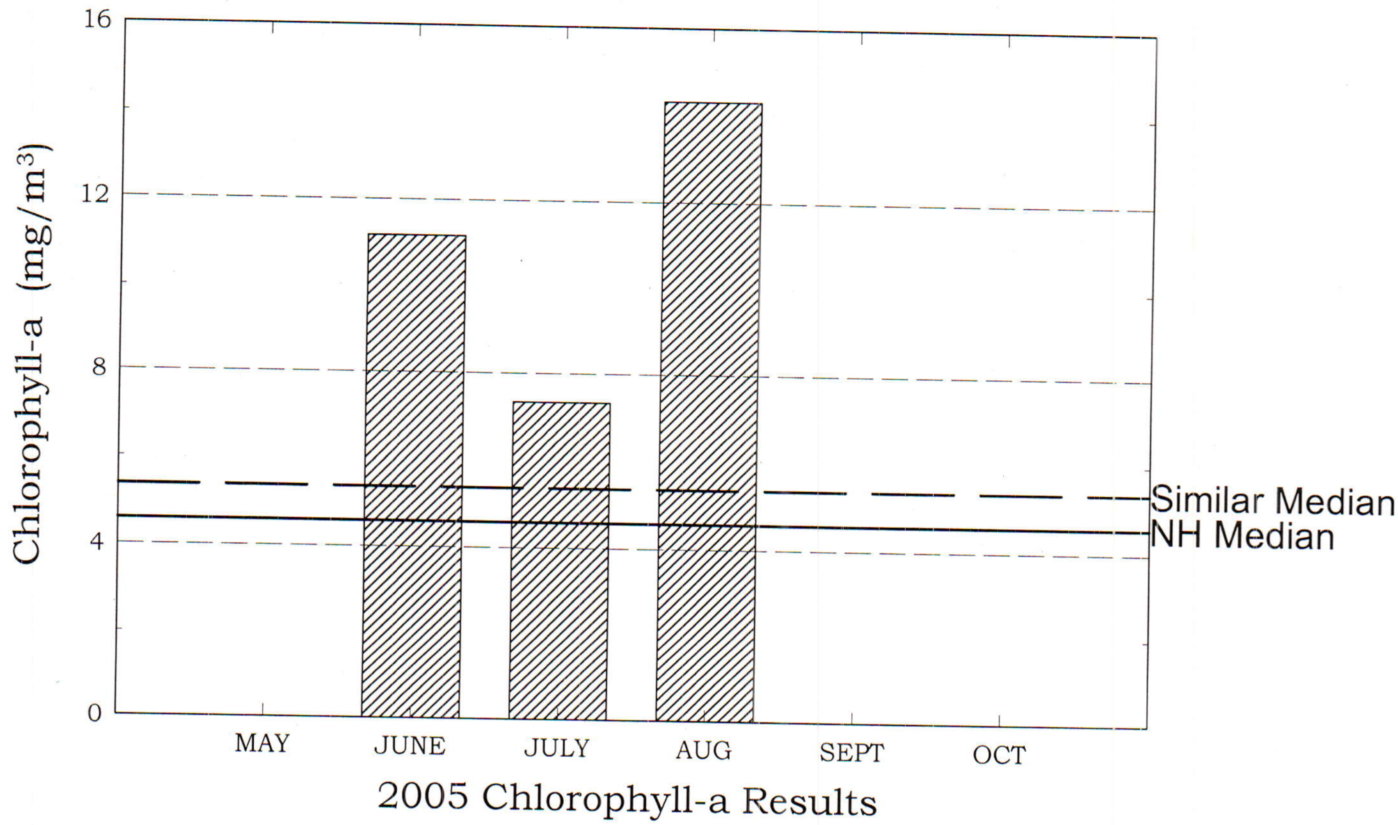
Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, NHDES Fact Sheet WD-BB-4, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-4.htm.

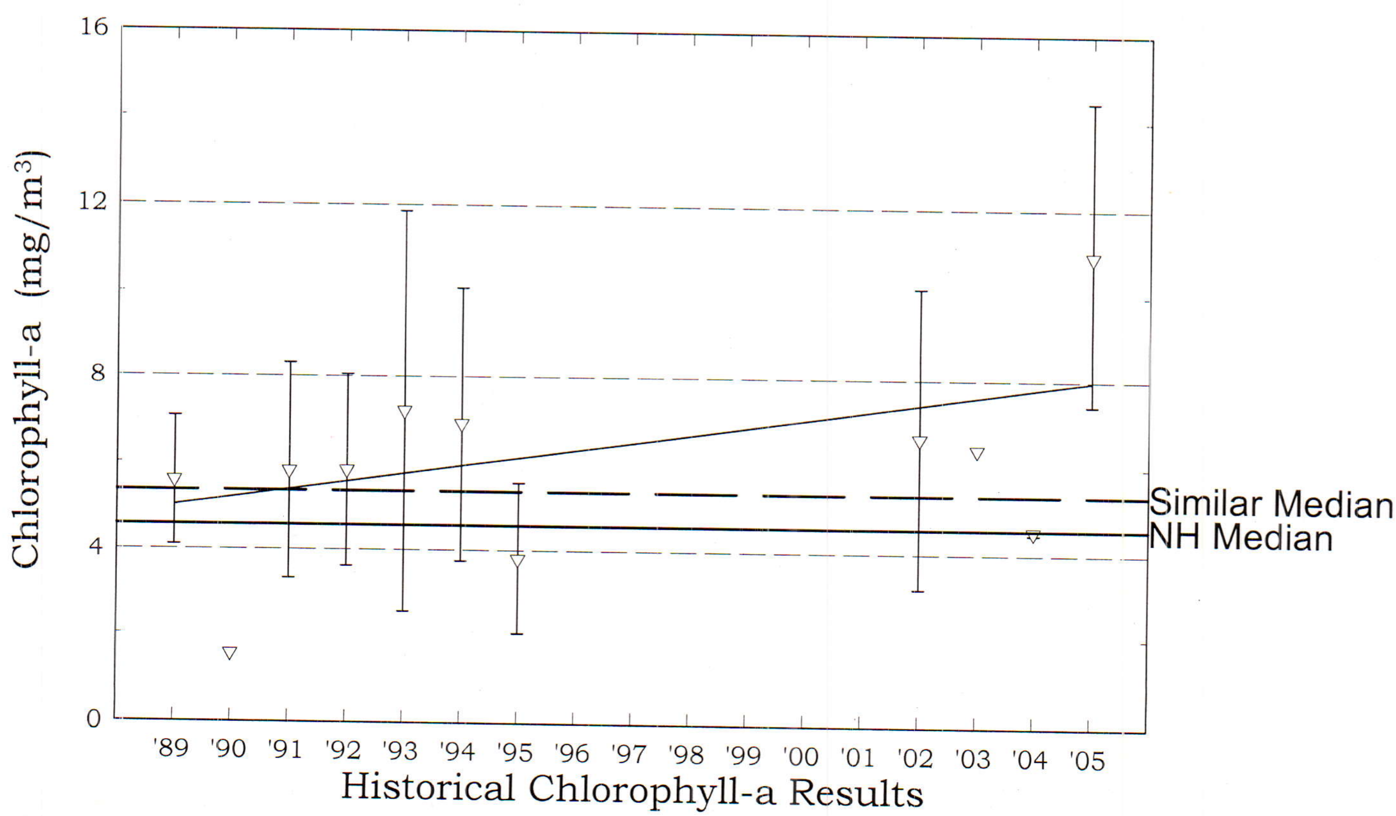
Watershed Districts and Ordinances, NHDES Fact Sheet WD-WMB-16, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-16.htm.

Appendix A: Graphs

Clough Pond, Loudon

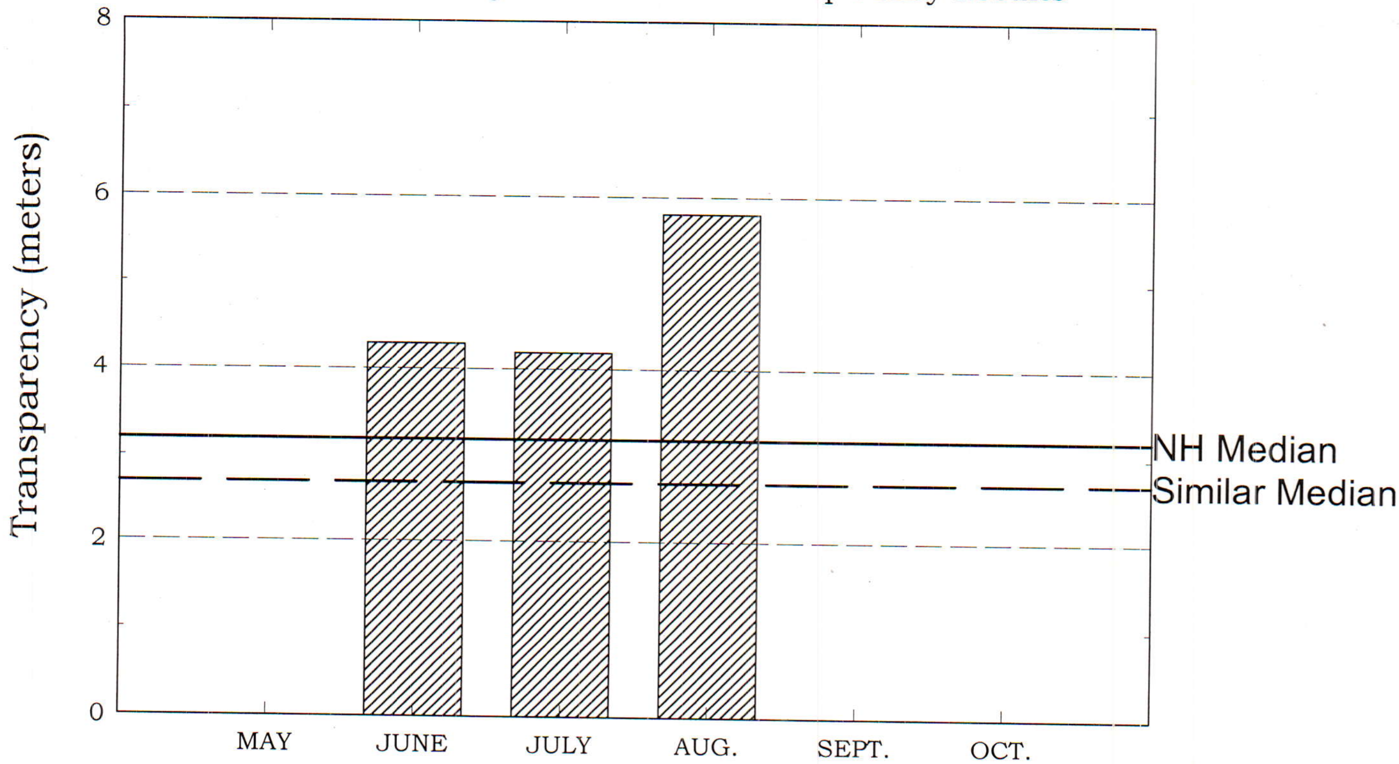
Figure 1. Monthly and Historical Chlorophyll-a Results



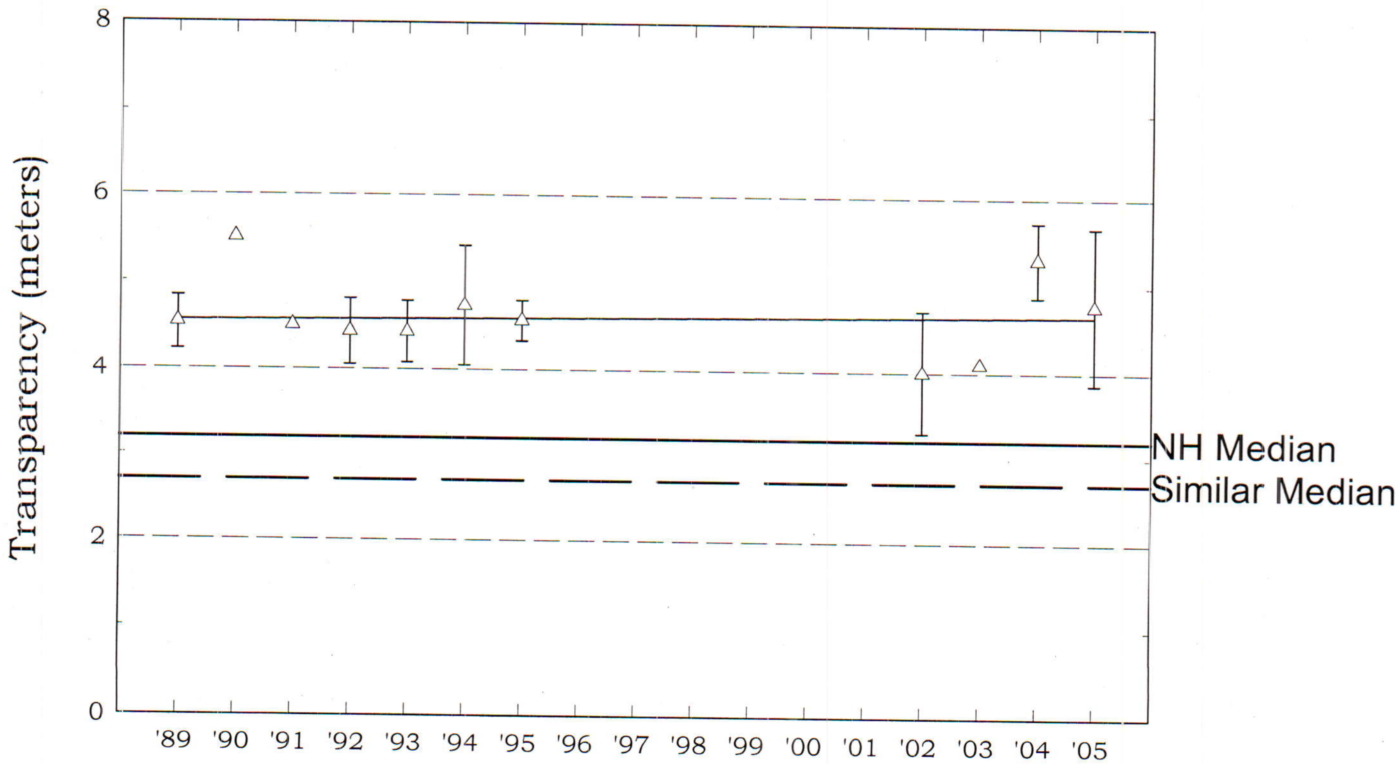


Clough Pond, Loudon

Figure 2. Monthly and Historical Transparency Results



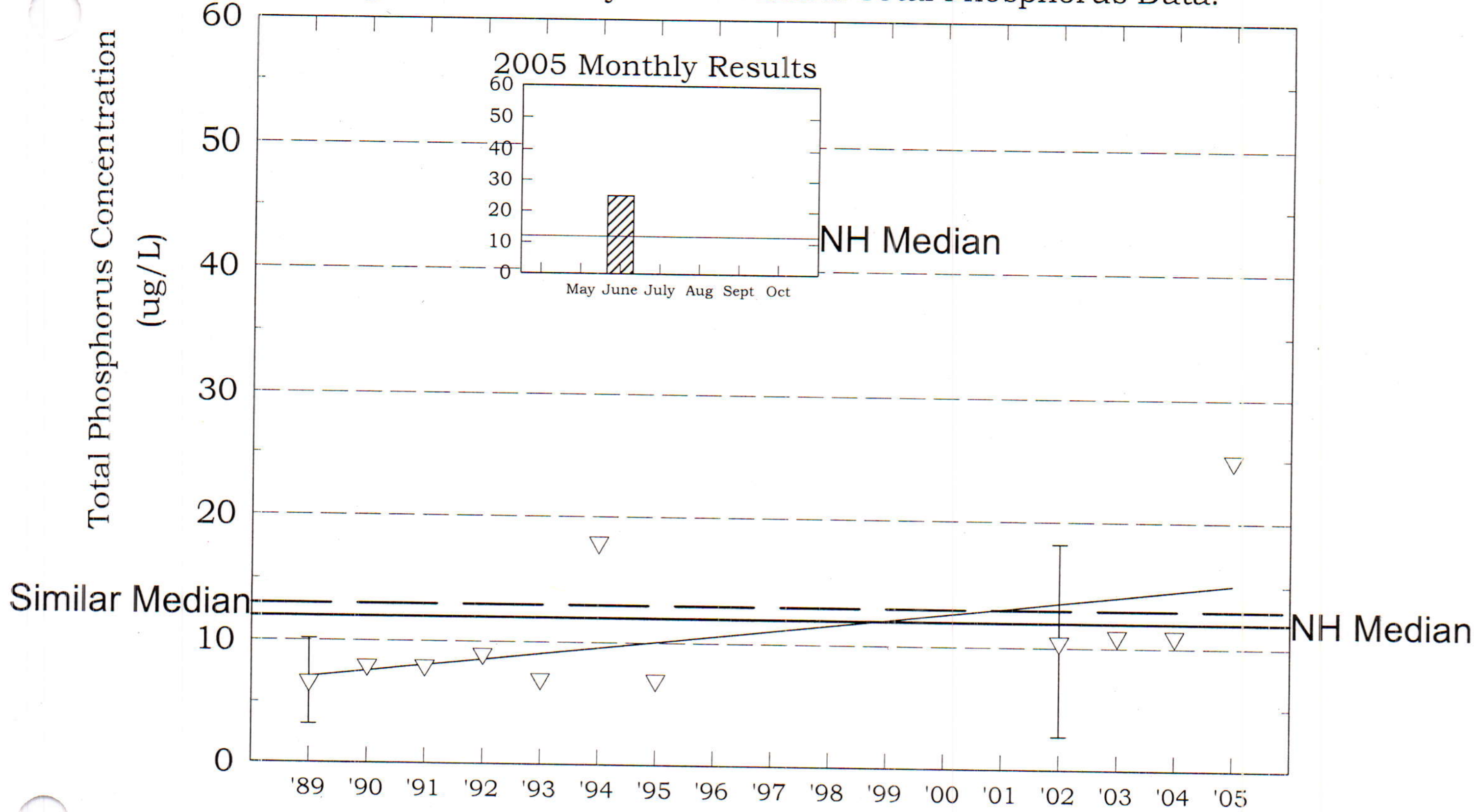
2005 Transparency Results



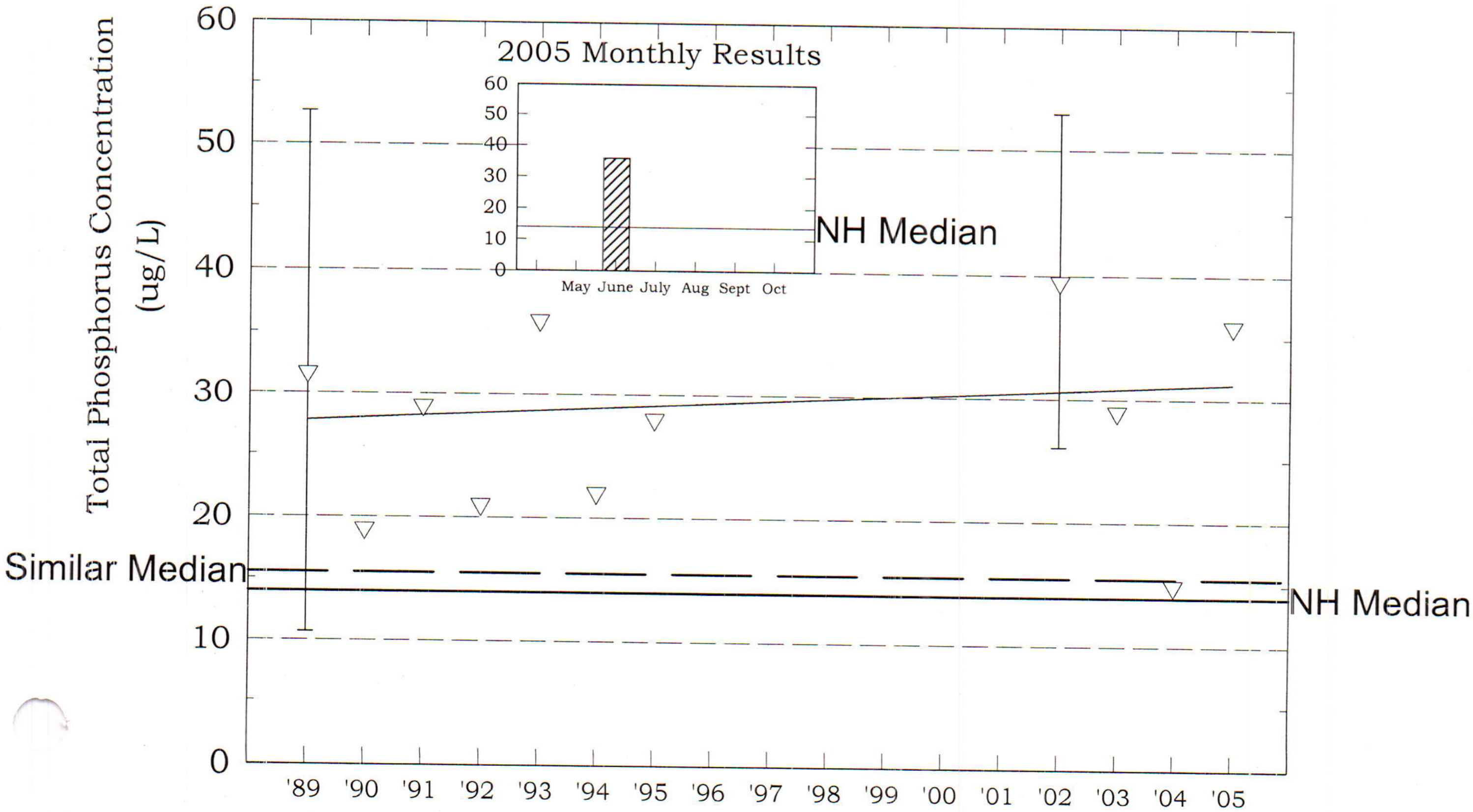
Historical Transparency Results

Clough Pond, Loudon

Figure 3. Monthly and Historical Total Phosphorus Data.



Epilimnion (Upper Water Layer)



Hypolimnion (Lower Water Layer)

Appendix B: Tables

Table 1

CLOUGH POND

LOUDON

Chlorophyll-a results (mg/m3) for current year and historical sampling periods.

Station ID	Station Name	Year	Minimum	Maximum	Mean
CLOLOUD	CLOUGH POND-DEEP SPOT	1989	4.36	7.23	5.59
		1990	1.54	1.54	1.54
		1991	3.22	8.20	5.81
		1992	4.38	8.39	5.84
		1993	3.82	12.51	7.20
		1994	3.82	10.17	6.92
		1995	2.51	5.81	3.80
		2002	4.20	9.15	6.68
		2003	6.43	6.43	6.43
		2004	4.50	4.60	4.55
		2005	7.33	14.33	10.94

Table 2.
CLOUGH POND
LOUDON

Phytoplankton species and relative percent abundance.
Summary for current and historical sampling seasons.

Date of Sample	Species Observed	Relative % Abundance
6/29/1989	SPHAEROCYSTIS	8
	TABELLARIA	55
	CHRYSOSPHAERELLA	17
7/17/1990	CERATIUM	42
	DINOBRYON	30
7/17/1991	DINOBRYON	49
	CERATIUM	45
7/23/1992	ASTERIONELLA	68
	DINOBRYON	12
	TABELLARIA	12
7/16/1993	UROGLENOPSIS	40
7/20/1994	DINOBRYON	88
7/26/1995	DINOBRYON	47
	TABELLARIA	22
	CHRYSOSPHAERELLA	17
7/2/2002	CHRYSOSPHAERELLA	49
	ASTERIONELLA	38
	CERATIUM	9
6/10/2003	ASTERIONELLA	43
	TABELLARIA	26
	DINOBRYON	25
7/21/2004	STAURASTRUM	23
	ELAKATOTHRIX	20
	DINOBRYON	17
7/11/2005	DINOBRYON	62
	CHRYSOSPHAERELLA	8
	PERIDINIUM	7

Table 3
CLOUGH POND
LOUDON

Summary of current and historical Secchi Disk Transparency results (in meters).

Station ID	Station Name	Year	Minimum	Maximum	Mean
CLOLOUD	CLOUGH POND-DEEP SPOT	1989	4.20	4.80	4.53
		1990	5.50	5.50	5.50
		1991	4.50	4.50	4.50
		1992	4.00	4.70	4.43
		1993	4.10	4.80	4.43
		1994	4.20	5.50	4.73
		1995	4.30	4.70	4.57
		2002	3.50	4.50	4.00
		2003	4.10	4.10	4.10
		2004	5.00	5.57	5.29
		2005	4.20	5.75	4.73

Table 4
CLOUGH POND
LOUDON

pH summary for current and historical sampling seasons. Values are in units, listed by station, depth and year.

Station Name	Depth Zone	Year	Minimum	Maximum	Mean
CLOUGH POND-DEEP SPOT	EPILIMNION	1989	7.04	7.25	7.15
		1990	7.10	7.10	7.10
		1991	4.43	7.15	6.23
		1992	5.05	6.71	6.14
		1993	6.86	7.42	7.14
		1994	7.03	7.10	7.07
		1995	6.98	7.02	7.00
		2002	6.80	6.85	6.83
		2003	6.71	6.71	6.71
		2004	6.61	6.83	6.72
		2005	6.83	6.95	6.90
	HYPOLIMNION	1989	6.27	6.51	6.39
		1990	6.11	6.11	6.11
		1991	6.13	6.40	6.25
		1992	5.53	6.32	6.01
		1993	6.19	6.32	6.26
		1994	5.88	6.32	6.12
		1995	6.26	6.35	6.31
		2002	6.10	6.16	6.13
		2003	6.04	6.04	6.04
		2004	6.10	6.11	6.11
		2005	6.06	6.27	6.20
	METALIMNION	1989	6.79	7.27	7.09
		1990	7.06	7.06	7.06
		1991	6.14	7.25	6.80
		1992	6.35	7.04	6.69
		1993	6.61	6.83	6.75
		1994	6.16	6.93	6.50
		1995	6.75	7.33	7.05
		2002	6.43	6.52	6.48
		2003	7.01	7.01	7.01
		2004	6.72	7.07	6.90
		2005	6.25	7.16	6.67

Table 4
CLOUGH POND
LOUDON

pH summary for current and historical sampling seasons. Values are in units, listed by station, depth and year.

Station Name	Depth Zone	Year	Minimum	Maximum	Mean
CLOUGH POND-INLET		1989	6.41	6.49	6.45
		1990	6.69	6.69	6.69
		1991	6.70	7.00	6.85
		1992	5.90	6.67	6.35
		1993	6.64	6.87	6.76
		1994	6.17	6.52	6.35
		1995	6.52	6.61	6.57
		2002	6.94	6.94	6.94
		2003	5.99	5.99	5.99
		2004	6.39	6.78	6.59
		2005	6.36	6.90	6.69
CLOUGH POND-OUTLET		1989	6.52	7.00	6.80
		1990	6.88	6.88	6.88
		1991	6.81	7.10	6.92
		1992	6.50	6.71	6.59
		1994	6.64	7.16	6.90
		1995	6.51	6.96	6.74
		2002	6.90	6.90	6.90
		2003	6.57	6.57	6.57
		2004	6.32	6.53	6.43
		2005	6.54	7.00	6.73

Table 5
CLOUGH POND
LOUDON

Summary of current and historical Acid Neutralizing Capacity. Values expressed in mg/L as CaCO3.

Station ID	Station Name	Year	Minimum	Maximum	Mean
CLOLOUD	CLOUGH POND-DEEP SPOT	1989	4.9	5.9	5.5
		1990	6.4	6.4	6.4
		1991	5.1	12.9	8.0
		1992	4.5	5.1	4.8
		1993	6.2	6.4	6.3
		1994	6.3	7.4	6.8
		1995	5.8	7.5	6.7
		2002	5.3	6.1	5.7
		2003	5.5	5.5	5.5
		2004	4.6	6.3	5.5
		2005	5.9	6.5	6.1

Table 6

CLOUGH POND
LOUDON

Specific conductance results from current and historic sampling seasons. Results in uMhos/cm.

Station Name	Depth Zone	Year	Minimum	Maximum	Mean
CLOUGH POND-DEEP SPOT	EPILIMNION	1989	47.84	49.80	48.91
		1990	53.20	53.20	53.20
		1991	50.00	51.50	50.73
		1992	49.50	53.20	51.93
		1993	51.90	59.40	54.50
		1994	54.40	55.00	54.67
		1995	54.20	55.40	54.70
		2002	55.73	63.85	59.79
		2003	72.38	72.38	72.38
		2004	72.09	76.11	74.10
		2005	71.20	84.16	76.50
	HYPOLIMNION	1989	50.20	59.00	53.57
		1990	52.50	52.50	52.50
		1991	51.40	54.90	52.87
		1992	46.10	56.40	52.33
		1993	63.90	74.90	68.53
		1994	59.70	68.90	63.33
		1995	55.60	63.90	60.93
		2002	59.49	64.92	62.21
		2003	80.66	80.66	80.66
		2004	76.05	89.36	82.71
		2005	90.03	112.60	97.85
	METALIMNION	1989	47.20	47.90	47.57
		1990	53.80	53.80	53.80
		1991	49.80	52.20	51.37
		1992	45.90	52.70	50.10
		1993	48.30	59.80	53.30
		1994	50.40	55.50	53.43
		1995	54.20	55.30	54.60
		2002	53.47	60.12	56.80
		2003	66.52	66.52	66.52
		2004	71.70	74.27	72.99
		2005	73.17	83.86	77.47

Table 6

CLOUGH POND

LOUDON

Specific conductance results from current and historic sampling seasons. Results in uMhos/cm.

Station Name	Depth Zone	Year	Minimum	Maximum	Mean
CLOUGH POND-INLET		1989	34.10	38.00	36.20
		1990	40.50	40.50	40.50
		1991	44.50	49.60	47.77
		1992	26.80	48.40	36.90
		1993	43.10	51.80	47.45
		1994	35.30	45.30	40.30
		1995	40.20	53.90	47.05
		2002	62.93	62.93	62.93
		2003	29.05	29.05	29.05
		2004	64.60	76.12	70.36
		2005	52.15	84.31	67.81
CLOUGH POND-OUTLET		1989	36.30	50.00	45.03
		1990	53.00	53.00	53.00
		1991	49.60	55.30	51.97
		1992	50.00	58.90	54.33
		1993	51.50	51.50	51.50
		1994	55.70	57.00	56.35
		1995	55.40	61.10	58.25
		2002	62.84	62.84	62.84
		2003	74.77	74.77	74.77
		2004	76.35	83.87	80.11
		2005	71.67	89.68	78.56

Table 8

CLOUGH POND

LOUDON

Summary of historical and current sampling seasons for Total Phosphurus data. Results in ug/L.

Station ID	Station Name	Depth	Year	Minimum	Maximum	Mean
CLOLOUD	CLOUGH POND-DEEP SPOT	EPILIMNION	1989	3	10	6.7
			1990	8	8	8.0
			1991	8	8	8.0
			1992	9	9	9.0
			1993	7	7	7.0
			1994	18	18	18.0
			1995	7	7	7.0
			2002	5	16	10.5
			2003	11	11	11.0
			2004	11	11	11.0
			2005	25	25	25.0
		HYPOLIMNION	1989	11	53	31.7
			1990	19	19	19.0
			1991	29	29	29.0
			1992	21	21	21.0
			1993	36	36	36.0
			1994	22	22	22.0
			1995	28	28	28.0
			2002	30	49	39.5
			2003	29	29	29.0
			2004	15	15	15.0
			2005	36	36	36.0
		METALIMNION	1989	13	17	15.3
			1990	12	12	12.0
			1991	14	14	14.0
			1992	17	17	17.0
			1993	8	8	8.0
			1994	15	15	15.0
			1995	12	12	12.0
			2002	13	18	15.5
			2003	15	15	15.0
			2004	14	14	14.0
			2005	27	27	27.0
CLOLOUI	CLOUGH POND-INLET		1989	38	47	42.0
			1990	38	38	38.0
			1991	71	71	71.0
			1992	51	51	51.0
			1993	65	65	65.0
			1994	96	96	96.0
			2002	5	5	5.0
			2003	39	39	39.0
			2004	15	15	15.0

Table 8
CLOUGH POND
LOUDON

Summary of historical and current sampling seasons for Total Phosphurus data. Results in ug/L.

Station ID	Station Name	Depth	Year	Minimum	Maximum	Mean
CLOLOUI	CLOUGH POND-INLET		2005	29	29	29.0
CLOLOUO	CLOUGH POND-OUTLET		1989	1	43	18.7
			1990	17	17	17.0
			1991	28	28	28.0
			1992	7	7	7.0
			1994	14	14	14.0
			2002	6	6	6.0
			2003	17	17	17.0
			2004	47	47	47.0
			2005	45	45	45.0

Table 9

CLOUGH POND

LOUDON

Current year dissolved oxygen and temperature data.

Station ID	Station Name	Date	Depth (m)	DO (mg/L)	DO Sat (%)	Temp (Deg C)
CLOLOUD	CLOUGH POND-DEEP SPOT	07/11/2005	0.1	7.82	92.3	23.6
			1.0	7.82	92.3	23.6
			2.0	7.84	92.5	23.6
			3.0	8.01	93.1	22.8
			4.0	9.86	103.4	17.6
			5.0	7.89	90.5	22.2
			6.0	9.33	97.0	17.2
			7.0	13.15	121.7	11.9
			8.0	12.68	112.4	10.0
			9.0	5.18	43.8	8.0
			10.0	1.15	9.4	6.6
			11.0	0.38	3.1	5.8
			12.0	0.34	2.7	5.5
			13.0	0.34	2.7	5.1
			14.0	0.37	2.9	5.0
			15.0	0.40	3.2	4.9
			16.0	0.44	3.5	4.8
			16.5	0.52	4.1	4.8

Table 10
CLOUGH POND
LOUDON

Historic Hypolimnion dissolved oxygen and temperature data.

Station ID	Station Name	Sample Date	Depth (m)	DO (mg/L)	DO Sat (%)	Temp (Deg C)
CLOLOUD	CLOUGH POND-DEEP SPOT	06/29/1989	13.0	0.0	0.0	6.0
		07/17/1990	13.0	0.9	7.1	5.5
		07/11/1991	14.0	0.0	0.0	5.0
		07/23/1992	12.0	0.1	0.8	6.3
		07/16/1993	14.5	0.3	2.0	5.8
		07/20/1994	15.0	0.2	1.0	6.2
		07/26/1995	16.0	0.2	2.0	5.5
		07/02/2002	16.0	0.5	4.5	6.8
		06/10/2003	16.5	0.4	3.0	6.2
		07/21/2004	17.0	0.7	5.8	5.5
		07/11/2005	16.5	0.5	4.1	4.8

Table 11

CLOUGH POND

LOUDON

Summary of current year and historic turbidity sampling. Results are in NTUs.

Station Name	Depth Zone	Year	Minimum	Maximum	Mean
CLOUGH POND-DEEP SPOT	EPILIMNION	2002	0.97	0.97	0.97
		2003	0.96	0.96	0.96
		2004	0.71	1.21	0.96
		2005	0.69	3.13	1.56
	HYPOLIMNION	2002	4.43	4.43	4.43
		2003	4.30	4.30	4.30
		2004	3.03	6.57	4.80
		2005	3.18	4.96	4.00
	METALIMNION	2002	2.92	2.92	2.92
		2003	1.54	1.54	1.54
		2004	1.39	1.68	1.54
		2005	0.82	1.73	1.20
CLOUGH POND-INLET		2002	1.01	1.01	1.01
		2003	3.50	3.50	3.50
		2004	1.10	1.38	1.24
		2005	0.63	3.52	1.65
CLOUGH POND-OUTLET		2002	2.07	2.07	2.07
		2003	8.58	8.58	8.58
		2004	0.96	24.00	12.48
		2005	0.93	7.06	3.24

Table 12
CLOUGH POND
LOUDON
Summary of current year and historic E. coli data. Results are in Counts/100ml.

Station ID	Station Name	Year	Minimum	Maximum
CLOLOU-GEN	CLOUGH POND-GENERIC	2002	0	0

Table 14
Current Year Chemical and Biological Raw Data
Annual Report

CLOUGH POND
LOUDON

Station Name	Depth	Sample Date	COND	Chl-A	TP	Turbidity	pH	ANC	Transparency	E. coli	Cl
CLOUGH POND-DEEP SPOT	COMPOSITE	06/13/2005		11.17							
		07/11/2005		7.33							
		08/10/2005		14.33							
	EPILIMNION	06/13/2005	=74.15		.025	=3.13	6.83	5.9	=4.25		
		07/11/2005	=71.2			=.85	6.95	6	=4.2		
		08/10/2005	=84.16			=.69	6.92	6.5	=5.75		
	HYPOLIMNION	06/13/2005	=90.03		.036	=3.18	6.06				
		07/11/2005	=90.92			=3.87	6.27				
		08/10/2005	=112.6			=4.96	6.26				
	METALIMNION	06/13/2005	=75.38		.027	=1.04	6.25				
		07/11/2005	=73.17			=1.73	7.16				
		08/10/2005	=83.86			=.82	6.61				
CLOUGH POND-INLET		06/13/2005	=52.15		.029	=3.52	6.36				
		07/11/2005	=66.98			=.81	6.8				
		08/10/2005	=84.31			=.63	6.9				
CLOUGH POND-OUTLET		06/13/2005	=74.34		.045	=7.06	6.64				
		07/11/2005	=71.67			=1.72	7				
		08/10/2005	=89.68			=.93	6.54				

Please Note: pH (units), TP (mg/L), Cond (UMHOS/cm), Transparency (M), E.coli (cts/100mL), Turbidity (NTU), ANC (mg/L), CL (mg/L), Chl-A (mg/M3)

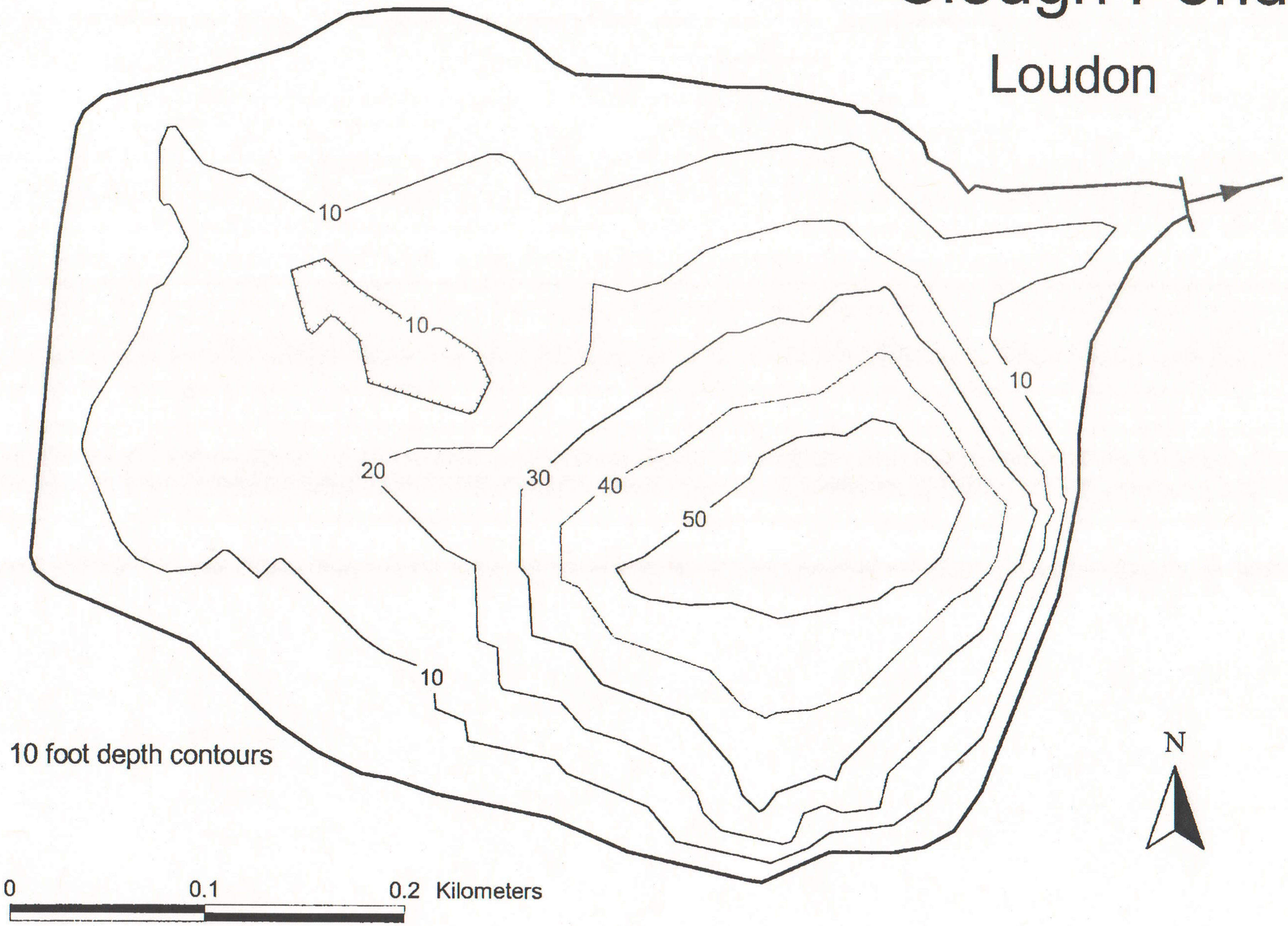
Table 15
SAMPLING STATONS
CLOUGH POND
LOUDON

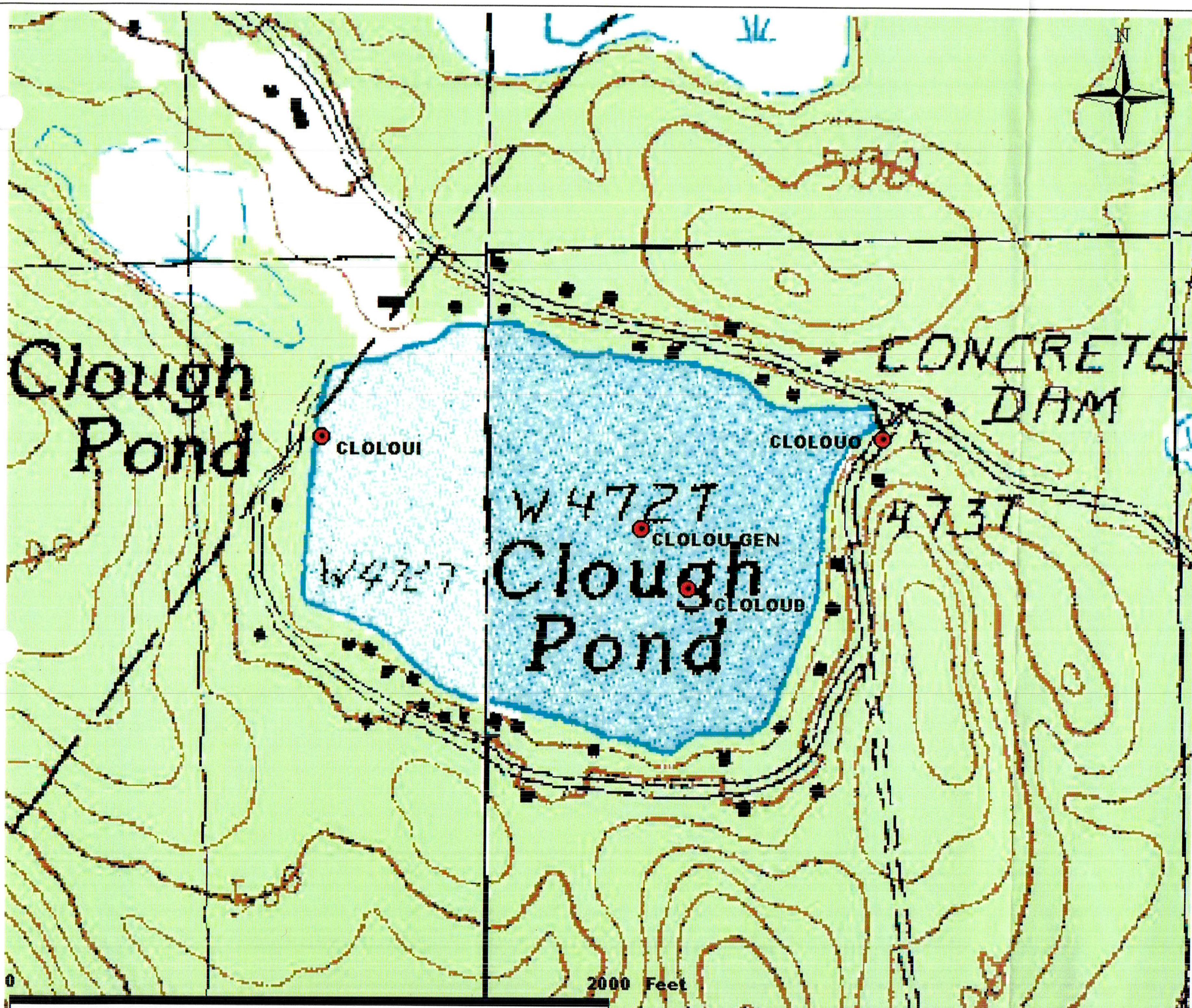
Station ID	Station Name	Depth Zone
CLOLOU-GEN	CLOUGH POND-GENERIC	
CLOLOUD	CLOUGH POND-DEEP SPOT	COMPOSITE
	CLOUGH POND-DEEP SPOT	EPILIMNION
	CLOUGH POND-DEEP SPOT	HYPOLIMNION
	CLOUGH POND-DEEP SPOT	METALIMNION
	CLOUGH POND-DEEP SPOT	
CLOLOUI	CLOUGH POND-INLET	
CLOLOUO	CLOUGH POND-OUTLET	

Appendix C: Maps

Clough Pond

Loudon





CLOUGH POND
TOWNS OF LOUDON AND CANTERBURY

STATION ID	STATION NAME
CLOBELD	DEEP SPOT
CLOLOU-GEN	GENERIC
CLOLOUD	DEEP SPOT
CLOLOUI	INLET
CLOLOUO	OUTLET

Appendix D: Special Topic

Lake Foam – Natural or Caused by Laundry Detergent?

Lakeshore property owners are often concerned when foam appears on their beach or they observe large patches of foam on the lake. However, most foam observed in lakes and streams is a product of nature; foam is not necessarily an indicator of pollution. Small trout streams, for example, often have naturally occurring pools of foam where fish will hide.

What causes the foaming of surface waters on lakes?

The foaming of surface waters on lakes is not a new phenomenon. It is a natural process that has been going on for a long time. Foam is created when the surface tension of water (attraction of surface molecules for each other) is reduced and the air is mixed in, forming bubbles. Man-made agents can also reduce surface tension.

All lakes contain organic matter, such as algae and plants, and when these decompose they release cellular products (surfactants) into the water, reducing the surface tension. Windy conditions result in waves that agitate this surface agent, thus transforming it into sudsy white foam. Currents and boats also mix air with the organic compounds present in the lake to produce foam.

During the 1950s through the 1970s, many communities experienced unnatural foam problems in waterbodies. This foam was caused by synthetic laundry detergents that were highly resistant to chemical breakdown and were only slowly degradable (broken down by bacteria). New Hampshire now makes it mandatory that all cleaning products sold in the state must be biodegradable and phosphate-free. Only automatic dish detergent is exempt from the phosphate-free requirement. A material is considered biodegradable if it a "material that, left to itself, will be decomposed by natural processes."

Where is lake foam found and what does it look like?
The foam will frequently form parallel streaks in the open water, caused by wind-induced surface currents. It will also collect in large quantities on windward shores, coves, or in eddies. Natural foam has a somewhat earthy fishy aroma and may have an off-white, tan, or brown color. Detergent foam in contrast will have a noticeable perfume smell, and is usually whiter in color.

Testing Lake Foam: Is it from natural sources or laundry detergent?
Optical brighteners, dyes used to make clothes appear whiter and brighter, are found in most laundry detergents used in the United States. Although optical brighteners are not actually harmful to the water itself, their presence in surface waters indicates that there is laundry detergent seepage into the water. This could mean that wastewater flowing into the waterbody is being inadequately treated, possibly due to a failing septic system or a complete lack of a wastewater treatment system altogether. Untreated wastewater may not only contain optical brighteners, but pollutants from the home such as phosphorus and nitrogen and household cleaning chemicals.

If you suspect that laundry detergent may be leaking into a surface water, there are two DES-approved sampling procedures you can follow to determine if optical brighteners are present in the water, as follows:

Procedure 1: Simple foam collection and analysis
If you observe foam along the shoreline or in a tributary, simply fill a clean jar with the foam and surface water and submit it to the DES Limnology Center for an optical brighteners test. In the Limnology Center, a biologist will soak an untreated cotton pad in the sample and then will place the cotton sample, a standard, and a blank under a black light. If the cotton pad with the sample fluoresces, this indicates that optical brighteners are present in the surface water. It is important to point out that the cotton pads used in this procedure are specially obtained to assure that they have not been in contact with any detergents or optical brighteners.

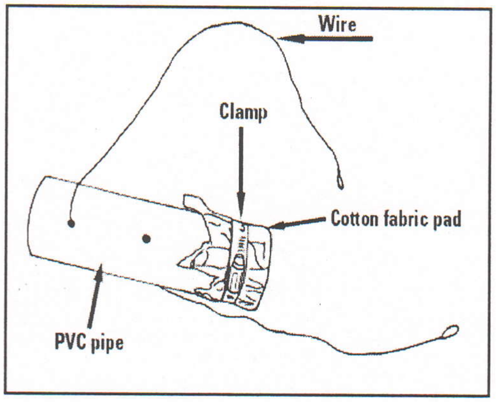
This is the simplest and quickest procedure to test for optical brighteners in a surface water; however, this method may not accurately depict the conditions in the stream if the concentration of optical brighteners is exceptionally dilute, or laundry detergent is flowing into the waterbody but foam is not present.

Procedure 2: Prolonged exposure
This option requires you to immerse untreated cotton pads in stream along the shoreline for an extended period of time. This will provide the cotton the greatest potential to absorb optical brighteners that may be leaching into the surface water without producing foam or may be leaching into the water during times when you are not able to observe the presence of foam. This method is most suitable for streams, storm drains, pipes, and catch basins.

1. Obtain a supply of untreated cotton and laboratory gloves. You can acquire these items via VWR Graphics (856-467-2600) or by contacting the VLAP Coordinator (603-271-2658). You must wear gloves whenever you handle the cotton. **Do not touch the cotton with your bare fingers and do not let the cotton brush up against your clothes.**

2. Once you have obtained the appropriate cotton, you will need to construct or obtain a simple trap to hold the cotton in place while in the water. This can be made with a PVC pipe that is two inches in diameter and approximately six to eight inches long, or by obtaining a rigid plastic cage. If using a PVC pipe, stretch the cotton across one end of the pipe to the other and then secure it with a rubber band or metal clamp. If using a plastic cage, make sure that the holes in the cage are small enough so that the cotton will not escape. **(Again, please remember to wear gloves while handling the cotton and do not let it touch your clothes!)**

3. Attach a wire or fishing line to the pipe or plastic cage. This will hold the trap in place at the testing site. It can be tied to a rock, branch, roots, dock, or anything else at the site that will keep it fixed. If using a pipe, the end of the pipe with cotton on it should be facing upstream against the direction of flow, and it should not be touching the bottom of the stream.



4. Keep the cotton in the waterbody for seven days.

5. After seven days, put on sterile gloves (make sure these gloves have not been in contact with laundry detergent!) and remove the cotton. If there is any sediment on the cotton, simply rinse the cotton in the surface water. Place the cotton in a plastic bag (making sure to keep it out of direct sunlight), and bring it to the DES Limnology Center as soon as possible for testing.

Additional Questions

If you have any additional questions about lake foam, or the optical brighteners sampling procedures, please do not hesitate to contact the VLAP Coordinator, at (603) 271-2658.

Sources:
www.epa.gov/owow/monitoring/volunteer/newsletter/volmon11no2.pdf
www.longwood.edu/cleanva/images/Sec5.opticalbrightlesson.pdf

Appendix E: Statistical Analysis and Raw Data

STATISTICS FOR HISTORICAL TREND ANALYSIS

For those lakes and ponds that have participated in VLAP for at least 10 consecutive years, we are now analyzing the in-lake data with a simple statistical test. The test is used to determine if there has been a *significant change* in the annual mean value for the three major sampling parameters during the period that the lake/pond has been sampled in VLAP. Specifically, we are using a **linear regression line and regression statistics** to determine if there has been an increase or decrease of the annual mean for chlorophyll-a, Secchi-disk transparency, and total phosphorus. Since this is a new addition to the VLAP annual report, we would greatly appreciate any feedback or comments that you can provide. Statistical analysis can be confusing, so please let us know if the analysis or explanation is difficult to understand.

WHAT ARE STATISTICS?

A statistical test provides a mechanism for making an objective, not subjective, decision about a process. The intent of a statistical test is to determine whether there is enough evidence to "reject" a hypothesis about the process. In the past, we have evaluated the data by "eyeing" (looking at) the trendline to determine if an overall increase or decrease in water quality for these parameters has occurred. This statistical test will allow mathematic equations to determine if there has been a change over time.

HOW WILL STATISTICS BE USED IN VLAP?

For VLAP, we are using a simple linear regression statistical test to determine if there is enough evidence to "reject" the null hypothesis that the annual mean value for the water quality parameter of interest (chlorophyll-a concentration, Secchi-disk transparency, or total phosphorus concentration) **has not changed** during the time that that lake/pond has been sampled in VLAP. If there is enough evidence to "reject" the null hypothesis, then we will accept the alternative hypothesis, which says that the mean value **has changed** (either increased or decreased) during the time that the lake/pond has been sampled in VLAP.

> **Ho (the null hypothesis):** The annual mean value for the water quality parameter of interest (either chlorophyll-a concentration, Secchi-disk transparency, or total phosphorus concentration) **has not changed** during the time that the lake/pond has been sampled in VLAP.
>
> **Ha (the alternative hypothesis):** The annual mean value for the water quality parameter of interest (either chlorophyll-a concentration, Secchi-disk transparency, or total phosphorus concentration) **has changed** (either increased or decreased) during the time that the lake/pond has been sampled in VLAP.

SIGNIFICANCE LEVELS

We want to know if the null hypothesis (that the annual mean value for the water quality parameter of interest **has not changed** over time) is "true" or "false", which is why we are "testing" it. The alternative hypothesis (that the annual mean value for the water quality parameter of interest **has changed** over time) might be true. The procedure to "test" the null hypothesis is constructed so that the risk of "rejecting" the null hypothesis, when it is in fact "true", is relatively small. The risk is referred to as the **significance level** of the "test". By having a significance level for the "test", we feel that we have actually "proved" something when we reject the null hypothesis.

For VLAP we are using a significance level of 0.05, which implies that the null hypothesis is only "rejected" 5% of the time, when it is in fact "true". Specifically, this means that only 5% of the time, we will be claiming that the annual mean value of the water quality parameter of interest **has changed** over time, when, in reality, it **has not** changed over time. Or, stated in another way, this means that we are 95% confident when we "reject" the null hypothesis that the annual mean value of the water quality parameter of interest **has changed** over time.

HOW DO WE DETERMINE IF THE NULL HYPOTHESIS IS "TRUE" OR "FALSE"?

To determine if the null hypothesis is "true" or "false" we look at a probability value. The **probability value (p-value)** of a statistical hypothesis test is the probability of getting a value of the test statistic as extreme or more extreme than that observed by chance alone, if the null hypothesis, is true. The p-value is compared with the significance level, and, if it is smaller, the result of the "test" is significant. Small p-values suggest that the null hypothesis is unlikely to be true. The smaller the p-value is, the more convincing the "rejection" of the null hypothesis is.

Specifically, for VLAP, since we are using a significance level of 0.05, this means that if the p-value is less than 0.05, we will "reject" the null hypothesis (that the annual mean value of the water quality parameter of interest **has not changed** over time). If we "reject" the null hypothesis, then we will accept the alternative hypothesis (that the annual mean value of the water quality parameter of interest **has changed** over time). Again, the smaller the p-value is, the more convincing the "rejection" of the null hypothesis is.

p-value	Action
greater than 0.05	"fail to reject" the null hypothesis
less than 0.05	"reject" the null hypothesis and "accept" the alternative hypothesis

How do we know if the change over time is "increasing" or "decreasing"?

If we "reject" the null hypothesis and conclude that the annual mean value for the water quality parameter of interest **has changed** since VLAP sampling began, then we will need to determine if the change over time has been an "**increasing trend**" or a "**decreasing trend**". To determine this, we look at the regression coefficient that is assigned to the "x" variable, which is actually the slope of the regression line. If the "x" variable coefficient is negative (less than 0), then this indicates that the change in the annual mean value of the water quality parameter of interest with respect to time is "decreasing". If the "x" variable (slope of the regression line) is positive, then this indicates that the change in the annual mean value of the water quality parameter of interest with respect to time is "increasing".

"x" variable coefficient (slope of the regression line)	**Trend Interpretation**
negative (less than 0)	decreasing trend
positive (greater than 0)	increasing trend

How do we know the strength of the trend?

If we have "rejected" the null hypothesis and have concluded that the annual mean value for the water quality parameter of interest **has changed** since VLAP sampling began, and we have also determined if the change over time has been an "**increasing trend**" or "**decreasing trend**", then we will want to know how **strong** of an increase or decrease this trend is. The strength of the trend can be reported as a **percent change over time**. To calculate the percent change in time for the water quality parameter of interest, we divide the slope of the regression line (the regression coefficient that is assigned to the "x" variable) by the mean value of the water quality parameter of interest over time. (To calculate the mean value over time, we simply add together the annual mean value for the water quality parameter of interest for each sampling season, and then divide this total by the number of years the lake/pond has been sampled in VLAP.) This number represents the percent change in the water quality parameter interest over time. The **larger** the percent change over time for the water quality parameter of interest indicates the **greater** the strength of the trend.

As an example, let's discuss the historical chlorophyll-a data from Kezar Lake in North Sutton:

1. We inputted the historical data from 1988 to 2001 for the chlorophyll-a concentration into the computer software program, and the results of the regression gave a **p-value of 0.007**, which is less than 0.05, so we **"rejected"** the null hypothesis and **"accepted"** the alternative hypothesis, which says that the chlorophyll-a concentration has changed over time.
2. Since the coefficient of the **"x" variable (slope of the regression line) is "– 0.392",** we know that the change in the annual mean chlorophyll-a concentration since the lake has been sampled is a **decrease**.

3. Now we want to know how **strong** the decrease is, so we calculate the **percent change in the annual mean chlorophyll-a concentration over time** (as shown below):

Sampling Season	Mean Annual Chlorophyll-a concentration (mg/m^3)
1988	12.20
1989	7.55
1990	9.93
1991	7.85
1992	5.47
1993	11.31
1994	8.76
1995	6.73
1996	6.08
1997	3.84
1998	6.22
1999	7.13
2000	5.31
2001	5.14
Total (sum of annual means) =	103.51
Overall Mean (Total/number of sampling seasons) =	6.90
"x"-variable coefficient (slope of regression line) =	-0.392
Percent Change over Time ("x" variable coefficient/Overall mean) x 100 =	-5.65%

4. This calculation shows the average percent change over time is –5.65%. Specifically, this means that the annual mean chlorophyll-a concentration in Kezar Lake has **decreased on average by 5.65% per year** during the sampling period 1988 – 2001. (We know that this is a decrease because there is a negative sign.)

HOW DO WE KNOW HOW MUCH OF THE CHANGE IN THE WATER QUALITY PARAMETER OF INTEREST IS CORRELATED WITH TIME?

To determine how much (or how little) of the change in the water quality parameter of interest is correlated with time, or stated another way, to determine the percentage of the variability in the water quality parameter of interest that is explained by the variability in time, we look at the **R-squared value**. The R-square value is a measure of the degree of relationship between two variables ("x" and "y"). (Again, the "x" variable is time (sampling season), and the "y" variable is the annual mean value of the water quality parameter of interest.) The R-squared value can have any value between "0" and "+1". An **R-squared value of "0"** indicates that there is no correlation, meaning that there is no amount of variability in the "y" variable (the water quality parameter of interest) that is explained by the variability in the "x" variable (time). An **R-squared value of "1"** indicates that there is a perfect correlation, meaning that all the variability in the "y" variable (the water quality parameter of interest) is explained by the variability in the "x" variable (time).

R-squared value	**Relationship between "x" and "y" variables**
0	no correlation, no variability explained
0 to 1	some correlation, some variability explained
1	all variability explained

Let's look at the Kezar Lake data again:

1. We determined the strength of the decrease in the annual mean chlorophyll-a concentration in Kezar Lake from 1988 to 2001 by calculating the percent change in the annual mean chlorophyll-a concentration over time. We determined that the annual mean chlorophyll-a concentration in Kezar Lake has **decreased on average by approximately 5.65%** per year during the sampling period 1988 – 2001.
2. Now we want to know how much of the 5.6 % decrease is explained by the variation in time. To do this, we look at the **correlation coefficient (R-squared value)** that was generated by the regression.
3. The results of the regression gave an **R-squared value of 0.46.**
4. This means that approximately half of the decrease in the annual mean chlorophyll-a concentration is explained by the variation in time. Since the R-square value is not "1", which would indicate that all of the variability in the annual mean chlorophyll-a concentration is explained by the variability in time, this means that there may be other variables that explain the variability in the chlorophyll-a concentration. These other variables could be the total phosphorus concentration in the lake or the amount of precipitation during the summer. We would need to conduct a multiple variable regression to determine what additional variables account for the remainder of the variation in the annual mean chlorophyll-a concentration.

APPENDIX F:
New Hampshire Similar Lake Groupings and Data

DES LAKE ASSESSMENT PROGRAM SUMMER EPILIMNION AND UPPER LAYER BIOLOGICAL AND CHEMICAL CHARACTERISTICS (page 1 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Secchi (m)	Chl-a (mg/m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 1	MIN	0.50	3000.00	0.40	0.55	1.000	4.50	-1.90	13.80
Volume = 1 - < 100,000 m3	MAX	9.80	99000.00	9.80	58.57	78.000	9.20	85.90	818.00
Maximum Depth = 0 - <10 m	MEAN	3.11	52683.54	2.16	8.23	18.888	6.36	8.35	67.57
	MEDIAN	2.50	53000.00	1.80	5.41	16.000	6.40	4.40	33.90
	COUNT	161.00	161.00	159.00	157.00	160.000	161.00	161.00	159.00
GROUP 2	MIN	1.20	100000.00	0.40	0.36	0.500	4.30	-3.00	14.80
Volume = 100,000 - < 5,000,000 m3	MAX	9.70	4696000.00	8.10	143.80	121.000	9.30	62.30	696.00
Maximum Depth = 0 - <10 m	MEAN	4.77	678122.80	2.93	8.23	15.000	6.53	6.43	67.58
	MEDIAN	4.45	341500.00	2.70	5.37	13.000	6.60	4.50	42.15
	COUNT	274.00	421.00	418.00	418.00	418.000	418.00	418.00	410.00
GROUP 3	MIN	4.9	5042000.0	2.7	1.8	7.000	6.1	1.5	27.3
Volume = 5,000,000 < 50,000,000 m3	MAX	9.7	43191500.0	8.0	6.0	18.000	6.9	15.6	77.7
Maximum Depth = 0 - <10 m	MEAN	8.0	11997600.0	3.7	4.3	11.250	6.6	5.3	47.6
	MEDIAN	7.8	8290750.0	3.3	4.5	10.000	6.8	5.0	43.3
	COUNT	10.0	10.0	10.0	10.0	8.000	10.0	10.0	10.0
GROUP 4	MIN	10.30	86000.00	5.0	5.81	10.000	5.90	0.50	18.00
Volume = 1 - < 100,000 m3	MAX	10.30	86000.00	5.0	5.81	10.000	5.90	0.50	18.00
Maximum Depth = 10 - <25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00
GROUP 5	MIN	10.00	123000.00	0.80	0.36	0.500	5.10	-0.20	14.42
Volume= 100,000 - < 5,000,000 m3	MAX	24.40	4951000.00	11.40	63.68	49.000	7.90	23.80	229.00
Maximum Depth = 10 - < 25 m	MEAN	14.34	1913529.91	4.91	5.14	8.409	6.63	5.03	50.36
	MEDIAN	13.60	1586500.00	4.50	4.17	7.000	6.70	3.80	34.05
	COUNT	117.00	117.00	116.00	113.00	116.000	117.00	117.00	116.00

DES LAKE ASSESSMENT PROGRAM SUMMER EPILIMNION AND UPPER LAYER BIOLOGICAL AND CHEMICAL CHARACTERISTICS (page 2 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Secchi (m)	Chl-a (mg/m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 6	MIN	10.10	5029000.00	2.10	1.28	2.500	5.70	0.90	19.33
Volume = 5,000,000 - < 50,000,000 m3	MAX	24.40	45548000.00	10.20	7.86	23.000	7.40	22.90	337.00
Maximum Depth = 10 - <25 m	MEAN	17.21	13544487.50	5.39	3.27	7.313	6.79	6.65	67.34
	MEDIAN	16.65	9288000.00	5.75	3.08	6.000	6.90	5.65	48.85
	COUNT	40.00	40.00	38.00	40.00	40.000	40.00	40.00	38.00
GROUP 7	MIN	14.60	54285000.00	3.40	1.99	2.000	6.30	4.50	28.77
Volume = >= 50,000,000 m3	MAX	18.50	120736500.00	4.00	3.73	10.000	6.70	5.50	134.40
Maximum Depth = 10 - <25 m	MEAN	16.17	94481000.00	3.67	3.06	6.330	6.53	5.03	69.50
	MEDIAN	15.40	108421500.00	3.60	3.46	7.000	6.60	5.10	45.34
	COUNT	3.00	3.00	3.00	3.00	3.000	3.00	3.00	3.00
GROUP 8	MIN	29.60	2313500.00	9.3	0.57	5.000	6.80	3.10	22.00
Volume = 100,000 - < 5,000,000 m3	MAX	29.60	2313500.00	9.3	0.57	5.000	6.80	3.10	22.00
Maximum Depth > = 25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1.00	1.00	1.000	1.00	1.00	1.00
GROUP 9	MIN	26.20	6662000.00	3.90	0.19	0.500	5.70	-0.10	21.20
Volume = 5,000,000 - < 50,000,000 m3	MAX	40.00	30024500.00	11.60	2.56	7.000	7.10	12.90	64.60
Maximum Depth > = 25 m	MEAN	30.88	15838800.00	7.77	1.45	3.800	6.43	4.21	34.24
	MEDIAN	30.35	12814250.00	7.50	1.27	4.000	6.40	2.90	30.20
	COUNT	10.00	10.00	9.00	10.00	10.000	9.00	9.00	8.00
GROUP 10	MIN	25.00	57503000.00	3.20	1.42	2.000	6.30	3.20	30.40
Volume = > 50,000,000 m3	MAX	55.50	2375841000.00	10.30	3.95	8.000	7.40	16.80	78.90
Maximum Depth > = 25 m	MEAN	41.04	348659833.33	7.34	2.39	4.958	6.94	7.09	50.19
	MEDIAN	43.00	187598500.00	8.50	2.02	4.500	6.90	6.40	45.50
	COUNT	12.00	12.00	12.00	12.00	12.000	11.00	11.00	11.00

DES LAKE ASSESSMENT PROGRAM SUMMER HYPOLIMNION CHEMICAL CHARACTERISTICS (page 1 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 1	MIN	1.70	11000.00	0.5000	4.70	-0.80	15.20
Volume = 1 - < 100,000 m3	MAX	9.80	99000.00	98.0000	8.80	85.00	458.00
Maximum Depth = 0 - <10 m	MEAN	4.29	65192.07	20.8110	6.18	8.06	56.87
	MEDIAN	3.95	67000.00	17.0000	6.20	4.70	31.40
	COUNT	82.00	82.00	82.0000	82.00	82.00	82.00
GROUP 2	MIN	2.20	100000.00	0.5000	4.30	-3.40	14.60
Volume = 100,000 - < 5,000,000 m3	MAX	9.90	4696000.00	217.0000	8.10	116.60	1419.00
Maximum Depth = 0 - <10 m	MEAN	5.73	731873.56	21.5754	6.28	7.67	75.35
	MEDIAN	5.80	374000.00	15.5000	6.30	5.30	41.78
	COUNT	382.00	382.00	378.0000	377.00	372.00	371.00
GROUP 3	MIN	4.90	5042000.00	0.5000	5.60	1.50	35.00
Volume = 5,000,000 < 50,000,000 m3	MAX	9.70	43191500.00	72.0000	6.90	30.10	96.70
Maximum Depth = 0 - <10 m	MEAN	7.97	11997600.00	29.2500	6.28	8.46	52.68
	MEDIAN	7.80	8290750.00	17.5000	6.30	4.80	42.03
	COUNT	10.00	10.00	10.0000	10.00	10.00	10.00
GROUP 4	MIN	10.30	86000.00	27.0000	5.90	7.90	30.00
Volume = 1 - < 100,000 m3	MAX	10.30	86000.00	27.0000	5.90	7.90	30.00
Maximum Depth = 10 - <25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1	1.00	1.00	1.00
GROUP 5	MIN	10.00	123000.00	0.5000	5.20	0.20	16.12
Volume= 100,000 - < 5,000,000 m3	MAX	24.40	4951000.00	247.0000	7.00	39.30	286.00
Maximum Depth = 10 - < 25 m	MEAN	14.37	1925306.03	20.0776	6.10	7.63	56.77
	MEDIAN	13.60	1606750.00	13.0000	6.10	5.70	39.30
	COUNT	116.00	116.00	116.0000	114.00	113.00	115.00

DES LAKE ASSESSMENT PROGRAM SUMMER HYPOLIMNION CHEMICAL CHARACTERISTICS (page 2 of 2)

Volume and Maximum Depth Category	Statistical Parameter	Maximum Depth (m)	Volume (m3)	Total Phos. (ug/L)	pH (units)	Alkalinity (mg/L)	Conductivity (uMhos/cm)
GROUP 6	MIN	10.10	5029000.00	2.5000	5.30	0.80	20.43
Volume = 5,000,000 - < 50,000,000 m3	MAX	24.40	45548000.00	79.0000	7.10	36.30	339.00
Maximum Depth = 10 - <25 m	MEAN	17.21	13544487.50	14.8125	6.19	7.86	70.05
	MEDIAN	16.65	9288000.00	11.0000	6.20	6.50	50.10
	COUNT	40.00	40.00	40.0000	40.00	40.00	37.00
GROUP 7	MIN	14.60	54285000.00	2.0000	6.00	3.50	29.17
Volume = >= 50,000,000 m3	MAX	18.50	120736500.00	8.0000	6.50	5.50	133.30
Maximum Depth = 10 - <25 m	MEAN	16.17	94481000.00	5.6667	6.27	4.37	68.31
	MEDIAN	15.40	108421500.00	7.0000	6.30	4.10	42.47
	COUNT	3.00	3.00	3.0000	3.00	3.00	3.00
GROUP 8	MIN	29.6	2313500	6.000	6.20	6.20	29.10
Volume = 100,000 - < 5,000,000 m3	MAX	29.6	2313500	6.000	6.20	6.20	29.10
Maximum Depth > = 25 m	MEAN	N/A	N/A	N/A	N/A	N/A	N/A
	MEDIAN	N/A	N/A	N/A	N/A	N/A	N/A
	COUNT	1.00	1.00	1	1.00	1.00	1.00
GROUP 9	MIN	26.20	6662000.00	0.5000	5.40	0.90	20.50
Volume = 5,000,000 - < 50,000,000 m3	MAX	40.00	30024500.00	25.0000	6.60	11.80	91.00
Maximum Depth > = 25 m	MEAN	30.88	15838800.00	6.6500	6.08	4.20	41.46
	MEDIAN	30.35	12814250.00	5.5000	6.10	3.60	35.70
	COUNT	10.00	10.00	10.0000	10.00	10.00	9.00
GROUP 10	MIN	25.00	57503000.00	1.0000	5.80	3.30	31.60
Volume = > 50,000,000 m3	MAX	55.50	2375841000.00	27.0000	7.00	9.70	77.90
Maximum Depth > = 25 m	MEAN	41.04	348659833.33	8.9167	6.36	6.37	48.26
	MEDIAN	43.00	187598500.00	7.0000	6.40	6.30	42.40
	COUNT	12.00	12.00	12.0000	12.00	12.00	12.00

2005 VLAP LAKES: SIMILAR GROUPINGS BASED ON LAKE VOLUME AND MAXIMUM DEPTH

Maximum Depth Category Breakpoints = 0-10 m; 10-25 m; >= 25 meters
Volume Category Breakpoints = 1-100,000 m3; 100,000 - 5,000,000 m3; 5,000,000-50,000,000 m3; >50,000,000 m3

GROUP 1
Volume = 1 - < 100,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
BRENTWOOD MITIGATION WL	BRENTWOOD	3					
DORRS POND	MANCHESTER	2.9	1.3	92000	7.12	596	31.2
HOUSTON (HARANTIS) POND	CHESTER	2.6	1.2	94000	8.13	588	32.5
MARSH POND	CHICHESTER	1.8					
MAXWELL POND	MANCHESTER	4	0.4	12900	2.22	608	217
MCQUESTEN POND	MANCHESTER	0.5					
MILL POND	STRATHAM	2.5					
PRATT POND	NEW IPSWICH	8.9		71000	15.58	113.2	9.1
SEAVEY POND	WINDHAM	2.5	0.8	34500	4.37	1482.9	202.5

GROUP 2
Volume = 100,000 - < 5,000,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
ARMINGTON LAKE	PIERMONT	9.7	3.7	2125500	57.55	553.6	1.7
ASHUELOT POND	WASHINGTON	7.8	1.8	2229500	121.2	6475	16.2
AYERS POND	BARRINGTON	9.1	4.4	4030500	92.11	804.1	1
BAPTIST POND	SPRINGFIELD	7.5	2.4	972500	40.02	673.4	3.7
BAXTER LAKE	FARMINGTON	4.6	2.1	2452500	119.34	987.1	1.9
BEARCAMP POND	SANDWICH	9.2	2.7	1769500	67.58	3108	8.5
CANAAN STREET LAKE	CANAAN	6.7	3.4	4146500	122.62	635.6	0.7
CAPTAIN POND	SALEM	8.6	2.5	874000	36.54	388.5	2.1
CENTER POND	STODDARD	8.5	3.9	1354500	34.4	466.2	2.1
CHALK POND	NEWBURY	3.6	2	166500	8.5	137.3	4.6
CHASE POND	WILMOT	3.4	1.9	296000	15.78	3643.1	62.5
CHESTNUT POND	EPSOM	7	3.4	420000	12.26	62.2	0.8
CLOUGH POND	BELMONT	6.4	3.7	165500	4.49	27.4	0.7
COLD (COLE) POND	ANDOVER	5.5	2.4	141500	5.99	298.5	10.7
CONTENTION POND	HILLSBOROUGH	9.9	5.7	2168500	38.28	802.9	2.2
CONTOOCOOK LAKE	JAFFREY	6.4	2.2	1944000	153.78	2382.8	6.8
CRESCENT LAKE	ACWORTH	7.3	3.2	1526500	47.02	1183.6	3.7
CRYSTAL LAKE	MANCHESTER	6.4	2.9	217000	7.53	81	1.8
DUTCHMAN POND	SPRINGFIELD	3	1.9	210000	11.29	46.3	1.4
EASTMAN POND	GRANTHAM	9.2	3	4066500	135.57	1985.8	2.1
FOREST LAKE	WINCHESTER	9.8	4.7	1653000	35.21	1813	5
FOREST LAKE	WHITEFIELD	6.4	3	2318000	77.58	505.9	1
FROST POND	JAFFREY	3.7	2.1	889500	41.8	126.9	0.8
GOVERNORS LAKE	RAYMOND	3	1.9	394000	21.12	275.1	3.4
HALFMOON LAKE	ALTON	8.2	4.4	4545000	102.38	1761.2	2
HALFMOON POND	WASHINGTON	5.8	2.6	856000	33.39	2002	16.6
HARVEY LAKE	NORTHWOOD	6.1	3.1	1320500	42.49	628.4	2.7
HAUNTED (SCOBIE) LAKE	FRANCESTOWN	5.2	2.4	1361500	69.08	1528.1	5.4
ISLAND POND	STODDARD	5.5	2.4	1529500	63.94	8852.1	353
IVANHOE, LAKE (ROUND POND)	WAKEFIELD	6.1	3.6	1809000	27.52	160.6	0.5
JENNESS POND	NORTHWOOD	8.5	2.7	2535500	94.09	743.3	1.6
KATHERINE, LAKE	PIERMONT	6.4	3.5	528000	15.01	212.4	2
KEZAR LAKE	SUTTON	8.2	2.7	1975500	73.49	2771.3	8.2
KILTON POND	GRAFTON	3.1	1.2	318500	27.52	1813	34.7
KOLELEMOOK LAKE	SPRINGFIELD	6.7	4.1	1623000	40.02	246.9	0.9
LEDGE POND	SUNAPEE	5.2	2.8	1233000	44.56	338	1.3
LOON LAKE	PLYMOUTH	8.8	3.9	1784500	45.28	906.5	2.6
MARTIN MEADOW POND	LANCASTER	9.1	4.1	1954000	47.75	388.5	0.9
MAY POND	WASHINGTON	7.6	2.4	1467700	60.3	1528	6.9
MEETINGHOUSE POND	MARLBOROUGH	3	1.3	318000	24.04	194.2	3.2
MELENDY POND	BROOKLINE	6.8	2.7	180000	6.76	82.9	2.2
MESSER POND	NEW LONDON	7.6	2.6	704000	26.99	569.8	4.7
MOUNTAIN LAKE, LOWER	HAVERHILL	7.7	3.8	917000	24.28	938.2	4.1
MOUNTAIN LAKE, UPPER	HAVERHILL	5.4	2.5	232500	12.14	872	17.1

GROUP 2 (CONTINUED)
Volume = 100,000 - < 5,000,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
MOUNTAINVIEW LAKE	SUNAPEE	6.7	4.1	1758000	42.41	336.7	1
NEW POND	CANTERBURY	3	1.4	167000	11.7	40.9	1.1
NUTT POND	MANCHESTER	9.2	4	260500	6.52	168	3.1
ONWAY LAKE	RAYMOND	8.9	3.2	2509000	77.7	2374.3	4.6
OTTER POND	SUNAPEE	7.6	4	3000500	74.87	4491.2	7.6
OTTERNICK POND	HUDSON	3.7	1.9	261500	13.76	1113.7	20.5
PEARLY LAKE	RINDGE	5.4	2	1156000	57.55	1036	5.2
PEMIGEWASSET LAKE	MEREDITH	8.8	2.4	2329500	97.61	1346.8	2.8
PERKINS POND	SUNAPEE	3	1.4	877000	63.54	284.9	1.3
PILLSBURY LAKE	WEBSTER	3	1.4	263500	18.21	2247.8	36.8
PINE ISLAND POND	MANCHESTER	3	1.5	265000	17.16	17889.2	326
PLEASANT POND	FRANCESTOWN	6.4	3.2	2394000	75.68	425.8	0.9
POOL POND	RINDGE	4.1	2.4	1175500	48.16	1113.7	5.5
POTANIPO POND	BROOKLINE	7.6	4.1	2823000	68.8	6267.8	10.7
POWWOW POND	KINGSTON	3.2	1.3	1296000	99.76	8158.5	30.3
RAND POND	GOSHEN	8.2	3.4	534000	15.66	132.1	1.4
ROBINSON POND	HUDSON	9	3.3	1189000	35.61	336.7	1.3
ROCK POND	WINDHAM	8.2	3	418500	14	172	2.5
ROCKWOOD POND	FITZWILLIAM	6.7	3.2	989500	30.76	336.7	1.8
ROCKYBOUND POND	CROYDON	9.1	4.5	1166500	26.14	214.2	0.7
RUSSELL RESERVOIR	HARRISVILLE	4.7	1.6	170000	10.52	2845.4	93.5
SEBBINS POND	BEDFORD	7	3.4	273500	8.01	90.6	1.6
SHELLCAMP POND	GILMANTON	4.9	1.6	950000	60.22	830.3	4.7
SHOWELL POND	SANDOWN	7.2	3.1	235500	8.09	62.2	1.2
SKATUTAKEE, LAKE	HARRISVILLE	6.2	2.9	3044500	105.58	4532.5	8.3
SONDOGARDY POND	NORTHFIELD	4.9	2.7	443000	16.51	1139.6	11.1
STEVENS POND	MANCHESTER	5.2	2.8	176000	6.27	180	4.9
STOCKER POND	GRANTHAM	5.8	2.7	697000	25.7	507.1	3.5
SUNCOOK POND, LOWER	BARNSTEAD	4.9	2.9	2916500	99.27	14193.1	22.2
SUNRISE LAKE	MIDDLETON	4.1	1.9	1966000	103.96	854.7	2
THORNDIKE POND	JAFFREY	7	3.4	3513500	107.24	1036	1.7
TODD LAKE	NEWBURY	6.1	2.2	1466500	68.07	155.4	0.5
TOLMAN POND	NELSON	3.9	2.4	364000	15.5	120.6	1.9
TOM POND	WARNER	4.1	2.5	314000	12.75	243.3	3.5
TUCKER POND	SALISBURY	6.7	2	449500	22.9	196.8	2.1
WARREN LAKE	ALSTEAD	4.2	2.2	1671000	75.07	1309.9	3.8
WAUKEENA LAKE	DANBURY	6.1	1.2	276500	21.29	114	2.5

GROUP 3
Volume = 5,000,000 < 50,000,000 m3
Maximum Depth = 0 - <10 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
FRENCH POND	HAVERHILL	7.8	3.5	43191500	12.54	310.8	2.9
HIGHLAND LAKE	STODDARD	9.6	2.4	6971500	288.14	7692.3	7
MONOMONAC, LAKE	RINDGE	7.8	2.8	8093500	287.78	5037.7	3.6
NORTHWOOD LAKE	NORTHWOOD	6.3	3.1	8488000	277.99	6225.9	3.9
PROVINCE LAKE	EFFINGHAM	4.9	2.8	11268500	410.37	1890.7	1

GROUP 4
Volume = 1 - < 100,000 m3
Maximum Depth = 10 - <25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)

GROUP 5
Volume= 100,000 - < 5,000,000 m3
Maximum Depth = 10 - < 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
ANGLE POND	SANDOWN	11.6	3	1924500	60.7	611.4	1.5
BEAVER LAKE	DERRY	14	5	2707500	54.07	2331	4.1
BEECH POND, LOWER	TUFTONBORO	15.2	6.8	4250500	62.73	647.5	0.8
BERRY BAY	FREEDOM	11.6	3.7	2147000	58.85	93211.8	254
BLAISDELL LAKE	SUTTON	13.1	5.4	3479500	64.06	181.3	0.3
CLEMENT POND	HOPKINTON	15.5	6.6	3153500	48.04	619	0.9
DANFORTH POND, LOWER	FREEDOM	16.8	7.1	918500	12.91	4765.6	31.6
DEERING RESERVOIR	DEERING	11.3	3.5	4442500	127.64	1139.6	1.3
FRENCH POND	HENNIKER	11.8	4.3	727500	16.79	196.7	1.2
GILMORE POND	JAFFREY	13.1	3.7	1736500	46.54	120.9	0.4
GOULD POND	HILLSBOROUGH	11.1	5.7	1113000	19.5	2590	11.8
GREAT POND	KINGSTON	16.2	4.5	3700500	82.56	2175.6	2.6
GREGG LAKE	ANTRIM	11	5.3	4199000	78.95	1191.4	1.6
HARRISVILLE POND	HARRISVILLE	12.5	4.7	2264500	48.56	3263.4	8.4
HERMIT LAKE	SANBORNTON	15.2	2.5	1756000	71.26	1504.6	4.2
HIGHLAND LAKE	ANDOVER	13.4	5	4278500	85.39	1320.9	1.5
HILLS POND	ALTON	12.8	5.5	3054000	55.68	595.7	1
ISLAND POND	WASHINGTON	16.8	5.6	4574000	81.83	647.5	1
KNOWLES POND	NORTHFIELD	17	5.8	1396500	24.28	147.6	0.6
LAUREL LAKE	FITZWILLIAM	13.4	6.1	3826000	62.73	310.8	0.4
LEAVITT BAY	OSSIPEE	12.8	3.4	2429000	71.31	92010	221.3
LEES POND	MOULTONBORO	11.3	3.7	2675000	72.56	7148.4	12.9
LONG POND	LEMPSTER	20.3	6	2955500	48.56	466.9	0.9
LOON POND	GILMANTON	13.6	7	3436000	49.05	440.3	0.6
MILLEN POND	WASHINGTON	12.6	5	3185500	63.13	336.7	0.7
PARTRIDGE LAKE	LITTLETON	15.2	5.8	2434000	42.05	362.6	0.6
PEA PORRIDGE POND, BIG	MADISON	13.7	4	2295500	57.54	579.2	1.5
PEA PORRIDGE POND, MIDDLE	MADISON	13.4	4.7	831500	17.52	751.1	5.3
PEQUAWKET POND	CONWAY	16.5	3.9	2236500	57.79	7096.6	18.5
POST POND	LYME	11.6	7	3132500	45.04	3367	4.4
RESERVOIR POND	DORCHESTER	13.7	3.8	1728000	44.92	117	0.4
SAND POND	MARLOW	21.6	6.2	3977500	64.38	334.7	0.5
STONE POND	MARLBOROUGH	14.6	6	1570500	26.26	284.9	1
SUNSET LAKE	ALTON	23.7	5.6	4651000	82.96	1456	1.7
SWANZEY LAKE	SWANZEY	16.2	6.9	3271500	47.35	414.4	0.6
WHITE OAK POND	HOLDERNESS	10.7	4	4697500	117.76	1217.3	1.3
WINONA, LAKE	NEW HAMPTON	14.6	6.6	4149000	62.45	1346.8	1.6

GROUP 6
Volume = 5,000,000 - < 50,000,000 m3
Maximum Depth = 10 - <25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
BROAD BAY	OSSIPEE	22.3	8.3	15573500	187.7	90826.3	34.1
CANOBIE LAKE	WINDHAM	15.2	5.5	8379000	151.11	569.8	0.3
COBBETTS POND	WINDHAM	19.2	5.2	7208000	139.5	828.8	0.4
CRYSTAL LAKE	GILMANTON	16.2	5	8998500	178.42	7133.6	3.8
ISLAND POND	DERRY	24.3	5.4	11558000	201.49	4403	1.8
MASCOMA LAKE	ENFIELD	20.1	8.7	39458000	451.18	39627	4.6
MASSASECUM, LAKE	BRADFORD	15.2	3.9	6420000	162.56	2446	1.9
PAWTUCKAWAY LAKE	NOTTINGHAM	15.2	2.9	10740000	364.22	5361.3	2.3
PINE RIVER POND	WAKEFIELD	16.8	3.7	9000000	240.38	3367	2.1
PLEASANT LAKE	DEERFIELD	19.8	7	13995000	199.71	906.5	0.4
RUST POND	WOLFEBORO	12.2	7.4	6310500	84.98	668.2	0.6
SPOFFORD LAKE	CHESTERFIELD	19.5	9.1	26020500	286.03	1165.5	0.2
STINSON LAKE	RUMNEY	23.5	10.7	14827500	141.64	1921.1	0.9
SUNAPEE LAKE, LITTLE	NEW LONDON	13.1	4.4	8449500	191.01	1605.8	1.1
SUNCOOK POND, UPPER	BARNSTEAD	13.1	5.6	7895000	140.26	12975.8	7.5
TARLETON, LAKE	PIERMONT	20	8.5	10881500	127.64	1945.5	1.1
WAUKEWAN, LAKE	MEREDITH	21.4	6.7	24809000	369.36	3056	0.6
WEBSTER LAKE	FRANKLIN	11.8	5.5	13586500	247.75	4506.6	1.5
WICWAS LAKE	MEREDITH	10.9	3.9	5110500	132.62	2149.7	2
WINNEPOCKET, LAKE	WEBSTER	20.4	5.8	5315500	91.82	699.3	0.6

GROUP 7
Volume = >= 50,000,000 m3
Maximum Depth = 10 - <25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
OSSIPEE LAKE	OSSIPEE	18.5	8.5	108,421,500	1251.25	84822.1	4.6

GROUP 8

Volume = 100,000 - < 5,000,000 m3
Maximum Depth > = 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)

GROUP 9
Volume = 5,000,000 - < 50,000,000 m3
Maximum Depth > = 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
GRANITE LAKE	STODDARD	28.9	9.8	9027000	92.19	984.2	0.7
NUBANUSIT LAKE	NELSON	30.2	11.5	30024500	289.35	2097.9	0.4
PLEASANT LAKE	NEW LONDON	28.6	10.5	25761000	245.2	3030.3	0.7
SILVER LAKE	HARRISVILLE	26.2	10.4	13878500	134.64	569.8	0.2

GROUP 10
Volume = > 50,000,000 m3
Maximum Depth > = 25 m

LAKE	TOWN	MAX DEPTH (m)	MEAN DEPTH (m)	VOLUME (m3)	AREA (hectare)	WATERSHED AREA (hectare)	FLUSHRATE (/yr)
SUNAPEE LAKE	SUNAPEE	31.9	11.4	188150000	1655.22	11680.8	0.3
WINNISQUAM, LAKE	LACONIA	53	15.2	262306500	1725.7	118028.7	2.2