APPENDIX A

ABBREVIATIONS & AGENCY ACRONYMS

ABBREVIATIONS & AGENCY ACRONYMS

AMC	Appalachian Mountain Club
ANC	Acid Neutralizing Capacity
CFS	Cubic Feet per Second
CNHRPC	Central New Hampshire Regional Planning Commission
CSWW	Cogswell Springs Water Works
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HCC	Henniker Conservation Commission
H-E FCR	Hopkinton-Everett Flood Control Reservoir
NEC	New England College
NH DES	New Hampshire Department of Environmental Services
NH DRED	New Hampshire Department of Resources and Economic Development
NH F&G	New Hampshire Department of Fish and Game
NRI	Natural Resources Inventory
NWIS	National Wetlands Inventory and Survey
PEM	Palustrine Emergent
PFO	Palustrine Forested
PSS	Palustrine Scrub-Shrub
SNE	Southern New England
SPNHF	Society for the Protection of New Hampshire Forests
UNH	University of New Hampshire
US EPA	United States Environmental Protection Agency
USDA NRCS	United States Department of Agriculture Natural Resources Conservation Service
USGS	United States Geological Survey
VLAP	Volunteer Lake Assessment Program

APPENDIX B

RESOURCES

RESOURCES

The following references contain information relevant to local natural resource conservation and conservation planning, general and specific to the Town of Henniker.

Adams, Lowell W. and Louise E. Dove. 1989. *Wildlife Reserves and Corridors in the Urban Environment: A Guide to Ecological Landscape Planning and Resource Conservation.* National Institute for Urban Wildlife. Columbia, MD. 91 pp.

Allee, David J. 1991. Environmental protection through land use controls. March, 1991. Cornell Agricultural Economics Staff Paper 91-5. Cornell University. Department of Agricultural Economics. Ithaca, NY. 9 pp.

Ammann, Alan P. and Amanda L. Stone. 1991. *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire*. State of New Hampshire. Department of Environmental Services. Concord, NH.

Auger, Phil, et. al., revised Amanda Lindley Stone. 2001. *Natural Resources Inventories: A Guide for New Hampshire Communities and Conservation Groups.* UNH Cooperative Extension. Durham, NH. 132 pp.

Aurelia, Michael A. 1989. "How to Protect Freshwater Wetlands and River Corridors at the Local Level." In *Proceedings of the International Wetland Symposium: Wetlands and River Corridor Management*. Association of State Wetland Managers.

Central New Hampshire Regional Planning Commission. 1974. Natural Resources Inventory. CNHRPC. Concord, NH. 131 pp.

-----. 1980. Open Space and Recreation Plan. CNHRPC. Concord, NH. 46 pp.

-----. 1991. Regional Master Plan: Land Use Element. CNHRPC. Concord, NH. 16 pp.

-----. 1999. Natural, Cultural, and Historical Resources Inventory of the Central New Hampshire Region (1998, with 1999 revisions). CNHRPC. Concord, NH. 483 pp.

-----. 1999. Town of Henniker Open Space Trail System. CNHRPC. Concord, NH. 133 pp.

Doppelt, Bob, Mary Scurlock, Chris Frissell, James Carr. 1993. *Entering the Watershed: A New Approach to Save America's River Ecosystems*. The Pacific Rivers Council. Island Press. Washington DC.

Federal Interagency Floodplain Management Task Force. 1996. *Protecting Floodplain Resources: A Guidebook for Communities*. Federal Emergency Management Agency. Washington, DC. 41pp.

Great Lakes Basin Commission. Undated. *The role of vegetation in shoreline management*. Great Lakes Basin Commission. Available from U.S. Army Corps of Engineers. North Central Division. Chicago, IL. 32 pp.

Harte, Philip T. and William Johnson. 1995. Geohydrology and water quality of stratified-drift aquifers in the Contoocook River Basin, south-central New Hampshire. Water Resources Investigations Report 92-4154. US Geological Survey, Bow, NH. 71 pp., appendices.

Henniker (Town of). 1988. Henniker Master Plan: Conservation and Preservation Element. Henniker, NH.

-----. 1988. Henniker Master Plan: Land Use Element. Henniker, NH.

-----. 1988. Henniker Master Plan: Recreation Element. Henniker, NH.

-----. 1988. Henniker Master Plan: Transportation Element. Henniker, NH.

-----. 1989. Water Resource Management and Protection Plan. Henniker, NH.

Henniker Trails Steering Committee and Central New Hampshire Regional Planning Commission. 1999. *Open Space Trail System Plan (July 1999)*. Henniker, NH. 125pp.

Hudson, Wendy E., ed. 1991. *Landscape Linkages and Biodiversity*. Defenders of Wildlife. Island Press. Washington, DC.

Kanter, John, Rebecca Suomala, and Ellen Snyder. 2001. *Identifying and Protecting New Hampshire's Significant Wildlife Habitat: A Guide for Towns and Conservation Groups*. NH Fish & Game. Concord, NH. 144 pp.

Knopf, Fritz L. 1992. Cautions about conservation corridors. U.S. Department of the Interior. Fish and Wildlife Service. Research Information Bulletin No. 94.

Kusler, Jon and Rutherford Platt. 1988. Common legal questions pertaining to the use of floodplains and wetlands. Madison, WI.

Multi-Objective River Corridor Planning. Proceedings of The Urban Stream Corridor and Stormwater Management Workshop, March 14-16, 1989, Colorado Springs, and or The Multi-Objective Management of River Corridors and Their Restoration Workshop, March 21-23, 1989, Knoxville, TN.

NH Department of Environmental Services. 2000. 305(b) Water Quality Report to Congress. DES. Concord, NH.

NH Department of Fish & Game. Fishing Access in NH. Posted online at <http://wildlife.state.nh.us/>

-----. Fish Stocking Reports. Posted online at <http://wildlife.state.nh.us/>

NH Department of Revenue and Economic Development. 2001. NH Natural Heritage Inventory. DRED. Concord, NH.

NH Geographically Referenced and Information Transfer (GRANIT) System. 2000. University of NH Complex Systems. Durham, NH.

NH Office of State Planning. 1997. Comprehensive Statewide Trails Study. OSP. Concord, NH.

Profous, George. Unpublished draft. *Planning development along rivers*. October, 1994. New York State. Department of Environmental Conservation. New Paltz, NY.

Smith, Daniel S. and Paul Cawood Hellmund. 1993. *Ecology of Greenways: Design and Function of Linear Conservation Areas*. Univ. of Minnesota Press. Minneapolis, MN.

Thomas, Holly L. 1991. *The economic benefits of land conservation*. February, 1991. Technical Memo. Duchess County Planning Department. Poughkeepsie, NY. 4 pp.

USDA-Forest Service. 1991. *Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources*. U.S. Department of Agriculture. Forest Service. Northeastern Forest Experiment Station. Radnor, PA.

-----. 1993. *Riparian Management: Common Threads and Shared Interests. Albuquerque, NM. Feb. 4-6, 1993*. U.S. Department of Agriculture. Forest Service. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 419 pp.

-----. 1993. *Proceedings of the 1993 Northeastern Recreation Research Symposium. Saratoga Springs, NY. April 18-20, 1993*. U.S. Department of Agriculture. Forest Service. Northeastern Forest Experiment Station. Radnor, PA. 229 pp.

USDI-Fish and Wildlife Service. National Wetlands Inventory, 1986-1990.

USDI-National Park Service. Date unknown. *Tools & Strategies: Protecting the Landscape & Shaping Growth*. U.S. Department of the Interior. National Park Service and New York State Regional Planning Association. Washington, DC.

-----. 1991. *A Casebook in Managing Rivers for Multiple Uses*. October, 1991. U.S. Department of the Interior. National Park Service. Washington, DC. 79 pp.

-----. 1992. *Economic Impacts of Protecting Rivers, Trails and Greenway Corridors: A Resource Book.* U.S. Department of the Interior. National Park Service. Rivers, Trails and Conservation Assistance Program. Washington, DC. 95 pp. and appendices.

Venno, Sharri A. 1991. *Integrating Wildlife Habitat into Local Planning: A Handbook for Maine Communities.* Misc. Pub. 712. Maine Agricultural Experiment Station. University of Maine. Orono, ME. 54 pp.

APPENDIX C

PRIME FARMLAND & IMPORTANT AGRICULTURAL SOILS

PRIME FARMLAND & IMPORTANT AGRICULTURAL SOILS

Name	Prime Farmland	Statewide Important	Locally Important	Soil symbol
Occum	√			1, 401
Pootatuck	√[a]			4
Hinckley			√	12A, 12B, 12C
Colton			√	22A, 22B, 22C
Agawam	√			24A, 24B
Winsor			√	26A, 26B, 26C
Groveton	√	√	√	27A, 27C, 27D
Madawaska	√			28A
Woodbridge	√			29B
Champlain			√	35A, 35B, 35C
Canton		√	√	42B, 43B, 43C, 43D
Montauk	√	√	√	44B, 44C, 45B
Henniker	√	√	√	46B, 46C, 46D
Hermon			√	55B, 55C, 55D
Becket	√	√	√	56B, 56C, 56D, 57B, 57C, 57D
Paxton	√	√	√	66B, 66C, 66D, 67B, 67C, 67D
Berkshire			√	73B, 73C, 73D
Marlow	√	√	√	76B, 76C, 76D, 77,B, 77C, 77D
Ondawa	√[a]			101
Podunk	√[a]			104
Gloucester			√	111b, 111C
Monadnock		√	√	129B, 129C
Marlow variant	√	√	√	166B, 166C, 166D, 167B, 167C, 167D
Sunapee			√	169B, 169C
Winsor-Hollis complex			√	180B, 180C
Adams-Lyman complex			√	190B, 190C
Colton variant			√	220A, 220B, 220C
Bice			√	226B, 226C, 226D
Hermon variant			√	245B, 245C, 245D
Chatfield-Hollis-Montauk complex			√	250B, 250C
Sunapee variant			√	269B, 269C

Champlain-Woodstock complex			√	290B, 290C
Deerfield	√			313
Dixfield	√	√	√	378A, 378B, 378C, 379A, 379B, 379C
Tunbridge-Lyman-Becket complex			√	380B, 380C, 380D
Monadnock variant		√	√	442B, 442C, 443B, 443C, 443D
Scituate-Newfields complex	√		√	447B, 447C
Skerry variant	√	√	√	458B, 458C, 459A, 459B, 459C, 459D
Dixfield variant	√	√	√	478A, 478B, 478C, 479A, 479B, 479C
Tunbridge variant-Woodstock Henniker complex			√	480B, 480C
Ninigret	√			513A, 513B
Belgrade	√	√		532B, 532C
Skerry	√	√	√	558B, 558C, 559A, 559B, 559C, 559D
Croghan	√			613

[a] If protected from flooding or not frequently flooded during the growing season.

USDA NRCS data, with HCC updates 2002.

APPENDIX D

HENNIKER LAKE SURVEY FALL 2000 & FALL 2001 RESULTS

Henniker Lake Survey Fall 2000 and Fall 2001 Results

A survey of water quality of Henniker ponds was conducted in the fall of 2000 and 2001 as part of the Henniker Natural Resources Inventory, a project funded through town warrant articles. This report summarizes the results of the 2000 and 2001 surveys and compares the results with lakes and ponds that were sampled statewide in the NH Volunteer Lake Assessment Program (VLAP) in 2000.

The Henniker Lake Survey

Henniker ponds were sampled in late September 2000 and late October in 2001. All samples were collected by boat using standard techniques. Water samples were collected from 11 ponds (French Pond, Keyser Pond, Long Pond, Middle Pond, Upper Pond, Morrill Pond, Craney Pond, Colleague Pond, Mud Pond and two unnamed ponds) by members of the Conservation Commission, volunteers from Henniker, New England College students, and staff from New England College.

The ponds in Henniker range considerably in area and depth (Table 1). Long Pond has the largest area at 91.1 acres (0.37 km^2) and Blaisdell Pond has the smallest area at 2.2 acres (0.009 km^2). French Pond is the deepest pond at 40 feet (12.19 m) and the shallowest pond is Craney Rookery at 5 feet (1.5 m). The ponds in Henniker have been formed over time in two different ways. Morrill Pond, Middle Pond, Blaisdell Pond, Pleasant Pond, and Mud Pond 1 were formed in glacial kettle holes and are very deep at the center of the pond. The second type are ponds that have been dammed by either human or beaver activity. This includes Craney Pond, Craney Rookery, and French Pond.

Table 1. Characteristics of Henniker Ponds

Pond	Area (acres)	Area km^2	Watershed Area (km^2)	Maximum Depth (ft)	Maximum Depth (m)	Mean Depth (ft)	Mean Depth (m)	Sampled Depth (m)
Blaisdell Pond	2.2	0.009	1.28	11.5	3.51	6.6	2.01	–
Carr Pond	11(1.9)	0.045	--	11.5	3.51	6.6	4.00	–
Colleague Pond	7	0.028	2.204	23	7.01	13.1	4.00	4
Craney Pond	36.5	0.148	1.764	29.9	9.11	9.2	2.80	7.5
Craney Rookery	17.6	0.071	0.532	4.9	1.5	4.9	1.5	1.5
French Pond	38	0.154	0.945	40	12.19	14.1	4.30	11
Grassy Pond	13.4 (2.0)	0.054	--	17.7	5.39	13.1	3.99	–
Keyser Pond	17.6	0.071	2.044	18.4	5.61	9.8	2.99	8
Long Pond	91.1	0.369	14.841	20	6.10	7.9	2.41	3
Middle Pond	7.2	0.029	14.819	22.9	7.00	13.1	3.99	5.5
Morrill Pond	9.3	0.038	1.681	32.8	10.0	15.1	4.60	9
Mud Pond I	7.8	0.032	0.142	11.8	3.60	7.9	2.41	5.5
Mud Pond 2	10.8	0.044	3.752	20	6.10	15.1	4.60	1.7
Pleasant Pond	85.1	0.344	3.419	27.9	8.50	16.1	4.91	6.5
Upper Pond	26.7	0.108	14.03	20	6.10	10.8	3.29	3.75

CNHRPC 1998, with HCC updates 2000. Numbers in parentheses indicate area within Henniker.

Ponds were identified based on the name listed on the U.S. Geological Survey 7.5 minute topographic map for Henniker (Figure 1). Two ponds which do not have names listed on the map were included in the survey. Names were assigned to them as Craney Rookery and Mud Pond 2 (Figure 2). Craney Rookery is an unnamed pond located near Craney Hill that historically has been a site for heron nesting. Mud Pond 2 is an unnamed pond located near Mud Pond near Bennet Rd.

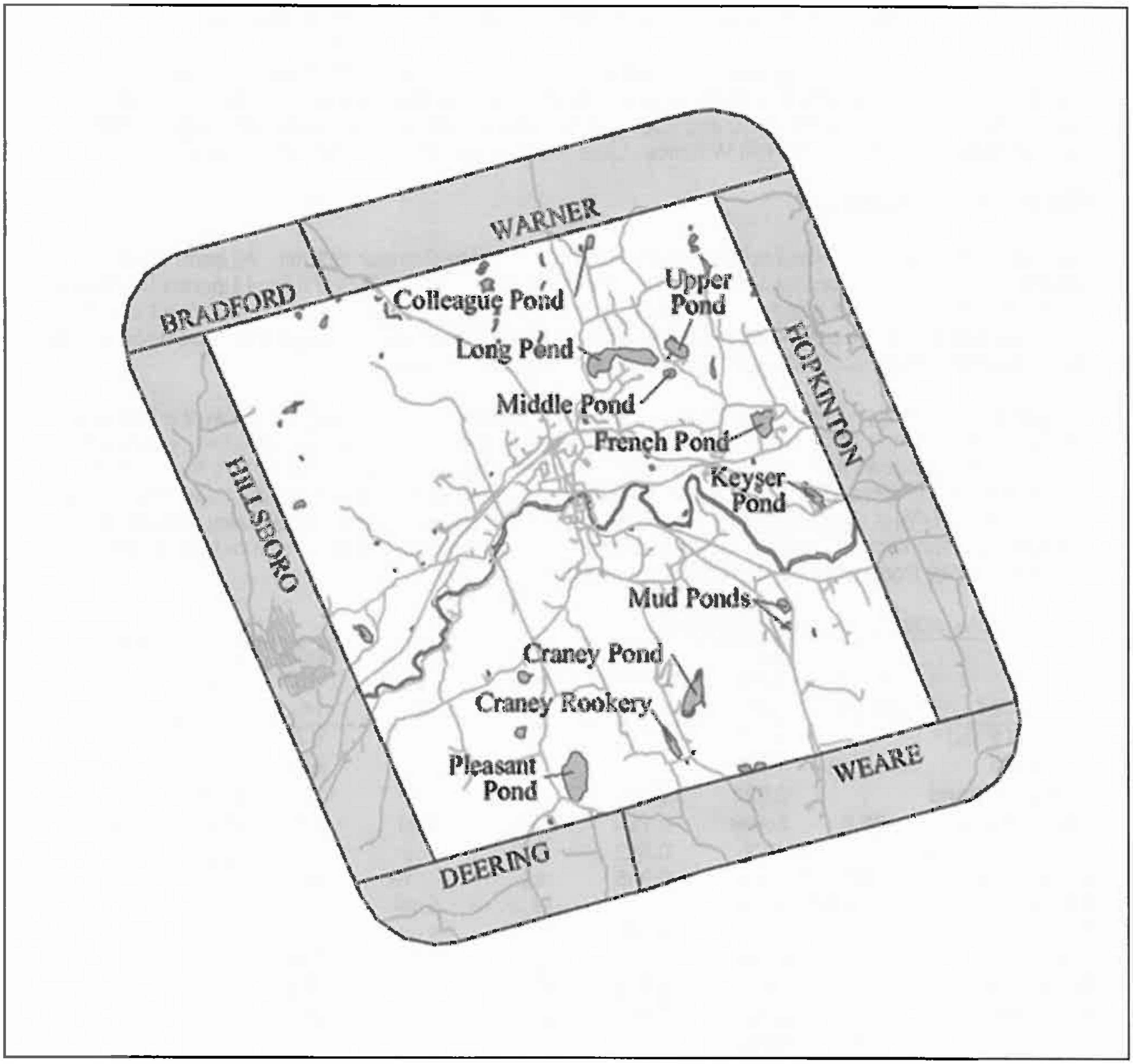


Figure 1. Location of Henniker Ponds Sampled in Fall, 2000 and Fall, 2001.

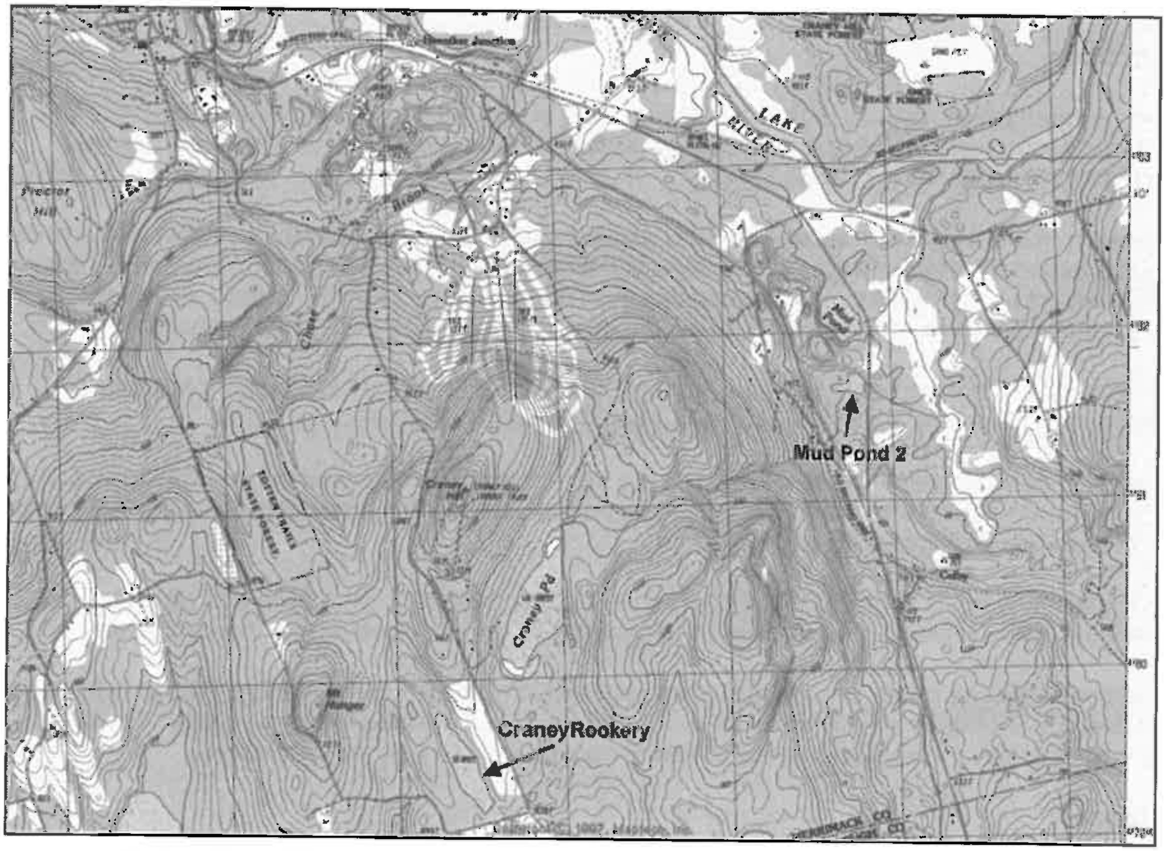


Figure 2. Location of Mud Pond 1 and Craney Rookery.

Study Design and Methods

All sampling was conducted following VLAP protocols (NHDES, 2000). The fall 2000 survey was conducted on September 16 and 17, 2000 and the fall 2001 survey was conducted on October 27 and 28, 2001.

Measurements were made at each pond for transparency, dissolved oxygen, and temperature. Samples were collected and analyzed for pH, alkalinity, turbidity, and specific conductivity at New England College. Additional samples were collected and analyzed for total phosphorus and chlorophyll-a by the NH Department of Environmental Services (DES) Limnology Center. The methods used are summarized in Table 2.

Table 2. Analytical Methods

Analytic	Matrix	Analytical Method
New England College Laboratory		
Conductivity	Water	2510B Standard Methods 20th Ed. 1998
Turbidity	Water	2130B Standard Methods 20th Ed. 1998
Alkalinity	Water	2320B Standard Methods 20th Ed. 1998
pH	Water	4500-H^{+}B Standard Methods 20th Ed. 1998
NHDES Limnology Center		
Chlorophyll A	Water	10200H Standard Methods 20th Ed. 1998
NHDES Lab		
Total Phosphorus	Water	EPA 365.1, NH DES Standard Operating Procedures and Protocols, 2000

Eutrophication

The term "eutrophication" is used to describe the impacts of high nutrient input to a lake or pond. The result can be an increase in undesirable biological activity such as algal blooms. Over time this may increase the rate of lake filling by sediment.

An increase in nutrient input can result from land use activity in the lake's watershed. In New Hampshire, phosphorus export from agricultural lands is at least 5 times greater than from forested lands and urban areas may export up to 10 times more phosphorus than forested land. (NHDES, 1995) Activities that influence eutrophication include use of fertilizers, malfunctioning septic systems, and erosion.

Trophic state is commonly used to describe nutrient status and biological production. Ponds can be categorized in three trophic groups: oligotrophic, mesotrophic, and eutrophic.

An oligotrophic pond indicates the nutrient inputs are low, the water is clear and there is little algal and rooted plant growth and little sediment accumulation on the bottom. Oligotrophic systems have high levels of dissolved oxygen throughout the year.

A mesotrophic pond tends to have measurable nutrient inputs, notable algal growth and sediment accumulation. These systems may also have brief periods of low dissolved oxygen concentrations.

Eutrophic ponds may be or are becoming shallow with a mucky bottom and abundant plant growth along the shoreline. Undesirable algal blooms may occur and result in low transparency or clarity. The bottom layers are likely to have prolonged periods of little or no dissolved oxygen concentrations.

Lake Turnover

As water temperature rises through spring and into summer, distinct temperature layers form in the lake/pond. Because water in the epilimnion is in continuous contact with the surface, it heats up as air temperature rises. The warmer surface water eventually forms a layer above a zone of colder water.

This process of forming distinct temperature zones is called thermal stratification (Figure 3). Cold water is denser than warm water and the surface and deeper waters will not mix because a density barrier forms between the cold and warmlayers preventing water in the hypolimnion from circulating to the surface.

The deeper, cooler hypolimnion water stays below the epilimnion. Water in the epilimnion tends to have higher oxygen levels due to aeration at the surface and oxygen production by aquatic plants that live in this zone. In lakes deeper than 2 meters, the hypolimnion will lose most of its oxygen because of decomposition of organic materials and the consumption of oxygen by aquatic animals. Little or no sunlight penetrates to the hypolimnion, so there are no oxygen-producing plants in this zone. As summer progresses, oxygen levels may become completely depleted.

The boundary between the warmer, upper water and the cold, bottom water is called the thermocline, the mesolimnion or the metalimnion. Water temperature and oxygen within this layer change dramatically from its upper to its lower levels. During the hot summer months, many sport fishes prefer the cool water in the thermocline, but they may not be able to live in this zone if oxygen levels are low.

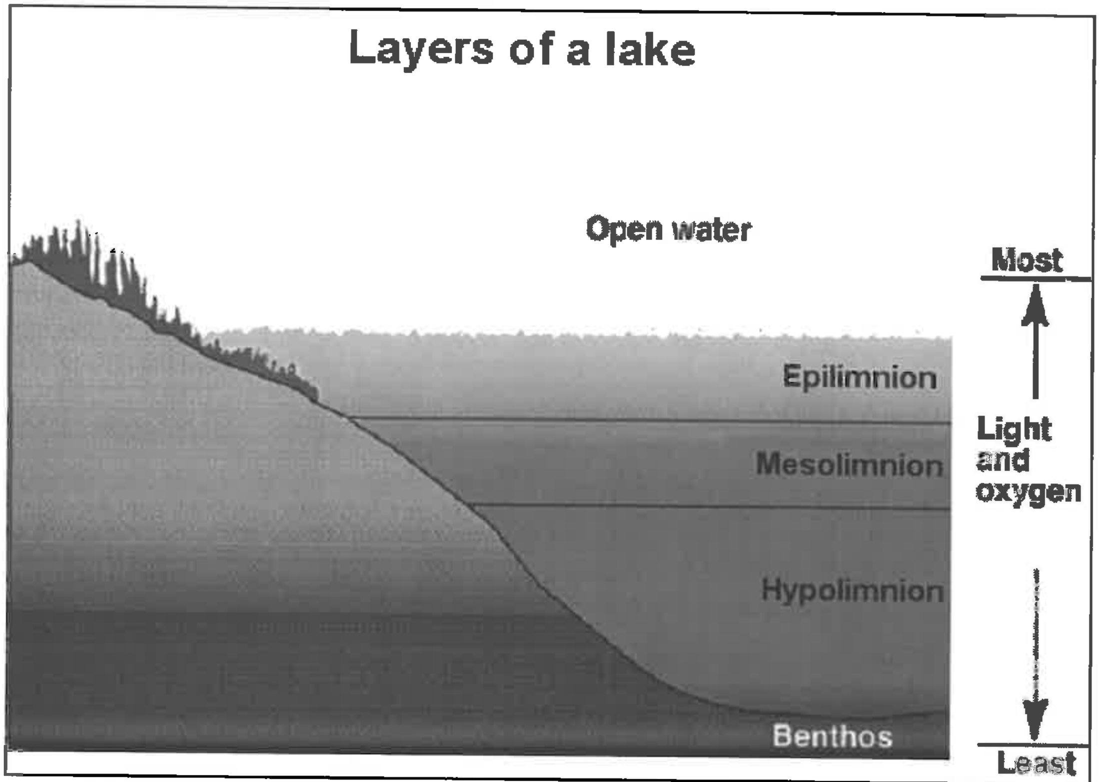


Figure 3. Layers of a Lake.

In the fall when surface water becomes less than 50 °F, the surface water is denser than the deeper water and sinks to the bottom of the pond (Figure 4). The downward movement of surface water causes the deeper water to rise. This seasonal temperature change and mixing of water is called "fall turnover". In some lakes, turnover can occur if the wind is strong enough to mix the waters. The result is a mixing of waters throughout the water column increasing oxygen levels in all layers. When the temperature is constant throughout the water column, the lake is considered to be "isothermal".

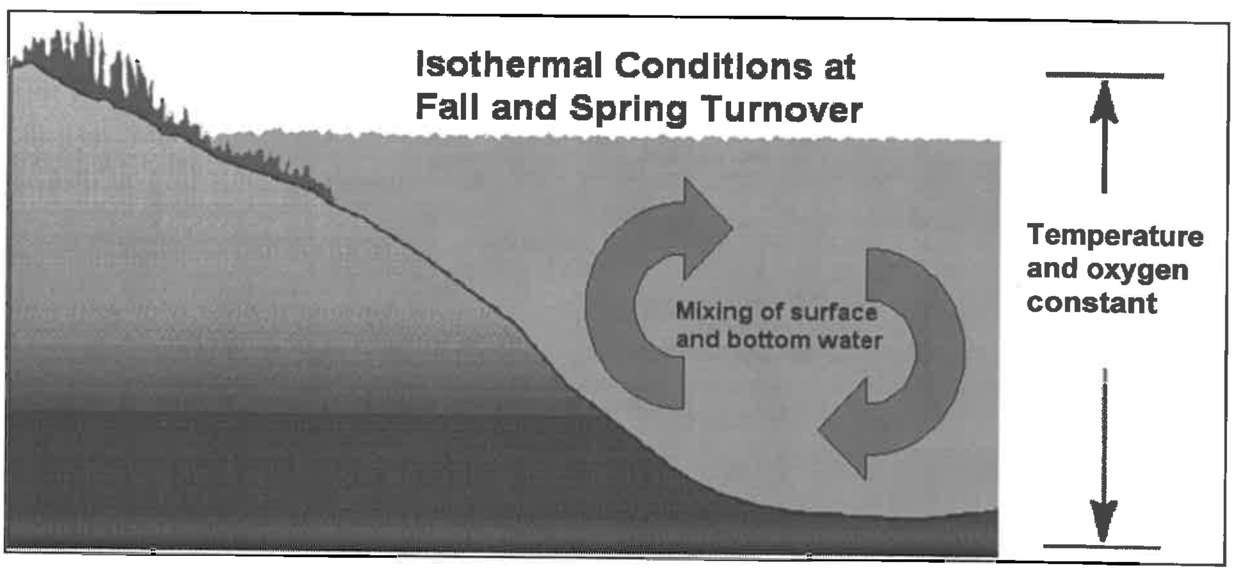


Figure 4. Lake/Pond Turnover.

When fall turnover occurs it is not uncommon for a sulfurous or rotten-egg odor to be present. This happens when trapped gas, produced during decomposition, is released to the atmosphere when the pond turns over. The water layers tend to stay uniform and well oxygenated during the winter. In spring just after the ice melts the surface water temperature is colder than the deeper water and sinks to the bottom displacing the deeper water. The result is another turnover of the water known as "spring turnover".

Every lake/pond has a similar turnover and stratification pattern from year to year. All lakes turn over, but not all of them become strongly stratified. Some shallow lakes contain warm water from the surface to the bottom, and even deep lakes do not significantly stratify if they are exposed to strong winds, which can continually circulate the water.

Comparison of Henniker Lakes with NHVLAP Lakes

The results of the Henniker survey is compared with the water chemistry of roughly 800 New Hampshire lakes sampled in the NHVLAP (New Hampshire Volunteer Lake Assessment Program) project in August 2000. The results of NHVLAP are summarized using the box plots (Figure 5). A box plot is a useful way to summarize a large amount of data. The distribution of the data is summarized with a box. The bottom of the box identifies the 25th percentile or the value at which 25 % of the data is equal to or less than. The top of the box identifies the value at which 75% of the data is equal to or less than. The line across the box between the top and the bottom is equal to value of the median or 50th percentile -- the value at which 50% of the data is equal to or less than. The value at the base of the vertical line that extends from the bottom of the box is equal to the 10th percentile and the value of the top of the vertical line that extends from the top of the box is the 90th percentile. The dot represents values that are greater than the 90th percentile or less than the 10th percentile. The dashed line that extends across the entire plot is equal to the average or mean value.

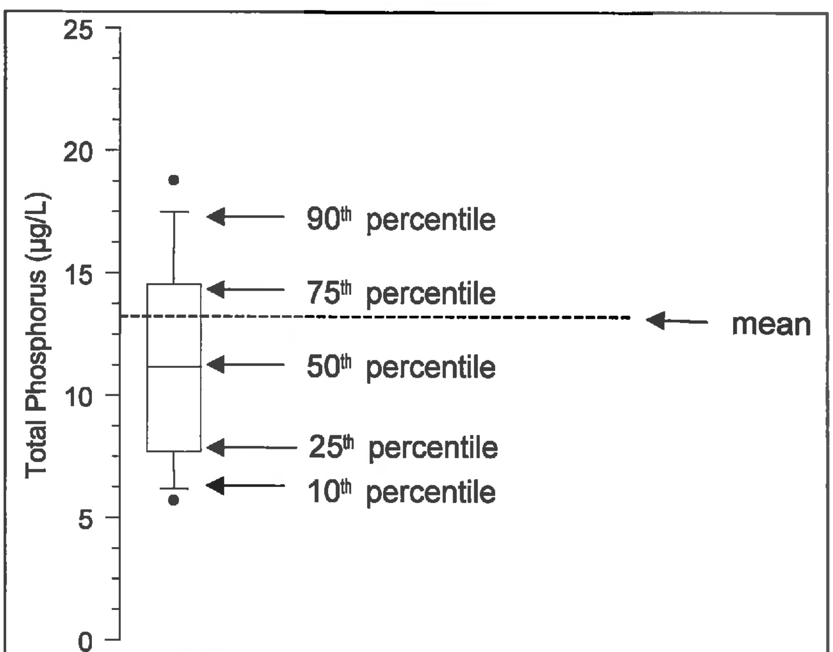


Figure 5. Explanation of Box Plots.

Survey Results

Temperature and Dissolved Oxygen Profiles

In the fall 2000 survey most of Henniker ponds were stratified by both temperature and dissolved oxygen (Figures 6 and 7). The ponds that were not stratified were less than 2 m deep and only a 1 meter sample was collected from the pond. In contrast, the fall 2001 survey was conducted a month later than when the Fall 2000 survey was conducted. The temperature profile data indicates that only two ponds were stratified at the time of sampling: French Pond and Morrill Pond. This is an important consideration because the influence that anaerobic (low oxygen concentrations) conditions have on water chemistry. Total phosphorus levels tend to be highest when the oxygen concentration is the lowest. Measurements of pH, alkalinity, specific conductivity, and turbidity are also likely to be different than when oxygen concentrations are high throughout the water column.

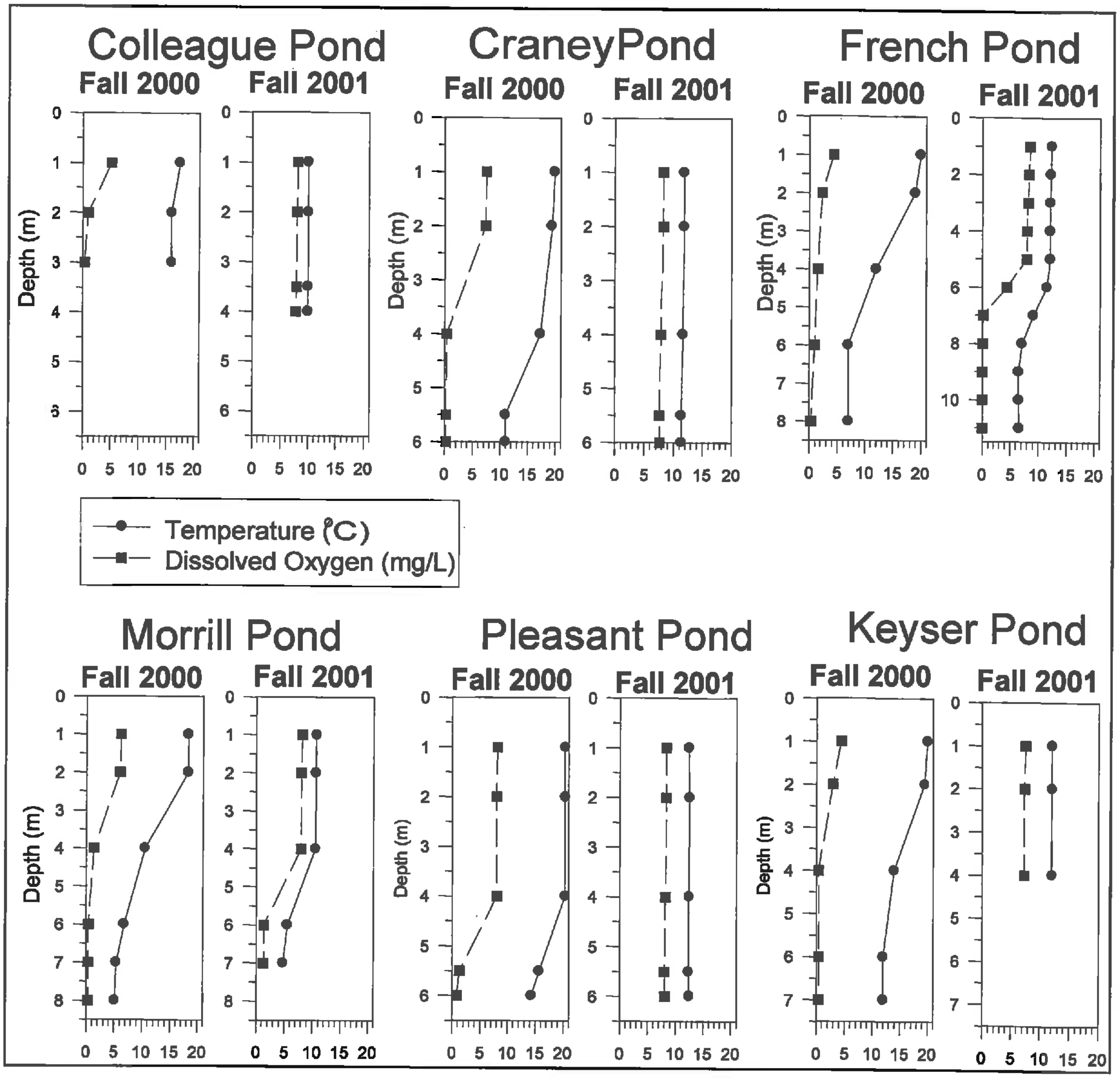


Figure 6. Temperature and Dissolved Oxygen Profiles Fall 2000 and Fall 2001 for Colleague Pond, Craney Pond, French Pond, Morrill Pond, Pleasant Pond, and Keyser Pond

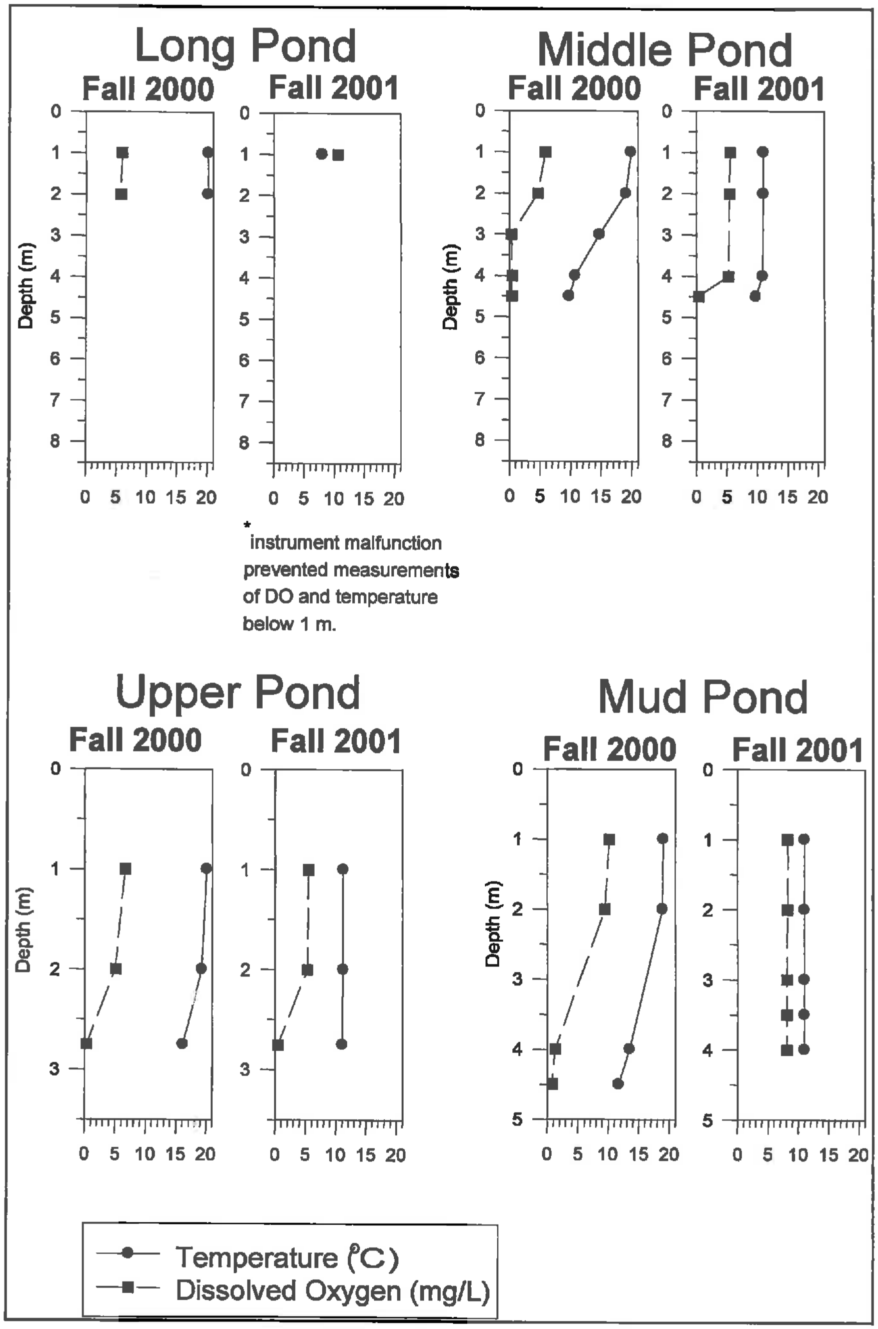


Figure 7. Temperature and Dissolved Oxygen Profiles Fall 2000 and Fall 2001 for Long Pond, Middle Pond, Upper Pond, and Mud Pond 1.

Transparency/Clarity

Water clarity or transparency is measured with a secchi disk. The higher the secchi disk value the more transparent or clearer the water. The New Hampshire Dept. of Environmental Services uses water clarity as part of the determination of the degree of lake eutrophication (NHDES, 1997). The clarity of Craney Pond and Pleasant Pond were in the high quality, oligotrophic condition (Table 3). French Pond, Keyser Pond, Long Pond, Morrill Pond, and Mud Pond 1 were in the moderate quality, mesotrophic condition. Middle Pond, Upper Pond, and Colleague Pond had clarities that would rank them in the low quality, eutrophic category. However, it is important to note that the total degree of eutrophication is determined using other parameters such as total phosphorus concentration, chlorophyll, and aquatic plant growth.

Table 3. Water Clarity Categories and Ranking of Henniker Ponds Based on Fall 2001 Measurements.

Category	Clarity (m)	Henniker Pond
Oligotrophic	≥ 4.0	Craney Pond and Pleasant Pond.
Mesotrophic	1.9 - 4.0	French Pond, Keyser Pond, Long Pond, Morrill Pond, and Mud Pond 1
Eutrophic	≤ 1.9	Middle Pond, Upper Pond, and Colleague Pond

In general, Henniker ponds had a secchi disk measurement that was less than the NH mean value of 3.7 meters (Figure 8). Pleasant Pond, followed by Craney Pond had the highest values during fall 2000 and fall 2001. The lowest values were measured in Mud 2. The low value for the Craney Rookery resulted from the fact that the pond is shallow (~1 m) and the bottom was visible from surface.

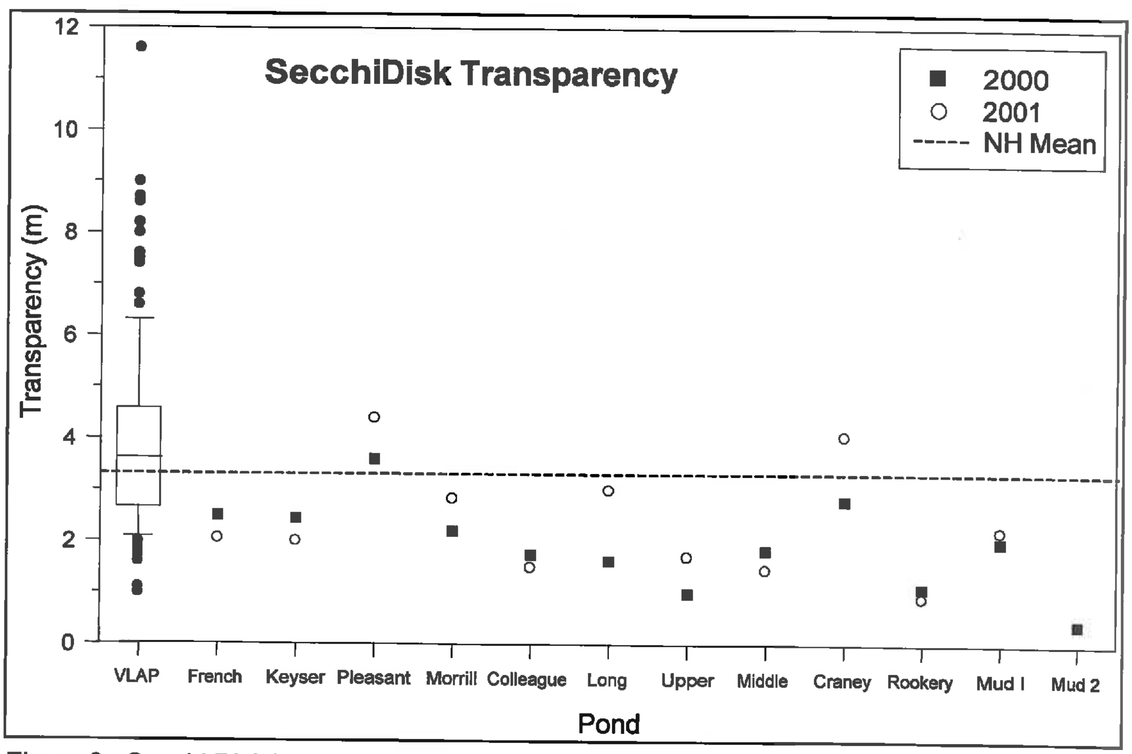


Figure 8. Secchi Disk Transparency measurements for Henniker Ponds, Fall 2000 and Fall 2001.

The transparency measurements of Keyser Pond and French Pond have historically been low and attributed to excessive algae growth (Connor and Martin, 1988). In the fall 2000 and 2001 pond surveys the transparency levels for both ponds were comparable to other Henniker ponds. Clarity is influenced by a number of factors including algae, suspended sediment, and natural colors of the water. Mud Pond 1 and Mud 2 are influenced by wetlands on their perimeter and their waters have a brownish color.

Turbidity

Turbidity is another measure of water clarity but rather than visual measurement made on the water surface it is measured using a turbidity meter that measures the amount of light absorbed or scattered in a water sample. Turbidity is a function of suspended particles such as clay, silt, and algae. The higher the turbidity value the poorer the clarity. Turbidity in the epilimnion of Henniker ponds is higher than the NH mean epilimnion value of 0.7 NTU (Figure 9). The highest values were measured in Mud Pond 1 and Mud Pond 2 and French Pond.

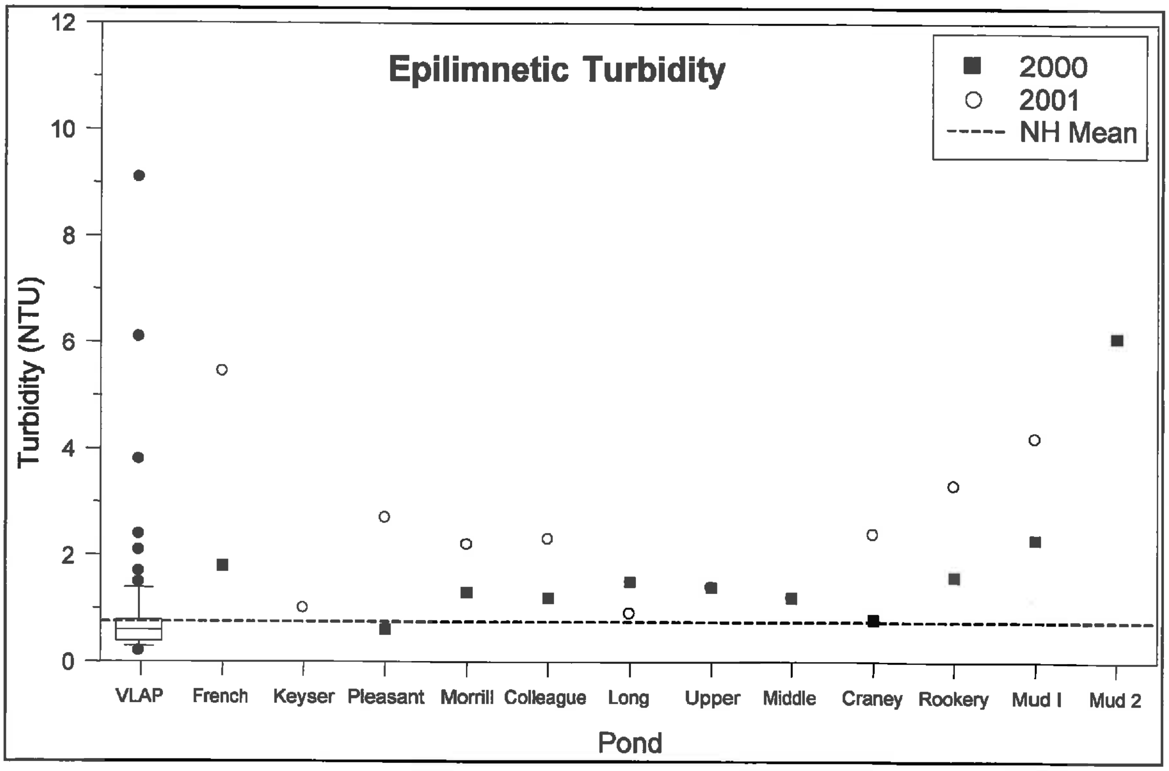


Figure 9. Epilimnetic Turbidity Levels of Henniker Ponds, Fall 2000 and Fall 2001.

Turbidity in the hypolimnion of Henniker ponds is closer the NH mean hypolimnion value of 3.2 (Figure 10). The highest values were measured in French Pond during fall 2000 and fall 2001 and Mud Pond 1 during fall 2001. The turbidity in French Pond was substantially higher than that measured in other Henniker Ponds.

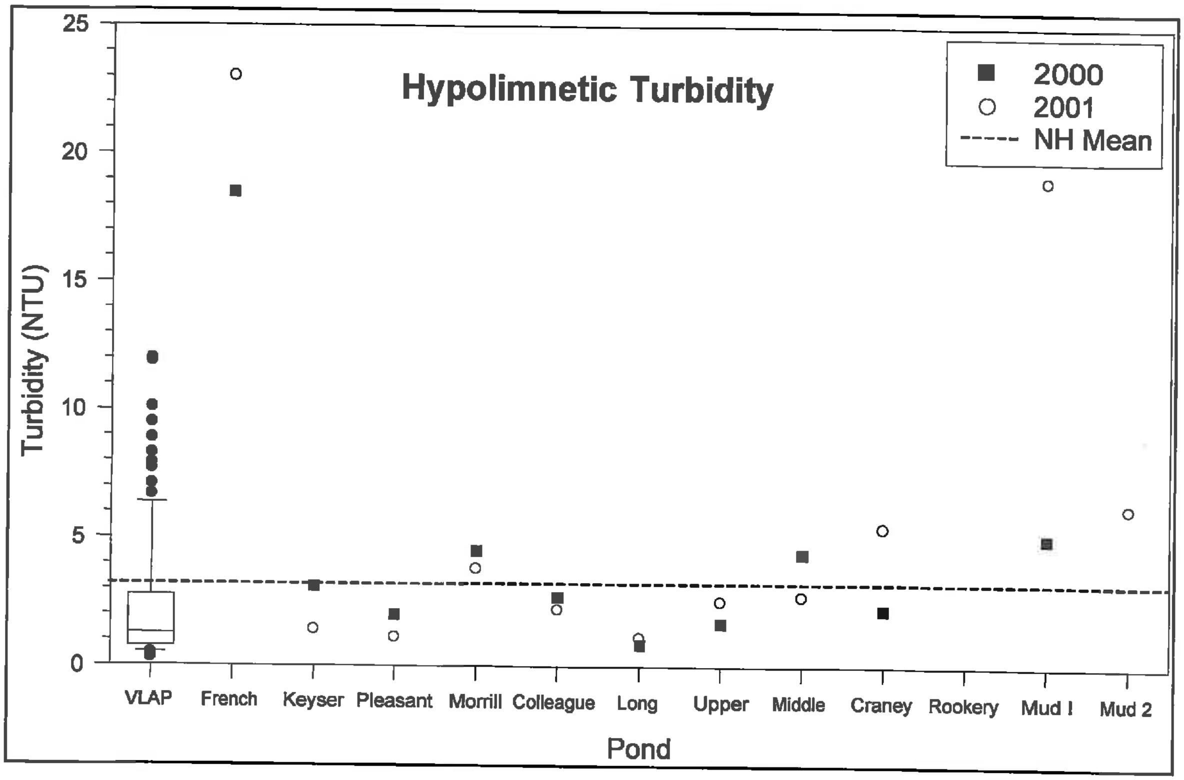


Figure 10. Hypolimnetic Turbidity levels of Henniker Ponds, Fall 2000 and Fall 2001.

Specific Conductivity

Specific conductivity is a measure of the water's ability to conduct electrical current. It is a measure of ions dissolved in the water. Specific conductivity can be used as a way to identify the amount of dissolved ions present. The higher the specific conductivity the more ions are dissolved in solution. Elevated values may result from man-made sources such as runoff containing road salt but may also be a function of watershed geology. Values of less than 50 µmhos are considered indicators of oligotrophic systems or lakes with minor impact from man-made sources. A value greater than 100 µmhos is typical of lakes impacted by human activity.

The specific conductivity of the epilimnion layer of Henniker Ponds is lower than the NH mean value of 89 µmhos (Figure 11). The lowest conductivity values (≤ 30 µmhos) were measured in the epilimnion of Colleague Pond, Pleasant Pond, Upper Pond, and Middle Pond. The highest epilimnion values were measured in Mud Pond 1, Keyser Pond, and French Pond.

Keyser Pond had elevated levels of specific conductivity (e.g., electrical conductance) compared to other Henniker ponds which suggests that runoff from Route 202/9 is having a small but measurable influence on water quality.

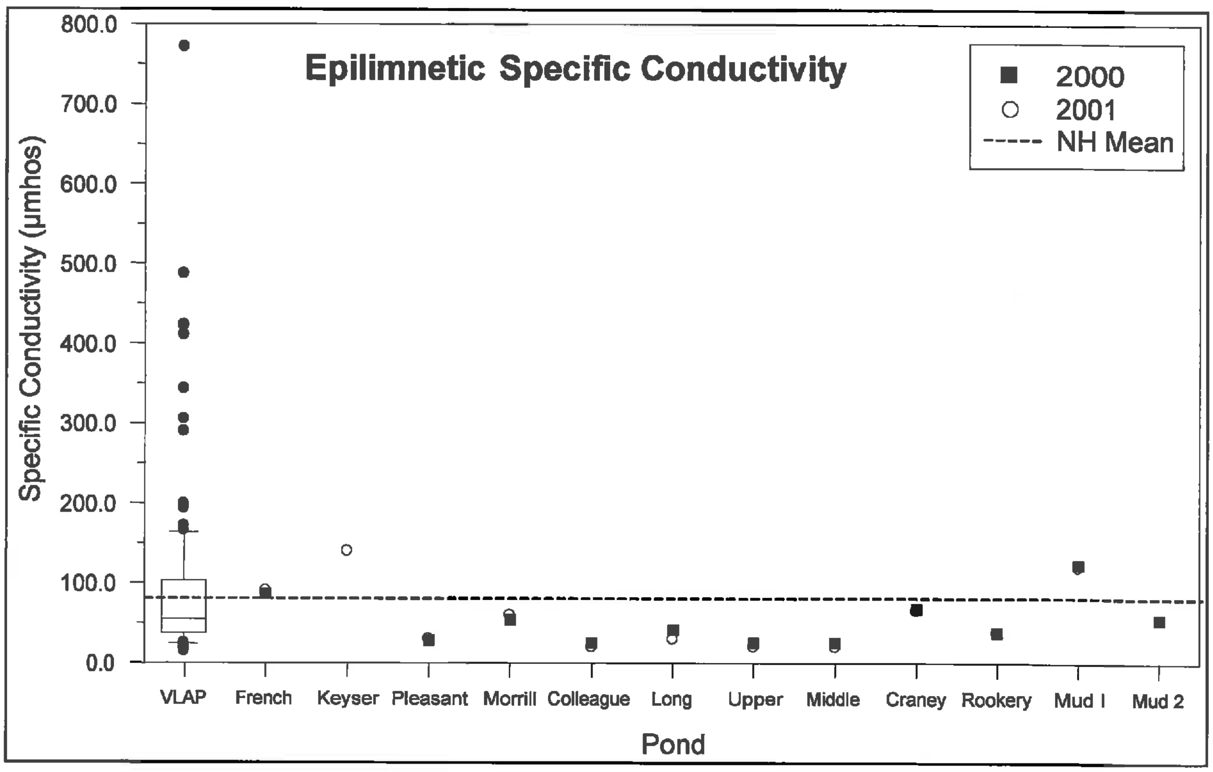


Figure 11. Epilimnetic Specific Conductivity for Henniker Ponds, Fall 2000 and Fall 2001.

The specific conductivity of the hypolimnion layer of Henniker Ponds was less than the mean hypolimnion value (105.6 µmhos) of other NH ponds for all but three Henniker ponds. The highest hypolimnion values were measured in Keyser Pond, French Pond, Mud Pond 1, and Morrill Pond. The lowest hypolimnion specific conductivity values in the other ponds in general suggest that they are not heavily impacted from man-made sources of pollution (Figure 12).

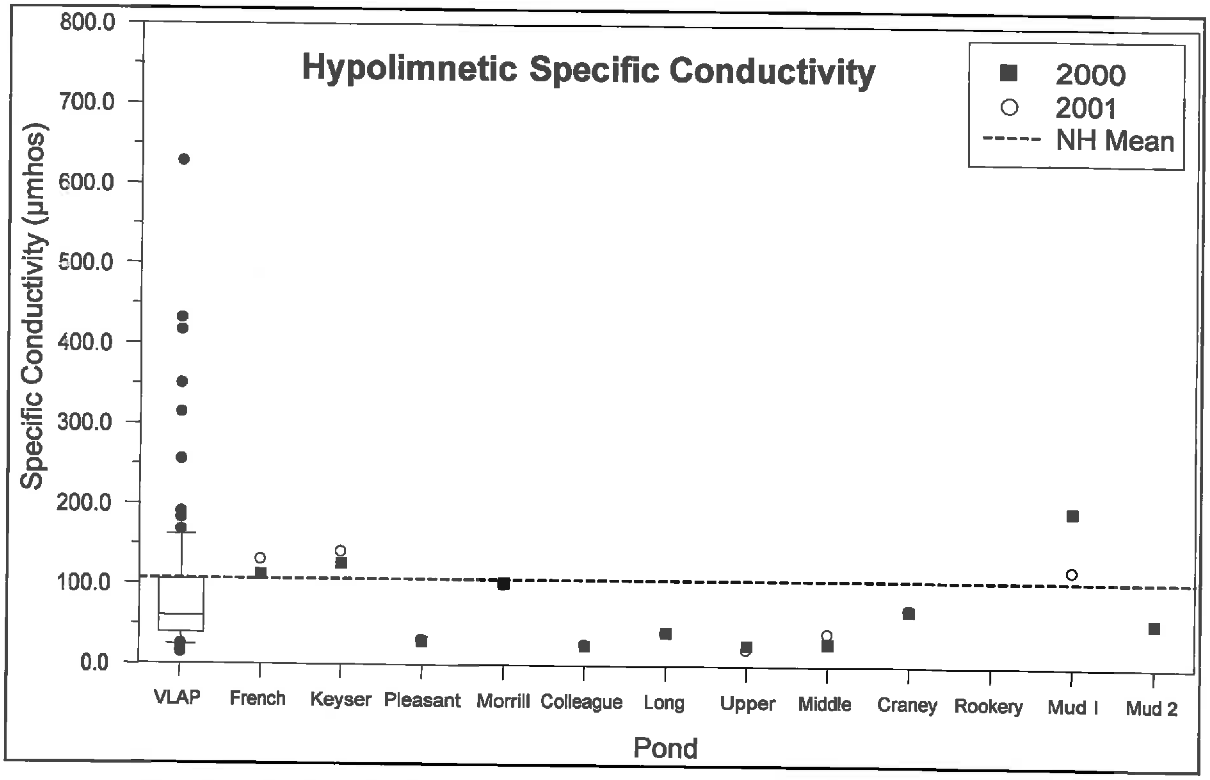


Figure 12. Hypolimnetic Specific Conductivity for Henniker Ponds, Fall 2000 and Fall 2001.

pH

The pH values of the epilimnion layer of Henniker ponds were generally lower than the NH mean value of 6.6. The epilimnion pH was lower during fall 2000 than in fall 2001 (Figures 13 and 14). The lowest pH value was measured in Mud Pond 2 in fall 2000 at a pH of 5.15. The next lowest fall 2000 values were measured in Morrill Pond (5.63), Craney Rookery (5.30), and Colleague Pond (5.98). All three of these ponds have wetlands associated with them and lower pH values are probably related to organic acids from the wetlands. The highest epilimnion pH values were measured in Mud Pond 1 (7.10), French Pond (6.92), Keyser Pond (6.78), and Long Pond (6.81).

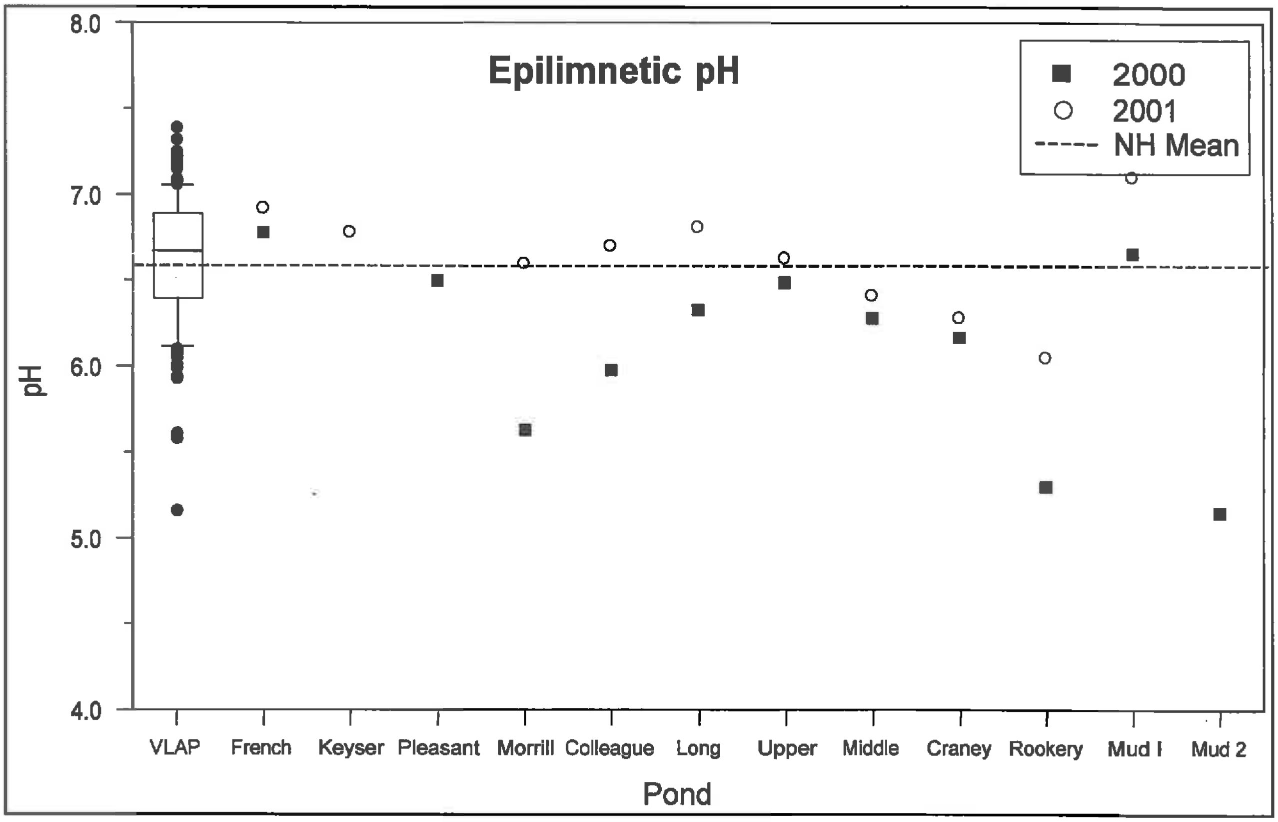


Figure 13. Epilimnetic pH for Henniker Ponds, Fall 2000 and Fall 2001.

The lowest hypolimnion pH values were measured in Mud Pond 2 (5.13), Middle Pond (6.23), and Morrill Pond (5.72) (Figure 14). The highest hypolimnion pH values were measured in Keyser Pond (6.89) and Mud Pond 1 (7.08).

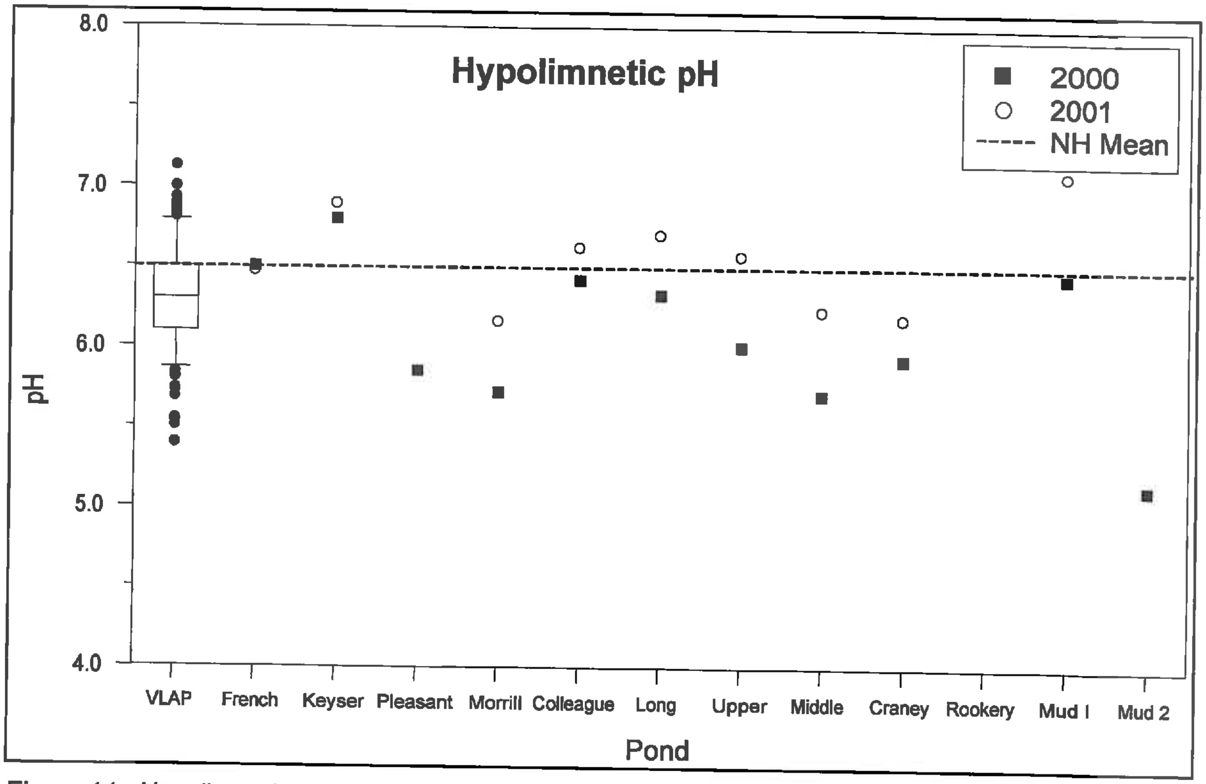


Figure 14. Hypolimnetic pH of Henniker Ponds, Fall 2000 and Fall 2001.

Total Phosphorus

In general, the concentration of total phosphorus in the epilimnion of Henniker ponds is slightly higher than the NH mean value (Figure 15). The New Hampshire Dept. of Environmental Services (DES) uses the concentration of total phosphorus as part of the determination of the degree of lake eutrophication (NHDES, 1997b). The ranking of Henniker ponds based on total phosphorus concentration and the categories used by NHDES is summarized in Table 4.

Table 4. Total Phosphorus Concentrations Categories and Ranking of Henniker Ponds According to the Hypolimnetic Phosphorus Concentration.

Category	Total Phosphorus (µg/L)	Henniker Pond
Low (good)	1 - 10	Craney Pond, Pleasant Pond
Average	11 - 20	Keyser Pond, Colleague Pond, Long Pond, Upper Pond
High	21 - 40	Middle Pond, Craney Rookery
Excessive	>40	French Pond, Morrill Pond, and Mud Pond 1, Mud Pond 2

The three highest epilimnion concentrations of total phosphorus were measured in French Pond, Craney Rookery, Mud Pond 1 and Mud Pond 2 with concentrations that were between 21 and 40 µg/L which ranks them as having high concentrations (Figure 15). Only Pleasant Pond had a value in low/good range.

The hypolimnetic phosphorus concentrations were on the borderline between low and average for Pleasant Pond, and Craney Pond (Figure 16). The Craney Rookery was too shallow (~1 m) for a hypolimnion sample to be collected. Keyser Pond, Long Pond and Upper Pond had hypolimnetic phosphorus concentrations in the high range (21 - 40 µg/L). The hypolimnetic total phosphorus concentration in Middle Pond was in the high range in fall 2000 (30 µg/L) and just above the cutoff of the excessive range (44 µg/L) in fall 2001.

Mud Pond 1 and Mud Pond 2 had excessive hypolimnetic phosphorus concentrations (98 µg/L and 60 µg/L, respectively) in fall 2000. However, the total phosphorus concentration measured in fall 2001 for Mud Pond 1 was in the high range (33 µg/L).

Mud Pond 2 was not sampled in fall 2001 because it was too shallow. Mud Pond 1 and Mud Pond 2 had excessive hypolimnetic phosphorus concentrations (98 µg/L and 60 µg/L, respectively) in fall 2000. However, the total phosphorus concentration measured in fall 2001 for Mud Pond 1 was in the high range (33 µg/L). Mud Pond 2 was not sampled in fall 2001 because it was too shallow.

Both Morrill Pond and French Pond had extremely high hypolimnetic total phosphorus concentrations (>100 µg/L) in both fall 2000 and fall 2001. The high concentrations of hypolimnetic phosphorus in French Pond has been studied by NH DES since 1987 (Connor and Martin, 1988) and the sources of phosphorus inputs to French Pond are being studied as part of the U.S. Environmental Protection Agency's Nonpoint Source Initiative Program which involves the collaboration of the Henniker Conservation Commission, the French Pond Association, NH Dept. of Environmental Services, and New England College.

Both Morrill Pond and French Pond are deep lakes (12 m and 10 m, respectively) and were stratified when water samples were collected both years. There is quite a bit of activity and potential for disturbance in

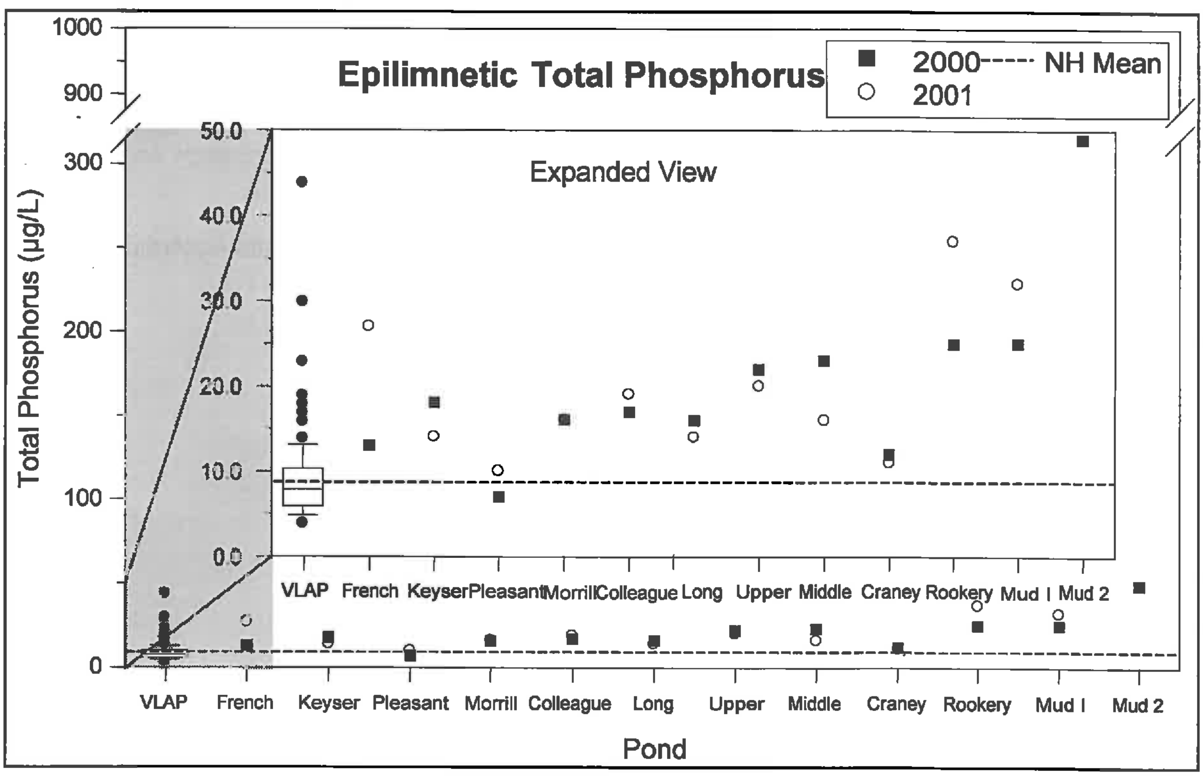


Figure 15. Epilimnetic Total Phosphorus Concentrations for Henniker Ponds, Fall 2000 and Fall 2001.

the French Pond watershed including residential land use, an orchard, and a livestock operation. The land immediately adjacent to French Pond has been developed for residential and agricultural use. Any visible changes in water quality such as algal blooms have been observed by surrounding homeowners. The outlet stream of French Pond is the primary source of inflow to Keyser Pond in which several algal blooms have been observed and documented by surrounding landowners.

In contrast there has been very little land use activity in the Morrill Pond watershed over the past decade. Although there have been no reports of excessive algal blooms for Morrill Pond this may have simply been the result of the lack of residential dwellings immediately adjacent to Morrill Pond and the absence of the constant observation of local residents that occurs on French Pond and Keyser Pond.

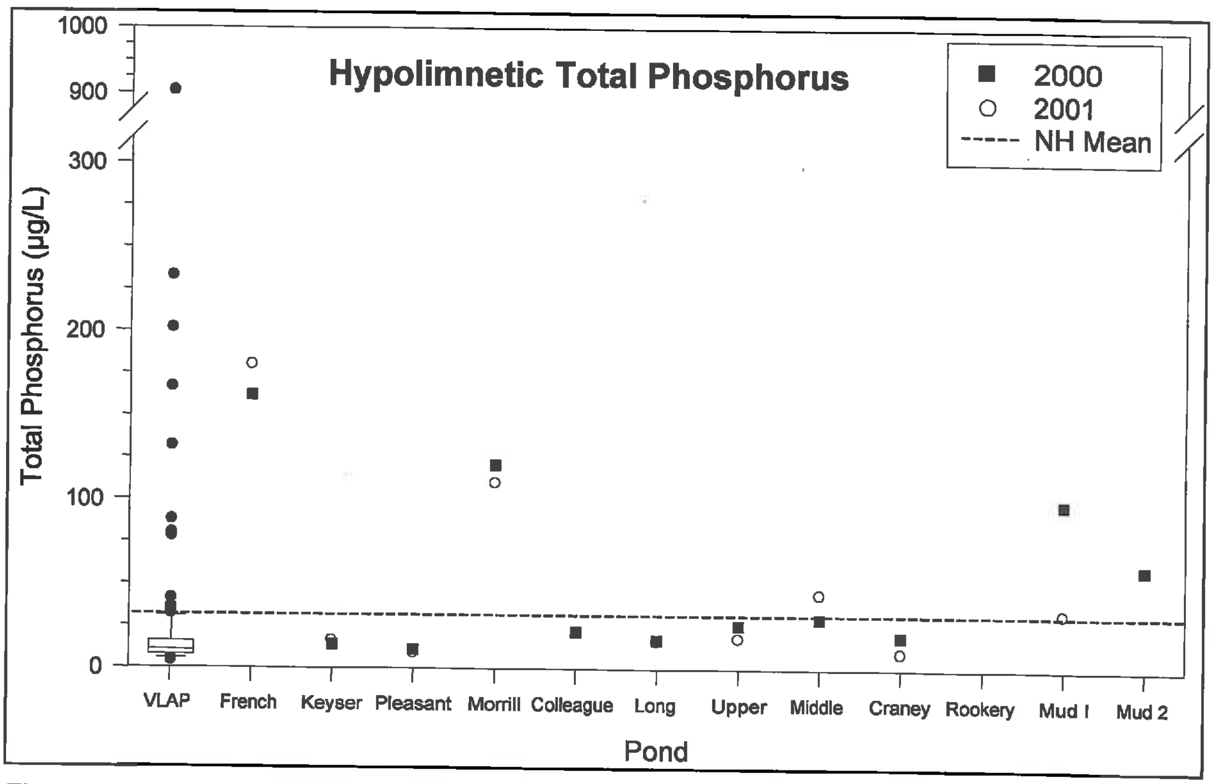


Figure 16. Hypolimnetic Total Phosphorus Concentrations for Henniker Ponds, Fall 2000 and Fall 2001.

Acid Neutralizing Capacity

The buffering capacity or Acid Neutralizing Capacity (ANC) is a measure of the ability of a solution to neutralize acids entering the lakes from an acidic input such as acid deposition -- the higher the ANC the greater the acid neutralizing ability. Low ANC values indicate that waters are not well buffered and may be adversely impacted by acidic inputs.

The New Hampshire Dept. of Environmental Services (DES) categorizes sensitivity of acidification based on ANC (NHDES, 1997a). The ranking of Henniker ponds based on ANC and the categories used by NHDES is summarized in Table 5.

Table 5. Acid Neutralizing Capacity Ranking of Henniker Ponds by Epilimnetic ANC levels.

Rank	ANC (mg/L $CaCO_3$)	Pond
Acidic	< 0	None
Critical	> 0 -2	Craney Pond and Craney Rookery
Endangered	> 2 - 5	Middle Pond
Highly Sensitive	> 5 - 10	Pleasant Pond, Morrill Pond, Long Pond, Upper Pond, and Colleague Pond
Sensitive	> 10 -20	French Pond and Keyser Pond
Not sensitive	> 20	Mud Pond 1

Historically, New Hampshire lakes have had naturally low ANC waters because of the prevalence of granite bedrock. The average epilimnetic ANC for New Hampshire VLAP lakes is 6.4 mg/L. This relatively low ANC value makes them vulnerable to the effects of acid precipitation.

ANC was only measured for fall 2001 samples. None of the sampled ponds were acidic in 2001 (Figure 17). The lowest ANC values for Henniker ponds were measured in Craney Pond (2.30 mg/L) and the Craney Rookery (1.74 mg/L), which places them in the Critical category. Only Middle Pond fell into the Endangered category. Long Pond, Upper Pond, Morrill Pond, Pleasant Pond and Colleague Pond had ANC values that place them in the Highly Sensitive category. French Pond and Keyser Pond had ANC values that place them in the Sensitive category. The highest epilimnetic ANC value was measured in Mud Pond 1 with value of 34.16 mg/L. The hypolimnetic ANC value for Mud Pond 1 was 36.5 mg/L indicating the value is true and not a result of sample or bottle contamination. Because most of the perimeter of Mud Pond 1 contains wetlands with substantial sphagnum mats, a much lower ANC was expected due to the presence of organic acids. Mud Pond 1 also had the highest epilimnetic and hypolimnetic pH values; 7.10 and 7.08, respectively.

In general, the ANC concentration of hypolimnion waters was considerably higher than in the epilimnion (Figure 18). The largest differences were measured in French Pond, which changed from 10.1 mg/L in the epilimnion to 36.5 mg/L in the hypolimnion. The ponds that had the largest difference in the ANC between epilimnion and hypolimnion waters were stratified at the time of sampling commonly with a two-fold difference in ANC. The ponds that were isothermal or with minimal stratification had the smallest difference in ANC between the epilimnion and the hypolimnion.

The ANC concentration of hypolimnion waters was considerably higher than in the epilimnion (Figure 18). The largest differences were measured in French Pond which changed from 10.1 mg/L in the epilimnion to 36.5 mg/L in the hypolimnion. Theponds that had the largest difference in the ANC between epilimnion and hypolimnion waters were stratified at the time of sampling commonly with a two-fold difference in ANC. The ponds that were isothermal or with minimal stratification had the smallest difference in ANC between the epilimnion and the hypolimnion.

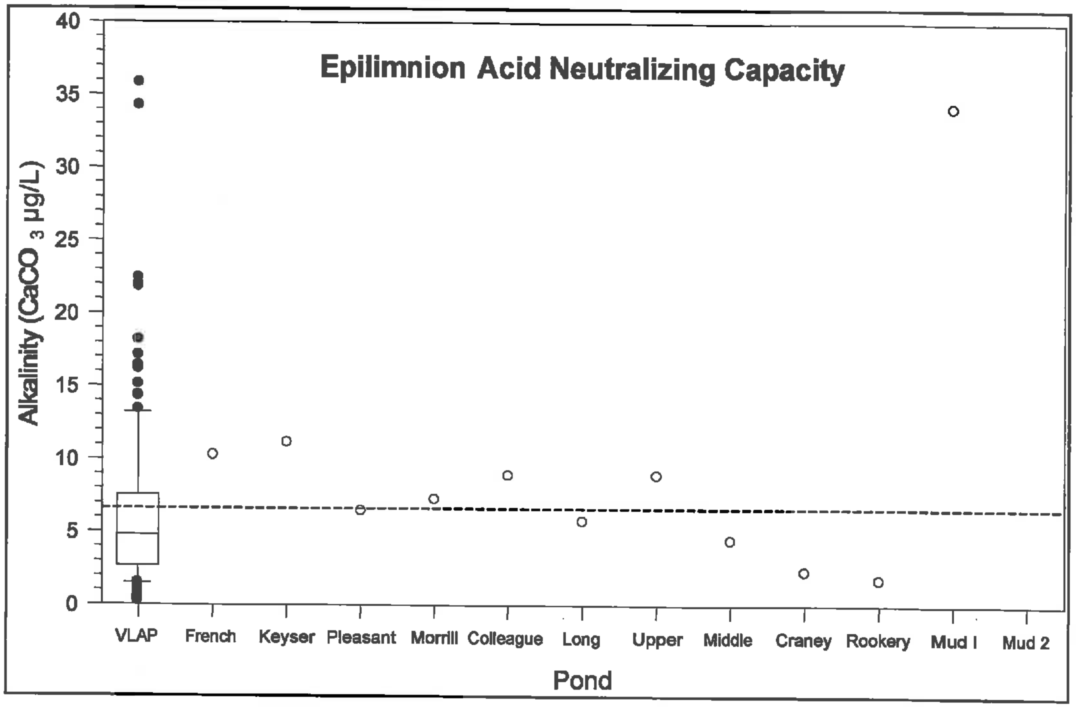


Figure 17. Epilimnetic ANC Concentrations for Henniker Ponds, Fall 2001.

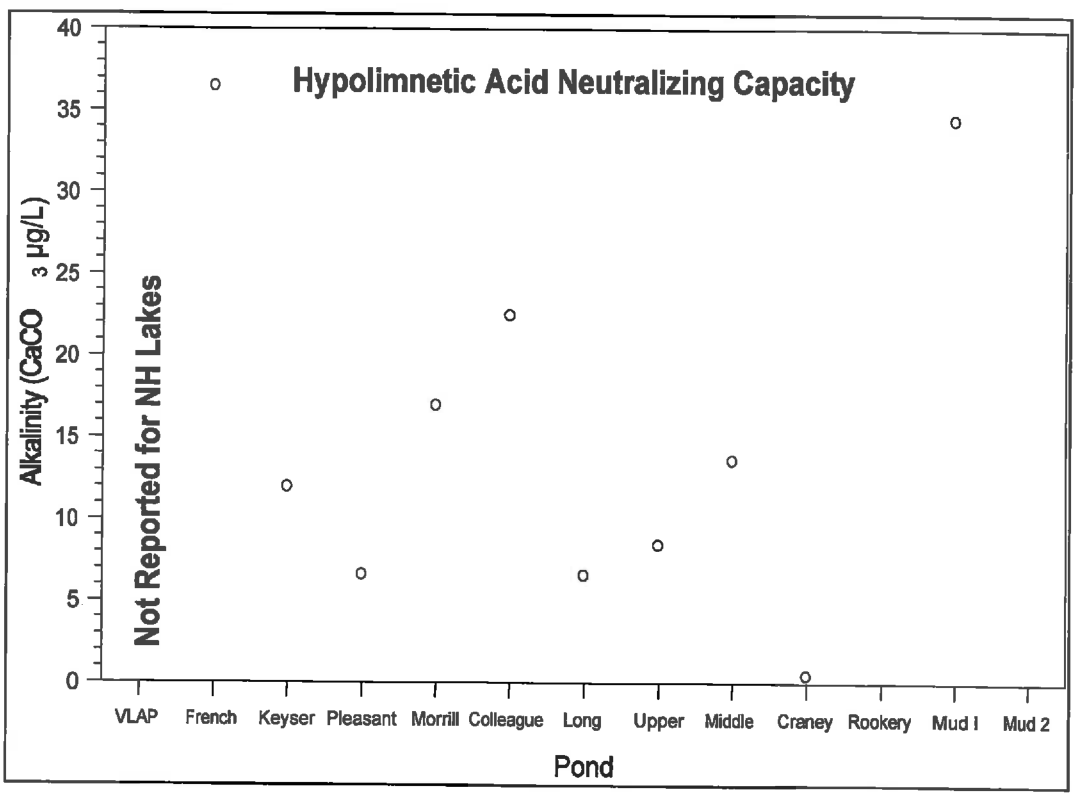


Figure 18. Hypolimnetic ANC Concentrations for Henniker Ponds, Fall 2001.

Summary and Conclusions

Based on the results of this survey the water quality of Henniker Ponds is good. No specific water quality problems (e.g., algal blooms) were reported during the period of the fall 2000 and fall 2001 surveys.

Craney Pond and Pleasant Pond have very low total phosphorus concentrations. There are three ponds with very high total phosphorus concentrations: French Pond, Morrill Pond, and Mud Pond 1. Although Mud Pond 1 had high total phosphorus levels measured in fall 2000, the fall 2001 survey results were lower. Considerable efforts continue to be put forth to address the high total phosphorus concentrations in French Pond.

The clarity of Henniker ponds was less than the NH mean. Clarity is influenced by a number of factors including algae, suspended sediment, and the color of the water. The lower levels of clarity are consistent with levels of turbidity that are greater than the NH mean value. However, there is no indication that there is a single cause for decreased clarity or that these results indicate a problem with water quality. The clarity measurements of Keyser Pond and French Pond have historically been low and attributed to excessive algae growth. We are pleased to report that in the fall 2000 and fall 2001 surveys the transparency levels for both ponds were comparable to other Henniker ponds.

The lowest levels of ANC were measured in Craney Pond and the Craney Rookery. Mud Pond was the only Henniker pond categorized as not sensitive to acidification. However, based on the available water chemistry data there is no indication that any of Henniker's ponds are impacted or influenced by acidic inputs.

References

American Public Health Association. 1998. Standard Methods for Examination of Water & Wastewater. 20th Edition. Ed. A.E. Greenberg, A.D. Eaton, and L.S. Cleseri.

Connor, J.N. and M.R. Martin. 1988. French and Keyser Pond Diagnostic/Feasibility Study, Henniker, NH. New Hampshire Department of Environmental Services. Staff Report #157.

New Hampshire Department of Environmental Services. 1995. Lake Eutrophication. Environmental Fact Sheet BB-3.

Figure 18. Hypolimnetic ANC Concentrations for Henniker Ponds, Fall 2001.

New Hampshire Department of Environmental Services. 1997a. DES's Lake Survey Program. Environmental Fact Sheet BB-16.

New Hampshire Department of Environmental Services. 1997b. Layman's Guide for Measuring A Lake's Trophic State. Environmental Fact Sheet BB-27.

New Hampshire Department of Environmental Services Limnology Center Laboratory. 2000. New Hampshire Volunteer Lake Assessment Program Monitor's Field Manual.

New Hampshire Department of Environmental Services Limnology Center Laboratory. 2000. Standard Operating Procedures and Protocols.

New Hampshire Department of Environmental Services. 2001. New Hampshire Volunteer Lake Assessment Program (NH VLAP). Environmental Fact Sheet WD-BB-26.

Individual Pond Summaries

French Pond

French Pond is probably the most studied and well documented pond in Henniker. Agricultural activity has been going on in the French Pond watershed for over 150 years. French Pond has a history of unpleasant algal blooms which have been linked to high concentrations of total phosphorus. The French Pond watershed has a long history of agriculture that has decreased over the last 50 years.

Current agricultural landuse includes orchard, livestock production, farming and a greenhouse. Results of the recent surveys indicate that French Pond still has seasonally high concentrations of total phosphorus. Although the extent of agricultural landuse has decreased, the number of homes near and around French Pond has increased over the last 50 years. While the number of seasonally used properties has decreased, the number of permanent, year long residences has increased. In addition a campground/trailer park was opened in the early 1970's. French Pond is also a favorite destination for local fisherman and is moderately to heavily used for recreation.

By the early 1980's French Pond came to the attention of the NH Department of Environmental Services (NHDES) after repeated algal blooms. A diagnostic study was conducted from spring 1986 through summer 1987 to determine the source of total phosphorus to French Pond (Connor and Martin, 1988). Leaky septic systems and agricultural runoff were not found to be substantial sources of phosphorus to the pond. Since the diagnostic study, annual monitoring has been conducted by the French Pond Association - an association of owners of property on or adjacent to French Pond. The high phosphorus concentrations still occur sometime between early July and late August (Figure 19). French Pond becomes strongly stratified by both temperature and dissolved oxygen during the summer months (Figure 6). At the peak of stratification when temperature differences are the highest, the hypolimnion is devoid of oxygen. At the time of 2000 and the 2001 pond surveys, French Pond was still strongly stratified. During the summer of 2001 a minor algal bloom was observed in August but was not large enough to result in unpleasant conditions. The lowest levels of clarity were observed in 1988 and 1998. This decrease in clarity corresponded to observed algal blooms. Based on clarity alone, French Pond would be categorized as mesotrophic. However, when accounting for all parameters of trophic status including clarity, total phosphorus, chlorophyll, and rooted vegetation, French Pond is eutrophic. Portions of French Pond, especially near the southern shore which includes the outlet, are very shallow with a large amount of rooted vegetation appearing during the growing season. In this area the bottom is very soft with several inches of mucky sediment.

At the request of the French Pond Association and the NH Department of Environmental Services, the Henniker Conservation Commission became actively involved and implemented a year long study of French Pond and its tributaries to assess the impact of storm events as a mechanism for delivering phosphorus to the pond. That work is near completion and the results will be released by early 2003.

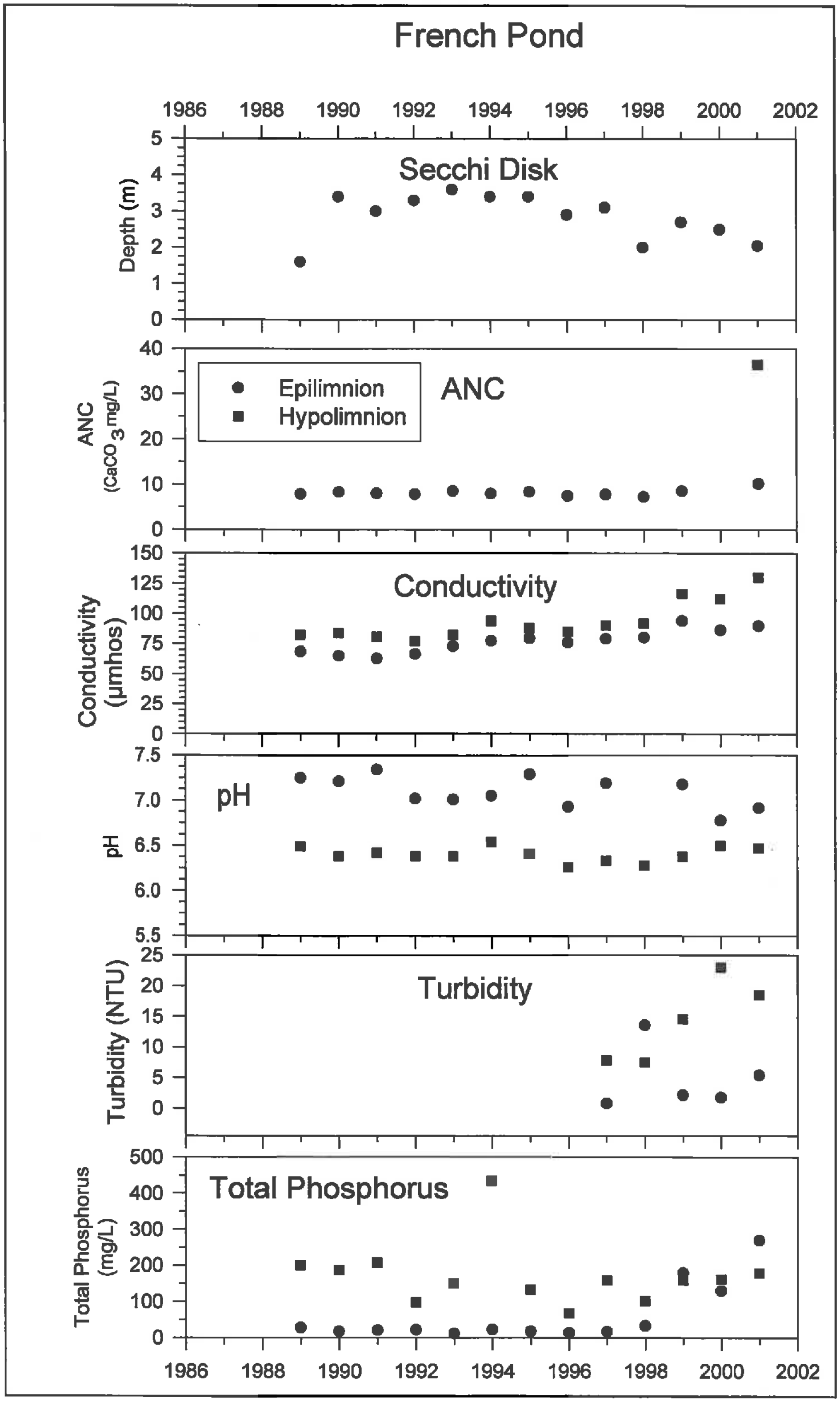
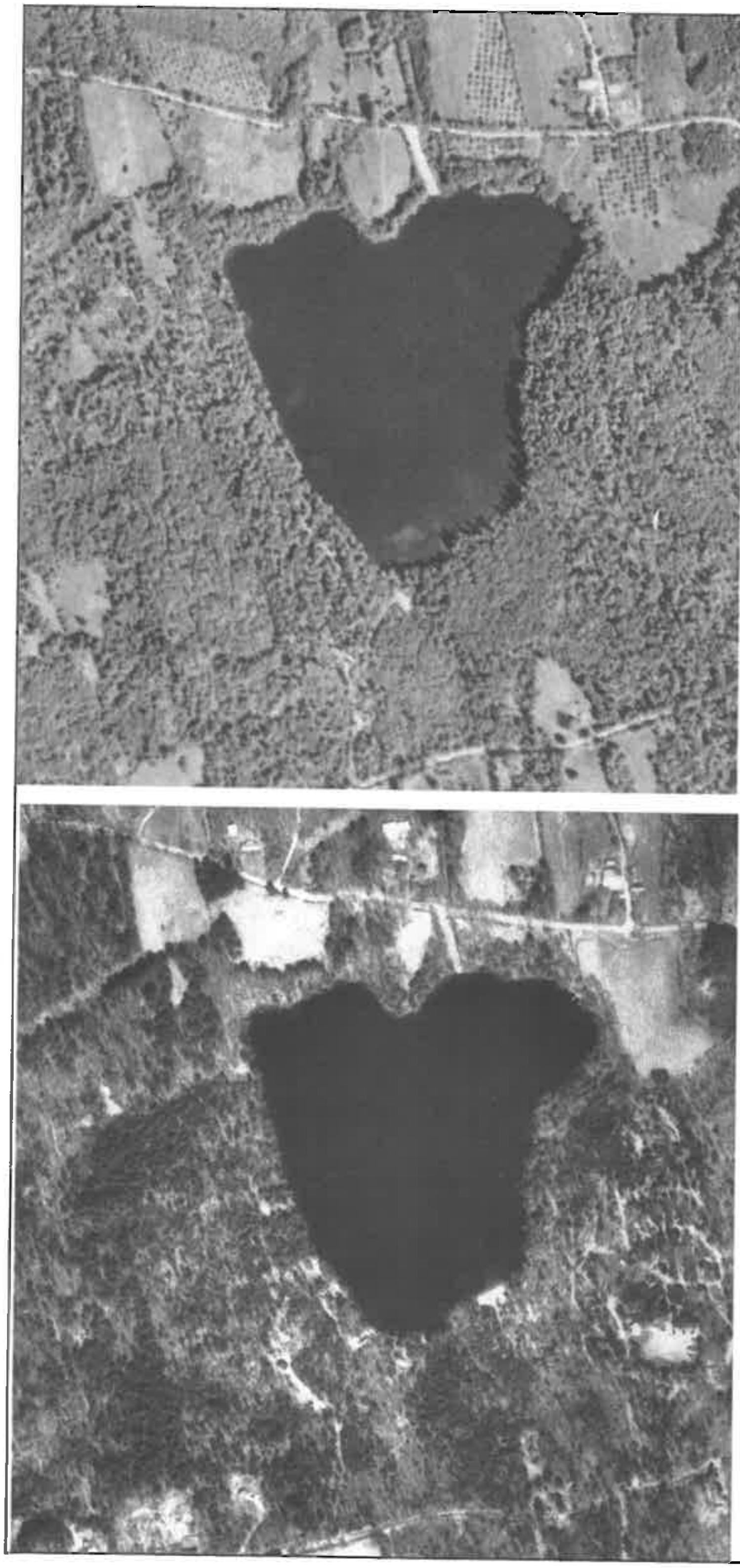


Figure 19. French Pond Temporal Water Chemistry Data.

French Pond



1953 Aerial Photograph

1998 Aerial Photograph

Figure 20. Aerial Photographs of French Pond taken in 1953 and 1998.

French Pond

1929 Hillsboro Quadrangle

1987 Henniker Quadrangle

Figure 21. Topographic Maps of the French Pond and Keyser Pond Watersheds Published in 1929 and 1987.

Keyser Pond

The outlet of French Pond eventually drains into Keyser Pond some 1.5 km away. Keyser Pond also has had a history of algal blooms that can impair recreational use. In fact, Keyser Pond has been noted as having the worst water clarity of all NH lakes when the blooms are at a peak. Results of this survey from the fall of 2000 and 2001 indicate only low concentrations of total phosphorus and a water clarity that is much higher than at the peak of an algal bloom (Figure 22). Under normal conditions, Keyser Pond's clarity is comparable to other Henniker ponds. When Keyser Pond was sampled in fall 2000, it was stratified with a large temperature and dissolved oxygen difference between the surface and bottom waters (Figure 6). When sampled in fall 2001, Keyser Pond was not stratified. However, it should be noted that the fall 2001 survey was conducted a month and a half later than 2000 survey. It is likely that the pond had undergone fall turnover before the 2001 survey was conducted.

State Route 202/9 passes along northern edge of the pond and runoff from the highway may be the cause of the slightly elevated specific conductivity levels. Keyser Pond was included in the 1985 NHDES diagnostic study and has been periodically monitored but not to the extent that French Pond has been. Although Keyser Pond has historically been categorized as having poor clarity and noticeable algal blooms, its trophic status based on clarity, and total phosphorus concentration would be a mesotrophic system. However, when accounting for chlorophyll and rooted vegetation, Keyser Pond appears to be a eutrophic system. Local residents have said that the amount of rooted vegetation on Keyser Pond has increased substantially over the last 20 years.

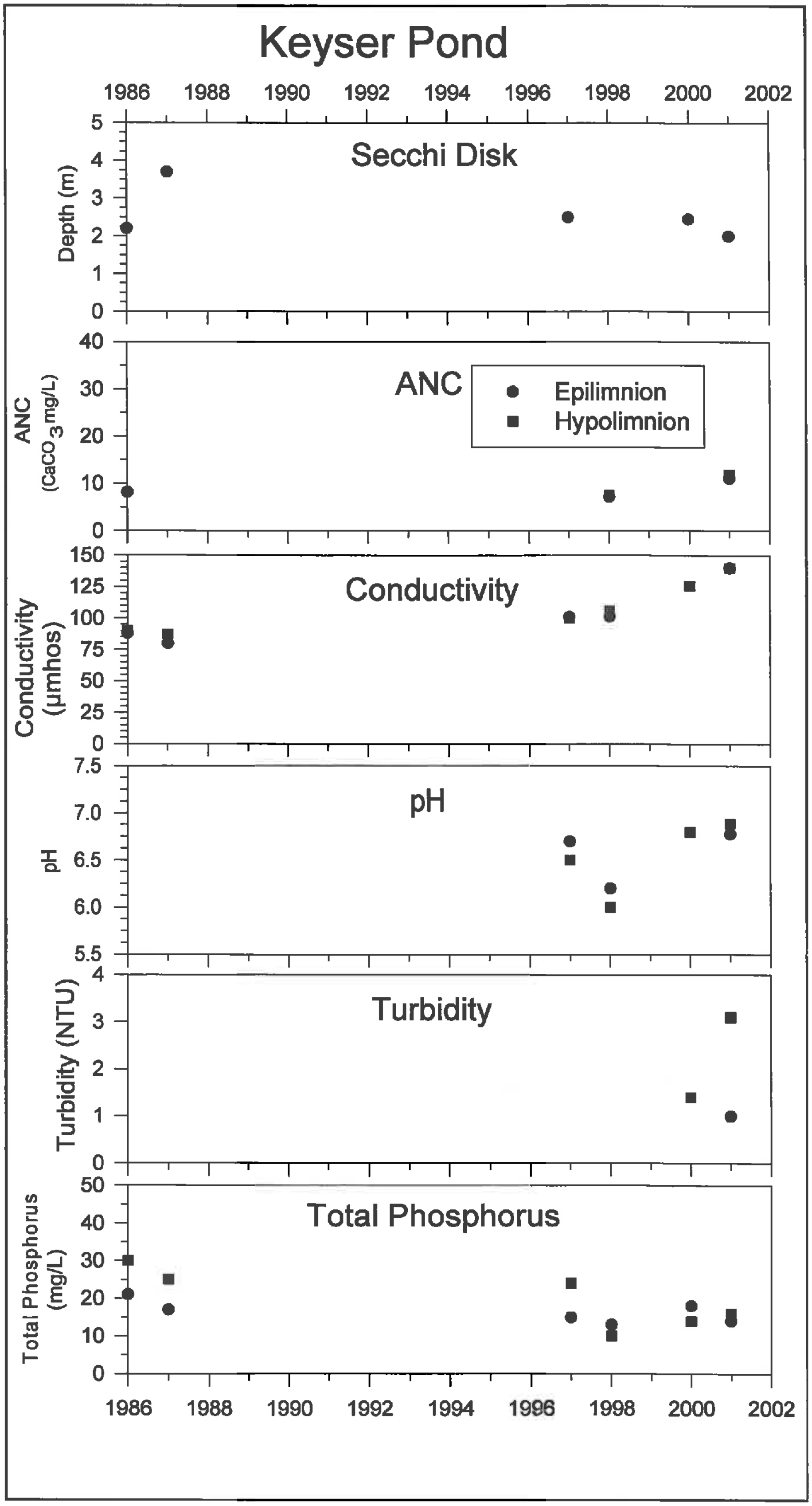


Figure 22. Keyser Pond Temporal Water Chemistry Data.

Keyser Pond

1953 Aerial Photograph

1998 Aerial Photograph

Figure 23. Aerial Photographs of Keyser Pond taken in 1953 and 1998.

Long Pond, Middle Pond, and Upper Pond

Upper, Middle, and Long Pond are a network of ponds hydrologically connected via streams and wetlands. The beginning of the network is Upper Pond with the largest watershed in Henniker at 14.03 km^2. This drainage area includes Bear Pond in Warner and a large wetland area. The outlet of Upper Pond drains into Middle Pond which in turns drains into Long Pond. While some logging has occurred in the northern portion of the watershed in the last 50 years, there has been little disturbance and changes in landuse immediately adjacent to Upper Pond. Less than 10 residences are present on the shore of the Upper Pond. Middle Pond is deep (>8 m) and is surrounded entirely by wetlands and forest. Although Long Pond is the largest pond in Henniker at 0.37 km^2, its deepest point is 6.1 m. The watershed of Long Pond has experienced the most development over the last 50 years with the building of the Tanglewood neighborhood. There are 10 homes present immediately adjacent to Long Pond in the 1953 aerial photo. In the 1998 aerial photo more than 25 homes are present. Agricultural landuse in the Long Pond watershed has decreased but there is still a substantial area of open field that is managed for hay production.

Both Upper and Middle Ponds were stratified in 2000 and 2001 (Figure 7). However, the extent of stratification was less in 2001. This is likely an indicator both ponds were close to fall turnover at the time of the 2001 survey. Upper Pond and Middle Pond had low levels of water clarity during both years indicating possible eutrophic conditions. However, in view of the total phosphorus concentrations, Upper Pond is borderline mesotrophic to eutrophic and Middle Pond is eutrophic (Figures 24 and 25).

Long Pond was not observed to be stratified in 2000. During the 2001 survey a complete depth profile could not be completed for Long Pond because of equipment malfunction. Based on data for clarity and total phosphorus concentration, Long Pond's trophic status is mesotrophic (Figure 26). Local home owners have commented that rooted vegetation has increased in the last 20 years on Long Pond.

Colleague Pond

Located in northern Henniker, Colleague Pond is located in one of the least developed areas in the town having only some logging in its watershed. Comparison of aerial photos from 1953 and 1998 indicate that there is less forested area and that wetlands are more open. With only one residence on Colleague Pond, very little of the shoreline has been disturbed. Because of its location on the northern edge of Henniker, Colleague Pond receives very little recreational use with its associated impacts.

Colleague Pond was stratified during the 2000 survey but not stratified in 2001 (Figure 6). Based on the clarity and total phosphorus concentration, Colleague Pond is borderline mesotrophic/eutrophic (Figure 29).

The outlet stream of Colleague Pond passes through several wetlands and forested areas before draining into Long Pond 2.5 km to the south.

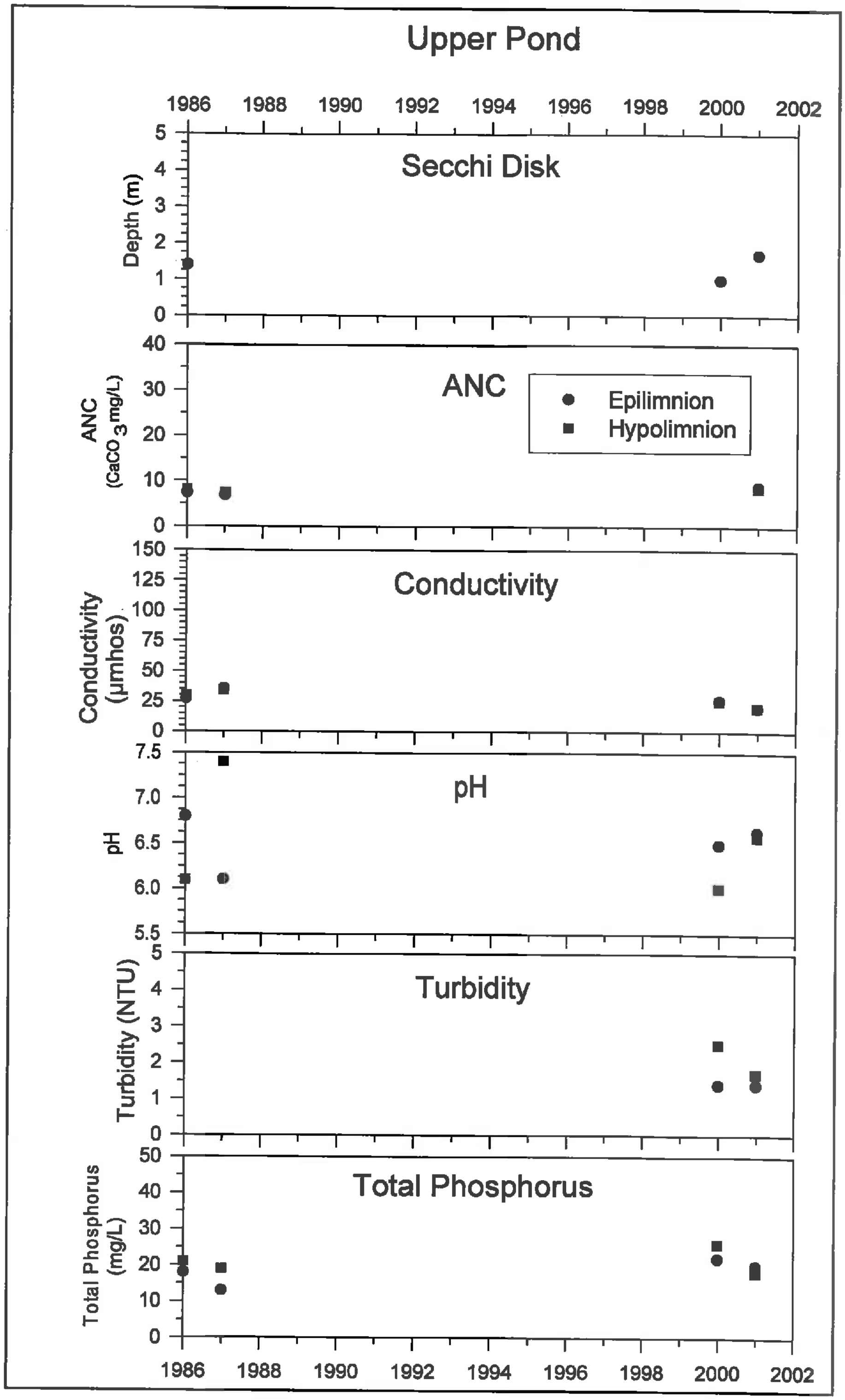


Figure 24. Upper Pond Temporal Water Chemistry Data.

Middle Pond

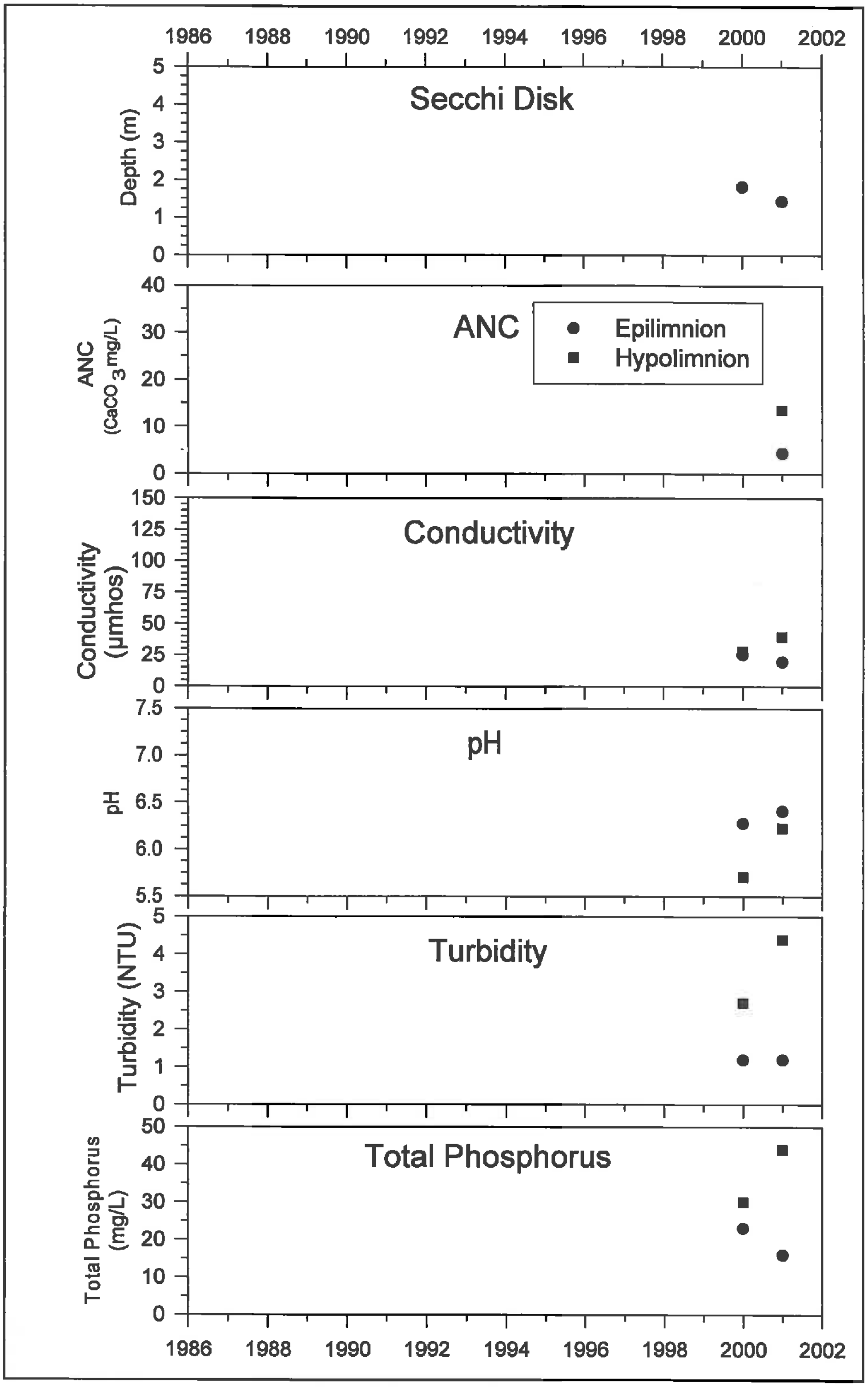


Figure 25. Middle Pond Temporal Water Chemistry Data

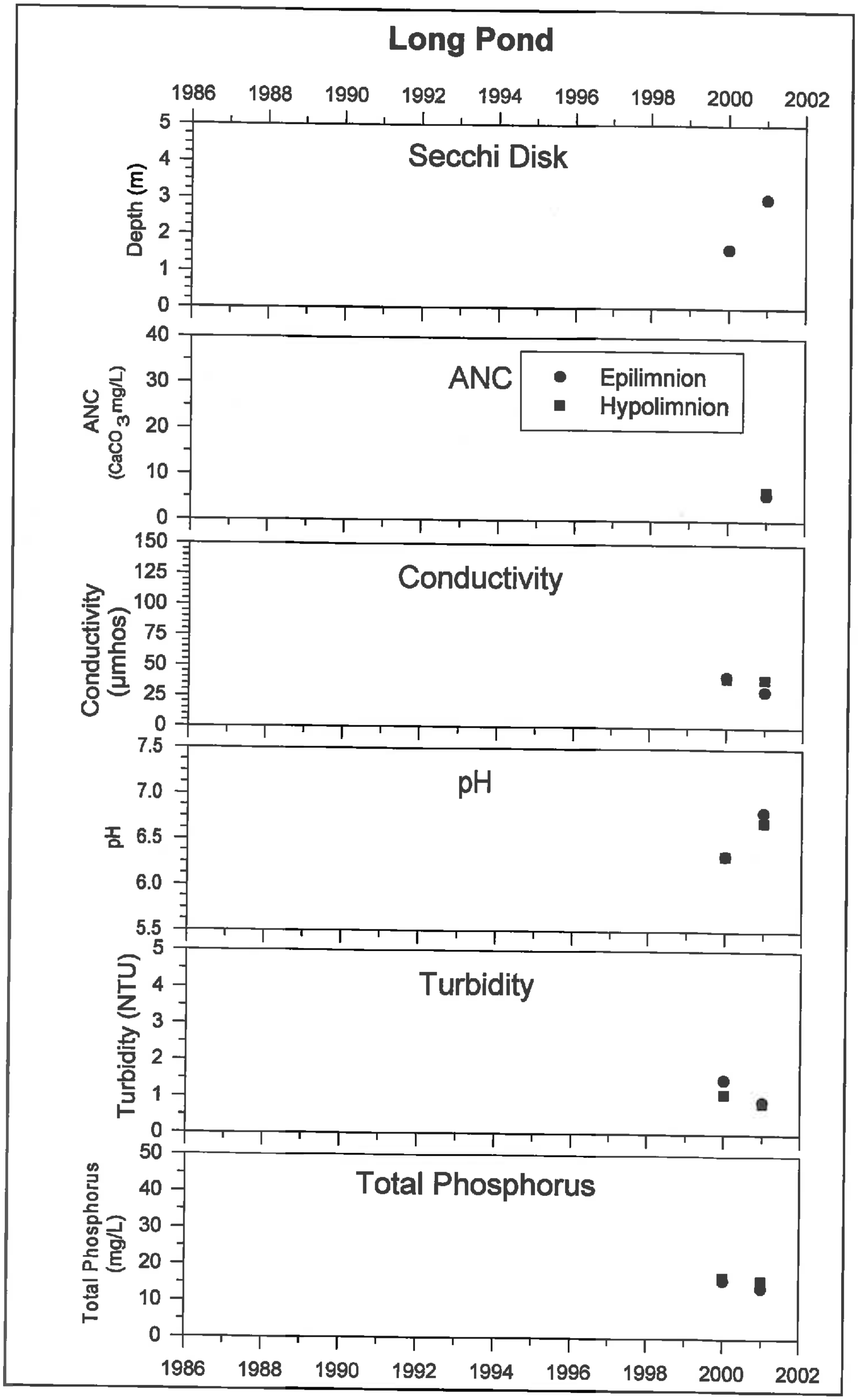


Figure 26. Long Pond Temporal Water Chemistry Data.

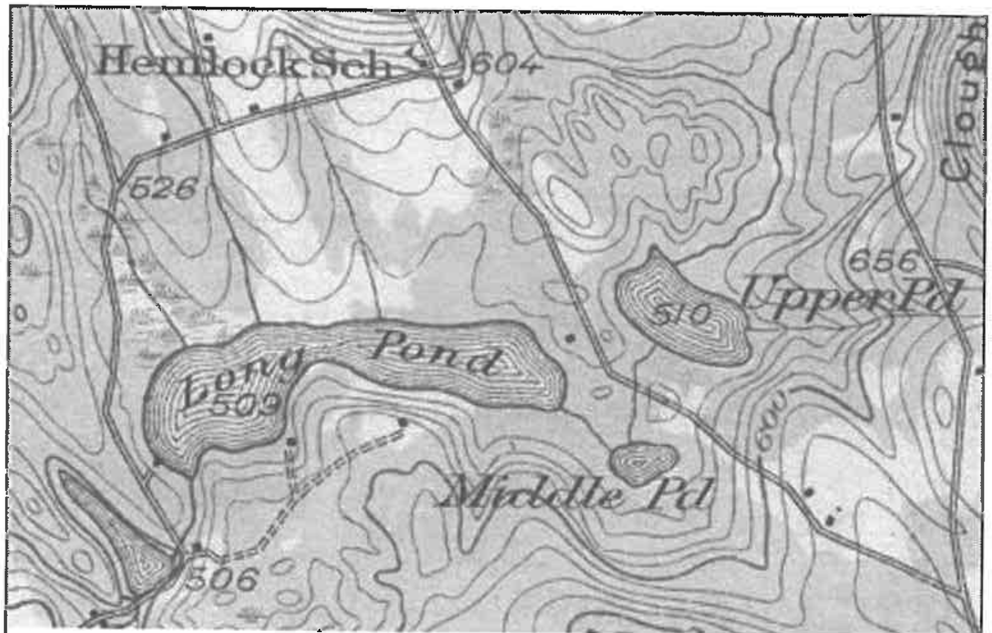
Long Pond, Middle Pond, and Upper Pond

1946 Aerial Photograph

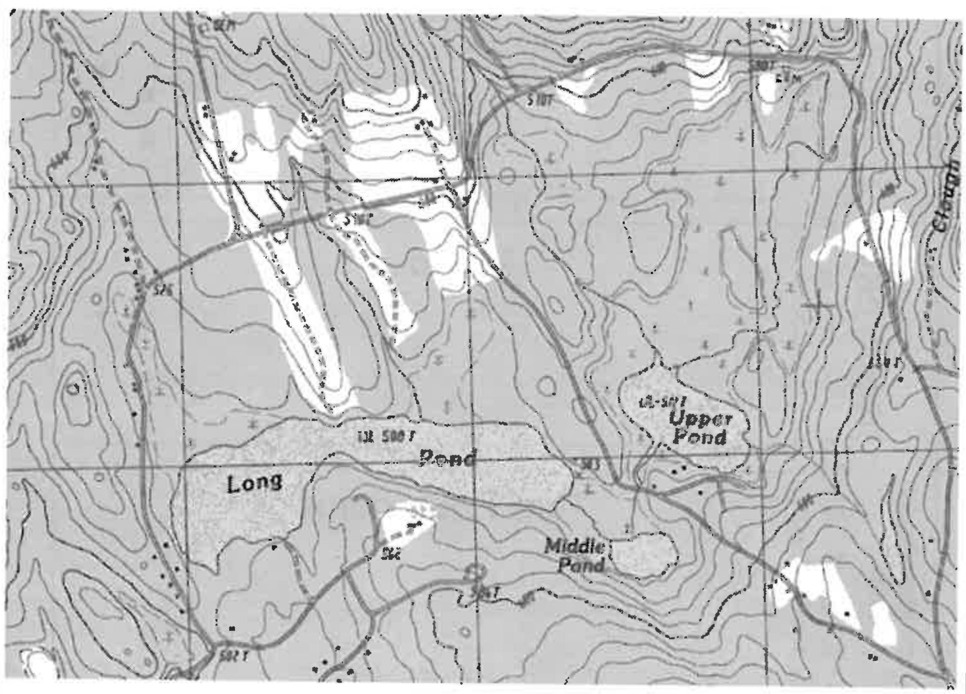
1998 Aerial Photograph

Figure 27. 1946 and 1998 Aerial Photographs of Long Pond, Middle Pond, and Upper Pond.

Long Pond, Middle Pond, and Upper Pond



1929 Hillsboro Quadrangle



1987 Henniker Quadrangle

Figure 28. 1929 and 1987 Topographic Maps of Long Pond, Middle Pond, and Upper Pond.

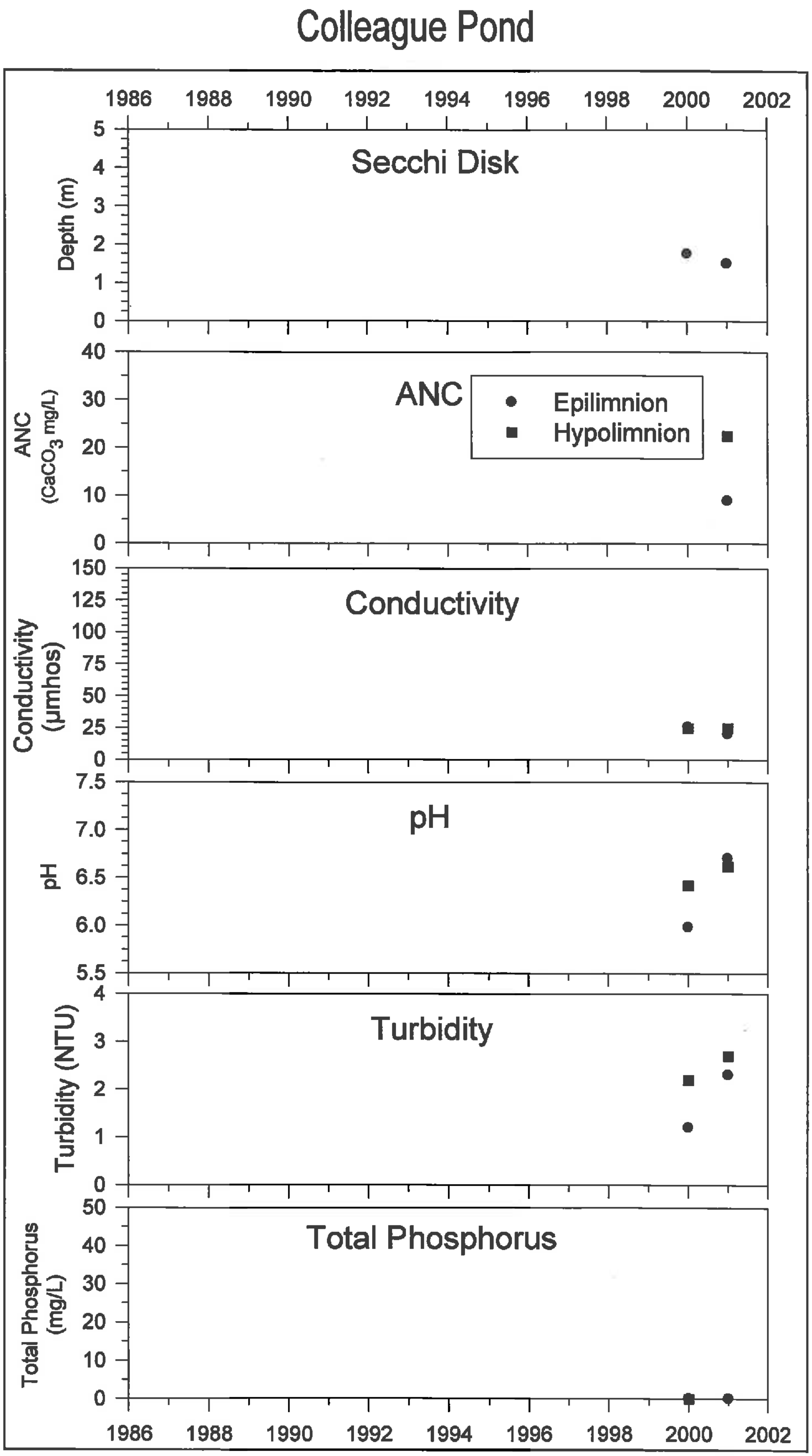


Figure 29. Colleague Pond Temporal Water Chemistry Data.

Colleague Pond

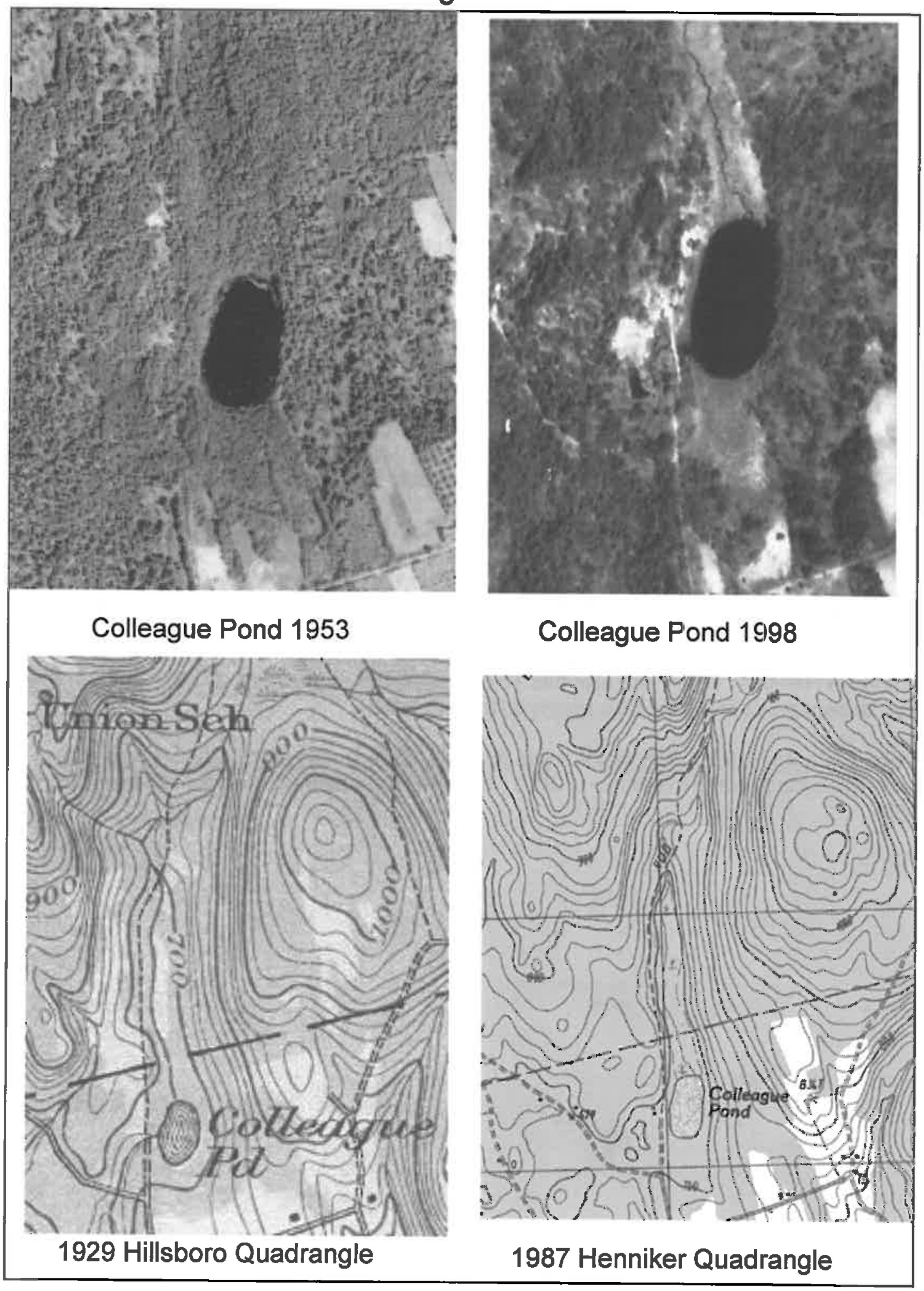


Figure 30. Aerial Photographs of Colleague Pond in 1953 and 1998. Topographic Maps of Colleague Pond Published in 1929 and 1987.

Mud Pond

While development of shoreland and landuse disturbance has occurred in Henniker over the last 50 years, the Mud Pond watershed area has experienced the largest landuse change. The cause of this change is a direct result of the creation of the USACOE (US Army Corps of Engineers) floodplain area along the Contoocook River that drains into the USACOE Hopkinton-Everett Reservoir in Hopkinton. As a result, the watershed has been allowed to revert back to an undeveloped state. Prior to the creation of the restricted use floodplain area there were buildings immediately adjacent to Mud Pond. At the same time State Route 114 used to run close enough to the pond that runoff from the road was most likely.

Discussions with the Henniker Historical Society also indicated that Mud Pond may have been impacted by runoff that drained from areas used by the old Maine and Boston Railroad line for storage of coal and possibly slag. Examination of the 1927 USGS topographic map indicate that runoff from this area drained towards Mud Pond. This storage area appears to have been near the site of the original Henniker landfill, known today as the Transfer Station. The topography of what became the landfill changed considerably via excavation such that this area no longer drains towards Mud Pond. The landfill has been capped and is in full compliance with state and federal regulations requiring maintenance and monitoring wells to minimize the possibility of groundwater contamination that could affect Mud Pond. The network of regularly sampled monitoring wells is located adjacent to the landfill and on the shore of Mud Pond. There is no evidence at this time that the landfill has had any influence on Mud Pond.

Mud Pond was strongly stratified in temperature and dissolved oxygen in 2000 when a high concentration of total phosphorus (98 µg/L) was measured (Figures 7 and 31). When Mud Pond was sampled in 2001 it was not stratified and the total phosphorus concentration was considerably less than the previous year (33 µg/L). The clarity of the pond is mesotrophic at around 2 meters. However, the total phosphorus concentration indicates the system is eutrophic. Mud Pond is surrounded by wetland with a floating sphagnum mat along most of the shoreline. The ANC concentrations (>30 mg/L $CaCO_3$) are the highest of any pond in Henniker. Mud Pond also has elevated specific conductivity, turbidity, and pH levels which are likely to be a result of the landuse history of the watershed.

Mud Pond 2 is a wetland in which water levels fluctuate from year to year. Although sampled in 2000 there was not enough water to sample in 2001. Its maximum depth was measured at around 1 meter in fall 2000.

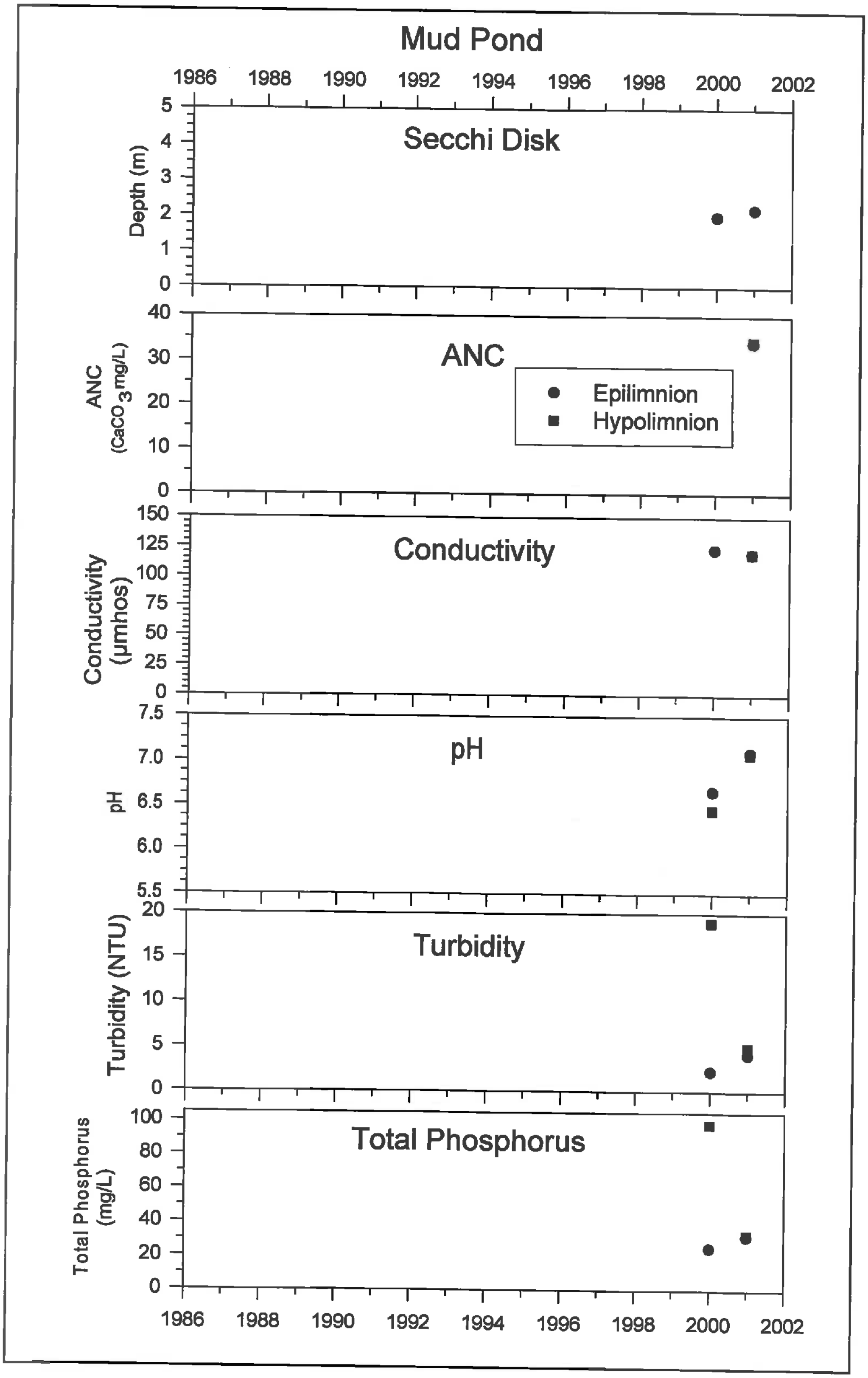


Figure 31. Mud Pond Temporal Water Chemistry Data.

Mud Pond

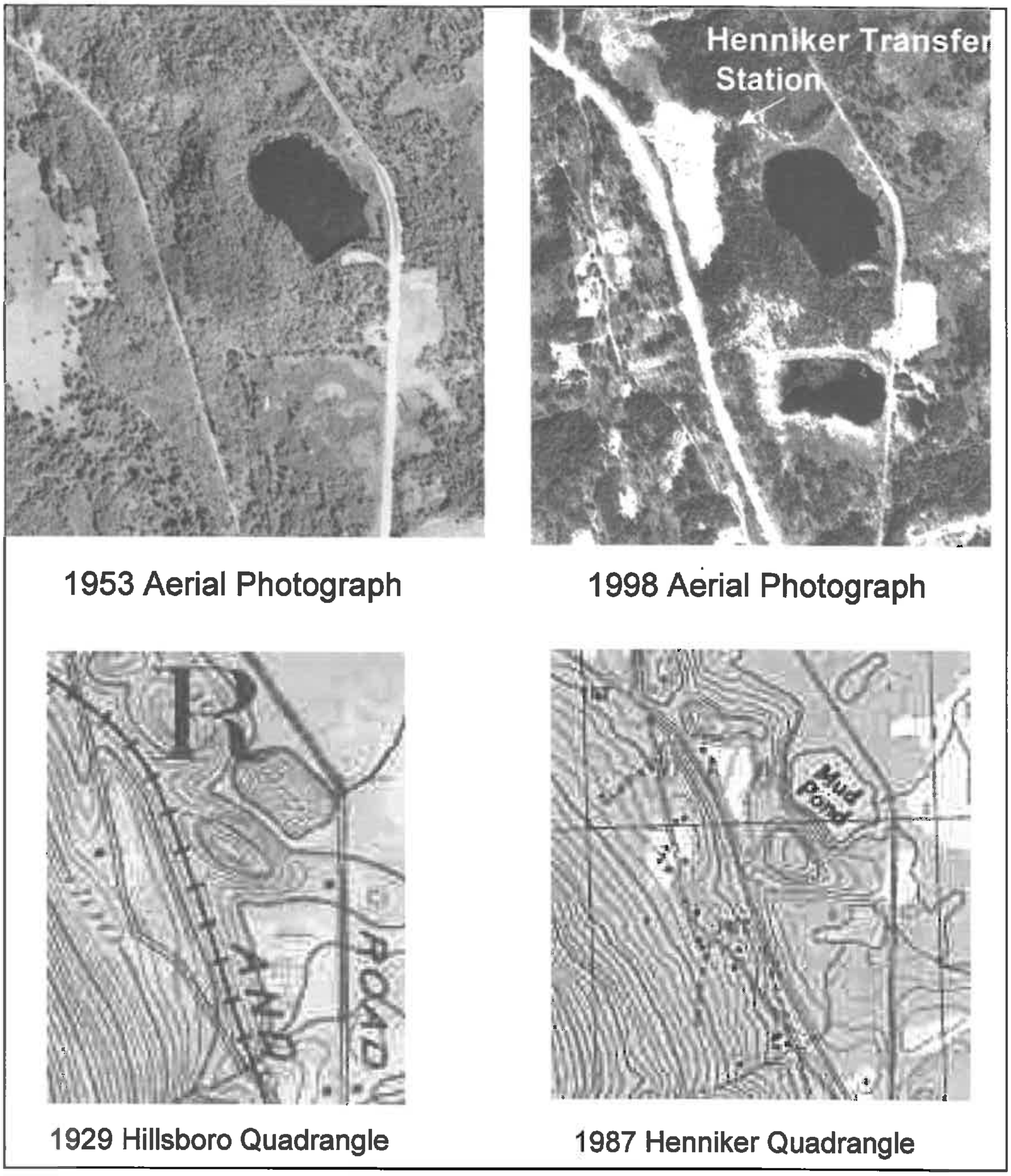


Figure 32. Aerial Photographs of Mud Pond From 1953 and 1998. Topographic Maps of Mud Pond published 1929 and 1987.

Craney Pond

Craney Pond is a high elevation pond with a small watershed area (1.8 km^2) that is fed by groundwater that passes through wetlands in its headwater. The outlet of Craney Pond is Cascade Brook. While there is evidence of logging in the forested portion of the watershed the primary landuse change has been a decrease in agricultural use and the addition of a few homes along Craney Hill Rd. Craney Pond's low ANC and relatively lower total phosphorus concentration along with its wetlands and forested area make it one of Henniker's sensitive ponds. The most recent influence has been the withdrawal of pond water for snow-making by the Pats Peak Ski Area. Considerable effort has been made by Pats Peak, the Henniker Conservation Commission, and abutting homeowners to ensure there are no adverse impacts to Craney Pond. The amount of and period of water withdrawal has been restricted to not more than 5 million gallons at a time for a total of 15 million gallons per season -- November 15 to February 1. The withdrawal process is carefully monitored and documented by Pats Peak and a summary report is compiled each year.

Craney Pond was strongly stratified by temperature and dissolved oxygen in 2000 (Figure 6). It was not observed to bestratified in the fall 2001 survey which was conducted a month and a half later than the 2000 survey. Craney Pond most likely underwent turnover prior to the fall 2001 survey.

Craney Pond had high clarity in 2001 and a moderate concentration of total phosphorus (19 µg/L) (Figure 33). In the fall 2000 survey the total phosphorus concentration was 9 µg/L. These results are very similar to values collected in 1987 and 1988 by NHDES which categorized Craney Pond as eutrophic. Specific conductivity values were slightly elevated relative to most Henniker ponds. No apparent cause is evident based on available information. Craney Pond also has very low ANC values indicating the pond is susceptible to change from acidic inputs. Based on these data the water quality of Craney Pond has not deteriorated over the last 15 years. While Craney Pond is a system sensitive to further eutrophication and acidification there is no indication at this time that Pats Peak's withdrawal of water has influenced water quality.

Craney Rookery

The Craney Rookery is the youngest pond in Henniker having been formed as a result of beaver activity in the late-sixties and early seventies. This is a very shallow pond that is less than 1.5 m deep throughout the entire pond. Many of the trees in the flooded area are still standing. There are no buildings within its watershed and the only landuse present is a small orchard that periodically uses the pond as a backup water supply.

The water chemistry of Craney Rookery indicates that water quality is good (Figure 34). However the shallow nature of the pond may limit its life. The pond is clear to the bottom over the entire pond. There is also rooted vegetation over the entire pond. There has been no indication that dissolved oxygen levels decrease throughout the year or that algal blooms influence water chemistry. The ANC concentration is very low indicating the pond may be susceptible to change from acidic inputs. The total phosphorus concentrations are elevated into the eutrophic range. Considering the concentration of total phosphorus, the amount of rooted vegetation in the pond, Craney Rookery is a eutrophic system. Unfortunately there is no historical water chemistry data to assess if water quality has deteriorated over the last 20 years. The results from the 2000 and 2001 surveys will be used as a baseline to compare with future water chemistry data to assess if watershed disturbances influence water quality.

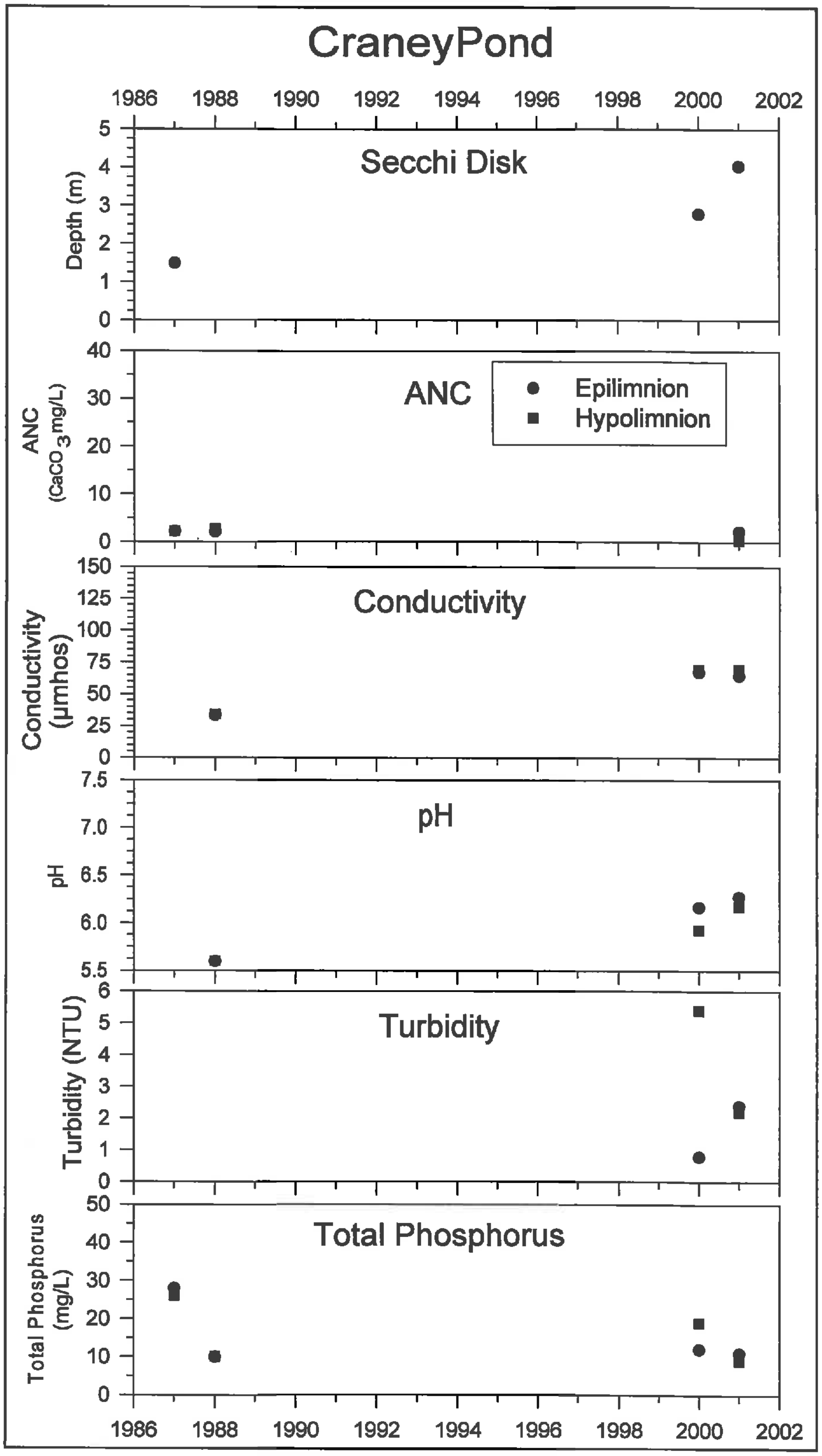


Figure 33. Craney Pond Temporal Water Chemistry Data.

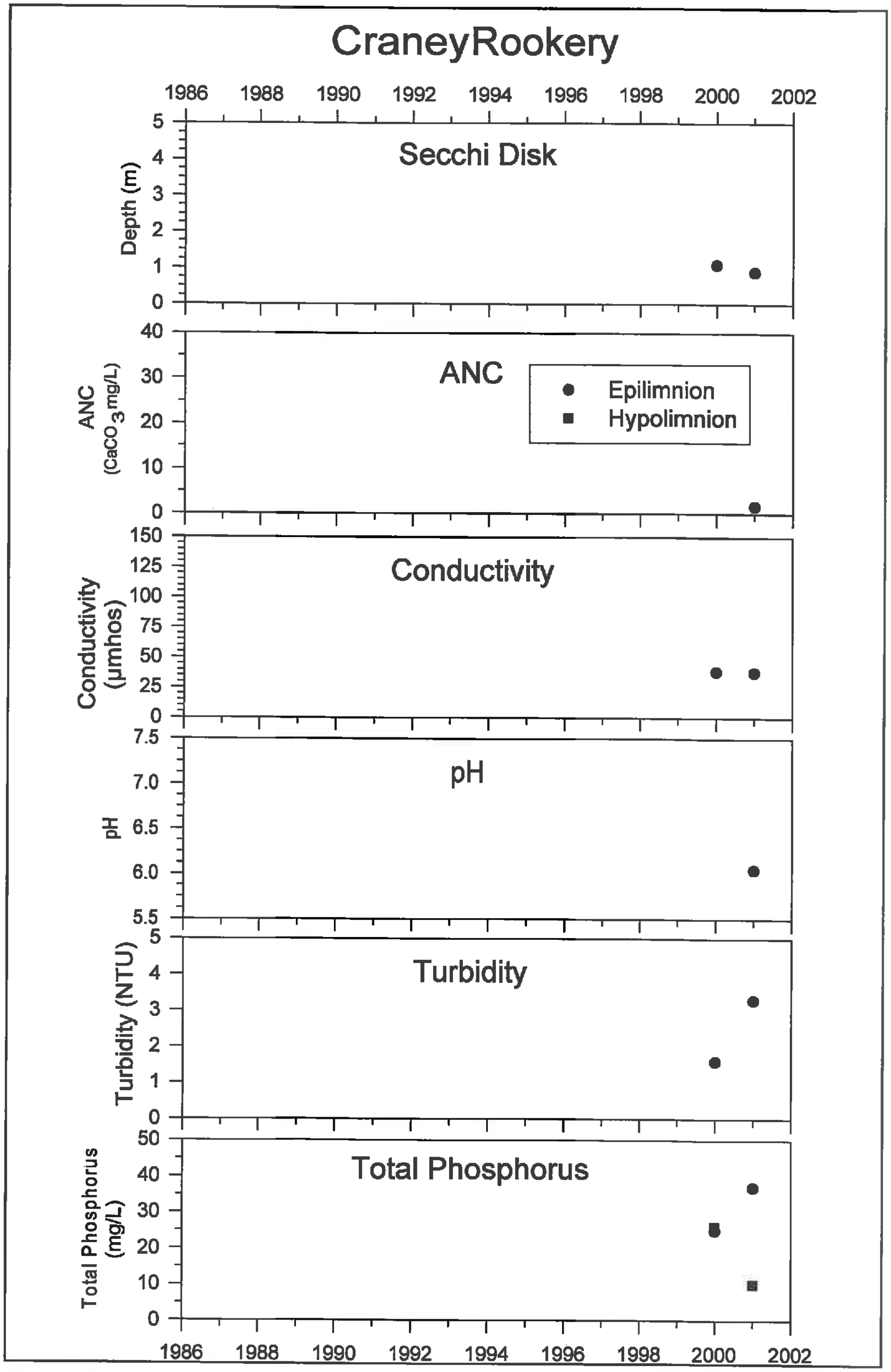


Figure 34. Craney Rookery Temporal Water Chemistry Data.

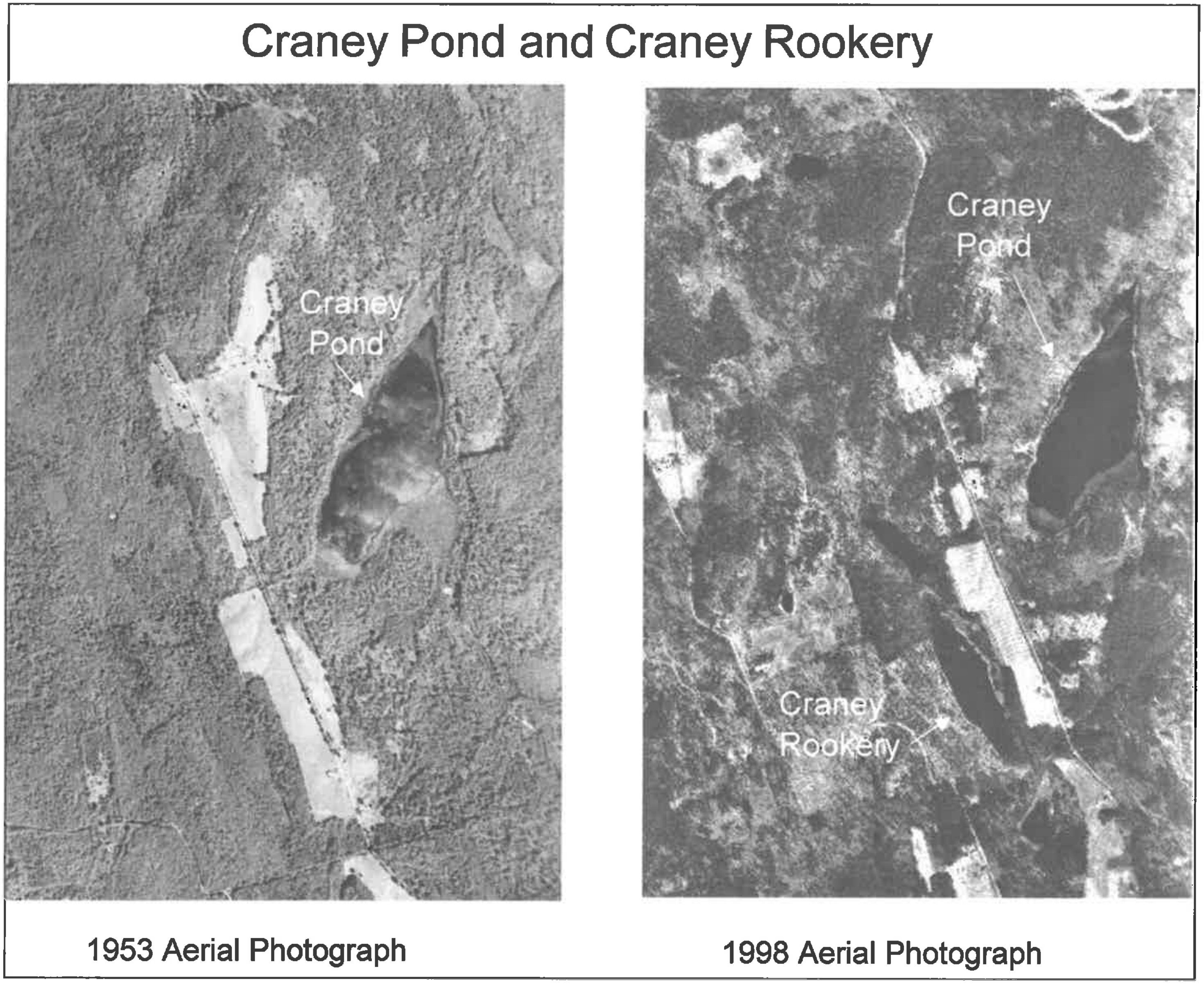
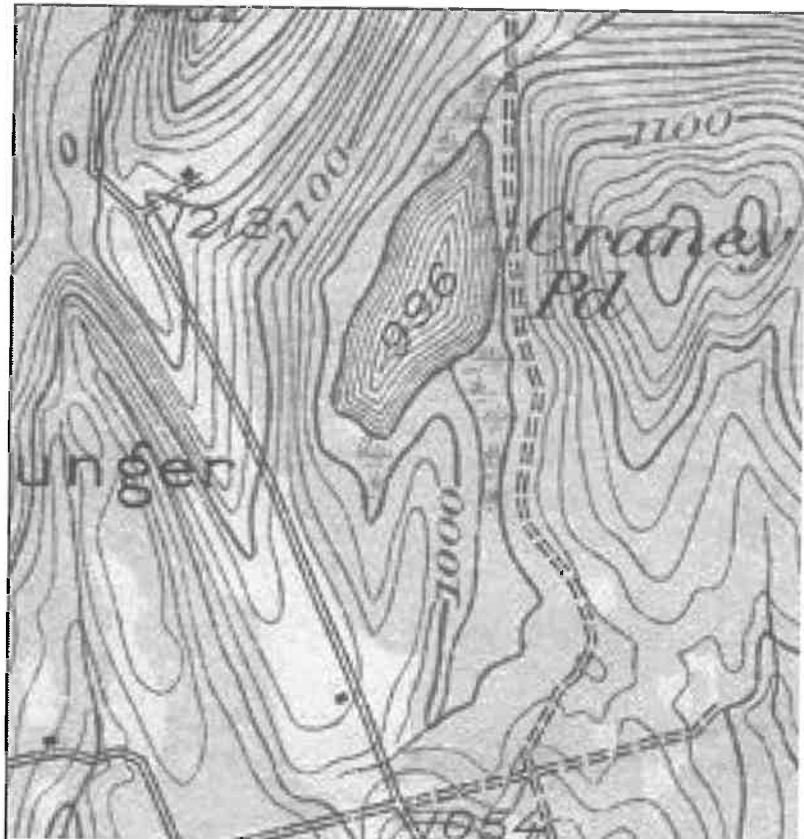
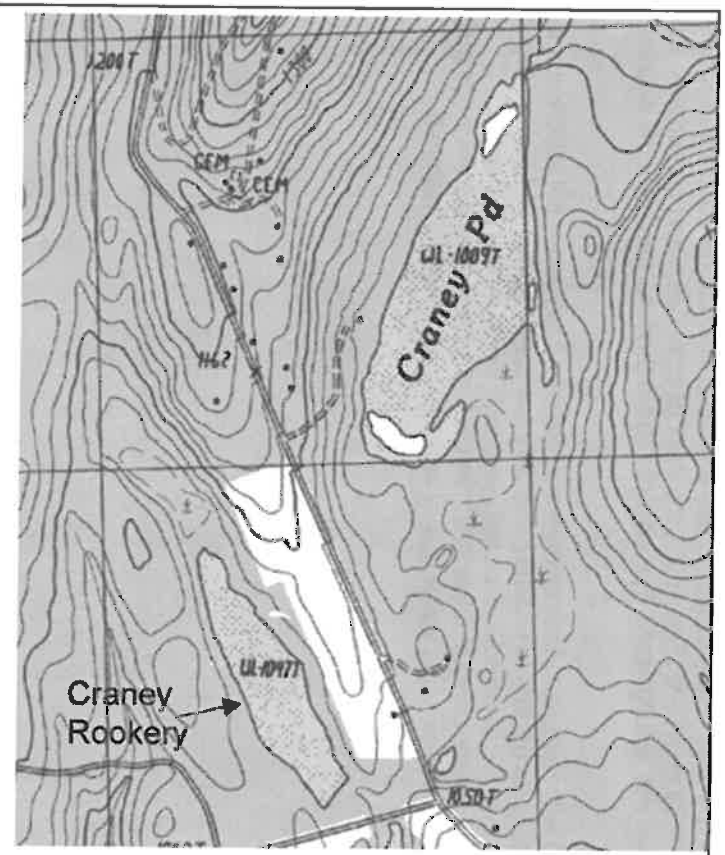


Figure 35. Aerial Photographs of Craney Pond and Craney Rookery from 1953 and 1998.



1929 Hillsboro Quadrangle



1987 Henniker Quadrangle

Figure 36. Topographic Maps of Craney Pond and Craney Rookery from 1929 and 1987.

Pleasant Pond

Pleasant Pond is located in Henniker's Quaker district. With consistently low ANC and total phosphorus concentrations, Pleasant Pond shows little evidence of the effects of landuse on water chemistry. Based on aerial photographs from 1953 and 1998 (Figure 38), the area of open fields and presumably agriculture has stayed fairly constant over the last 50 years. The only change in landuse has been the addition of homes adjacent to the pond.

Pleasant Pond was stratified with respect to temperature and dissolved oxygen in fall 2000 but not at the time of the fall 2001 survey (Figure 6). The high clarity and very low concentrations of total phosphorus indicate that Pleasant Pond is an oligotrophic system with very high water quality (Figure 37).
Pleasant Pond has low specific conductivity and low ANC which further supports the evidence that there is little or no influence from land use on pond water quality in the Pleasant Pond watershed.

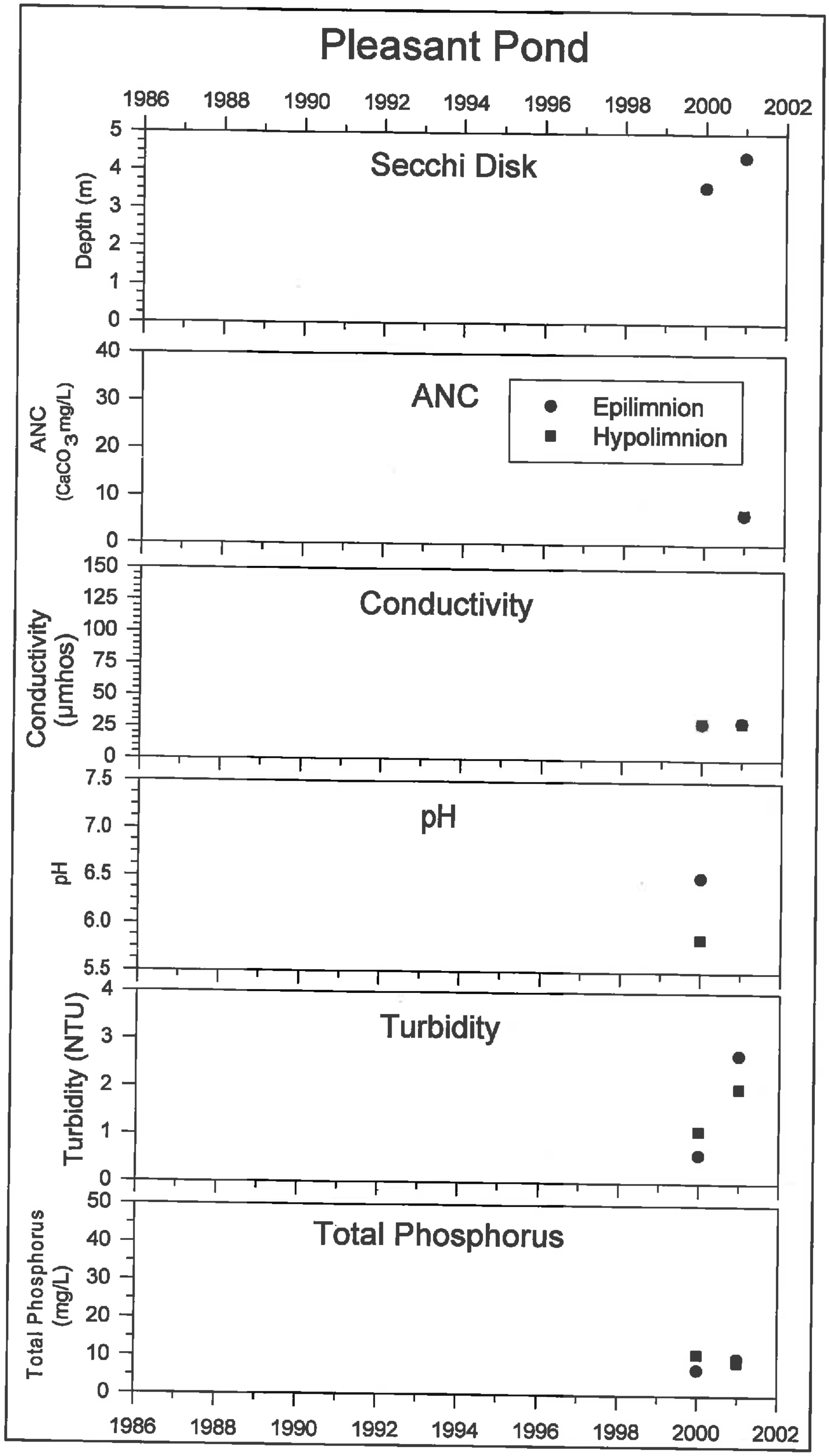


Figure 37. Pleasant Pond Temporal Water Chemistry Data.

Pleasant Pond

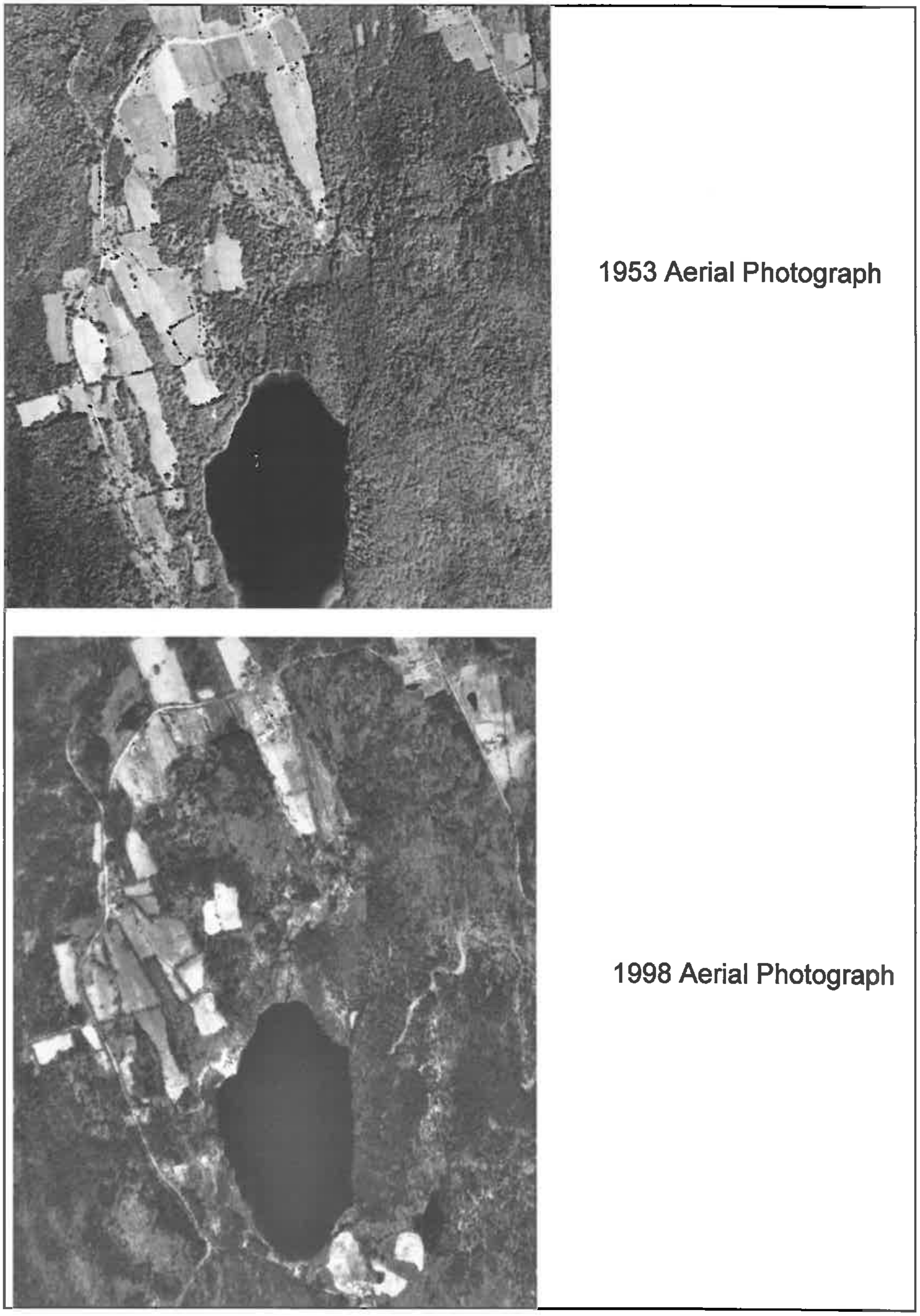
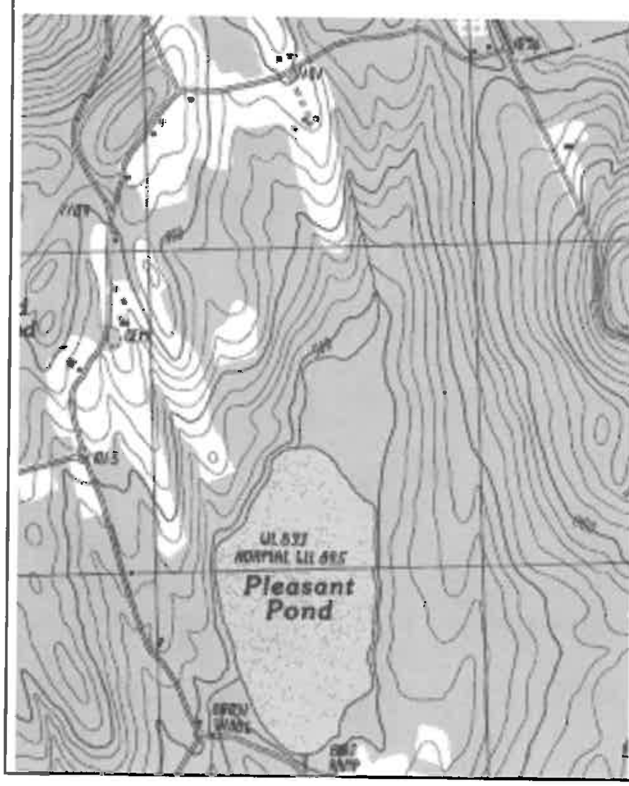


Figure 38. Aerial Photographs of Pleasant Pond from 1953 and 1998.

Pleasant Pond

1929 Hillsboro Quadrangle



1987 Henniker Quadrangle

Figure 39. Topographic Maps of Pleasant Pond Published in 1929 and 1927.

Morrill Pond

Morrill Pond is deep (> 8m) and is currently surrounded by wetlands and forest. However a portion of the watershed has been in open field and in agricultural use, including a dairy farm, for more than the last 150 years. Comparisons of aerial photographs from 1953 and 1998 indicate that the total area of open fields has not substantially changed (Figure 41). However there does appear to be less area in pastureland.

Morrill Pond was stratified by temperature and dissolved oxygen at the sampling in 2000 and 2001 (Figure 6). Clarity was moderate and somewhat higher than many of Henniker's ponds. During both years of the survey Morrill Pond was anaerobic in the hypolimnion. Morrill Pond has a slightly elevated specific conductivity and ANC compared to other Henniker Ponds.

Almost all of the shoreline of Morrill Pond is wetland with substantial rooted vegetation. However, the depth of Morrill Pond increases significantly within 10 meters of the shore which limits the extent to which sunlight can penetrate and the amount rooted vegetation in the pond. The elevated concentrations of total phosphorus indicate that the Morrill Pond is eutrophic (Figure 40). However, comparison of the amount of open water from aerial photographs from 1953 and 1998 does not indicate that Morrill Pond is filling in at an appreciable rate.

The pond seen to the south of Morrill Pond in the aerial photographs, Mud Pond 3, was not sampled as part of the recent surveys because of its inaccessibility.

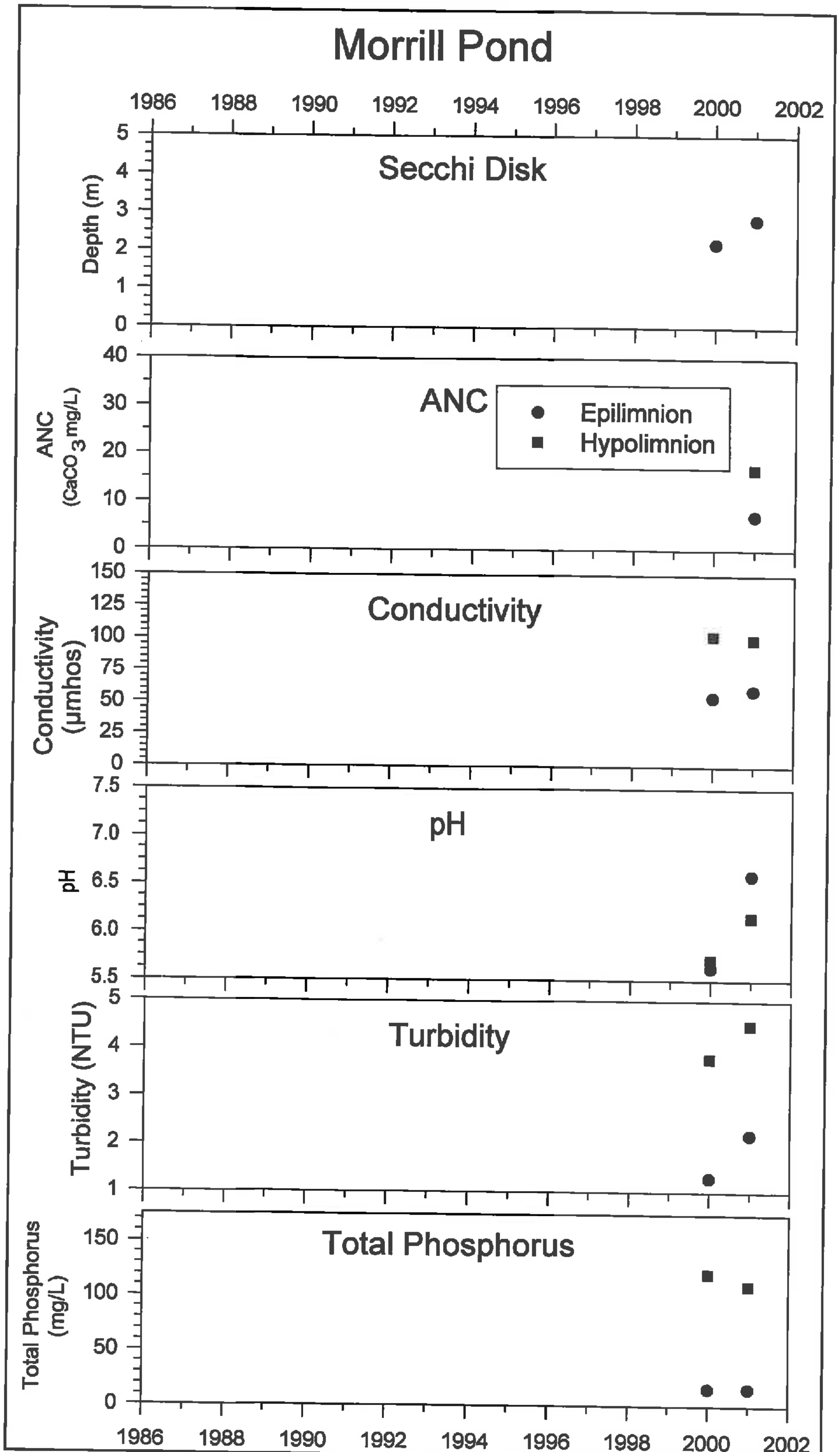


Figure 40. Morrill Pond Temporal Water Chemistry Data.

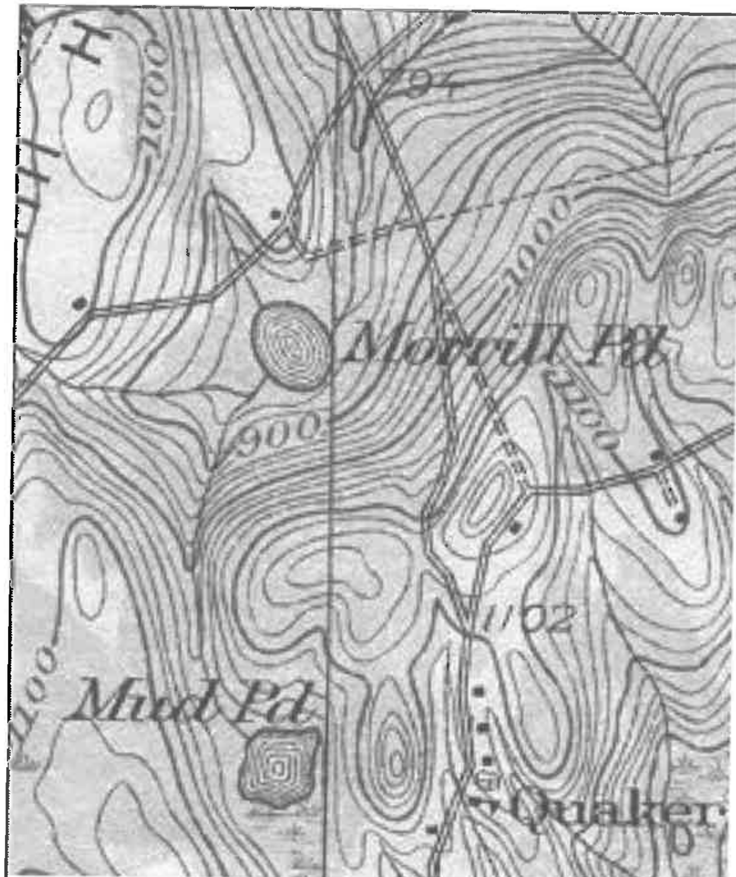
Morrill Pond

1953 Aerial Photograph

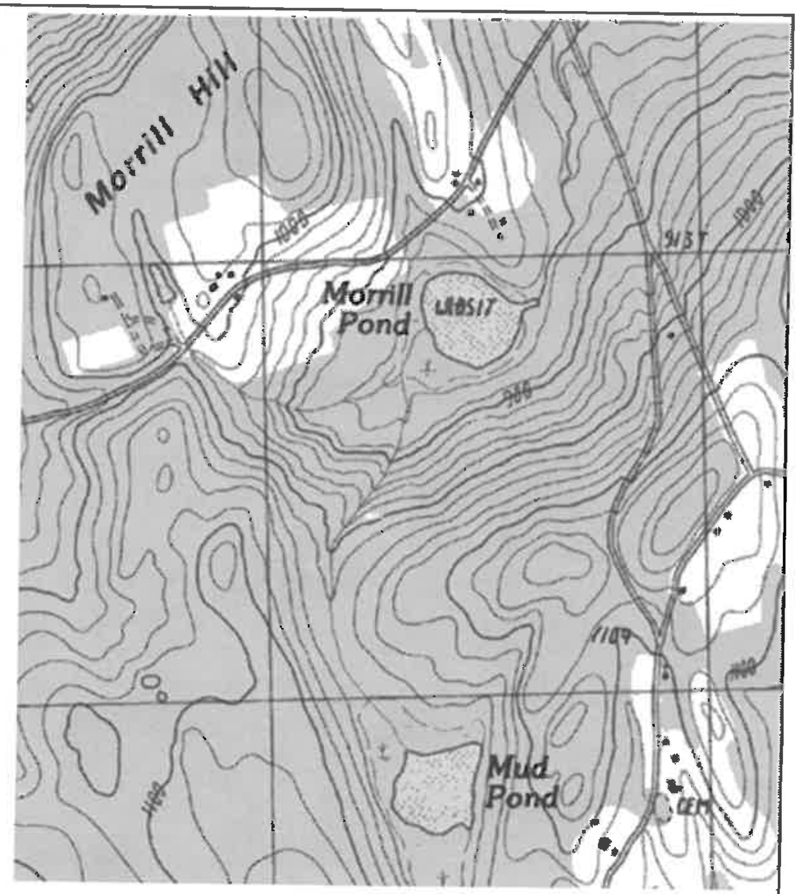
1998 Aerial Photograph

Figure 41. Aerial Photographs of Morrill Pond from 1953 and 1998.

Morrill Pond



1929 Hillsboro Quadrangle



1987 Henniker Quadrangle

Figure 42. Topographic Maps of Morrill Pond Published in 1929 and 1987.