# AN ASSESSMENT OF THE WATER QUALITY OF CROOKED LAKE RENSSELAER COUNTY, NEW YORK

by

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## Background

Crooked Lake is located in the south-central portion of Rensselaer County in the Town of Sand Lake. The lake's watershed is in the hilly area at the foot of the Rensselaer Plateau with a small portion of the eastern part of the watershed on the Plateau. Elevations within the watershed range from 827 feet at the surface of the lake to 1500 feet above sea level.

The lake has a surface area of 106 acres and a watershed of 840 acres. The outlet of Crooked Lake, a culvert running under the Eastern Union Turnpike, drains into Glass Lake through a large marshy area. An outlet at the western end of the lake which previously controlled drainage to Burden Lake is blocked. The lake ultimately drains into the Hudson River via Glass Lake and the Wynantskill. The drainage of the lake was altered by Henry Burden to provide water power to his rolling mill on the Wynantskill in the early 1800's.

The lake has a maximum depth of 10 meters (36 ft.) and exhibits thermal stratification. The surficial geology is all till (a sand and gravel soil without exposed bedrock) derived from glacial and alluvial deposits. The soil associations are Alps-Culvers-Cattaraugus and Worth-Empeyville- Westbury deposits. The former deposits are composed of upland soils derived from red slate and shale. The latter, occurring on the Rensselaer Plateau, consists of stones, boulders and outcrops on glacial till derived from sandstone. Drainage in these deposits is moderate to poor, and their ability to furnish lime, nitrogen and phosphorus to plants via root uptake is low to medium. From soil survey maps published by Rensselaer County Soil Conservation Service, soils at the eastern end of Crooked Lake appear adequate, but soils at the western end of the lake are not well suited for septic system use.

Table 1. Physical Features of Crooked Lake.

CROOKED LAKE - Sand Lake, Rensselaer County, New York

| | |
|---|---|
| Latitude | 42 degrees 37 minutes |
| Longitude | 73 degrees 32 minutes |
| Maximum Depth | 11 meters (36 feet) |
| Surface Area | 43 hectares (106 acres) |
| Watershed Area | 340 hectares (840 acres) |
| Elevation Above Sea Level | 255 meters (827 feet) |
| Annual Precipitation | 102-128 centimeters (40-50 inches) |
| Mean Annual Temperature | 8.6° C (47.5° Fahrenheit) |

Crooked Lake is a recreational lake with boating, fishing and swimming the primary uses. Public access for small boats and swimming is available at Methodist Farm Beach and Crooked Lake Inn. It is also possible to launch small boats near the outlet culvert where the Eastern Union Turnpike meets the lake. The watershed is densely populated, but some areas of undeveloped shoreline remain. Commercial land use on the shore of the lake is nominal. Sewage treatment is on an individual septic system basis. A septic survey conducted during the summer of 1971 by Rensselaer County Health Department found that of the 110 occupied structures, 21 had septic systems which were overflowing to the surface of the ground and several were flowing directly into the lake. Within a reasonable amount of time, 10 of the failing systems were repaired. There is no information available concerning the other 11 failing systems.

Copper sulfate has been added to Crooked Lake on a regular basis since 1953 in an attempt to control algae. Previous reports indicate that the level of copper in the lake water is low but that the sediments contain considerable amounts of copper.

## Sampling Locations

In order to characterize the chemistry of Crooked Lake water, five sampling sites were selected (Figure 1 and Table 2). Sites were selected to provide samples representative of the lake as a whole. Selection criteria include: water depth, degree of shoreline development, density of aquatic weed growth, proximity to inlets or outlets, and the presence of public access sites.

Table 2. Chemical Water Quality Sampling Sites.

| Site | Name | Location |
|---|---|---|
| 1 | Midlake | The sampling site was located midway between the large point of land on the northwest shore of the lake and the north shore of the lake. Maximum water depth at this site was 10 meters. |
| 2 | Outlet | The sampling site was located 10 meters south of the outlet culvert. Maximum water depth at this site was 3 meters. |
| 3 | Northwest Bay | The sampling site was located 50 meters east of the blocked outlet. Maximum water depth at this site was 1.5 meters. |
| 4 | East Midlake | The sampling site was in the center of the lake, midway between the Methodist Farm Beach and the junction of Rte. 66 and the Eastern Union Turnpike. Maximum water depth at this site was 8.6 meters. |
| 5 | Inn | The sampling site was located 20 meters west of the Crooked Lake Inn. Maximum water depth at this site was 4 meters. |

## Sampling Methods

At each lake site various types of water samples were collected: a surface grab for coliform bacteria analysis, an integrated sample to a predetermined depth (1, 2, 3, or 5 meters), a deep point sample from near the bottom of the lake in deep waters (i.e. greater than 8 meters), and specimens of aquatic vegetation.

Samples for coliform bacteria analysis were collected by submerging a sterile 500 milliliter bottle below the surface of the water and then inverting it to fill in such a manner that the mouth of the bottle was as far as possible from human skin. Care was taken to avoid collecting portions of the surface film in the sample. All samples were analysed within 6 hours of collection.

Integrated samples, encompassing a portion of the water column, were collected with a polyvinyl chloride hose. The hose was weighted at one end and lowered to the desired depth. The opposite end of the tube was sealed and the entire tube retrieved. The sample was drained into a collection bottle and mixed. Integrated samples were collected at all sites. At sites where the depth was 5 meters or greater, deep water point samples were taken using a Van Dorn collection bottle. The Van Dorn bottle was lowered to the depth in the lake where the sample was to be collected and remotely triggered to shut, thus collecting a sample of water at the depth where it was triggered.

At each site, the following measurements were made if conditions permitted: 1) water transparency by secchi depth, 2) water depth, 3) temperature, and 4) dissolved oxygen (D.O.) using a YSI Model 54 D.O./Temperature Meter. Water samples collected by the two previously described methods (integrator hose and Van Dorn collection bottle) were stored on ice until return to the laboratory. Immediately upon returning to the laboratory a portion of each sample was analysed for pH, specific conductance and alkalinity. A separate portion to be used for total phosphorus determination was frozen until analysed. A third portion was preserved with nitric acid for determination of copper. The remainder of each sample was filtered (0.4 um Nuclepore filter) and stored at 4° C until analysed for nitrate, ammonia, chloride and soluble silica concentrations. The analytical methods used for all determinations are listed in Appendix A.

## Results

Samples were collected from Crooked Lake on August 11 and 16, September 20, and October 25, 1984. The lake was thermally stratified throughout the summer months and destratification (turn over) had begun by the October 25 sampling (Figure 2). Thermal stratification, when used to describe a lake, refers to an increase or decrease in water temperature from the surface to the bottom of the lake. Since most of the heating of the lake occurs at the surface, temperature in the surface waters during the summer months is highest and decreases with depth. There is however, a zone of rapid temperature change over a small increase in depth (Figure 2). This zone is referred to as the thermocline. This thermocline acts as a barrier, effectively stopping mixing of the waters above it with the waters below it. The part of the lake above the thermocline is referred to as the epilimnion and the portion below the thermocline is known as the hypolimnion. From Figure 2, it is apparent that the thermocline in Crooked Lake occurs at between 6 and 7 meters (19-23 feet) during the summer months.

Depth profiles of dissolved oxygen and temperature were made on August 16, September 20 and October 25, 1984 (see Figure 2). The lack of oxygen in the hypolimnion (waters deeper than 6 meters) of Crooked Lake during the summer controls the type of organisms capable of utilizing this portion of the lake. This lack of oxygen is due to decomposition going on in the deep waters and sediments. Bacterial activity in the sediments of the lake bottom consumes oxygen and once the lake is stratified, the deep waters are effectively cut off from the primary source of oxygen to a lake, the atmosphere. A byproduct of some of the bacteria capable of living in the absence of dissolved oxygen is hydrogen sulfide which gives the water a "rotten egg" odor. Results from samples collected on October 25 (Figure 2) indicated that summer stratification was breaking up. The thermocline, though still present, occurred between 8 and 9 meters and dissolved oxygen was still absent in waters deeper than 8 meters.

The chemical constituents of primary concern for Crooked Lake residents would be those which promote the growth of algae and aquatic weeds. These materials, notably phosphorus and nitrogenous compounds, are fertilizers in that they are present in the shortest supply relative to the amounts needed to sustain algal growth. Addition of one or both of these nutrients generally results in a reduction of water quality since the concentrations of these nutrients control the amount of plant and thus animal material capable of growing in the lake. Sources of nitrogen and phosphorus to the lake include: the atmosphere through rain, snow, etc., surface runoff of soils, septic system leachate, resuspension from the sediments of the lake, runoff of fertilizers from farm fields or lawns and gardens, and fecal material from domestic animals.

Phosphorus is generally considered to be the primary limiting nutrient to plant growth. Total phosphorus concentrations listed in Tables 3 and 4 indicate that the amount of phosphorus in the surface waters of Crooked Lake is moderate and comparable to other Rensselaer County lakes. At any one time, most of the phosphorus is probably tied up in the cellular material of the organisms in the lake. Phosphorus concentrations in the deeper waters of the lake (midlake) during the summer months were quite high (121 ppb). As the lake turned over in the fall, rapid algal growth resulted from the large amounts of the phosphorus present in the deep waters being brought to the surface. The remains of an algal bloom were apparent during the fall sampling trip.

The methods used to determine the amount of nitrogenous compounds in the lake water only measure materials not contained in living tissue or particulate material. From Table 3, it is apparent that there are little or no nitrogenous compounds (ammonia and nitrates) available in the surface waters during the period of summer stratification (August 11, 16 and September 20 samples). Most of the nitrogenous material is probably bound up in living tissue (i.e. algae, plants, fish, etc.). As there was not a discernable algal bloom occurring at the time of sampling, the lack of available ammonia and nitrates indicates that nitrogenous material may be limiting to algal productivity in Crooked Lake. The deeper waters of the lake (midlake and East midlake samples) had considerable amounts of ammonia, a byproduct of the decomposition processes going on in the sediments. As the lake mixed during fall overturn the nitrate and ammonia concentrations of the hypolimnion decreased (Table 3, October 25 samples). The resultant increase of nitrate and ammonia in the surface waters probably spurred the considerable growth of algae observed during the fall sampling trip.

Alkalinity and pH records for Crooked Lake are listed in Table 3. The pH at all sites was approximately neutral (pH near 7.0). The ability of a lake to neutralize additions of acid via acid rain or surface runoff is measured by alkalinity or the buffering capacity present in the lake water. The alkalinity of Crooked Lake ranged from 17.6 to 19.0 mg/L as $CaCO_3$ in the surface waters (epilimnion). These alkalinity values are low but as evidenced by the neutral pH of the lake water, it presently has an adaquate capacity to buffer any acids coming into the lake. The greatest amount of acid enters the lake during the spring when rapid melting of snow occurs. This is generally the time when the most acidic (less than 7) pH values are observed in lakes and streams. Since spring water samples were not included in this study, the effects of spring snowmelt on the pH of Crooked Lake remains to be determined.

Secchi depth is a simple measure of water transparency. Water transparency is controlled by the density of plankton and the amount of fine grained silts and clays present in the water. Nutrient rich lakes, for example Saratoga Lake listed in Table 4 for comparison, generally have large numbers of plankton in the water which result in low transparency results. Shallow lakes in areas where the soils are mainly fine clays and silts also have generally low secchi transparency readings due to constant resuspension of the fine sediments via wave activity. Water transparency in Crooked Lake as measured with a Secchi Disk averaged 3.5 meters (11 feet). This transparency is comparable to other lakes in Rensselaer County (Table 4).

Specific Conductance is a measure of the total dissolved compounds present in the water. Conductivity values in the surface waters ranged from 65 to 77 umhos. Samples taken from the hypolimnion, waters deeper than seven meters, exhibited considerably higher conductivities than other locations with a range of from 81 to 105 umhos during summer stratification. Higher conductivities in the deeper waters are partially due to increased concentrations of ammonia and phosphorus. During fall overturn, the October 25 samples, conductivity values in the surface waters were higher than recorded for summer samples. The fact that the conductivity at the deep midlake site was still much higher (105 umhos) than the surface waters of the lake indicates that mixing of the lake was still not complete. The east midlake sample taken at 8 meters depth however, was similar to the surface water results.

The chloride concentrations for all samples from Crooked Lake ranged from 9.6 to 10.7 milligrams per liter. Concentrations of chloride in this range are average for Rensselaer County (Table 4) and present little or no hazard. Since spring samples were not collected specific statements on input of chlorides to the lake via road salt cannot be made at this time.

Copper sulfate has been used for algae control in Crooked Lake since 1953. The levels of copper in the surface water are measureable, but fairly low (Table 3). Studies done at Russell Sage by Dr. Armstrong indicate that even though copper levels in the water are quite low, there is a moderate amount of copper present in the sediments. Presently there appears to be little health hazard however, alternate methods are available which present little potential for human health hazards and may be more effective than copper sulfate for algae control.

The coliform group of bacteria are used as the principal indicator of suitability of water for domestic and recreational use. These bacteria are found in the digestive tract of warm blooded animals and excreted with fecal material. Coliform bacteria though not generally pathogenic (disease causing) in humans indicate the presence of sewage which frequently carries other potentially pathogenic bacteria and viruses. Ratios of the different groups of coliform organisms are used to determine whether the sewage source was human or other warm blooded animal, e.g. cattle, poultry, etc. Assays of total and fecal coliform bacteria in Crooked Lake were made at various locations to determine potential locations of sewage input and to provide assurance that Crooked Lake remains within NYS guidelines for contact recreation (i.e. swimming). Levels of coliform bacteria in the lake (Table 3) are well below the allowable limits set by New York State for contact recreation (Table 5, Class B). The number of coliform bacteria in samples collected during the fall sampling were generally lower than results from the summer samples. Since coliform bacteria levels in samples taken during the time of greatest human activity (summer) were considerably higher than samples collected in the fall, some sewage may be entering the lake.

A bathymetric map of Crooked Lake (Figure 3) is provided courtesy of NYS Department of Environmental Conservation.

Specimens of rooted aquatic plants (macrophytes) present were collected at each site. A list of the species collected is included as Table 6. In addition, a map of the weed beds present during the August 16 sampling is included (Figure 4) with a characterization of the different groups of plants found for each bed. Aquatic weeds do not presently appear to be a problem for boating but the densities observed in the northwest bay and to a lesser extent the southeast bay provide undesirable conditions for swimming. In all likelihood, the weed beds provide habitats for numerous fish and other organisms allowing for a good warm water sports fishery. Filamentous algae, primarily of the genera *Spirogyra* and *Mugeotia*, were observed growing in dense mats over the surfaces of rocks and aquatic weeds along the shoreline. A pamphlet on control techniques for both aquatic weeds and filamentous algae produced by NYS Dept. of Environmental Conservation is included for your information.

A list of the fish species reported for Crooked Lake (Table 7) is included courtesy of the NYS Department of Environmental Conservation.

A survey of water quality in Rensselaer County lakes was completed by RPI in 1972. Comparison of data from this report with the present study indicates that the chemistry of Crooked Lake water has remained fairly stable over the last 12 years (Table 8). Decreases in both phosphorus and nitrate concentrations in the lake water are apparent. Chemistry data on Crooked Lake water for 1978, provided by Dr. Armstrong of Russell Sage (Table 8), is comparable to results from the present study.

Only two sets of water chemistry data for Crooked Lake (Table 9) were found in Rensselaer County Department of Health records. One entry for 1934 indicates that the pH and to a lesser extent alkalinity of Crooked Lake have not changed substantially during the last 50 years. Chloride concentrations reported in the present study are double those reported by DOH in 1970. The discrepancy may be due to improved analytical techniques, however a closer look at the chloride inputs to the lake is warranted.

## SUMMARY AND SUGGESTIONS

At present, the water quality of Crooked Lake is adequate for the primary use of its' residents, namely recreation. The chemical and bacteriological results are well within guidelines set by New York State for these uses (Class B, Table 5). Use of Crooked Lake water for drinking or food preparation without prior treatment (chlorination) is probably not advisable. If it is necessary to use lake water for these purposes, chlorination is desirable to kill any potential pathogenic organisms and filtration to remove particulates is well worth the small additional cost. Location of intakes for lake water systems should be given careful consideration. The intake should be no deeper than 5 meters (17 feet) to assure well oxygenated water and should be no shallower than 2 meters (6 feet) to avoid sediments mixed by wave action and recreational activity. Without active concern the good water quality presently enjoyed by residents is not guaranteed.

Since the lake serves public and private users as a bathing area, elimination of all inputs from septic systems should be of primary concern. Initiation of a new Septic Survey by the Rensselaer County Department of Health (DOH) should be expedited. The survey will determine any severe problems and it then becomes the Department of Health's responsibility to oversee correction of any problems encountered. If the DOH, as a result of a lack of manpower, is unable to complete the survey, the association members may wish to do their own survey. I have included a sample septic survey form for your information (Appendix B). The only shortcoming of doing your own survey is the lack of any legal right to force residents to correct failing systems. DOH may be willing on a case by case basis to help you with this. After completion of the survey, lake residents should still police themselves since systems that were operational during the survey may fail shortly afterward.

As previously discussed, nitrogen and phosphorus compounds entering the lake are likely to cause the greatest problems for recreational users. There are a number of ways that the amount of these nutrients entering the lake can be reduced. Methods for reduction will be discussed in relation to the source of input.

Nutrient additions from the atmosphere through rain, snow, etc. are a large part of the total nutrients added to a lake each year. The ability to reduce inputs from this source is limited.

Reduction of the amount of impermeable surfaces adjacent to the lake (paved roads and driveways, sidewalks, etc.) will slow the flow of rainwater to the lake by forcing it to percolate through soils prior to entering the lake. Soils act as a natural filter removing much of the nitrogen and phosphorus compounds before the water reaches the lake. Eliminating stormwater drains emptying directly into the lake is also helpful. The drains may be redirected to small gravelled areas for slow dispersal of the water.

Sewage from failing or improperly located septic systems can be a major source of nutrients to a lake. In a properly maintained and located septic system, solid material is allowed to settle in the septic tank where microorganisms can decompose it into water soluble material. The water soluble components (leachate) are allowed to pass into lateral drainage fields where the liquid slowly percolates into adjacent soils. In the soil, chemical reactions and bacteria remove the nitrogen and phosphorus compounds from the water and convert it to insoluble material, cellular material and gaseous material. Thus, in a properly operating system nitrogen and phosphorus are removed before the water finally percolates back to the lake. In a system which is not operating properly, insufficient time is available for complete removal of nitrogen and phosphorus compounds before the leachate reaches the lake. Septic system failure is likely to occur when the systems are:

1) built in fill over an old wetland or natural drainage area

whose water table is near the surface of the soil.

2) not of sufficient size to handle normal and peak loading rates.

3) located where the depth of soil present over bedrock is less than six feet.

4) located less than 50 feet from the shore of a lake or a stream.

5) located in soils with extremely high permeability or steeply sloping ground resulting in too rapid a movement of liquid through the system.

6) receiving excessive amounts of undigestable or slowly digested materials (i.e. plastics, bone or eggshells) without frequent pumpout.

7) older than 30 years and have never been upgraded.

Extreme septic system failures may be observed as clogged toilets and drains or puddling of water on the surface of the ground near the location of the septic leaching device of the system. Puddling is most likely to occur when the soils are quite wet primarily during the spring of the year and after periods of heavy rain in the summer. Surface pooling of water is also most common at high water usage times of day, generally in the morning. Septic inputs directly into the lake generally result in excessive growth of dense filamentous mats of algae near the point where the sewage enters the lake.

Eroding soils carry considerable amounts of nutrients into the lake. Soils generally contain much greater amounts of nitrogen and phosphorus compounds than lake water. If soils are stabilized by good vegetation cover, only small amounts of nutrients are washed into the lake. If large areas of timber are logged or if roads and developments are improperly designed, large scale erosion of soils frequently results. Soil erosion may be controlled in several ways by: 1) maintaining or planting effective ground cover vegetation (e.g. Crown Vetch) in erosion prone areas, 2) restricting the amount of acreage that may be logged at any one time and the time of year when logging operations occur, 3) providing guidelines on road construction within the basin and methods that contractors use to develop property, and 4) maintenance of a vegetated area along the shoreline. Considerable amounts of soils are deposited in the lake by streams. Some of the soils may be removed by minimum adjustments to the stream bed to reduce the water velocity in the stream prior to entry into the lake. Reduced water velocity in the stream will cause the bulk of the suspended soils to be deposited in the low velocity area and with occasional cleanout this area can be maintained fairly easily. Your local Soil Conservation Service representative can provide valuable assistance in determining the extent of erosion problems and suggesting methods for soil conservation.

The runoff of fertilizers applied to lawns and gardens can frequently add nitrogen and phosphorus to a lake. There are a number of "common sense" methods for reducing the inputs from these sources. Don't fertilize early in the spring or at other times when soils are saturated from recent rainstorms. Try to apply small amounts of fertilizer more frequently (i.e. twice per year add one-half the amount usually applied once per year). Don't locate vegetable gardens or other gardens that you plan to fertilize heavily close to the lake. Don't fertilize immediately before a rainstorm is forecast.

Continued monitoring of Crooked Lake water quality by your association is desirable. A chemical assay program as extensive as that presented in this report is not necessary on an annual basis. Lake Association members in conjunction with their water quality committee can make certain measurements that will prove useful in observing any long-term trends in water quality. The Fresh Water Institute currently assists the Lake George Association in operating a Lay Monitoring Program on Lake George. A similar program could be beneficial to Crooked Lake. Association members are provided with Secchi disks and thermometers to record the transparency and temperature of the lake once per week during the summer months. At the end of the year, the data is gathered and compared to results from previous years to provide a measure of any significant changes in water transparency. If your association is interested in initiating such a program, an FWI staff member would be glad to meet with you and discuss the training and equipment necessary. On a three or five year basis, more complete chemical assays and observations of the lake may be advisable. These lake observations and chemical assays may be conducted by such groups as Dyken Pond Environmental Management Center, RPI Freshwater Institute, RPI Department of Environmental Engineering, and many others. If the association feels that they want to collect samples and make their own assessments, laboratories such as Bender Labs in Albany, C.T. Male in Latham, or the Fresh Water Institute are certainly capable of sample analysis on a fee per sample basis.

The Rensselaer County Department of Health currently monitors the levels of coliform bacteria and selected chemical compounds in the lake adjacent to the Methodist Farm Beach. Your water quality committee or a member of the lake association can request copies of this information and an annual review of this data would be desirable. Storage of historical data from this source and annual reviews are something that can probably be done by members of the association. If professional help is desired, the FWI or some of the state agencies already mentioned can probably be of help.

An informed community is also an important asset. The FWI currently provides a lecture series at our Bolton Landing facility, one evening each week during the summer months, covering environmental and other topics of general interest. Your association could sponsor a similar program at little cost. I have enclosed a list of last summers lecturers to give you an idea of the agencies willing to provide lecturers (Appendix C). In addition, certain universities, state and local agencies offer summer programs and courses for children and adults at nominal costs. I have enclosed the course brochure for summer courses provided by the Fresh Water Institute and I'm sure that the Dyken Pond Environmental Management Center, Five Rivers Environmental Education Center or the Huyck Preserve have similar offerings and may even be willing to conduct one or two day field activities at Crooked Lake.

**ACKNOWLEDGEMENTS**

We would like to thank Dr. Roger Armstrong of the Chemistry Department of Russell Sage College for providing us with his unpublished chemistry data on Crooked Lake, Doug Carlson of NYSDEC, Region 4 for fisheries data, and Dennis Carroll for providing Rensselaer County Department of Health reports for Crooked Lake. We would also like to thank Robert Lilly of the Crooked Lake Association for locating a boat for our use and access to the lake.

TABLE 3. Results of Water Chemistry from Crooked Lake.

| Site | Depth (M) | Secchi Depth (Meters) | Alkalinity mg/l as CaCO3 | Conductivity (umhos) | TP ppb | Nitrate (ppm) | Chloride (ppm) | Ammonia (ppm) | Copper (ppm) | pH | TC | FC | Soluble Silica (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 08/11/84 | | | | | | | | | | | | | |
| outlet | surf. | | 20.6 | 73 | | 0.03 | 9.8 | <0.01 | 0.02 | 6.93 | 640 | 1460 | 0.18 |
| 08/16/84 | | | | | | | | | | | | | |
| outlet | 0-2 | | 19.0 | 66 | 12 | 0.03 | 10.0 | 0.03 | <0.01 | 6.85 | 20 | 385 | 0.25 |
| SE Bay | 0-3 | 3.2 | 17.6 | 66 | 21 | 0.03 | 9.9 | 0.05 | 0.01 | 6.75 | 50 | 230 | 0.16 |
| NW Bay | 0-1 | | 17.6 | 70 | 14 | 0.04 | 9.6 | 0.03 | 0.01 | 6.88 | 20 | 800 | 0.25 |
| midlake | 0-5 | 4.2 | 17.6 | 65 | 13 | 0.02 | 9.7 | <0.01 | <0.01 | 6.87 | 37 | | 0.24 |
| midlake | 10 | | 58.0 | 87 | 121 | 0.02 | 10.6 | 0.86 | 0.03 | 7.23 | | | 2.50 |
| Inn | 0-2 | | 17.6 | 66 | | <0.01 | 9.7 | <0.01 | <0.01 | 6.81 | 0 | 320 | 0.27 |
| 09/20/84 | | | | | | | | | | | | | |
| midlake | 0-5 | 2.5 | 17.6 | 68 | | <0.01 | 10.4 | 0.03 | <0.01 | | | | 0.90 |
| 10/25/84 | | | | | | | | | | | | | |
| outlet | 0-2 | | 17.6 | 76 | 10 | 0.01 | 10.4 | 0.01 | <0.01 | 6.81 | 0 | 0 | 0.91 |
| SE Bay | 0-3 | | 17.6 | 78 | 14 | 0.01 | 10.4 | 0.03 | <0.01 | 6.86 | <10 | 10 | 0.86 |
| NW Bay | 0-1 | | 17.6 | 76 | 18 | 0.01 | 10.4 | 0.02 | <0.01 | 6.82 | 0 | 0 | 0.95 |
| midlake | 0-5 | 3.4 | 17.6 | 76 | 12 | <0.01 | 10.2 | 0.02 | <0.01 | 6.94 | 10 | 5 | 0.90 |
| midlake | 10 | | 33.3 | 105 | 34 | <0.01 | 10.7 | 0.38 | <0.01 | 6.47 | | | 2.84 |
| E midlake | 0-5 | 3.9 | 17.6 | 77 | 16 | 0.01 | 10.3 | 0.05 | <0.01 | 6.92 | | | 1.00 |
| E midlake | 8 | | 19.6 | 81 | 36 | 0.01 | 10.2 | 0.13 | 0.01 | 6.39 | | | 1.44 |
| Inn | 0-2 | 3.8 | 17.6 | 76 | 13 | <0.01 | 10.3 | 0.05 | <0.01 | 6.92 | 0 | 0 | 0.92 |

TP=Total Phosphorus
TC=Total Coliform Bacteria as Colonies per 100 milliters of sample
FC=Fecal Coliform Bacteria as Colonies per 100 milliters of sample
<=Less Than. This notation is used to indicate concentrations below analytical limit of detection
ppm=Parts per Million
ppb=Parts per Billion

TABLE 4. Surface Water Chemistry for Selected Lakes.

| Lake | Secchi Depth (meters) | Alkalinity (mg/l as CaCO3) | Specific Conductance (umhos) | Total Phosphorus (ppb) | Nitrate (ppm) | Ammonia (ppm) | Chloride (ppm) |
|---|---|---|---|---|---|---|---|
| Lake George New York | 8.0 | 26.0 | 95.0 | 5.0 | <0.01 | <0.01 | 6.5 |
| Babcock Lake Rensselaer Co., NY | 3.7 | 16.0 | 72.0 | 13.0 | 0.01 | 0.03 | 9.6 |
| Glass Lake Rensselaer Co., NY | 3.3 | 24.0 | 67.0 | 13.0 | 0.01 | <0.01 | 8.2 |
| Crooked Lake Rensselaer Co., NY | 3.5 | 15.0 | 71.0 | 15.0 | 0.01 | 0.03 | 10.0 |
| Saratoga Lake Saratoga Co., NY | 2.2 | 77.0 | | 100.0 | 0.30 | 0.30 | |

## Table 5. CLASSIFICATIONS AND STANDARDS FOR FRESH SURFACE WATERS

| | | | DISSOLVED OXYGEN STANDARDS | | | | | COLIFORM STANDARD[1] | | | | | | RADIOACTIVITY STANDARDS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Trout Waters | | | Non Trout Waters | | | | | | | | | | |
| Classification | Best Usage | Conditions of Best Usage | Trout Waters Spawning | Min. Daily Average | Min. | Min. Daily Average | Min. | Monthly Median Value | 20% of Sample | Monthly Geometric Mean | pH | Total Dissolved Solids | Phenolic Compounds | Gross Beta | Radium 226 | Strontium 90 |
| Class AA | Water supply for drinking or food processing | Waters will meet Health Department standards | 7 mg/l | 6 mg/l | 5 mg/l | 5 mg/l | 4 mg/l | Less than 50/100ml coliforms | Less than 240/100ml coliforms | ----- | 6.5-8.5 | As low as practicable. Less than 500 mg/l | Less than 0.001 mg/l (phenol) | Less than 1000pc/l (In absence of $Sr^{90}$ and alpha emitters) | Less than 3pc/l | Less than 10pc/l |
| Class A | Water supply for drinking or food processing | Waters will meet Health Department standards for drinking water with approved treatment | 7 mg/l | 6 mg/l | 5 mg/l | 5 mg/l | 4 mg/l | Less than 5000/100ml coliforms | Less than 20,000/100ml coliforms | Less than 200/100ml fecal coliforms | 6.5-8.5 | As low as practicable. Less than 500 mg/l | Less than 0.005 mg/l (phenol) | Less than 1000pc/l (In absence of $Sr^{90}$ and alpha emitters) | Less than 3pc/l | Less than 10pc/l |
| Class B | Contact recreation and other uses except water supply and food processing | ------ | 7 mg/l | 6 mg/l | 5 mg/l | 5 mg/l | 4 mg/l | Less than[2] 2,400/100 ml coliforms | Less than[2] 5,000/100 ml coliforms | Less than[2] 200/100ml fecal coliforms | 6.5-8.5 | None detrimental to aquatic life. Waters currently less than 500mg/l shall remain below this limit. | ------ | ------ | ------ | ------ |
| Class C | Fishing and other uses except water supply, food processing and contact recreation | ------ | 7 mg/l | 6 mg/l | 5 mg/l | 5 mg/l | 4 mg/l | ------ | ------ | Less than[2] 10,000/100ml coliforms and 2,000/100ml fecal coliforms | 6.5-8.5 | None detrimental to aquatic life. Waters currently less than 500mg/l shall remain below this limit. | ------ | ------ | ------ | ------ |
| Class D | Secondary contact recreation. Waters are not suitable for propagation of fish | Waters must be suitable for fish survival | ------ | ------ | ------ | ------ | 3 mg/l | ------ | ------ | ------ | 6.0-9.5 | ------ | ------ | ------ | ------ | ------ |
| Class N | Enjoyment of water in its natural condition for whatever compatible purposes | No waste discharges whatsoever permitted without approved filtration through 200' of unconsolidated earth | Natural | Natural | Natural | Natural | Natural | Natural | Natural | Natural | Natural | Natural | ------ | Natural | Natural | Natural |

NOTES:

1) A minimum of five examinations are required.
2) Standard to be met during all periods of disinfection.
3) Additional standards applicable to the above classifications: Turbidity-no increase that will cause a substantial visible contrast to natural conditions; Color-None from man-made sources that will be detrimental to the specified best usage of waters; Suspended, colloidal or other solids-None from any waste discharge which will cause deposition to the best usage of water; Oil and floating substances-No residue attributable to a waste discharge nor visible oil film nor globules of grease; Taste and odor-producing substances, toxic wastes and deleterious substances-None that will be injurious to fish life or which will adversely affect the flavor, color or odor, thereof, or impair the waters for the specified best usage of water; Thermal discharges-No discharge which will be injurious to fish life or to make the waters unsafe or unsuitable for any classified use.
4) With reference to certain toxic substances affecting fish life, the establishment of any single numerical standard for waters of New York State would be too restrictive. There are many waters, which because of poor buffering capacity and composition will require special study to determine safe concentrations of toxic substances. However, most of the non-trout waters near industrial areas in this state will have an alkalinity of 80 milligrams per liter or above. Without considering increased or decreased toxicity from possible combinations, the following may be considered as safe stream concentrations for certain substances to comply with the above standard for this type of water. Water of lower alkalinity must be specifically considered since the toxic effect of most pollutants will be greatly increased. Ammonia or Ammonium Compounds-Not greater than 2.0 milligrams per liter expressed as $NH_3$ at pH of 8.0 or above; Cyanide-Not greater than 0.1 milligrams per liter expressed as CN; Ferro or Ferricyanide-Not greater than 0.4 milligrams per liter expressed as Fe(CN)6; Copper-Not greater than 0.2 milligrams per liter expressed [illegible] expressed as Zn; Cadmium-Not greater than 0.3 milligrams per liter expressed as Cd.

**Table 6. Rooted Aquatic Plants Found at Crooked Lake Sampling Sites.**

| Common Name | Classification | Frequency |
|---|---|---|
| Yellow Pond Lily | Nuphar advena | A |
| White Pond Lily | Nymphaea tuberosa | O |
| Fern Pond Weed | Potamegeton robbinsii | A |
| Broad Leafed Pond Weed | Potamegeton amplifolius | A |
| Pickerel Weed | Pontedaria chordata | C |
| Coontail | Ceratophyllum demersum | C |
| Waterweed | Elodea | A |
| Broad Leaved Cattail | Typha latifolia | C |

A= Abundant
C= Common
O= Occasional

**Table 7. Fish Indigenous to Crooked Lake.**

| Common Name | Classification |
|---|---|
| Largemouth Bass | Micropterus salmoides |
| Chain Pickerel | Esox niger |
| Brown Bullhead | Ictalurus nebulosus |
| Pumpkinseed Sunfish | Lepomis gibbosus |
| Redbreast Sunfish | Lepomis auritus |
| Rock Bass | Ambloplites rupestris |
| Black Crappie | Pomoxis nigromaculatus |
| Yellow Perch | Perca flavescens |
| White Perch | Morone americana |

Table 8. Historical Water Chemistry Data on Crooked Lake.

| Parameter | 1978 | 1977 | 1972 |
|---|---|---|---|
| Total Phosphorus (ppb) | 15 | | 36 |
| Ortho Phosphorus (ppb) | 2 | | |
| Nitrate (ppm) | | | 0.07 |
| Chlorophyll *a* (ppb) | 3.1 | | |
| Secchi Transparency (m) | 3.9 | 2.9 | 2.8 |
| Alkalinity (ppm) | | | 41 |
| pH | | | 6.3 |
| Soluble Silica (ppb) | 85.0 | | |

CONNECTION (Crooked to Glass)

| | Total Phosphorus (ppb) | Ortho Phosphorus (ppb) |
|---|---|---|
| 1-Crooked Outlet | 44 | 15 |
| 2- | 45 | 18 |
| 3- | 45 | 19 |
| 4- | 22 | 8 |
| 5- | 27 | 5 |
| 6- | 20 | 4 |
| 7-Glass Inlet | 10 | 2 |

Table 9. Crooked Lake Chemistry Records from Rensselaer County Dept. of Health.

| Date | pH | Alkalinity (ppm) | Nitrate (ppm) | Ammonia (ppm) | TP (ppb) | Chloride (ppm) |
|---|---|---|---|---|---|---|
| 08/21/34 | 6.9 | 12.0 | | | | |
| 09/11/70 | 7.0 | 11.0 | <0.1 | 0.1 | 200 | 4.6 |

Figure 1. Crooked Lake Sampling Site Locations.

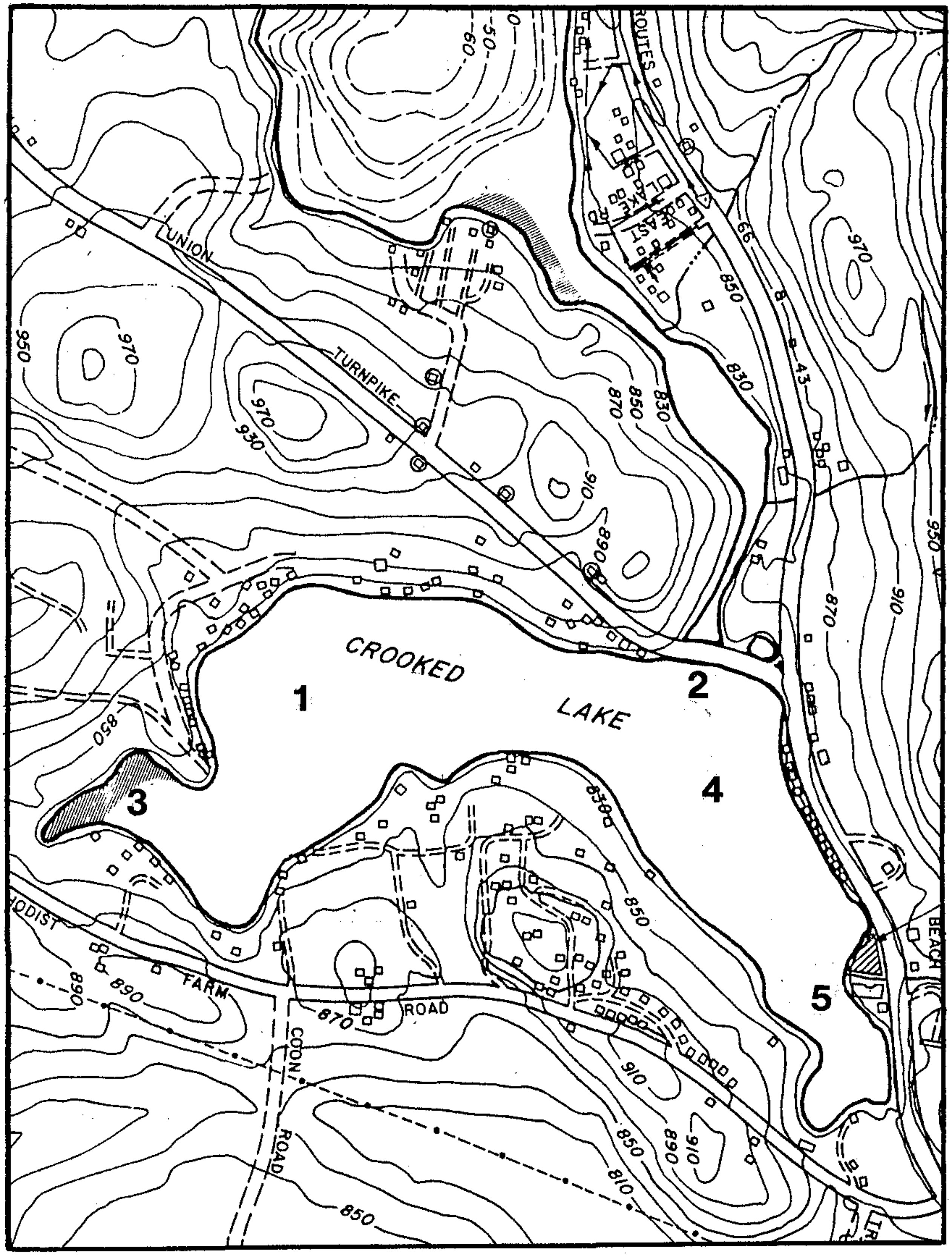
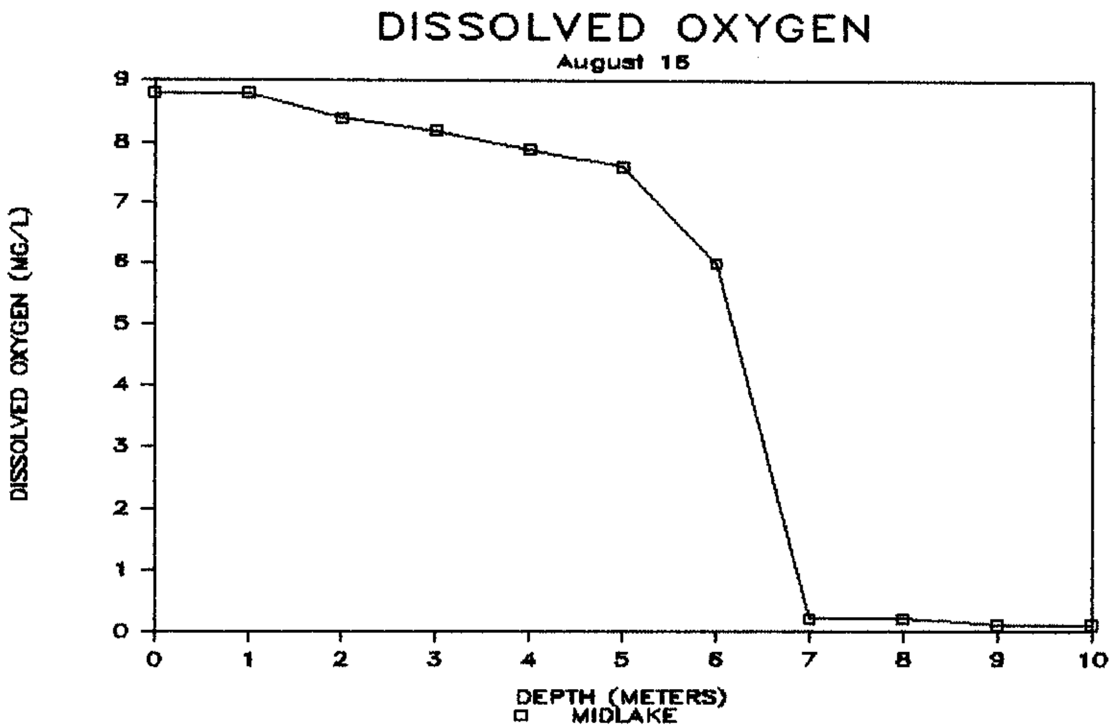


Figure 2. Dissolved Oxygen and Temperature Profiles of Crooked Lake.



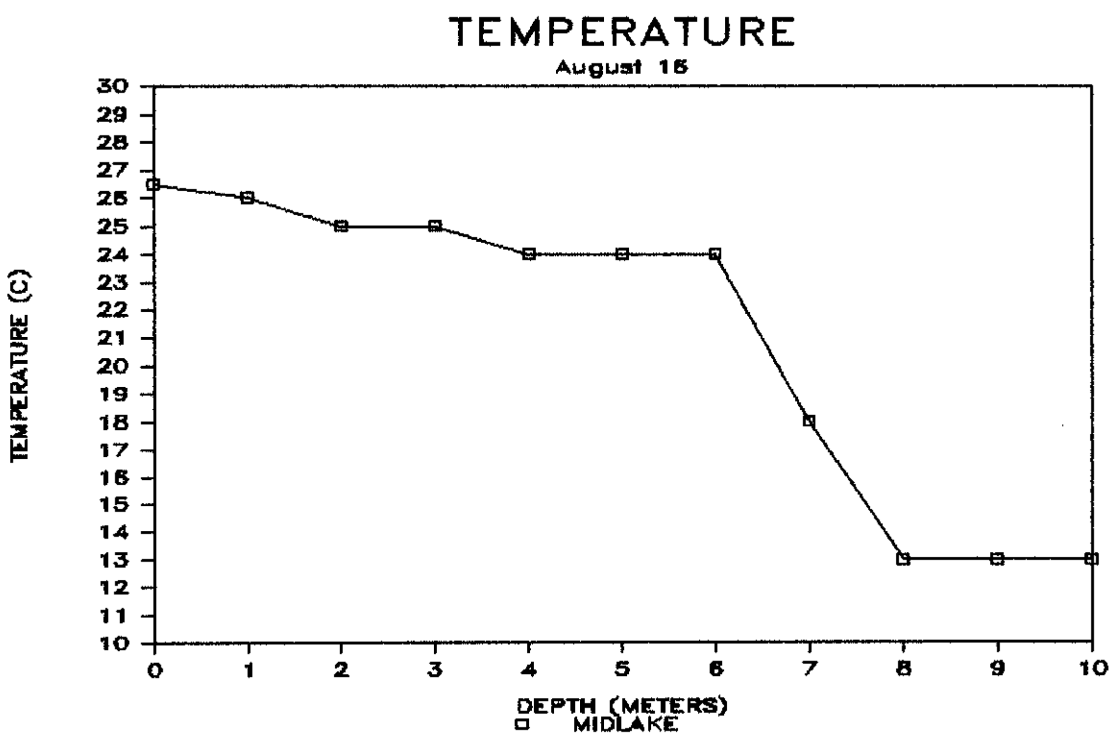
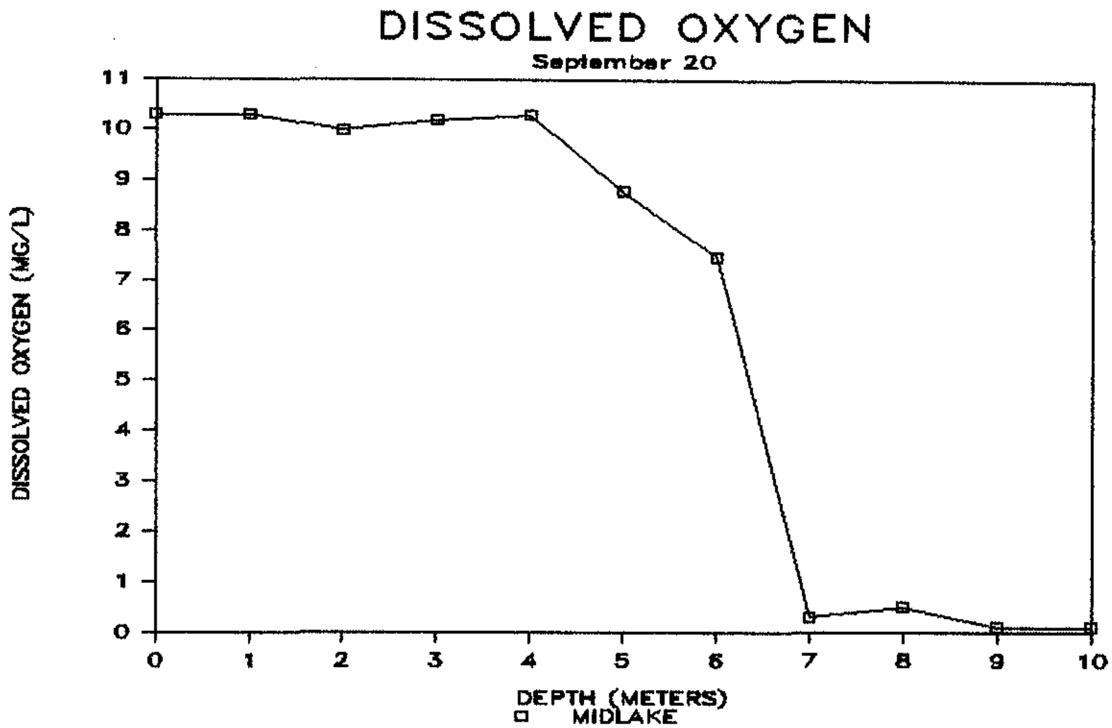



Figure 2 (cont). Dissolved Oxygen and Temperature Profiles of Crooked Lake.



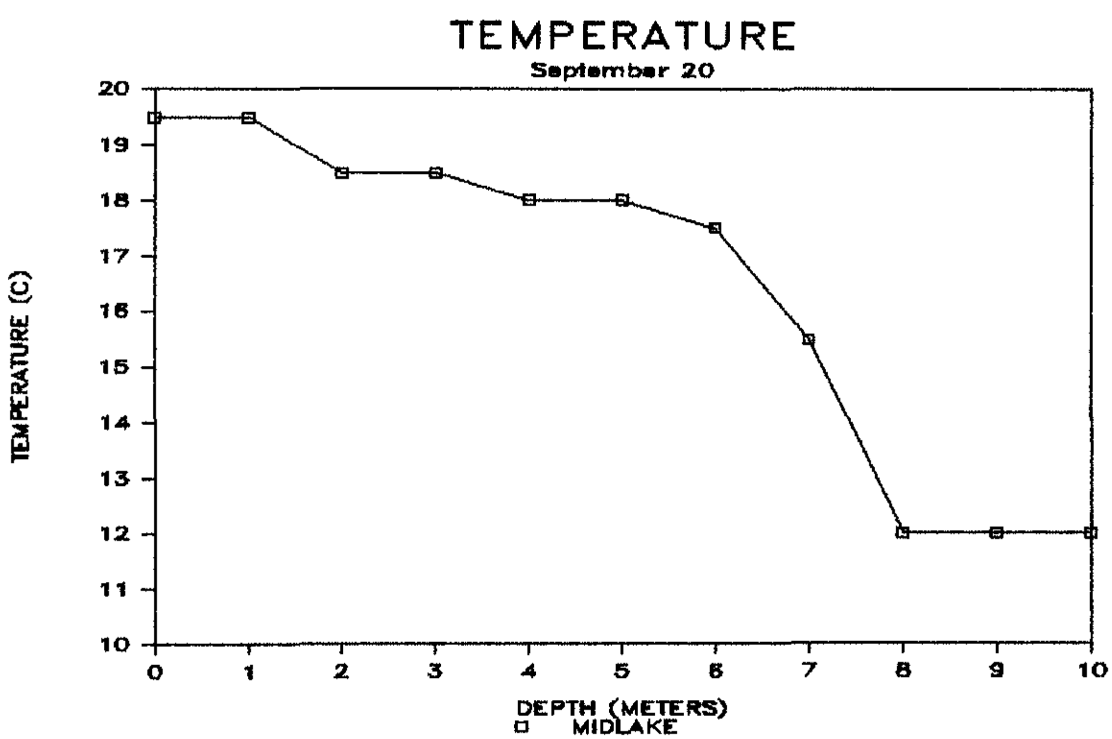
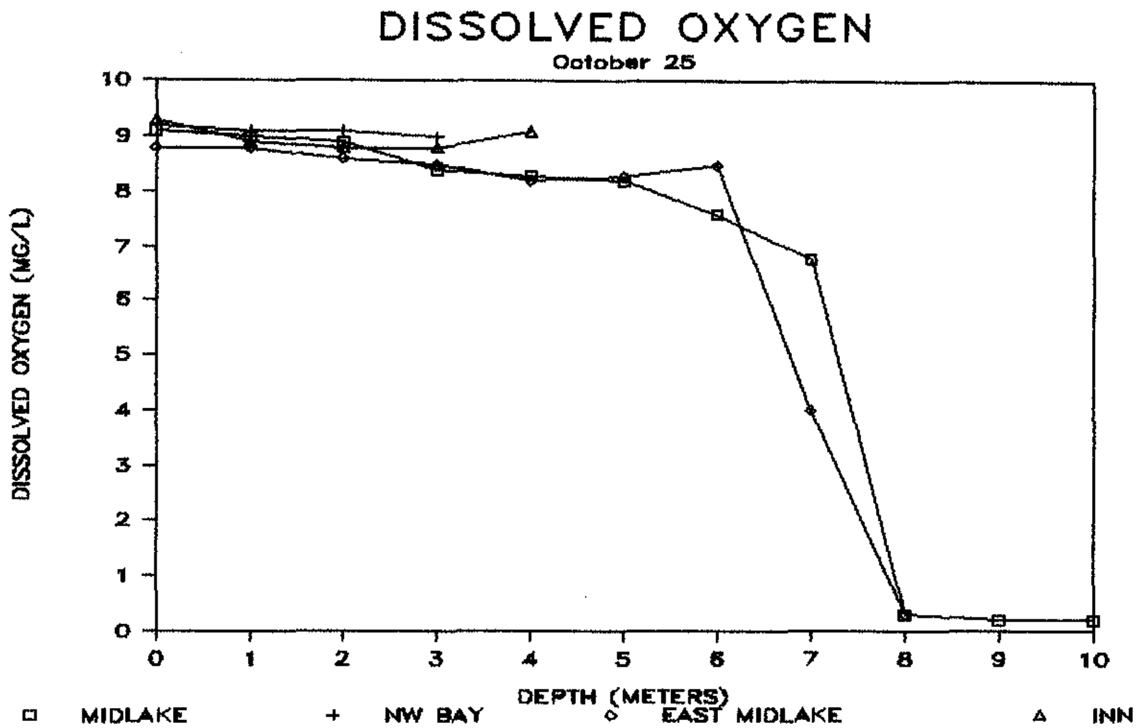



Figure 2 (cont). Dissolved Oxygen and Temperature Profiles of Crooked Lake.



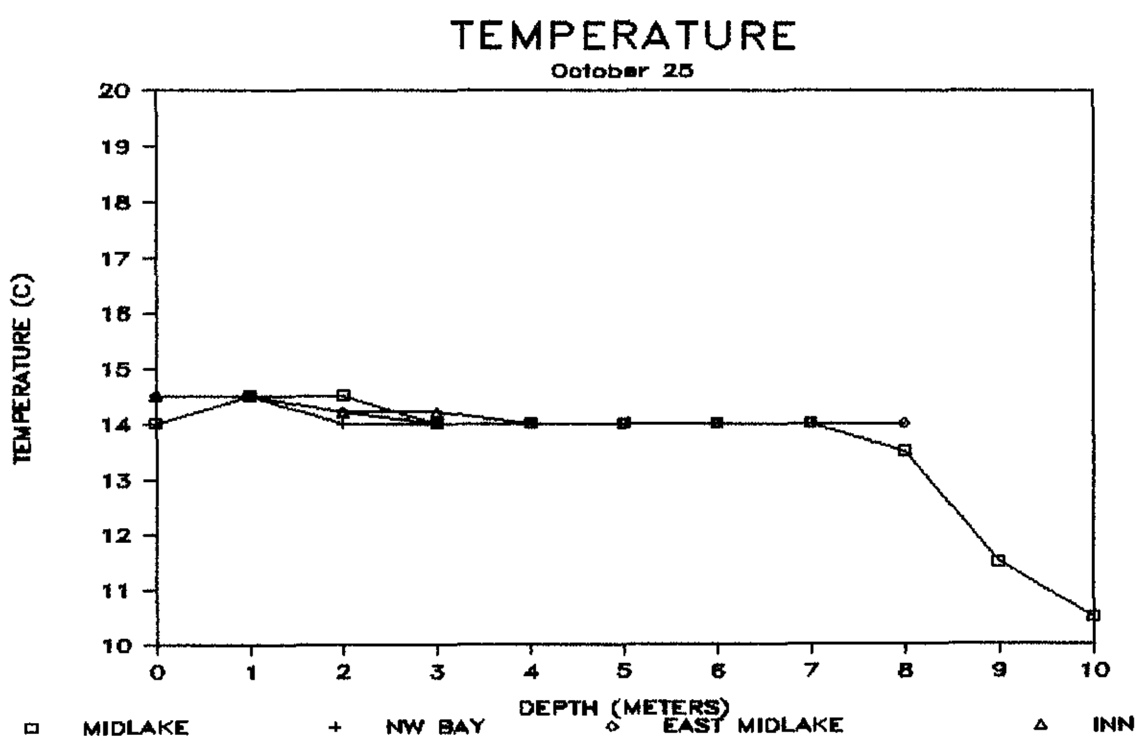



Figure 3. Bathymetric (Depth) Map of Crooked Lake. All depths are reported in feet.

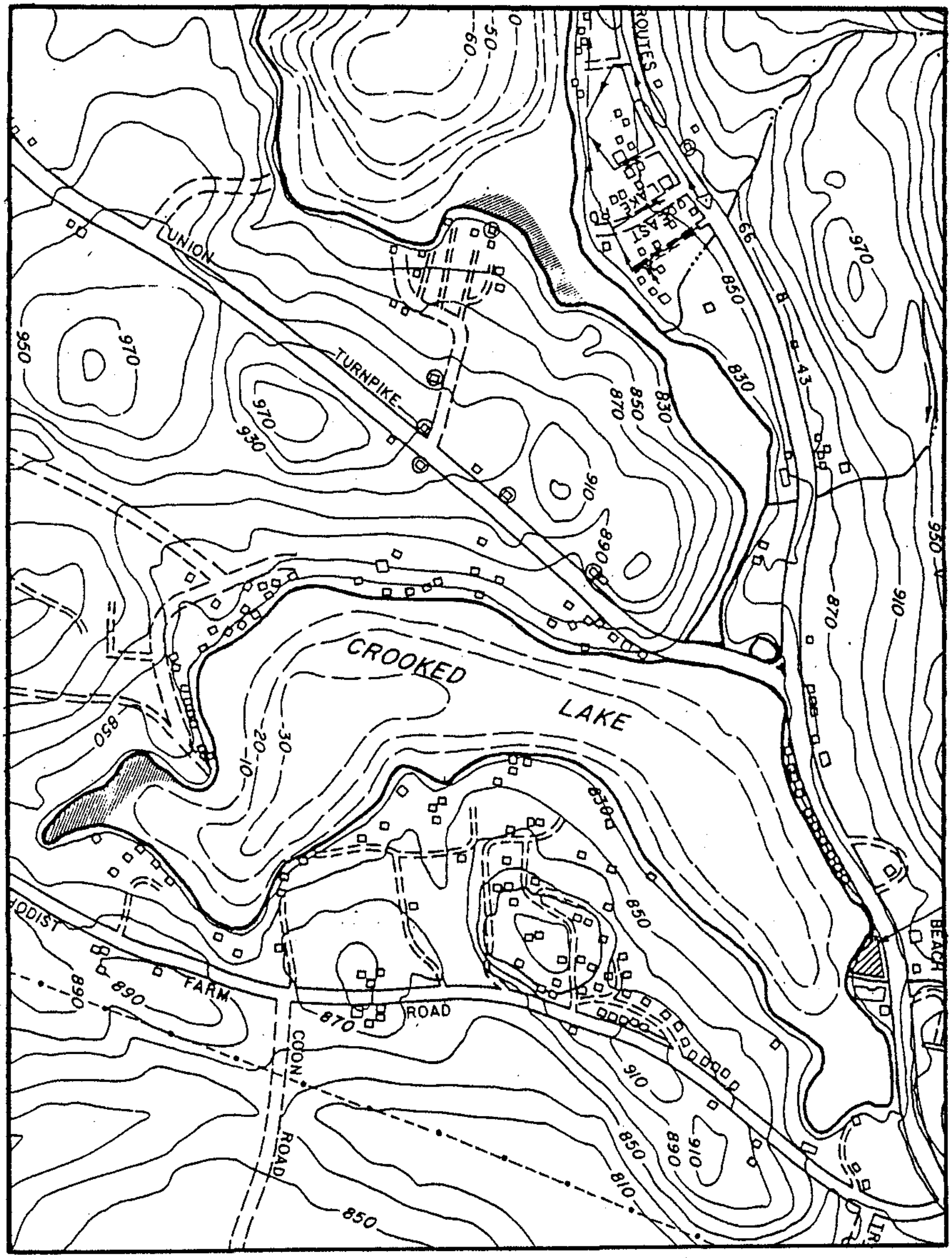
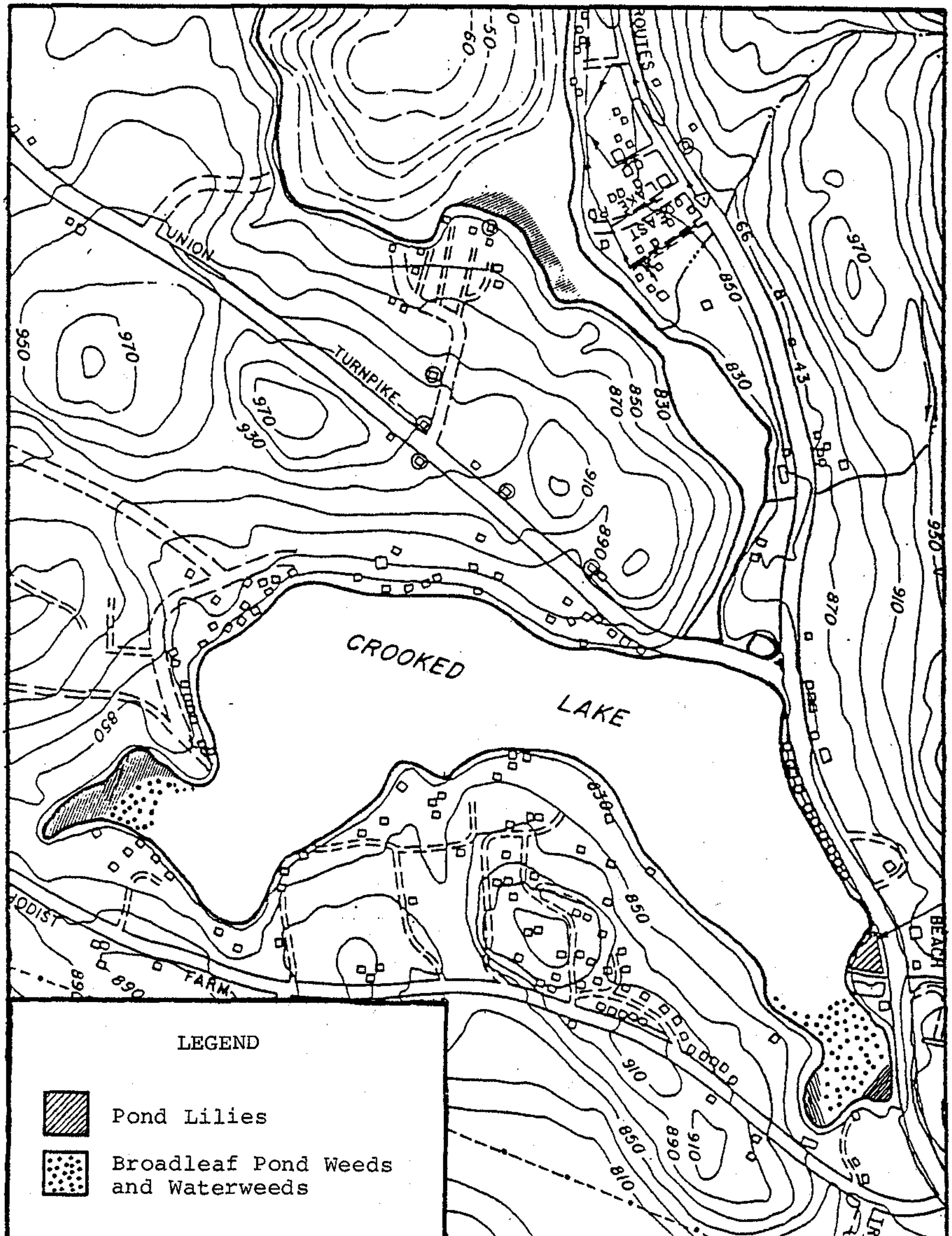


Figure 4. Map of Rooted Aquatic Plant Beds in Crooked Lake.



# APPENDICES

## Appendix A. Analytical Methods and Equipment.

| Analysis | Method | Instrument |
|---|---|---|
| pH | Expanded Scale pH/millivolt meter | Orion, Model 811 |
| Alkalinity | Gran Plot Titration | Orion, Model 811 |
| Specific Conductance | Wheatstone Bridge type meter | YSI, Model 31 |
| Chloride | Automated Ferricyanide (EPA Method 325.2) | Technicon Autoanalyzer II |
| Nitrate | Automated Cadmium Reduction (EPA Method 353.2) | Technicon Autoanalyzer II |
| Ammonia | Automated Phenate (EPA Method 350.1) | Technicon Autoanalyzer II |
| Total Phosphorus | Single Reagent Ascorbic Acid (EPA Method 365.2) | Bausch and Lomb Spectronics 70 |
| Soluble Silica | Automated Molybdate (Standard Methods, 425E) | Technicon Autoanalyser II |
| Copper | Direct Aspiration (EPA Method 220.1) | Perkin-Elmer Model 403 |
| Total Coliform | Membrane Filtration (Standard Methods, 909A) | |
| Fecal Coliform | Membrane Filtration (Standard Methods, 909C) | |

EPA Methods = USEPA, 1979, Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Cincinnati, OH.

Standard Methods = APHA-AWWA-WPCF, 1980, Standard Methods for the Analysis of Water and Wastewater, 15th edition, American Public Health Association, Washington, D.C. 1134 pp.

APPENDIX B.

FORM NO.__________

# SANITARY SURVEY

1. SITE DESCRIPTION

   A. NAME OF OCCUPANT________________________________________

   B. MAILING ADDRESS__________________________________________
   Street Address, Box Number

   ____________________________________________
   City, Town, Zip Code

   ___________________________
   Telephone

   C. NAME OF OWNER____________________________________________

   D. PROPERTY LOCATION________________________________________

   E. TAX MAP NUMBER___________________________________________

2. TYPE OF BUILDING

   A. PRIVATE RESIDENCE
   B. APARTMENT BUILDING
   C. HOTEL OR MOTEL NUMBER OF UNITS____________
   D. RESTAURANT
   E. OTHER DESCRIPTION_______________

   ____________________________________________________________

   F. YEAR BUILDING CONSTRUCTED________________________________

   G. LENGTH OF OCCUPANCY:
   SEASONAL FROM________TO_______
   YEAR ROUND
   VACANT

   H. AVERAGE NUMBER OF OCCUPANTS OR PATRONS_________
   I. COLOR AND CONSTRUCTION TYPE______________________________
   ____________________________________________________________

J. APPROXIMATE SIZE ($FT^2$) OF LAWN AND GARDEN________________
K. USE LAWN OR GARDEN FERTILIZER
YES_____ ANNUAL AMT (IF KNOWN)_____LBS.

3. WATER SUPPLY

A. TYPE PUBLIC MAINS
PRIVATE WELL APPROXIMATE DEPTH (FEET)_____

B. CHLORINATED YES
NO

C. WATER USAGE

| | |
|---|---|
| SHOWERS | ______ |
| BATH TUBS | ______ |
| DISHWASHERS | ______ |
| GARBAGE DISPOSAL | ______ |
| SINKS | ______ |
| TOILETS | ______ |
| WASHING MACHINE | ______ |

4. WASTEWATER DISPOSAL FACILITIES

A. TYPE OF SYSTEM

CESSPOOL__ SEPTIC TANK-SEEPAGE PIT__
SEPTIC TANK-TILE FIELD__ HOLDING TANK__
OTHER DESCRIPTION________________________________
__________________________________________________________

B. TANK CONSTRUCTION

SIZE (gallons)_______________________
AGE (years) _______________________
TYPE OF CONSTRUCTION:
CONCRETE___
METAL___
OTHER___ DESCRIPTION________________________
__________________________________________________________

HOW MANY YEARS SINCE PUMPED?___________________

APPROXIMATE DISTANCE FROM LAKE (feet)__________

C. TILE FIELD

APPROXIMATE LENGTH (feet)____________
AGE (years)
APPROXIMATE DISTANCE FROM LAKE (feet)________________

D. SEEPAGE PITS

NUMBER OF PITS________ AGE(years)__________
SIZE________ APPROXIMATE DISTANCE FROM LAKE (feet)__________

E. SKETCH OF BUILDING AND SYSTEM

5. PROBLEMS

A. WHAT PROBLEMS HAS YOUR SYSTEM CAUSED?

ODORS____
SLOW DRAINING OF PLUMBING____
SURFACING OF SEWAGE________
BACKUP OF SEWAGE INTO HOUSE____
NONE _____
OTHER___ DESCRIPTION__________________________________
______________________________________________________

B. HOW OFTEN DO PROBLEMS OCCUR?____________________________
______________________________________________________

C. IF YOU LIVE ALONG THE LAKESHORE, DO YOU NOTICE ANY OF THE FOLLOWING, ADJACENT TO YOUR PROPERTY?

ALGAE OR SCUM ON ROCKS ________
AQUATIC VEGETATION ("WEEDS") ________

6. OTHER INFORMATION

A. WHAT TYPE OF SOIL DO YOU HAVE:

| | |
|---|---|
| SANDY LOAM | SILTY LOAM |
| CLAY | DON'T KNOW |

B. SOIL COLOR

BLACK-DARK BROWN
LIGHT BROWN
GRAY
REDDISH-BROWN

C. HOW WELL DRAINED IS YOUR SOIL?

WELL DRAINED_________
DRAINS SLOWLY________
DON'T KNOW___________

D. ARE THERE ROCK OUTCROPS ON YOUR PROPERTY?

YES _____
NO _____

E. WOULD YOU BE WILLING TO ALLOW AN ONSITE TEST OF YOUR WASTEWATER DISPOSAL SYSTEM: YES____ NO____

7. SIGNATURE OF PERSON (S) WHO FILLED OUT FORM

______________________________________ DATE______________

8. COMMENTS OR REMARKS

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

Appendix C.

# Fresh Water Institute

## Summer Lecture Series

concerning Lake George & the Adirondacks

Rensselaer's Fresh Water Institute, newly relocated on route 9N in Bolton Landing, is pleased to host a weekly series of presentations to the general public by distinguished professional specialists.

| | |
|---|---|
| Monday June 28 | Rare and Endangered Plants of New York<br>*Richard S. Mitchell*, New York State Biological Survey, Albany |
| Wednesday July 7 | Furbearers and Furbearer Research in the Adirondacks<br>*Mark Brown*, Dept of Environmental Conservation, Warrensburg |
| Wednesday July 14 | History of Warren County Courthouse<br>*Donald Fangboner*, Lake George Historical Society, Lake George Village |
| Monday July 19 | The Timber Rattlesnake: Natural History of a Threatened Species<br>*William Brown*, Skidmore College, Saratoga Springs |
| Monday July 26 | The Geology of the Adirondack Mountains: Their Birth, Death and Resurrection<br>*Yngvar Isachsen*, New York State Geological Survey, Albany |
| Monday August 2 | Natural History of Adirondack Game Fish<br>*Carl George*, Union College, Schenectady |
| Monday August 9 | Multiple Use Management of Woodlands<br>*Richard Nason*, Finch Pruyn, Glens Falls |
| Monday August 16 | Prehistoric Archeology in New York<br>*Philip Lord*, New York State Archeological Survey, Albany |
| Monday August 23 | C.H. Peck—The Man Who Named Mushrooms<br>*John Haines*, New York State Biological Survey, Albany |
| Monday August 30 | The New York State Forest Preserve<br>*Gary A. Randorf*, The Adirondack Council, Elizabethtown |

Program begins at 7:30 PM. Tours of the new FWI site will be given at 7:00 PM preceding each program.

Funding for this series has been provided by generous gifts from the UPS Foundation, The Knapp Fund and Mrs. Edmund Froelich.