SARATOGA LAKE PHASE I DIAGNOSTIC FEASIBILITY STUDY AND MANAGEMENT PLAN

EXECUTIVE SUMMARY

SEPTEMBER 1983

Executive Summary
of the
Saratoga Lake Diagnostic-Feasibility Study
and
Management Plan

September 1983

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Preface

The Saratoga Lake Diagnostic-Feasibility Study and Management Plan was compiled and written as part of the requirements under the Clean Lakes Program (Section 314, Clean Water Act) grant award to New York State DEC from the U.S. Environmental Protection Agency (award number S002336010, July 15, 1980). Copies of the report are on file at NYSDEC, Albany, NY, The Saratoga County Offices, Ballston Spa, NY, and at USEPA, Region II, Technical Resources Branch, 26 Federal Plaza, New York, NY 10278.

The conclusions and recommendations contained in this document are those of the authors and do not necessarily reflect the views and recommendations of the State and Federal agencies involved. The mention of trade names and commercial products also does not signify the recommendation of such by the authors or supporting agencies.

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I. Introduction and Objectives

In the fall of 1979 the Towns of Saratoga, Stillwater, Malta, the City of Saratoga Springs, and the Saratoga Lake Property Owners Association petitioned Saratoga County to assist in applying for a Federal grant which would provide for a study of Saratoga Lake and recommend control strategies which might be effective in reducing aquatic weed growth plaguing the lake. On November 20, 1979 the Saratoga County Board of Supervisors, by resolution number 411 authorized Saratoga County to contribute a sum not to exceed $8,000 to be combined with $7,000 from the aforementioned municipalities and the Saratoga Lake Property Owners Association to conduct a joint study to examine potential techniques of controlling the growth of weeds in Saratoga Lake. During the winter of 1979 and 1980, several meetings were held in Ballston Spa and Albany with representatives of Saratoga County, local municipalities, and the New York State Department of Environmental Conservation to discuss the Federal Clean Lakes Program and the possibility of obtaining Federal monies to assist in a diagnostic-feasibility study of Saratoga Lake.

The Clean Lakes Program provides, pursuant to Section 314 of the Clean Water Act, for the establishment of cooperative funding agreements designed to assist states in carrying out approved methods and procedures for the restoration of publicly owned freshwater lakes exhibiting substantial water quality problems. Although the cooperative agreements may be awarded only to states, the program does allow states, through substate agreements, to delegate some or all of the required work to substate agencies. Only projects which deal with publicly owned freshwater lakes are eligible for assistance. The state must have assigned a priority to restore the lake, and the state must certify that the lake project is consistent

with the State Water Quality Management Plan developed under the New York State/ Environmental Protection Agency Agreement.

The Clean Lakes Program provides for Phase I and Phase II cooperative agreements. The purpose of a Phase I cooperative agreement is to allow a state, or a local government to conduct a diagnostic-feasibility study to determine a lake's quality, evaluate possible solutions to existing pollution problems occurring there, and to recommend a feasible program to restore or preserve the quality of the lake. The cost of a Phase I study is 70% reimbursed by the Federal government (USEPA).

A Phase II cooperative agreement is to be used for implementing recommended methods and procedures for controlling pollution entering the lake and restoring the lake. An award of Phase I assistance does not obligate USEPA to award Phase II assistance for that project. Although a Phase I award is not necessarily a prerequisite in every instance for the consideration of a Phase II award, it was considered a prerequisite by the Federal government for the Saratoga Lake Project because of significant water quality changes which had occurred since the 1974 RPI study (i.e., the 1977 sewering of a substantial portion of the drainage basin).

On March 18, 1980 the Saratoga County Board of Supervisors established a Saratoga Lake Study Committee composed of county legislators from the municipalities contiguous to Saratoga Lake, the Chairmen of the Saratoga County Agriculture and Conservation Committee and the Saratoga County Planning Committee. A technical advisory committee composed of representatives of the Saratoga County Environmental Management Council, the Saratoga County Planning Department, the Saratoga County Sewer District No. 1, and the New York State Department of

Environmental Conservation was also established to assist the Saratoga Lake Study Committee in its charge of overseeing the completion of the Saratoga Lake Diagnostic feasibility study.

During the summer of 1980 a request for proposal was developed by Saratoga County and the N.Y.S. Department of Environmental Conservation for the diagnostic portion of the study and on September 5, 1980 let to consultants for competitive bidding. A total of seven consultant proposals were received by Saratoga County by the September 30, 1980 deadline set by the County. After reviewing the consultant bid proposals submitted for the diagnostic portion of the study, it became apparent to Saratoga County and the N.Y.S. Department of Environmental Conservation that additional monies would be needed to conduct the study. In November of 1980 the N.Y.S. Department of Environmental Conservation requested a grant amendment from the U.S. Environmental Protection Agency to provide an adequate level of funding for the contractual portion of the study. A local in-kind service match in the form of personal services of the staff of the Saratoga County Environmental Management Council provided the local 30% share of the grant amendment.

As the result of consultant interviews conducted by the Saratoga Lake Study Committee in November the Saratoga County Board of Supervisors, authorized in December of 1980 the hiring, contingent upon the county signing of a substate agreement with the N.Y.S. Department of Environmental Conservation, of C.T. Male Associates and Environmed Associates until May 5, 1981 to conduct the Saratoga Lake diagnostic study. Due to administrative delays the processing of the State and Federal cooperative funding agreement and the State and County substate agreement authorizing the transfer of Saratoga Lake Study funds to Saratoga

County, a contract was not signed between Saratoga County and C.T. Male Associates until May 5, 1981.

The Phase I diagnostic-feasibility study was initiated in May, 1981 with chemical and biological monitoring continuing through November of 1982. Project administration and public participation requirements for the study were the responsibility of Saratoga County.

Diagnostic monitoring of Saratoga Lake which included watershed studies, as well as chemical, biological and physical monitoring of Saratoga Lake were the responsibility of Enviromed Associates. The New York State Department of Environmental Conservation conducted in-lake feasibility and pilot studies including, evaluation, costing and selection of weed control methods as well as evaluating associated environmental impacts.

II. Water Quality Assessment

Several lake and watershed restoration techniques were evaluated for purposes of a feasible implementation program at Saratoga Lake. The primary objectives and considerations of the restoration strategy evaluations were based on existing technology, current lake and watershed data, pilot study evaluations, environmental impacts and cost comparisons. All were important in developing the recommended scheme. Comparisons to historic Saratoga Lake data on water quality, use impairment and case studies of projects on lakes with similar problems were also important in determining the proposed recommendations. A basic summary of the lake's status and conclusions concerning it is appropriate:

1. Historic records indicate moderate levels of aquatic vegetation in 1932 and in 1969. The fishery was apparently similar to current conditions with the exception of documented cold water species in the late 1800's, indicating better quality than noted in the late 1960's;

2. Water quality degraded significantly in the early 1970's, reflected in data collected on transparency, productivity and lake nutrient levels and watershed inputs. This was apparently due to decades of high nutrient loadings to the lake, primarily from sewage treatment plant effluents in the watershed;

3. Fishery dynamics evaluated in the mid to late 1970's indicated high quality populations and angler harvest of walleyes, northern pike and bass;

4. Major point source discharges of nutrients were diverted from the watershed in 1977, reducing the average annual phosphorus loading to the lake by approximately 50%. Current nutrient loadings are still creating eutrophic conditions but are close to the upper boundary of 'permissible' loadings as defined by trophic state classification systems.

5. Since the sewage treatment plant diversions, water clarity has improved slightly along with decreases in algal productivity. Vegetation densities and areal distribution have increased dramatically, however. The primary species of concern are exotics, Myriophyllum spicatum and Potamogeton crispus, both found only sporadically in 1969.

6. Recreational use impairment due to vegetation densities is currently severe during the open water season;

The evaluation of technically feasible restoration techniques was initiated based on this information and the concurrent collection of baseline water quality data specific to the development of several lake management strategies. Chemical, physical and biological parameters investigated during 1981-1982 indicate the following significant conditions:

1. Lake water quality has improved significantly since the diversion in 1977 of the Saratoga Springs and Ballston Spa sewage treatment plant effluents. Average annual phosphorus loading to the lake has been reduced approximately 50% and nitrogen loading by 20%. Average lake level concentrations of both nutrients have decreased by similar amounts:

2. The moderately high nutrient loadings to the lake still produce fluctuating algal populations of relatively high biomass levels, however, productivity and transparency have improved slightly;

3. The two deep areas of the lake are oxygen depleted for much of the thermally stratified period, creating anoxic volumes equal to 23% of the total lake volume. Nutrient levels in the hypolimnion are very high and could be contributing significantly to the total lake phosphorus standing mass available for algal and macrophyte production during that the fall and following open water season;

4. The Kayaderosseras Creek drainage basin contributes almost 89% of the

annual phosphorus loading and 87% of the annual nitrogen loading to Saratoga Lake. Few point discharges still exist in the watershed, contributing approximately 7% of the annual phosphorus loading to the lake. Estimates of the agricultural inputs of phosphorus are approximately 20% of the total loading. Urban inputs could account for an equivalent loading, also;

5. The two major nuisance species of macrophytes, M. spicatum and P. crispus affect almost 25% of the total lake surface area during the open water season. P. crispus biomass peaks in June and is dense in the 2-4 m contours. Its' biomass decreases naturally by July. M. spicatum biomass peaks by August and is the major species from the shoreline to the 2 m contour. Plant phosphorus levels are different around the lake and could be related to sediment differences. The total plant biomass levels are also different, the worst areas being the northeast area (Franklin's Beach) and the southern areas. The biomass levels in 1982 had decreased from the levels observed in 1981.

III. Evaluation of Feasible Restoration Strategies

Evaluations of several vegetation control techniques were completed under pilot studies directed at this problem. Several mechanical control techniques were used experimentally to document their effectiveness and control capability. These techniques included mechanical harvesting, bottom blanketing and shading. Additionally, the direct and indirect effects of these techniques on littoral zone fish populations were investigated and utilized for lakewide impact assessment. Results indicate that harvesting is an efficient means of providing short-term, but immediate control of densely vegetated areas. Control provided several weeks

of reduced plant biomass levels. No apparent differences in effectiveness were noted in June vs. August harvestings. Harvester efficiency is directly dependent on size, plant density, depth, turbidity, species, and weather conditions. The area a harvester would potentially cut was determined to be approximately 0.6 ha/day. Operating 90 days, one harvester could potentially harvest 54 ha if cut once (3.3% of the lake surface, 14.2% of the affected area). This equates to approximately 110 tonnes (dry weight) of vegetation removed over the season and potentially, 594 kg of phosphorus or equivalent to nearly 5% of the total annual phosphorus loading. Harvesting directly removed a small percentage of the juvenile fish standing crop (2-5%), primarily Bluegill sunfish. The numbers directly affected were slightly higher during late August harvesting. No adult fish were removed during harvesting. Changes in plant species after harvesting were not observed. The only other impact noted was temporary increases in turbidity.

Bottom blanketing materials also proved to be an effective means of controlling vegetation in small areas. The most durable are fiberglass window screening or a commercial products developed for that purpose. Other materials such as burlap and black plastic are less effective and more difficult to use, however they are inexpensive, relative to the screening. The ease of application, non-toxic nature and effectiveness in shallow areas that a harvester cannot reach make these materials additionally useful.

Lake level regulation is the artificial fluctuation of the lake water level so as to create environmental conditions in the exposed areas, unsuitable for aquatic plants. Generally this is done by means of reducing the level in the fall through the winter in order to cause freezing of shoreline area sediments. Additionally, increasing the level in the spring has been shown to inhibit plant growth by the

reduction of light transmission. The technique is predicated upon the existence of a water level control structure on the lake outlet. The extent of drawdown is also dictated by the physical dimensions and conditions of the structure, the lake bathymetry and the spring and fall hydrologic conditions.

At Saratoga Lake, the outlet dam is located 10 km downstream from the lake on Fish Creek. This distance, the very low slope from the lake to the dam, and the size of the structure itself make relatively difficult conditions for simple water level fluctuations. The lake level responds very slowly to outlet releases after the lake has dropped 0.3 m (1 ft.) or so below the normal level of 61.5 m (203 ft.) above mean seal level. Simple mathematical modelling, based on previous hydrologic studies and data provided by Niagara Mohawk Power Corporation, the owners of the dam, indicate a wide range of times needed for drawdown of the lake. If level reduction is started in October after the highest use season at the lake is over, it would take from 45 to 60 days to draw the lake down. While 0.9 m (3 ft.) is a maximum based on physical characteristics, the real drawdown capability is probably closer to 0.6 m (2 ft.) due to hydrologic conditions expected at that time. Time to refill the lake in the spring after ice-out should be in the range of 10-30 days and the normal 61.8 m (204 ft.) level could be reached by April. Extending the natural spring levels of 61.9 m (204.4 ft.) into May might aid in the effect of the technique.

The effects of drawdown are difficult to predict, but reduction of plant biomass in the exposed areas should occur. Three years of consecutive fluctuations are probably needed to guarantee effectiveness. No major adverse environmental impacts are anticipated. Slight water level reductions in adjacent wetlands near Manning's Cove and Fish Creek can be expected. The survey of water supply

facilities in the lake is necessary before initiating drawdown procedures. The number of pipes extending into the lake or their intake depths is not known. Shoreline area clean up of fragmented vegetation will be necessary in the spring.

Nutrients entering the lake have been reduced. However, release of phosphorus from bottom sediments during periods of no oxygen in the bottom waters is considered to be an important factor potentially affecting plant and algal production. The use of phosphorus binding agents to interrupt the release of phosphorus from the sediments and to take the nutrient out of the lower waters has proved successful in other studies. The control can range as high as 5 years, with approximately 3 being the average anticipated time for retreatment. As additional point and non-point sources of nutrients are reduced in the watershed, internal cycling of nutrients will become more important. Interrupting the internal cycling could significantly reduce the time it might naturally take for improved water quality conditions.

The technique involved in this treatment involves pumping liquid alum (aluminum sulfate) into the bottom anoxic waters in the early summer. If both the Snake Hill deep area and the North Deepwater area are treated, it would require approximately 1 million gallons of alum to reach an average dose rate. This would reduce phosphorus levels in the 29 million m^3 of effected volume (23% of the total lake volume). Exact dose rates would be determined by direct analyses at the time of treatment and could reduce the total cost of the technique. A barge delivery system with holding tanks, pumps, and a manifold system are needed. The major cost would be the alum (95%). No adverse environmental impacts are anticipated.

Recommendations for an overall management plan include a three-way approach toward

implementation. They include 1) long-term watershed control techniques to reduce nutrients inputs; 2) long-term in-lake techniques aimed at nutrient/plant interactions; and 3) short-term methods to provide immediate reductions in use impairment caused by dense vegetation. An administrative vehicle for implementing long-term lake management objectives is a high priority recommendation needed to coordinate the numerous government and public groups interested in and affecting the use and quality of Saratoga Lake.

IV. County Lake Management District

On September 1, 1981 Chapter 761 of the New York State Laws of 1981 went into effect which enabled counties in New York State to create special districts for the purpose of lake protection and rehabilitation. This legislation amended various sections of Article 5-A of New York State County Law which provides for the establishment of certain county agencies and special districts, to also include the formation of public inland lake protection and rehabilitation agencies and districts. Under this legislation counties can appoint or establish an officer, board or body, or may designate an existing officer, board or body, or public authority to act as a public inland lake protection and rehabilitation agency. Such an agency as empowered by a county board of supervisors may assemble data relating to any measures reasonably related to lake protection and rehabilitation, including surveys of sources of degradation, the treatment of aquatic nuisances, and the elimination of such problems. A lake protection and rehabilitation agency may incur such other expenses as may be necessary within the amounts made available therefore by budget appropriation and when authorized by the board of supervisors may also apply for and expend state aid for various comprehensive studies and reports.

This 1981 legislation also enables municipalities or the public to petition county boards of supervisors for the creation of a county lake protection and rehabilitation districts. A county board of supervisors may direct a lake protection and rehabilitation agency to cause maps and plans to be prepared for a project or for the establishment of a certain area or areas of the county to be designated as a lake management district. Such maps or plans shall show (1) the boundaries of the area or areas which the agency in its judgment considers will be benefited by the particular project, (2) a description of the area or areas sufficient to permit definite and conclusive identification of all parcels of property included within it, (3) the proposed location of all facilities, (4) estimates of the cost of construction of these facilities and the method of financing same and (5) an evaluation of rehabilitation needs based upon water quality, public use and private development, special wildlife, scenic or other values, sedimentation, shoreland zoning, potential for adequate pollution and erosion controls within the drainage basin, and potential for future successful management (Chapter 761, N.Y.S. Laws of 1981).

A new section entitled 263-a was also added to Article 5-A of N.Y.S. County Law by the 1981 lake management district amendments. This new section provides for the following powers to be given to public, inland lake protection and rehabilitation agencies:

1. The initiation and coordination of research and surveys for the purpose of gathering data on the lake, related shorelands, and the drainage basin;

2. The planning of lake rehabilitation projects;

3. The adoption by resolution of rules for carrying out their duties and plans for lake rehabilitation projects;

4. The contracting and attempting to secure the cooperation of officials of units of general purpose government in the area for the purpose of enacting ordinances deemed necessary by the board of supervisors as furthering the objectives of the district;

5. The carrying out lake protection and rehabilitation projects and obtaining any necessary permits therefore; and

6. Maintaining liaison with those officials of state and local government involved in lake protection and rehabilitation.

A public inland lake protection and rehabilitation agency in its preparation of maps and plans transmitted to a county board of supervisors may include recommendations relating to the establishment of two or more zones of assessment within the proposed district and the estimated initial allocation of the cost of the proposed improvements. A county board of supervisors, may, after public hearing adopt a resolution approving the establishment of a lake protection and rehabilation district including the costs between such zones to be assessed, levied, and collected. The establishment of the district shall be predicated on:

1. Whether all the property and property owners within the proposed district are benefited;

2. Whether all of the property and property owners benefited are included within the limits of the proposed district;

3. Whether it is in the public interest to establish the district;

4. Whether zones of assessment (if applicable) and the allocation of the costs among such zones represent as nearly as may be the proportionate amount of benefit which the land situated in such zones will derive therefrom (Section 256, Chapter 761 N.Y.S. Laws of 1981).

Although a county board of supervisors may adopt a resolution approving the establishment of the district, such resolution and the establishment of a lake protection and rehabilitation district shall be subject to permissive referendum which may involve petitioning and the subsequent affirmative approval of a majority of the qualified electors residing with the district (Article 3, N.Y.S. County Law).

V. Recommendations

It is recommended that a Phase II Clean Lakes Program application be submitted to the U.S. Environmental Protection Agency for funding consideration through NYSDEC for the following water quality management program to be conducted at Saratoga Lake:

1. Formation of a Saratoga Lake Management District

It is recommended that the formation of a Saratoga Lake Management District be

initiated pursuant to Chapter 761 of the New York State Laws of 1981 to oversee the implementation of the following Saratoga Lake Management Plant recommendations. It is recommended that the District's boundary be coincident with the area included within the Saratoga Lake drainage basin and that representation include of each municipality within the District, including a representative of the Saratoga Lake Property Owners Association, the Saratoga County Environmental Management Council, the Saratoga County Soil and Water Conservation District, the Saratoga County Agricultural Stabilization and Conservation Service, the Soil Conservation Service, Niagara Mohawk Power Corp., and NYSDEC. The primary objective of the District should be the reevaluation of the current non-point sources of nutrient inputs to the lake, especially from urban and developed areas, and the potential for reducing those inputs to the drainage basin.

2. Lake Level Regulation

As part of a short-term Saratoga Lake management strategy to control nuisance, aquatic vegetation at Saratoga Lake, it is recommended that a water level regulation program be implemented on a trial basis during the fall of 1983 and spring of 1984. This program would consist of lowering the surface elevation of Saratoga Lake approximately 0.6 m -0.9 m (2-3 ft.) beginning in October of 1983, maintaining an over winter drawdown condition through February of 1984 before allowing it to refill by normal spring runoff. Based upon the hydrologic evaluation in this report, it is estimated that under normal flow conditions it would take approximately 45-60 days to lower Saratoga Lake's level and approximately 10-30 days to refill this body of water. Towards the implementation of this strategy, it is recommended that representatives of Saratoga County, New York State Department of Environmental Conservation, the Saratoga Lake Property Owners

Association and Niagara Mohawk Power Corporation meet to further discuss the feasibility of trial Saratoga Lake level regulation in October of 1983.

3. Aquatic Vegetation Harvesting

It is recommended that 1or 2 aquatic weed harvesters be purchased or leased and utilized for at least 90 days each growing season to harvest aquatic weeds at Saratoga Lake. The areas within Saratoga Lake to receive harvesting will be determined by the proposed Saratoga Lake Management District or by the Study Committee and will be based in part upon aquatic weed densities as determined by this study. Major consideration will also be given to maximizing and maintaining public access "corridors" in Saratoga Lake to promote water related recreational uses of this water body. Towards the implementation of an effective weed harvesting program at Saratoga Lake, it is recommended that the Saratoga Lake Management District in conjunction with the municipalities surrounding Saratoga Lake explore the possibility of utilizing Wilton Mt. McGregor Correctional Facility inmates as a potential labor force for the annual harvesting program.

4. In-Lake Nutrient Inactivation

Based on the significantly high levels of phosphorus identified as the result of this study within the bottom sediments of the deep hole area of Snake Hill, the North Deepwater area, and the release of nutrients during periods of anoxia, it is recommended that a trial application of alum (aluminum sulfate) be injected into the hypolimnion and bottom sediments in the Spring of 1984 in an attempt to inhibit the release of phosphorus in this area to the overlying waters. It is

recommended that this treatment be undertaken in conjunction with aforementioned lake level regulation and aquatic weed harvesting program, if possible.

5. Cost-Sharing for the Implementation of Agricultural Best Management Practices (BMP's) and Agricultural Conservation Practices (ACP's) within the Saratoga Lake Drainage Basin.

It is recommended that Federal monies be allocated through the Clean Lakes Phase II program to provide financial incentives to farmers within the Saratoga Lake drainage area to implement additional agricultural related erosion and nutrient control projects. It is further recommended that the Saratoga County Agricultural Stabilization and Conservation Service, the Soil Conservation Service, and the Saratoga County Soil and Water Conservation District in conjunction with the proposed Saratoga Lake Management District coordinate the implementation of this program within the agricultural community of the Saratoga Lake drainage area.

6. Increased Regulation of Phosphorus Point Discharges within the Saratoga Lake Drainage Basin

It is recommended that the New York State Department of Environmental Conservation through its State Pollutant Discharge Elimination System (SPDES) permit program evaluate phosphorus effluent limitations on significant existing point discharges to surface waters of the Saratoga Lake drainage area. It is also recommended that all future Saratoga Lake drainage area SPDES permit applications which would relate to any surface or subsurface effluent discharge in excess of 1,000 gallons per day receive phosphorus limitation considerations by the

Department of Environmental Conservation. The degree of regulation of phosphorus discharges on all future SPDES applications within the drainage basin should be predicated on such factors as phosphorus discharge concentration, discharge volumes and in the case of subsurface disposal the phosphorus attenuation properties of the soils.

7. Continuation of Baseline Monitoring Program at Saratoga Lake

It is recommended that a modest water quality monitoring program be continued at Saratoga Lake to document any water quality changes which might occur as the result of the aforementioned recommendations. A continued Saratoga Lake water quality monitoring program would also be useful in documenting environmental impacts and water quality changes at Saratoga Lake resulting from the implementation of the Saratoga Lake county sewer project and the proposed management plan.

8. Other Recommendations

a) Develop a watershed management plan to update and properly maintain individual septic systems, if necessary, and distribute information regarding proper maintenance to the public;

b) Help reduce urban runoff by evaluating current street de-icing practices, storm water discharge systems, etc.;

c) Encourage shoreline owners to utilize bottom blanketing materials or hand harvesting techniques to control vegetation in dock and swimming areas.

VI. Proposed Budget

Summary of potential restoration technique costs for Saratoga Lake (1983, U.S. dollars).

Technique	Estimated Cost
In-Lake	
I. Water Level Regulation	$8300 - $11,450
II. Vegetation Harvesting	84,500 - 100,050
III. Nutrient Inactivation	612,379
IV. Monitoring	10,000 - 20,000
V. Eng. Design	70,500
sub-total	$785,679 - $814,379
Watershed	
I. Lake Mgt. District	$30,000 - $50,000
II. BMP Implementation (10% of Agricultural area)	165,000
sub-total	$195,000 - $215,000
Total	$ 980,679 - $ 1,029,379

Table 1. Comparison of Spring and Fall in-lake phosphorus and nitrogen concentrations before and after diversion of municipal wastewater.

	Spring Conditions		
	Before Diversion		After Diversion
	USEPA[a]	RPI[b]	EA/CTM[c]
Total P (mg/l)	0.031	0.059	0.018
Soluble P (mg/l)	0.020	-	0.012
NO_3-N (mg/l)	0.31	0.60	0.33
NH_3-N (mg/l)	0.06	-	0.26

a) Sampling on May 15-18, 1972

b) Sampling on May 24, 1973

c) Sampling on May 25, 1982

	Fall Conditions		
	Before Diversion		After Diversion
	USEPA[a]	RPI[b]	EA/CTM[c]
Total P (mg/l)	0.031	0.044	0.020
Soluble P (mg/l)	0.020	-	0.012
NO_3-N (mg/l)	0.07	0.38	0.17
NH_3-N (mg/l)	0.08	0.05	0.15

a) Sampling on Oct. 11, 1972

b) Sampling on Oct. 22, 1972

c) Sampling on Oct. 28, 1981

Table 2. Summary of recommended in-lake restoration techniques, objectives and potential impacts.

Technique	Description	Objective(s)	Considerations/ Impact(s)	Severity[1.]
1. Water level regulation	Extend natural spring (March) water level to May; lower water level 2-3 ft. in October through winter; refill by March.	Reduce shallow area vegetation by freezing, reduced spring light penetration and sediment compaction.	a) Vegetation reduction	++
			b) Cost	++
			c) Fish habitat reduction	-
			d) Winter access	-
			e) Wetland reduction	-
			f) Vegetation fragmentation	-
			g) Wetland water level reduction	-
			h) Reinfestation of non-target species	-
			i) Exposed water supply systems	?
2. Vegetation Harvesting	Mechanically harvest vegetation during high use season by barge/ conveyor system.	Provide immediate access and use impairment improvement; potentially reduce lake nutrients; potential long term plant biomass reductions.	a) Vegetation reduction	+++
			b) Improved access, use	++
			c) Nutrient reduction	+
			d) Biomass (long term) reduction	+
			e) Fish habitat reduction	-
			f) Juvenile fish harvest	-
			g) Reinfestation of non-target species	-
			h) Cost	-
			i) Vegetation disposal	-
3. Nutrient Inactivation	Pump phosphorus binding agent (alum) into bottom waters and sediment near Snake Hill and North Deep-water areas.	Inhibit release of phosphorus from deep sediments; remove phosphorus from deep layer waters.	a) Phosphorus removal	+++
			b) Phosphorus sediment release reduction	+++
			c) Improved water clarity	++
			d) Long-term nutrient control	++
			e) Improved fishery habitat	+
			f) Other env. impacts	0
			g) Cost	=
			h) Potential increase vegetation areal extent	=

1. +++ most positive impact; = most negative impact.

Figure 1. Approximate extent of surface area that could be harvested in one season (90 days) by two harvesters (exact areas of operation to be determined).

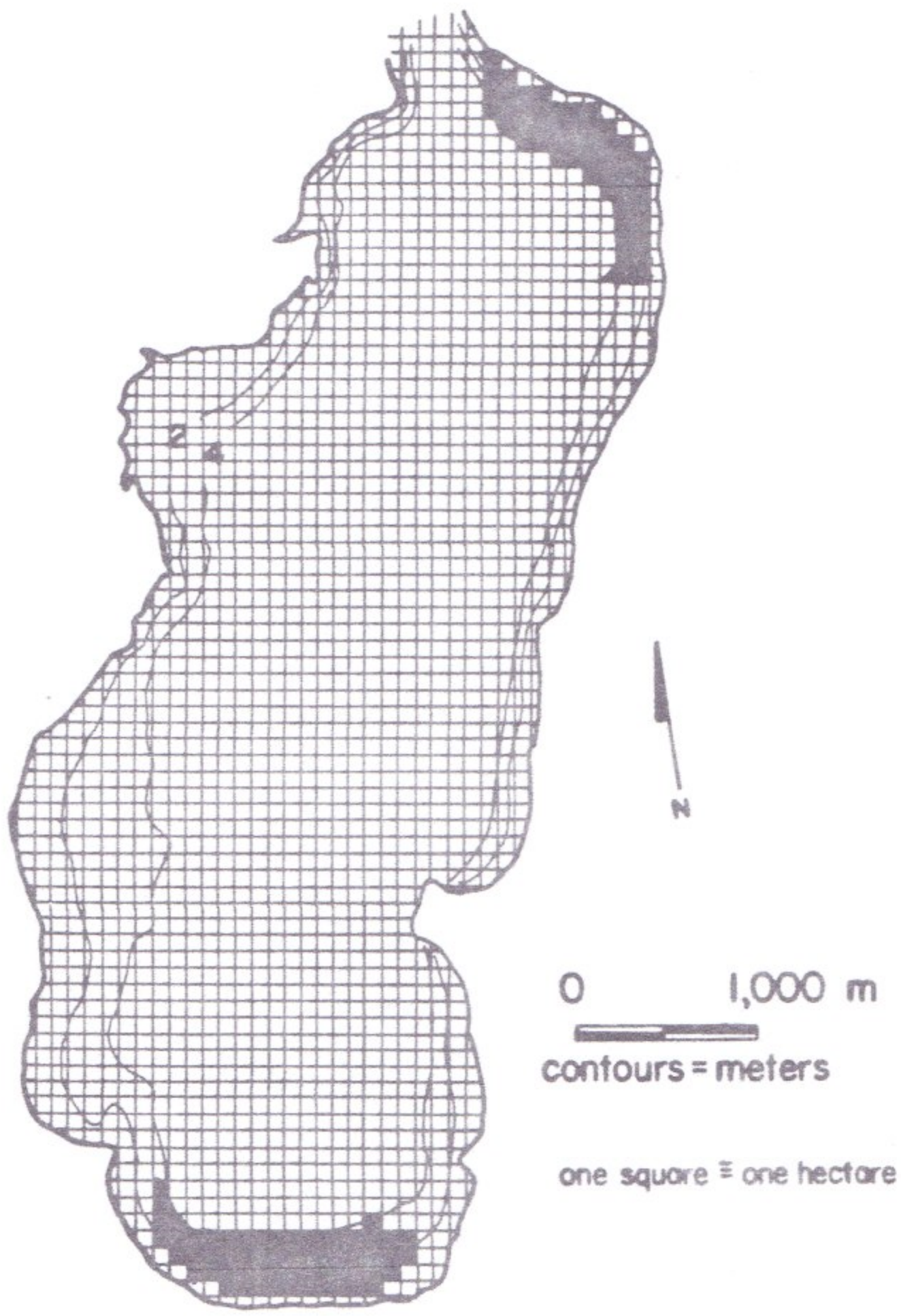
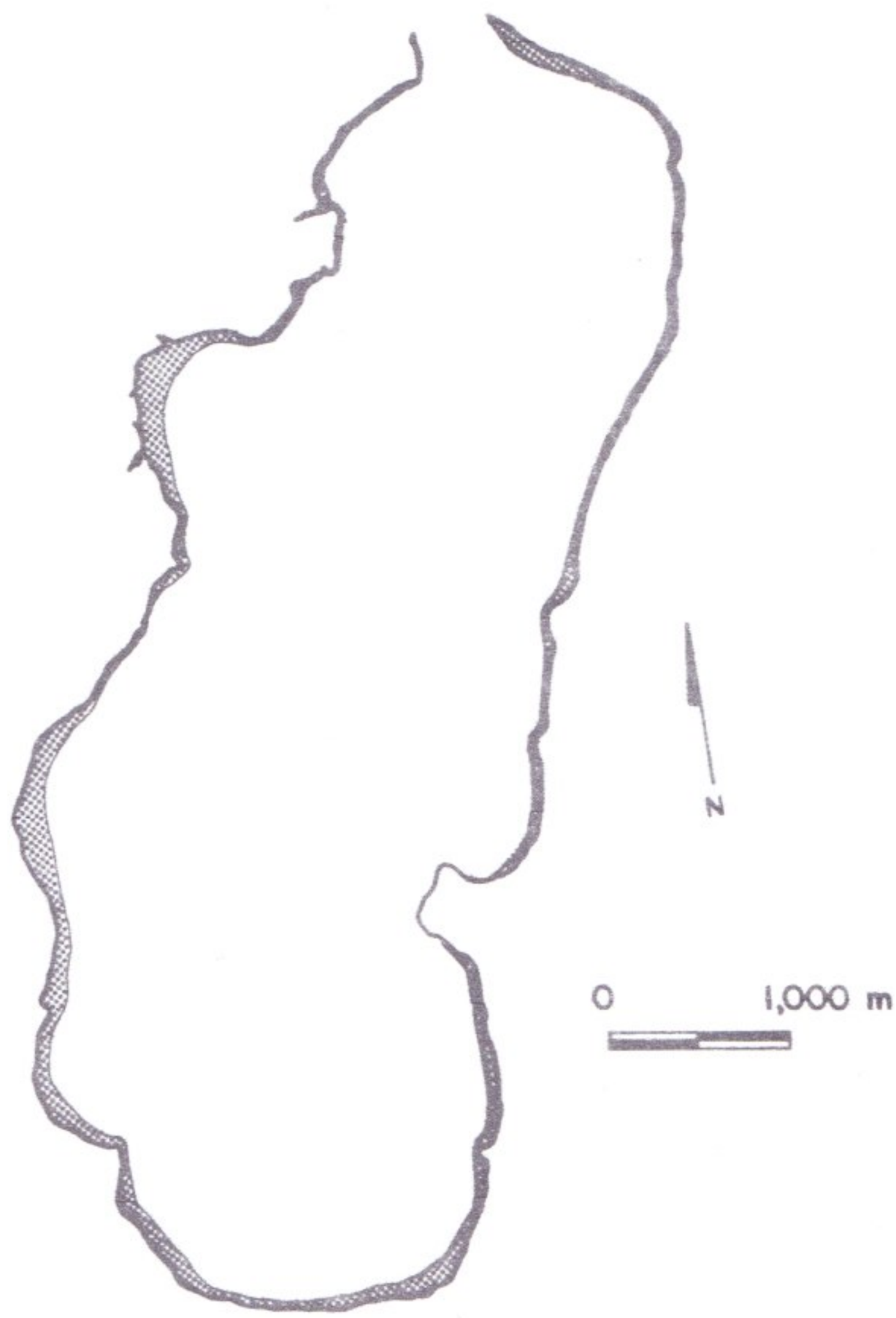
Figure 2. Approximate area that would be exposed by a 0.6 m - 0.9 m water level reduction at Saratoga Lake.