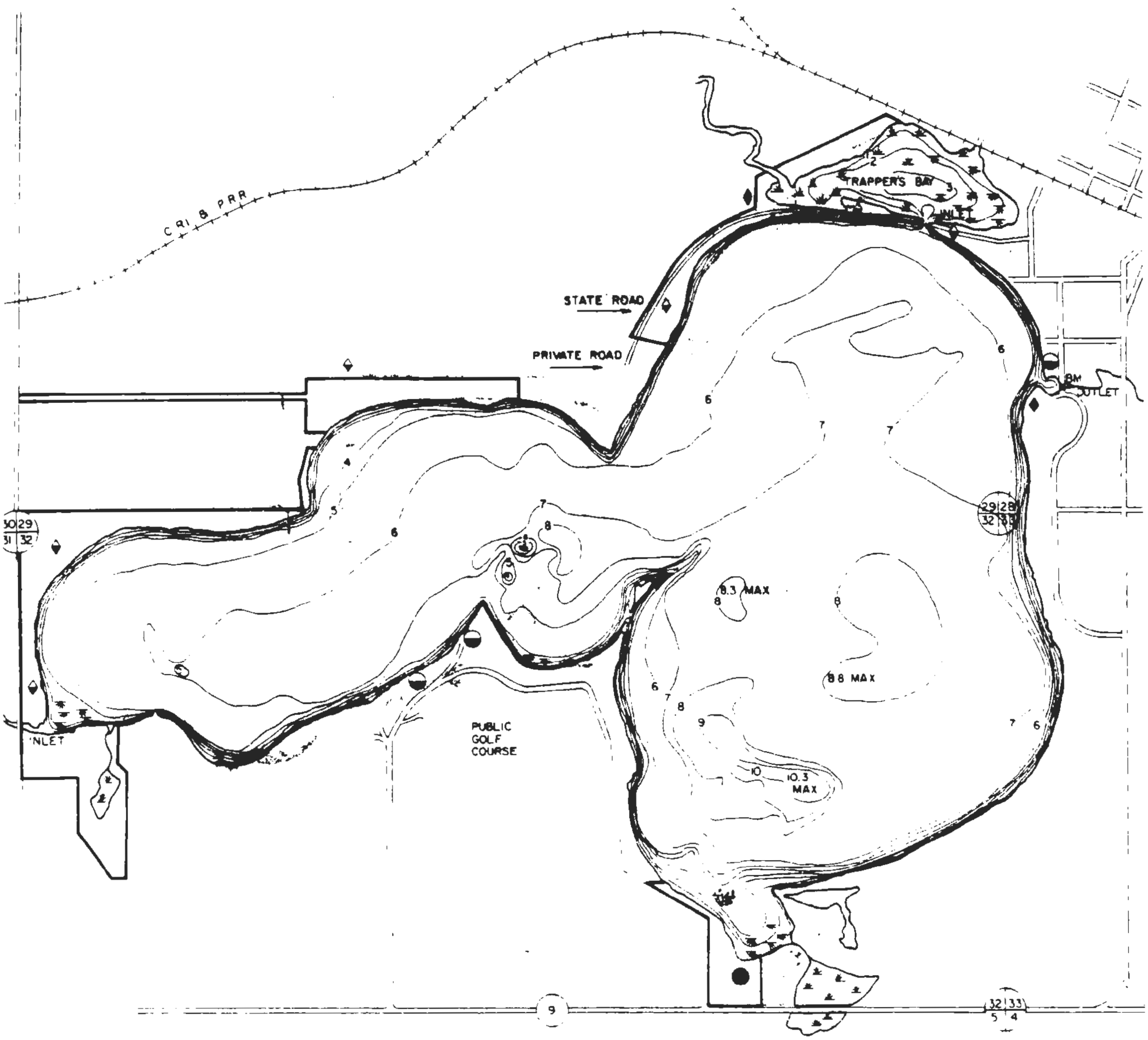
# CLEAN LAKES CLASSIFICATION STUDY OF IOWA LAKES FOR RESTORATION




1980

# CLEAN LAKES CLASSIFICATION STUDY OF IOWA'S LAKES FOR RESTORATION

Final Report

by

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## CONTENTS

# INTRODUCTION

Because many lakes in the United States are suffering from pollution and eutrophication problems, the United States Environmental Protection Agency (EPA) through Section 314 of the Clean Water Act provides financial assistance to states for the restoration of public freshwater lakes. This study was carried out in response to the requirement that each state make a survey of their public lakes in need of restoration and/or protection and develop a priority ranking of the lakes for restoration projects in order to be eligible for Clean Lakes federal assistance after January 1, 1982. The information obtained in this study is also needed for Phase I (diagnostic-feasibility) Clean Lakes cooperative agreement applications. Primary funding for this study was provided by a grant from the EPA and the study was carried out through the cooperative efforts of the Iowa Department of Environmental Quality (DEQ), the Iowa Conservation Commission (ICC), and Iowa State University.

A group of 107 publicly owned lakes was selected for the survey. Selection criteria (see Appendix A) included a surface area of at least 25 hectares (10 acres) and a watershed to surface area ratio less than 200:1. No shallow marsh-like lakes, federal flood-control impoundments, or lakes used solely as water supply reservoirs were included in the survey. The specific objectives of the study were:

1) To provide an evaluation of current conditions in significant publicly owned lakes in Iowa.

2) To develop a ranking of lakes in need of management and restorative measures based on existing water quality, pollution potential, and public benefit.

A data collection program was initiated on each of the lakes selected, and the results of this effort were submitted to the ICC and the DEQ in a series of interim reports. The first report described the physical features of the lakes and their watersheds. The second report included an assesement of pollution conditions of the lakes including a summary of current water quality information, lake trophic state, and an identification of major nonpoint pollution sources and major point source pollution discharges. A third report included an assessment of lake uses for each lake and a description of any inherent recreational values that are impaired by degraded water quality. A fourth report included recommended lake restoration measures for each lake that needed restoration or protection.

The information in these four reports was updated and corrected on the basis of comments from the ICC and DEQ and is presented in Appendix E.

A criteria ranking system was developed for the purpose of establishing a priority ranking list of lakes for restoration. This list is required by the U S EPA and will be used to determine the order in which Iowa lakes should be considered for possible restoration projects. This ranking system was applied to the 107 Iowa lakes in the survey. The top ten lakes on the priority list were then recommended for future diagnostic and feasibility studies. These work products were initially submitted to ICC and DEQ as interim reports and are included in their corrected forms as sections in this final report. The ICC conducted public meetings at the top ten lakes. They explained the Clean Lakes program and solicited comments from the public. Summaries of these meetings are in Appendix C.

## CONCLUSIONS

Because of the fertility of Iowa soils and the subsequent high nutrient content of land runoff, all of the lakes in this study were classified as eutrophic. This is a broad category of lakes with high biological productivity, and most of the lakes had water quality problems. For this reason restoration recommendations were made for most lakes. The most common reccmmendation was the adoption of best land management practices in the watershed to reduce soil erosion. For some of the shallower lakes dredging and/or artificial aeration was recommended to prevent winter fishkills. A few of the lakes had point-source or divertable pollution, and recomendations were made to eliminate these sources of nutrients.

A priority ranking system was developed to rank the lakes for future restoration projects. The ranking was based on a combination of severity of water quality problems, probability of success of the proposed restoration measures, and the expected public benefits. When the system was applied to the 107 Iowa lakes (see CRITERIA RANKING SYSTEM section of this report) the following ranking was found:

| Rank | Lake | County |
|---|---|---|
| 1 | Union Grove Lake | Tama |
| 2 | Black Hawk Lake | Sac |
| 3 | Lake Manawa | Pottawattamie |
| 4 | Lower Pine Lake | Hardin |
| 5 | Swan Lake | Carroll |
| 6 | Rock Creek Lake | Jasper |
| 7 | Little Wall Lake | Hamilton |
| 8 | Arbor Lake | Poweshiek |
| 9 | Storm Lake | Buena Vista |
| 10 | Lake Hendricks | Howard |
| 11 | North Twin Lake | Calhoun |
| 12 | Lost Island Lake | Palo Alto |
| 13 | DeSoto Bend Lake | Harrison |
| 14 | Central Lake | Jones |
| 15 | Lake Cornelia | Wright |
| 16 | Ottumwa Lagoon | Wapello |
| 17 | Lake Darling | Washington |
| 18 | Hannen Lake | Benton |
| 19 | Easter Lake | Polk |
| 20 | Lower Gar Lake | Dickinson |
| 21 | Silver Lake | Worth |
| 22 | Tuttle Lake | Emmet |

| | | |
|---|---|---|
| 23 | Carter Lake | Pottawattamie |
| 24 | Rodgers Park Lake | Benton |
| 25 | Silver Lake | Palo Alto |
| 26 | Lake of the Hills | Scott |
| 27 | Upper Gar Lake | Dickinson |
| 28 | Clear Lake | Cerro Gordo |
| 29 | Lake Keomah | Mahaska |
| 30 | Trumbull Lake | Clay |
| 31 | Hickory Hills Lake | Tama |
| 32 | Mariposa Lake | Jasper |
| 33 | Eldred Sherwood Lake | Hancock |
| 34 | East Okoboji | Dickinson |
| 35 | Lake Iowa | Iowa |
| 36 | Arrowhead Lake | Pottawattamie |
| 37 | Browns Lake | Woodbury |
| 38 | Hickory Grove | Story |
| 39 | Lake Macbride | Johnson |
| 40 | Prairie Rose Lake | Shelby |
| 41 | Center Lake | Dickinson |
| 42 | Springbrook Lake | Guthrie |
| 43 | Kent Park Lake | Johnson |
| 44 | Spring Lake | Greene |
| 45 | Lake Meyers | Winneshiek |
| 46 | Silver Lake | Delaware |
| 47 | Little Spirit Lake | Dickinson |
| 48 | Silver Lake | Dickinson |
| 49 | Crystal Lake | Hancock |
| 50 | Green Valley Lake | Union |
| 51 | Pierce Creek Pond | Page |
| 52 | East Lake (Osceola) | Clarke |
| 53 | Upper Pine Lake | Hardin |
| 54 | Lake Ahquabi | Warren |
| 55 | Beeds Lake | Franklin |
| 56 | Lake Pahoja | Lyon |
| 57 | Red Haw Lake | Lucas |
| 58 | Lake Geode | Henry |
| 59 | Lake Minnewashta | Dickinson |
| 60 | Green Castle Lake | Marshall |
| 61 | Chatfield Lake | Lee |
| 62 | Indian Lake | Van Buren |
| 63 | Ingham Lake | Emmet |
| 64 | Lake of Three Fires | Taylor |
| 65 | Meadow Lake | Adair |
| 66 | Big Creek Lake | Polk |
| 67 | Bob White Lake | Wayne |
| 68 | Smith Lake | Kossuth |
| 69 | Nelson Lake | Crawford |
| 70 | George Wyth Lake | Black Hawk |
| 71 | Lake Icaria | Adams |
| 72 | Viking Lake | Montgomery |
| 73 | Five Island Lake | Palo Alto |
| 74 | Windmill Lake | Taylor |
| 75 | Crawford Creek Lake | Ida |
| 76 | Little Sioux Park | Woodbury |

| | | |
|---|---|---|
| 77 | Otter Creek Lake | Tama |
| 78 | Williamson Pond | Lucas |
| 79 | Pleasant Creek Lake | Linn |
| 80 | Diamond Lake | Poweshiek |
| 81 | Lacey-Keosauqua Lake | Van Buren |
| 82 | Lake Miami | Monroe |
| 83 | Oldham Lake | Monona |
| 84 | Lake Anita | Cass |
| 85 | Badger Lake | Webster |
| 86 | Pollmiller Lake | Lee |
| 87 | Don Williams Lake | Boone |
| 88 | Lake Orient | Adair |
| 89 | Big Spirit Lake | Dickinson |
| 90 | Moorehead Lake | Ida |
| 91 | Thayer Lake | Union |
| 92 | Lake Wapello | Davis |
| 93 | Dog Creek Lake | O'Brien |
| 94 | Wilson Lake | Taylor |
| 95 | West Okoboji | Dickinson |
| 96 | Manteno Lake | Shelby |
| 97 | Willow Lake | Harrison |
| 98 | Nine Eagles | Decatur |
| 99 | Morman Trail | Adair |
| 100 | Slip Bluff Lake | Decatur |
| 101 | Arrowhead Lake | Sac |

## METHODS AND PROCEDURES FOR COLLECTING LAKE INFORMATION

### FIELD SAMPLING METHODS

Each lake was sampled 3 times in the period from late June to early October, 1979. On each visit, one station in the deepest part of the lake was sampled. In some lakes, the greatest depth sampled was much less than the given maximum depth, presumably indicating the effect of sedimentation between the sampling date and the year the lake contour map was drawn. A vertical temperature profile was obtained to determine the depth of thermal stratification, if present. Water samples were collected using a Van Dorn or Kemmerer bottle. From 3 to 6 water samples were collected at equally spaced (usually 2m) depth intervals in the water column of unstratified lakes. In stratified lakes, at least 3 different water samples were obtained from the mixed water layer and at least one additional sample was taken from the hypolimnion. The water collected was placed in one-quart polyethylene bottles, stored on ice, and returned to the laboratory for analysis.

Analyses for the various nitrogen fractions were carried out only for samples obtained on the third sampling visit. Replicate surface water samples for nitrogen analyses were placed in 200 ml Nalgene bottles, preserved with 0.8 ml concentrated sulfuric acid and frozen. Profile analyses for chloride and sulfate were done only with water collected on the second sampling visit for each lake. Replicate surface water samples for sodium and potassium analyses were obtained on the third sampling visit for each lake. Replicate secchi disc transparencies were obtained on each visit. Sampling was usually done between 8 AM and 5 PM. Laboratory analysis was usually completed within a 24 to 36 hour period after sampling. Approximately 10% of all analyses were replicated to provide estimates of intrinsic error for each method.

### CHEMICAL MEASUREMENTS

The pH of the lake water was measured in the laboratory using a Beckman Model N pH meter. Specific conductance, in micromhos/cm, was measured with a Hach model 2511 conductivity meter. Turbidity was measured using a Hach model 2100 turbidimeter and expressed in JTU units. Sulfate concentration was determined by the barium chloride turbidimetric method (APHA,AWWA,WPCF 1976).

Seston dry weight (suspended solids), in mg/l, was determined by filtering a known water volume onto precombusted, preweighed Gelman Type A/E glass fiber filters, which were then dried and reweighed. These results were corrected for filter weight loss upon filtration using filters treated with distilled water only. The filters were combusted at 550 C for one hour in a muffle furnace, cooled and reweighed. The organic fraction of the seston dry weight was that portion lost upon combustion, corrected for filter loss. The inorganic fraction was determined from the residue remaining following combustion. All weighing was done on a Cahn electrobalance.

The total phosphorus concentration was determined after ammonium persulfate digestion of the lake water sample in an autoclave at 18 psig for 40 minutes (APHA, AWWA, WPCF 1976). The ascorbic acid colorimetric method was then used and the absorbance at 880 nm was recorded spectrophotometrically. Standard curves relating the measured absorbance and total phosphorus concentration were prepared for each day of analysis.

Ammonia nitrogen and total Kjeldahl nitrogen were determined using the automated phenate method. Nitrite plus nitrate nitrogen was measured using the automated cadmium reduction method (United States EPA 1974, APHA,AWWA,WPCF, 1976). Analyses of the various nitrogen fractions were done by the Engineering Research Institute cf Iowa State University.

Dissolved oxygen concentrations were determined by the Winkler method on samples fixed in the field. Total alkalinity, in mg/l as CaC03, was determined by titration with .02N sulfuric acid. Calcium and total hardness concentrations were determined by titrating to appropriate endpoints with .02N EDTA (Titraver). Chloride concentration was determined by titrating the lake water sample with mercuric nitrate after the addition of diphenylcarbazone.

Sodium and potassium concentrations were measured with an Instrumentation Laboratories Model 143 lithium internal standard flame photometer (APHA, AWWA, WPCF 1976).

## BIOLOGICAL MEASUREMENTS

The concentration of chlorophyll a corrected for phaeophytin was obtained by filtering a known volume of lake water onto Gelman Type A/E glass fiber filters. The filters were then frozen over dessicant in the dark until analysis. At such time the filters were ground for 1 minute using a Teflon pestle and the chlorophyll pigment extracted with 90% acetone for 30 minutes in the dark. The absorption of the extract at four wavelengths (630, 645, 6,63, and 750 nm) was recorded using a Beckman DU-2 spectrophotometer. Two drops of 1N HCl were then added to the extract and the absorption at 663 and 750 nm read after one minute. Concentrations of chlorophyll a, phaeophytin, and chlorophyll a corrected for phaeophytin (all in mg/m3) were obtained from equations given in the literature (APHA,AWWA,WPCF

1976).

Submerged and floating aquatic vegetation coverage was estimated for many state park lakes using aerial infra-red photographs available from the Iowa Conservation Commission. These photos were taken during July and August, 1976. Aquatic plant coverage for West Okoboji, East Okoboji, Big Spirit Lake, Lower and Upper Gar, and Lake Minnewashta was taken from Crum and Bachmann (1973). The remaining lakes were aerially mapped during August and early September, 1979. Submerged and floating vegetation was sketched onto lake maps and the percent coverage determined by planimetry.

## MORPHOMETRIC AND PHYSICAL MEASUREMENTS

Lake surface area was determined by planimetering the shoreline of the best available contour map. Lake volume was calculated by adding together the volumes between consecutive depth contours. Mean depth was obtained by dividing the lake volume by the surface area. Shoreline length was determined using a map measurer. The volume development index and shoreline development index were calculated from equations given in Hutchinson (1975).

Permanent inflows and outflows were identified using United States Geological Survey (U.S.G.S.) topographic maps (7.5 minute series), Iowa Department of Transportation county maps, and Larimer (1974). Unnamed permanent inflows and outflows were counted. Lake watersheds were determined using U.S.G.S. topographic maps (7.5 minute series) ordered from the Iowa Geological Survey in Iowa City, orthophotographs (7.5 minute series), and advanced copy maps (7.5 minute series) ordered from the U.S.G.S. in Rolla, Missouri. Tiling maps obtained from local Soil Conservation Service offices and county engineers were also used for determining watershed boundaries. The watershed area for each lake was obtained using planimetry and the watershed area/lake area ratio was calculated.

Soil associations and descriptions within each watershed were obtained using soil survey maps for Iowa (Iowa Agriculture and Home Economics Experiment Station 1978) and portions of Nebraska and Minnesota (Bartlett 1975, Dunsmore and Quade 1979a,b). Each soil association within a watershed was planimetered and its percentage of the watershed computed. Watershed land use percentages (the number of hectares in row crops, pastureland, woodland, etc.) were obtained from Harmon and Duncan eds. (1978) and Dunsmore and Quade (1979a,b).

Estimated annual precipitation and runoff figures were obtained from state maps (Waite 1969 and Wiitala 1969). Evaporation figures came from a U.S. Weather Bureau Technical Paper (Kohler et. al. 1959). Shoreline ownership was obtained from county platt books using a map measurer and from information provided by the Iowa Conservation Commission. The 208 agency boundaries came from the Iowa Department of Environmental Quality.

## RECREATIONAL USAGE

Recreational usage estimates for each lake were obtained from questionnaires (Appendix B) distributed to ICC district fisheries biologists. The fisheries biologists obtained usage estimates from a variety of sources; state park officers, county park officers, publications, and direct field observations. The questionnaire asked for estimates of the number of people that engaged in a particular activity on a typical day depending upon the season of the year and whether it was a weekend or weekday. These daily estimates were expanded into an annual total usage estimate (people-days) for each of the activities named. The annual total usages for each lakes were divided by the lake surface area to define a density of use (people-days per hectare or acre).

An additional questionnaire (Appendix B) was sent to county conservation boards that had jurisdiction over lakes in the survey. Respondents were asked to comment on lake impairments and watershed problems. Summerkill and winterkill frequencies as well as aeration methods were obtained from ICC district fisheries biologists.

Lake recreation impairment was determined in several ways. Comments from ICC personnel were encouraged by means of the previously mentioned questionnaires. Swimming was considered impaired when Secchi transparency was less than one meter. If Secchi transparency was less than 1 meter and the mean epilimentic chlorophyll a concentration was less than 20 mg/cubic meter, suspended sediments were assumed to be a significant source of turbidity. The location of aquatic plants, the extent of coverage, and comments by ICC personnel were also used to assess recreation impairment, i.e. boating, swimming, and fishing.

## POINT AND NON POINT DISCHARGE INFORMATION

Point source discharges within each lake's watershed were identified from the list provided in the Iowa Water Quality Management Plan (Iowa Department of Environmental Quality 1976). Reference numbers assigned to each of the dischargers were cross referenced with Iowa DEQ files to obtain NPDES permit numbers. Animal feeding operations were included in the point source discharge list.

Non point discharges included shoreline erosion and soil erosion within the watershed. Shoreline erosion estimates were based on observations by field crews, and comments from ICC personnel. Shoreline erosion was classified as follows;

negligible, a few sections of shoreline with severe erosion, or as a significant source of siltation. Severe shoreline erosion was also considered an impairment to access and shoreline fishing. Soil erosion in each lake's watershed was estimated from the Iowa Soil Conservation Service maps of erosion rates in the state.

The percentage of land within the watershed under approved soil conservation practices was estimated by District Soil Conservationists. This figure does not necessarily represent the percentage of land meeting the legal soil loss limit but simply refers to the amount of land under approved soil practices. Best land management practices for each watershed were also obtained from the District Conservationists.

PRESENTATION OF RESULTS

The results of the studies on the individual lakes are presented in Appendix E. To characterize the lakes, standard statistical procedures were used to calculate averages and standard errors for sample parameters measured on samples obtained from the mixed zone of each lake. The sample size varies because of replicate measurements made on some samples as a part of the quality assurance program followed in the laboratory. Also some lakes were not stratified and thus more of the samples were from the mixed zone. Results of chemical measurements on the lakes have been entred into the U S EPA STORET system.

## LAKE RESTORATION MEASURES

Most public lakes in Iowa have water quality problems that interfere with their usefulness. In formulating restoration plans it was useful to consider the geographic setting and origins of Iowa lakes. The majority of the natural lakes are of glacial origin and lie in the Des Moines lobe of the Wisconsin glacier in north central Iowa. The land is gently rolling and poorly drained. With the exception of Lake West Okoboji with a maximum depth of 42 meters these lakes are characterized by shallow depths, high nutrient concentrations, and frequent blue-green algae blooms. Those lakes lacking algal problems often have massive growths of higher aquatic vegetation filling their basins. The combination of shallow depths and high biological productivity often leads to winterkills, particularly in the shallower lakes. Other natural lakes include a few oxbow lakes found within the floodplain of the Missouri River. With the exception of DeSoto Bend Lake, a recent manmade cutoff of the river, these lakes have been partially filled by silt from past floods on the Missouri River. Some have also had drops in water levels due to a general lowering of the water table in the flood plain. Since various engineering works on the Missouri River ensure it will no longer flood, the basins are now permanent, but the lakes suffer from the same problems as other shallow lakes in the state.

Most of the artificial impoundments are located outside of the recently glaciated areas. In comparison with the natural lakes they are deeper on the average, have greater ratios of watershed area to lake surface area, and are located in more hilly topography. They are subject to higher rates of siltation from soil erosion in their watersheds. Like the natural lakes they are also highly productive and subject to algal blooms.

The other class of lakes includes former gravel pits, quarries, and other water bodies with low ratios of watershed area to surface area. Because of the restricted influence of surface runoff on these lakes, they are generally of high quality and do not require restoration measures.

For most of the lakes point-source pollution is not a problem. There are few lakes with urban areas within their watershed and most of the lakes with extensive cottage development have already installed sanitary sewage systems to collect, treat, and divert wastes from the lakes. Non-point pollution is the major problem. A recent analysis of the nutrient loads of streams sampled in the National Eutrophication Survey of the U.S. Environmental Protection Agency showed that the Iowa streams had some of the highest levels of phosphorus and nitrogen found anywhere in the continental United States (Omernik 1977). It is not possible to determine if these high nutrient levels are the result of the natural fertility of the original prairie soils or if they are related to the intensive agriculture practiced in the state. It is known, however, that poor farming practices can lead to accelerated soil erosion and ultimately to the transport of soil particles with associated nutrients and pesticides to lakes and reservoirs. High concentrations of livestock may also make significant contributions to the nutrient inputs of some lakes.

Lake restoration/management plans have two sites of operation: in the lake and in the lake's watershed. Techniques useful in the lake's watershed include: wastewater treatment and diversion, soil and water conservation practices and treatment of inflows. In-lake techniques include: lake deepening, aeration, biotic harvesting, and shoreline erosion control. Methods employed in the watershed are designed to reduce the rate of eutrophication; whereas most in-lake measures are designed to manage the consequences of eutrophication. Reviews of the effectiveness of various restoration techniques are given elsewhere (Dunst et al. 1974, U.S. Environmental Protection Agency 1979a,b and Breck et al. 1979).

## WATERSHED TECHNIQUES

### Wastewater Treatment and Diversion

Wastewater from municipal, industrial, and agricultural sources may be diverted out of a lake's watershed or treated to reduce its impact on the receiving body of water. Three levels of wastewater treatment are generally recognized: primary, secondary, and tertiary. Primary treatment consists of the removal of solid organic materials by gravitational settling which reduces the biochemical oxygen demand (BOD) of the incoming waste. Secondary treatment promotes biological activity in the wastewater resulting in further reduction of the BOD and suspended matter concentrations of the waste. The combined use of primary and secondary treatment can result in a 50% reduction in total volatile solids, a 40% reduction in total nitrogen, and a 30% reduction of total phosphorus in the incoming waste (Hammer, 1975). Tertiary treatment emphasizes nutrient removal by physio-chemical or chemical processes. Tertiary treatment can remove up to 98% of the phosphorus and nitrogen present in the wastewater (Hammer 1975).

Diversion of wastewater away from lakes has been effectively used to reduce nutrient loading. In a well-documented example municipal wastes were divereted away from Lake Washington in Seattle. This action reversed the accelerated eutrophication of that lake and rapidly improved water quality (Edmondson 1970, 1972). Diversion of sanitary wastes from cottages and towns along many of the major Iowa natural lakes (Clear Lake, Storm

Lake, Spirit Lake, West Okoboji) has been practiced for many years as a means of lake protection.

**Soil and Water** Conservation Practices

Soil and water conservation practices (SWCP) also known as best management practices (BMP) are agricultural practices designed for erosion and water control. SWCPs also have the potential to reduce non-point source pollution. SWCPs may be divided into two groups, cultural practices and structural practices. Cultural practices include: no tillage, conservation tillage, contour tillage, contour strip cropping, and sod based rotations. Structural practices include: terraces, grassed waterways, filter or buffer strips, artificial drainage, and sediment control basins. Pesticides, nutrients, and sediment are differentially affected by SWCPs.

The available information on the effectiveness of soil and water conservation practices in controlling non-point source pollution has been reviewed (U.S.EPA 1979a). The following is a summary of the conclusions:

1. The effectivenss of SWCPs in controlling losses of agricultural chemicals from croplands in runoff and percolation are largely determined by the site specific effects the SWCPs have on sediment losses and water movement.

2. SWCPs are more effective in controlling sediment yield from fields than in reducing runoff.

3. It follows that SWCPs are more effective in removing chemical constituents associated with particles, such as organic N and P, inorganic particulate P, and organochlorine pesticides, than in removing dissolved constituents.

4. There are additional practices capable of reducing pollutant losses from cropland such as fertilizer management, integrated pest management, and management of animal wastes.

5. The relationship between any practice used on a field and surface or groundwater quality is uncertain.

Treatment of Inflows

Treatment of the inflowing water may be justified where the sources of nutrients or sediment are so diffuse they cannot be individually controlled and diversion is not possible. Examples of inflow treatment include the aeration of inflowing streams, construction of sedimentation basins, and diversion of inflow through natural or artificial marshes (Dunst et al. 1974, DeJong 1976, Wolverton et al. 1976, Spangler et al. 1977, and Sloey et al. 1978).

## IN-LAKE TECHNIQUES

### Lake Deepening

Lake deepening can be achieved by raising the water level in a lake or by removing sediments from the lake bottom. Benefits associated with increased depth are increased lake volume, increased suitability for recreational use, and decreased rooted aquatic plant growth. Lake deepening may also be achieved by exposing lake bottom sediments resulting in dessication and sediment consolidation.

Dredging may improve water quality by removing sediments which leach nutrients to the overlying water. Basin deepening may also prevent the resuspension of sediments by wave action, thus further reducing turbidity and nutrient release. Dredging may restrict the growth of aquatic plants by physically removing them and by increasing lake depth beyond the zone where rooted plants will grow.

Drawdown and exposure of lake bottom sediments may result in substantial sediment consolidation and an increase in lake depth (Dunst et. al. 1974). The applicability of drawdown as a lake deepening technique depends on the feasibility of water removal as well as the nature of the sediments. Overwinter drawdowns which permit the sediments to freeze may help reduce aquatic plant growth as well (Beard 1973).

### Aeration

Artificial aeration relies on the use of compressed air or mechanical pumps to circulate water within a lake. The circulation patterns developed bring bottom waters low in dissolved oxygen to the surface of the lake where they absorb oxygen from the atmosphere. By maintaining the oxygen concentration in the water column, aeration prevents fishkills and increases the amount of habitat suitable for aquatic organisms.

### Biotic Harvesting

Biotic harvesting is the removal of living organisms from the lake. Two primary targets of biotic harvesting are fish and aquatic vascular plants. Fish may be removed from a lake to reduce the effects of overcrowding or to free the available food resources for other, more desirable, fish species. Removal of bottom feeding fish, such as carp, may also reduce turbidity generated by their feeding behavior.

Aquatic plant growth may be controlled by mechanical, chemical, or biological means. Mechanical control measures include cutting and/or dredging to physically remove the plants. The effectiveness of mechanical harvesting depends on the frequency of harvesting, the time of the year, the depth at which the plants are cut, and the species of plants harvested. Chemical control of plants consists of the use of herbicides or toxicants to reduce or eliminate plant growth. A basic difference between harvesting and chemical control is that chemical techniques generally do not include removal of plant biomass. Since plant material is not removed, nutrients released from the decaying vegetation are available for biological uptake. The oxygen demand associated with the decaying vegetation may also result in oxygen depletion in the lake. Biological control involves the introduction of grazers, parasites, diseases, or competitors adversely affecting plant growth. The most common means of biological control is the introduction of grass carp (White Amur). Grass carp reduce plant biomass by feeding on the shoots and leaves of submersed plants.

### Shoreline Erosion Control

Shoreline erosion control involves such techniques as shoreline riprapping, shoreline plantings, construction of floating or submersed breakwaters and control of human activities on the shoreline. Control of shoreline erosion may reduce turbidity and sedimentation in the lake.

## APPROACHES TO LAKE RESTORATION IN IOWA

In determining restoration measures for a given lake, first consideration was given to identifiable pollution sources such as urban or industrial runoff, unsewered lakeside homes, or large concentrations of livestock. Recommendations were generally made to divert these inflows from the lake. In the shallow lakes subject to winter oxygen depletion, generally two types of recommendations were made. For the short term artificial aeration was recommended as a way of dealing with the problem's symptoms. For the longer term increases in water depths were recommended to increase the oxygen holding capacity of the lake. In most cases this will involve dredging of accumulated sediments, while in some it may be possible to artificially raise water levels by installing or modifying water-controlling structures or by providing a supplemental water source.

With the exception of a few lakes with largely urban watersheds or with small ratios of watershed area to lake surface area, the institution of best land management practices was a recommendation common to all lakes. The reduction of soil erosion in the watersheds should help reduce the rate of basin filling and also reduce the inputs of nutrients and other chemicals carried with the soil particles. In addition methods for reducing the runoff of livestock wastes into tributary streams were also recommended. Unfortunately we do not have sufficient information in most cases to determine if these measures will result in significant improvements in water quality through deceases in nutrient loadings. These practices should, however, help to prolong the life of the lake basin and thus be of long term benefit.

Lastly, in those lakes with high populations of higher aquatic plants we have recommended programs of vegetation control. In some cases this will be accomplished through lake deepening but in most cases mechanical, chemical, or biological controls will be more cost-effective. We have recommended consideration of the use of the imported White Amur for biological control since they have been effective in other Iowa lakes.

## CRITERIA RANKING SYSTEM

Under Section 314 of the Clean Water Act, the United States Environmental Protection Agency may provide financial assistance to States to restore freshwater lakes. A requirement of this act is that each State establish a lake priority list for restoration purposes. The following criteria ranking system was developed to establish the priority ranking list of Iowa public lakes for restoration projects under this act. The system takes into consideration the significance and public benefit of each lake as measured by actual and potential use, the water quality conditions within each lake, and the restoration plans. The goal is to give highest priority to lakes of greatest importance with the most severe problems and where restorative actions are needed and implementation appears highly probable.

It should be pointed out this priority system was developed specifically for the Clean Lakes Program following federal guidelines for that program. For this reason the resulting priority list may not be the same as other priority lists for programs affecting Iowa lakes, since other programs may have different goals and different criteria for setting priorities.

The final restoration priority list was developed from lake rankings for public benefit, water quality, and restoration effectiveness. Estimated public benefit ranking was from the lake with the highest benefit (number 1) to the lowest benefit (number 107). Water quality ranking ranged from the lake with the poorest water quality (number 1) to the highest (number 107). Restoration effectiveness was ranked from the lake where restoration efforts to improve water quality would probably be most effective (number 1) to least (number 107). For each lake the rankings from the three lists were added together and the sums ranked from the lowest to highest. This ranking is the final priority list with the number 1 priority representing the lake with the highest restoration priority (see Figure 1).

The public benefits ranking was derived from two other ranking lists. The first (Table 1) was a ranking of the lakes based on annual use (data are presented in sections on individual lakes in Appendix E). A weighted sum for each lake was developed by giving full weight to fishing activity, swimming, boating, and number of people using the lake as a water supply (if the lake is used as a public water supply). One-half weight was given to the number of persons involved in picnicking, camping and other activities prompted by the lake's presence, and one-third weight was given to hunting, snowmobiling, ice skating and cross-country skiing. The second ranking list (Table 2) involves the number of people living within the vicinity of the lake and gives some information about potential public use in a lake following a

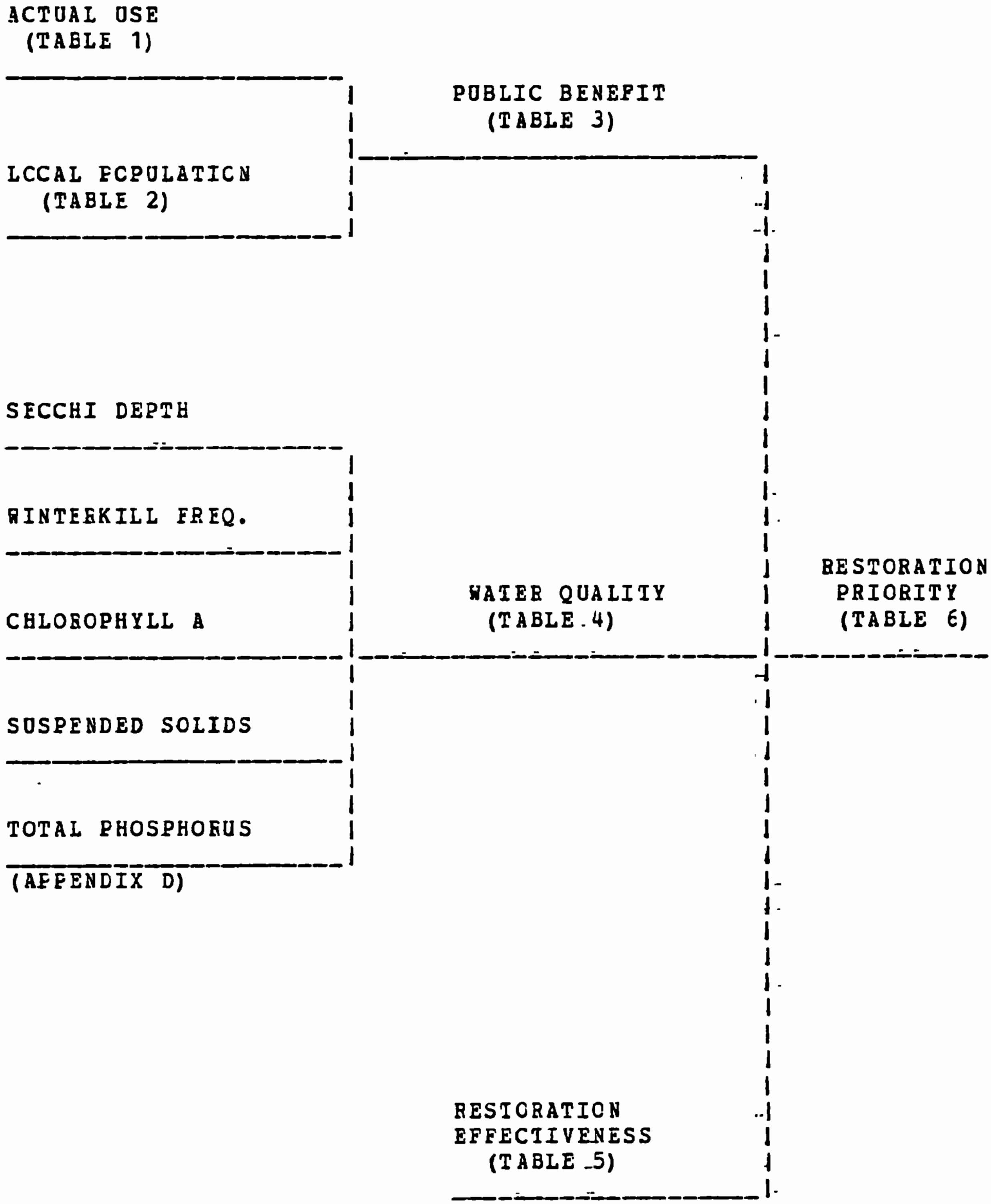


Figure 1. Summary of ranking process. Items on the left are ranked first and then combined moving to the right across the chart.

successful restoration program. This local population ranking was developed in the following manner. The important public lakes in Iowa were considered to be the 107 lakes in this study plus the 11 navigation pools on the Mississippi River and the 4 U.S. Army Corps of Engineers' reservoirs within the state (Coralville, Rathbun, Red Rock, and Saylorville). For each of the 1664 townships in Iowa, the 1970 census population was divided by the number of lakes within 80.5 kilometers (50 miles) of the township center. This population was assigned to each of the lakes within the 80.5 kilometer radius. In effect, each Iowan was assigned to one of the 122 public water bodies in the state. The lakes were then ranked by the total number of assigned people and this ranking was then combined with the actual use ranking on an equal basis to derive the public benefit ranking (Table 3).

Table 1. Actual use ranking of lakes in survey.

| Rank | Lake | County |
|---|---|---|
| 1 | West Okoboji | Dickinson |
| 2 | Clear Lake | Cerro Gordo |
| 3 | Big Spirit Lake | Dickinson |
| 4 | Lake Manawa | Pottawattamie |
| 5 | East Okoboji | Dickinson |
| 6 | Green Valley Lake | Union |
| 7 | Blue Lake | Monona |
| 8 | Lake Macbride | Johnson |
| 9 | Big Creek Lake | Polk |
| 10 | Red Haw Lake | Lucas |
| 11 | Beeds Lake | Franklin |
| 12 | Lost Island Lake | Palo Alto |
| 13 | Rock Creek Lake | Jasper |
| 14 | George Wyth Lake | Black Hawk |
| 15 | Union Grove Lake | Tama |
| 16 | Lake Keomah | Mahaska |
| 17 | Lake Icaria | Adams |
| 18 | Lake of Three Fires | Taylor |
| 19 | Lake Ahquabi | Warren |
| 20 | Hickory Grove | Story |
| 21 | Lake Geode | Henry |
| 22 | Black Hawk Lake | Sac |
| 23 | Storm Lake | Buena Vista |
| 24 | Swan Lake | Carroll |
| 25 | Little Wall Lake | Hamilton |
| 26 | Viking Lake | Montgomery |
| 27 | Nine Eagles | Decatur |
| 28 | Lower Pine Lake | Hardin |
| 29 | Easter Lake | Polk |
| 30 | Little Spirit Lake | Dickinson |
| 31 | Upper Pine Lake | Hardin |
| 32 | Pollmiller Lake | Lee |
| 33 | Don Williams Lake | Boone |
| 34 | Briggs Woods Lake | Hamilton |

| | | |
|---|---|---|
| 35 | DeSoto Bend Lake | Harrison |
| 36 | Browns Lake | Woodbury |
| 37 | Lacey-Keosauqua Lake | Van Buren |
| 38 | Carter Lake | Pottawattamie |
| 39 | Lake of the Hills | Scott |
| 40 | Silver Lake | Dickinson |
| 41 | Pleasant Creek Lake | Linn |
| 42 | Lake Anita | Cass |
| 43 | Central Lake | Jones |
| 44 | Lake Wapello | Davis |
| 45 | Diamond Lake | Poweshiek |
| 46 | North Twin Lake | Calhoun |
| 47 | Kent Park Lake | Johnson |
| 48 | Prairie Rose Lake | Shelby |
| 49 | Hannen Lake | Benton |
| 50 | Five Island Lake | Palo Alto |
| 51 | Lake Darling | Washington |
| 52 | Lake Iowa | Iowa |
| 53 | Crystal Lake | Hancock |
| 54 | Smith Lake | Kossuth |
| 55 | Ingham Lake | Emmet |
| 56 | Badger Lake | Webster |
| 57 | Lake Cornelia | Wright |
| 58 | Silver Lake | Palo Alto |
| 59 | Lower Gar Lake | Dickinson |
| 60 | Cold Springs | Cass |
| 61 | Yen-ruo-gis Lake | Keokuk |
| 62 | Eldred Sherwood Lake | Hancock |
| 63 | Hickory Hills Lake | Tama |
| 64 | Spring Lake | Greene |
| 65 | Springbrook Lake | Guthrie |
| 66 | Tuttle Lake | Emmet |
| 67 | Mill Creek | O'Brien |
| 68 | Lake Miami | Monroe |
| 69 | Morman Trail | Adair |
| 70 | Bob White Lake | Wayne |
| 71 | Center Lake | Dickinson |
| 72 | Oldham Lake | Monona |
| 73 | Pierce Creek Pond | Page |
| 74 | Lake Minnewashta | Dickinson |
| 75 | Arrowhead Lake | Pottawattamie |
| 76 | Lake Hendricks | Howard |
| 77 | Wilson Lake | Lee |
| 78 | Lake Pahoja | Lyon |
| 79 | Little Sioux Park | Woodbury |
| 80 | Indian Lake | Van Buren |
| 81 | Nelson Lake | Crawford |
| 82 | Otter Creek Lake | Tama |
| 83 | Mariposa Lake | Jasper |
| 84 | Dog Creek Lake | O'Brien |
| 85 | Ottumwa Lagoon | Wapello |
| 86 | Green Castle Lake | Marshall |
| 87 | Windmill Lake | Taylor |
| 88 | Upper Gar Lake | Dickinson |

| | | |
|---|---|---|
| 89 | Wilson Lake | Taylor |
| 90 | Willow Lake | Harrison |
| 91 | Williamson Pond | Lucas |
| 92 | Lake Meyers | Winneshiek |
| 93 | Chatfield Lake | Lee |
| 94 | Meadow Lake | Adair |
| 95 | Lake Orient | Adair |
| 96 | Moorehead Lake | Ida |
| 97 | East Lake (Osceola) | Clarke |
| 98 | Arbor Lake | Poweshiek |
| 99 | Slip Bluff Lake | Decatur |
| 100 | Trumbull Lake | Clay |
| 101 | Thayer Lake | Union |
| 102 | Silver Lake | Delaware |
| 103 | Arrowhead Lake | Sac |
| 104 | Manteno Lake | Shelby |
| 105 | Rodgers Park Lake | Benton |
| 106 | Silver Lake | Worth |
| 107 | Crawford Creek Lake | Ida |

Table 2. Local population ranking of lakes in survey.

| Rank | Lake | County |
|---|---|---|
| 1 | Central Lake | Jones |
| 2 | Rodgers Park Lake | Benton |
| 3 | Silver Lake | Delaware |
| 4 | Pleasant Creek Lake | Linn |
| 5 | Hickory Hills Lake | Tama |
| 6 | Hannen Lake | Benton |
| 7 | Otter Creek Lake | Tama |
| 8 | Lake of the Hills | Scott |
| 9 | Lake Meyers | Winneshiek |
| 10 | George Wyth Lake | Black Hawk |
| 11 | Beeds Lake | Franklin |
| 12 | Green Castle Lake | Marshall |
| 13 | Lake Macbride | Johnson |
| 14 | East Lake (Osceola) | Clarke |
| 15 | Lake Iowa | Iowa |
| 16 | Mill Creek | O'Brien |
| 17 | Little Wall Lake | Hamilton |
| 18 | Kent Park Lake | Johnson |
| 19 | Hickory Grove | Story |
| 20 | Upper Pine Lake | Hardin |
| 21 | Don Williams Lake | Boone |
| 22 | Lower Pine Lake | Hardin |
| 23 | Easter Lake | Polk |
| 24 | Lake Hendricks | Howard |
| 25 | Big Creek Lake | Polk |
| 26 | Spring Lake | Greene |
| 27 | Rock Creek Lake | Jasper |
| 28 | Union Grove Lake | Tama |
| 29 | Mariposa Lake | Jasper |
| 30 | Yen-ruo-gis Lake | Keokuk |

| | | |
|---|---|---|
| 31 | Lake Ahquabi | Warren |
| 32 | Springbrook Lake | Guthrie |
| 33 | Williamson Pond | Lucas |
| 34 | Little Sioux Park | Woodbury |
| 35 | Arbor Lake | Poweshiek |
| 36 | Moorehead Lake | Ida |
| 37 | Eldred Sherwood Lake | Hancock |
| 38 | Lake Darling | Washington |
| 39 | Crawford Creek Lake | Ida |
| 40 | Meadow Lake | Adair |
| 41 | Red Haw Lake | Lucas |
| 42 | Lake Cornelia | Wright |
| 43 | Clear Lake | Cerro Gordo |
| 44 | Thayer Lake | Union |
| 45 | Oldham Lake | Monona |
| 46 | Browns Lake | Woodbury |
| 47 | Lake Orient | Adair |
| 48 | Briggs Woods Lake | Hamilton |
| 49 | Green Valley Lake | Union |
| 50 | Lacey-Keosauqua Lake | Van Buren |
| 51 | Blue Lake | Monona |
| 52 | Cold Springs | Cass |
| 53 | Lake Miami | Monroe |
| 54 | Badger Lake | Webster |
| 55 | Dog Creek Lake | O'Brien |
| 56 | Silver Lake | Worth |
| 57 | Prairie Rose Lake | Shelby |
| 58 | Lake Geode | Henry |
| 59 | Diamond Lake | Poweshiek |
| 60 | Indian Lake | Van Buren |
| 61 | Crystal Lake | Hancock |
| 62 | Viking Lake | Montgomery |
| 63 | Manteno Lake | Shelby |
| 64 | Arrowhead Lake | Pottawattamie |
| 65 | Nelson Lake | Crawford |
| 66 | Lake Keomah | Mahaska |
| 67 | North Twin Lake | Calhoun |
| 68 | Pollmiller Lake | Lee |
| 69 | Smith Lake | Kossuth |
| 70 | Wilson Lake | Lee |
| 71 | Lake Pahoja | Lyon |
| 72 | Lake Manawa | Pottawattamie |
| 73 | Swan Lake | Carroll |
| 74 | Pierce Creek Pond | Page |
| 75 | Willow Lake | Harrison |
| 76 | Arrowhead Lake | Sac |
| 77 | Black Hawk Lake | Sac |
| 78 | Ottumwa Lagoon | Wapello |
| 79 | Storm Lake | Buena Vista |
| 80 | Morman Trail | Adair |
| 81 | Carter Lake | Pottawattamie |
| 82 | DeSoto Bend Lake | Harrison |
| 83 | Chatfield Lake | Lee |
| 84 | Lake Anita | Cass |

| | | |
|---|---|---|
| 85 | Lake Wapello | Davis |
| 86 | Silver Lake | Palo Alto |
| 87 | Lake Icaria | Adams |
| 88 | Five Island Lake | Palo Alto |
| 89 | Lost Island Lake | Palo Alto |
| 90 | Trumbull Lake | Clay |
| 91 | Silver Lake | Dickinson |
| 92 | Wilson Lake | Taylor |
| 93 | Lower Gar Lake | Dickinson |
| 94 | Windmill Lake | Taylor |
| 95 | Lake Minnewashta | Dickinson |
| 96 | Lake of Three Fires | Taylor |
| 97 | Upper Gar Lake | Dickinson |
| 98 | Bob White Lake | Wayne |
| 99 | Ingham Lake | Emmet |
| 100 | West Okoboji | Dickinson |
| 101 | East Okoboji | Dickinson |
| 102 | Center Lake | Dickinson |
| 103 | Slip Bluff Lake | Decatur |
| 104 | Tuttle Lake | Emmet |
| 105 | Nine Eagles | Decatur |
| 106 | Big Spirit Lake | Dickinson |
| 107 | Little Spirit Lake | Dickinson |

Table 3. Public benefit ranking of lakes in survey.

| Rank | Lake | County |
|---|---|---|
| 1 | Lake Macbride | Johnson |
| 2 | Beeds Lake | Franklin |
| 3 | George Wyth Lake | Black Hawk |
| 4 | Big Creek Lake | Polk |
| 5 | Hickory Grove | Story |
| 6 | Rock Creek Lake | Jasper |
| 7 | Little Wall Lake | Hamilton |
| 8 | Union Grove Lake | Tama |
| 9 | Central Lake | Jones |
| 10 | Clear Lake | Cerro Gordo |
| 11 | Pleasant Creek Lake | Linn |
| 12 | Lake of the Hills | Scott |
| 13 | Lake Ahquabi | Warren |
| 14 | Lower Pine Lake | Hardin |
| 15 | Red Haw Lake | Lucas |
| 16 | Upper Pine Lake | Hardin |
| 17 | Easter Lake | Polk |
| 18 | Don Williams Lake | Boone |
| 19 | Green Valley Lake | Union |
| 20 | Hannen Lake | Benton |
| 21 | Blue Lake | Monona |
| 22 | Kent Park Lake | Johnson |
| 23 | Lake Iowa | Iowa |
| 24 | Hickory Hills Lake | Tama |
| 25 | Lake Manawa | Pottawattamie |
| 26 | Lake Geode | Henry |

| | | |
|---|---|---|
| 27 | Briggs Woods Lake | Hamilton |
| 28 | Browns Lake | Woodbury |
| 29 | Lake Keomah | Mahaska |
| 30 | Mill Creek | O'Brien |
| 31 | Lacey-Keosauqua Lake | Van Buren |
| 32 | Viking Lake | Montgomery |
| 33 | Lake Darling | Washington |
| 34 | Otter Creek Lake | Tama |
| 35 | Spring Lake | Greene |
| 36 | Yen-ruo-gis Lake | Keokuk |
| 37 | Springbrook Lake | Guthrie |
| 38 | Swan Lake | Carroll |
| 39 | Green Castle Lake | Marshall |
| 40 | Black Hawk Lake | Sac |
| 41 | Lake Cornelia | Wright |
| 42 | Eldred Sherwood Lake | Hancock |
| 43 | Lake Hendricks | Howard |
| 44 | Follmiller Lake | Lee |
| 45 | Lost Island Lake | Palo Alto |
| 46 | Lake Meyers | Winneshiek |
| 47 | West Okoboji | Dickinson |
| 48 | Storm Lake | Buena Vista |
| 49 | Diamond Lake | Poweshiek |
| 50 | Lake Icaria | Adams |
| 51 | Prairie Rose Lake | Shelby |
| 52 | Silver Lake | Delaware |
| 53 | East Okoboji | Dickinson |
| 54 | Rodgers Park Lake | Benton |
| 55 | Big Spirit Lake | Dickinson |
| 56 | Badger Lake | Webster |
| 57 | East Lake (Osceola) | Clarke |
| 58 | Cold Springs | Cass |
| 59 | Mariposa Lake | Jasper |
| 60 | Little Sioux Park | Woodbury |
| 61 | North Twin Lake | Calhoun |
| 62 | Crystal Lake | Hancock |
| 63 | Lake of Three Fires | Taylor |
| 64 | DeSoto Bend Lake | Harrison |
| 65 | Oldham Lake | Monona |
| 66 | Carter Lake | Pottawattamie |
| 67 | Lake Miami | Monroe |
| 68 | Smith Lake | Kossuth |
| 69 | Williamson Pond | Lucas |
| 70 | Lake Anita | Cass |
| 71 | Lake Wapello | Davis |
| 72 | Silver Lake | Dickinson |
| 73 | Moorehead Lake | Ida |
| 74 | Nine Eagles | Decatur |
| 75 | Arbor Lake | Poweshiek |
| 76 | Meadow Lake | Adair |
| 77 | Little Spirit Lake | Dickinson |
| 78 | Five Island Lake | Palo Alto |
| 79 | Arrowhead Lake | Pottawattamie |
| 80 | Dog Creek Lake | O'Brien |

| | | |
|---|---|---|
| 81 | Indian Lake | Van Buren |
| 82 | Lake Orient | Adair |
| 83 | Silver Lake | Palo Alto |
| 84 | Thayer Lake | Union |
| 85 | Crawford Creek Lake | Ida |
| 86 | Nelson Lake | Crawford |
| 87 | Pierce Creek Pond | Page |
| 88 | Wilson Lake | Lee |
| 89 | Morman Trail | Adair |
| 90 | Lake Pahcja | Lyon |
| 91 | Lower Gar Lake | Dickinson |
| 92 | Ingham Lake | Emmet |
| 93 | Silver Lake | Worth |
| 94 | Ottumwa Lagoon | Wapello |
| 95 | Willow Lake | Harrison |
| 96 | Manteno Lake | Shelby |
| 97 | Bob White Lake | Wayne |
| 98 | Lake Minnewashta | Dickinson |
| 99 | Tuttle Lake | Emmet |
| 100 | Center Lake | Dickinson |
| 101 | Chatfield Lake | Lee |
| 102 | Arrowhead Lake | Sac |
| 103 | Wilson Lake | Taylor |
| 104 | Windmill Lake | Taylor |
| 105 | Upper Gar Lake | Dickinson |
| 106 | Trumbull Lake | Clay |
| 107 | Slip Bluff Lake | Decatur |

Four water quality parameters measured in the 1979 lake survey plus the estimates of winter fishkill frequencies were used to derive the water quality ranking. While these parameters are interrelated, each measures a somewhat different aspect of water quality. Secchi disc depth is a measure of water transparency with greater depths representing better water quality. Total phosphorus is a measure of plant nutrient availability and indicates potential problems with plankton algae or rooted aquatic plants. Suspended solids concentrations represent the amount of inorganic and organic particulate matter suspended in the water resulting from soil erosion, plankton growth, and sediment resuspension. Chlorophyll a concentrations estimate the standing crop of suspended algae and are a measure of the algal problem. High fish winterkill frequencies indicate high rates of oxygen consumption by biological materials relative to the lake's capacity to store oxygen. Each of these parameters was used to rank the lakes from those with the worst water quality (#1) to those with the best (#107) (Appendix D). The five ranks for each lake were summed and the totals were ranked to give the water quality ranking (Table 4).

Table 4. Water quality ranking of lakes in survey.

| Rank | Lake | County |
|---|---|---|
| 1 | Black Hawk Lake | Sac |

| | | |
|---|---|---|
| 2 | DeSoto Bend Lake | Harrison |
| 3 | Lower Gar Lake | Dickinson |
| 4 | Silver Lake | Worth |
| 5 | Trumbull Lake | Clay |
| 6 | Upper Gar Lake | Dickinson |
| 7 | Tuttle Lake | Emmet |
| 8 | Silver Lake | Palo Alto |
| 9 | Arbor Lake | Poweshiek |
| 10 | Center Lake | Dickinson |
| 11 | Ottumwa Lagoon | Wapello |
| 12 | Hannen Lake | Benton |
| 13 | Swan Lake | Carroll |
| 14 | Windmill Lake | Taylor |
| 15 | Rodgers Park Lake | Benton |
| 16 | Union Grove Lake | Tama |
| 17 | Central Lake | Jones |
| 18 | Hickory Hills Lake | Tama |
| 19 | Lake Darling | Washington |
| 20 | Lake Manawa | Pottawattamie |
| 21 | Clear Lake | Cerro Gordo |
| 22 | Smith Lake | Kossuth |
| 23 | Arrowhead Lake | Pottawattamie |
| 24 | Rock Creek Lake | Jasper |
| 25 | North Twin Lake | Calhoun |
| 26 | East Lake (Osceola) | Clarke |
| 27 | Pierce Creek Pond | Page |
| 28 | Bob White Lake | Wayne |
| 29 | Meadow Lake | Adair |
| 30 | Lake Hendricks | Howard |
| 31 | Lower Pine Lake | Hardin |
| 32 | Mariposa Lake | Jasper |
| 33 | Lake Iowa | Iowa |
| 34 | Storm Lake | Buena Vista |
| 35 | Eldred Sherwood Lake | Hancock |
| 36 | Lake Keomah | Mahaska |
| 37 | Lake Minnewashta | Dickinson |
| 38 | Little Wall Lake | Hamilton |
| 39 | Lost Island Lake | Palo Alto |
| 40 | Lake Meyers | Winneshiek |
| 41 | Prairie Rose Lake | Shelby |
| 42 | Little Spirit Lake | Dickinson |
| 43 | Upper Pine Lake | Hardin |
| 44 | Green Valley Lake | Union |
| 45 | Wilson Lake | Taylor |
| 46 | Carter Lake | Pottawattamie |
| 47 | Badger Lake | Webster |
| 48 | Springbrook Lake | Guthrie |
| 49 | Lake of Three Fires | Taylor |
| 50 | East Okoboji | Dickinson |
| 51 | Manteno Lake | Shelby |
| 52 | Silver Lake | Dickinson |
| 53 | Lake Cornelia | Wright |
| 54 | Ingham Lake | Emmet |
| 55 | Beeds Lake | Franklin |

| | | |
|---|---|---|
| 56 | Dog Creek Lake | O'Brien |
| 57 | Kent Park Lake | Johnson |
| 58 | Nelson Lake | Crawford |
| 59 | Hickory Grove | Story |
| 60 | Crawford Creek Lake | Ida |
| 61 | Indian Lake | Van Buren |
| 62 | Cold Springs | Cass |
| 63 | Lake Pahoja | Lyon |
| 64 | Lake Orient | Adair |
| 65 | Chatfield Lake | Lee |
| 66 | Lake Anita | Cass |
| 67 | Lake of the Hills | Scott |
| 68 | Lake Macbride | Johnson |
| 69 | Big Spirit Lake | Dickinson |
| 70 | Crystal Lake | Hancock |
| 71 | Viking Lake | Montgomery |
| 72 | Lake Icaria | Adams |
| 73 | Lake Miami | Monroe |
| 74 | Silver Lake | Delaware |
| 75 | Red Haw Lake | Lucas |
| 76 | Lake Wapello | Davis |
| 77 | Browns Lake | Woodbury |
| 78 | Williamson Pond | Lucas |
| 79 | Thayer Lake | Union |
| 80 | Otter Creek Lake | Tama |
| 81 | Easter Lake | Polk |
| 82 | Five Island Lake | Palo Alto |
| 83 | Lake Ahquabi | Warren |
| 84 | Green Castle Lake | Marshall |
| 85 | Pollmiller Lake | Lee |
| 86 | Lake Geode | Henry |
| 87 | George Wyth Lake | Black Hawk |
| 88 | Pleasant Creek Lake | Linn |
| 89 | Spring Lake | Greene |
| 90 | Blue Lake | Monona |
| 91 | Don Williams Lake | Boone |
| 92 | Moorehead Lake | Ida |
| 93 | Briggs Woods Lake | Hamilton |
| 94 | Diamond Lake | Poweshiek |
| 95 | Nine Eagles | Decatur |
| 96 | Big Creek Lake | Polk |
| 97 | Oldham Lake | Monona |
| 98 | Little Sioux Park | Woodbury |
| 99 | Arrowhead Lake | Sac |
| 100 | Lacey-Keosauqua Lake | Van Buren |
| 101 | Morman Trail | Adair |
| 102 | Wilson Lake | Lee |
| 103 | West Okoboji | Dickinson |
| 104 | Slip Bluff Lake | Decatur |
| 105 | Willow Lake | Harrison |
| 106 | Yen-ruo-gis Lake | Keokuk |
| 107 | Mill Creek | O'Brien |

The ranking of lake restoration effectiveness was developed to give the highest priority to those lakes where the recommended lake restoration program would probably have the greatest effect. Initially each lake was placed in one of five groups. Group I contained those lakes with identifiable point source pollution or with divertable non-point source pollution. Lakes within this group should respond well to restoration programs since the removal of point source pollution should cause a direct and predictable change in the water quality of a lake.

The lakes within Group I were ranked by giving first priority to lakes receiving sewage effluents from sewage lagoons or overflows from sanitary sewer lines. Second priority was given to lakes receiving septic tank outflow, seepage, or urban storm sewer effluents and last ranking was given to lakes receiving divertable non-point pollution.

GROUP I LAKES. Lakes receiving point source pollution or divertable pollution.

| Rank | Lake | County |
|---|---|---|
| 1 | Badger Lake | Webster |
| 2 | Ottumwa Lagoon | Wapello |
| 3 | Storm Lake | Buena Vista |
| 4 | Lost Island Lake | Palo Alto |
| 5 | Lake Cornelia | Wright |
| 6 | Chatfield Lake | Lee |
| 7 | North Twin Lake | Calhoun |
| 8 | Arbor Lake | Poweshiek |
| 9 | Carter Lake | Pottawattamie |
| 10 | Easter Lake | Polk |
| 11 | Lake Manawa | Pottawattamie |

The lakes in Group II have ratios of watershed area to lake surface area less than 100 and have impairments related to shallowness. In some lakes the shallowness encourages the massive growth of higher aquatic plants that interfere with fishing, boating, and other recreational activities; while others have winter fishkills once every 10 or fewer years due to reduced oxygen concentrations. Eliminating the high densities of aquatic plants will have immediate beneficial impacts on boating, fishing, and swimming activities while the elimination of the winter oxygen problem will have a direct and measurable effect on the lake's use for fishing purposes. Lakes within this group were ranked on the basis of winter fishkill frequency with first preference given to those lakes with the highest frequencies. Ties were broken by giving preference to the shallowest lakes. Lakes with high watershed ratios were excluded since experience has shown they are less likely to respond to lake restoration measures.

GROUP II LAKES. Lakes with problems due to shallowness.

| Rank | Lake | County |
|---|---|---|
| 1 | Swan Lake | Carroll |
| 2 | Silver Lake | Worth |
| 3 | Lake Hendricks | Howard |
| 4 | Spring Lake | Greene |
| 5 | Browns Lake | Woodbury |
| 6 | Crystal Lake | Hancock |
| 7 | Black Hawk Lake | Sac |
| 8 | Upper Gar Lake | Dickinson |
| 9 | Lower Gar Lake | Dickinson |
| 10 | Little Wall Lake | Hamilton |
| 11 | Arbor Lake | Poweshiek |
| 12 | Lake Pahoja | Lyon |
| 13 | Lake Minnewashta | Dickinson |
| 14 | Silver Lake | Delaware |
| 15 | Ottumwa Lagoon | Wapello |
| 16 | Lower Pine Lake | Hardin |
| 17 | Chatfield Lake | Lee |
| 18 | Carter Lake | Pottawattamie |
| 19 | North Twin Lake | Calhoun |
| 20 | Five Island Lake | Palo Alto |
| 21 | Tuttle Lake | Emmet |
| 22 | Little Spirit Lake | Dickinson |
| 23 | Silver Lake | Dickinson |
| 24 | Ingham Lake | Emmet |
| 25 | Indian Lake | Van Buren |
| 26 | Union Grove Lake | Tama |
| 27 | DeSoto Bend Lake | Harrison |
| 28 | Trumbull Lake | Clay |
| 29 | Silver Lake | Palo Alto |
| 30 | East Okoboji | Dickinson |
| 31 | Center Lake | Dickinson |
| 32 | Little Sioux Park | Woodbury |
| 33 | Storm Lake | Buena Vista |

Group III contains lakes needing watershed protection and with watershed to surface area ratios less than 100. These lakes were ranked by an adjusted siltation index (AI) calculated as follows:

$$AI = (WA/SA) \times ER \times (1 - 0.5 \times (SC/100))$$

where WA is the watershed area, SA the lake surface area, ER the erosion rate for the region where the lake is located, and SC is the percent of the watershed farmed under approved soil conservation practices. This index gives the highest ranking to lakes receiving the greatest impact from soil erosion and having the greatest need for a soil conservation program.

GROUP III LAKES. Lakes with non-point pollution problems.

| Rank | Lake | County |
|---|---|---|
| 1 | Arbor Lake | Poweshiek |
| 2 | Arrowhead Lake | Pottawattamie |
| 3 | Rock Creek Lake | Jasper |
| 4 | Pierce Creek Pond | Page |
| 5 | Nelson Lake | Crawford |
| 6 | Oldham Lake | Monona |
| 7 | Mariposa Lake | Jasper |
| 8 | Green Castle Lake | Marshall |
| 9 | Crawford Creek Lake | Ida |
| 10 | Lake of the Hills | Scott |
| 11 | Lake Geode | Henry |
| 12 | Williamson Pond | Lucas |
| 13 | Rodgers Park Lake | Benton |
| 14 | Lake Pahoja | Lyon |
| 15 | Prairie Rose Lake | Shelby |
| 16 | Lake Darling | Washington |
| 17 | Moorehead Lake | Ida |
| 18 | Thayer Lake | Union |
| 19 | Willow Lake | Harrison |
| 20 | Union Grove Lake | Tama |
| 21 | Tuttle Lake | Emmet |
| 22 | Bob White Lake | Wayne |
| 23 | Eldred Sherwood Lake | Hancock |
| 24 | Diamond Lake | Poweshiek |
| 25 | Lake of Three Fires | Taylor |
| 26 | Springbrook Lake | Guthrie |
| 27 | Lake Ahquabi | Warren |
| 28 | Lake Meyers | Winneshiek |
| 29 | Ottumwa Lagoon | Wapello |
| 30 | Lake Miami | Monroe |
| 31 | Lake Keomah | Mahaska |
| 32 | Kent Park Lake | Johnson |
| 33 | Red Haw Lake | Lucas |
| 34 | Lake Icaria | Adams |
| 35 | Lake Anita | Cass |
| 36 | Lake Orient | Adair |
| 37 | Lacey-Keosauqua Lake | Van Buren |
| 38 | Lake Macbride | Johnson |
| 39 | Hannen Lake | Benton |
| 40 | Meadow Lake | Adair |
| 41 | Lower Gar Lake | Dickinson |
| 42 | Central Lake | Jones |
| 43 | Lake Hendricks | Howard |
| 44 | Hickory Grove | Story |
| 45 | Windmill Lake | Taylor |
| 46 | Big Creek Lake | Polk |
| 47 | East Lake (Osceola) | Clarke |
| 48 | Easter Lake | Polk |
| 49 | Lake Iowa | Iowa |
| 50 | Lake Wapello | Davis |

| | | |
|---|---|---|
| 51 | Otter Creek Lake | Tama |
| 52 | Pollmiller Lake | Lee |
| 53 | Morman Trail | Adair |
| 54 | Viking Lake | Montgomery |
| 55 | Lower Pine Lake | Hardin |
| 56 | Trumbull Lake | Clay |
| 57 | Nine Eagles | Decatur |
| 58 | Green Valley Lake | Union |
| 59 | Slip Bluff Lake | Decatur |
| 60 | Wilson Lake | Taylor |
| 61 | Chatfield Lake | Lee |
| 62 | Hickory Hills Lake | Tama |
| 63 | Black Hawk Lake | Sac |
| 64 | Ingham Lake | Emmet |
| 65 | Indian Lake | Van Buren |
| 66 | George Wyth Lake | Black Hawk |
| 67 | Upper Gar Lake | Dickinson |
| 68 | Silver Lake | Worth |
| 69 | Silver Lake | Delaware |
| 70 | Swan Lake | Carroll |
| 71 | Silver Lake | Palo Alto |
| 72 | Silver Lake | Dickinson |
| 73 | Spring Lake | Greene |
| 74 | Crystal Lake | Hancock |
| 75 | Storm Lake | Buena Vista |
| 76 | East Okoboji | Dickinson |
| 77 | Big Spirit Lake | Dickinson |
| 78 | Smith Lake | Kossuth |
| 79 | Pleasant Creek Lake | Linn |
| 80 | DeSoto Bend Lake | Harrison |
| 81 | West Okoboji | Dickinson |
| 82 | Center Lake | Dickinson |
| 83 | Lost Island Lake | Palo Alto |
| 84 | Little Spirit Lake | Dickinson |
| 85 | Clear Lake | Cerro Gordo |
| 86 | Five Island Lake | Palo Alto |
| 87 | Lake Minnewashta | Dickinson |
| 88 | North Twin Lake | Calhoun |
| 89 | Lake Manawa | Pottawattamie |
| 90 | Lake Cornelia | Wright |
| 91 | Little Wall Lake | Hamilton |

Group IV contains all lakes with watershed area to lake surface area ratios greater than 100. In the long run these lakes will be the most difficult to improve due to their large watersheds magnifying even low rates of non-point pollution. Within this group, first preference was given to lakes with the highest winterkill frequencies, followed by lakes with a high adjusted soil erosion index.

GROUP IV LAKES. Lakes with watershed area to surface area ratios greater than 100 and having non-point pollution problems.

| Rank | Lake | County |
|---|---|---|

| | | |
|---|---|---|
| 1 | Manteno Lake | Shelby |
| 2 | Upper Pine Lake | Hardin |
| 3 | Badger Lake | Webster |
| 4 | Dog Creek Lake | O'Brien |
| 5 | Beeds Lake | Franklin |
| 6 | Don Williams Lake | Boone |

The last group includes lakes that are not recommended for restoration programs. Some of these lakes have no identifiable sources of point or non-point pollution while others have recently undergone a lake restoration program. A few of these lakes do not meet the 24.7 hectare (10 acre) minimum surface area requirement. These lakes were not included in the final priority ranking.

GROUP V LAKES. Lakes not considered for restoration.

| Lake | County |
|---|---|
| Arrowhead Lake | Sac |
| Blue Lake | Monona |
| Briggs Woods Lake | Hamilton |
| Cold Springs | Cass |
| Mill Creek | O'Brien |
| Wilson Lake | Lee |
| Yen-ruo-gis Lake | Keokuk |

The final restoration effectiveness ranking list (Table 5) was derived by giving first priority to lakes having multiple problems; these lakes appeared simultaneously on the lists for Group I (lakes with point source or divertable pollution), Group II (shallow, winterkill lakes), and Group III (lakes with non-point pollution problems). The individual rankings on each of the three lists were combined to determine the final effectiveness ranking for these lakes. Second priority was given to lakes that appeared in both Group I and Group II, and have problems with point source or divertable pollution and shallowness. The individual rankings on each of the two lists were combined to determine the final ranking. Third priority was given to lakes that appeared in both Group I and Group III. These lakes have problems of point source or divertable pollution and non-point pollution and were ranked by combining the individual rankings from each list. Lakes with only a point source or divertable pollution problem were ranked next followed by lakes appearing in both Group II and Group III. These lakes have problems with both shallowness and non-point pollution and were ranked by combining the individual rankings from Group II and Group III. Next priority was given to lakes appearing only in Group II followed by the lakes in Group III. Final priority was given to lakes in Group IV. The lakes in Group V were not included in the ranking.

The lake restoration priority list derived by the above procedure is given in Table 6.

Table 5. Restoration effectiveness ranking.

| Rank | Lake | County |
|---|---|---|
| 1 | Arbor Lake | Poweshiek |
| 2 | Ottumwa Lagoon | Wapello |
| 3 | Chatfield Lake | Lee |
| 4 | Storm Lake | Buena Vista |
| 5 | North Twin Lake | Calhoun |
| 6 | Carter Lake | Pottawattamie |
| 7 | Easter Lake | Polk |
| 8 | Lost Island Lake | Palo Alto |
| 9 | Lake Cornelia | Wright |
| 10 | Lake Manawa | Pottawattamie |
| 11 | Lake Pahoja | Lyon |
| 12 | Tuttle Lake | Emmet |
| 13 | Lake Hendricks | Howard |
| 14 | Union Grove Lake | Tama |
| 15 | Lower Gar Lake | Dickinson |
| 16 | Silver Lake | Worth |
| 17 | Black Hawk Lake | Sac |
| 18 | Swan Lake | Carroll |
| 19 | Lower Pine Lake | Hardin |
| 20 | Upper Gar Lake | Dickinson |
| 21 | Spring Lake | Greene |
| 22 | Crystal Lake | Hancock |
| 23 | Silver Lake | Delaware |
| 24 | Trumbull Lake | Clay |
| 25 | Ingham Lake | Emmet |
| 26 | Indian Lake | Van Buren |
| 27 | Silver Lake | Dickinson |
| 28 | Lake Minnewashta | Dickinson |
| 29 | Silver Lake | Palo Alto |
| 30 | Little Wall Lake | Hamilton |
| 31 | Five Island Lake | Palo Alto |
| 32 | Little Spirit Lake | Dickinson |
| 33 | East Okoboji | Dickinson |
| 34 | DeSoto Bend Lake | Harrison |
| 35 | Center Lake | Dickinson |
| 36 | Browns Lake | Woodbury |
| 37 | Little Sioux Park | Woodbury |
| 38 | Arrowhead Lake | Pottawattamie |
| 39 | Rock Creek Lake | Jasper |
| 40 | Pierce Creek Pond | Page |
| 41 | Nelson Lake | Crawford |
| 42 | Oldham Lake | Monona |
| 43 | Mariposa Lake | Jasper |
| 44 | Green Castle Lake | Marshall |
| 45 | Crawford Creek Lake | Ida |
| 46 | Lake of the Hills | Scott |
| 47 | Lake Geode | Henry |
| 48 | Williamson Pond | Lucas |

| | | |
|---|---|---|
| 49 | Rodgers Park Lake | Benton |
| 50 | Prairie Rose Lake | Shelby |
| 51 | Lake Darling | Washington |
| 52 | Moorehead Lake | Ida |
| 53 | Thayer Lake | Union |
| 54 | Willow Lake | Harrison |
| 55 | Bob White Lake | Wayne |
| 56 | Eldred Sherwood Lake | Hancock |
| 57 | Diamond Lake | Poweshiek |
| 58 | Lake of Three Fires | Taylor |
| 59 | Springbrook Lake | Guthrie |
| 60 | Lake Ahquabi | Warren |
| 61 | Lake Meyers | Winneshiek |
| 62 | Lake Miami | Monroe |
| 63 | Lake Keomah | Mahaska |
| 64 | Kent Park Lake | Johnson |
| 65 | Red Haw Lake | Lucas |
| 66 | Lake Icaria | Adams |
| 67 | Lake Anita | Cass |
| 68 | Lake Orient | Adair |
| 69 | Lacey-Keosauqua Lake | Van Buren |
| 70 | Lake Macbride | Johnson |
| 71 | Hannen Lake | Benton |
| 72 | Meadow Lake | Adair |
| 73 | Central Lake | Jones |
| 74 | Hickory Grove | Story |
| 75 | Windmill Lake | Taylor |
| 76 | Big Creek Lake | Polk |
| 77 | East Lake (Osceola) | Clarke |
| 78 | Lake Iowa | Iowa |
| 79 | Lake Wapello | Davis |
| 80 | Otter Creek Lake | Tama |
| 81 | Pollmiller Lake | Lee |
| 82 | Morman Trail | Adair |
| 83 | Viking Lake | Montgomery |
| 84 | Nine Eagles | Decatur |
| 85 | Green Valley Lake | Union |
| 86 | Slip Bluff Lake | Decatur |
| 87 | Wilson Lake | Taylor |
| 88 | Hickory Hills Lake | Tama |
| 89 | George Wyth Lake | Black Hawk |
| 90 | Big Spirit Lake | Dickinson |
| 91 | Smith Lake | Kossuth |
| 92 | Pleasant Creek Lake | Linn |
| 93 | West Okoboji | Dickinson |
| 94 | Clear Lake | Cerro Gordo |
| 95 | Manteno Lake | Shelby |
| 96 | Upper Pine Lake | Hardin |
| 97 | Badger Lake | Webster |
| 98 | Dog Creek Lake | O'Brien |
| 99 | Beeds Lake | Franklin |
| 100 | Don Williams Lake | Boone |
| 101 | Arrowhead Lake | Sac |

Table 6. Lake restoration priority list for Iowa.

| Rank | Lake | County |
|---|---|---|
| 1 | Union Grove Lake | Tama |
| 2 | Black Hawk Lake | Sac |
| 3 | Lake Manawa | Pottawattamie |
| 4 | Lower Pine Lake | Hardin |
| 5 | Swan Lake | Carroll |
| 6 | Rock Creek Lake | Jasper |
| 7 | Little Wall Lake | Hamilton |
| 8 | Arbor Lake | Poweshiek |
| 9 | Storm Lake | Buena Vista |
| 10 | Lake Hendricks | Howard |
| 11 | North Twin Lake | Calhoun |
| 12 | Lost Island Lake | Palo Alto |
| 13 | DeSoto Bend Lake | Harrison |
| 14 | Central Lake | Jones |
| 15 | Lake Cornelia | Wright |
| 16 | Ottumwa Lagoon | Wapello |
| 17 | Lake Darling | Washington |
| 18 | Hannen Lake | Benton |
| 19 | Easter Lake | Polk |
| 20 | Lower Gar Lake | Dickinson |
| 21 | Silver Lake | Worth |
| 22 | Tuttle Lake | Emmet |
| 23 | Carter Lake | Pottawattamie |
| 24 | Rodgers Park Lake | Benton |
| 25 | Silver Lake | Palo Alto |
| 26 | Lake of the Hills | Scott |
| 27 | Upper Gar Lake | Dickinson |
| 28 | Clear Lake | Cerro Gordo |
| 29 | Lake Keomah | Mahaska |
| 30 | Trumbull Lake | Clay |
| 31 | Hickory Hills Lake | Tama |
| 32 | Mariposa Lake | Jasper |
| 33 | Eldred Sherwood Lake | Hancock |
| 34 | East Okoboji | Dickinson |
| 35 | Lake Iowa | Iowa |
| 36 | Arrowhead Lake | Pottawattamie |
| 37 | Browns Lake | Woodbury |
| 38 | Hickory Grove | Story |
| 39 | Lake Macbride | Johnson |
| 40 | Prairie Rose Lake | Shelby |
| 41 | Center Lake | Dickinson |
| 42 | Springbrook Lake | Guthrie |
| 43 | Kent Park Lake | Johnson |
| 44 | Spring Lake | Greene |
| 45 | Lake Meyers | Winneshiek |
| 46 | Silver Lake | Delaware |
| 47 | Little Spirit Lake | Dickinson |
| 48 | Silver Lake | Dickinson |
| 49 | Crystal Lake | Hancock |
| 50 | Green Valley Lake | Union |

| | | |
|---|---|---|
| 51 | Pierce Creek Pond | Page |
| 52 | East Lake (Osceola) | Clarke |
| 53 | Upper Pine Lake | Hardin |
| 54 | Lake Ahquabi | Warren |
| 55 | Beeds Lake | Franklin |
| 56 | Lake Pahoja | Lyon |
| 57 | Red Haw Lake | Lucas |
| 58 | Lake Geode | Henry |
| 59 | Lake Minnewashta | Dickinson |
| 60 | Green Castle Lake | Marshall |
| 61 | Chatfield Lake | Lee |
| 62 | Indian Lake | Van Buren |
| 63 | Ingham Lake | Emmet |
| 64 | Lake of Three Fires | Taylor |
| 65 | Meadow Lake | Adair |
| 66 | Big Creek Lake | Polk |
| 67 | Bob White Lake | Wayne |
| 68 | Smith Lake | Kossuth |
| 69 | Nelson Lake | Crawford |
| 70 | George Wyth Lake | Black Hawk |
| 71 | Lake Icaria | Adams |
| 72 | Viking Lake | Montgomery |
| 73 | Five Island Lake | Palo Alto |
| 74 | Windmill Lake | Taylor |
| 75 | Crawford Creek Lake | Ida |
| 76 | Little Sioux Park | Woodbury |
| 77 | Otter Creek Lake | Tama |
| 78 | Williamson Pond | Lucas |
| 79 | Pleasant Creek Lake | Linn |
| 80 | Diamond Lake | Poweshiek |
| 81 | Lacey-Keosauqua Lake | Van Buren |
| 82 | Lake Miami | Monroe |
| 83 | Oldham Lake | Monona |
| 84 | Lake Anita | Cass |
| 85 | Badger Lake | Webster |
| 86 | Pollmiller Lake | Lee |
| 87 | Don Williams Lake | Boone |
| 88 | Lake Orient | Adair |
| 89 | Big Spirit Lake | Dickinson |
| 90 | Moorehead Lake | Ida |
| 91 | Thayer Lake | Union |
| 92 | Lake Wapello | Davis |
| 93 | Dog Creek Lake | O'Brien |
| 94 | Wilson Lake | Taylor |
| 95 | West Okoboji | Dickinson |
| 96 | Manteno Lake | Shelby |
| 97 | Willow Lake | Harrison |
| 98 | Nine Eagles | Decatur |
| 99 | Morman Trail | Adair |
| 100 | Slip Bluff Lake | Decatur |
| 101 | Arrowhead Lake | Sac |

## USE OF PRIORITY LIST

The top ten lakes in this list have been selected for further evaluation. This will involve determining the level of local public interest in proceeding with lake restoration, availability of local or state funding for the restoration project, and determination as to eligibility of the restoration project for Clean Lakes funding. Based on these criteria, some lakes may not qualify for a diagnostic/feasibility study.

Diagnostic/feasibility studies, Clean Lakes Phase 1 projects, will be recommended for eligible lakes of the top ten as part of the statewide water quality management strategy of Iowa's Water Quality Management Plan. In the event that state or local match funds are not available for these lakes, lakes with a lower priority that do have local match funds available will be considered. As part of the annual update of the statewide water quality management strategy, additional lakes from the Priority List in priority order will be further evaluated and included in the statewide water quality management strategy for diagnostic/feasibility studies.

A list of lakes eligible for Clean Lakes Phase 2 - implementation projects will also be developed and included in the statewide water quality management strategy. Lakes qualifying for Phase 2 funding shall consist of renovation projects found feasible in a diagnostic/feasibility study. A qualifying diagnostic/feasibility study could have been conducted through a Phase 1 Clean Lakes project, the result of other ongoing state programs or developed as an independent project. Lakes elegible for Phase 2 Clean Lakes funding will be reviewed according to EPA's Application Review Criteria contained in the Clean Lakes Regulations.

### CHANGES IN PRIORITY LIST

After a final verification of the data on individual lakes, it was found that Lake Pahoja had a watershed area/lake surface area ratio of 229:1 which is greater than the cutoff value of 200:1 for inclusion in the priority ranking. In addition the 10 acre minimum surface area was not met by Green Castle Lake (7 acres) and Chatfield Lake (3 acres). For this reason, it is reccommended that the priority ranking list be revised for the next update of the Water Quality Management Plan and that these three lakes be deleted from the list.

## LAKES FOR FEASIBILITY AND DIAGNOSTIC STUDIES

The top 10 lakes on the priority list of lakes for restoration are recommended for consideration for feasibility and diagnostic (Phase I) studies at this time. The 10 lakes were determined using a criteria ranking system which addressed the significance and public benefit of each lake as measured by actual and potential use, the water quality conditions within each lake, and the restoration plans. The 10 lakes in order include:

1. Union Grove Lake--Tama County
2. Black Hawk Lake--Sac County
3. Lake Manawa--Pottawattamie County
4. Lower Pine Lake--Hardin County
5. Swan Lake--Carroll County
6. Rock Creek Lake--Jasper County
7. Little Wall Lake--Hamilton County
8. Arbor Lake--Poweshiek County
9. Storm Lake--Buena Vista County
10. Lake Hendricks--Howard County

The following paragraphs summarize the problems and recommendations for each of the 10 lakes.

### 1. Union Grove Lake

Shallowness and poor water quality are major problems in Union Grove Lake. Winter fishkills occur occasionally due to the reduced capacity of the shallow lake basin to hold dissolved oxygen. Summer algal standing crops are very large and result in sustained poor water transparency. The oxygen demand associated with algal decomposition may enhance the frequency of winterkills. Swimming activity may be restricted by algal blooms, as well. Aquatic plant coverage is not extensive, but plants are locally abundant in bays and along the shoreline. Boating and shoreline fishing are restricted to some degree by aquatic vegetation.

Winter aeration would help to maintain the fishery at Union Grove. Dredging should also be considered as a more long-term solution to the problems caused by basin shallowness. Implementation of best land management practices in the watershed should accompany in-lake restoration measures. While the beneficial effects on water quality from improved watershed management cannot be quantitatively predicted, the rate of basin-filling from sedimentation will be reduced. Mechanical removal of plants from small areas of the lake may be practical;

however, the feasibility and cost-effectiveness of this method should be compared to that of other available plant control measures, such as chemical treatment or the stocking of grass carp.

2. Black Hawk Lake

Shallowness and poor water quality are major problems in Black Hawk Lake. Winter fishkills occur frequently due to the reduced capacity of the lake basin to hold dissolved oxygen. Black Hawk has the poorest overall water quality among all 107 lakes in the survey. Summer algal standing crops are very large and result in sustained poor water transparency. Swimming activity may be restricted by the frequent algal blooms and other suspended materials.

Black Hawk Lake is currently undergoing an extensive fisheries renovation. The fish restocking program in the lake will be completed in 1980. An experimental aeration program has been carried out during 1978 and 1979. Continued winter aeration will help to sustain the lake fishery. Dredging should also be considered as a more long-term solution to the problems caused by basin shallowness. Implementation of best land management practices in the watershed should accompany in-lake restoration measures.

3. Lake Manawa

Shallowness and poor water quality are major problems in Lake Manawa. Water quality is degraded by the diversion of supplemental water of poor quality from Mosquito Creek. Surface runoff and direct precipitation are insufficient to offset water losses due to evaporation and seepage; therefore lake levels are maintained with water diverted on a controlled basis from Mosquito Creek. Summer algal standing crops are very large and result in sustained poor water transparency. Swimming activity may be restricted by the frequent algal blooms.

Various lake restoration measures are presently being planned for Lake Manawa. Dredging of the lake basin will alleviate problems associated with shallowness and enhance the establishment of a good fishery. Removal of sediment from Mosquito Creek will reduce the adverse impact on water quality from this supplemental water source. The fish population will also be renovated to remove rough fish species that contribute to the turbidity problem.

4. Lower Pine Lake

Shallowness and poor water quality are major problems in Lower Pine Lake. Frequent winter and summer fishkills result from the reduced capacity of the lake basin to hold dissolved oxygen. Summer periods of low dissolved oxygen may be aggravated by poor wind mixing due to the hills surrounding the lake.

Summer algal standing crops are large and result in sustained poor water transparency. Swimming activity may be restricted by the frequent algal blooms. Aquatic vascular plants may interfere with boating, shoreline fishing, and swimming.

Winter and/or year-round aeration is recommended to prevent the winter and/or summer fishkills in Lower Pine Lake. Dredging should be considered as a more long-term solution to the problems caused by basin shallowness. The stocking of sufficient numbers of grass carp should control the growth of aquatic plants. Implementation of best land management practices in the watershed is also recommended.

5. Swan Lake

Shallowness and poor water quality are major problems in Swan Lake. Frequent winter and summer fishkills result from the reduced capacity of the lake basin to hold dissolved oxygen. Summer algal standing crops are large and result in sustained poor water transparency. Swimming activity may be restricted by the frequent algal blooms.

Winter and/or year-round aeration is recommended to prevent the winter and/or summer fishkills in Swan Lake. Dredging should also be considered as a more long-term solution to the problems caused by basin shallowness. Continued implementation of best land management practices in the watershed should accompany in-lake restoration measures.

6. Rock Creek Lake

Rock Creek's major problem is a high potential for nonpoint pollution. Because the soil type within this relatively large watershed exhibits a high soil erosion rate and a low percentage of the watershed is in approved soil conservation practices, soil erosion and soil transport into Rock Creek is likely. Another problem in Rock Creek is reduced water transparency impairing swimming. This is due to relatively high algal populations and other suspended matter in the water column.

The recommendation for Rock Creek is improved watershed management. According to the SCS official for Jasper County, the best land management practices for this area are conservation tillage, strip cropping, terracing, and gully control structures. Although the effects of best land management practices upon water quality improvement through decreases in nutrients are unknown, such land practices prolong the life of the lake basin.

7. Little Wall Lake

Frequent winter fishkills are a problem in Little Wall Lake. Because the lake is relatively shallow, the basin has a reduced capacity to hold dissolved oxygen. Relatively high algal standing crops enhance winterkill frequencies when decomposing algal populations create oxygen demands. Algal populations sometimes reduce water transparency and impair swimming. Winter aeration is recommended to maintain dissolved oxygen concentrations in the lake and prevent winter fishkills. Implementation of best land management practices in the watershed should accompany aeration. Best land management practices for the Little Wall Lake watershed include conservation tillage and terracing.

8. Arbor Lake

Arbor Lake has three problems: urban runoff pollution, poor water quality, and winter fishkills. Storm water runoff enters the lake from the southwest corner of Grinnell and from southeast of the lake. Roadway dirt, deicing salt, oils, oxygen demanding materials, and nutrients may be introduced into the lake by this means. There may be septic tank taps emptying into the storm sewer system as well. Poor water quality in Arbor Lake results from high total phosphorus values and relatively high algal standing crops. Reduced water transparency from algal populations and suspended matter impair swimming. Lastly, frequent fish winterkills may limit fishing potential. Although the lake was dredged in 1977, it is still relatively shallow and the basin has a reduced capacity to hold dissolved oxygen. The relatively high algal standing crops enhance winterkill frequencies when decomposing algal populations create oxygen demands.

Recommendations for Arbor Lake include the diversion of storm water runoff and an examination of other possible point source pollution. The use of artificial aeration devices to maintain dissolved oxygen concentrations is also recommended for the prevention of winter fishkills. Because the Arbor Lake watershed has a high soil erosion rate, implementation of best land management practices in the watershed should accompany aeration.

9. Storm Lake

Approximately 50% of the storm water runoff for the city of Storm Lake enters the lake. Roadway dirt, deicing salt, organic matter, and nutrients may be introduced into the lake by this urban runoff. In addition, raw sewage enters the lake during heavy rainfalls because of inadequate pumping stations. Such sewage inputs increase the nutrient and organic matter loading as well as introducing the risk of bacterial contamination.

Lesser problems include poor water transparency and occassional fish winterkills. Swimming in Storm Lake may be impaired because of algal populations and other suspended matter. Winterkills once in every 10 years may limit fishing potential; however, the problem does not appear severe enough to warrant dredging or aeration. Recommendations for Storm Lake include the diversion of all storm sewers away from the lake and the replacement of inadequate sanitary sewer equipment. Implementation of best land management practices in the watershed may reduce soil erosion and improve water transparency.

10. Lake Hendricks

Frequent winter fishkills are a problem in Lake Hendricks. Because the lake is relatively shallow, the basin has a reduced capacity to hold dissolved oxygen. Relatively high algal standing crops enhance winterkill frequencies when decomposing algal populations create oxygen demands. Algal populations also reduce water transparency thus impairing swimming.

Recommendations for Lake Hendricks include winter aeration to maintain dissolved oxygen concentrations. Dredging should be considered as a more long-term solution to the problems caused by basin shallowness. Implementation of best land management practices in the watershed should accompany in-lake restoration measures. While the beneficial effects on water quality from improved watershed management cannot be quantitatively predicted, the rate of basin-filling from sedimentation should be reduced.

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## APPENDIX A

List of significant public-owned lakes submitted to the Iowa Department of Environmental Quality by the Iowa Conservation Commission on May 29, 1979 and approved by DEQ on May 31, 1979.

## INTRODUCTION

Approximately 175 lakes and reservoirs were considered by the ICC staff for inclusion into the list of lakes to be surveyed and classified. Many of these 175 lakes are contained in "Iowa Fishing Guide", a publication of the Iowa Conservation Commission. Time and money precluded survey and classification of all lakes; therefore, the list was reduced to include only significant lakes in public ownership.

## SIGNIFICANT LAKES--DEFINED AND EXPLAINED

Significant publicly-owned lakes were defined as those lakes which are principally maintained for public use containing a minimum surface area of 10 acres and capable of supporting fish stocks of at least 200 pounds per acre. Species diversity in water bodies containing less than 10 acres is habitually low resulting in a fish population density with minimal potential for maximum sustained yields via sport or foodfish fisheries. Shallow lakes which are most characteristic of wetlands and marsh-like habitat, that are subject to chronic and extensive fish winterkills were excluded from the survey. Establishment of productive fish populations is hopeless where massive mortality results from the lowering of life supporting oxygen concentrations under ice cover each winter. Federal-owned onstream impoundment constructed for floodwater control and reservoirs constructed for domestic or industrial water supplies were excluded because of Clean Water Act regulations. Multi-purpose lakes providing domestic water supply as only one of several major management objectives were included in the study. Impoundments containing a watershed to surface area ratio greater than 200:1 acres were omitted from the list since they are mainly onstream impoundments formed by lowhead dams and emulate riverine habitat rather than lake environment.

## LIST OF LAKES
## TO BE
## SURVEYED AND CLASSIFIED

The following 107 lakes will be surveyed and classified according to the scope of work outlined in Article III, Public-Owned Lakes Management Restoration Contract.

| Lake | Location |
|---|---|
| Lake Orient | Adair |
| Meadow Lake | Adair |
| Morman Trail | Adair |
| Lake Icaria | Adams |
| Hannen Lake | Benton |
| Rodgers Park Lake | Benton |
| George Wyth Lake | Black Hawk |
| Don Williams Lake | Boone |
| Storm Lake | Buena Vista |
| North Twin Lake | Calhoun |
| Swan Lake | Carroll |
| Cold Springs | Cass |
| Lake Anita | Cass |
| Clear Lake | Cerro Gordo |
| East Lake (Osceola) | Clarke |
| Trumbull Lake | Clay |
| Nelson Lake | Crawford |
| Lake Wapello | Davis |
| Nine Eagles | Decatur |
| Slip Bluff | Decatur |
| Silver Lake | Delaware |
| Center Lake | Dickinson |
| East Okoboji | Dickinson |
| Little Spirit Lake | Dickinson |
| Upper Gar | Dickinson |
| Lower Gar | Dickinson |
| Minnewashta | Dickinson |
| Silver Lake | Dickinson |
| Spirit Lake | Dickinson |
| West Okoboji | Dickinson |
| Ingham Lake | Emmet |
| Tuttle Lake | Emmet |

| | |
|---|---|
| Beeds Lake | Franklin |
| Spring Lake | Greene |
| Springbrook Lake | Guthrie |
| Briggs Woods Lake | Hamilton |
| Little Wall Lake | Hamilton |
| Crystal Lake | Hancock |
| Eldred Sherwood Lake | Hancock |
| Lower Pine Lake | Hardin |
| Upper Pine Lake | Hardin |
| DeSoto Bend | Harrison |
| Willow Lake | Harrison |
| Lake Geode | Henry |
| Lake Hendricks | Howard |
| Battle Creek Lake | Ida |
| Moorehead Lake | Ida |
| Lake Iowa | Iowa |
| Mariposa Lake | Jasper |
| Rock Creek Lake | Jasper |
| Kent Park Lake | Johnson |
| Lake Macbride | Johnson |
| Central Lake | Jones |
| Yenrougis | Keokuk |
| Lake Smith | Kossuth |
| Chatfield Lake | Lee |
| Pollmiller Park | Lee |
| Wilson Lake | Lee |
| Pleasant Creek Lake | Linn |
| Red Haw | Lucas |
| Williamson Pond | Lucas |
| Lake Pahoja | Lyon |
| Lake Keomah | Mahaska |
| Green Castle Lake | Marshall |
| Blue Lake | Monona |
| Oldham Lake | Monona |

| | |
|---|---|
| Lake Miami | Monroe |
| Viking Lake | Montgomery |
| Mill Creek | O'Brien |
| Dog Creek Lake | O'Brien |
| Pierce Creek Pond | Page |
| Five Island Lake | Palo Alto |
| Lost Island | Palo Alto |
| Silver Lake | Palo Alto |
| Big Creek Lake | Polk |
| Easter Lake | Polk |
| Arrowhead Lake | Pottawattamie |
| Carter Lake | Pottawattamie |
| Lake Manawa | Pottawattamie |
| Arbor Lake | Poweshiek |
| Diamond Lake | Poweshiek |
| Arrowhead Lake | Sac |
| Black Hawk Lake | Sac |
| Lake of the Hills | Scott |
| Manteno Lake | Shelby |
| Prairie Rose Lake | Shelby |
| Hickory Grove | Story |
| Hockory Hills | Tama |
| Otter Creek Lake | Tama |
| Union Grove Lake | Tama |
| Lake of Three Fires | Taylor |
| Wilson Lake | Taylor |
| Windmill Lake | Taylor |
| Green Valley Lake | Union |
| Thayer Lake | Union |
| Indian Lake | Van Buren |
| Lacey-Keosauquq | Van Buren |
| Ottumwa Reservoir | Wapello |
| Lake Ahquabi | Warren |
| Lake Darling | Washington |

| | |
|---|---|
| Bob White | Wayne |
| Badger Lake | Webster |
| Lake Meyers | Winneshiek |
| Little Sioux Park | Woodbury |
| Brown's Lake | Woodbury |
| Silver Lake | Worth |
| Lake Cornelia | Wright |

## APPENDIX B

Survey forms filled out by ICC fisheries biologists and county conservation board representatives.

LAKE RECREATIONAL USE SURVEY

.ake______________________ County______________________

Your name______________________ Address______________________

DIRECTIONS. On the following section you are asked to make your best estimate of the ıverage daily recreational usages for the lake broken down by type of use, weekdays, ıeekends, and season. This information will be used to calculate the total annual use of the lake. If you have actual counts of annual use for any of the categories, write them in on the appropriate line and indicate that they are total counts. On the last page list the sources (people, publications, reports, etc.) used to obtain this information.

I. WEEKDAY recreational use. Estimate how many people engage in the following activities at the lake on a typical WEEKDAY for each season.

| ‾ishing | SUMMER (JUN-AUG) | FALL (SEP-NOV) | WINTER (DEC-MAR) | SPRING (APR-MAY) |
|---|---|---|---|---|
| From boats | ________ | ________ | ________ | ________ |
| Shoreline or ice fishing | ________ | ________ | ________ | ________ |
| ›wimming | ________ | ________ | ________ | ________ |
| ›oating (pleasure) | ________ | ________ | ________ | ________ |
| łunting | ________ | ________ | ________ | ________ |
| ›icnicking, camping, other shoreline activities prompted by lake's presence | ________ | ________ | ________ | ________ |
| Snowmobiling | ________ | ________ | ________ | ________ |
| Ice skating & cross country skiing | ________ | ________ | ________ | ________ |

2. WEEKEND recreational use. Estimate how many people engage in the following activities at the lake on a typical WEEKEND day for each season.

| | SUMMER (JUN-AUG) | FALL (SEP-NOV) | WINTER (DEC-MAR) | SPRING APR-MAY) |
|---|---|---|---|---|
| Fishing | | | | |
| From boats | ________ | ________ | ________ | ________ |
| Shoreline or ice fishing | ________ | ________ | ________ | ________ |
| Swimming | ________ | ________ | ________ | ________ |
| Boating (pleasure) | ________ | ________ | ________ | ________ |
| Hunting | ________ | ________ | ________ | ________ |
| Picnicking, camping hiking, other shoreline activities prompted by lake's presence | ________ | ________ | ________ | ________ |
| Snowmobiling | ________ | ________ | ________ | ________ |
| Ice skating & cross country skiing | ________ | ________ | ________ | ________ |

3. SPECIAL EVENTS. List any special events, such as fishing derbies or other organized activities that contribute to more than normal use.

| Event | Date and Length | Total Number of Visitors |
|---|---|---|
| ________ | ________ | ________ |
| ________ | ________ | ________ |
| ________ | ________ | ________ |

4. LAKE QUALITY AND USAGE.

Are any of the lake's inherent recreational values impaired due to degraded water quality?___________

If so, what are the problems (examples might be algal blooms, suspended sediments, massive growths of higher aquatic plants)?

Is lake usage at, above, or below its potential (circle one)?

If use is below potential, what is the reason?

5. PUBLIC ACCESSIBILITY.

How many boat ramps are available?__________

List any state, county, or city parks on the lake.

6. List sources (people, publications, reports, etc.) used to obtain this information.

Please return your questionnaire to: Roger W. Bachmann
Department of Animal Ecology
Science Hall II
Iowa State University
Ames, IA 50011

Thanks for your help.

# LAKE SURVEY FORM

LAKE________________________ COUNTY______________________________

SECTION__________ TOWNSHIP ________________ RANGE________________

A. OWNERSHIP

WHAT PERCENT OF THE LAKESHORE IS IN PUBLIC OWNERSHIP? __________

LIST THE NAMES OF ANY PUBLIC PARKS OR RECREATION AREAS

B. LAKE PROBLEMS

DESCRIBE ANY PROBLEMS THAT THE LAKE HAS SUCH AS HEAVY ALGAL GROWTHS, (GREEN WATER, SCUMS), EXCESS GROWTHS OF HIGHER AQUATIC PLANTS, DISSOLVED OXYGEN PROBLEMS OR WINTER FISH KILLS, SHORELINE EROSION, EXCESS SILTATION, OR OTHER PROBLEMS THAT INTEREFERE WITH THE USE OF THE LAKE.

C. WATERSHED PROBLEMS

DO YOU HAVE PROBLEMS WITH POINT SOURCE POLLUTION SUCH AS RUNOFF FROM LARGE FEEDLOTS? DESCRIBE.

DO YOU HAVE PROBLEMS WITH NON-POINT POLLUTION SUCH AS HEAVY SOIL EROSION IN THE WATERSHED? DESCRIBE.

ABOUT WHAT PERCENT OF THE WATERSHED IS IN APPROVED SOIL CONSERVATION PRACTICES(IF KNOWN)?

D. DATA AVAILABLE ON LAKE

DO YOU HAVE THE FOLLOWING KINDS OF INFORMATION IN YOUR FILES THAT WE MIGHT COPY IF NECESSARY?

LAKE MAP WITH DEPTH CONTOURS?

MEASUREMENTS OF TEMPERATURE,
DISSOLVED OXYGEN, TRANSPARANCY,
OR OTHER WATER QUALITY MEASUREMENTS?

COUNTS OR ESTIMATES OF RECREATIONAL
USE ON THE LAKE?

THANK YOU FOR YOUR COOPERATION

PLEASE RETURN TO: ROGER W. BACHMANN
DEPARTMENT OF ANIMAL ECOLOGY
IOWA STATE UNIVERSITY
AMES, IOWA 50010

## APPENDIX C

Summary of public meetings held by Iowa Conservation Commission staff to determine local interest and resource commitments relative to the restoration of ten public-owned lakes across Iowa.

Public meetings were held to determine local interest and resource commitments relative to the resotration of ten public-owned lakes across Iowa. The lakes were the top ten on the state's priority list for renovation and are listed in order below:

1. Union Grove Lake--Tama County
2. Black Hawk Lake--Sac County
3. Lake Manawa--Pottawattamie County
4. Lower Pine Lake--Hardin County
5. Swan Lake--Carroll County
6. Rock Creek Lake--Jasper County
7. Little Wall Lake--Hamilton County
8. Arbor Lake--Poweshiek County
9. Storm Lake--Buena Vista County
10. Lake Hendricks--Howard County

Notices of the meetings were mailed to all newspapers, radio stations, and TV stations on May 8, 1980. The release briefly described the Clean Lakes Program.

Meetings commenced with a discussion of the background of the Clean Lake Program and the need for the priority ranking. The introduction was followed by a short slide series which described the criteria andranking system. The specific problems affecting water quality and possible solutions were presented for the lake in question. The meetings were then opened to comment and suggestions from meeting attendees. Attendance, comments, and possible local funding were recorded. The following paragraphs summarize information obtained at public meetings for each of the 10 lakes.

Lake: Union Grove
County: Tama
Priority Ranking: 1
PUBLIC MEETING
Location: Lake Park Youth Holding Center, North Shore, Union Grove Lake
Date: May 19, 1980
Time: 7:30 p.m.
Number of Meeting Attendes: 128
LOCAL MONEY AVAILABLE FOR FEASIBILITY STUDY
Amount: $10,000
Contributor: Lake Park Holding Corporation
Amount: $2,500
Contributor: Tama County Conservation Board
Total: $12,500
Comments:

1. Petitions were presented with 3,500 signatures supporting improvements for Union Grove Lake.
2. The majority of attendees felt the lake needs deepening.
3. No negative comments were made concerning suggested lake and watershed improvement alternatives.
4. Heavy growths of vegetation were cited as a nuisance.

5. Grass carp were suggested as a method of weed removal.
6. Several individuals wish to assist in application procedure.
7. A great deal of interest was expressed for the northern pike fishery.
8. Suggested improving boat ramps, lighting, and weed control.
9. It was suggested a great deal of watershed work is completed.

Summary: A great deal of enthusiasm was expressed at the meeting. Money for local match of a feasibility study doesn't seem to be a problem and all were interested in speeding application along.

Lake: Black Hawk Lake
County: Sac
Priority Ranking: 2
PUBLIC MEETING
Location: Lake View
Date: May 28, 1980
Time: 7:10 p.m.
Number of Meeting Attendees: 131 including Senator Scott, Representative Wayne Bennett, another representative, and Lake View mayor.
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY: Lake View Commercial Club had $3,000 to $4,000. $1,600 more raised at meeting. Local bank assured Association that any check would be made good. No fiscal hold-ups here. Letter received May 30, 1980, indicated Lake View Commercial Club has funds in excess of $7,000 earmarked specificially for lake improvement projects.
Comments:

1. Why did lake rank where it did? (Water quality poorest, effective restoration.)
2. Who will do the feasibility study? (Consultants and/or University types.)
3. What is the time frame? (No dollars until October 1. Application can be started now.)
4. What's difference between feasibility study done a few years ago and this one?
5. Could information from past studies be used?
6. Can the previous study be used as soft match?
7. How long is a feasibility study good for?
8. Is a certain percent of watershed required to be under control?
9. Does the first lake to apply receive the first funds?
10. How solid are these federal dollars?
11. Does ICC have monies available?
12. Would it be best to appear in person before Acting Director?
13. Would a letter and check do?
14. Can county conservation board funds be used?
15. What about dredging of inlet area?
16. This was studied earlier and would this alternative

be looked at in a new study?

17. Credit given to Miller for getting Black Hawk Lake prioritized #2.

Summary:

Lots of enthusiasm at meeting. Primary concerns were not local match money, but one of speeding the application process up. Letter received from W. H. Bohnenkamp, Vice Chairman of the Black Hawk Improvement Committee, to Robert Fagerland (received May 30, 1980) asked for application for Phase I monies as soon as possible. The letter guarenteed the non-federal portion of the cost-share for feasibility study from the local area. Attached to the letter was the signature of 122 interested people who attended the meeting. No adverse comments were received.

Lake: Manawa
County: Pottawattamie
Priority Ranking: 3
PUBLIC MEETING
Location: Fish and Game Clubhouse, Lake Manawa
Date: May 27, 1980
Time: 7:00 p.m.
Number of Meeting Attendees: 0
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY
Amount: $0
Comments: None
Summary: Local citizens are content with work presently planned for Lake Manawa and approved through Clean Lakes funding procedures.

Lake: Lower Pine Lake
County: Hardin
Priority Ranking: 4
PUBLIC MEETING
Location: Eldora
Date: May 22, 1980
Time: 7:15 p.m.
Number of Meeting Attendees: 13 including mayor of Eldora
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY: No money available now. Felt it could be generated.
Comments:

1. Are we phasing out "new lake" projects and replacing them with lake restoration projects?
2. Needed explanation of water quality ranking...though water quality pretty good at lake.
3. Wanted to know time table.
4. Question regarding the status of dam(s) as it relates to the Clean Lakes Program. Could reconstructions be a part of the grant?
5. Thought Pine Lake watershed already under control. A lot of money has been spent there.
6. Lots of interest in weed control by grass carp.
7. Concerns expressed over development. The big draw to

area is the pretty scenery.
Summary: No adverse comments were received.

Lake: Swan Lake
County: Carroll
Priority Ranking: 5
PUBLIC MEETING
Location: County Courthouse, Carroll
Date: May 23, 1980
Time: 7:00 p.m.
Number of Meeting Attendees: 27
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY
Amount: $7,400
Contributor: Carroll County Conservation Board
Total: $7,400
Comments:
1. Fishing in lake is poor.
2. The lake needs deepening.
3. Most of the watershed is in good soil conservation practices.
4. No negative comments were made concerning suggested lake and watershed alternatives.
5. Concern was expressed in decreasing the size of the lake.
6. Wells should be considered as a possible source of water.

Summary: Local citizens support the program very much but feel the program is moving too slowly.

Lake: Rock Creek
County: Jasper
Priority Ranking: 6
PUBLIC MEETING
Location: Izaak Walton League Clubhouse, Newton
Date: May 20, 1980
Time 7:00 p.m.
Number of Meeting Attendees: 16
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY
Amount $0
Comments
1. A study of Rock Creek Lake was made by Grinnell College.
2. Siltation is the major problem of Rock Creek Lake.
3. Cooperation of landowners to improve soil conservation will increase if the government will pay 85 per cent of the construction costs.
4. Construct demonstration project on state land.
5. How long will it take lake to silt in?
6. Size of lake should be doubled.
7. No negative comments were made concerning suggested lake improvement alternatives.

Summary: The majority of water quality problems are due to poor soil conservation practices. Past funding assistance of 75 per cent has accomplished very little but several felt 85 per cent cost-share will get the job done.

Lake: Little Wall Lake
County: Hamilton
Priority Ranking: 7
PUBLIC MEETING
Location: Jewell
Date: May 23, 1980
Time: 7:15 p.m.
Number of Meeting Attendees: 13
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY: No money available now. Comments that past lobbying efforts have been frustrating.
Comments:
1. What is the time frame?
2. Big motors are detrimental to lake. Should ban them.
3. Big motor usage reduced since Saylorville. No problem.
4. Real problem with shoreline erosion, especially north shore.
5. Lake needs a better outlet to get rid of high water so banks don't erode.
6. Needs jetties for fishing and to break wave action.
7. What is operational cost of aeration?
8. Water supply to lake felt adequate with new system.

Summary: No adverse comments were received. Enthusiasm for local money share of feasibility study lacking.

Lake: Arbor
County: Poweshiek
Priority Ranking: 8
PUBLIC MEETING
Location: Grinnell Memorial Building, Grinnell
Date: May 22, 1980
Time: 7:00 p.m.
Number of Meeting Attendees: 2
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY
Amount: $0
Comments:
1. The City of Grinnell is working with the Department of Environmental Quality to separate sanitary sewer and storm sewer--a possible problem at Arbor Lake.
2. The constructin cost for the interceptor system and storm sewer ponding pond was $1,092,000.
3. It is estimated it will cost approximately $675,000 to exclude storm sewer from sanitary sewer system.
4. The City of Grinnell spent $41,040 to remove silt from Arbor Lake. Silt removal was completed in 1977.
5. The Poweshiek Conty Conservation Board signed a 20-year lease agreement with the City of Grinnell in June, 1974, whereby the Board would develop and maintain a park facility around Arbor Lake. In 1978 the Board entered into agreement with the HCRS to cost-share development of park facilities (Project No. 19-00851). To date, $58,105.97 has been spent on development (mainly picnic

tables, shelter house, and sanitary facilities, boat ramp, parking lot, and landscaping) under this project. It is estimated that another $10-15,000 will be spent in the near future on the project.

6. No negative comments were made concerning suggested lake and watershed improvement alternatives.

Summary: Local interest in Arbor Lake is great as reflected in recent expenditures to improve the lake and associated areas.

Lake: Storm Lake
County: Buena Vista
Priority Ranking: 9
PUBLIC MEETING
Location: Eply Auditorium, Buena Vista College, Storm Lake
Date: May 21, 1980
Time: 7:00 p.m.
Number of Meeting Attendees: 21
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY
Amount $0
Comments:

1. Siltation was suggested as a problem.
2. Storm sewer by lake patrol is a point source of pollution from turkey plant.
3. Will elimination of storm sewer runoff affect lake level?
4. Remove jetty from inlet of Storm Lake.
5. Use Little Storm Lake as a silt trap.
6. The City of Storm Lake is working to remove septic sewage overflow from Storm Lake.
7. No negative comments were made concerning suggested lake and watershed improvment alternatives.

Summary: City officials indicated a concerted effort was being made to eliminate dumping of sanitary sewage into Storm Lake.

Lake: Hendricks
County: Howard
Priority Ranking: 10
PUBLIC MEETING
Location: Riceville
Date: May 21, 1980
Time: 7:10 p.m.
Number of Meeting Attendees: 7,including State Representative Jim Johnson
LOCAL MONEY AVAILABLE TO FEASIBILITY STUDY: No money available now
Comments:

1. Retired county conservation board employee suggested construction of a low-head dam on bypass channel for continual water source to lake to prevent fish winterkill.
2. A pond just above th lake on private land was washed out and should be reconstructed.
3. Thought maybe spending $2,000 to $4,000 on aeration in interim might be advisable.

4. Letter received June 3, 1980, from Riceville citizen supporting the clean-up of the lake. This was in response to local newspaper article covring the public meeting.
5. Letter received June 4, 1908, from Riceville citizen objecting to drainage and dredging of the lake. He is a senior citizen who thinks such a project would spoil fishing for many years. In his opinion the lake should be left as it is.

Summary: No adverse comments were received at the meeting. It appears that the Howard County Conservation Board could possitly raise some local money for non-federal share of feasibility study.

## APPENDIX D

Rankings of lakes on the basis of the selected water quality parameters (suspended solids, chlorophyll a, total phosphorus, Secchi disc depth, and winterkill frequency) used to derive the water quality ranking.

Table D-1. Ranking of lakes on the basis of suspended solids.

| Suspended solids mg/l | Lake | |
|---|---|---|
| 59.9 | LOWER GAR LAKE | Dickinson |
| 56.6 | TRUMBULL LAKE | Clay |
| 44.2 | BOB WHITE LAKE | Wayne |
| 39.2 | BLACK HAWK LAKE | Sac |
| 38.7 | LAKE MANAWA | Pottawattamie |
| 33.5 | CENTER LAKE | Dickinson |
| 27.6 | STORM LAKE | Buena Vista |
| 27.4 | NELSON LAKE | Crawford |
| 27.4 | NORTH TWIN LAKE | Calhoun |
| 26.8 | HANNEN LAKE | Benton |
| 26.5 | DESOTO BEND LAKE | Harrison |
| 26.0 | SILVER LAKE | Palo Alto |
| 25.9 | TUTTLE LAKE | Emmet |
| 25.4 | CLEAR LAKE | Cerro Gordo |
| 25.4 | PIERCE CREEK POND | Page |
| 25.2 | PRAIRIE ROSE LAKE | Shelby |
| 24.4 | SILVER LAKE | Worth |
| 23.6 | UPPER GAR LAKE | Dickinson |
| 23.2 | ARROWHEAD LAKE | Pottawattamie |
| 23.0 | LAKE DARLING | Washington |
| 22.0 | WINDMILL LAKE | Taylor |
| 21.9 | HICKORY HILLS LAKE | Tama |
| 21.4 | ARBOR LAKE | Poweshiek |
| 20.8 | MEADOW LAKE | Adair |
| 20.6 | SILVER LAKE | Dickinson |
| 20.3 | LAKE CORNELIA | Wright |
| 20.3 | UNION GROVE LAKE | Tama |
| 20.0 | LAKE MEYERS | Winneshiek |
| 20.0 | SMITH LAKE | Kossuth |
| 19.6 | SWAN LAKE | Carroll |
| 19.5 | SPRINGBROOK LAKE | Guthrie |
| 19.3 | ROCK CREEK LAKE | Jasper |
| 18.8 | LOST ISLAND LAKE | Palo Alto |
| 18.3 | LAKE KEOMAH | Mahaska |
| 18.3 | RODGERS PARK LAKE | Benton |
| 18.2 | ELDRED SHERWOOD LAKE | Hancock |
| 18.0 | OTTUMWA LAGOON | Wapello |
| 17.9 | WILSON LAKE | Taylor |
| 17.7 | CENTRAL LAKE | Jones |
| 17.4 | EAST LAKE (OSCEOLA) | Clarke |
| 17.4 | LAKE HENDRICKS | Howard |
| 16.7 | KENT PARK LAKE | Johnson |
| 15.9 | LAKE OF THREE FIRES | Taylor |
| 15.9 | LITTLE SPIRIT LAKE | Dickinson |
| 15.9 | LAKE MINNEWASHTA | Dickinson |
| 15.8 | MARIPOSA LAKE | Jasper |
| 15.5 | INDIAN LAKE | Van Buren |
| 15.2 | LAKE IOWA | Iowa |
| 14.6 | LAKE OF THE HILLS | Scott |

| | | |
|---|---|---|
| 14.4 | BEEDS LAKE | Franklin |
| 14.3 | BIG SPIRIT LAKE | Dickinson |
| 14.2 | BADGER LAKE | Webster |
| 14.2 | LITTLE WALL LAKE | Hamilton |
| 14.1 | LOWER PINE LAKE | Hardin |
| 13.8 | CHATFIELD LAKE | Lee |
| 13.8 | LAKE MACBRIDE | Johnson |
| 13.6 | EAST OKOBOJI | Dickinson |
| 13.5 | DOG CREEK LAKE | O'Brien |
| 13.5 | HICKORY GROVE | Story |
| 13.1 | LAKE ANITA | Cass |
| 12.9 | MANTENO LAKE | Shelby |
| 12.8 | CRAWFORD CREEK LAKE | Ida |
| 12.4 | GREEN VALLEY LAKE | Union |
| 12.4 | LAKE ORIENT | Adair |
| 12.3 | VIKING LAKE | Montgomery |
| 11.9 | CARTER LAKE | Pottawattamie |
| 11.8 | UPPER PINE LAKE | Hardin |
| 11.6 | COLD SPRINGS | Cass |
| 11.4 | RED HAW LAKE | Lucas |
| 11.2 | BROWNS LAKE | Woodbury |
| 11.2 | LAKE ICARIA | Adams |
| 11.1 | INGHAM LAKE | Emmet |
| 11.1 | LAKE WAPELLO | Davis |
| 10.3 | LAKE MIAMI | Monroe |
| 9.4 | EASTER LAKE | Polk |
| 9.2 | WILLIAMSON POND | Lucas |
| 8.8 | POLLMILLER LAKE | Lee |
| 8.4 | LAKE GEODE | Henry |
| 8.3 | OTTER CREEK LAKE | Tama |
| 8.0 | LAKE AHQUABI | Warren |
| 6.7 | THAYER LAKE | Union |
| 6.4 | MOOREHEAD LAKE | Ida |
| 6.2 | NINE EAGLES | Decatur |
| 6.0 | LAKE PAHOJA | Lyon |
| 5.9 | DON WILLIAMS LAKE | Boone |
| 5.9 | GEORGE WYTH LAKE | Black Hawk |
| 5.4 | CRYSTAL LAKE | Hancock |
| 5.4 | GREEN CASTLE LAKE | Marshall |
| 5.2 | DIAMOND LAKE | Poweshiek |
| 4.4 | ARROWHEAD LAKE | Sac |
| 4.4 | OLDHAM LAKE | Monona |
| 3.9 | BIG CREEK LAKE | Polk |
| 3.9 | PLEASANT CREEK LAKE | Linn |
| 3.6 | SILVER LAKE | Delaware |
| 3.6 | YEN-RUO-GIS LAKE | Keokuk |
| 3.5 | BRIGGS WOODS LAKE | Hamilton |
| 3.5 | MORMAN TRAIL | Adair |
| 3.4 | LACEY-KEOSAUQUA LAKE | Van Buren |
| 3.3 | WILSON LAKE | Lee |
| 2.9 | BLUE LAKE | Monona |
| 2.9 | SLIP BLUFF LAKE | Decatur |
| 2.7 | FIVE ISLAND LAKE | Palo Alto |
| 2.7 | WILLOW LAKE | Harrison |

| | | |
|---|---|---|
| 2.4 | WEST OKOBOJI | Dickinson |
| 2.3 | SPRING LAKE | Greene |
| 1.2 | LITTLE SIOUX PARK | Woodbury |

Table D-2. Ranking of lakes on the basis of chlorophyll a concentration.

| Chlorophyll a mg/cubic meter | Lake | |
|---|---|---|
| 148.6 | BLACK HAWK LAKE | Sac |
| 143.4 | CLEAR LAKE | Cerro Gordo |
| 135.0 | RODGERS PARK LAKE | Benton |
| 131.3 | TRUMBULL LAKE | Clay |
| 128.0 | MEADOW LAKE | Adair |
| 120.7 | HICKORY HILLS LAKE | Tama |
| 119.1 | DESOTO BEND LAKE | Harrison |
| 110.3 | WINDMILL LAKE | Taylor |
| 108.6 | UNION GROVE LAKE | Tama |
| 103.4 | CENTRAL LAKE | Jones |
| 100.3 | SILVER LAKE | Worth |
| 91.5 | SMITH LAKE | Kossuth |
| 90.3 | CENTER LAKE | Dickinson |
| 90.0 | LAKE IOWA | Iowa |
| 89.7 | LAKE DARLING | Washington |
| 89.5 | UPPER GAR LAKE | Dickinson |
| 88.6 | LOWER PINE LAKE | Hardin |
| 86.7 | HANNEN LAKE | Benton |
| 84.3 | UPPER PINE LAKE | Hardin |
| 84.2 | MANTENO LAKE | Shelby |
| 79.1 | REEDS LAKE | Franklin |
| 77.3 | OTTUMWA LAGOON | Wapello |
| 77.1 | SILVER LAKE | Palo Alto |
| 75.9 | ROCK CREEK LAKE | Jasper |
| 75.7 | EAST LAKE (OSCEOLA) | Clarke |
| 75.3 | LAKE HENDRICKS | Howard |
| 72.6 | LOWER GAR LAKE | Dickinson |
| 70.0 | ELDRED SHERWOOD LAKE | Hancock |
| 67.7 | GREEN VALLEY LAKE | Union |
| 66.7 | COLD SPRINGS | Cass |
| 65.6 | LAKE KEOMAH | Mahaska |
| 64.5 | MARIPOSA LAKE | Jasper |
| 62.8 | ARROWHEAD LAKE | Pottawattamie |
| 62.8 | TUTTLE LAKE | Emmet |
| 62.1 | INGHAM LAKE | Emmet |
| 61.8 | ARBOR LAKE | Poweshiek |
| 61.8 | CRAWFORD CREEK LAKE | Ida |
| 61.8 | LAKE MEYERS | Winneshiek |
| 58.2 | LOST ISLAND LAKE | Palo Alto |
| 55.9 | HICKORY GROVE | Story |
| 55.6 | VIKING LAKE | Montgomery |
| 55.1 | RED HAW LAKE | Lucas |
| 52.8 | SPRINGBROOK LAKE | Guthrie |
| 52.4 | WILSON LAKE | Taylor |

| | | |
|---|---|---|
| 51.8 | LAKE ICARIA | Adams |
| 51.7 | GREEN CASTLE LAKE | Marshall |
| 50.3 | LITTLE WALL LAKE | Hamilton |
| 49.5 | LAKE WAPELLO | Davis |
| 48.7 | LAKE MANAWA | Pottawattamie |
| 47.4 | LAKE ANITA | Cass |
| 47.2 | SWAN LAKE | Carroll |
| 46.2 | BIG SPIRIT LAKE | Dickinson |
| 45.5 | OTTER CREEK LAKE | Tama |
| 44.8 | LAKE ORIENT | Adair |
| 44.2 | PIERCE CREEK POND | Page |
| 42.8 | LITTLE SPIRIT LAKE | Dickinson |
| 42.6 | LAKE MIAMI | Monroe |
| 42.2 | NORTH TWIN LAKE | Calhoun |
| 39.7 | KENT PARK LAKE | Johnson |
| 39.4 | CARTER LAKE | Pottawattamie |
| 38.6 | PRAIRIE ROSE LAKE | Shelby |
| 38.3 | LAKE OF THE HILLS | Scott |
| 36.2 | LAKE OF THREE FIRES | Taylor |
| 34.2 | DOG CREEK LAKE | O'Brien |
| 34.1 | SILVER LAKE | Dickinson |
| 32.5 | LAKE MACBRIDE | Johnson |
| 32.4 | LAKE CORNELIA | Wright |
| 32.0 | BRIGGS WOODS LAKE | Hamilton |
| 31.4 | BADGER LAKE | Webster |
| 29.6 | LAKE MINNEWASHTA | Dickinson |
| 29.6 | STORM LAKE | Buena Vista |
| 28.0 | EASTER LAKE | Polk |
| 25.8 | EAST OKOBOJI | Dickinson |
| 23.0 | INDIAN LAKE | Van Buren |
| 22.0 | CHATFIELD LAKE | Lee |
| 21.7 | THAYER LAKE | Union |
| 21.6 | LAKE GEODE | Henry |
| 21.4 | WILLIAMSON POND | Lucas |
| 20.5 | POLLMILLER LAKE | Lee |
| 19.9 | GEORGE WYTH LAKE | Black Hawk |
| 19.5 | LAKE AHQUABI | Warren |
| 18.6 | PLEASANT CREEK LAKE | Linn |
| 17.6 | LAKE PAHOJA | Lyon |
| 16.2 | DON WILLIAMS LAKE | Boone |
| 16.0 | NINE EAGLES | Decatur |
| 15.5 | NELSON LAKE | Crawford |
| 15.3 | ARROWHEAD LAKE | Sac |
| 14.6 | MOOREHEAD LAKE | Ida |
| 14.5 | BIG CREEK LAKE | Polk |
| 12.9 | SILVER LAKE | Delaware |
| 12.7 | BOB WHITE LAKE | Wayne |
| 10.6 | LACEY-KEOSAUQUA LAKE | Van Buren |
| 10.1 | DIAMOND LAKE | Poweshiek |
| 9.9 | MORMAN TRAIL | Adair |
| 9.3 | WILLOW LAKE | Harrison |
| 6.3 | WEST OKOBOJI | Dickinson |
| 5.6 | CRYSTAL LAKE | Hancock |
| 5.6 | SPRING LAKE | Greene |

| | | |
|---|---|---|
| 4.7 | BLUE LAKE | Monona |
| 4.7 | OLDHAM LAKE | Monona |
| 4.6 | SLIP BLUFF LAKE | Decatur |
| 4.3 | WILSON LAKE | Lee |
| 3.9 | YEN-RUO-GIS LAKE | Keokuk |
| 3.1 | LITTLE SIOUX PARK | Woodbury |
| 2.7 | FIVE ISLAND LAKE | Palo Alto |
| 2.4 | BROWNS LAKE | Woodbury |

Table D-3. Ranking of lakes on the basis of total phosphorus concentration.

| Total phosphorus mg/cubic meter | Lake | |
|---|---|---|
| 743.7 | LAKE PAHOJA | Lyon |
| 440.9 | OTTUMWA LAGOON | Wapello |
| 259.5 | ARBOR LAKE | Poweshiek |
| 236.3 | BLACK HAWK LAKE | Sac |
| 222.0 | SILVER LAKE | Palo Alto |
| 204.6 | SWAN LAKE | Carroll |
| 200.5 | SILVER LAKE | Delaware |
| 196.0 | TUTTLE LAKE | Emmet |
| 193.0 | GREEN VALLEY LAKE | Union |
| 173.1 | EAST LAKE (OSCEOLA) | Clarke |
| 171.9 | CRYSTAL LAKE | Hancock |
| 171.9 | LITTLE WALL LAKE | Hamilton |
| 169.1 | MARIPOSA LAKE | Jasper |
| 168.5 | LOWER GAR LAKE | Dickinson |
| 166.7 | BOB WHITE LAKE | Wayne |
| 160.4 | CENTRAL LAKE | Jones |
| 151.0 | RODGERS PARK LAKE | Benton |
| 147.3 | FIVE ISLAND LAKE | Palo Alto |
| 145.5 | HANNEN LAKE | Benton |
| 140.4 | DESOTO BEND LAKE | Harrison |
| 139.1 | EAST OKOBOJI | Dickinson |
| 138.6 | BADGER LAKE | Webster |
| 138.6 | SILVER LAKE | Worth |
| 136.6 | UPPER GAR LAKE | Dickinson |
| 132.5 | LAKE MINNEWASHTA | Dickinson |
| 130.1 | TRUMBULL LAKE | Clay |
| 127.7 | MEADOW LAKE | Adair |
| 127.7 | WINDMILL LAKE | Taylor |
| 126.0 | INGHAM LAKE | Emmet |
| 125.9 | ARROWHEAD LAKE | Pottawattamie |
| 124.2 | PIERCE CREEK POND | Page |
| 119.8 | CENTER LAKE | Dickinson |
| 119.2 | ROCK CREEK LAKE | Jasper |
| 118.6 | UNION GROVE LAKE | Tama |
| 117.6 | LAKE MANAWA | Pottawattamie |
| 115.2 | LITTLE SPIRIT LAKE | Dickinson |
| 111.6 | MANTENO LAKE | Shelby |
| 110.5 | CLEAR LAKE | Cerro Gordo |
| 110.2 | SMITH LAKE | Kossuth |

| | | |
|---|---|---|
| 107.8 | HICKORY HILLS LAKE | Tama |
| 106.5 | ELDRED SHERWOOD LAKE | Hancock |
| 97.1 | SILVER LAKE | Dickinson |
| 96.0 | LAKE DARLING | Washington |
| 95.0 | PRAIRIE ROSE LAKE | Shelby |
| 93.5 | LAKE MEYERS | Winneshiek |
| 91.8 | LAKE ORIENT | Adair |
| 90.4 | NELSON LAKE | Crawford |
| 86.3 | CARTER LAKE | Pottawattamie |
| 86.1 | LAKE KEOMAH | Mahaska |
| 82.2 | LOWER PINE LAKE | Hardin |
| 80.3 | NORTH TWIN LAKE | Calhoun |
| 78.6 | BEEDS LAKE | Franklin |
| 77.9 | DOG CREEK LAKE | O'Brien |
| 76.3 | UPPER PINE LAKE | Hardin |
| 76.2 | CRAWFORD CREEK LAKE | Ida |
| 74.1 | KENT PARK LAKE | Johnson |
| 73.8 | STORM LAKE | Buena Vista |
| 69.1 | LAKE OF THREE FIRES | Taylor |
| 68.3 | LAKE HENDRICKS | Howard |
| 67.4 | BIG SPIRIT LAKE | Dickinson |
| 67.2 | SPRINGBROOK LAKE | Guthrie |
| 66.3 | LAKE IOWA | Iowa |
| 64.6 | COLD SPRINGS | Cass |
| 62.1 | INDIAN LAKE | Van Buren |
| 61.7 | THAYER LAKE | Union |
| 61.6 | LOST ISLAND LAKE | Palo Alto |
| 61.4 | LAKE CORNELIA | Wright |
| 61.3 | HICKORY GROVE | Story |
| 59.8 | WILSON LAKE | Taylor |
| 58.7 | LAKE MACBRIDE | Johnson |
| 58.3 | PLEASANT CREEK LAKE | Linn |
| 57.1 | LAKE MIAMI | Monroe |
| 55.8 | LAKE ANITA | Cass |
| 55.5 | WILLIAMSON POND | Lucas |
| 54.8 | LAKE ICARIA | Adams |
| 54.5 | EASTER LAKE | Polk |
| 54.5 | VIKING LAKE | Montgomery |
| 52.2 | LAKE AHQUABI | Warren |
| 52.2 | LAKE OF THE HILLS | Scott |
| 50.8 | CHATFIELD LAKE | Lee |
| 49.9 | LAKE WAPELLO | Davis |
| 48.6 | OTTER CREEK LAKE | Tama |
| 43.1 | BROWNS LAKE | Woodbury |
| 42.4 | DIAMOND LAKE | Poweshiek |
| 39.6 | BRIGGS WOODS LAKE | Hamilton |
| 38.3 | BLUE LAKE | Monona |
| 37.6 | RED HAW LAKE | Lucas |
| 37.2 | LAKE GEODE | Henry |
| 37.2 | GREEN CASTLE LAKE | Marshall |
| 36.7 | FOLLMILLER LAKE | Lee |
| 33.4 | OLDHAM LAKE | Monona |
| 30.9 | GEORGE WYTH LAKE | Black Hawk |
| 30.7 | DON WILLIAMS LAKE | Boone |

| | | |
|---|---|---|
| 30.5 | MOOREHEAD LAKE | Ida |
| 29.6 | LACEY-KEOSAUQUA LAKE | Van Buren |
| 28.8 | BIG CREEK LAKE | Polk |
| 28.5 | WEST OKOBOJI | Dickinson |
| 25.7 | NINE EAGLES | Decatur |
| 25.1 | MORMAN TRAIL | Adair |
| 22.8 | ARROWHEAD LAKE | Sac |
| 22.3 | WILLOW LAKE | Harrison |
| 20.4 | SPRING LAKE | Greene |
| 15.8 | SLIP BLUFF LAKE | Decatur |
| 15.0 | LITTLE SIOUX PARK | Woodbury |
| 13.6 | YEN-RUO-GIS LAKE | Keokuk |
| 12.2 | WILSCN LAKE | Lee |

Table D-4. Ranking of lakes based on Secchi disc depth.

| Secchi depth meters | Lake | |
|---|---|---|
| 0.2 | BLACK HAWK LAKE | Sac |
| 0.2 | BOB WHITE LAKE | Wayne |
| 0.3 | DESOTO BEND LAKE | Harrison |
| 0.3 | LOWER GAR LAKE | Dickinson |
| 0.3 | LAKE MANAWA | Pottawattamie |
| 0.3 | TRUMBULL LAKE | Clay |
| 0.4 | CENTER LAKE | Dickinson |
| 0.4 | CENTRAL LAKE | Jones |
| 0.4 | LAKE DARLING | Washington |
| 0.4 | HANNEN LAKE | Benton |
| 0.4 | HICKORY HILLS LAKE | Tama |
| 0.4 | PIERCE CREEK POND | Page |
| 0.4 | TUTTLE LAKE | Emmet |
| 0.4 | WINDMILL LAKE | Taylor |
| 0.5 | ARBOR LAKE | Poweshiek |
| 0.5 | ARROWHEAD LAKE | Pottawattamie |
| 0.5 | LAKE IOWA | Iowa |
| 0.5 | LAKE OF THREE FIRES | Taylor |
| 0.5 | LOST ISLAND LAKE | Palo Alto |
| 0.5 | NORTH TWIN LAKE | Calhoun |
| 0.5 | OTTUMWA LAGOON | Wapello |
| 0.5 | ROCK CREEK LAKE | Jasper |
| 0.5 | RODGERS PARK LAKE | Benton |
| 0.5 | SILVER LAKE | Palo Alto |
| 0.5 | SILVER LAKE | Worth |
| 0.5 | SMITH LAKE | Kossuth |
| 0.5 | STORM LAKE | Buena Vista |
| 0.5 | SWAN LAKE | Carroll |
| 0.5 | UNICN GROVE LAKE | Tama |
| 0.5 | UPPER GAR LAKE | Dickinson |
| 0.5 | WILSCN LAKE | Taylor |
| 0.6 | BADGER LAKE | Webster |
| 0.6 | CARTER LAKE | Pottawattamie |
| 0.6 | LAKE CORNELIA | Wright |
| 0.6 | EAST LAKE (OSCEOLA) | Clarke |

| | | |
|---|---|---|
| 0.6 | LAKE HENDRICKS | Howard |
| 0.6 | LAKE KEOMAH | Mahaska |
| 0.6 | LOWER PINE LAKE | Hardin |
| 0.6 | PRAIRIE ROSE LAKE | Shelby |
| 0.6 | UPPER PINE LAKE | Hardin |
| 0.7 | LAKE ANITA | Cass |
| 0.7 | CHATFIELD LAKE | Lee |
| 0.7 | CLEAR LAKE | Cerro Gordo |
| 0.7 | DOG CREEK LAKE | O'Brien |
| 0.7 | EAST OKOBOJI | Dickinson |
| 0.7 | ELDRED SHERWOOD LAKE | Hancock |
| 0.7 | HICKORY GROVE | Story |
| 0.7 | INDIAN LAKE | Van Buren |
| 0.7 | KENT PARK LAKE | Johnson |
| 0.7 | LAKE OF THE HILLS | Scott |
| 0.7 | LITTLE SPIRIT LAKE | Dickinson |
| 0.7 | LAKE MACBRIDE | Johnson |
| 0.7 | MARIPOSA LAKE | Jasper |
| 0.7 | LAKE MEYERS | Winneshiek |
| 0.7 | LAKE MINNEWASHTA | Dickinson |
| 0.7 | SPRINGBROOK LAKE | Guthrie |
| 0.8 | CRAWFORD CREEK LAKE | Ida |
| 0.8 | LAKE ICARIA | Adams |
| 0.8 | MEADOW LAKE | Adair |
| 0.8 | LAKE MIAMI | Monroe |
| 0.8 | LAKE ORIENT | Adair |
| 0.8 | VIKING LAKE | Montgomery |
| 0.8 | WILLIAMSON POND | Lucas |
| 0.9 | LAKE AHQUABI | Warren |
| 0.9 | BROWNS LAKE | Woodbury |
| 0.9 | COLD SPRINGS | Cass |
| 0.9 | GREEN VALLEY LAKE | Union |
| 0.9 | NELSON LAKE | Crawford |
| 0.9 | POLLMILLER LAKE | Lee |
| 0.9 | RED HAW LAKE | Lucas |
| 0.9 | THAYER LAKE | Union |
| 1.0 | BEEDS LAKE | Franklin |
| 1.0 | BIG SPIRIT LAKE | Dickinson |
| 1.0 | EASTER LAKE | Polk |
| 1.0 | LAKE GEODE | Henry |
| 1.0 | LITTLE WALL LAKE | Hamilton |
| 1.0 | MANTENO LAKE | Shelby |
| 1.0 | LAKE WAPELLO | Davis |
| 1.1 | INGHAM LAKE | Emmet |
| 1.1 | OTTER CREEK LAKE | Tama |
| 1.1 | SILVER LAKE | Dickinson |
| 1.4 | CRYSTAL LAKE | Hancock |
| 1.4 | SPRING LAKE | Greene |
| 1.5 | LAKE PAHOJA | Lyon |
| 1.6 | GREEN CASTLE LAKE | Marshall |
| 1.7 | GEORGE WYTH LAKE | Black Hawk |
| 1.8 | DON WILLIAMS LAKE | Boone |
| 1.8 | MOOREHEAD LAKE | Ida |
| 1.9 | DIAMOND LAKE | Poweshiek |

| | | |
|---|---|---|
| 1.9 | WILSON LAKE | Lee |
| 2.0 | BLUE LAKE | Monona |
| 2.0 | OLDHAM LAKE | Monona |
| 2.1 | BIG CREEK LAKE | Polk |
| 2.1 | MORMAN TRAIL | Adair |
| 2.1 | NINE EAGLES | Decatur |
| 2.2 | LACEY-KEOSAUQUA LAKE | Van Buren |
| 2.2 | SILVER LAKE | Delaware |
| 2.4 | ARROWHEAD LAKE | Sac |
| 2.4 | FIVE ISLAND LAKE | Palo Alto |
| 2.4 | SLIP BLUFF LAKE | Decatur |
| 2.5 | PLEASANT CREEK LAKE | Linn |
| 2.5 | YEN-RUO-GIS LAKE | Keokuk |
| 2.6 | LITTLE SIOUX PARK | Woodbury |
| 2.8 | BRIGGS WOODS LAKE | Hamilton |
| 2.8 | WILLOW LAKE | Harrison |
| 2.9 | WEST OKOBOJI | Dickinson |

Table D-5. Ranking of lakes based on frequency of winter fishkills. A fishkill is expected one year out of X years. If no winterkills have been recorded, 'NEVER' is indicated.

| Frequency X years | Lake | |
|---|---|---|
| 2 | LAKE HENDRICKS | Howard |
| 2 | SILVER LAKE | Worth |
| 2 | SWAN LAKE | Carroll |
| 3 | BLACK HAWK LAKE | Sac |
| 3 | BROWNS LAKE | Woodbury |
| 3 | CRYSTAL LAKE | Hancock |
| 3 | SPRING LAKE | Greene |
| 3-5 | LAKE MINNEWASHTA | Dickinson |
| 3-5 | UPPER GAR LAKE | Dickinson |
| 4 | ARBOR LAKE | Poweshiek |
| 4 | LITTLE WALL LAKE | Hamilton |
| 3-5 | LOWER GAR LAKE | Dickinson |
| 3-5 | LAKE PAHOJA | Lyon |
| 5 | BLUE LAKE | Monona |
| 5 | CARTER LAKE | Pottawattamie |
| 5 | CHATFIELD LAKE | Lee |
| 5 | LOWER PINE LAKE | Hardin |
| 5 | NORTH TWIN LAKE | Calhoun |
| 5 | OTTUMWA LAGOON | Wapello |
| 5 | SILVER LAKE | Delaware |
| 5-7 | DOG CREEK LAKE | O'Brien |
| 5-7 | FIVE ISLAND LAKE | Palo Alto |
| 5-7 | INGHAM LAKE | Emmet |
| 5-7 | LITTLE SPIRIT LAKE | Dickinson |
| 5-7 | SILVER LAKE | Dickinson |
| 5-7 | TUTTLE LAKE | Emmet |
| 7 | DESOTO BEND LAKE | Harrison |
| 7 | INDIAN LAKE | Van Buren |
| 7 | UNION GROVE LAKE | Tama |

| | | |
|---|---|---|
| 7 | UPPER PINE LAKE | Hardin |
| 7-10 | CENTER LAKE | Dickinson |
| 7-10 | EAST OKOBOJI | Dickinson |
| 7-10 | SILVER LAKE | Palo Alto |
| 7-10 | TRUMBULL LAKE | Clay |
| 10 | LITTLE SIOUX PARK | Woodbury |
| 10 | STORM LAKE | Buena Vista |
| 10-12 | MILL CREEK | O'Brien |
| 15 | BADGER LAKE | Webster |
| 15 | COLD SPRINGS | Cass |
| 15 | MANTENO LAKE | Shelby |
| 15 | MARIPOSA LAKE | Jasper |
| 15-20 | LOST ISLAND LAKE | Palo Alto |
| 100 | CLEAR LAKE | Cerro Gordo |
| NEVER | LAKE ANITA | Cass |
| NEVER | ARROWHEAD LAKE | Pottawattamie |
| NEVER | ARROWHEAD LAKE | Sac |
| NEVER | LAKE AHQUABI | Warren |
| NEVER | BEEDS LAKE | Franklin |
| NEVER | BIG CREEK LAKE | Polk |
| NEVER | BIG SPIRIT LAKE | Dickinson |
| NEVER | BOB WHITE LAKE | Wayne |
| NEVER | BRIGGS WOODS LAKE | Hamilton |
| NEVER | CENTRAL LAKE | Jones |
| NEVER | LAKE CORNELIA | Wright |
| NEVER | CRAWFORD CREEK LAKE | Ida |
| NEVER | LAKE DARLING | Washington |
| NEVER | DIAMOND LAKE | Poweshiek |
| NEVER | DON WILLIAMS LAKE | Boone |
| NEVER | EAST LAKE (OSCEOLA) | Clarke |
| NEVER | EASTER LAKE | Polk |
| NEVER | ELDRED SHERWOOD LAKE | Hancock |
| NEVER | LAKE GEODE | Henry |
| NEVER | GEORGE WYTH LAKE | Black Hawk |
| NEVER | GREEN CASTLE LAKE | Marshall |
| NEVER | GREEN VALLEY LAKE | Union |
| NEVER | HANNEN LAKE | Benton |
| NEVER | HICKORY GROVE | Story |
| NEVER | HICKORY HILLS LAKE | Tama |
| NEVER | LAKE ICARIA | Adams |
| NEVER | LAKE IOWA | Iowa |
| NEVER | KENT PARK LAKE | Johnson |
| NEVER | LAKE KEOMAH | Mahaska |
| NEVER | LACEY-KEOSAUQUA LAKE | Van Buren |
| NEVER | LAKE OF THE HILLS | Scott |
| NEVER | LAKE OF THREE FIRES | Taylor |
| NEVER | LAKE MACBRIDE | Johnson |
| NEVER | LAKE MANAWA | Pottawattamie |
| NEVER | MEADOW LAKE | Adair |
| NEVER | LAKE MEYERS | Winneshiek |
| NEVER | LAKE MIAMI | Monroe |
| NEVER | MOOREHEAD LAKE | Ida |
| NEVER | MORMAN TRAIL | Adair |
| NEVER | NELSON LAKE | Crawford |

| | | |
|---|---|---|
| NEVER | NINE EAGLES | Decatur |
| NEVER | OLDHAM LAKE | Monona |
| NEVER | LAKE ORIENT | Adair |
| NEVER | OTTER CREEK LAKE | Tama |
| NEVER | PIERCE CREEK POND | Page |
| NEVER | PLEASANT CREEK LAKE | Linn |
| NEVER | POLLMILLER LAKE | Lee |
| NEVER | PRAIRIE ROSE LAKE | Shelby |
| NEVER | RED HAW LAKE | Lucas |
| NEVER | ROCK CREEK LAKE | Jasper |
| NEVER | RODGERS PARK LAKE | Benton |
| NEVER | SLIP BLUFF LAKE | Decatur |
| NEVER | SMITH LAKE | Kossuth |
| NEVER | SPRINGBROOK LAKE | Guthrie |
| NEVER | THAYER LAKE | Union |
| NEVER | VIKING LAKE | Montgomery |
| NEVER | LAKE WAPELLO | Davis |
| NEVER | WEST OKOBOJI | Dickinson |
| NEVER | WILLIAMSON POND | Lucas |
| NEVER | WILLOW LAKE | Harrison |
| NEVER | WILSON LAKE | Lee |
| NEVER | WILSON LAKE | Taylor |
| NEVER | WINDMILL LAKE | Taylor |
| NEVER | YEN-RUO-GIS LAKE | Keokuk |

## APPENDIX E

Data for individual lakes including survey and physical description, map, pollution conditions, assesement of lake uses, and restoration measures.

INDEX

LAKE AHQUABI

LOCATION
County: Warren Latitude 41 Deg 17 Min N
Longitude 93 Deg 35 Min W
Township 75 N Range 24 W Section 23

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
1344. hectares ( 3321. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 34 | 25. | 1.8 |
| 36 | 402. | 29.9 |
| 37 | 917. | 68.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 54.8 | 33.8 | 7.7 | 0.0 | 3.7 |

Description of topography and soils in soil associations represented in the watershed

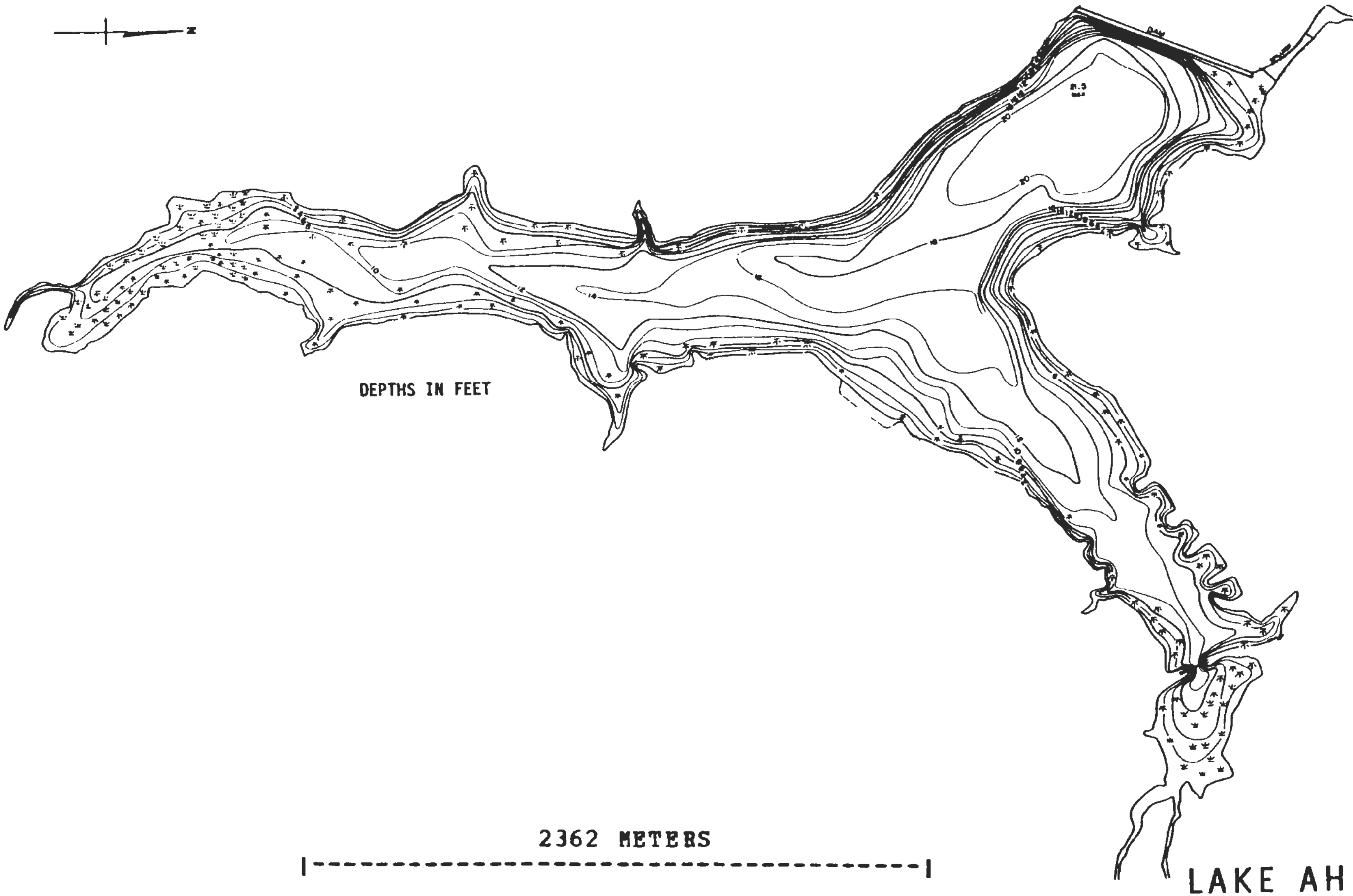
34 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from pre-Wisconsin till, pre-Wisconsin till-derived paleosols, or loess. Shelby, Adair, and Sharpsburg soils.

36 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Grundy, Haig, Shelby, and Adair soils.

37 Gently sloping to moderately steep (2-18%) prairie and forest-derived soils developed from pre-Wisconsin till-derived paleosols, pre-Wisconsin till, or loess. Adair, Shelby, Lindley, and Grundy soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1973 map
Area 46. ha ( 114. A)
Length of shoreline 7853. m ( 25765. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 3.0 m ( 10. ft)
Volume 1366144. cubic meters ( 1107. acre-feet)
Shoreline development 3.27 Volume development 1.33
Watershed/lake area ratio 29.2
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 94. cm
Thermal stratification? Yes




LAKE AHQUABI
Warren County

Major inflows (named and/or permanent streams)
Unnamed
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.9 | 0.07 |
| Chlorophyll a mg/cubic meter | 9 | 19.5 | 1.74 |
| Total phosphorus mg/cubic meter | 8 | 52.2 | 4.51 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 8 | 8.0 | 0.51 |
| Turbidity JTU | 8 | 5.7 | 0.48 |
| Total hardness mg/l as CaCO3 | 9 | 123.8 | 1.58 |
| Calcium hardness mg/l as CaCO3 | 8 | 90.5 | 2.23 |
| Total alkalinity mg/l as CaCO3 | 9 | 114.2 | 1.84 |
| Dissolved oxygen mg/l | 8 | 7.3 | 0.44 |
| Specific conductance micromhos/cm at 25 C | 9 | 237.8 | 6.07 |
| Sulfate mg/l | 3 | 15.7 | 1.01 |
| Chloride mg/l | 3 | 6.0 | 0.01 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/21/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.1 | 8.4 | 53.5 | 8.5 | 29.2 |
| 1 | 26.1 | | | | |
| 2 | 26.1 | 7.3 | 56.6 | 8.6 | 26.6 |
| 3 | 24.3 | | | | |
| 4 | 23.7 | 2.5 | 65.2 | 7.7 | 16.8 |
| 5 | 22.9 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 368.
Potential nutrient input index =
area watershed in row crops/lake area = 16.0
70.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
terraces, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 2700 persons at Lake Ahquabi State Park.

Public parks:
Ahquabi State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 6770. | 59.4 | 147.2 |
| Shore or ice fishing | 14195. | 124.5 | 308.6 |
| Swimming | 24485. | 214.8 | 532.3 |
| Pleasure boating | 6644. | 58.3 | 144.4 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 72250. | 633.8 | 1570.7 |
| Snowmobiling | 7375. | 64.7 | 160.3 |
| Ice skating and cross-country skiing | 1041. | 9.1 | 22.6 |
| TOTAL | 132760. | 1164.6 | 2886.1 |

Special events at Lake Ahquabi contributing to more than normal use include a fishing derby (50 people).

IMPAIRMENTS

Aquatic vascular plant growth in Lake Ahquabi may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential because of poor fishing; possibly due to an overabundance of gizzard shad.

Estimated aquatic plant coverage 28 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE ANITA

LOCATION

County: Cass  Latitude 41 Deg 26 Min N
Longitude 94 Deg 47 Min W
Township 77 N  Range 34 W  Section 32

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
978. hectares ( 2417. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 350. | 35.8 |
| 31 | 628. | 64.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 69.1 | 23.2 | 4.8 | 0.0 | 2.9 |

Description of topography and soils in soil associations represented in the watershed

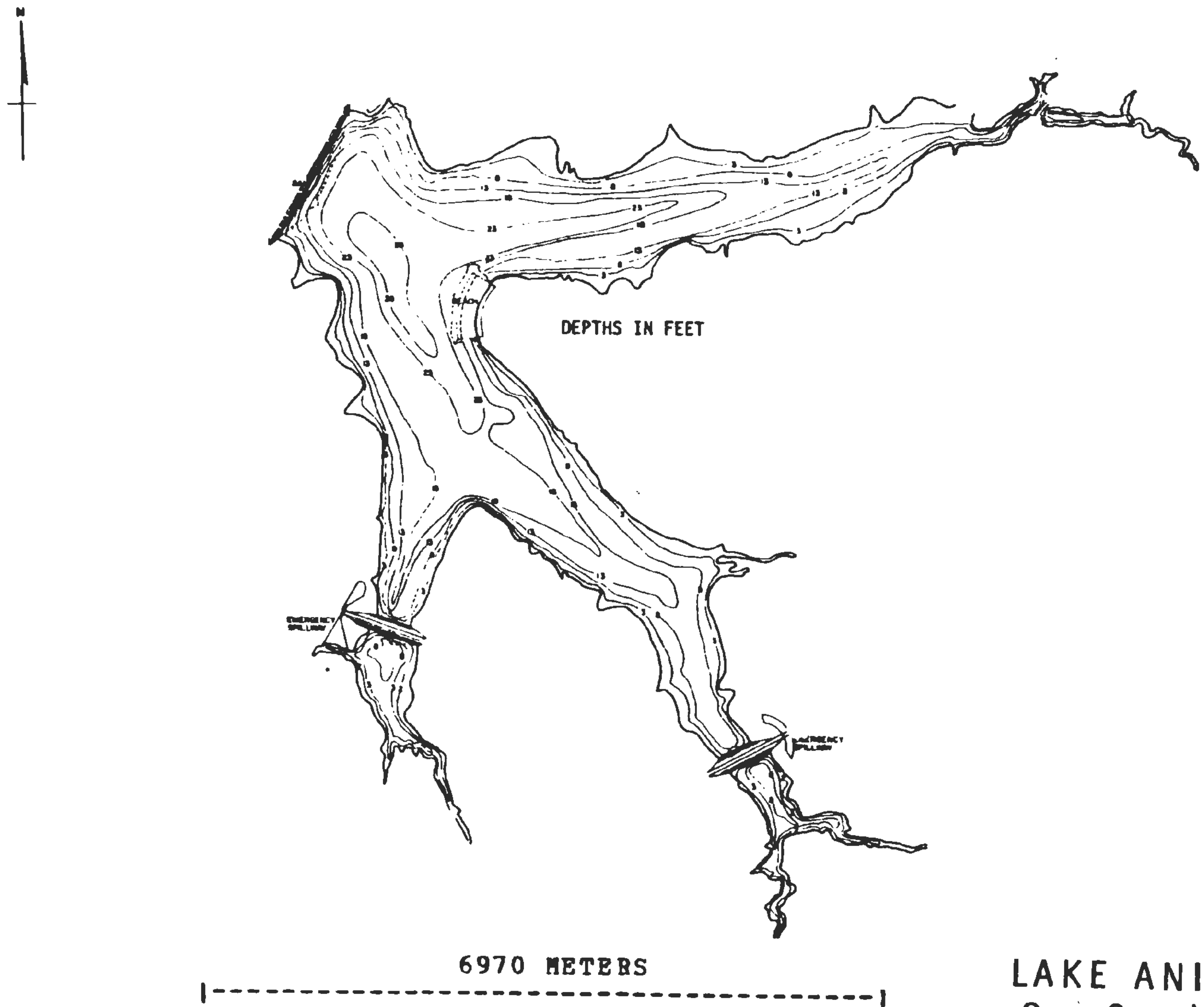
30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

31 Gently to strongly sloping (2-14%) prairie-derived soils developed from pre-Wisconsin till or pre-Wisconsin till-derived paleosols. Shelby, Sharpsburg, and Adair soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1971 map
Area 74. ha ( 182. A)
Length of shoreline 12338. m ( 40481. ft)
Maximum depth 8.5 m ( 28.0 ft)
Mean depth 3.7 m ( 12. ft)
Volume 2746513. cubic meters ( 2227. acre-feet)
Shoreline development 4.05  Volume development 1.31
Watershed/lake area ratio 13.2
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




LAKE ANITA
Cass County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.10 |
| Chlorophyll a mg/cubic meter | 8 | 47.4 | 5.65 |
| Total phosphorus mg/cubic meter | 8 | 55.8 | 4.39 |
| Kjeldahl nitrogen mg/l | 2 | 0.19 | 0.04 |
| Ammonia nitrogen mg/l | 2 | 0.22 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.09 | 0.01 |
| Seston dry weight mg/l | 8 | 13.1 | 0.95 |
| Turbidity JTU | 9 | 12.2 | 1.50 |
| Total hardness mg/l as CaCO3 | 9 | 98.2 | 3.04 |
| Calcium hardness mg/l as CaCO3 | 9 | 55.8 | 3.08 |
| Total alkalinity mg/l as CaCO3 | 10 | 97.4 | 3.33 |
| Dissolved oxygen mg/l | 8 | 8.7 | 0.18 |
| Specific conductance micromhos/cm at 25 C | 8 | 227.5 | 9.96 |
| Sulfate mg/l | 1 | 1.0 | 0.00 |
| Chloride mg/l | 4 | 8.0 | 0.00 |
| Sodium mg/l | 2 | 5.5 | 0.50 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 9/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 28.2 | 8.3 | 62.3 | 9.0 | 52.0 |
| 1 | 28.2 | | | | |
| 2 | 28.2 | 8.1 | 67.2 | 9.0 | 59.9 |
| 3 | 28.2 | | | | |
| 4 | 28.1 | 8.0 | 65.4 | 9.0 | 68.4 |
| 5 | 23.0 | | | | |
| 6 | 21.2 | 2.8 | 74.9 | 7.8 | 43.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 14.31-27.77 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 289.
Potential nutrient input index =
  area watershed in row crops/lake area = 9.1
 60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, contouring, strip-cropping, conservation tillage, gulley control structures/ erosion control structures, pastureland and pastureland improvement, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
   Class A-primary body contact recreation.
   Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
   Lake Anita State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 4406. | 24.2 | 59.5 |
| Shore or ice fishing | 10336. | 56.8 | 139.7 |
| Swimming | 13025. | 71.6 | 176.0 |
| Pleasure boating | 269. | 1.5 | 3.6 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 41062. | 225.6 | 554.9 |
| Snowmobiling | 243. | 1.3 | 3.3 |
| Ice skating and cross-country skiing | 122. | 0.7 | 1.6 |
| TOTAL | 69463. | 381.7 | 938.7 |

Special events at Lake Anita contributing to more than normal use include one to five fishing tournaments per year (25 to 100 people each).

IMPAIRMENTS

Swimming may be impaired in Lake Anita throughout the summer because of Secchi depths less than one meter caused by algal populations. According to Iowa Conservation Commission personnel, aquatic plants may hamper shoreline fishing in midsummer. I.C.C. personnel consider lake usage to be below its potential due to underharvest of the fish population.

Estimated aquatic plant coverage 10 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see

section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

ARBOR LAKE

LOCATION
County: Poweshiek    Latitude 41 Deg 44 Min N
Longitude 92 Deg 44 Min W
Township 80 N    Range 16 W    Section 17

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
396. hectares ( 979. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 55 | 285. | 72.0 |
| 56 | 111. | 28.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 26.0 | 1.8 | 0.2 | 70.9 | 1.0 |

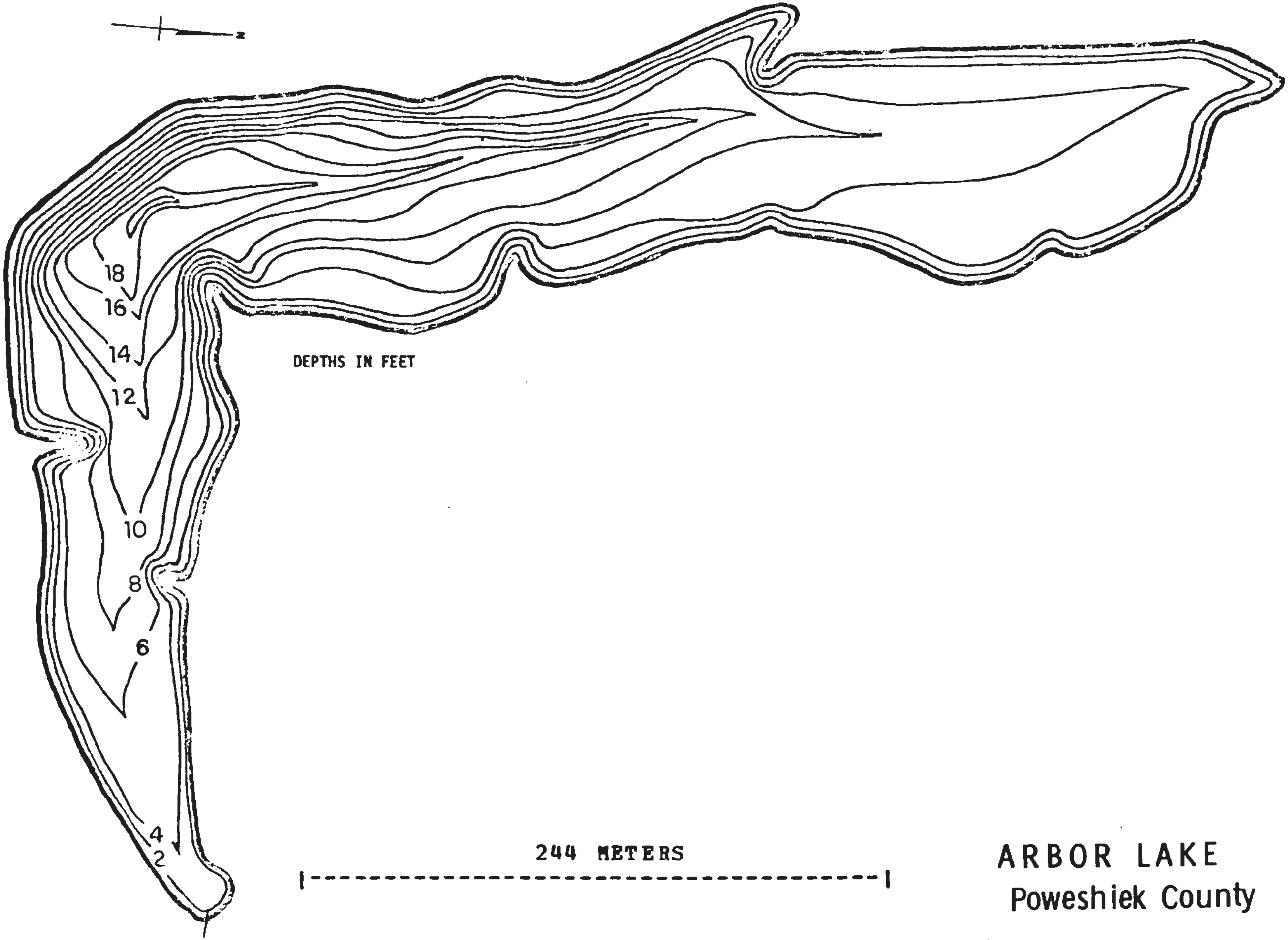
Description of topography and soils in soil associations represented in the watershed

55 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess. Tama and Muscatine soils.

56 Gently to strongly sloping (2-14%) prairie to forest-derived soils developed from loess. Tama, Downs, and Fayette soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1978 map
Area 6. ha ( 14. A)
Length of shoreline 1702. m ( 5583. ft)
Maximum depth 6.1 m ( 20.0 ft)
Mean depth 2.3 m ( 7. ft)
Volume 127686. cubic meters ( 103. acre-feet)
Shoreline development 2.02    Volume development 1.12
Watershed/lake area ratio 66.0
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




ARBOR LAKE
Poweshiek County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.07 |
| Chlorophyll a mg/cubic meter | 8 | 61.8 | 21.19 |
| Total phosphorus mg/cubic meter | 7 | 259.5 | 47.50 |
| Kjeldahl nitrogen mg/l | 2 | 1.2 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.04 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.2 | 0.01 |
| Seston dry weight mg/l | 8 | 21.4 | 3.29 |
| Turbidity JTU | 9 | 13.3 | 2.04 |
| Total hardness mg/l as $CaCO_3$ | 8 | 155.5 | 5.67 |
| Calcium hardness mg/l as $CaCO_3$ | 8 | 95.5 | 6.23 |
| Total alkalinity mg/l as $CaCO_3$ | 8 | 111.7 | 5.55 |
| Dissolved oxygen mg/l | 8 | 12.1 | 2.04 |
| Specific conductance micromhos/cm at 25 C | 8 | 378.8 | 11.09 |
| Sulfate mg/l | 3 | 55.3 | 8.48 |
| Chloride mg/l | 3 | 34.8 | 3.59 |
| Sodium mg/l | 2 | 21.0 | 1.00 |
| Potassium mg/l | 2 | 5.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/30/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.6 | 19.9 | 307.1 | 9.5 | 131.0 |
| 1 | 23.9 | 12.0 | 303.7 | 8.8 | 44.2 |
| 2 | 21.7 | | | | |
| 3 | 19.4 | 2.7 | 507.3 | 7.5 | 7.5 |
| 4 | 16.1 | | | | |
| 5 | 12.2 | 0.0 | 2237.0 | 7.4 | 12.0 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 1445.
Potential nutrient input index =
area watershed in row crops/lake area = 17.2
50.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: ponds/sediment and water control basins, contouring, conservation tillage.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Miracle Equipment Co. IA0062324 | Septic tank |
| City of Grinnell | Stormwater runoff |

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Arbor Lake County Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 109. | 7.8 | 18.2 |
| Shore or ice fishing | 4026. | 287.6 | 671.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 52. | 3.7 | 8.7 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 3458. | 247.0 | 576.3 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 7645. | 546.1 | 1274.2 |

IMPAIRMENTS

Water clarity is poor in Arbor Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations and other suspended matter. Frequent winterkills may limit fishing potential. According to county conservation personnel, point source pollution from industrial sources and city sanitary sewers as well as non-point pollution from urban construction, may occur. Dredging was completed in 1977 and fish have recently been stocked. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 0.4%
Estimated winterkill frequencies: 1 year out of 4
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The feasibility of diverting urban runoff from Arbor Lake should be examined since water quality in Arbor Lake may be affected by a variety of urban inputs. Storm water runoff from the southwest corner of Grinnell and from southeast of the lake is directed into the lake. Roadway dirt, deicing salt, oils, oxygen demanding materials and nutrients may be introduced into the lake by this means. City officials state there may be septic tank taps into the storm sewer system as well. Diverting the storm water runoff may improve the water quality of this small lake by reducing the input of nutrients, organic matter, and materials directly harmful to aquatic organisms. According to city officials Arbor Lake has been deleteriously affected in recent years by waste and metal discharges from the Miracle Equipment Company. In the last year the company installed a new septic tank and field within the Arbor Lake watershed rather than sending wastes to the Grinnell sanitary sewer system. Close examination of this system's performance and reliability should be undertaken.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

ARROWHEAD LAKE

LOCATION
County: Pottawattamie    Latitude 41 Deg 26 Min N
Longitude 95 Deg 35 Min W
Township 77 N    Range 41 W    Section 29

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
419. hectares ( 1036. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 20 | 419. | 100.0 |

Estimated land uses (%)

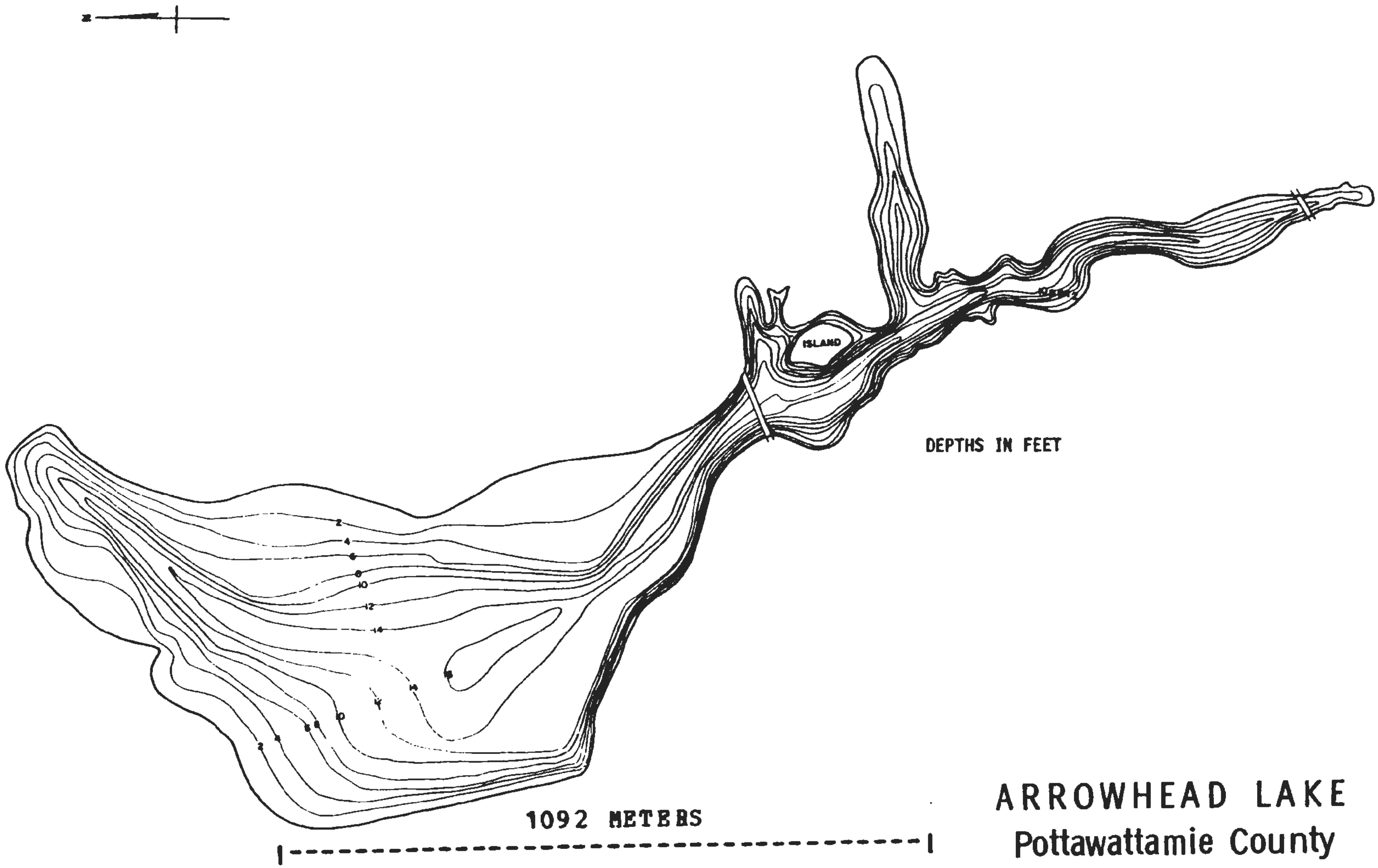
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 78.8 | 15.3 | 3.2 | 0.0 | 2.7 |

Description of topography and soils in soil associations represented in the watershed

20 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from loess or loess-derived sediments. Ida, Napier, and Monona soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 6. ha ( 14. A)
Length of shoreline 2128. m ( 6980. ft)
Maximum depth 4.9 m ( 16.0 ft)
Mean depth 2.2 m ( 7. ft)
Volume 124590. cubic meters ( 101. acre-feet)
Shoreline development 2.51    Volume development 1.34
Watershed/lake area ratio 69.8
Origin of basin: Impoundment
Estimated annual precipitation 79. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 102. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




ARROWHEAD LAKE
Pottawattamie County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.00 |
| Chlorophyll a mg/cubic meter | 8 | 62.8 | 2.67 |
| Total phosphorus mg/cubic meter | 8 | 125.9 | 4.80 |
| Kjeldahl nitrogen mg/l | 2 | 1.1 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 8 | 23.2 | 3.58 |
| Turbidity JTU | 8 | 12.9 | 0.67 |
| Total hardness mg/l as CaCO3 | 8 | 166.7 | 1.60 |
| Calcium hardness mg/l as CaCO3 | 8 | 79.0 | 2.27 |
| Total alkalinity mg/l as CaCO3 | 7 | 163.1 | 2.13 |
| Dissolved oxygen mg/l | 8 | 8.8 | 1.32 |
| Specific conductance micromhos/cm at 25 C | 8 | 335.6 | 4.95 |
| Sulfate mg/l | 4 | 12.7 | 2.09 |
| Chloride mg/l | 5 | 10.0 | 0.16 |
| Sodium mg/l | 2 | 11.5 | 0.50 |
| Potassium mg/l | 2 | 9.0 | 1.00 |

Vertical profile for selected measurements on the sampling date ( 7/24/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.9 | 9.5 | 136.3 | 8.8 | 77.8 |
| 1 | 26.1 | | | | |
| 2 | 24.2 | 1.2 | 171.8 | 8.0 | 62.1 |
| 3 | 22.2 | | | | |
| 4 | 20.2 | 0.0 | 586.0 | 7.5 | 16.5 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 1529.
Potential nutrient input index =
area watershed in row crops/lake area = 55.0
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: pastureland and pastureland improvement, terraces, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Arrowhead Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1020. | 72.9 | 170.0 |
| Shore or ice fishing | 4338. | 309.9 | 723.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 117. | 8.4 | 19.5 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 15751. | 1125.1 | 2625.2 |
| Snowmobiling | 868. | 62.0 | 144.7 |
| Ice skating and cross-country skiing | 122. | 8.7 | 20.3 |
| TOTAL | 22216. | 1586.9 | 3702.7 |

IMPAIRMENTS

Water clarity is poor in Arrowhead Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. According to Iowa Conservation Commission personnel, aquatic vegetation has caused problems with anglers. I.C.C. personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 0.7%
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

ARROWHEAD LAKE

LOCATION
County: Sac Latitude 42 Deg 18 Min N
Longitude 95 Deg 3 Min W
Township 87 N Range 36 W Section 33

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
60. hectares ( 148. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 6 | 17. | 28.9 |
| 11 | 43. | 71.1 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 83.5 | 10.6 | 2.4 | 0.0 | 3.5 |

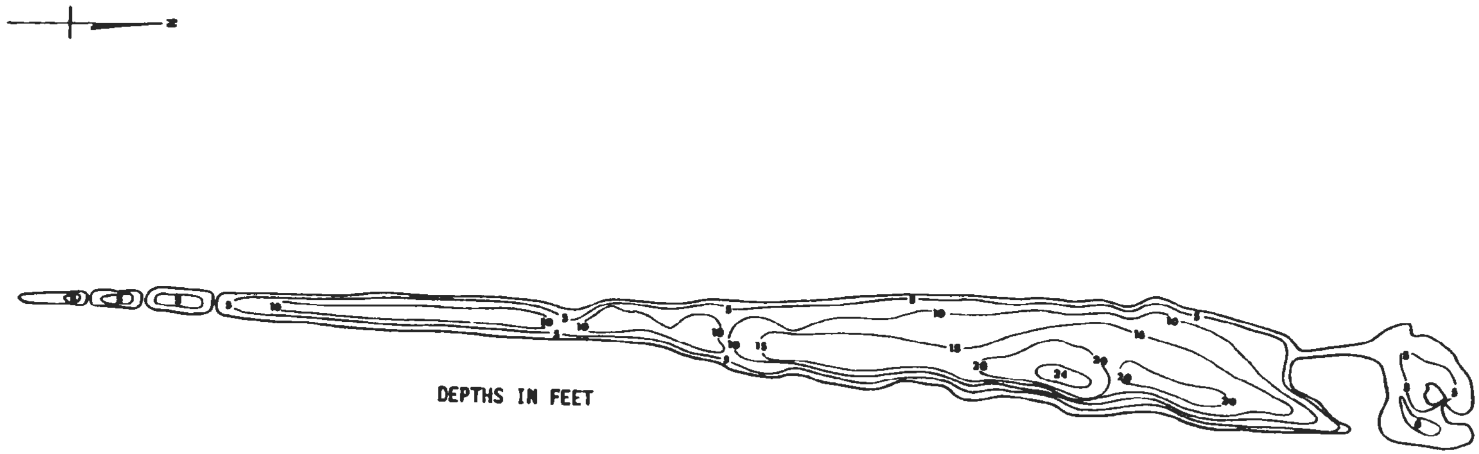
Description of topography and soils in soil associations represented in the watershed

6 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over Wisconsin or pre-Wisconsin till. Galva, Primghar, and Sac soils.

11 Nearly level and gently sloping (0-5%) prairie-derived upland and terrace soils developed from alluvium. Wadena, Talcot, Flagler, and Saude soils.

Per cent of shoreline in public ownership 35 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 12. ha ( 31. A)
Length of shoreline 3623. m ( 11888. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 3.2 m ( 11. ft)
Volume 394959. cubic meters ( 320. acre-feet)
Shoreline development 2.91 Volume development 1.31
Watershed/lake area ratio 5.0
Origin of basin: Gravel pit
Estimated annual precipitation 74. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 97. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: None
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




3024 METERS

# ARROWHEAD LAKE
Sac County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 2.4 | 0.34 |
| Chlorophyll a<br>mg/cubic meter | 9 | 15.3 | 4.42 |
| Total phosphorus<br>mg/cubic meter | 6 | 22.8 | 1.35 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.5 | 0.02 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.05 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight<br>mg/l | 10 | 4.4 | 0.36 |
| Turbidity<br>JTU | 11 | 2.5 | 0.33 |
| Total hardness<br>mg/l as CaCO3 | 9 | 222.9 | 2.61 |
| Calcium hardness<br>mg/l as CaCO3 | 9 | 114.4 | 2.64 |
| Total alkalinity<br>mg/l as CaCO3 | 11 | 167.8 | 0.91 |
| Dissolved oxygen<br>mg/l | 9 | 6.6 | 0.35 |
| Specific conductance<br>micromhos/cm at 25 C | 9 | 403.3 | 11.76 |
| Sulfate<br>mg/l | 6 | 59.7 | 1.81 |
| Chloride<br>mg/l | 6 | 9.3 | 0.11 |
| Sodium<br>mg/l | 2 | 8.0 | 1.00 |
| Potassium<br>mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/16/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.5 | 5.2 | 24.0 | 8.0 | 15.0 |
| 1 | 22.4 | | | | |
| 2 | 22.4 | 5.2 | 24.7 | 8.0 | 10.5 |
| 3 | 22.4 | | | | |
| 4 | 22.4 | 5.3 | 21.9 | 8.0 | 48.6 |
| 5 | 22.4 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 30.
Potential nutrient input index =
area watershed in row crops/lake area = 4.2
100.% of watershed is in approved soil conservation practices.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Blackhawk State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1303. | 42.0 | 108.6 |
| Shore or ice fishing | 1872. | 60.4 | 156.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 152. | 4.9 | 12.7 |
| Hunting | 195. | 6.3 | 16.3 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 2128. | 68.6 | 177.3 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 156. | 5.0 | 13.0 |
| TOTAL | 5806. | 187.3 | 483.8 |

IMPAIRMENTS

Aquatic vascular plant growth in Arrowhead Lake may impair boating and shoreline fishing. White Amur were stocked in 1977 in response to this problem. Iowa Conservation Commision personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 16 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

This lake's water quality is not significantly impaired. Arrowhead Lake has a small watershed/surface area ratio and is a former gravel pit. The lake receives little surface runoff. Consequently, sediment and nutrient inputs are minimal. White Amur were stocked in the lake in 1977 to control aquatic plant growth.

BADGER LAKE

LOCATION
County: Webster    Latitude 42 Deg 35 Min N
Longitude 94 Deg 11 Min W
Township 90 N    Range 28 W    Section 30

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
3500. hectares ( 8650. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 3236. | 92.4 |
| 16 | 29. | 0.8 |
| 217 | 236. | 6.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 91.7 | 3.7 | 1.8 | 0.0 | 2.7 |

Description of topography and soils in soil associations represented in the watershed

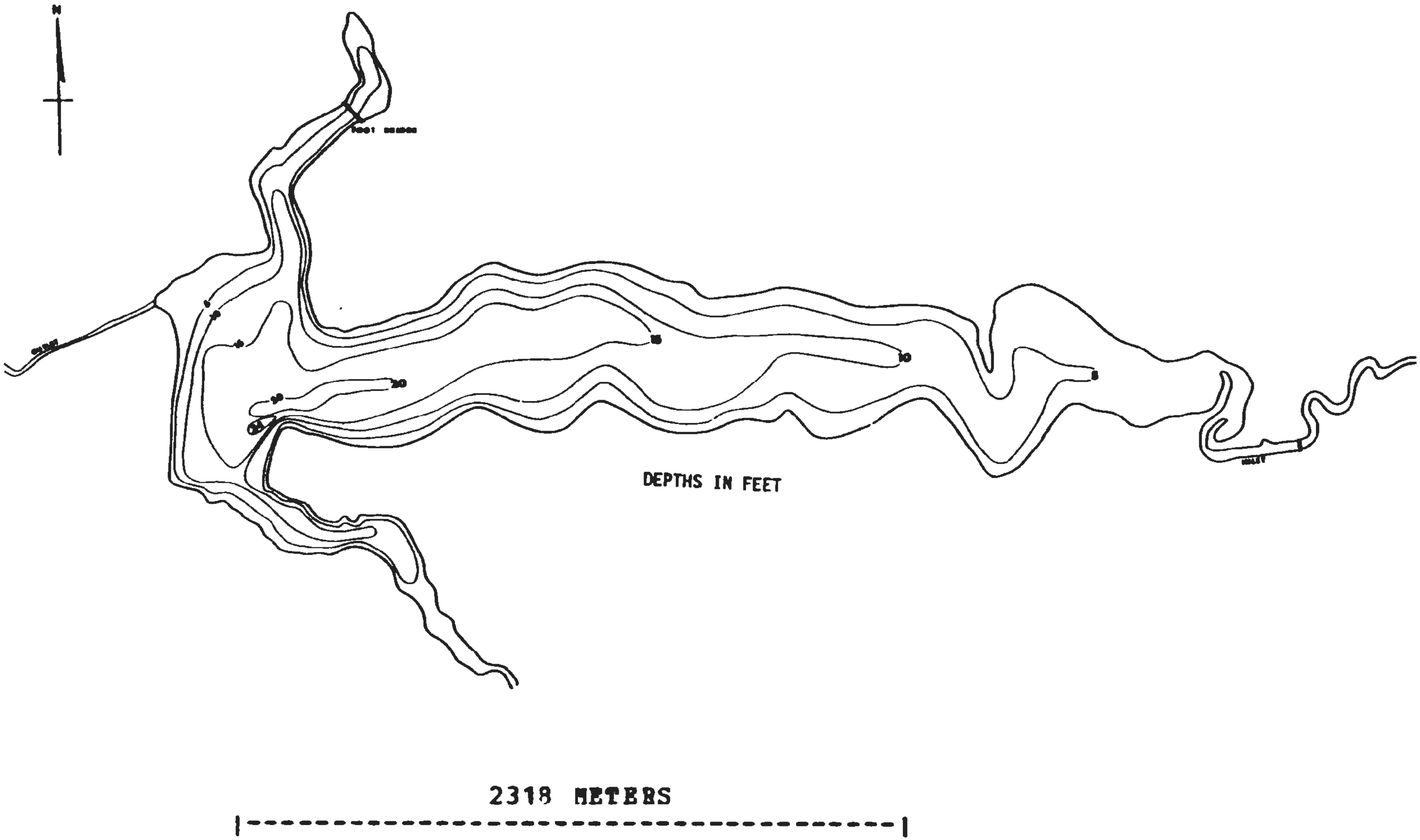
12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

16 Level and nearly level (0-2%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Webster, Harps, Canisteo, Nicollet, and Okoboji soils.

217 Nearly level to very steep (0-40%) forest and mixed prairie-forest-derived soils developed from Wisconsin till on the Cary Lobe. Includes some soils on bottomlands and terraces. Hayden and Lester soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 18. ha ( 45. A)
Length of shoreline 4564. m ( 14974. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 2.6 m ( 8. ft)
Volume 469289. cubic meters ( 380. acre-feet)
Shoreline development 3.00    Volume development 1.05
Watershed/lake area ratio 194.4
Origin of basin: Impoundment
Estimated annual precipitation 76. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes




BADGER LAKE
Webster County

Major inflows (named and/or permanent streams)
Badger Cr
Outlet: Badger Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.6 | 0.08 |
| Chlorophyll a mg/cubic meter | 9 | 31.4 | 8.16 |
| Total phosphorus mg/cubic meter | 8 | 138.6 | 12.12 |
| Kjeldahl nitrogen mg/l | 2 | 0.9 | 0.14 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 10.3 | 0.05 |
| Seston dry weight mg/l | 9 | 14.2 | 1.19 |
| Turbidity JTU | 9 | 9.5 | 1.37 |
| Total hardness mg/l as $CaCO_3$ | 10 | 347.8 | 2.74 |
| Calcium hardness mg/l as $CaCO_3$ | 10 | 232.8 | 8.98 |
| Total alkalinity mg/l as $CaCO_3$ | 8 | 246.5 | 4.61 |
| Dissolved oxygen mg/l | 9 | 9.2 | 1.54 |
| Specific conductance micromhos/cm at 25 C | 9 | 615.6 | 10.65 |
| Sulfate mg/l | 8 | 36.4 | 1.60 |
| Chloride mg/l | 8 | 23.4 | 1.21 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 18.6 | 6.8 | 167.8 | 7.8 | 7.9 |
| 1 | 18.5 | 6.4 | 167.8 | 7.8 | 8.2 |
| 2 | 18.1 | 6.2 | 165.7 | 7.7 | 7.1 |
| 3 | 17.6 | | | | |
| 4 | 17.1 | 3.6 | 150.3 | 7.5 | 2.2 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 778.
Potential nutrient input index =
area watershed in row crops/lake area = 178.3
20.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, contouring.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Badger IA0029041 | two-cell lagoon |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Kennedy Memorial Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1017. | 22.6 | 56.5 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 5356. | 119.0 | 297.6 |
| Swimming | 5603. | 124.5 | 311.3 |
| Pleasure boating | 1671. | 37.1 | 92.8 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 29423. | 653.8 | 1634.6 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 7375. | 163.9 | 409.7 |
| TOTAL | 50445. | 1121.0 | 2802.5 |

Special events at Badger Lake contributing to more than normal use include Memorial Day hot air balloon races (10,000 people).

IMPAIRMENTS

Swimming may be impaired in Badger Lake throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be above its potential.

Estimated aquatic plant coverage 8 %
Estimated winterkill frequencies: 1 year out of 15
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in Badger Lake may be affected by sewage input from the Badger city sewage lagoon. This lagoon is inadequate and must be flushed twice each year in the late fall and early spring. Outflow passes through tile into a creek feeding Badger Lake. Badger city officials are aware of this problem and have completed a phase 1 study determining the need for a new lagoon, at an approximate cost of 3/4 million dollars. Planning efforts for the new system under a phase 2 engineering study (approximate cost $50,000) are currently hindered by a lack of cost-sharing funds. It is recommended the necessary steps be taken to complete the construction of a treatment lagoon in Badger. Elimination of such an important point source of nutrients and organic matter may significantly improve water quality in the lake. Such action will also eliminate the potential danger of bacterial contamination to lake users.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term

extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

BEEDS LAKE

LOCATION

County: Franklin    Latitude 42 Deg 46 Min N
Longitude 93 Deg 15 Min W

Township 92 N    Range 20 W    Section 19

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
7676. hectares ( 18966. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 5274. | 68.7 |
| 14 | 2152. | 28.0 |
| 65 | 250. | 3.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 92.8 | 3.6 | 0.1 | 0.4 | 3.0 |

Description of topography and soils in soil associations represented in the watershed

12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

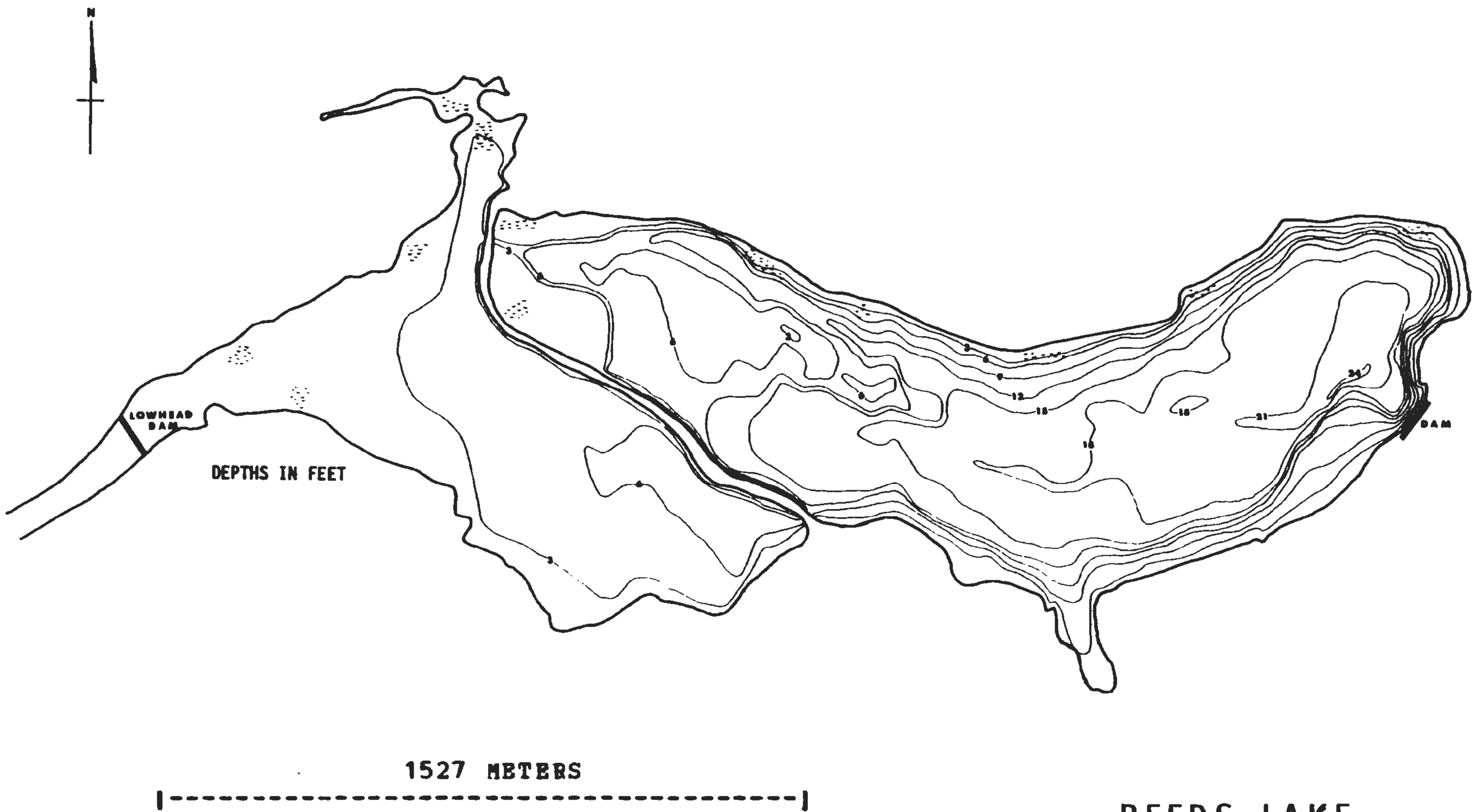
14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

65 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess over pre-Wisconsin till or from pre-Wisconsin till on the Iowan Erosion Surface. Dinsdale, Klinger, Maxfield, Tama, and Kenyon soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 41. ha ( 100. A)
Length of shoreline 4657. m ( 15279. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 2.6 m ( 9. ft)
Volume 1066189. cubic meters ( 864. acre-feet)
Shoreline development 2.06    Volume development 1.08
Watershed/lake area ratio 187.2
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 89. cm




BEEDS LAKE
Franklin County

Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Spring Cr
Outlet: Spring Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.0 | 0.14 |
| Chlorophyll a mg/cubic meter | 8 | 79.1 | 18.77 |
| Total phosphorus mg/cubic meter | 7 | 78.6 | 14.31 |
| Kjeldahl nitrogen mg/l | 2 | 1.1 | 0.13 |
| Ammonia nitrogen mg/l | 2 | 0.4 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 5.9 | 0.02 |
| Seston dry weight mg/l | 8 | 14.4 | 1.54 |
| Turbidity JTU | 7 | 8.0 | 0.92 |
| Total hardness mg/l as CaCO3 | 7 | 279.1 | 16.90 |
| Calcium hardness mg/l as CaCO3 | 8 | 176.2 | 9.46 |
| Total alkalinity mg/l as CaCO3 | 7 | 213.3 | 16.63 |
| Dissolved oxygen mg/l | 7 | 11.2 | 1.91 |
| Specific conductance micromhos/cm at 25 C | 8 | 507.5 | 19.32 |
| Sulfate mg/l | 9 | 29.8 | 0.97 |
| Chloride mg/l | 10 | 18.2 | 0.15 |
| Sodium mg/l | 2 | 7.5 | 0.50 |
| Potassium mg/l | 2 | 2.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.2 | 10.8 | 149.5 | 8.3 | 196.1 |
| 1 | 22.2 | 6.5 | 104.6 | 8.1 | 103.7 |
| 2 | 21.7 | | | | |
| 3 | 21.1 | 5.5 | 96.3 | 8.0 | 72.2 |
| 4 | 20.6 | | | | |
| 5 | 18.9 | 0.1 | 111.5 | 7.7 | 7.1 |
| 6 | 17.8 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 749.
Potential nutrient input index =
area watershed in row crops/lake area = 173.7
75.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, contouring, strip-cropping, gulley control structures/ erosion control structures, ponds/sediment and water control basins, grass waterways, pastureland and pastureland improvement, field windbreaks.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Latimer WTP | Filter backwash once/wk. |
| 1200 hogs | Storage tank |
| 380 hogs | Storage tank |
| 310 cattle | Storage tank |
| 350 cattle | Runoff control |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Beeds Lake State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 13982. | 139.8 | 341.0 |
| Shore or ice fishing | 55144. | 551.4 | 1345.0 |
| Swimming | 16930. | 169.3 | 412.9 |
| Pleasure boating | 7135. | 71.3 | 174.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 156997. | 1570.0 | 3829.2 |
| Snowmobiling | 3817. | 38.2 | 93.1 |
| Ice skating and cross-country skiing | 590. | 5.9 | 14.4 |
| TOTAL | 254595. | 2545.9 | 6209.6 |

Special events at Beeds Lake contributing to more than normal use include July 4th fireworks (7,500 people) and a snowmobile rally (180 people).

IMPAIRMENTS

Swimming may be impaired in Beeds Lake for part of the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Iowa Conservation Commission personnel consider lake usage to be above its potential due to an overabundance of fishermen.

Estimated aquatic plant coverage 0.5%
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition,

it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

BIG CREEK LAKE

LOCATION

County: Polk    Latitude 41 Deg 49 Min N
Longitude 93 Deg 45 Min W

Township 81 N    Range 25 W    Section 22

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
19639. hectares ( 48527. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 11205. | 57.1 |
| 15 | 8434. | 42.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 88.2 | 7.2 | 0.7 | 0.5 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1974 map

Area 367. ha ( 905. A)

Length of shoreline 33059. m ( 108464. ft)

Maximum depth 16.2 m ( 53.0 ft)

Mean depth 5.3 m ( 17. ft)

Volume 19261000. cubic meters ( 15609. acre-feet)

Shoreline development 4.87    Volume development 0.98

Watershed/lake area ratio 53.5

Origin of basin: Impoundment

Estimated annual precipitation 81. cm

Estimated annual runoff 15. cm

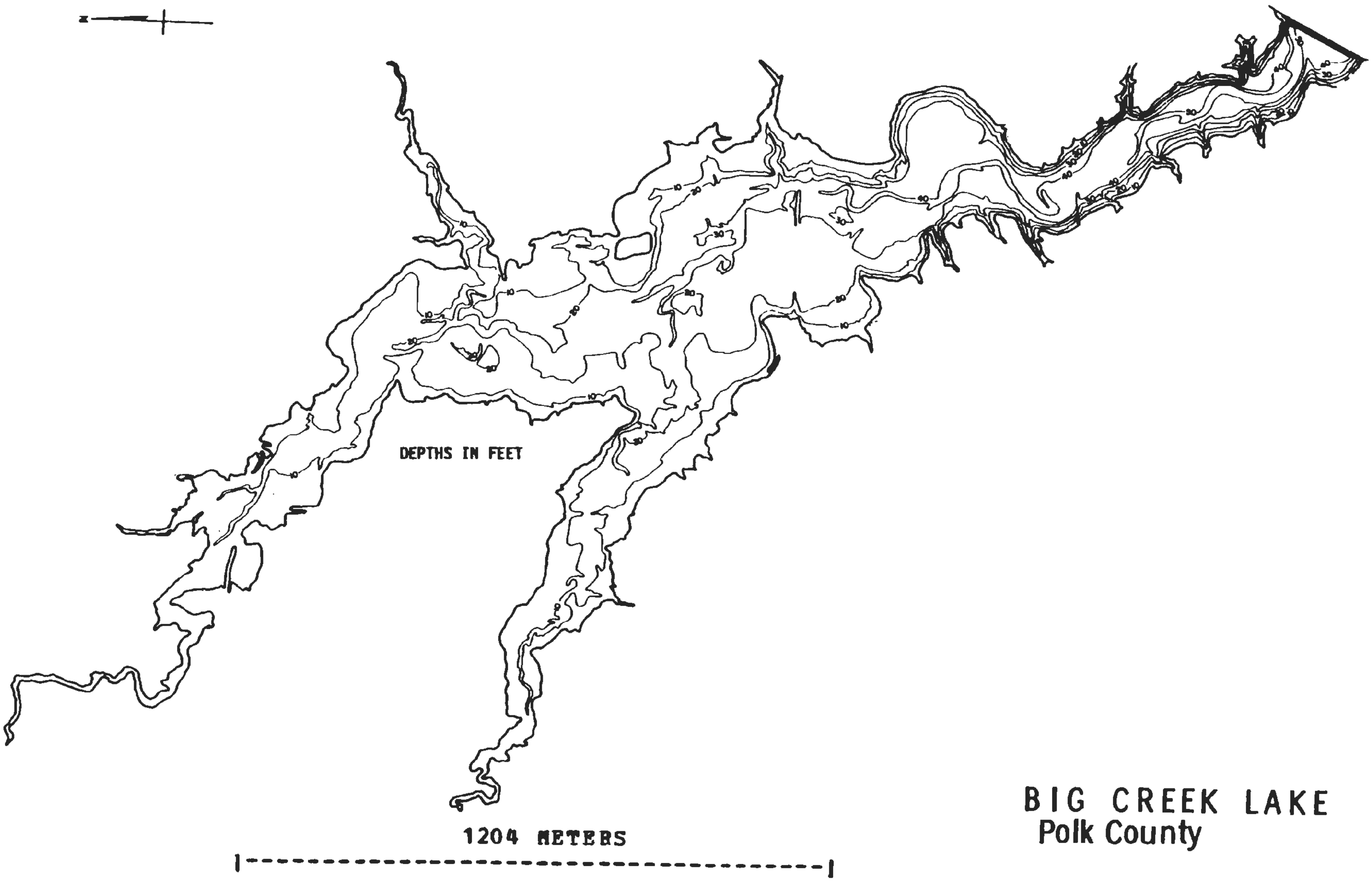
Estimated lake evaporation 94. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)

Turkey Cr, Big Cr, Little Cr

Outlet: To Saylorville Res




BIG CREEK LAKE
Polk County

208 Agency:
Des Moines 208 Agency
Central Iowa Regional Association of Local Govts.
104 East Locust St.
Des Moines, IA 50306

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 2.1 | 0.24 |
| Chlorophyll a mg/cubic meter | 6 | 14.5 | 3.50 |
| Total phosphorus mg/cubic meter | 6 | 28.8 | 1.76 |
| Kjeldahl nitrogen mg/l | 2 | 1.27 | 1.62 |
| Ammonia nitrogen mg/l | 2 | 0.24 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.47 | 0.16 |
| Seston dry weight mg/l | 6 | 3.9 | 1.86 |
| Turbidity JTU | 6 | 3.7 | 0.78 |
| Total hardness mg/l as CaCO3 | 6 | 251.7 | 2.33 |
| Calcium hardness mg/l as CaCO3 | 6 | 147.0 | 2.35 |
| Total alkalinity mg/l as CaCO3 | 6 | 180.3 | 3.95 |
| Dissolved oxygen mg/l | 7 | 7.3 | 0.67 |
| Specific conductance micromhos/cm at 25 C | 7 | 477.1 | 25.42 |
| Sulfate mg/l | 6 | 35.9 | 1.31 |
| Chloride mg/l | 7 | 19.3 | 0.10 |
| Sodium mg/l | 2 | 5.5 | 0.50 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 2/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.1 | 6.8 | 22.1 | 8.2 | 8.8 |
| 1 | 26.0 | | | | |
| 2 | 25.4 | | | | |
| 3 | 25.1 | 3.5 | 32.0 | 8.0 | 12.0 |
| 4 | 24.9 | | | | |
| 5 | 24.7 | 2.0 | 27.7 | 7.8 | 6.7 |
| 6 | 23.7 | | | | |
| 7 | 21.7 | | | | |
| 8 | 20.3 | 0.1 | 21.7 | 7.7 | 1.7 |
| 9 | 19.2 | | | | |
| 10 | 18.6 | | | | |
| 11 | 17.5 | 0.2 | 138.8 | 7.6 | 0.9 |
| 12 | 16.3 | | | | |
| 13 | 14.6 | | | | |
| 14 | 13.6 | 0.3 | 395.4 | 8.0 | 0.7 |
| 15 | 12.9 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Shoreline erosion may be a significant source of siltation
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 214.
Potential nutrient input index =
area watershed in row crops/lake area = 47.2
75.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Plaines Poultry Farms, Inc. IA0043354 & IA0037478 | 5-cell lagoon with no outflow |
| 750 hogs | Sewage lagoon |

## LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Big Creek State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 26415. | 29.2 | 72.0 |
| Shore or ice fishing | 70575. | 78.0 | 192.3 |
| Swimming | 45575. | 50.4 | 124.2 |
| Pleasure boating | 22060. | 24.4 | 60.1 |
| Hunting | 2823. | 3.1 | 7.7 |
| Picnicking,camping,other activities prompted by the lake's presence | 37675. | 41.6 | 102.7 |
| Snowmobiling | 1737. | 1.9 | 4.7 |
| Ice skating and cross-country skiing | 175. | 0.2 | 0.5 |
| TOTAL | 207035. | 228.8 | 564.1 |

Special events at Big Creek Lake contributing to more than normal use include four to five fishing tournaments (30 people each) and two sailing regattas each month in the summer (700 people each).

## IMPAIRMENTS

Recreation activities in Big Creek Lake do not appear to be impaired by poor water quality or aquatic plants. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 10 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

## LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

BIG SPIRIT LAKE

LOCATION
County: Dickinson          Latitude   43 Deg   28 Min N
        Jackson,MN         Longitude  95 Deg  '6 Min W
Township 100 N      Range 36 W      Section 16

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
     13950. hectares ( 34471. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 12546. | 89.9 |
| 15 | 1404. | 10.1 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 89.6 | 6.5 | 0.4 | 0.1 | 3.5 |

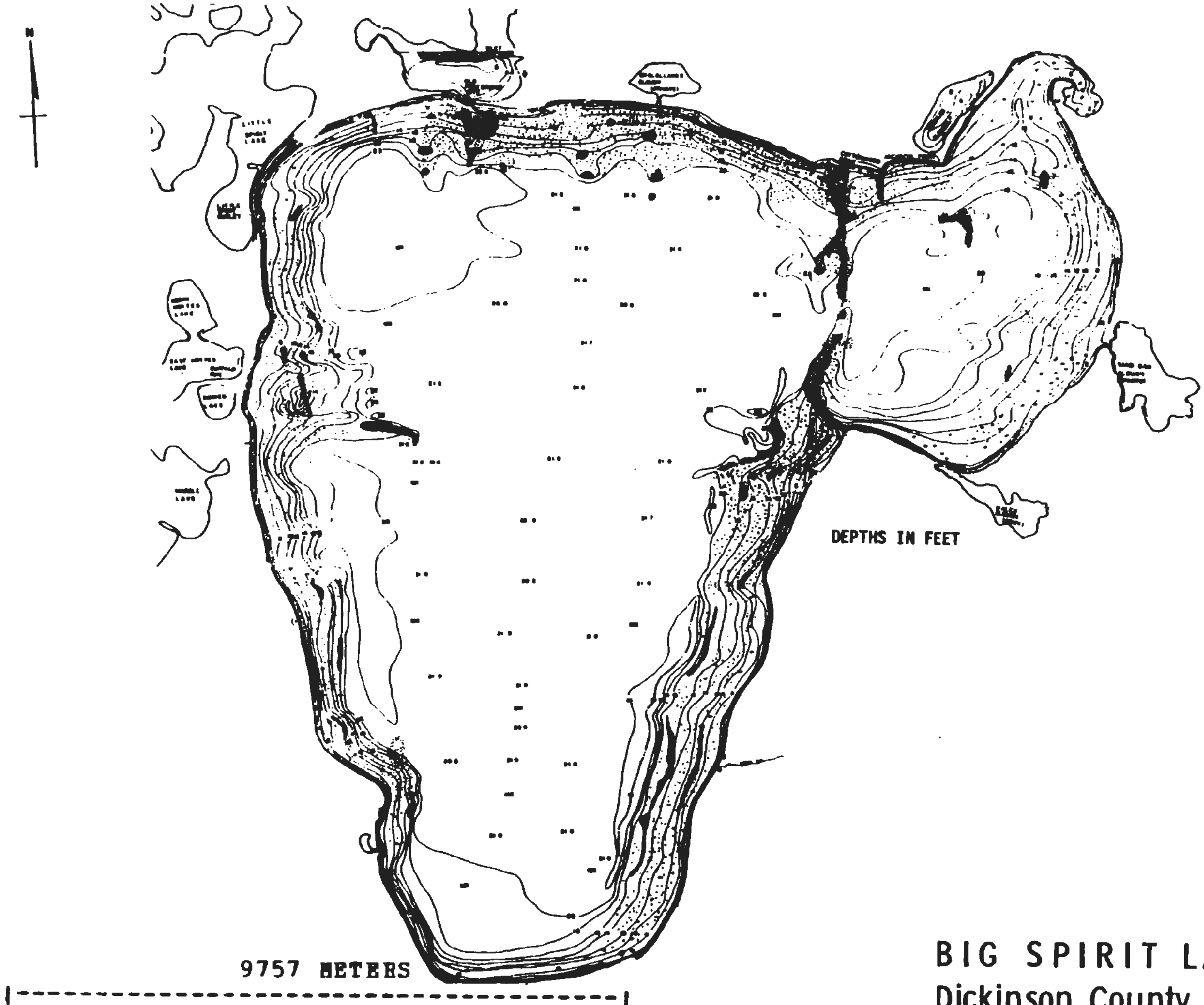
Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership  17 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1971 map
Area 1688. ha (4169. A)
Length of shoreline   26344. m (  86432. ft)
Maximum depth  7.3 m ( 24.0 ft)
Mean depth  5.3 m ( 17. ft)
Volume 116135600. cubic meters ( 94114. acre-feet)
Shoreline development  1.58    Volume development  2.16
Watershed/lake area ratio       8.3
Origin of basin: Natural
Estimated annual precipitation  69. cm
Estimated annual runoff          8. cm
Estimated lake evaporation      89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
  Unnamed Cr from Loon L,MN
Outlet: To East Okoboji L




BIG SPIRIT LAKE
Dickinson County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.0 | 0.07 |
| Chlorophyll a mg/cubic meter | 9 | 46.2 | 5.20 |
| Total phosphorus mg/cubic meter | 8 | 67.4 | 6.11 |
| Kjeldahl nitrogen mg/l | 2 | 1.1 | 0.22 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 8 | 14.3 | 0.81 |
| Turbidity JTU | 8 | 11.0 | 0.68 |
| Total hardness mg/l as CaCO3 | 9 | 236.4 | 1.56 |
| Calcium hardness mg/l as CaCO3 | 9 | 82.4 | 2.28 |
| Total alkalinity mg/l as CaCO3 | 8 | 190.7 | 1.42 |
| Dissolved oxygen mg/l | 8 | 8.4 | 0.55 |
| Specific conductance micromhos/cm at 25 C | 9 | 426.7 | 4.93 |
| Sulfate mg/l | 3 | 43.8 | 0.93 |
| Chloride mg/l | 3 | 16.3 | 0.17 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 8.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.4 | 6.8 | 80.1 | 8.6 | 68.4 |
| 1 | 21.4 | | | | |
| 2 | 21.5 | 6.9 | 82.2 | 8.6 | 53.7 |
| 3 | 21.5 | | | | |
| 4 | 21.5 | 6.5 | 79.1 | 8.6 | 56.9 |
| 5 | 21.5 | | | | |
| 6 | 21.5 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus, perhaps sometimes nitrogen.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 25.
Potential nutrient input index =
area watershed in row crops/lake area = 5.7
32.% of watershed is in approved soil conservation practices.
Best management practices reccmmended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| 80 cattle | No controls |
| 600 cattle | Runoff controls |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake has also been designated as high quality water and is thus subject to higher standards to protect existing uses.
This lake is used as a raw water source for about 3400 persons at Spirit Lake.

Public parks:
Ainsworth Beach and boat ramp (County)
Marble Beach Park (State)
Orleans Access (Public)
Minnewaukon Fish and Wildlife Access
Crandalls Beach
Hales Slough Fish and Wildlife Access

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 50556. | 12.1 | 30.0 |
| Shore or ice fishing | 99767. | 23.9 | 59.1 |
| Swimming | 66124. | 15.9 | 39.2 |
| Pleasure boating | 12244. | 2.9 | 7.3 |
| Hunting | 2541. | 0.6 | 1.5 |
| Picnicking,camping,other activities prompted by the lake's presence | 616587. | 147.9 | 365.3 |
| Snowmobiling | 16925. | 4.1 | 10.0 |
| Ice skating and cross-country skiing | 4343. | 1.0 | 2.6 |
| TOTAL | 869087. | 208.5 | 514.9 |

Special events at Big Spirit Lake contributing to more than normal use include sailing regattas (75-100 people each).

IMPAIRMENTS

Swimming may be impaired in Big Spirit Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 25 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

BLACK HAWK LAKE

LOCATION

County: Sac        Latitude 42 Deg 18 Min N
                   Longitude 95 Deg 1 Min W

Township 87 N      Range 36 W      Section 34

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
4961. hectares ( 12259. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 11 | 914. | 18.4 |
| 14 | 187. | 3.8 |
| 15 | 3517. | 70.9 |
| 18 | 87. | 1.8 |
| 24 | 18. | 0.4 |
| 26 | 238. | 4.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 80.9 | 12.4 | 1.8 | 1.0 | 3.9 |

Description of topography and soils in soil associations represented in the watershed

11 Nearly level and gently sloping (0-5%) prairie-derived upland and terrace soils developed from alluvium. Wadena, Talcot, Flagler, and Saude soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

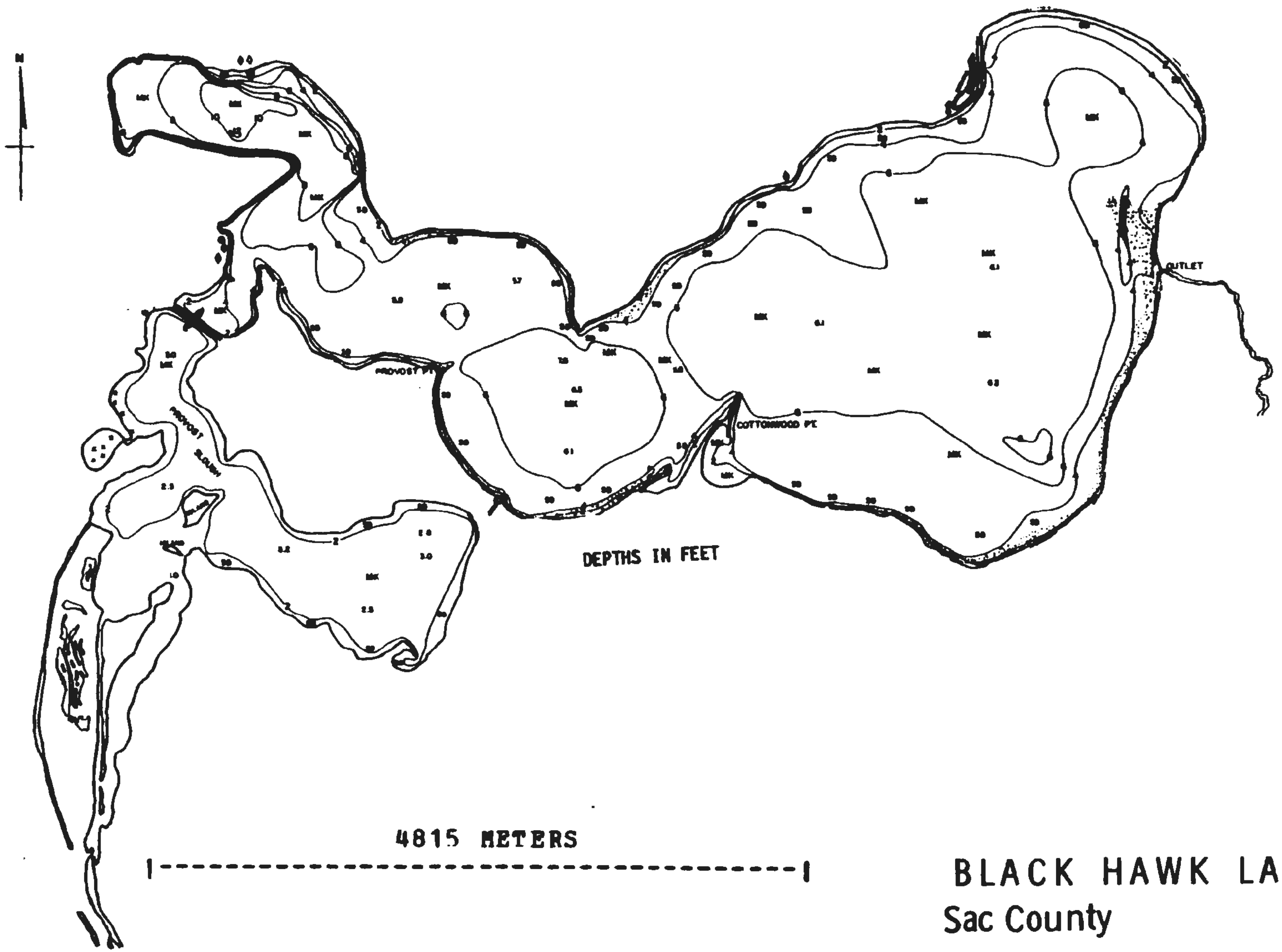
15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

18 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Calcareous soils are common. Clarion, Harps, Canisteo, Webster, and Nicollet soils.

24 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess. Marshall and Monona soils.

26 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess. Marshall soils.

Per cent of shoreline in public ownership 59 %




BLACK HAWK LAKE
Sac County

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1973 map
Area 374. ha ( 925. A)
Length of shoreline 18329. m ( 60134. ft)
Maximum depth 3.7 m ( 12.0 ft)
Mean depth 1.6 m ( 5. ft)
Volume 5821896. cubic meters ( 4718. acre-feet)
Shoreline development 2.67 Volume development 1.28
Watershed/lake area ratio 13.3
Origin of basin: Natural
Estimated annual precipitation 74. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 97. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
Wall Lake Inlet
Outlet: Wall Lake Outlet
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.2 | 0.03 |
| Chlorophyll a mg/cubic meter | 30 | 148.6 | 10.92 |
| Total phosphorus mg/cubic meter | 9 | 236.3 | 16.79 |
| Kjeldahl nitrogen mg/l | 12 | 1.30 | 0.06 |
| Ammonia nitrogen mg/l | 12 | 0.07 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 12 | 0.10 | 0.02 |
| Seston dry weight mg/l | 36 | 39.2 | 2.83 |
| Turbidity JTU | 10 | 30.3 | 3.08 |
| Total hardness mg/l as $CaCO_3$ | 10 | 231.8 | 6.20 |

| | | | |
|---|---|---|---|
| Calcium hardness mg/l as CaCO3 | 10 | 124.8 | 3.97 |
| Total alkalinity mg/l as CaCO3 | 10 | 173.8 | 5.03 |
| Dissolved oxygen mg/l | 9 | 5.8 | 0.35 |
| Specific conductance micromhos/cm at 25 C | 9 | 383.3 | 29.47 |
| Sulfate mg/l | 7 | 47.2 | 4.76 |
| Chloride mg/l | 6 | 21.8 | 0.11 |
| Sodium mg/l | 2 | 11.5 | 0.50 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/16/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 19.6 | 7.0 | 212.4 | 8.3 | 214.1 |
| 1 | 19.6 | 6.9 | 211.4 | 8.3 | 216.3 |
| 2 | 19.6 | 6.9 | 203.8 | 8.3 | 154.4 |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus, perhaps sometimes nitrogen.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 80.
Potential nutrient input index =
area watershed in row crops/lake area = 10.7
33.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
terraces, conservation tillage, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.

This lake is not designated as a public water supply.

Public parks:
Black Hawk State Park
Speaker Park (City)
Cresent Beach Park (City)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 803. | 0.9 | 2.1 |
| Shore or ice fishing | 19092. | 20.6 | 51.0 |
| Swimming | 22150. | 23.9 | 59.2 |
| Pleasure boating | 14434. | 15.6 | 38.6 |
| Hunting | 2279. | 2.5 | 6.1 |
| Picnicking,camping,other activities prompted by the lake's presence | 64862. | 70.1 | 173.4 |
| Snowmobiling | 2865. | 3.1 | 7.7 |
| Ice skating and cross-country skiing | 1475. | 1.6 | 3.9 |
| TOTAL | 127960. | 138.3 | 342.1 |

Special events at Black Hawk Lake contributing to more than normal use include a summer water carnival (35,000 people).

IMPAIRMENTS

Swimming may be impaired in Black Hawk Lake throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential because of a severe fish winterkill in 1974. Fishery renovation using chemicals was undertaken in 1979. Winter aeration was started in 1978.

Estimated aquatic plant coverage 0 %
Artificial aeration used
Estimated winterkill frequencies: 1 year out of 3
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

BLUE LAKE

LOCATION

County: Monona    Latitude 42 Deg 2 Min N
Longitude 96 Deg 10 Min W
Township 83 N    Range 46 W    Section 2

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
643. hectares ( 1590. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 21 | 581. | 90.3 |
| 22 | 63. | 9.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 89.3 | 4.7 | 2.2 | 0.0 | 3.7 |

Description of topography and soils in soil associations represented in the watershed

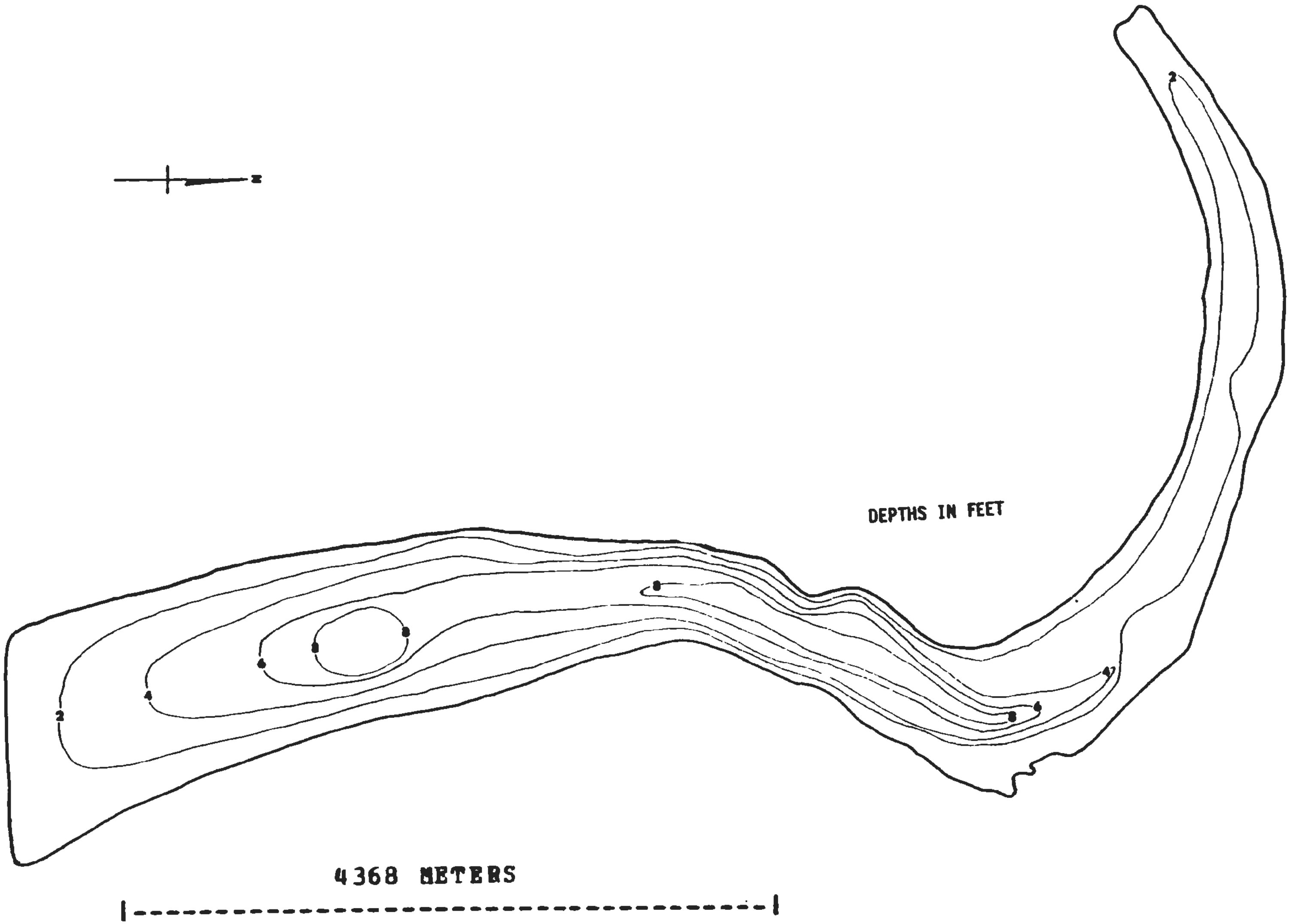
21 Nearly level (0-2%) soils developed from alluvium. Albaton, Haynie, and Onawa soils.

22 Level and nearly level (0-2%) soils developed from alluvium. Luton, Blencoe, Keg, and Salix soils.

Per cent of shoreline in public ownership 16 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1977 map
Area 109. ha ( 269. A)
Length of shoreline 8832. m ( 28977. ft)
Maximum depth 2.4 m ( 8.0 ft)
Mean depth 1.0 m ( 3. ft)
Volume 1105680. cubic meters ( 896. acre-feet)
Shoreline development 2.39    Volume development 1.25
Watershed/lake area ratio 5.9
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 102. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: None
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




BLUE LAKE
Monona County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 3 | 2.0 | 0.29 |
| Chlorophyll a<br>mg/cubic meter | 26 | 4.7 | 1.07 |
| Total phosphorus<br>mg/cubic meter | 5 | 38.3 | 1.40 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.88 | 0.04 |
| Ammonia nitrogen<br>mg/l | 2 | 0.23 | 0.04 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.07 | 0.01 |
| Seston dry weight<br>mg/l | 14 | 2.9 | 0.32 |
| Turbidity<br>JTU | 8 | 5.5 | 2.53 |
| Total hardness<br>mg/l as $CaCO_3$ | 8 | 266.5 | 9.68 |
| Calcium hardness<br>mg/l as $CaCO_3$ | 8 | 101.2 | 11.16 |
| Total alkalinity<br>mg/l as $CaCO_3$ | 8 | 242.5 | 12.60 |
| Dissolved oxygen<br>mg/l | 8 | 7.3 | 0.56 |
| Specific conductance<br>micromhos/cm at 25 C | 8 | 568.8 | 12.17 |
| Sulfate<br>mg/l | 3 | 99.2 | 1.59 |
| Chloride<br>mg/l | 3 | 4.5 | 0.00 |
| Sodium<br>mg/l | 1 | 46.0 | |
| Potassium<br>mg/l | 1 | 11.0 | |

Vertical profile for selected measurements on the sampling date ( 8/28/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.8 | 8.1 | 40.8 | 8.3 | 28.1 |
| 1 | 22.6 | 8.8 | 40.1 | 8.2 | 15.3 |
| 2 | 21.0 | 4.2 | 43.2 | 7.8 | 3.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 9.
Potential nutrient input index =
area watershed in row crops/lake area = 5.3
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, conservation planting (trees,grass), crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Lewis and Clark State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 17414. | 64.7 | 159.8 |
| Shore or ice fishing | 16370. | 60.9 | 150.2 |
| Swimming | 36618. | 136.1 | 335.9 |
| Pleasure boating | 41565. | 154.5 | 381.3 |
| Hunting | 14102. | 52.4 | 129.4 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 274806. | 1021.6 | 2521.2 |
| Snowmobiling | 1215. | 4.5 | 11.1 |
| Ice skating and cross-country skiing | 5642. | 21.0 | 51.8 |
| TOTAL | 407732. | 1515.7 | 3740.7 |

Special events at Blue Lake contributing to more than normal use include July 4th fireworks (5,000 people).

## IMPAIRMENTS

Aquatic vascular plant growth in Blue Lake has restricted boating, swimming, and fishing activities. Frequent winterkills and occasional summerkills have further impacted fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 82 %
Estimated winterkill frequencies: 1 year out of 5
Estimated summerkill frequencies: 1 year out of 10

## LAKE RESTORATION RECOMMENDATIONS

Blue Lake is characterized by shallow depths, fluctuating water levels, a large population of aquatic plants, and frequent winterkills. Blue Lake is currently undergoing a restoration program which includes dredging, addition of supplemental ground water, and stocking of White Amur. Blue Lake's watershed is also being enlarged to provide the lake with additional surface runoff.

BOB WHITE LAKE

LOCATION

County: Wayne | Latitude 40 Deg 43 Min N | Longitude 93 Deg 24 Min W

Township 68 N | Range 22 W | Section 4

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
1375. hectares ( 3398. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 39 | 611. | 44.5 |
| 40 | 764. | 55.5 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 72.2 | 22.9 | 2.0 | 0.0 | 2.9 |

Description of topography and soils in soil associations represented in the watershed

39 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess. Edina and Seymour soils.

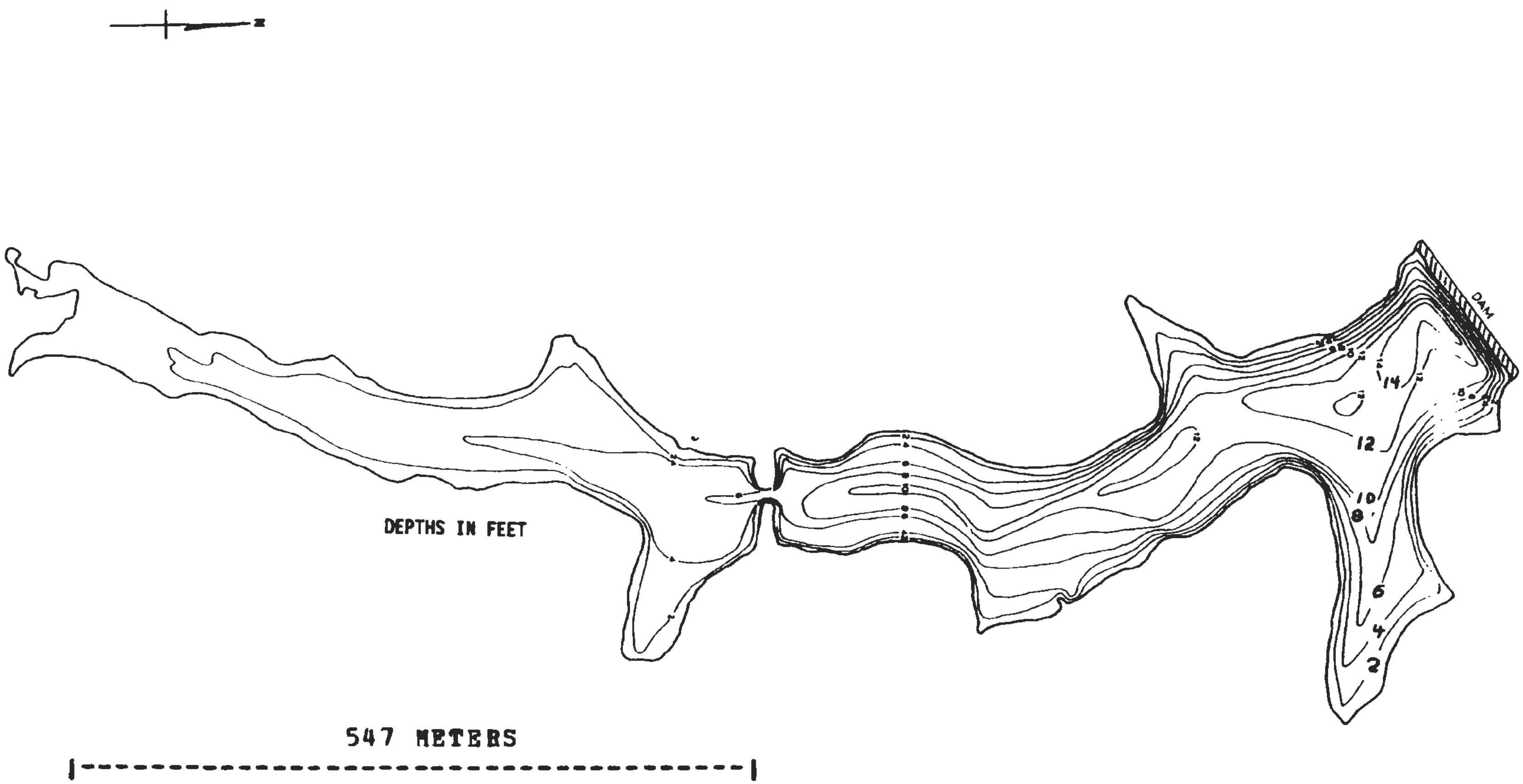
40 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Seymour, Edina, Clarinda, Adair, and Shelby soils.

Per cent of shoreline in public ownership 71 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1977 map .
Area 36. ha ( 89. A)
Length of shoreline 6300. m ( 20670. ft)
Maximum depth 4.3 m ( 14.0 ft)
Mean depth 1.5 m ( 5. ft)
Volume 548053. cubic meters ( 444. acre-feet)
Shoreline development 2.97 Volume development 1.07
Watershed/lake area ratio 38.2
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
S Fork Chariton R
Outlet: S Fork Chariton R
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

148




BOB WHITE LAKE
Wayne County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.2 | 0.03 |
| Chlorophyll a mg/cubic meter | 9 | 12.7 | 1.42 |
| Total phosphorus mg/cubic meter | 7 | 166.7 | 37.54 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.13 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.4 | 0.02 |
| Seston dry weight mg/l | 9 | 44.2 | 12.55 |
| Turbidity JTU | 7 | 48.7 | 13.03 |
| Total hardness mg/l as CaCO3 | 8 | 94.3 | 2.55 |
| Calcium hardness mg/l as CaCO3 | 8 | 69.2 | 1.85 |
| Total alkalinity mg/l as CaCO3 | 8 | 69.0 | 2.51 |
| Dissolved oxygen mg/l | 8 | 6.7 | 0.77 |
| Specific conductance micromhos/cm at 25 C | 8 | 208.1 | 2.98 |
| Sulfate mg/l | 3 | 23.5 | 0.50 |
| Chloride mg/l | 4 | 8.2 | 0.14 |
| Sodium mg/l | 2 | 7.0 | 0.00 |
| Potassium mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/21/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.8 | 7.2 | 179.1 | 7.9 | 12.0 |
| 1 | 26.8 | | | | |
| 2 | 26.6 | 6.8 | 194.9 | 7.9 | 16.5 |
| 3 | 22.2 | 2.3 | 298.1 | 7.4 | 6.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 435.
Potential nutrient input index =
area watershed in row crops/lake area = 27.6
55.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, contouring, conservation tillage, crop rotation, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 700 persons at Allerton.

Public parks:
Bob White State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 435. | 4.9 | 12.1 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 5383. | 60.5 | 149.5 |
| Swimming | 7698. | 86.5 | 213.8 |
| Pleasure boating | 91. | 1.0 | 2.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 2170. | 24.4 | 60.3 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 122. | 1.4 | 3.4 |
| TOTAL | 15899. | 178.6 | 441.6 |

IMPAIRMENTS

Swimming may be impaired in Bob White Lake throughout the summer due to high concentrations of suspended matter. Iowa Conservation Commission personnel consider lake usage to be below its potential because of siltation problems and poor fishing.

Estimated aquatic plant coverage 2 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will

help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

BRIGGS WOODS LAKE

LOCATION
County: Hamilton    Latitude 42 Deg 26 Min N
    Longitude 93 Deg 48 Min W
Township 88 N    Range 25 W    Section 17

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
1054. hectares ( 2606. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 892. | 84.6 |
| 217 | 162. | 15.4 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 84.7 | 7.7 | 4.4 | 0.0 | 3.2 |

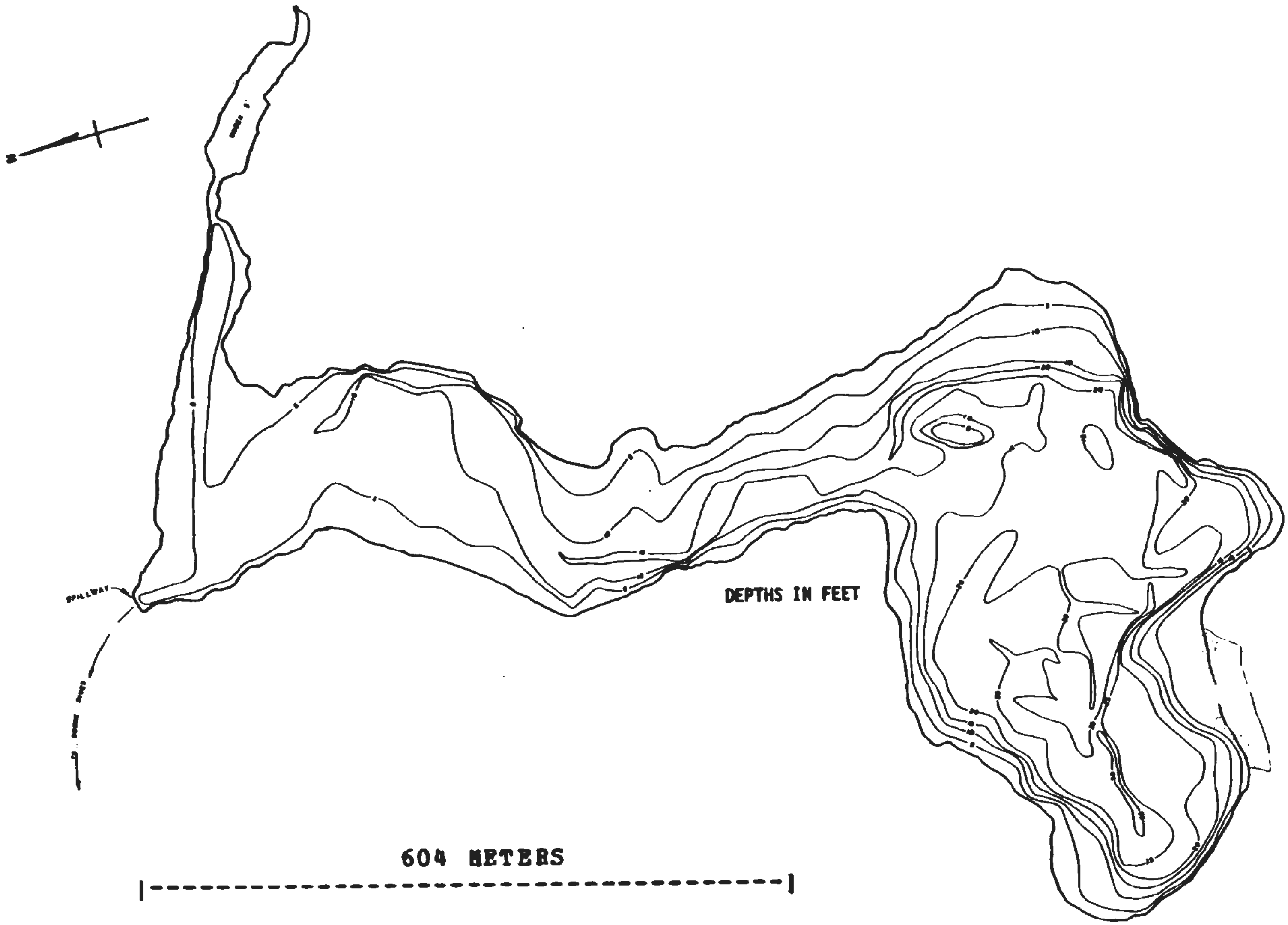
Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

217 Nearly level to very steep (0-40%) forest and mixed prairie-forest-derived soils developed from Wisconsin till on the Cary Lobe. Includes some soils on bottomlands and terraces. Hayden and Lester soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 24. ha ( 59. A)
Length of shoreline 3810. m ( 12499. ft)
Maximum depth 9.1 m ( 30.0 ft)
Mean depth 3.6 m ( 12. ft)
Volume 865638. cubic meters ( 701. acre-feet)
Shoreline development 2.19    Volume development 1.18
Watershed/lake area ratio 43.9
Origin of basin: Impoundment
Estimated annual precipitation 76. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




BRIGGS WOODS LAKE
Hamilton County

15.4

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 2.8 | 0.66 |
| Chlorophyll a mg/cubic meter | 9 | 32.0 | 10.27 |
| Total phosphorus mg/cubic meter | 9 | 39.6 | 13.37 |
| Kjeldahl nitrogen mg/l | 2 | 1.8 | 0.84 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 4.7 | 0.25 |
| Seston dry weight mg/l | 9 | 3.5 | 1.27 |
| Turbidity JTU | 9 | 1.9 | 0.52 |
| Total hardness mg/l as CaCO3 | 10 | 298.2 | 7.69 |
| Calcium hardness mg/l as CaCO3 | 10 | 175.4 | 5.14 |
| Total alkalinity mg/l as CaCO3 | 9 | 213.1 | 4.68 |
| Dissolved oxygen mg/l | 12 | 9.5 | 0.44 |
| Specific conductance micromhos/cm at 25 C | 9 | 532.8 | 16.40 |
| Sulfate mg/l | 4 | 34.7 | 2.95 |
| Chloride mg/l | 5 | 22.6 | 1.40 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.5 | 8.8 | 17.1 | 8.4 | 60.8 |
| 1 | 22.6 | 8.9 | 15.7 | 8.4 | 5.1 |
| 2 | 22.6 | 8.7 | 18.5 | 8.5 | 70.2 |
| 3 | 21.4 | | | | |
| 4 | 20.5 | 4.6 | 149.6 | 7.7 | 4.1 |
| 5 | 19.9 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 66.
Potential nutrient input index =
  area watershed in row crops/lake area = 37.2
95.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
terraces, crop rotation, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  Briggs Woods

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 7034. | 119.2 | 293.1 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 15242. | 258.3 | 635.1 |
| Swimming | 16827. | 285.2 | 701.1 |
| Pleasure boating | 3212. | 54.4 | 133.8 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 39030. | 661.5 | 1626.3 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 1128. | 19.1 | 47.0 |
| TOTAL | 82473. | 1397.8 | 3436.4 |

Special events at Briggs Woods Lake contributing to more than normal use include a Boy Scout camparee (400 people).

IMPAIRMENTS

Swimming may be impaired in Briggs Woods Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 25 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

No specific restoration efforts are recommended for Briggs Woods Lake. The high water quality of this lake is indicated by the four meter Secchi disc transparency observed in June sampling, the highest for any lake throughout the survey. However, late summer blooms of blue-green algae may still occur. Briggs Woods Lake is fed primarily by tile outflows that are low in suspended matter and attached phosphorus. Another potential inflowing stream, with lower water quality due to surface runoff of sediments and nutrients, has been diverted away from the lake. Limiting lake inflows to tile runoff, and diverting streams of lower water quality, should be considered in the restoration program for other lakes in Iowa.

BROWNS LAKE

LOCATION

County: Woodbury  Latitude 42 Deg 19 Min N  Longitude 96 Deg 19 Min W

Township 87 N  Range 47 W  Section 33

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
421. hectares ( 1040. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 22 | 37. | 8.7 |
| 21 | 365. | 86.7 |
| 1 | 19. | 4.6 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 88.7 | 4.9 | 2.6 | 0.0 | 3.8 |

Description of topography and soils in soil associations represented in the watershed

22 Level and nearly level (0-2%) soils developed from alluvium. Luton, Blencoe, Keg, and Salix soils.

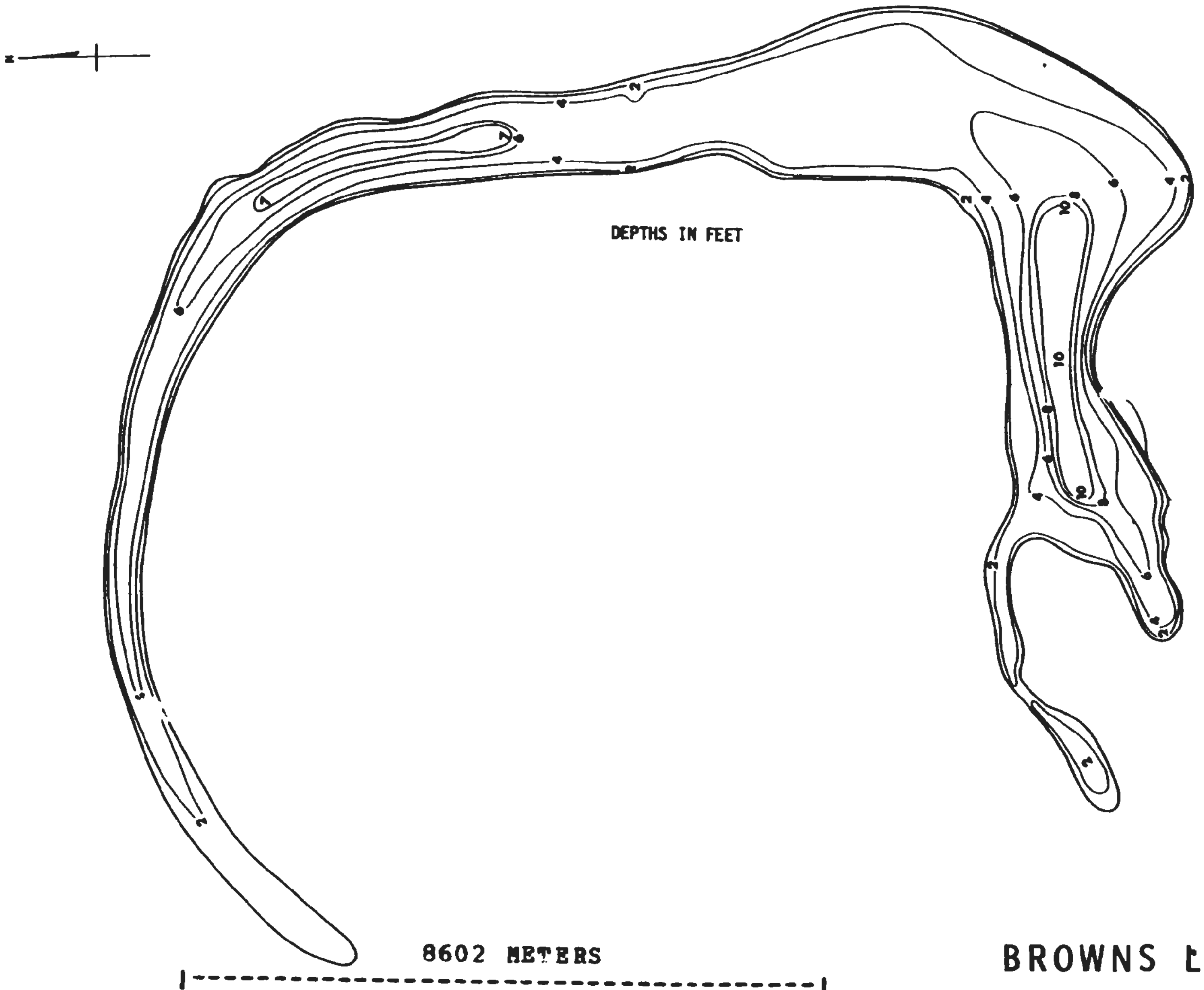
21 Nearly level (0-2%) soils developed from alluvium. Albaton, Haynie, and Onawa soils.

1 Nearly level and gently sloping (0-5%) soils developed from alluvium. Fluvents and Sarpy soils.

Per cent of shoreline in public ownership 60 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 89. ha ( 219. A)
Length of shoreline 9953. m ( 32654. ft)
Maximum depth 3.0 m ( 10.0 ft)
Mean depth 1.4 m ( 5. ft)
Volume 1280627. cubic meters ( 1038. acre-feet)
Shoreline development 2.98  Volume development 1.42
Watershed/lake area ratio 4.7
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 97. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




# BROWNS LAKE
Woodbury County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 3 | 0.9 | 0.09 |
| Chlorophyll a mg/cubic meter | 20 | 2.4 | 0.38 |
| Total phosphorus mg/cubic meter | 6 | 43.1 | 2.77 |
| Kjeldahl nitrogen mg/l | 2 | 0.63 | 0.20 |
| Ammonia nitrogen mg/l | 2 | 0.13 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.09 | 0.05 |
| Seston dry weight mg/l | 9 | 11.2 | 1.58 |
| Turbidity JTU | 9 | 9.0 | 0.65 |
| Total hardness mg/l as CaCO3 | 9 | 152.7 | 2.14 |
| Calcium hardness mg/l as CaCO3 | 9 | 36.7 | 2.45 |
| Total alkalinity mg/l as CaCO3 | 9 | 190.7 | 4.42 |
| Dissolved oxygen mg/l | 9 | 7.5 | 0.15 |
| Specific conductance micromhos/cm at 25 C | 9 | 372.2 | 5.72 |
| Sulfate mg/l | 3 | 28.0 | 1.26 |
| Chloride mg/l | 3 | 10.2 | 0.17 |
| Sodium mg/l | 2 | 40.5 | 1.50 |
| Potassium mg/l | 2 | 10.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/28/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.5 | 8.0 | 31.8 | 9.2 | 7.1 |
| 1 | 23.4 | 7.8 | 39.7 | 9.2 | 6.0 |
| 2 | 22.8 | 7.9 | 42.8 | 9.2 | 0.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
        (watershed area/lake area) x soil loss rate = 7.
Potential nutrient input index =
        area watershed in row crops/lake area = 4.2
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
   Class A-primary body contact recreation.
   Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
   Browns Lake-Bigelow Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1068. | 4.9 | 12.0 |
| Shore or ice fishing | 3992. | 18.2 | 44.9 |
| Swimming | 32550. | 148.6 | 365.7 |
| Pleasure boating | 3361. | 15.3 | 37.8 |
| Hunting | 9254. | 42.3 | 104.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 26050. | 118.9 | 292.7 |
| Snowmobiling | 226. | 1.0 | 2.5 |
| Ice skating and cross-country skiing | 382. | 1.7 | 4.3 |
| TOTAL | 76883. | 351.1 | 863.9 |

IMPAIRMENTS

Swimming may be impaired in Browns Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Aquatic plant growth may impair boating and shoreline fishing. Frequent winterkills may also limit fishing potential. Point source pollution from septic systems may occur. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 90 %
Estimated winterkill frequencies: 1 year out of 3
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Brown's Lake is characterized by shallowness, a large population of macrophytes, and frequent winterkills. In an effort to increase the recreational value of Brown's Lake, the water level in the lake is being raised by the addition of heated effluent from a coal fired power station. The addition of this water is projected to increase the lake's maximum depth by .85 meters and its surface area by 135 hectares. Much of the additional surface area will be less than one meter in depth and should support extensive stands of aquatic macrophytes. The stocking of White Amur is recommended for the control of aquatic vegetation. Water quality and biological populations in the lake should be monitored to determine the impact of heated effluent additions.

CARTER LAKE

LOCATION

County: Pottawattamie    Latitude   41 Deg  18 Min N
        Douglas,NE       Longitude  95 Deg  55 Min W

Township  75 N      Range 44 W      Section 16

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
4707. hectares ( 11632. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 6NE | 2092. | 44.4 |
| 5NE | 2615. | 55.6 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 100.0 | 0.0 |

Description of topography and soils in soil associations represented in the watershed

6NE Albaton-Haynie association: Deep, poorly drained to moderately well drained, nearly level clayey and silty soils on bottom land along the Missouri River.

5NE Monona-Ida association: Deep, well-drained, nearly level to very steep silty soils on bluffs adjacent to the Missouri River Valley.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map

Area  128. ha ( 315. A)

Length of shoreline  10771. m ( 35339. ft)

Maximum depth  8.5 m ( 28.0 ft)

Mean depth  2.5 m ( 8. ft)

Volume  3180873. cubic meters ( 2578. acre-feet)

Shoreline development  2.69    Volume development  0.88

Watershed/lake area ratio    36.8

Origin of basin: Natural

Estimated annual precipitation  81. cm

Estimated annual runoff    10. cm

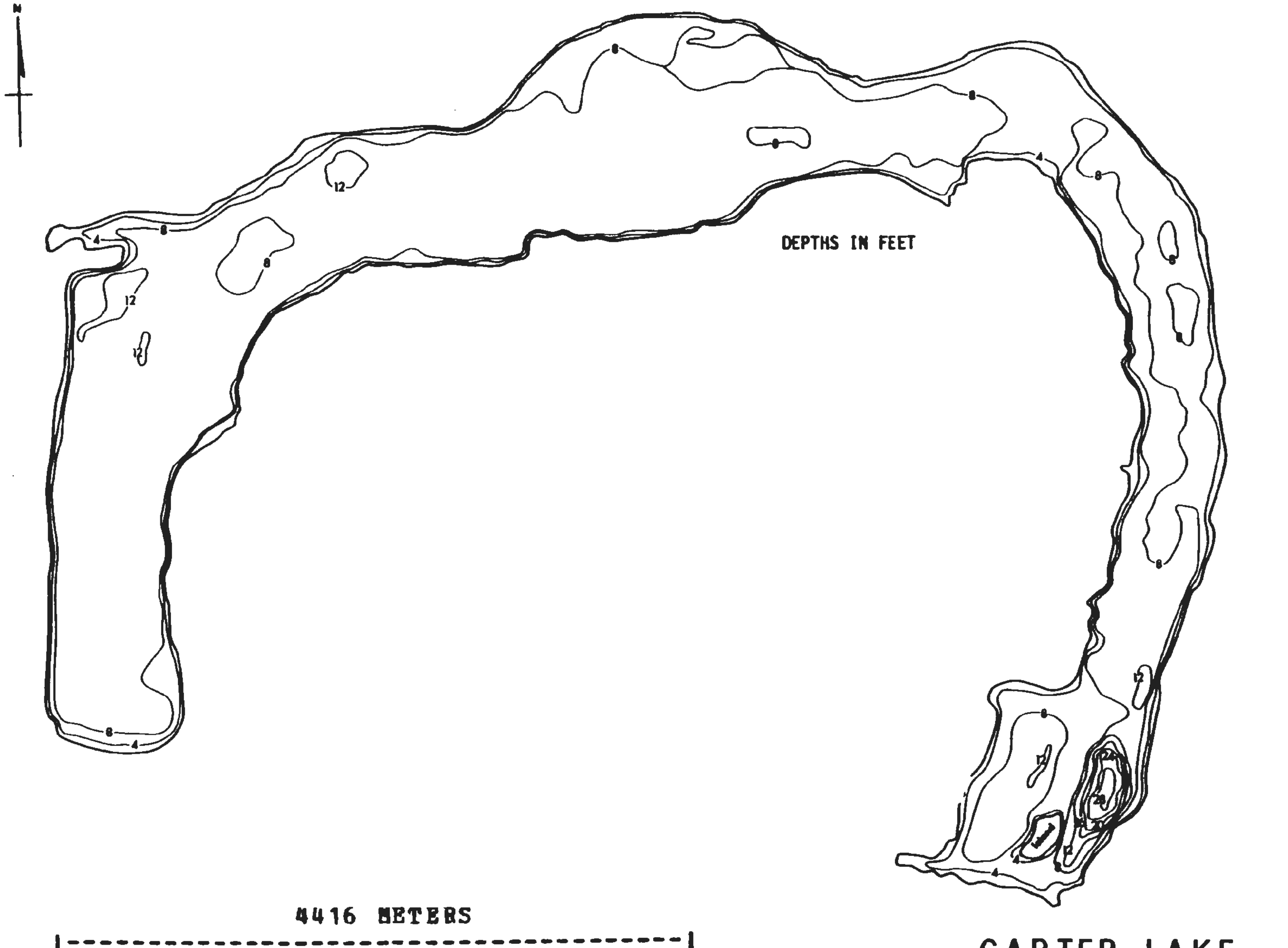
Estimated lake evaporation   102. cm

Thermal stratification? No

Major inflows (named and/or permanent streams)
None

Outlet: None

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




CARTER LAKE
Pottawattamie County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.6 | 0.05 |
| Chlorophyll a mg/cubic meter | 10 | 39.4 | 3.21 |
| Total phosphorus mg/cubic meter | 10 | 86.3 | 6.56 |
| Kjeldahl nitrogen mg/l | 2 | 0.9 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 10 | 11.9 | 1.10 |
| Turbidity JTU | 11 | 9.8 | 0.95 |
| Total hardness mg/l as CaCO3 | 10 | 219.0 | 5.86 |
| Calcium hardness mg/l as CaCO3 | 9 | 107.3 | 4.53 |
| Total alkalinity mg/l as CaCO3 | 11 | 218.4 | 2.57 |
| Dissolved oxygen mg/l | 10 | 7.5 | 0.83 |
| Specific conductance micromhos/cm at 25 C | 9 | 541.1 | 10.37 |
| Sulfate mg/l | 3 | 60.2 | 0.60 |
| Chloride mg/l | 3 | 24.8 | 0.17 |
| Sodium mg/l | 2 | 45.0 | 1.00 |
| Potassium mg/l | 2 | 8.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/27/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.5 | 4.5 | 92.2 | 8.3 | 31.4 |
| 1 | 23.5 | 4.3 | 105.0 | 8.3 | 25.8 |
| 2 | 23.5 | 4.2 | 102.2 | 8.2 | 30.7 |
| 3 | 22.4 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region =      0- 3.0  Tons/Acre/Yr
Potential siltation index =
        (watershed area/lake area) x soil loss rate =   55.
Potential nutrient input index =
        area watershed in row crops/lake area =    0.0
  0.% of watershed is in approved soil conservation practices.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Eppley Airport NE0111848 | Stormwater runoff |
| City of Omaha | Stormwater runoff |

LAKE USE ASSESSMENT

Surface water classification(s)
   Class A-primary body contact recreation.
   Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
   Levi-Carter Park (City of Omaha)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2540. | 8.1 | 19.8 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 11682. | 37.1 | 91.3 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 28994. | 92.0 | 226.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 18347. | 58.2 | 143.3 |
| Snowmobiling | 782. | 2.5 | 6.1 |
| Ice skating and cross-country skiing | 782. | 2.5 | 6.1 |
| TOTAL | 63127. | 200.4 | 493.2 |

IMPAIRMENTS

Swimming may be impaired in Carter Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may interfere with shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 27 %
Estimated winterkill frequencies: 1 year out of 5
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in Carter Lake is degraded by several urban inputs. The Nebraska Department of Environmental Control has prepared a report describing the poor water quality resulting from storm water runoff from the city of Omaha and Eppley Airport (A Report on Carter Lake, Fall 1979). Storm water runoff carries roadway dirt, deicing salt, organic matter, and nutrients to the lake. There has also been a problem with possible illegal discharges to the storm sewer system to the northwest of the lake. In addition, Eppley Airport has contributed minor discharges of aviation fuel and ethylene glycol used in airplane deicing, as well as major inputs, such as a 1977 jet fuel spill introducing approximately 6,500 gallons of fuel to the lake. Eppley Airport has obtained an NPDES permit for its storm water discharges, which are regularly monitored to insure compliance.

It is recommended that storm water runoff from the airport and urban areas be diverted away from Carter Lake and that water be pumped from the Missouri River to maintain water levels. To minimize siltation problems, a desilting basin should be used to help remove particulate materials from the Missouri River water prior to its introduction to the lake.

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

CENTER LAKE

LOCATION
County: Dickinson        Latitude 43 Deg 25 Min N
                         Longitude 95 Deg 8 Min W
Township 99 N      Range 36 W      Section 7

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
302. hectares ( 745. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 302. | 100.0 |

Estimated land uses (%)

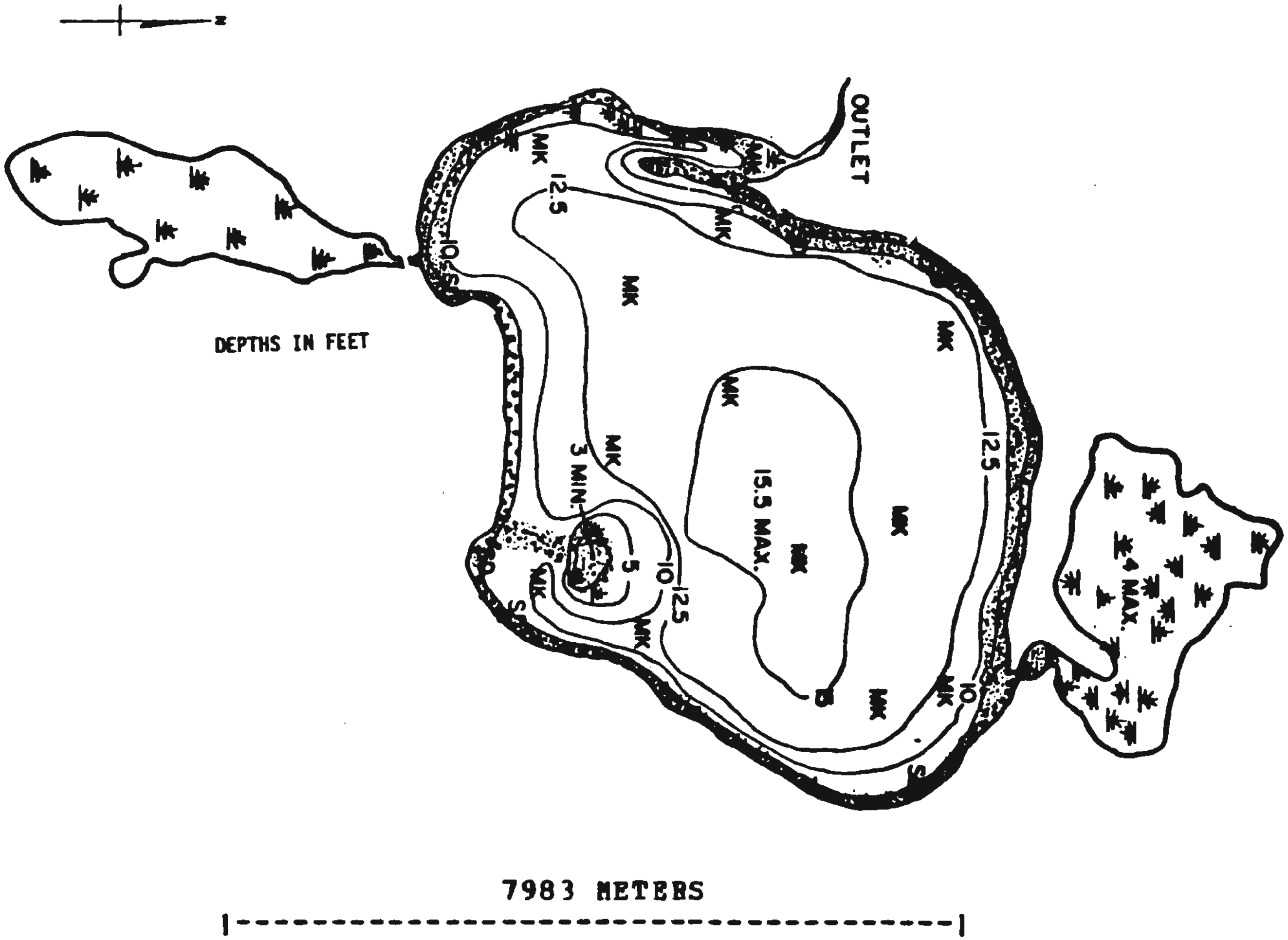
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 90.6 | 5.7 | 0.3 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

Per cent of shoreline in public ownership 16 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1970 map
Area 89. ha ( 220. A)
Length of shoreline 4161. m ( 13651. ft)
Maximum depth 4.6 m ( 15.0 ft)
Mean depth 3.5 m ( 11. ft)
Volume 3105489. cubic meters ( 2517. acre-feet)
Shoreline development 1.24    Volume development 2.28
Watershed/lake area ratio 3.4
Origin of basin: Natural
Estimated annual precipitation 69. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




CENTER LAKE
Dickinson County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.4 | 0.04 |
| Chlorophyll a mg/cubic meter | 6 | 90.3 | 9.18 |
| Total phosphorus mg/cubic meter | 10 | 119.8 | 6.78 |
| Kjeldahl nitrogen mg/l | 2 | 1.7 | 0.06 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 11 | 33.5 | 3.16 |
| Turbidity JTU | 10 | 24.8 | 2.31 |
| Total hardness mg/l as CaCO3 | 11 | 203.3 | 1.18 |
| Calcium hardness mg/l as CaCO3 | 12 | 50.3 | 2.45 |
| Total alkalinity mg/l as CaCO3 | 10 | 178.8 | 12.18 |
| Dissolved oxygen mg/l | 9 | 9.2 | 1.35 |
| Specific conductance micromhos/cm at 25 C | 9 | 406.1 | 8.07 |
| Sulfate mg/l | 3 | 5.3 | 0.60 |
| Chloride mg/l | 3 | 28.3 | 0.17 |
| Sodium mg/l | 2 | 13.5 | 0.50 |
| Potassium mg/l | 2 | 15.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/13/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.4 | 6.5 | 109.8 | 9.2 | 101.0 |
| 1 | 22.4 | 6.4 | 106.6 | 9.1 | 116.0 |
| 2 | 22.4 | | | | |
| 3 | 22.4 | 6.4 | 109.4 | 9.1 | 112.3 |
| 4 | 22.4 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 14.
Potential nutrient input index =
area watershed in row crops/lake area = 3.1
32.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
State Fish and Wildlife Access

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1659. | 7.5 | 18.6 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 5642. | 25.6 | 63.4 |
| Swimming | 4152. | 18.9 | 46.7 |
| Pleasure boating | 1329. | 6.0 | 14.9 |
| Hunting | 964. | 4.4 | 10.8 |
| Picnicking,camping,other activities prompted by the lake's presence | 1850. | 8.4 | 20.8 |
| Snowmobiling | 1737. | 7.9 | 19.5 |
| Ice skating and cross-country skiing | 1042. | 4.7 | 11.7 |
| TOTAL | 18375. | 83.5 | 206.5 |

Special events at Center Lake contributing to more than normal use include slalom ski contests (75 people).

IMPAIRMENTS

Swimming may be impaired in Center Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential because of stunted bull-head and black crappie populations.

Estimated aquatic plant coverage 2 %
Estimated winterkill frequencies: 1 year out of 7-10
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

CENTRAL LAKE

LOCATION
County: Jones Latitude 42 Deg 7 Min N
Longitude 91 Deg 8 Min W
Township 84 N Range 3 W Section 1

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
148. hectares ( 365. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 82 | 148. | 100.0 |

Estimated land uses (%)

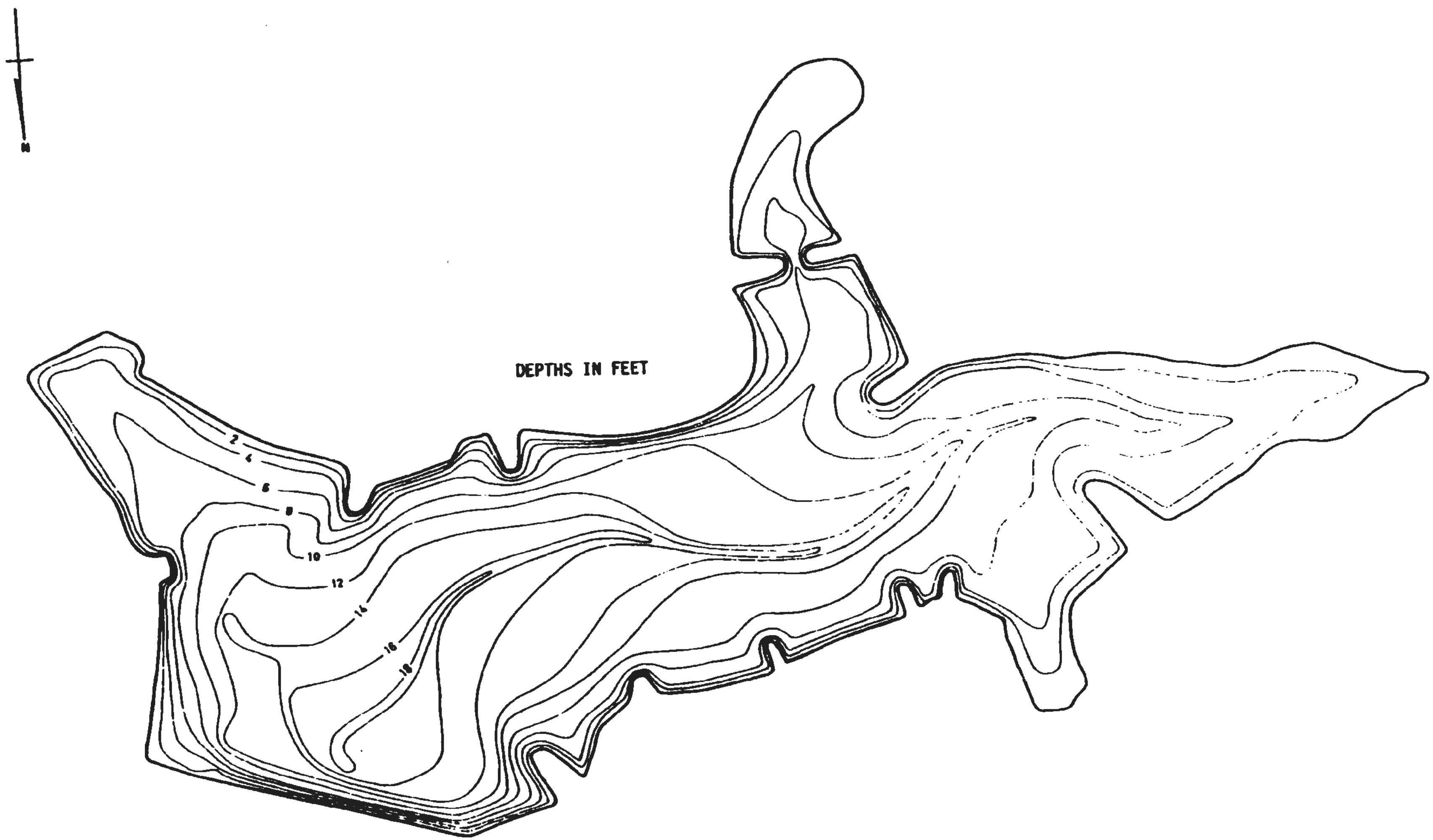
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 77.5 | 17.0 | 1.6 | 0.0 | 3.8 |

Description of topography and soils in soil associations represented in the watershed

82 Gently sloping to moderately steep (2-18%) prairie to forest-derived soils developed from loess or loess over pre-Wisconsin till. Downs, Fayette, Tama, and Dinsdale soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1976 map
Area 10. ha ( 25. A)
Length of shoreline 2524. m ( 8279. ft)
Maximum depth 5.5 m ( 18.0 ft)
Mean depth 2.4 m ( 8. ft)
Volume 242355. cubic meters ( 196. acre-feet)
Shoreline development 2.24 Volume development 1.31
Watershed/lake area ratio 14.8
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 20. cm
Estimated lake evaporation 86. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Unnamed
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




1384 METERS

CENTRAL LAKE
Jones County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.4 | 0.04 |
| Chlorophyll a mg/cubic meter | 5 | 103.4 | 14.42 |
| Total phosphorus mg/cubic meter | 6 | 160.4 | 21.68 |
| Kjeldahl nitrogen mg/l | 2 | 1.3 | 0.10 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.06 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 9 | 17.7 | 2.67 |
| Turbidity JTU | 7 | 15.2 | 2.24 |
| Total hardness mg/l as CaCO3 | 6 | 127.0 | 0.68 |
| Calcium hardness mg/l as CaCO3 | 8 | 57.7 | 2.58 |
| Total alkalinity mg/l as CaCO3 | 7 | 111.7 | 2.37 |
| Dissolved oxygen mg/l | 6 | 8.4 | 0.69 |
| Specific conductance micromhos/cm at 25 C | 6 | 230.0 | 5.63 |
| Sulfate mg/l | 2 | 11.3 | 0.25 |
| Chloride mg/l | 3 | 12.2 | 0.17 |
| Sodium mg/l | 2 | 8.0 | 0.00 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/30/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.6 | 7.1 | 142.2 | 8.7 | 74.1 |
| 1 | 27.6 | 7.0 | 164.4 | 8.7 | 100.7 |
| 2 | 27.2 | | | | |
| 3 | 22.6 | 0.0 | 551.1 | 7.8 | 22.5 |
| 4 | 20.3 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 13.20-14.30 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 203.
Potential nutrient input index =
area watershed in row crops/lake area = 11.5
50.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, contouring, strip-cropping.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Central Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2260. | 90.4 | 226.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 14313. | 572.5 | 1431.3 |
| Swimming | 11725. | 469.0 | 1172.5 |
| Pleasure boating | 1347. | 53.9 | 134.7 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking, camping, other activities prompted by the lake's presence | 35359. | 1414.4 | 3535.9 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 65004. | 2600.2 | 6500.4 |

Special events at Central Lake contributing to more than normal use include the I.W.L.A.-I.C.C. Fisheree (500 people).

## IMPAIRMENTS

Swimming may be impaired in Central Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be above its potential.

Estimated aquatic plant coverage 8 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

## LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

CHATFIELD LAKE

LOCATION

County: Lee — Latitude 40 Deg 26 Min N; Longitude 91 Deg 27 Min W

Township 65 N — Range 5 W — Section 9

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
55. hectares ( 136. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 38 | 55. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 32.9 | 34.5 | 26.9 | 4.1 | 1.7 |

Description of topography and soils in soil associations represented in the watershed

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1977 map

Area 1. ha ( 3. A)

Length of shoreline 1774. m ( 5821. ft)

Maximum depth 5.5 m ( 18.0 ft)

Mean depth 2.6 m ( 8. ft)

Volume 110405. cubic meters ( 89. acre-feet)

Shoreline development 2.41 Volume development 1.39

Watershed/lake area ratio 55.0

Origin of basin: Impoundment

Estimated annual precipitation 89. cm

Estimated annual runoff 18. cm

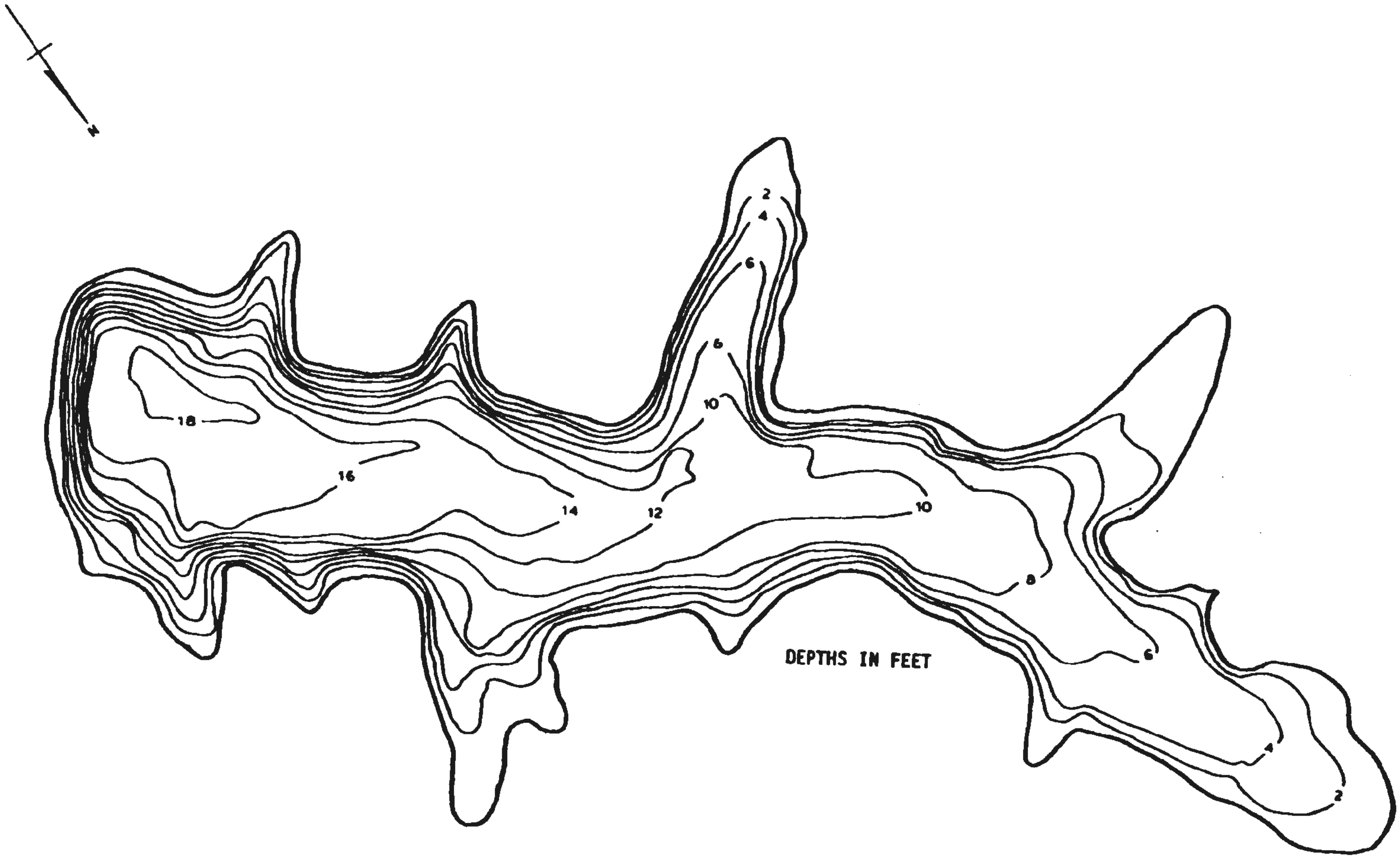
Estimated lake evaporation 89. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)
None

Outlet: Unnamed

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




760 METERS

CHATFIELD LAKE

Lee County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.11 |
| Chlorophyll a mg/cubic meter | 7 | 22.0 | 6.35 |
| Total phosphorus mg/cubic meter | 8 | 50.8 | 3.23 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.13 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.16 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 7 | 13.8 | 1.83 |
| Turbidity JTU | 8 | 11.6 | 1.36 |
| Total hardness mg/l as CaCO3 | 8 | 92.0 | 0.54 |
| Calcium hardness mg/l as CaCO3 | 7 | 72.3 | 1.41 |
| Total alkalinity mg/l as CaCO3 | 7 | 88.6 | 1.13 |
| Dissolved oxygen mg/l | 7 | 6.7 | 0.98 |
| Specific conductance micromhos/cm at 25 C | 8 | 261.9 | 12.46 |
| Sulfate mg/l | 3 | 15.3 | 1.17 |
| Chloride mg/l | 4 | 14.4 | 0.47 |
| Sodium mg/l | 2 | 18.5 | 0.50 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/ 6/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.1 | 8.3 | 57.7 | 8.5 | 46.2 |
| 1 | 25.6 | 8.4 | 62.0 | 8.5 | 44.4 |
| 2 | 24.4 | 1.4 | 58.0 | 7.9 | 14.6 |
| 3 | 20.0 | | | | |
| 4 | 15.6 | 0.0 | 457.2 | 7.3 | 29.9 |
| 5 | 12.2 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 157.
Potential nutrient input index =
area watershed in row crops/lake area = 4.5
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
crop rotation.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Village of Mooar | Septic tank inflows |

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Chatfield Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 890. | 296.7 | 890.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 1682. | 560.7 | 1682.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 298. | 99.3 | 298.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 6794. | 2264.7 | 6794.0 |
| Snowmobiling | 608. | 202.7 | 608.0 |
| Ice skating and cross-country skiing | 608. | 202.7 | 608.0 |
| TOTAL | 10880. | 3626.7 | 10880.0 |

IMPAIRMENTS

Swimming may be impaired in Chatfield Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Overflow from an outdated sewer system in Mooar may affect water quality. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: 1 year out of 5
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in Chatfield Lake may be impaired by septic tank outflows from the village of Mooar. An examination of the septic system's efficiency and the extent of sewage inputs to the lake, if any, has not been made. We recommend that appropriate measures be taken to identify and correct, if necessary, any point sources of pollution to the lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices

recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

CLEAR LAKE

LOCATION

County: Cerro Gordo — Latitude 43 Deg 8 Min N; Longitude 93 Deg 25 Min W

Township 96 N — Range 22 W — Section 14

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
3548. hectares ( 8767. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 1621. | 45.7 |
| 15 | 1531. | 43.1 |
| 12 | 382. | 10.8 |
| 11 | 14. | 0.4 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 76.9 | 7.8 | 0.8 | 11.2 | 3.3 |

Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

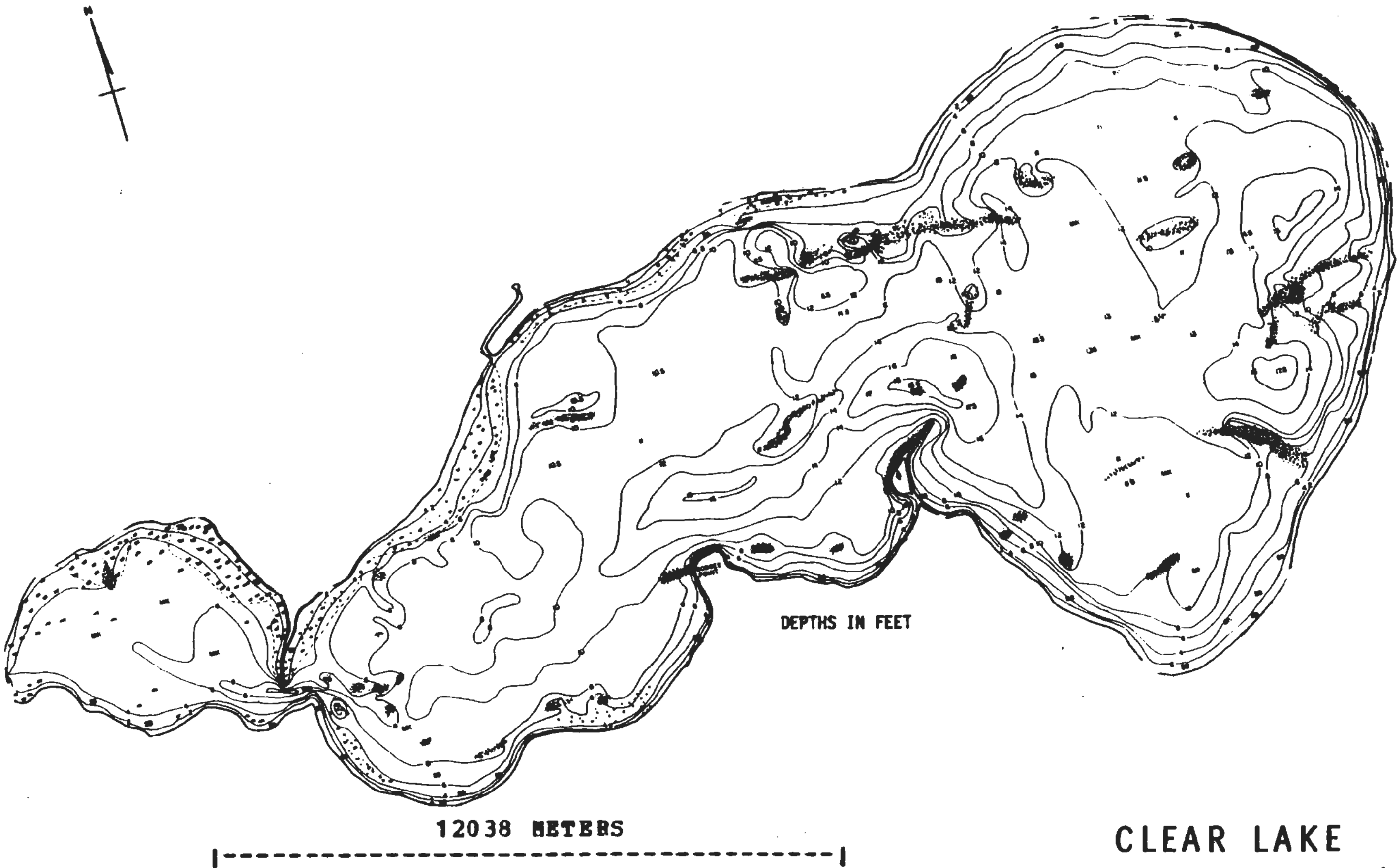
12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

11 Nearly level and gently sloping (0-5%) prairie-derived upland and terrace soils developed from alluvium. Wadena, Talcot, Flagler, and Saude soils.

Per cent of shoreline in public ownership 10 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1971 map
Area 1491. ha (3684. A)
Length of shoreline 21931. m ( 71954. ft)
Maximum depth 5.8 m ( 19.0 ft)
Mean depth 2.9 m ( 10. ft)
Volume 42955560. cubic meters ( 34810. acre-feet)
Shoreline development 1.60 Volume development 1.49
Watershed/lake area ratio 2.4




CLEAR LAKE
Cerro Gordo County

Origin of basin: Natural
Estimated annual precipitation 79. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 86. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
From Ventura Marsh
Outlet: Clear Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.7 | 0.07 |
| Chlorophyll a mg/cubic meter | 9 | 143.4 | 38.65 |
| Total phosphorus mg/cubic meter | 8 | 110.5 | 22.29 |
| Kjeldahl nitrogen mg/l | 2 | 1.3 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 9 | 25.4 | 4.61 |
| Turbidity JTU | 9 | 18.9 | 3.05 |
| Total hardness mg/l as CaCO3 | 8 | 149.0 | 1.07 |
| Calcium hardness mg/l as CaCO3 | 8 | 75.7 | 2.81 |
| Total alkalinity mg/l as CaCO3 | 9 | 129.1 | 0.49 |
| Dissolved oxygen mg/l | 7 | 12.3 | 1.77 |
| Specific conductance micromhos/cm at 25 C | 8 | 284.4 | 7.53 |
| Sulfate mg/l | 7 | 3.4 | 0.78 |
| Chloride mg/l | 8 | 17.7 | 0.42 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.2 | 9.6 | 90.5 | 9.0 | 55.8 |
| 1 | 22.2 | 9.5 | 89.4 | 9.1 | 65.5 |
| 2 | 22.2 | 2.4 | 82.9 | 9.1 | 69.2 |
| 3 | 22.2 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus, perhaps sometimes nitrogen.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region =   4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate =   14.
Potential nutrient input index =
  area watershed in row crops/lake area =   1.8
 75.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, contouring, terraces, grass waterways, tile drainage, fencing and animal exclusion, ponds/sediment and water control basins, gulley control structures/ erosion control structures, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
  Class C-raw water source for a potable water supply.
This lake is used as a raw water source for
  about 6900 persons at Clear Lake.

Public parks:
  Clear Lake City Park
  Clear Lake State Park
  McIntosh State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 41683. | 11.3 | 28.0 |
| Shore or ice fishing | 81192. | 22.0 | 54.5 |
| Swimming | 180363. | 49.0 | 121.0 |
| Pleasure boating | 107250. | 29.1 | 71.9 |
| Hunting | 16288. | 4.4 | 10.9 |
| Picnicking, camping, other activities prompted by the lake's presence | 522852. | 141.9 | 350.7 |
| Snowmobiling | 33850. | 9.2 | 22.7 |
| Ice skating and cross-country skiing | 4775. | 1.3 | 3.2 |
| TOTAL | 988253. | 268.3 | 662.8 |

IMPAIRMENTS

Swimming may be impaired in Clear Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Fluctuating water levels are also a problem. In 1978 the first extensive winterkill in recorded history occurred. Iowa Conservation Commission personnel consider lake usage to be at its potential although there are occasional conflicts between various recreational activities.

Estimated aquatic plant coverage 10 %
Estimated winterkill frequencies: 1 year out of 100
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Clear Lake serves as a municipal water supply for 6900 persons in the city of Clear Lake. The water quality is generally good, due in part to the low ratio of watershed area to lake surface area. During drought periods, however, the lake is subject to significant water level lowering and loss of storage capacity. This has caused a number of water quality problems including taste and odors in the water supply and a fishkill in the winter of 1978-79. Steps should be taken to maintain the water levels in the lake. This might include reducing the amount of water withdrawn by the city of Clear Lake and/or the recycling of water from the waste treatment plant following advanced waste treatment to remove nutrients and any harmful materials. Careful study will be needed, however, before the latter is adopted.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

COLD SPRINGS

LOCATION
County: Cass  Latitude 41 Deg 18 Min N
Longitude 95 Deg 5 Min W
Township 75 N  Range 37 W  Section 15

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
4. hectares ( 10. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 25 | 4. | 100.0 |

Estimated land uses (%)

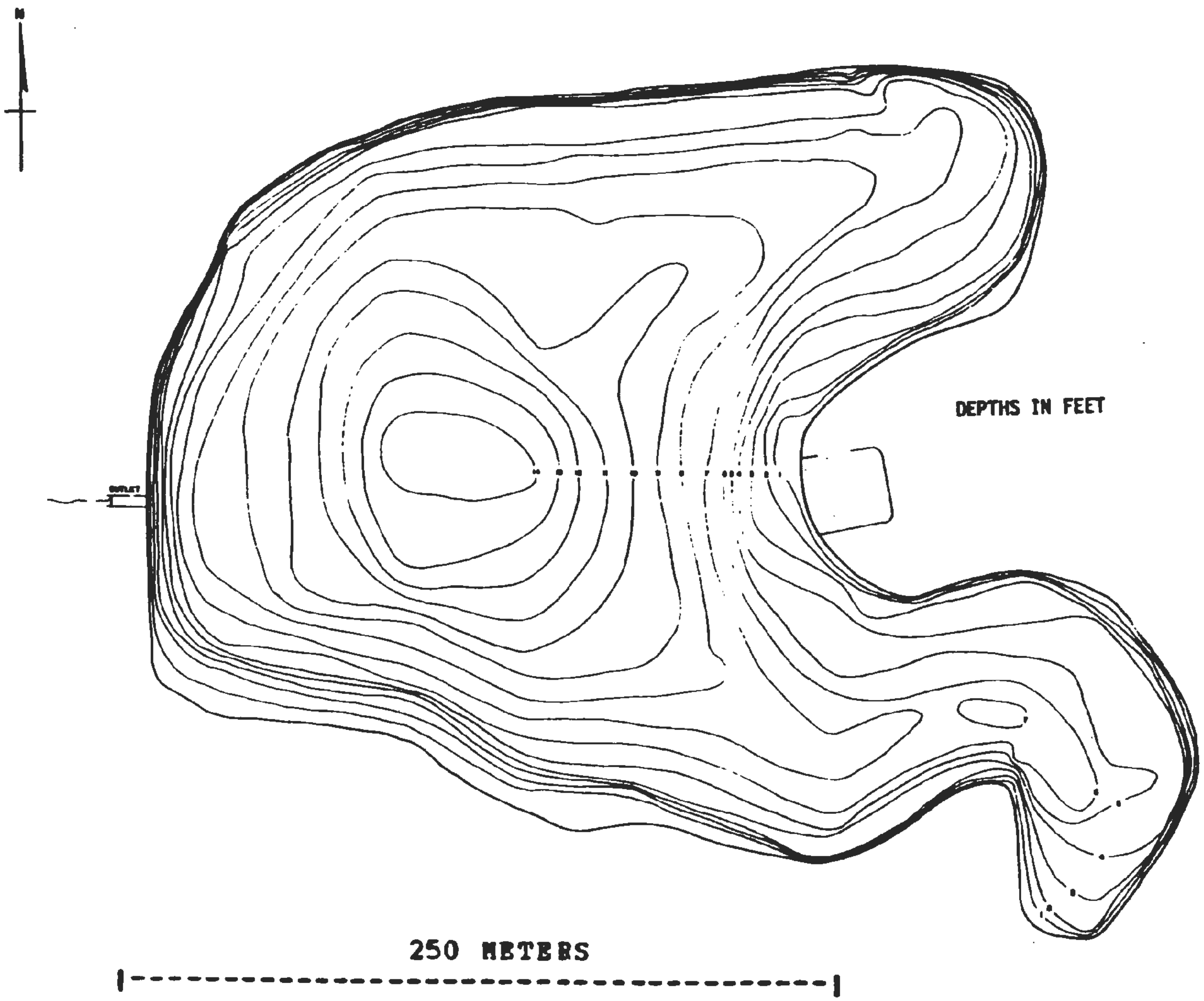
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 0.0 | 0.0 | 100.0 | 0.0 | 0.0 |

Description of topography and soils in soil associations represented in the watershed

25 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from loess, outcrops of pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Marhsall, Shelby, and Adair soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1970 map
Area 6. ha ( 16. A)
Length of shoreline 1218. m ( 3996. ft)
Maximum depth 4.3 m ( 14.0 ft)
Mean depth 2.1 m ( 7. ft)
Volume 138492. cubic meters ( 112. acre-feet)
Shoreline development 1.35  Volume development 1.50
Watershed/lake area ratio 0.7
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 99. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




COLD SPRINGS
Cass County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.9 | 0.19 |
| Chlorophyll a mg/cubic meter | 9 | 66.7 | 15.30 |
| Tctal phosphorus mg/cubic meter | 9 | 64.6 | 4.82 |
| Kjeldahl nitrogen mg/l | 2 | 0.17 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.24 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 1.25 | 0.00 |
| Seston dry weight mg/l | 9 | 11.6 | 2.20 |
| Turbidity JTU | 11 | 11.6 | 2.00 |
| Tctal hardness mg/l as CaCO3 | 8 | 100.7 | 5.45 |
| Calcium hardness mg/l as CaCO3 | 8 | 53.7 | 5.16 |
| Tctal alkalinity mg/l as CaCC3 | 9 | 104.4 | 5.12 |
| Dissolved oxygen mg/l | 8 | 9.0 | 1.12 |
| Specitic conductance micrcmhos/cm at 25 C | 9 | 212.2 | 13.41 |
| Sulfate mg/l | 1 | 6.0 | 0.00 |
| Chloride mg/l | 3 | 3.5 | 0.00 |
| Scdium mg/l | 2 | 6.0 | 0.00 |
| Pctassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 9/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 31.7 | 13.5 | 83.6 | 9.2 | 153.4 |
| 1 | 29.1 | | | | |
| 2 | 27.1 | 2.1 | 70.0 | 8.9 | 134.7 |
| 3 | 23.8 | | | | |
| 4 | 20.4 | 0.0 | 240.7 | 7.5 | 12.0 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 8.
Potential nutrient input index =
area watershed in row crops/lake area = 0.0
50.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, contouring, ponds/sediment and water control basins, pastureland and pastureland improvement, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Cold Springs State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1708. | 106.8 | 284.7 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 4537. | 283.6 | 756.2 |
| Swimming | 7163. | 447.7 | 1193.8 |
| Pleasure boating | 178. | 11.1 | 29.7 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 19952. | 1247.0 | 3325.3 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 122. | 7.6 | 20.3 |
| TOTAL | 33660. | 2103.8 | 5610.0 |

IMPAIRMENTS

Swimming may be impaired in Cold Springs throughout the summer because of Secchi depths less than one meter caused by algal populations. Occasional winterkills may limit fishing potential. White Amur were stocked in the lake to control aquatic weed growth. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: 1 year out of 15
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

This lake's water quality is not significantly impaired. Cold Springs Lake is spring fed and has a small watershed/surface area ratio. The lake receives little surface runoff. Consequently, sediment and nutrient inputs are relative small. White Amur have been stocked in the lake to control aquatic vegetation.

LAKE CORNELIA

LOCATION
County: Wright          Latitude  42 Deg 47 Min N
                        Longitude 93 Deg 41 Min W
Township 92 N      Range 24 W      Section 16

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
202. hectares ( 499. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 51. | 25.2 |
| 17 | 151. | 74.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 85.7 | 7.9 | 0.8 | 2.6 | 3.0 |

Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

17 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Canisteo, Nicollet, Webster, Lester, and Storden soils.

Per cent of shoreline in public ownership 28 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 98. ha ( 243. A)
Length of shoreline 3850. m ( 12632. ft)
Maximum depth 5.5 m ( 18.0 ft)
Mean depth 2.3 m ( 8. ft)
Volume 2291328. cubic meters ( 1857. acre-feet)
Shoreline development 1.10   Volume development 1.28
Watershed/lake area ratio 2.1
Origin of basin: Natural
Estimated annual precipitation 79. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: None


1590 METERS

# LAKE CORNELIA
## Wright County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.6 | 0.04 |
| Chlorophyll a mg/cubic meter | 8 | 32.4 | 6.99 |
| Total phosphorus mg/cubic meter | 10 | 61.4 | 3.89 |
| Kjeldahl nitrogen mg/l | 2 | 1.5 | 0.10 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.03 |
| Seston dry weight mg/l | 9 | 20.3 | 2.10 |
| Turbidity JTU | 9 | 8.2 | 0.52 |
| Total hardness mg/l as CaCO3 | 9 | 148.4 | 1.32 |
| Calcium hardness mg/l as CaCO3 | 9 | 58.2 | 5.43 |
| Total alkalinity mg/l as CaCO3 | 10 | 141.8 | 2.03 |
| Dissolved oxygen mg/l | 9 | 7.8 | 0.66 |
| Specific conductance micromhos/cm at 25 C | 9 | 305.0 | 8.42 |
| Sulfate mg/l | 6 | 3.1 | 0.89 |
| Chloride mg/l | 6 | 16.1 | 0.42 |
| Sodium mg/l | 2 | 12.0 | 0.00 |
| Potassium mg/l | 2 | 7.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/25/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 17.2 | 10.5 | 56.2 | 9.1 | 4.9 |
| 1 | 16.7 | 10.6 | 55.1 | 9.1 | 3.2 |
| 2 | 16.1 | | | | |
| 3 | 16.1 | 9.2 | 57.9 | 9.1 | 61.7 |
| 4 | 16.1 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 3.
Potential nutrient input index =
area watershed in row crops/lake area = 1.8
43.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, contouring.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Cabins along lakeshore | Septic tank inflows |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Lake Cornelia Park (County)
Eldridge Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2484. | 10.2 | 25.3 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 5938. | 24.4 | 60.6 |
| Swimming | 11327. | 46.6 | 115.6 |
| Pleasure boating | 3138. | 12.9 | 32.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 7745. | 31.9 | 79.0 |
| Snowmobiling | 1216. | 5.0 | 12.4 |
| Ice skating and cross-country skiing | 521. | 2.1 | 5.3 |
| TOTAL | 32369. | 133.2 | 330.3 |

Special events at Lake Cornelia contributing to more than normal use include the Lake Cornelia Association Fun Day (250 people) and the Jaycee snowmobile races (400 people).

IMPAIRMENTS

Swimming may be impaired in Lake Cornelia throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Septic runoff from cabins and nearby homes may enter the lake. High fecal bacteria counts have been recorded at times. Iowa Conservation Commission personnel consider lake usage to be below its potential..

Estimated aquatic plant coverage 4 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Septic tank systems are a major pollution source to Lake Cornelia. Dye tests conducted in 1978 and 1979 indicated septic inflow into the lake in about 15% of the systems examined. Extremely high fecal coliform counts (up to 5000/100ml in January 1978) have been measured in various parts of the lake. Septic systems on the lakeshore may also be responsible for high fecal coliform counts in two drainage wells near the lake. A sanitary district was formed in 1979. Efforts to plan and construct the necessary sanitary sewer system are currently hindered by a lack of cost-sharing funds. It is recommended the necessary steps be taken to complete the sewer system. Elimination of septic tank inflow may significantly improve water quality, as well as eliminate the potential danger of bacterial contamination to lake users.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

CRAWFORD CREEK LAKE

LOCATION
County: Ida                    Latitude   42 Deg  16 Min N
                               Longitude  95 Deg  36 Min W
Township  86 N       Range 41 W      Section 10

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
       958. hectares (  2367. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 19 | 958. | 100.0 |

Estimated land uses (%)

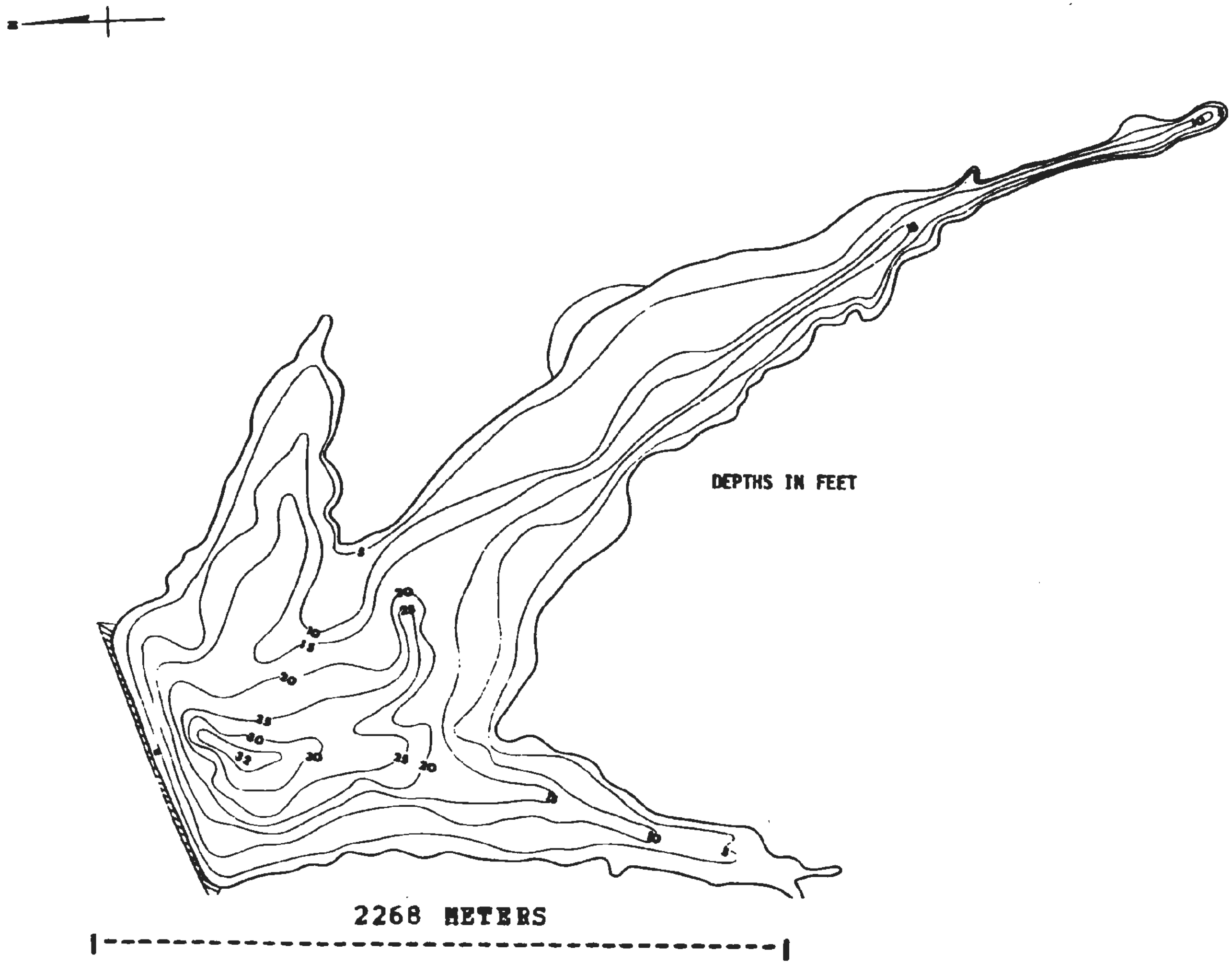
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 50.0 | 28.2 | 18.4 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

19 Gently sloping to very steep (2-40%+) prairie-derived soils developed from loess or loess-derived sediments. Ida, Napier, Castana, Hamburg, and Monona soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area   25. ha (  62. A)
Length of shoreline   4152. m (  13622. ft)
Maximum depth  9.8 m ( 32.0 ft)
Mean depth  3.4 m ( 11. ft)
Volume    864870. cubic meters (   701. acre-feet)
Shoreline development  2.34    Volume development  1.06
Watershed/lake area ratio     38.3
Origin of basin: Impoundment
Estimated annual precipitation  71. cm
Estimated annual runoff         10. cm
Estimated lake evaporation      97. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
  Unnamed
Outlet: Unnamed
208 Agency:
   Iowa Department of Environmental Quality
   900 East Grand Avenue
   Des Moines, Iowa 50319




# CRAWFORD CREEK LAKE
## Ida County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.8 | 0.05 |
| Chlorophyll a mg/cubic meter | 10 | 61.8 | 8.61 |
| Total phosphorus mg/cubic meter | 9 | 76.2 | 7.12 |
| Kjeldahl nitrogen mg/l | 2 | 1.1 | 0.03 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 10 | 12.8 | 0.92 |
| Turbidity JTU | 10 | 6.2 | 0.39 |
| Total hardness mg/l as $CaCO_3$ | 10 | 185.2 | 2.86 |
| Calcium hardness mg/l as $CaCO_3$ | 10 | 107.4 | 3.08 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 169.8 | 1.99 |
| Dissolved oxygen mg/l | 11 | 6.0 | 0.20 |
| Specific conductance micromhos/cm at 25 C | 10 | 353.0 | 6.51 |
| Sulfate mg/l | 7 | 24.6 | 0.34 |
| Chloride mg/l | 8 | 6.3 | 0.09 |
| Sodium mg/l | 2 | 6.0 | 1.00 |
| Potassium mg/l | 2 | 10.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 7/24/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.8 | 6.1 | 22.6 | 8.2 | 59.9 |
| 1 | 25.1 | 5.6 | 91.7 | 8.3 | 43.8 |
| 2 | 25.0 | 5.0 | 80.2 | 8.2 | 25.8 |
| 3 | 24.9 | | | | |
| 4 | 24.5 | 1.6 | 33.3 | 8.2 | 6.4 |
| 5 | 22.3 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 839.
Potential nutrient input index =
area watershed in row crops/lake area = 19.2
90.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Crawford Creek (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 104. | 1.7 | 4.2 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 846. | 13.6 | 33.8 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 260. | 4.2 | 10.4 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 1210. | 19.5 | 48.4 |

IMPAIRMENTS

Swimming may be impaired in Crawford Creek Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to the lake's recent construction and uncompleted facilities.

Estimated aquatic plant coverage 4 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will

help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

CRYSTAL LAKE

LOCATION
County: Hancock	Latitude 43 Deg 14 Min N
Longitude 93 Deg 48 Min W
Township 97 N	Range 25 W	Section 9

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
741. hectares ( 1831. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 13 | 123. | 16.6 |
| 14 | 88. | 11.9 |
| 17 | 529. | 71.4 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 84.6 | 8.9 | 1.6 | 2.0 | 2.9 |

Description of topography and soils in soil associations represented in the watershed

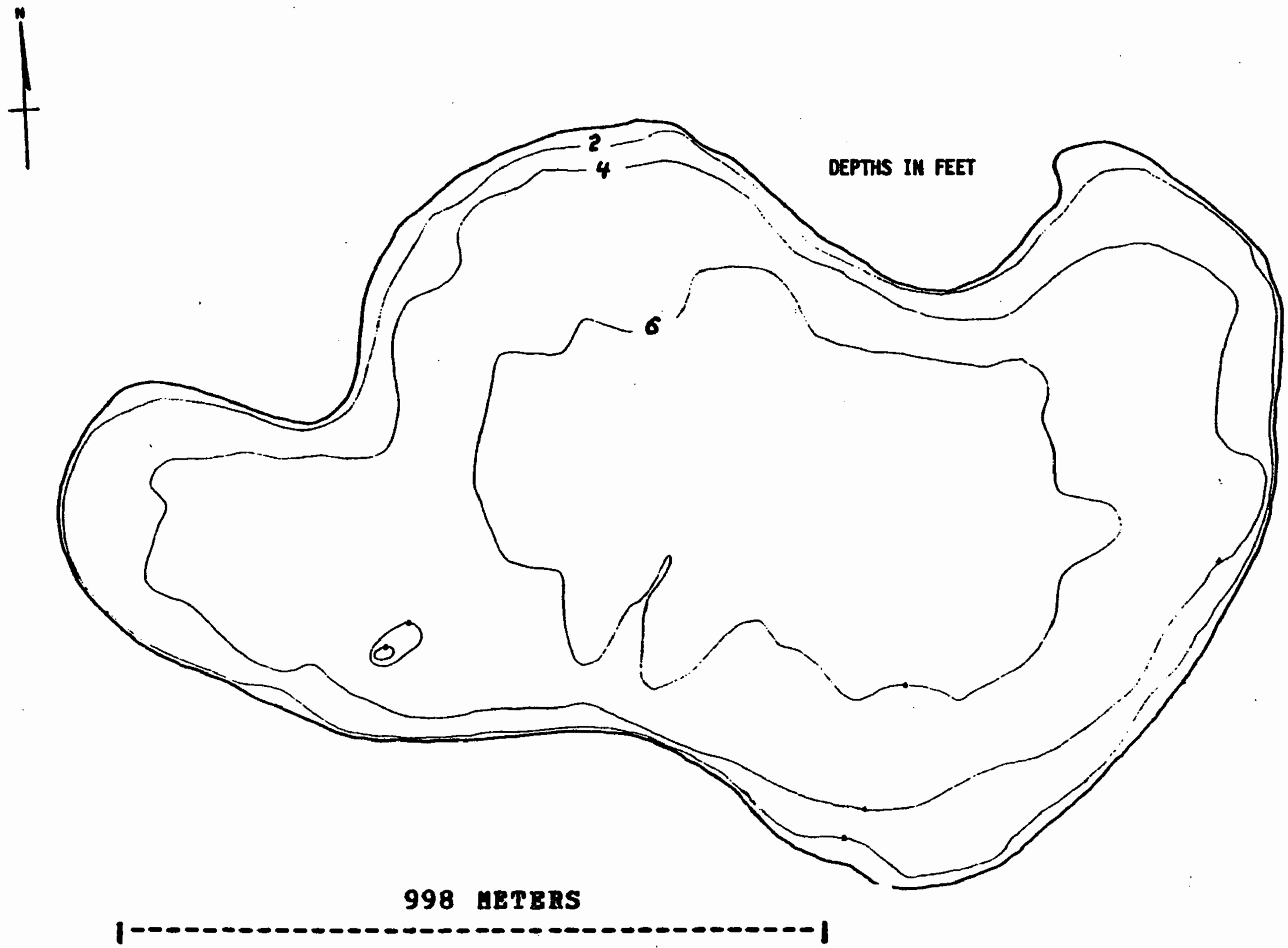
13 Strongly sloping (9-14%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion and Storden soils. Includes some bottomland soils such as Colo.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

17 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Canisteo, Nicollet, Webster, Lester, and Storden soils.

Per cent of shoreline in public ownership 36 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1955 map
Area 99. ha ( 244. A)
Length of shoreline 4596. m ( 15079. ft)
Maximum depth 2.4 m ( 8.0 ft)
Mean depth 1.5 m ( 5. ft)
Volume 1469175. cubic meters ( 1191. acre-feet)
Shoreline development 1.31 Volume development 1.83
Watershed/lake area ratio 7.5
Origin of basin: Natural
Estimated annual precipitation 76. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 86. cm
Thermal stratification? No




CRYSTAL LAKE
Hancock County

Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 1.4 | 0.15 |
| Chlorophyll a mg/cubic meter | 9 | 5.6 | 1.33 |
| Total phosphorus mg/cubic meter | 9 | 171.9 | 6.84 |
| Kjeldahl nitrogen mg/l | 1 | 1.5 | |
| Ammonia nitrogen mg/l | 1 | 0.1 | |
| Nitrate + nitrite nitrogen mg/l | 1 | 0.1 | |
| Seston dry weight mg/l | 9 | 5.4 | 0.60 |
| Turbidity JTU | 10 | 5.6 | 0.94 |
| Total hardness mg/l as CaCO3 | 11 | 184.0 | 5.56 |
| Calcium hardness mg/l as CaCO3 | 10 | 132.4 | 5.46 |
| Total alkalinity mg/l as CaCO3 | 9 | 152.6 | 4.78 |
| Dissolved oxygen mg/l | 9 | 6.5 | 0.83 |
| Specific conductance micromhos/cm at 25 C | 9 | 360.0 | 15.00 |
| Sulfate mg/l | 6 | 14.6 | 0.68 |
| Chloride mg/l | 6 | 21.7 | 2.35 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.1 | 6.0 | 150.9 | 8.1 | 2.6 |
| 1 | 21.1 | 6.0 | 158.1 | 8.0 | 1.9 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 30.
Potential nutrient input index =
area watershed in row crops/lake area = 6.3
15.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, terraces.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Crystal Lake State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2592. | 10.6 | 26.2 |
| Shore or ice fishing | 5731. | 23.5 | 57.9 |
| Swimming | 7913. | 32.4 | 79.9 |
| Pleasure boating | 3991. | 16.4 | 40.3 |
| Hunting | 365. | 1.5 | 3.7 |
| Picnicking,camping,other activities prompted by the lake's presence | 22984. | 94.2 | 232.2 |

| | | | |
|---|---|---|---|
| Snowmobiling | 1649. | 6.8 | 16.7 |
| Ice skating and cross-country skiing | 1737. | 7.1 | 17.5 |
| TOTAL | 46962. | 192.5 | 474.4 |

Special events at Crystal Lake contributing to more than normal use include Earth Day (250 people) and snowmobile races (150 people).

IMPAIRMENTS

Swimming may be impaired in Crystal Lake during part of the summer due to high concentrations of suspended matter. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to winterkills and occasional large fluctuations in water level.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: 1 year out of 3
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE DARLING

LOCATION
County: Washington Latitude 41 Deg 12 Min N
Longitude 91 Deg 54 Min W
Township 74 N Range 9 W Section 21

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
4929. hectares ( 12179. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 45 | 930. | 18.9 |
| 46 | 2596. | 52.7 |
| 47 | 1402. | 28.4 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 75.7 | 14.9 | 6.3 | 0.0 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

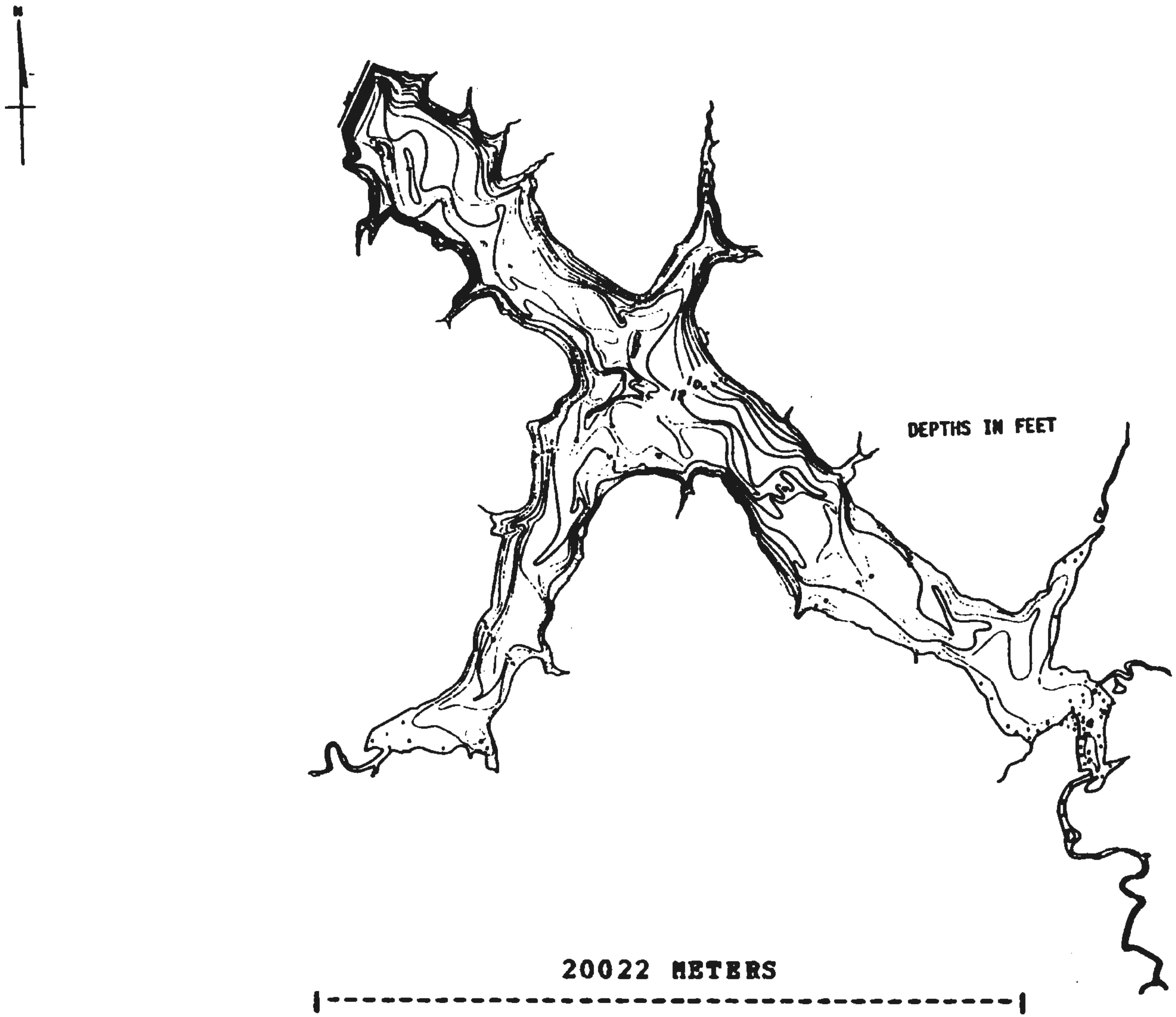
45 Nearly level to gently sloping (0-5%) prairie-derived soils developed from loess. Mahaska, Otley, and Taintor soils.

46 Nearly level to strongly sloping (0-14%) prairie to forest-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Otley, Mahaska, Ladoga, Clinton, and Adair soils.

47 Moderately sloping to very steep (5-30%) forest-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Clinton, Lindley, and Keswick soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1972 map
Area 121. ha ( 299. A)
Length of shoreline 13132. m ( 43085. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 2.7 m ( 9. ft)
Volume 3240745. cubic meters ( 2626. acre-feet)
Shoreline development 3.37 Volume development 1.10
Watershed/lake area ratio 40.7
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 89. cm
Thermal stratification? Partial




LAKE DARLING
Washington County

Major inflows (named and/or permanent streams)
Honey Cr + 1 Unnamed
Outlet: Honey Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.4 | 0.02 |
| Chlorophyll a mg/cubic meter | 10 | 89.7 | 8.30 |
| Total phosphorus mg/cubic meter | 8 | 96.0 | 8.41 |
| Kjeldahl nitrogen mg/l | 2 | 0.8 | 0.08 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 10 | 23.0 | 0.74 |
| Turbidity JTU | 8 | 14.9 | 1.01 |
| Total hardness mg/l as CaCO3 | 9 | 115.8 | 8.02 |
| Calcium hardness mg/l as CaCO3 | 8 | 77.2 | 7.14 |
| Total alkalinity mg/l as CaCO3 | 8 | 94.0 | 5.90 |
| Dissolved oxygen mg/l | 9 | 10.1 | 0.48 |
| Specific conductance micromhos/cm at 25 C | 8 | 269.9 | 17.19 |
| Sulfate mg/l | 3 | 12.5 | 0.29 |
| Chloride mg/l | 4 | 9.6 | 1.05 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 9/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 31.6 | 11.4 | 124.5 | 9.4 | 125.7 |
| 1 | 31.6 | 11.1 | 122.7 | 9.3 | 120.6 |
| 2 | 29.3 | 4.0 | 111.5 | 8.1 | 56.9 |
| 3 | 25.5 | | | | |
| 4 | 23.8 | 0.0 | 661.0 | 7.2 | 8.7 |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Shoreline erosion may be a significant source of siltation
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 513.
Potential nutrient input index =
area watershed in row crops/lake area = 30.8
46.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, grass waterways, gulley control structures/ erosion control structures, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Lake Darling State Park | Water intake filter backwash |
| 560 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 2500 persons at Lake Darling State Park.

Public parks:
Lake Darling State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2226. | 7.4 | 18.4 |
| Shore or ice fishing | 9723. | 32.5 | 80.4 |
| Swimming | 13656. | 45.7 | 112.9 |
| Pleasure boating | 3322. | 11.1 | 27.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 6276. | 21.0 | 51.9 |
| Snowmobiling | 347. | 1.2 | 2.9 |
| Ice skating and cross-country skiing | 278. | 0.9 | 2.3 |
| TOTAL | 35828. | 119.8 | 296.1 |

Special events at Lake Darling contributing to more than normal use include the Lake Darling Youth Center Camp (1800 people) and two conservation days (350 people).

IMPAIRMENTS

Swimming may be impaired in Lake Darling throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor water quality.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Shoreline erosion is a serious problem in Lake Darling. Shoreline protection through riprapping may reduce siltation and turbidity in the lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this

reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

DESOTO BEND LAKE

LOCATION

County: Harrison Latitude 41 Deg 32 Min N
Pottawattamie Longitude 96 Deg 0 Min W
Township 78 N Range 45 W Section 22

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
6585. hectares ( 16272. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 1 | 2994. | 45.5 |
| 21 | 1324. | 20.1 |
| 22 | 2267. | 34.4 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 84.4 | 7.0 | 4.8 | 0.1 | 3.7 |

Description of topography and soils in soil associations represented in the watershed

1 Nearly level and gently sloping (0-5%) soils developed from alluvium. Fluvents and Sarpy soils.

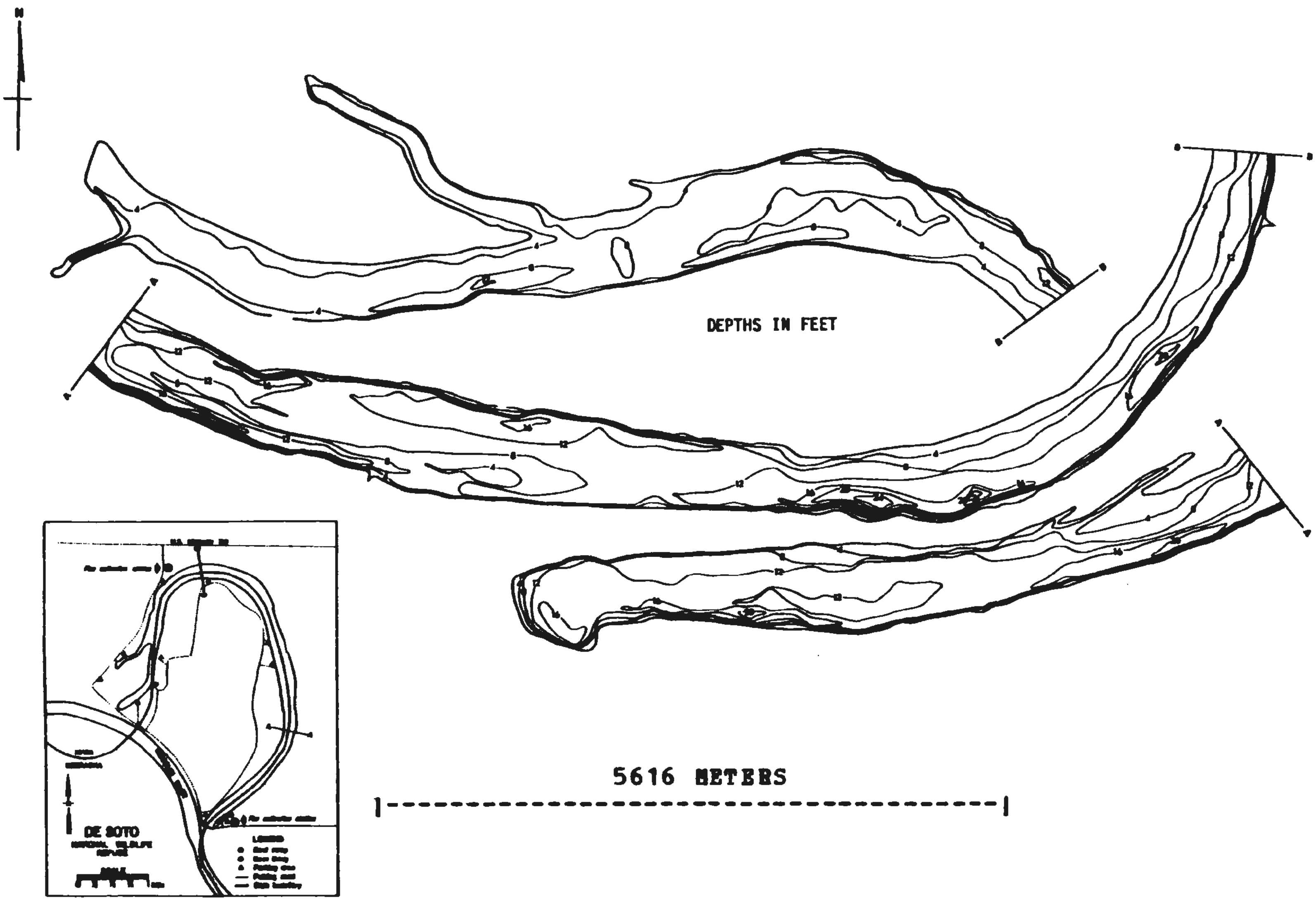
21 Nearly level (0-2%) soils developed from alluvium. Albaton, Haynie, and Onawa soils.

22 Level and nearly level (0-2%) soils developed from alluvium. Luton, Blencoe, Keg, and Salix soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 328. ha ( 811. A)
Length of shoreline 27660. m ( 90750. ft)
Maximum depth 7.9 m ( 26.0 ft)
Mean depth 2.5 m ( 8. ft)
Volume 8307680. cubic meters ( 6732. acre-feet)
Shoreline development 4.30 Volume development 0.95
Watershed/lake area ratio 20.1
Origin of basin: Natural
Estimated annual precipitation 76. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 102. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
Young's Ditch+ 1 Unnamed
Outlet: To Missouri R




DESOTO BEND LAKE
Harrison County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 3 | 0.3 | 0.03 |
| Chlorophyll a mg/cubic meter | 43 | 119.1 | 5.40 |
| Total phosphorus mg/cubic meter | 11 | 140.4 | 3.84 |
| Kjeldahl nitrogen mg/l | 2 | 1.21 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.19 | 0.04 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.11 | 0.04 |
| Seston dry weight mg/l | 17 | 26.5 | 1.50 |
| Turbidity JTU | 14 | 15.8 | 0.95 |
| Total hardness mg/l as $CaCO_3$ | 14 | 186.1 | 1.95 |
| Calcium hardness mg/l as $CaCO_3$ | 14 | 72.9 | 3.48 |
| Total alkalinity mg/l as $CaCO_3$ | 14 | 231.1 | 1.93 |
| Dissolved oxygen mg/l | 14 | 5.4 | 0.36 |
| Specific conductance micromhos/cm at 25 C | 14 | 445.0 | 4.54 |
| Sulfate mg/l | 7 | 22.1 | 0.95 |
| Chloride mg/l | 6 | 5.3 | 0.11 |
| Sodium mg/l | 1 | 36.0 | |
| Potassium mg/l | 1 | 8.0 | |

Vertical profile for selected measurements on the sampling date ( 8/29/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.8 | 9.0 | 133.6 | 9.0 | 199.1 |
| 1 | 23.8 | 7.1 | 125.3 | 8.9 | 156.4 |
| 2 | 23.7 | 6.2 | 122.9 | 8.8 | 152.7 |
| 3 | 23.7 | 6.1 | 155.4 | 8.8 | 124.2 |
| 4 | 23.7 | 4.2 | 161.9 | 8.6 | 136.2 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Shoreline erosion may be a significant source of siltation
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 30.
Potential nutrient input index =
area watershed in row crops/lake area = 16.9
90.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: field windbreaks, conservation tillage, conservation planting (trees,grass), landgrading for drainage, tile drainage, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake has also been designated as high quality water and is thus subject to higher standards to protect existing uses.
This lake is not designated as a public water supply.

Public parks:
- DeSoto National Wildlife Refuge

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2216. | 2.7 | 6.8 |
| Shore or ice fishing | 7079. | 8.7 | 21.6 |
| Swimming | 8683. | 10.7 | 26.5 |
| Pleasure boating | 30387. | 37.5 | 92.6 |
| Hunting | 1499. | 1.8 | 4.6 |
| Picnicking,camping,other activities prompted by the lake's presence | 20439. | 25.2 | 62.3 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 70303. | 86.7 | 214.3 |

IMPAIRMENTS

Swimming may be impaired in Desoto Bend Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 10 %
Estimated winterkill frequencies: 1 year out of 7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

DeSoto Bend is a "dual purpose" lake serving both as a waterfowl refuge and recreation lake. As a result, management alternatives must be assessed in terms of their impact on waterfowl management as well as their effect on water quality and recreational usefulness of the lake. Management practices improving DeSoto Bend's recreational usefulness include: shoreline protection, surface water runoff diversion, and aeration. Shoreline riprapping would reduce bank erosion and sedimentation in the lake while improving fishing access. Shoreline protection would not appear to interfere with waterfowl management. Diversion of surface water runoff would decrease nutrient and sediment loading to the lake. The impact of surface water diversion on waterfowl management depends on resulting water level changes in the lake. Aeration, to prevent the occurrence of winterkills in the lake, would create additional open water areas. The establishment of these open water areas should start after ice has formed to discourage overwintering by waterfowl and thus interfere with management plans.

DIAMOND LAKE

LOCATION

County: Poweshiek  Latitude 41 Deg 35 Min N
Longitude 92 Deg 33 Min W

Township 78 N  Range 15 W  Section 2

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
1103. hectares ( 2727. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 45 | 495. | 44.9 |
| 46 | 575. | 52.1 |
| 51 | 33. | 3.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 80.9 | 8.2 | 1.8 | 0.0 | 9.1 |

Description of topography and soils in soil associations represented in the watershed

45 Nearly level to gently sloping (0-5%) prairie-derived soils developed from loess. Mahaska, Otley, and Taintor soils.

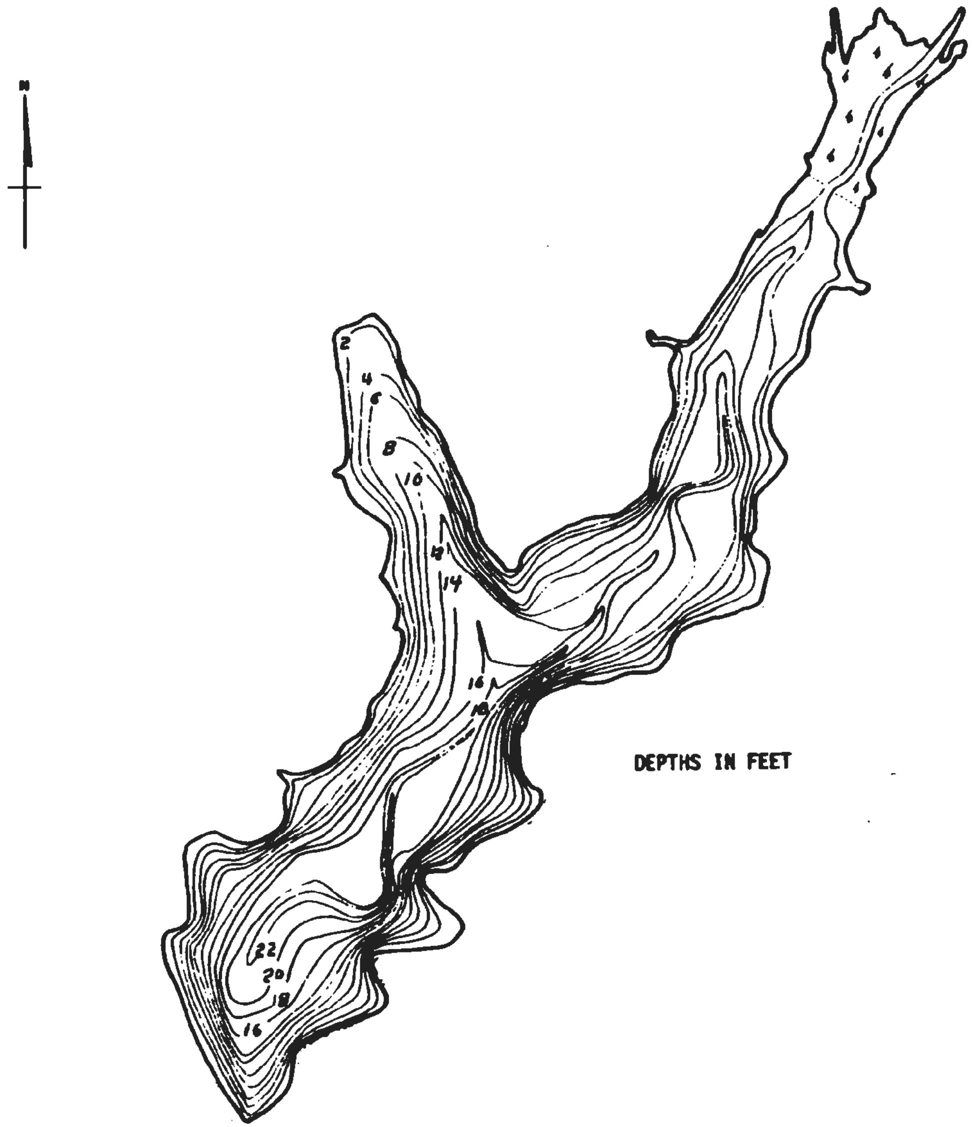
46 Nearly level to strongly sloping (0-14%) prairie to forest-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Otley, Mahaska, Ladoga, Clinton, and Adair soils.

51 Gently sloping to moderately steep (2-18%) prairie to forest-derived soils developed from loess or pre-Wisconsin till. Otley, Clinton, and Lindley soils.

Per cent of shoreline in public ownership 45 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1976 map
Area 39. ha ( 98. A)
Length of shoreline 5724. m ( 18780. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 2.6 m ( 9. ft)
Volume 1027227. cubic meters ( 832. acre-feet)
Shoreline development 2.57  Volume development 1.16
Watershed/lake area ratio 28.3
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 91. cm
Thermal stratification? Partial




DEPTHS IN FEET

4266 METERS

# DIAMOND LAKE
Poweshiek County

Major inflows (named and/or permanent streams)
None
Cutlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.9 | 0.20 |
| Chlorophyll a mg/cubic meter | 7 | 10.1 | 0.66 |
| Total phosphorus mg/cubic meter | 8 | 42.4 | 2.66 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.00 |
| Ammonia nitrogen mg/l | 2 | 0.0 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 7 | 5.2 | 0.81 |
| Turbidity JTU | 7 | 3.2 | 0.30 |
| Total hardness mg/l as CaCO3 | 7 | 127.7 | 6.46 |
| Calcium hardness mg/l as CaCO3 | 8 | 76.2 | 5.09 |
| Total alkalinity mg/l as CaCO3 | 7 | 112.3 | 5.00 |
| Dissolved oxygen mg/l | 7 | 8.0 | 0.45 |
| Specific conductance micromhos/cm at 25 C | 7 | 254.3 | 11.92 |
| Sulfate mg/l | 3 | 14.2 | 0.44 |
| Chloride mg/l | 3 | 8.5 | 0.01 |
| Sodium mg/l | 2 | 7.0 | 0.00 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.6 | 6.5 | 45.4 | 8.3 | 10.6 |
| 1 | 26.6 | | | | |
| 2 | 26.5 | 6.1 | 56.5 | 8.3 | 9.2 |
| 3 | 26.1 | | | | |
| 4 | 23.6 | 1.9 | 144.5 | 7.5 | 8.8 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 13.20-14.30 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 387.
Potential nutrient input index =
area watershed in row crops/lake area = 22.9
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: ponds/sediment and water control basins, contouring, conservation tillage, strip-cropping, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 1200 persons at Montezuma.

Public parks:
Diamond Lake (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 4409. | 45.0 | 113.1 |
| Shore or ice fishing | 19452. | 198.5 | 498.8 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 1168. | 11.9 | 29.9 |
| Hunting | 1055. | 10.8 | 27.1 |
| Picnicking,camping,other activities prompted by the lake's presence | 35873. | 366.1 | 919.8 |
| Snowmobiling | 469. | 4.8 | 12.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 62426. | 637.0 | 1600.7 |

Special events at Diamond Lake contributing to more than normal use include a fifth grade field day (350 people) and educational tours (900 people).

## IMPAIRMENTS

Aquatic vascular plant growth in Diamond Lake may impair boating and shoreline fishing. Aquatic plants are being treated with copper sulfate application. Iowa Conservation Commission personnel consider lake usage to be below its potential due to aquatic plant growth.

Estimated aquatic plant coverage 37 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

## LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term

extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

DOG CREEK LAKE

LOCATION
County: O'Brien Latitude 42 Deg 56 Min N
Longitude 95 Deg 28 Min W
Township 94 N Range 39 W Section 29

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
1160. hectares ( 2866. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 8 | 731. | 63.0 |
| 10 | 429. | 37.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 78.6 | 15.8 | 2.9 | 0.0 | 2.8 |

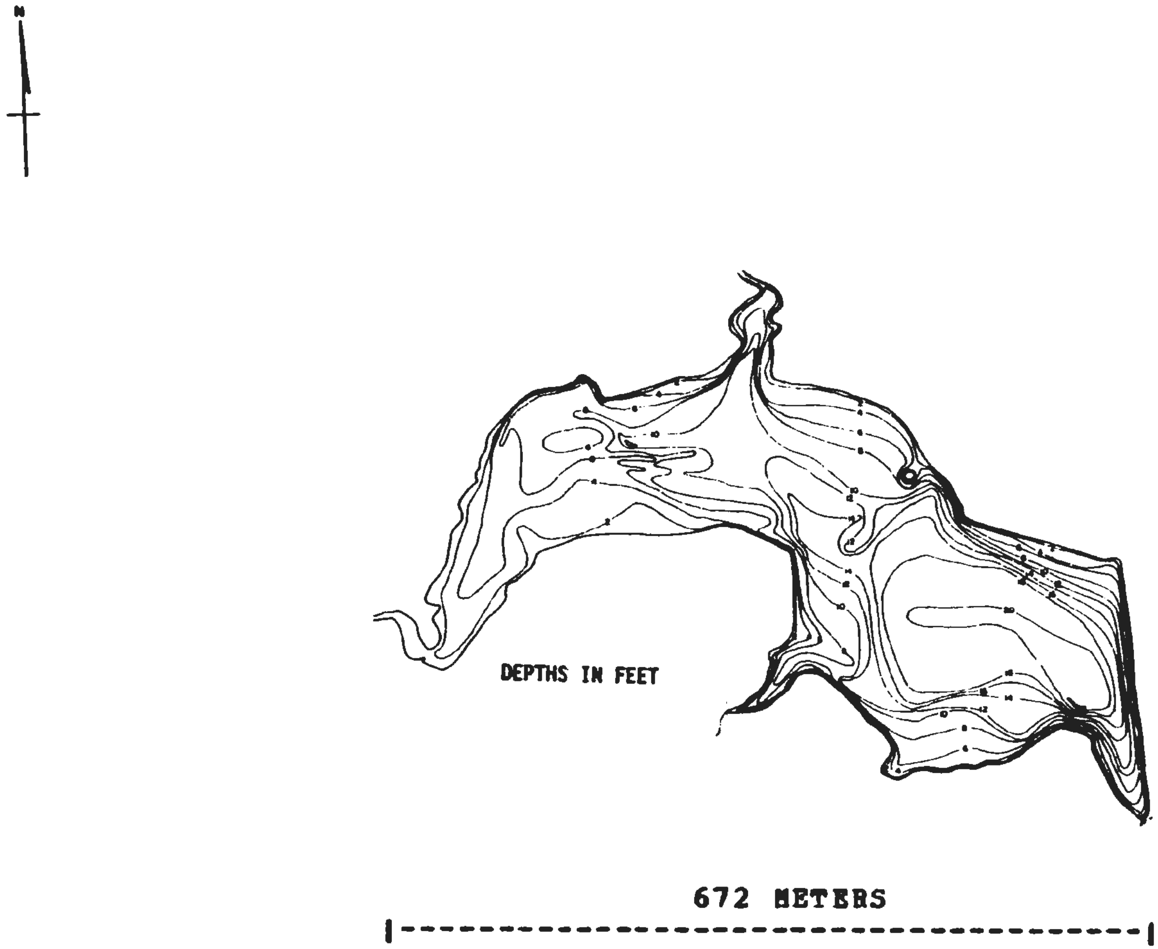
Description of topography and soils in soil associations represented in the watershed

8 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over Wisconsin or pre-Wisconsin till. Galva, Primghar, Marcus, and Sac soils.

10 Moderately to very steep (14-40%) prairie-derived soils developed from pre-Wisconsin till. Steinauer and Shelby soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1972 map
Area 11. ha ( 28. A)
Length of shoreline 2443. m ( 8016. ft)
Maximum depth 6.1 m ( 20.0 ft)
Mean depth 3.0 m ( 10. ft)
Volume 341477. cubic meters ( 277. acre-feet)
Shoreline development 2.04 Volume development 1.48
Watershed/lake area ratio 105.5
Origin of basin: Impoundment
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Dog Cr
Outlet: Dog Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




DOG CREEK LAKE
O'Brien County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.7 | 0.05 |
| Chlorophyll a mg/cubic meter | 9 | 34.2 | 3.75 |
| Total phosphorus mg/cubic meter | 9 | 77.9 | 12.43 |
| Kjeldahl nitrogen mg/l | 2 | 1.8 | 0.14 |
| Ammonia nitrogen mg/l | 2 | 1.2 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.6 | 0.14 |
| Seston dry weight mg/l | 9 | 13.5 | 1.80 |
| Turbidity JTU | 9 | 10.1 | 0.26 |
| Total hardness mg/l as CaCO3 | 8 | 224.2 | 4.42 |
| Calcium hardness mg/l as CaCO3 | 8 | 113.2 | 4.91 |
| Total alkalinity mg/l as CaCO3 | 9 | 173.6 | 4.72 |
| Dissolved oxygen mg/l | 8 | 5.4 | 0.48 |
| Specific conductance micromhos/cm at 25 C | 9 | 425.0 | 9.65 |
| Sulfate mg/l | 4 | 49.5 | 2.54 |
| Chloride mg/l | 5 | 16.5 | 0.00 |
| Sodium mg/l | 2 | 11.0 | 0.00 |
| Potassium mg/l | 2 | 8.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/13/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.8 | 4.8 | 74.5 | 8.0 | 47.2 |
| 1 | 22.8 | 4.8 | 86.4 | 8.0 | 46.8 |
| 2 | 22.8 | | | | |
| 3 | 22.7 | 3.8 | 68.9 | 7.8 | 32.9 |
| 4 | 22.5 | | | | |
| 5 | 19.7 | 1.6 | 117.8 | 7.6 | 17.3 |
| 6 | 17.3 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 9.19-10.79 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 1055.
Potential nutrient input index =
area watershed in row crops/lake area = 82.9
70.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, pastureland and pastureland improvement, gulley control structures/ erosion control structures, terraces, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Dog Creek Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2118. | 75.6 | 192.5 |
| Shore or ice fishing | 4039. | 144.3 | 367.2 |
| Swimming | 1676. | 59.9 | 152.4 |
| Pleasure boating | 434. | 15.5 | 39.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 3258. | 116.4 | 296.2 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 122. | 4.4 | 11.1 |
| TOTAL | 11647. | 416.0 | 1058.8 |

Special events at Dog Creek Lake contributing to more than normal use include the O'Brien County Annual Outdoor Classroom (200 people).

IMPAIRMENTS

Swimming may be impaired in Dog Creek Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic plant growth may impair shoreline fishing. Frequent winterkills and occasional summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 4 %
Estimated winterkill frequencies: 1 year out of 5-7
Estimated summerkill frequencies: 1 year out of 7-10

LAKE RESTORATION RECOMMENDATIONS

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments

introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

DCN WILLIAMS LAKE

LOCATION

| | | | |
|---|---|---|---|
| County: Boone | | Latitude | 42 Deg 7 Min N |
| | | Longitude | 94 Deg 1 Min W |
| Township 84 N | Range 27 W | | Section 5 |

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
7847. hectares ( 19389. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 1933. | 24.6 |
| 14 | 3282. | 41.8 |
| 18 | 2348. | 29.9 |
| 217 | 284. | 3.6 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 90.8 | 4.9 | 1.1 | 0.2 | 2.9 |

Description of topography and soils in soil associations represented in the watershed

12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

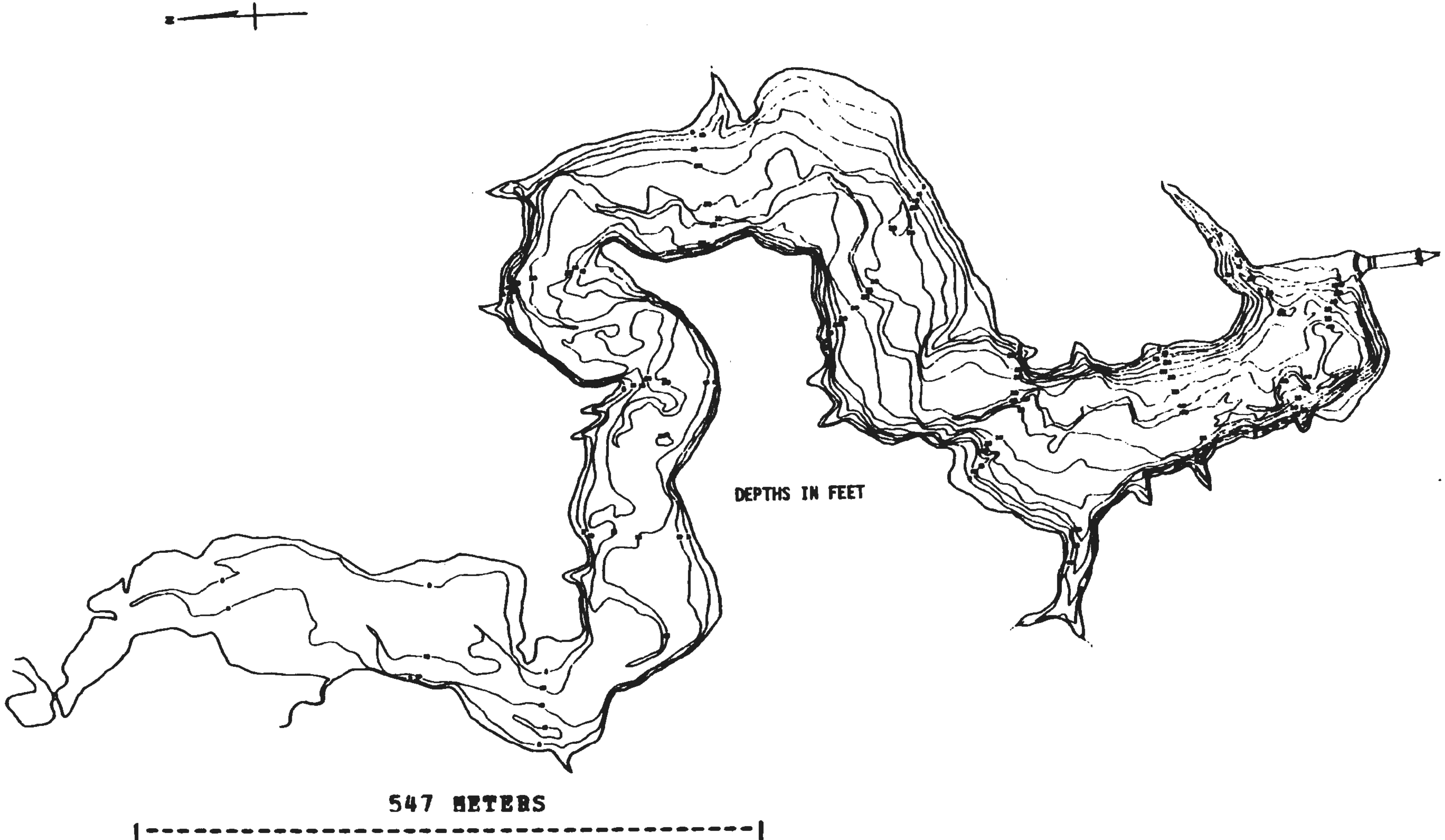
18 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Calcareous soils are common. Clarion, Harps, Canisteo, Webster, and Nicollet soils.

217 Nearly level to very steep (0-40%) forest and mixed prairie-forest-derived soils developed from Wisconsin till on the Cary Lobe. Includes some soils on bottomlands and terraces. Hayden and Lester soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1974 map
Area 60. ha ( 148. A)
Length of shoreline 9042. m ( 29667. ft)
Maximum depth 14.0 m ( 46.0 ft)
Mean depth 5.2 m ( 17. ft)
Volume 3333249. cubic meters ( 2701. acre-feet)
Shoreline development 3.18 Volume development 1.11




# DON WILLIAMS LAKE
Boone County

Watershed/lake area ratio 130.8
Origin of basin: Impoundment
Estimated annual precipitation 79. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 94. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Beaver Cr
Outlet: Beaver Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.8 | 0.07 |
| Chlorophyll a mg/cubic meter | 7 | 16.2 | 3.14 |
| Total phosphorus mg/cubic meter | 8 | 30.7 | 3.93 |
| Kjeldahl nitrogen mg/l | 2 | 0.3 | 0.00 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.07 |
| Nitrate + nitrite nitrogen mg/l | 2 | 4.0 | 0.38 |
| Seston dry weight mg/l | 8 | 5.9 | 0.56 |
| Turbidity JTU | 8 | 2.8 | 0.22 |
| Total hardness mg/l as CaCO3 | 8 | 274.0 | 3.40 |
| Calcium hardness mg/l as CaCO3 | 8 | 160.0 | 3.65 |
| Total alkalinity mg/l as CaCO3 | 9 | 169.1 | 2.03 |
| Dissolved oxygen mg/l | 8 | 8.6 | 0.85 |
| Specific conductance micromhos/cm at 25 C | 9 | 520.0 | 14.04 |
| Sulfate mg/l | 6 | 54.8 | 2.41 |
| Chloride mg/l | 6 | 19.9 | 0.08 |

| | | | |
|---|---|---|---|
| Sodium mg/l | 2 | 5.5 | 0.50 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 2/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 24.9 | 7.6 | 37.6 | 8.0 | 18.5 |
| 1 | 24.9 | | | | |
| 2 | 24.9 | 7.8 | 34.9 | 8.1 | 16.3 |
| 3 | 24.3 | 4.3 | 37.9 | 8.0 | 18.3 |
| 4 | 23.1 | | | | |
| 5 | 21.6 | | | | |
| 6 | 20.3 | 0.2 | 54.7 | 7.4 | 14.2 |
| 7 | 19.5 | | | | |
| 8 | 18.6 | | | | |
| 9 | 17.5 | 0.2 | 24.7 | 7.6 | 3.4 |
| 10 | 16.2 | | | | |
| 11 | 14.5 | 0.1 | 533.8 | 7.2 | 2.2 |
| 12 | 13.1 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 490.
Potential nutrient input index =
area watershed in row crops/lake area = 111.3
74.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, terraces.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Pilot Mound IA0058530 | Lagoon with no outflow |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.

This lake is not designated as a public water supply.

Public parks:
Don Williams Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 6005. | 40.6 | 100.1 |
| Shore or ice fishing | 10825. | 73.1 | 180.4 |
| Swimming | 17225. | 116.4 | 287.1 |
| Pleasure boating | 8715. | 58.9 | 145.3 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 40955. | 276.7 | 682.6 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 122. | 0.8 | 2.0 |
| TOTAL | 83847. | 566.5 | 1397.4 |

Special events at Don Williams Lake contributing to more than normal use include a bass fishing tournament (35 people) and a golf tournament (500 people).

IMPAIRMENTS

Recreational activities do not appear to be impaired by poor water quality or aquatic plants. Siltation may be an important problem in the north end of the lake. Shoreline erosion may interfere with shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 0.6%
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Shoreline erosion is a serious problem in Don Williams Lake. Shoreline protection through riprapping may reduce siltation and turbidity in the lake and provide better access for shoreline fishing.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term

extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

EAST LAKE (OSCEOLA)

LOCATION
County: Clarke Latitude 42 Deg 2 Min N
Longitude 93 Deg 44 Min W
Township 72 N Range 25 W Section 16

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
100. hectares ( 247. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 36 | 18. | 18.2 |
| 37 | 82. | 81.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 53.0 | 34.5 | 8.6 | 0.0 | 3.9 |

Description of topography and soils in soil associations represented in the watershed

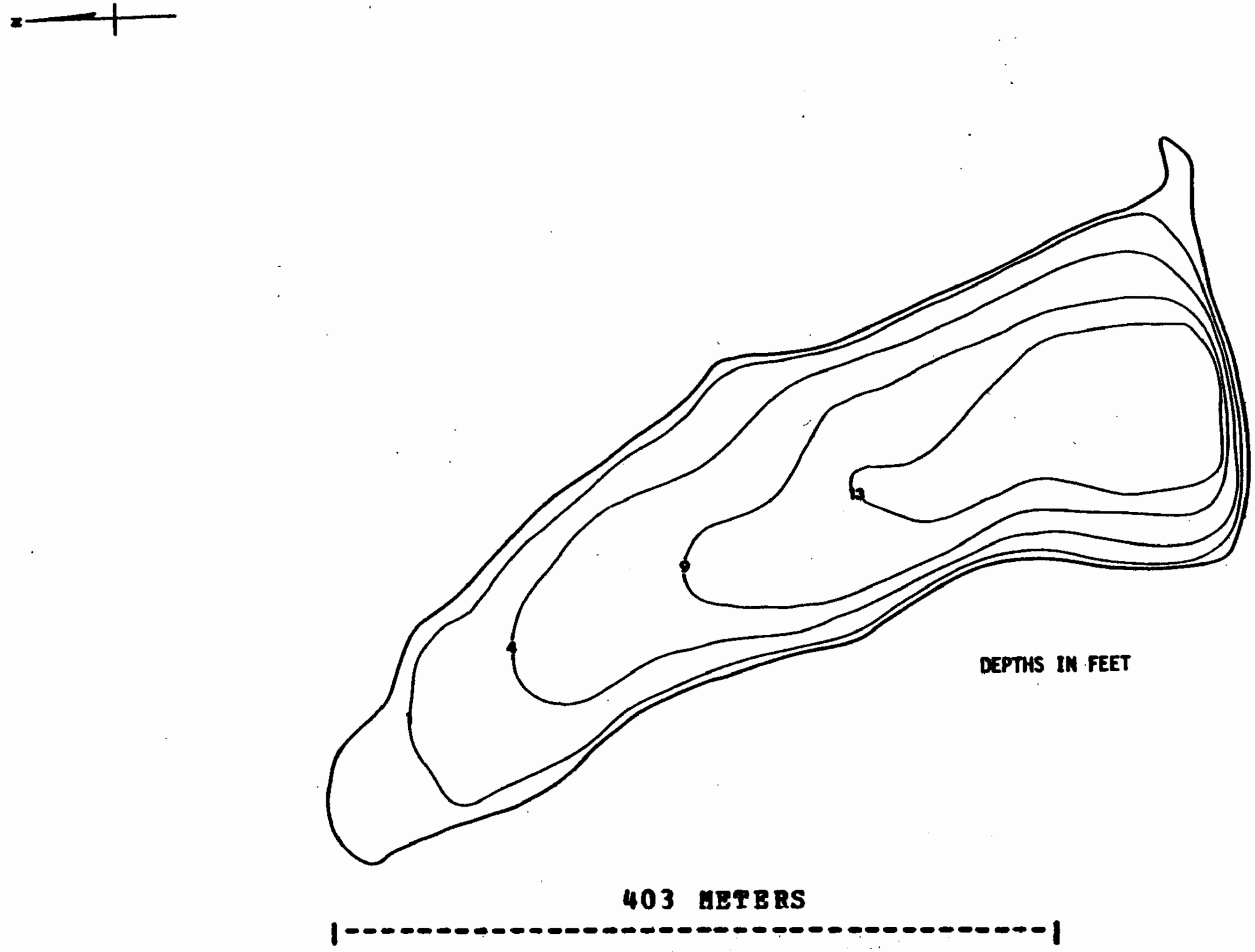
36 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Grundy, Haig, Shelby, and Adair soils.

37 Gently sloping to moderately steep (2-18%) prairie and forest-derived soils developed from pre-Wisconsin till-derived paleosols, pre-Wisconsin till, or loess. Adair, Shelby, Lindley, and Grundy soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1978 map
Area 5. ha ( 14. A)
Length of shoreline 1194. m ( 3917. ft)
Maximum depth 4.0 m ( 13.0 ft)
Mean depth 2.1 m ( 7. ft)
Volume 117104. cubic meters ( 95. acre-feet)
Shoreline development 1.44 Volume development 1.61
Watershed/lake area ratio 20.0
Origin of basin: Impoundment
Estimated annual precipitation 79. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed

246




EAST LAKE
Clarke County

2C8 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

PCLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.6 | 0.08 |
| Chlorophyll a mg/cubic meter | 8 | 75.7 | 15.4 |
| Total phosphorus mg/cubic meter | 10 | 173.1 | 17.36 |
| Kjeldahl nitrogen mg/l | 2 | 1.0 | 0.04 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 10 | 17.4 | 1.49 |
| Turbidity JTU | 8 | 12.6 | 1.97 |
| Total hardness mg/l as CaCO3 | 8 | 110.5 | 3.06 |
| Calcium hardness mg/l as CaCO3 | 9 | 76.7 | 0.82 |
| Total alkalinity mg/l as CaCO3 | 9 | 105.1 | 2.47 |
| Dissolved oxygen mg/l | 9 | 8.4 | 0.86 |
| Specific conductance micromhos/cm at 25 C | 8 | 226.9 | 7.96 |
| Sulfate mg/l | 3 | 6.3 | 4.34 |
| Chloride mg/l | 5 | 11.1 | 0.10 |
| Sodium mg/l | 2 | 7.0 | 0.00 |
| Potassium mg/l | 2 | 9.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/21/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.2 | 9.0 | 206.9 | 9.2 | 68.9 |
| 1 | 26.0 | 6.1 | 246.6 | 8.9 | 71.9 |
| 2 | 23.4 | 7.0 | 239.7 | 9.0 | 62.9 |
| 3 | 21.6 | 0.0 | 226.0 | 7.4 | 10.1 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 252.
Potential nutrient input index =
area watershed in row crops/lake area = 10.6
88.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, terraces.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
East Lake Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 30. | 2.1 | 6.0 |
| Shore or ice fishing | 2000. | 142.9 | 400.0 |
| Swimming | 30. | 2.1 | 6.0 |
| Pleasure boating | 43. | 3.1 | 8.6 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 9123. | 651.6 | 1824.6 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 50. | 3.6 | 10.0 |
| TOTAL | 11276. | 805.4 | 2255.2 |

IMPAIRMENTS

Water clarity is poor in East Lake (Osceola) throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to uncompleted facilities.

Estimated aquatic plant coverage 23 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

EAST OKOBOJI

LOCATION

County: Dickinson  Latitude 43 Deg 24 Min N
Longitude 95 Deg 5 Min W
Township 99 N  Range 36 W  Section 15

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
4942. hectares ( 12212. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 3659. | 74.0 |
| 15 | 1283. | 26.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 84.5 | 7.5 | 0.6 | 4.0 | 3.5 |

Description of topography and soils in soil associations represented in the watershed

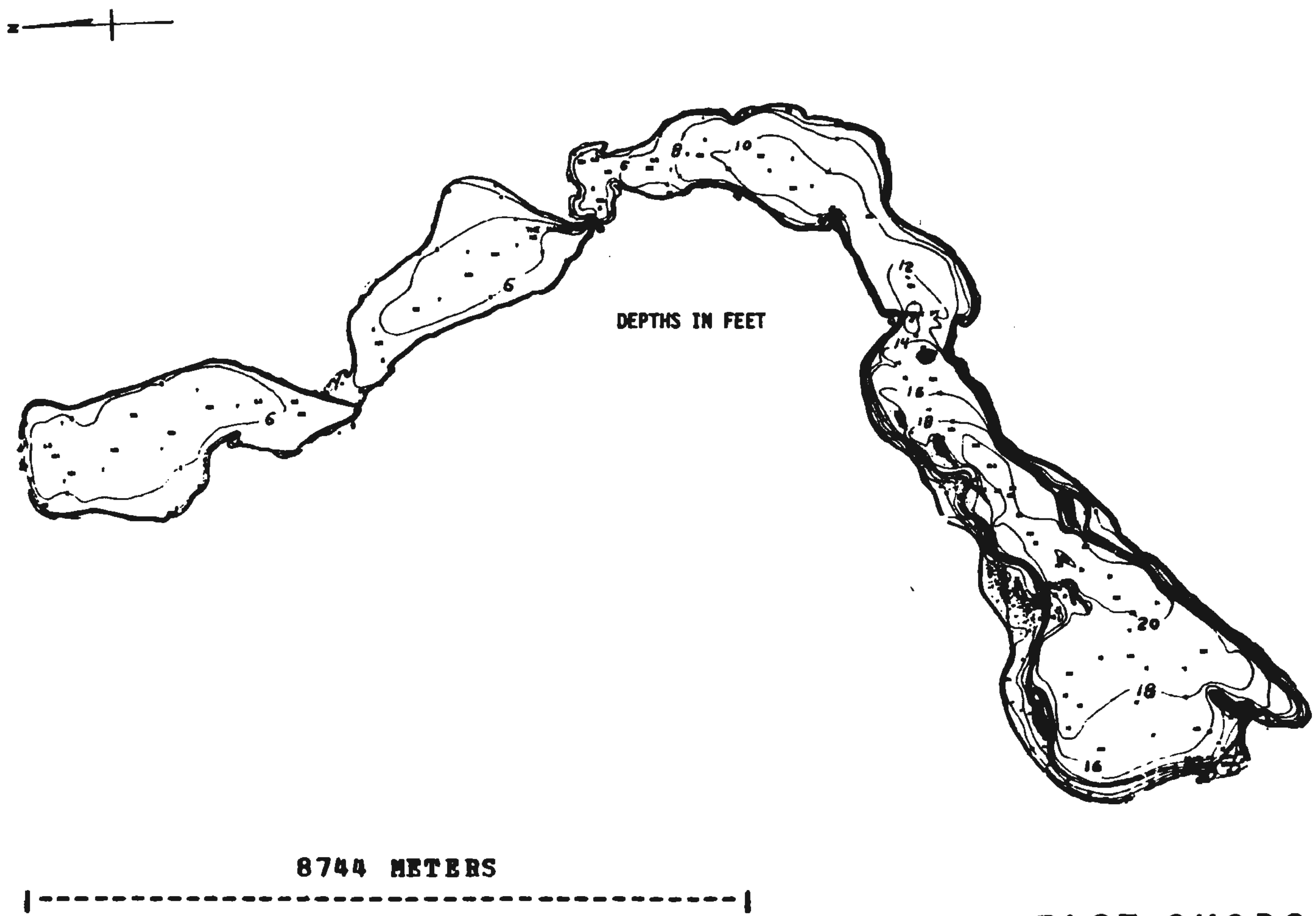
14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 8 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1970 map
Area 743. ha (1835. A)
Length of shoreline 27068. m ( 88808. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 3.2 m ( 10. ft)
Volume 23474520. cubic meters ( 19023. acre-feet)
Shoreline development 2.80  Volume development 1.41
Watershed/lake area ratio 6.7
Origin of basin: Natural
Estimated annual precipitation 69. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
From Big Spirit L
Outlet: To Upper Gar L




EAST OKOBOJI
Dickinson County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.11 |
| Chlorophyll a mg/cubic meter | 9 | 25.8 | 8.29 |
| Total phosphorus mg/cubic meter | 10 | 139.1 | 11.02 |
| Kjeldahl nitrogen mg/l | 2 | 1.2 | 0.04 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.04 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.7 | 0.02 |
| Seston dry weight mg/l | 11 | 13.6 | 1.49 |
| Turbidity JTU | 10 | 12.2 | 0.93 |
| Total hardness mg/l as $CaCO_3$ | 9 | 230.7 | 5.99 |
| Calcium hardness mg/l as $CaCO_3$ | 9 | 98.7 | 3.46 |
| Total alkalinity mg/l as $CaCO_3$ | 10 | 196.3 | 1.21 |
| Dissolved oxygen mg/l | 10 | 7.4 | 0.88 |
| Specific conductance micromhos/cm at 25 C | 9 | 422.2 | 5.96 |
| Sulfate mg/l | 3 | 28.7 | 0.67 |
| Chloride mg/l | 3 | 15.0 | 0.00 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 7.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.7 | 5.3 | 175.7 | 8.1 | 8.2 |
| 1 | 21.7 | | | | |
| 2 | 21.7 | 5.1 | 168.8 | 8.1 | 7.5 |
| 3 | 21.7 | | | | |
| 4 | 21.7 | 5.1 | 165.7 | 8.1 | 3.0 |
| 5 | 21.7 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 27.
Potential nutrient input index =
area watershed in row crops/lake area = 5.6
32.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| 125 cattle | Runoff control |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake has also been designated as high quality water and is thus subject to higher standards to protect existing uses.
This lake is not designated as a public water supply.

Public parks:
Isthmus Park Access (State)
Gilbert's Park (City)
Memorial Park (City)
Clare Wilson Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 13237. | 7.2 | 17.8 |
| Shore or ice fishing | 45446. | 24.8 | 61.2 |
| Swimming | 35283. | 19.2 | 47.5 |
| Pleasure boating | 24488. | 13.3 | 33.0 |
| Hunting | 1867. | 1.0 | 2.5 |
| Picnicking,camping,other activities prompted by the lake's presence | 314484. | 171.4 | 423.3 |
| Snowmobiling | 15178. | 8.3 | 20.4 |
| Ice skating and cross-country skiing | 3127. | 1.7 | 4.2 |
| TOTAL | 453110. | 246.9 | 609.8 |

Special events at East Okoboji Lake contributing to more than normal use include boat races (80 people) and skiing contests (50 people).

IMPAIRMENTS

Swimming and boating may be impaired in East Okoboji throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Frequent summerkills and occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential because of limited shoreline access and poor fishing.

Estimated aquatic plant coverage 15 %
Estimated winterkill frequencies: 1 year out of 7-10
Estimated summerkill frequencies: 1 year out of 3-5

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices

recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

EASTER LAKE

LOCATION

County: Polk — Latitude 41 Deg 33 Min N; Longitude 93 Deg 33 Min W

Township 78 N — Range 23 W — Section 19

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
2618. hectares ( 6470. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 2618. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 43.5 | 13.6 | 2.8 | 37.6 | 2.5 |

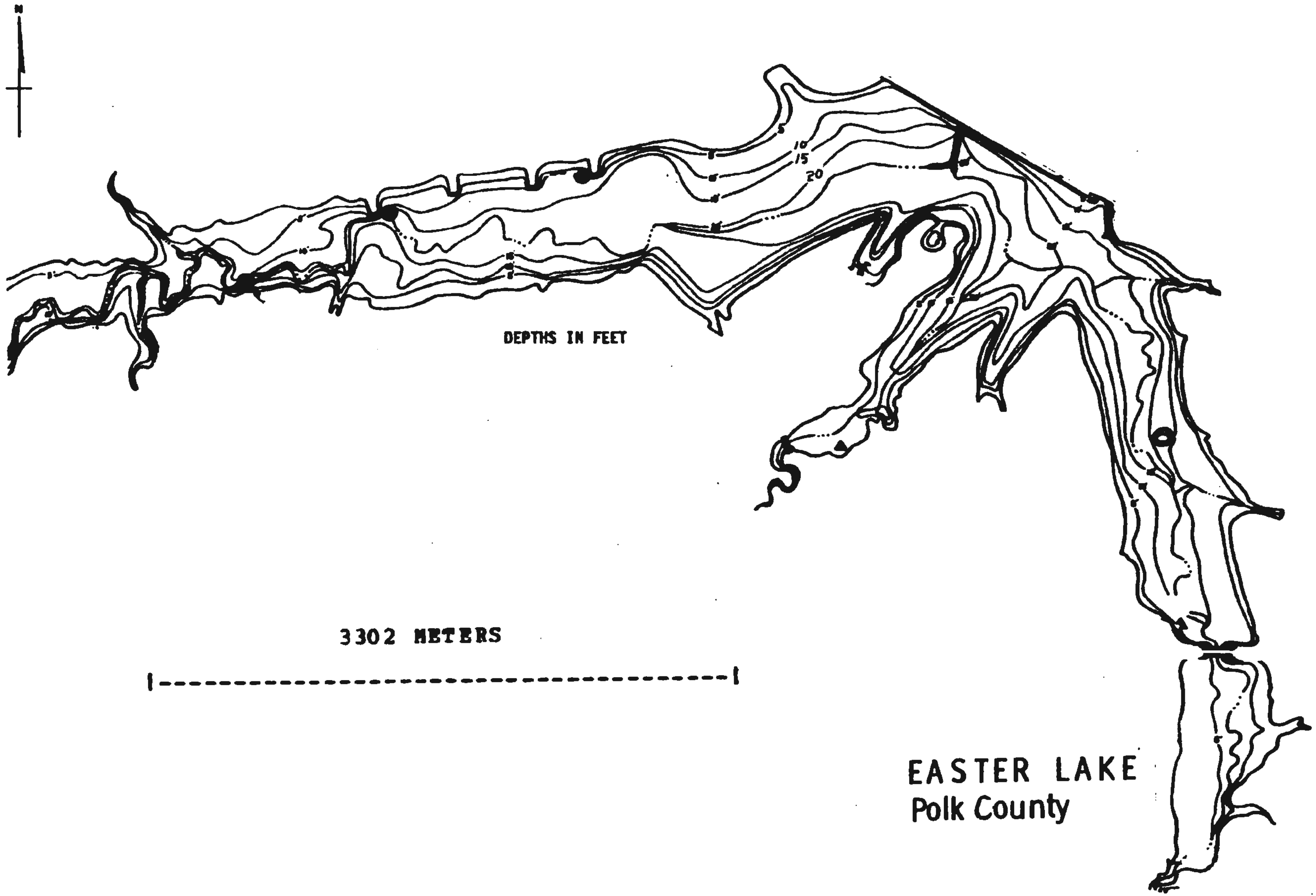
Description of topography and soils in soil associations represented in the watershed

30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1977 map
Area 70. ha ( 172. A)
Length of shoreline 10747. m ( 35260. ft)
Maximum depth 7.6 m ( 25.0 ft)
Mean depth 3.3 m ( 11. ft)
Volume 2326057. cubic meters ( 1885. acre-feet)
Shoreline development 3.64 Volume development 1.32
Watershed/lake area ratio 37.4
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 94. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Yeader Cr
Outlet: Yeader Cr
208 Agency:
Des Moines 208 Agency
Central Iowa Regional Association of Local Govts.
104 East Locust St.
Des Moines, IA 50306




EASTER LAKE
Polk County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.0 | 0.10 |
| Chlorophyll a mg/cubic meter | 8 | 28.0 | 5.59 |
| Total phosphorus mg/cubic meter | 8 | 54.5 | 3.56 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.0 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 8 | 9.4 | 0.81 |
| Turbidity JTU | 10 | 8.0 | 0.60 |
| Total hardness mg/l as CaCO3 | 9 | 170.0 | 1.80 |
| Calcium hardness mg/l as CaCO3 | 9 | 107.6 | 0.93 |
| Total alkalinity mg/l as CaCO3 | 8 | 122.0 | 1.25 |
| Dissolved oxygen mg/l | 8 | 9.1 | 0.28 |
| Specific conductance micromhos/cm at 25 C | 10 | 362.0 | 12.02 |
| Sulfate mg/l | 3 | 50.0 | 1.04 |
| Chloride mg/l | 3 | 22.5 | 0.29 |
| Sodium mg/l | 2 | 13.5 | 0.50 |
| Potassium mg/l | 2 | 3.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/21/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.7 | 10.0 | 55.2 | 8.7 | 55.8 |
| 1 | 23.7 | | | | |
| 2 | 23.4 | 7.4 | 70.3 | 8.3 | 48.6 |
| 3 | 22.9 | | | | |
| 4 | 22.4 | | | | |
| 5 | 20.0 | 0.6 | 70.7 | 7.7 | 14.2 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 224.
Potential nutrient input index =
area watershed in row crops/lake area = 16.3
90.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

Source/NPEDES # (if any)      Comments

Des Moines Municipal Airport  Stormwater runoff

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Yeader Creek Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 4905. | 28.5 | 70.1 |
| Shore or ice fishing | 15334. | 89.2 | 219.1 |
| Swimming | 25388. | 147.6 | 362.7 |
| Pleasure boating | 2713. | 15.8 | 38.8 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 36002. | 209.3 | 514.3 |
| Snowmobiling | 782. | 4.5 | 11.2 |
| Ice skating and cross-country skiing | 782. | 4.5 | 11.2 |
| TOTAL | 85906. | 499.5 | 1227.2 |

IMPAIRMENTS

Swimming may be impaired in Easter Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing. Renovation of the fishery was completed in 1978.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can

make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

ELDRED SHERWOOD LAKE

LOCATION
County: Hancock    Latitude 42 Deg 56 Min N
Longitude 93 Deg 34 Min W
Township 94 N    Range 23 W    Section 21

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
778. hectares ( 1923. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 117 | 597. | 76.7 |
| 14 | 181. | 23.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 70.9 | 16.1 | 10.2 | 0.0 | 2.8 |

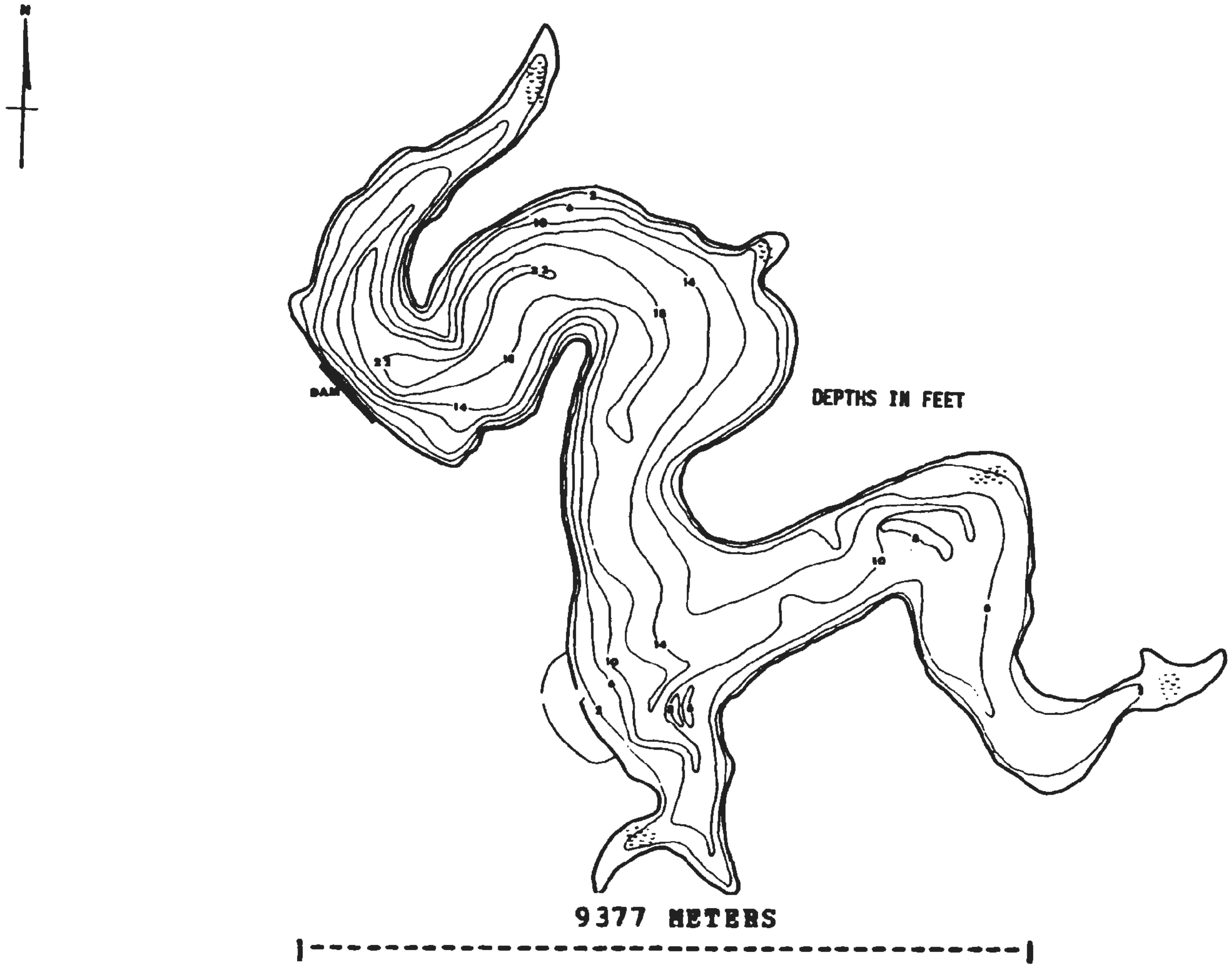
Description of topography and soils in soil associations represented in the watershed

117 Nearly level to very steep (0-40%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes some soils on bottomlands and terraces. Storden and Clarion soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 8. ha ( 21. A)
Length of shoreline 2709. m ( 8887. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 2.8 m ( 9. ft)
Volume 235182. cubic meters ( 191. acre-feet)
Shoreline development 2.65    Volume development 1.26
Watershed/lake area ratio 97.3
Origin of basin: Impoundment
Estimated annual precipitation 79. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




ELDRED SHERWOOD LAKE
Hancock County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.07 |
| Chlorophyll a mg/cubic meter | 10 | 70.0 | 6.74 |
| Total phosphorus mg/cubic meter | 9 | 106.5 | 9.40 |
| Kjeldahl nitrogen mg/l | 2 | 1.2 | 0.12 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 8.0 | 0.11 |
| Seston dry weight mg/l | 10 | 18.2 | 1.20 |
| Turbidity JTU | 9 | 9.1 | 0.71 |
| Total hardness mg/l as CaCO3 | 9 | 371.1 | 15.32 |
| Calcium hardness mg/l as CaCO3 | 10 | 258.2 | 11.32 |
| Total alkalinity mg/l as CaCO3 | 9 | 279.8 | 15.48 |
| Dissolved oxygen mg/l | 8 | 8.2 | 1.18 |
| Specific conductance micromhos/cm at 25 C | 10 | 654.5 | 18.23 |
| Sulfate mg/l | 8 | 32.6 | 1.01 |
| Chloride mg/l | 9 | 21.8 | 0.24 |
| Sodium mg/l | 3 | 5.3 | 0.33 |
| Potassium mg/l | 3 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 19.4 | 6.6 | 146.4 | 7.8 | 93.2 |
| 1 | 18.9 | 4.2 | 140.9 | 7.8 | 65.9 |
| 2 | 17.8 | | | | |
| 3 | 17.2 | 9.4 | 136.4 | 7.6 | 17.2 |
| 4 | 17.2 | | | | |
| 5 | 17.2 | 0.2 | 216.8 | 7.5 | 12.7 |
| 6 | 17.2 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 389.
Potential nutrient input index =
area watershed in row crops/lake area = 69.0
45.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, crop rotation, terraces.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Eldred Sherwood Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2432. | 115.8 | 304.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 5167. | 246.0 | 645.9 |
| Swimming | 7424. | 353.5 | 928.0 |
| Pleasure boating | 1180. | 56.2 | 147.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 13617. | 648.4 | 1702.1 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 29820. | 1420.0 | 3727.5 |

Special events at Eldred Sherwood Lake contributing to more than normal use include the Girl Scout Day Camp (100 people).

IMPAIRMENTS

Swimming may be impaired in Eldred Sherwood Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential because there is no boat access.

Estimated aquatic plant coverage 4 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

FIVE ISLAND LAKE

LOCATION

County: Palo Alto      Latitude 43 Deg 8 Min N
                       Longitude 94 Deg 39 Min W

Township 96 N      Range 32 W      Section 18

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
3411. hectares ( 8429. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 1971. | 57.8 |
| 14 | 1440. | 42.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 92.9 | 3.9 | 0.1 | 0.0 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

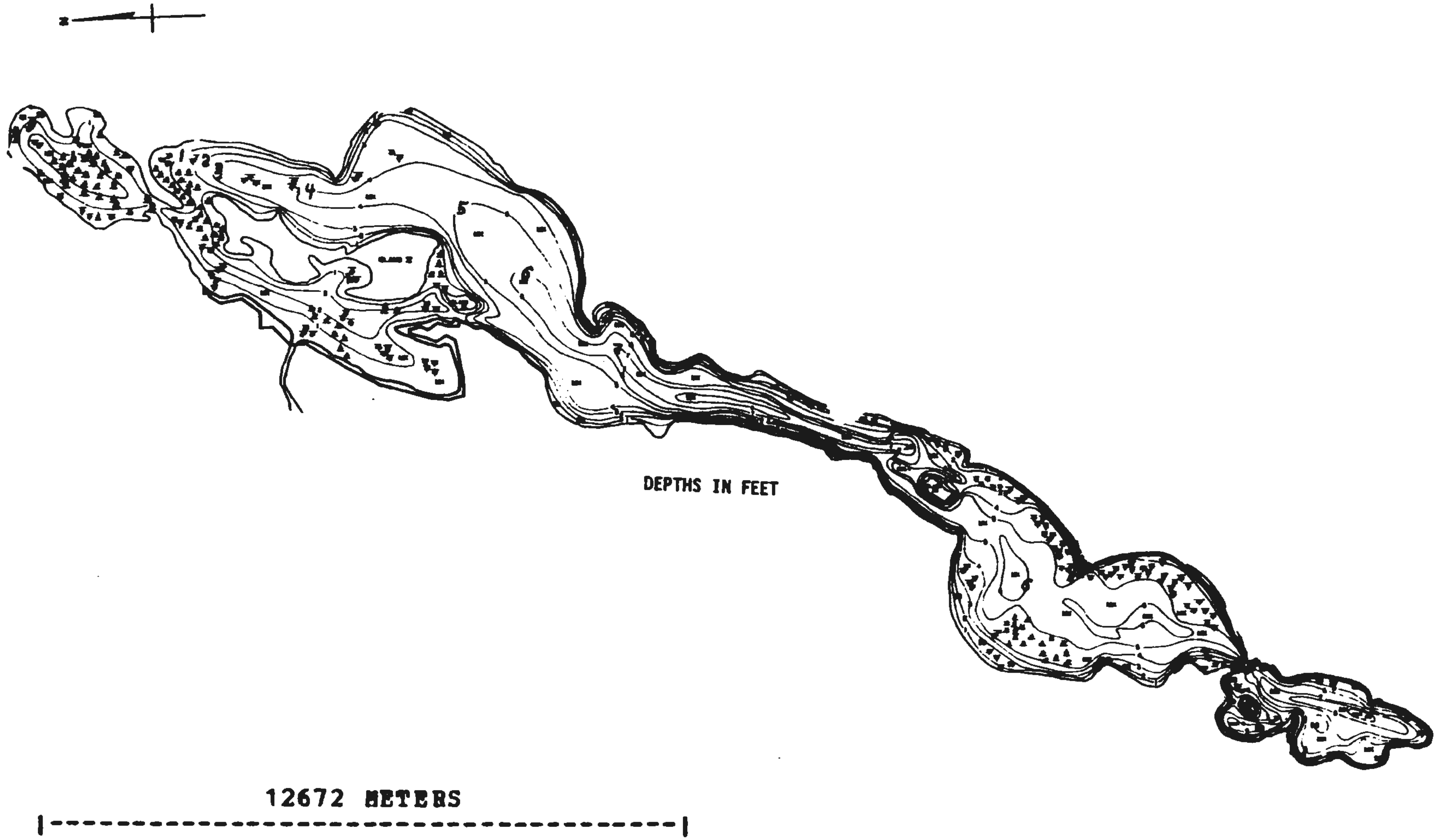
12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

Per cent of shoreline in public ownership 26 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1970 map
Area 404. ha ( 998. A)
Length of shoreline 20481. m ( 67196. ft)
Maximum depth 2.6 m ( 9.0 ft)
Mean depth 1.0 m ( 3. ft)
Volume 4221342. cubic meters ( 3421. acre-feet)
Shoreline development 2.87    Volume development 1.21
Watershed/lake area ratio 8.4
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: Drainage Ditch 80




FIVE ISLAND LAKE
Palo Alto County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 3 | 2.4 | 0.12 |
| Chlorophyll a mg/cubic meter | 10 | 2.7 | 0.48 |
| Total phosphorus mg/cubic meter | 11 | 147.3 | 2.90 |
| Kjeldahl nitrogen mg/l | 2 | 1.1 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 10 | 2.7 | 0.49 |
| Turbidity JTU | 11 | 1.6 | 0.08 |
| Total hardness mg/l as CaCO3 | 11 | 192.0 | 2.34 |
| Calcium hardness mg/l as CaCO3 | 10 | 113.2 | 6.51 |
| Total alkalinity mg/l as CaCO3 | 11 | 147.4 | 4.21 |
| Dissolved oxygen mg/l | 9 | 5.6 | 0.70 |
| Specific conductance micromhos/cm at 25 C | 11 | 391.4 | 14.56 |
| Sulfate mg/l | 3 | 16.2 | 0.67 |
| Chloride mg/l | 3 | 33.5 | 0.01 |
| Sodium mg/l | 2 | 8.0 | 0.00 |
| Potassium mg/l | 2 | 3.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.3 | 3.9 | 145.1 | 7.9 | 2.8 |
| 1 | 21.2 | 3.8 | 139.5 | 7.9 | 4.1 |
| 2 | 21.1 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 13.
Potential nutrient input index =
area watershed in row crops/lake area = 7.8
70.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, crop rotation, terraces, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Kearney Park (City)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 830. | 0.8 | 2.1 |
| Shore or ice fishing | 9407. | 9.4 | 23.3 |
| Swimming | 955. | 1.0 | 2.4 |
| Pleasure boating | 2423. | 2.4 | 6.0 |
| Hunting | 1173. | 1.2 | 2.9 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 26698. | 26.8 | 66.1 |
| Snowmobiling | 7392. | 7.4 | 18.3 |
| Ice skating and cross-country skiing | 19100. | 19.1 | 47.3 |
| TOTAL | 67978. | 68.1 | 168.3 |

Special events at Five Island Lake contributing to more than normal use include boat races (150-200 people).

IMPAIRMENTS

Aquatic vascular plant growth in Five Island Lake may impair boating and shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 33 %
Estimated winterkill frequencies: 1 year out of 5-7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE GEODE

LOCATION
County: Henry    Latitude 40 Deg 49 Min N
Longitude 91 Deg 23 Min W
Township 70 N    Range 5 W    Section 36

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
3994. hectares ( 9869. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 18. | 0.4 |
| 47 | 2104. | 52.7 |
| 50 | 1872. | 46.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 68.4 | 19.1 | 9.9 | 0.0 | 2.6 |

Description of topography and soils in soil associations represented in the watershed

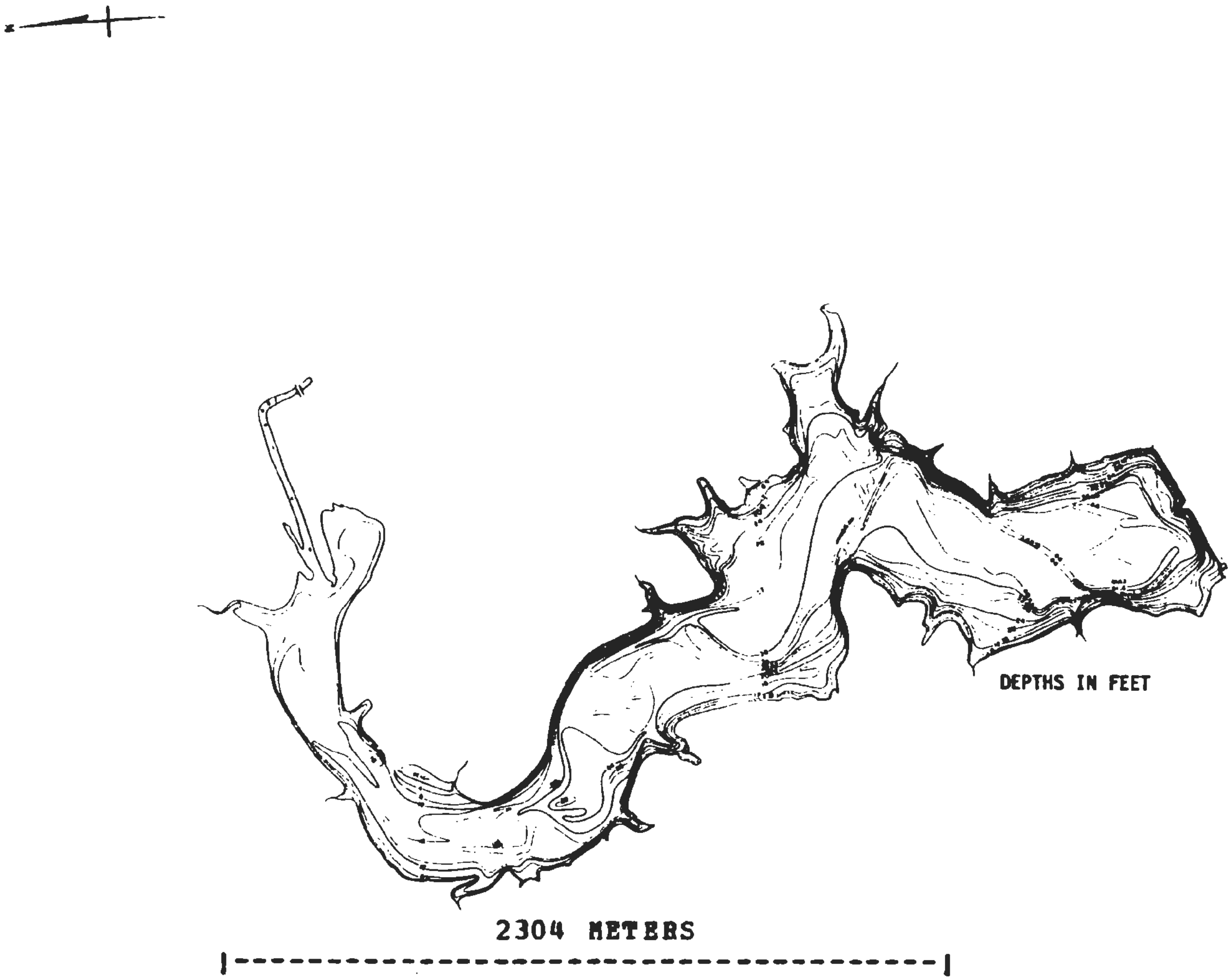
7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

47 Moderately sloping to very steep (5-30%) forest-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Clinton, Lindley, and Keswick soils.

50 Nearly level to moderately sloping (0-9%) prairie to forest-derived soils developed from loess. Mahaska, Taintor, Clinton, and Givin soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1973 map
Area 76. ha ( 187. A)
Length of shoreline 9108. m ( 29883. ft)
Maximum depth 15.8 m ( 52.0 ft)
Mean depth 7.2 m ( 24. ft)
Volume 5570858. cubic meters ( 4515. acre-feet)
Shoreline development 2.92    Volume development 1.36
Watershed/lake area ratio 52.6
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Cedar Cr




LAKE GEODE
Henry County

Outlet: Cedar Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 4 | 1.0 | 0.15 |
| Chlorophyll a mg/cubic meter | 11 | 21.6 | 3.63 |
| Total phosphorus mg/cubic meter | 10 | 37.2 | 1.69 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.06 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 10 | 8.4 | 1.40 |
| Turbidity JTU | 10 | 3.7 | 0.28 |
| Total hardness mg/l as CaCO3 | 10 | 124.8 | 5.56 |
| Calcium hardness mg/l as CaCO3 | 10 | 68.4 | 5.23 |
| Total alkalinity mg/l as CaCO3 | 10 | 93.0 | 4.70 |
| Dissolved oxygen mg/l | 10 | 10.2 | 0.58 |
| Specific conductance micromhos/cm at 25 C | 10 | 283.5 | 9.89 |
| Sulfate mg/l | 6 | 27.2 | 2.68 |
| Chloride mg/l | 6 | 18.3 | 4.14 |
| Sodium mg/l | 2 | 10.5 | 0.50 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 8/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 32.1 | 11.7 | 37.2 | 9.2 | 20.2 |
| 1 | 31.6 | 11.6 | 32.3 | 9.3 | 15.7 |
| 2 | 30.1 | 13.8 | 38.9 | 9.2 | 27.7 |
| 3 | 28.3 | | | | |
| 4 | 26.6 | | | | |
| 5 | 22.9 | 0.2 | 40.3 | 7.7 | 15.0 |
| 6 | 18.2 | | | | |
| 7 | 15.2 | | | | |
| 8 | 12.6 | | | | |
| 9 | 11.5 | 0.1 | 172.6 | 7.5 | 4.1 |
| 10 | 11.1 | | | | |
| 11 | 10.6 | | | | |
| 12 | 10.1 | 0.1 | 619.0 | 7.4 | 9.0 |
| 13 | 9.8 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 654.
Potential nutrient input index =
area watershed in row crops/lake area = 35.5
64.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
terraces, gulley control structures/ erosion control structures, conservation tillage, pastureland and pastureland improvement, .

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Lake Geode State Park | Water intake filter backwash |
| 40 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.

This lake is not designated as a public water supply.

Public parks:
Geode State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 7426. | 39.7 | 97.7 |
| Shore or ice fishing | 6878. | 36.8 | 90.5 |
| Swimming | 57640. | 308.2 | 758.4 |
| Pleasure boating | 5581. | 29.8 | 73.4 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking, camping, other activities prompted by the lake's presence | 26453. | 141.5 | 348.1 |
| Snowmobiling | 608. | 3.3 | 8.0 |
| Ice skating and cross-country skiing | 1998. | 10.7 | 26.3 |
| TOTAL | 106584. | 570.0 | 1402.4 |

Special events at Lake Geode contributing to more than normal use include two or three fishing tournaments each year (50 people each).

IMPAIRMENTS

Swimming may be impaired in Lake Geode during part of the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing; possibly resulting from an overabundance of gizzard shad.

Estimated aquatic plant coverage 5 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

GEORGE WYTH LAKE

LOCATION

County: Black Hawk    Latitude 42 Deg 32 Min N
                      Longitude 92 Deg 24 Min W

Township 89 N    Range 13 W    Section 8

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
263. hectares ( 650. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 263. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 67.1 | 12.0 | 9.1 | 7.6 | 4.2 |

Description of topography and soils in soil associations represented in the watershed

7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map

Area 21. ha ( 51. A)

Length of shoreline 2543. m ( 8342. ft)

Maximum depth 4.6 m ( 15.0 ft)

Mean depth 2.7 m ( 9. ft)

Volume 549470. cubic meters ( 445. acre-feet)

Shoreline development 1.58    Volume development 1.75

Watershed/lake area ratio 12.5

Origin of basin: Gravel Pitt

Estimated annual precipitation 84. cm

Estimated annual runoff 15. cm

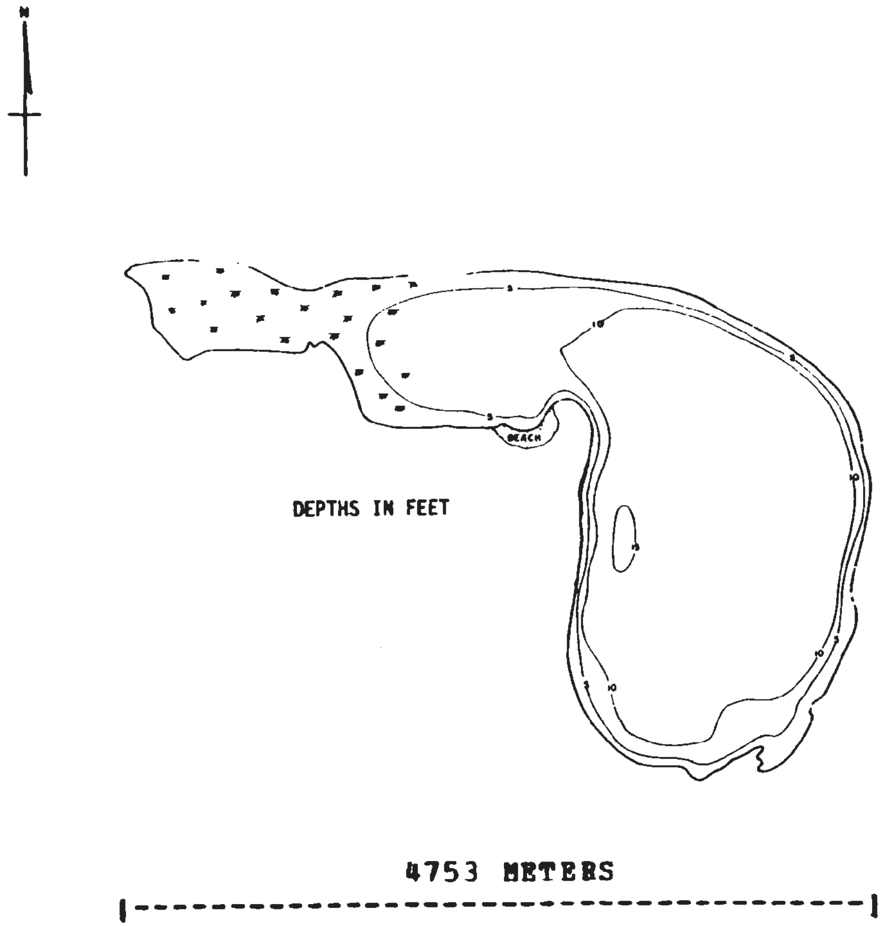
Estimated lake evaporation 86. cm

Thermal stratification? Partial

Major inflows (named and/or permanent streams)
None

Outlet: None

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




GEORGE WYTH LAKE
Black Hawk County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 1.7 | 0.29 |
| Chlorophyll a mg/cubic meter | 10 | 19.9 | 6.09 |
| Total phosphorus mg/cubic meter | 10 | 30.9 | 3.05 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.05 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 12 | 5.9 | 0.96 |
| Turbidity JTU | 10 | 4.6 | 1.06 |
| Total hardness mg/l as CaCO3 | 11 | 150.4 | 3.07 |
| Calcium hardness mg/l as CaCO3 | 11 | 76.4 | 1.92 |
| Total alkalinity mg/l as CaCO3 | 11 | 104.5 | 2.44 |
| Dissolved oxygen mg/l | 11 | 8.7 | 0.35 |
| Specific conductance micromhos/cm at 25 C | 11 | 322.7 | 8.18 |
| Sulfate mg/l | 3 | 37.7 | 0.67 |
| Chloride mg/l | 3 | 20.8 | 0.17 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.7 | 9.2 | 25.4 | 8.9 | 12.9 |
| 1 | 26.7 | 9.1 | 26.0 | 8.9 | 12.5 |
| 2 | 26.7 | | | | |
| 3 | 26.7 | 9.4 | 26.7 | 8.9 | 13.7 |
| 4 | 25.6 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 50.
Potential nutrient input index =
area watershed in row crops/lake area = 8.4
5.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: strip-cropping, field windbreaks.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
George Wyth Memorial State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1772. | 34.7 | 84.4 |
| Shore or ice fishing | 9643. | 189.1 | 459.2 |
| Swimming | 104250. | 2044.1 | 4964.3 |
| Pleasure boating | 1520. | 29.8 | 72.4 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 14C85. | 276.2 | 670.7 |
| Snowmobiling | 1998. | 39.2 | 95.1 |
| Ice skating and cross-country skiing | 869. | 17.0 | 41.4 |
| TOTAL | 134137. | 2630.1 | 6387.5 |

Special events at George Wyth Lake contributing to more than normal use include a sailboat regatta (3,000 people).

IMPAIRMENTS

Recreational activities in George Wyth Lake do not appear to be impaired by poor water quality or aquatic plants. Iowa Conservation Commission personnel consider lake usage to be above its potential.

Estimated aquatic plant coverage 26 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

GREEN CASTLE LAKE

LOCATION

County: Marshall    Latitude 41 Deg 56 Min N
Longitude 92 Deg 52 Min W
Township 82 N    Range 17 W    Section 8

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
107. hectares ( 264. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 59 | 13. | 12.3 |
| 56 | 94. | 87.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 49.5 | 7.2 | 1.4 | 0.0 | 41.9 |

Description of topography and soils in soil associations represented in the watershed

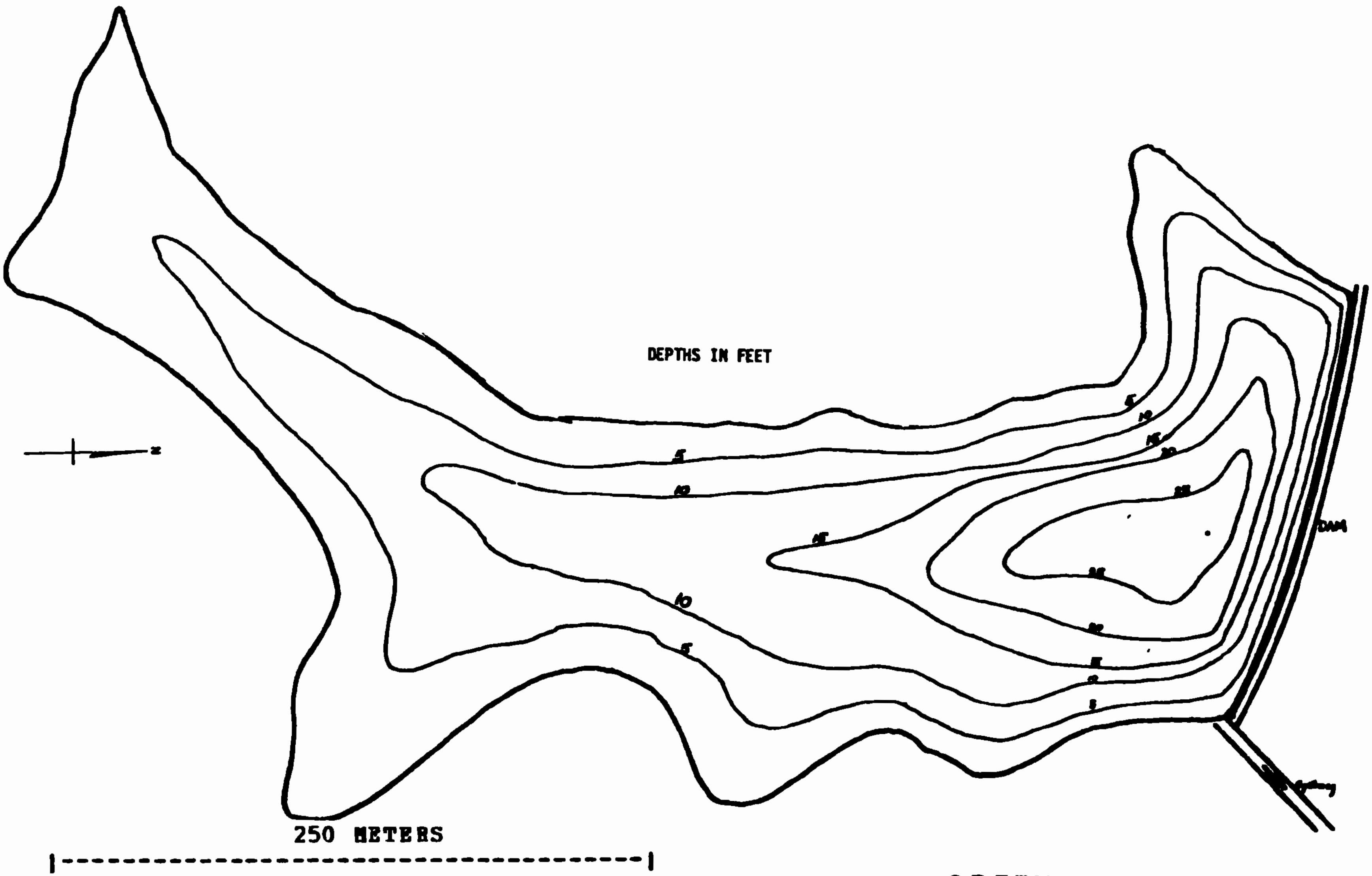
59 Gently to moderately sloping (2-9%) prairie or mixed prairie-forest-derived soils developed from loess or loess over pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, and Downs soils.

56 Gently to strongly sloping (2-14%) prairie to forest-derived soils developed from loess. Tama, Downs, and Fayette soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 3. ha ( 7. A)
Length of shoreline 1754. m ( 5753. ft)
Maximum depth 7.6 m ( 25.0 ft)
Mean depth 2.8 m ( 9. ft)
Volume 182357. cubic meters ( 148. acre-feet)
Shoreline development 1.94    Volume development 1.10
Watershed/lake area ratio 35.7
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




GREEN CASTLE LAKE
Marshall County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 1.6 | 0.12 |
| Chlorophyll a mg/cubic meter | 10 | 51.7 | 22.27 |
| Total phosphorus mg/cubic meter | 8 | 37.2 | 3.07 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.15 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 10 | 5.4 | 0.75 |
| Turbidity JTU | 11 | 3.7 | 0.27 |
| Total hardness mg/l as CaCO3 | 9 | 145.1 | 4.49 |
| Calcium hardness mg/l as CaCO3 | 9 | 77.3 | 2.93 |
| Total alkalinity mg/l as CaCO3 | 10 | 129.6 | 3.42 |
| Dissolved oxygen mg/l | 10 | 8.0 | 0.64 |
| Specific conductance micromhos/cm at 25 C | 10 | 262.5 | 9.17 |
| Sulfate mg/l | 3 | 12.0 | 1.04 |
| Chloride mg/l | 3 | 7.3 | 0.17 |
| Sodium mg/l | 2 | 5.5 | 0.50 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/30/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.6 | 9.2 | 33.8 | 8.4 | 16.7 |
| 1 | 25.0 | 8.7 | 28.6 | 8.4 | 17.4 |
| 2 | 23.3 | 7.1 | 38.6 | 8.2 | 30.7 |
| 3 | 23.3 | | | | |
| 4 | 21.7 | 1.3 | 47.3 | 7.8 | 7.8 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 335.
Potential nutrient input index =
area watershed in row crops/lake area = 7.6
80.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: pastureland and pastureland improvement, conservation tillage, terraces, grass waterways, contouring, strip-cropping.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Green Castle Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 4314. | 616.3 | 1438.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 9024. | 1289.1 | 3008.0 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 295. | 42.1 | 98.3 |
| TOTAL | 13633. | 1947.6 | 4544.3 |

Special events at Green Castle Lake contributing to more than normal use include family reunions (150 people), Ferguson Picnic (110 people), and the Marshalltown Park and Recreation sponsored kid's fishing day (75 people).

IMPAIRMENTS

Aquatic vascular plant growth in Green Castle Lake may impair shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to aquatic vegetation and poor fishing.

Estimated aquatic plant coverage 39 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices

recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

GREEN VALLEY LAKE

LOCATION
County: Union                Latitude   41 Deg  6 Min N
                             Longitude  94 Deg 23 Min W
Township 73 N      Range 31 W      Section 23

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
2004. hectares ( 4952. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 656. | 32.7 |
| 33 | 1348. | 67.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 76.9 | 17.7 | 1.7 | 0.4 | 3.2 |

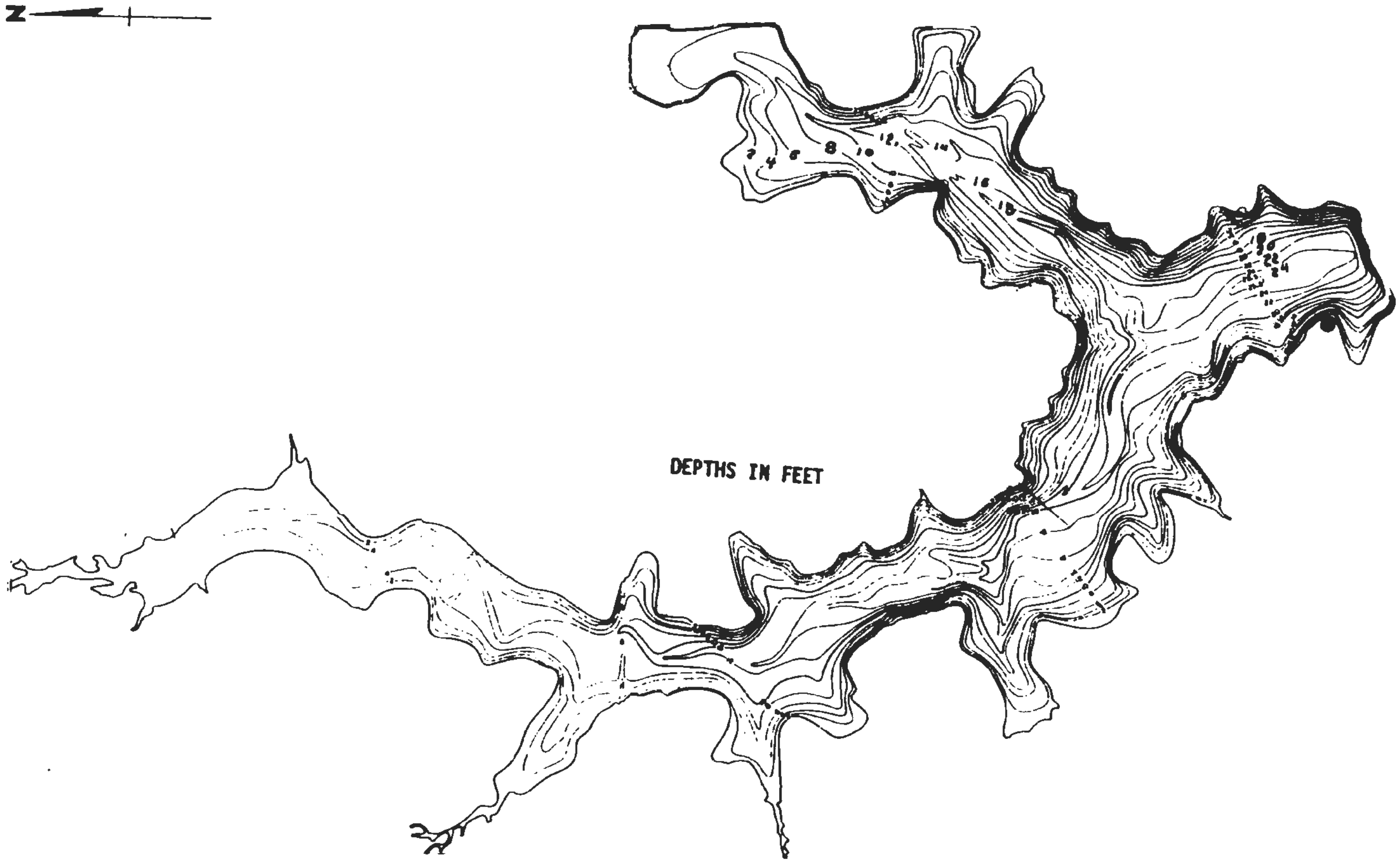
Description of topography and soils in soil associations represented in the watershed

30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

33 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or pre-Wisconsin till-derived paleosols. Sharpsburg, Macksburg, Winterset, and Clarinda soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1973 map
Area 173. ha ( 428. A)
Length of shoreline 19431. m ( 63752. ft)
Maximum depth 7.9 m ( 26.0 ft)
Mean depth 3.0 m ( 10. ft)
Volume 4920956. cubic meters ( 3988. acre-feet)
Shoreline development 4.27    Volume development 1.13
Watershed/lake area ratio 11.6
Origin of basin: Impoundment
Estimated annual precipitation 79. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Platte R
Outlet: Platte R




5069 METERS

GREEN VALLEY LAKE
Union County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.9 | 0.15 |
| Chlorophyll a mg/cubic meter | 10 | 67.7 | 19.76 |
| Total phosphorus mg/cubic meter | 10 | 193.0 | 7.69 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 10 | 12.4 | 1.64 |
| Turbidity JTU | 10 | 9.2 | 1.03 |
| Total hardness mg/l as $CaCO_3$ | 6 | 112.7 | 0.42 |
| Calcium hardness mg/l as $CaCO_3$ | 6 | 82.7 | 1.84 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 106.9 | 0.48 |
| Dissolved oxygen mg/l | 10 | 6.7 | 0.70 |
| Specific conductance micromhos/cm at 25 C | 9 | 252.8 | 12.34 |
| Sulfate mg/l | 4 | 5.7 | 0.97 |
| Chloride mg/l | 5 | 9.7 | 0.12 |
| Sodium mg/l | 2 | 6.0 | 0.00 |
| Potassium mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/ 4/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 24.5 | 6.9 | 207.5 | 8.8 | 59.1 |
| 1 | 24.3 | | | | |
| 2 | 24.3 | 6.9 | 230.7 | 8.9 | 62.5 |
| 3 | 23.9 | | | | |
| 4 | 23.6 | 3.5 | 219.1 | 8.4 | 16.1 |
| 5 | 23.5 | | | | |
| 6 | 23.4 | 1.2 | 257.6 | 8.2 | 15.0 |
| 7 | 23.3 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 9.19-10.79 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 121.
Potential nutrient input index =
area watershed in row crops/lake area = 9.3
44.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, contouring, terraces, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Green Valley State Park | Two one-cell lagoons; Total retention |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 8300 persons at Creston (backup only) also state park.

Public parks:
Green Valley State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 7426. | 17.4 | 42.9 |
| Shore or ice fishing | 11182. | 26.1 | 64.6 |
| Swimming | 16153. | 37.7 | 93.4 |
| Pleasure boating | 4690. | 11.0 | 27.1 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 398000. | 929.9 | 2300.6 |
| Snowmobiling | 250. | 0.6 | 1.4 |
| Ice skating and cross-country skiing | 191. | 0.4 | 1.1 |
| TOTAL | 437892. | 1023.1 | 2531.2 |

Special events at Green Valley Lake contributing to more than normal use include three bass fishing tournaments (75 people).

IMPAIRMENTS

Swimming may be impaired in Green Valley Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to the high algal population.

Estimated aquatic plant coverage 0.5%
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: 1 year out of 3

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see

section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

HANNEN LAKE

LOCATION

County: Benton    Latitude 41 Deg 52 Min N
                  Longitude 92 Deg 7 Min W

Township 82 N    Range 11 W    Section 34

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
235. hectares ( 581. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 57 | 235. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 34.6 | 39.9 | 12.7 | 0.0 | 2.8 |

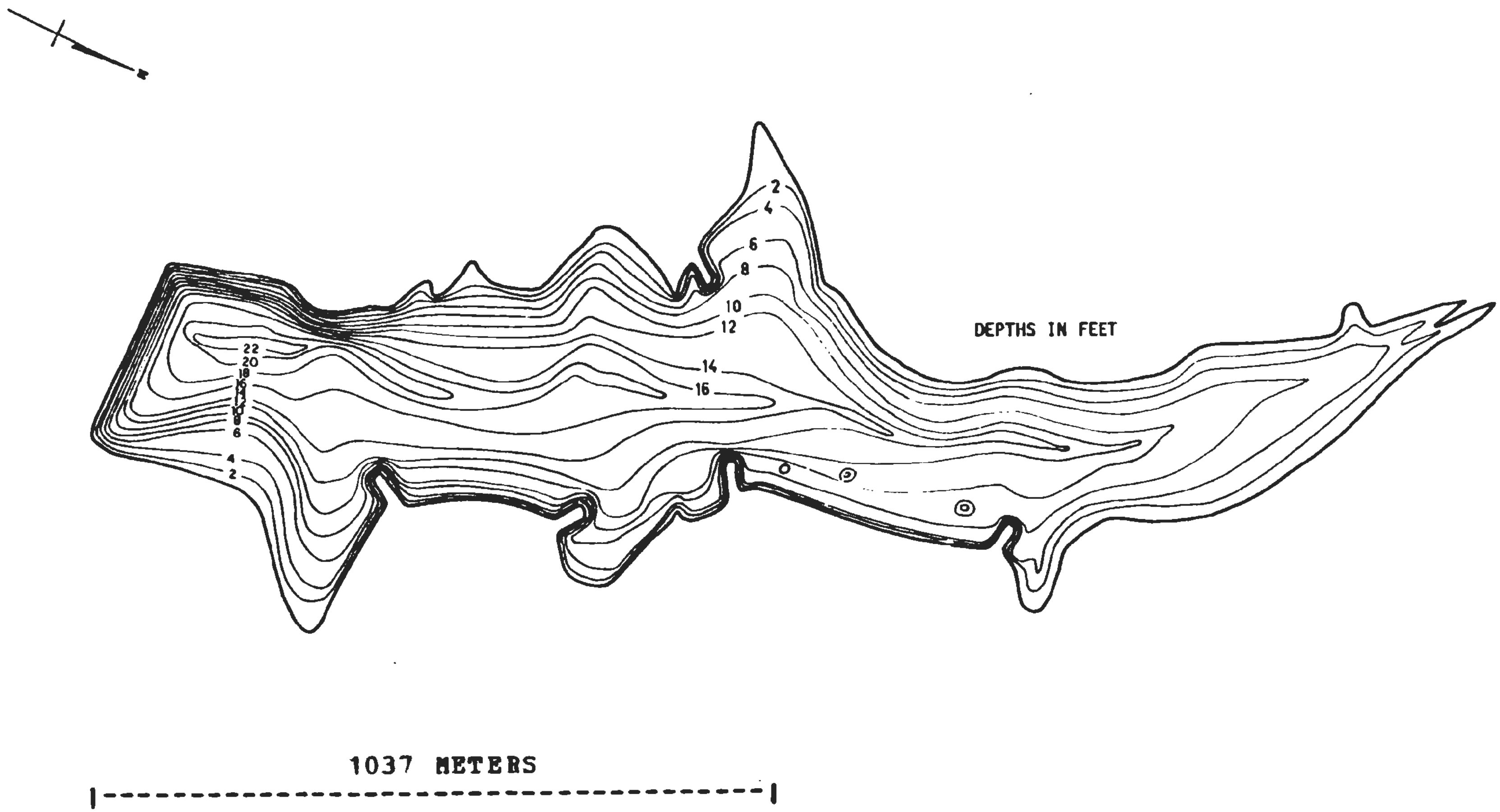
Description of topography and soils in soil associations represented in the watershed

57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 15. ha ( 38. A)
Length of shoreline 2950. m ( 9679. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 2.7 m ( 9. ft)
Volume 411982. cubic meters ( 334. acre-feet)
Shoreline development 2.12    Volume development 1.19
Watershed/lake area ratio 15.7
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




HANNEN LAKE

Benton County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 0.4 | 0.06 |
| Chlorophyll a<br>mg/cubic meter | 9 | 86.7 | 27.69 |
| Total phosphorus<br>mg/cubic meter | 8 | 145.5 | 16.45 |
| Kjeldahl nitrogen<br>mg/l | 2 | 1.3 | 0.03 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight<br>mg/l | 9 | 26.8 | 2.81 |
| Turbidity<br>JTU | 10 | 15.3 | 3.01 |
| Total hardness<br>mg/l as CaCO3 | 10 | 131.0 | 4.98 |
| Calcium hardness<br>mg/l as CaCO3 | 9 | 75.6 | 1.48 |
| Total alkalinity<br>mg/l as CaCO3 | 9 | 118.4 | 3.41 |
| Dissolved oxygen<br>mg/l | 8 | 7.3 | 1.35 |
| Specific conductance<br>micromhos/cm at 25 C | 9 | 251.1 | 11.36 |
| Sulfate<br>mg/l | 3 | 10.2 | 1.59 |
| Chloride<br>mg/l | 3 | 7.5 | 0.00 |
| Sodium<br>mg/l | 2 | 5.5 | 0.50 |
| Potassium<br>mg/l | 2 | 8.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/30/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.7 | 3.1 | 156.6 | 7.6 | 67.4 |
| 1 | 25.4 | 2.8 | 162.0 | 7.8 | 55.8 |
| 2 | 25.1 | | | | |
| 3 | 24.2 | 0.0 | 369.6 | 7.2 | 26.2 |
| 4 | 21.9 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
        (watershed area/lake area) x soil loss rate = 179.
Potential nutrient input index =
        area watershed in row crops/lake area = 5.4
  9.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
   Class A-primary body contact recreation.
   Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
   Hannen Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 5124. | 134.8 | 341.6 |
| Shore or ice fishing | 14376. | 378.3 | 958.4 |
| Swimming | 7445. | 195.9 | 496.3 |
| Pleasure boating | 1258. | 33.1 | 83.9 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 17902. | 471.1 | 1193.5 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 46105. | 1213.3 | 3073.7 |

Special events at Hannen Lake contributing to more than normal use include an ice fisheree (760 people).

IMPAIRMENTS

Swimming may be impaired in Hannen Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. A drawdown was completed in August 1979 to renovate the shoreline.

Estimated aquatic plant coverage 17 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE HENDRICKS

LOCATION

County: Howard    Latitude 43 Deg 22 Min N
Longitude 92 Deg 33 Min W
Township 99 N    Range 14 W    Section 19

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
454. hectares ( 1122. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 61 | 454. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 84.5 | 9.7 | 2.6 | 0.0 | 3.2 |

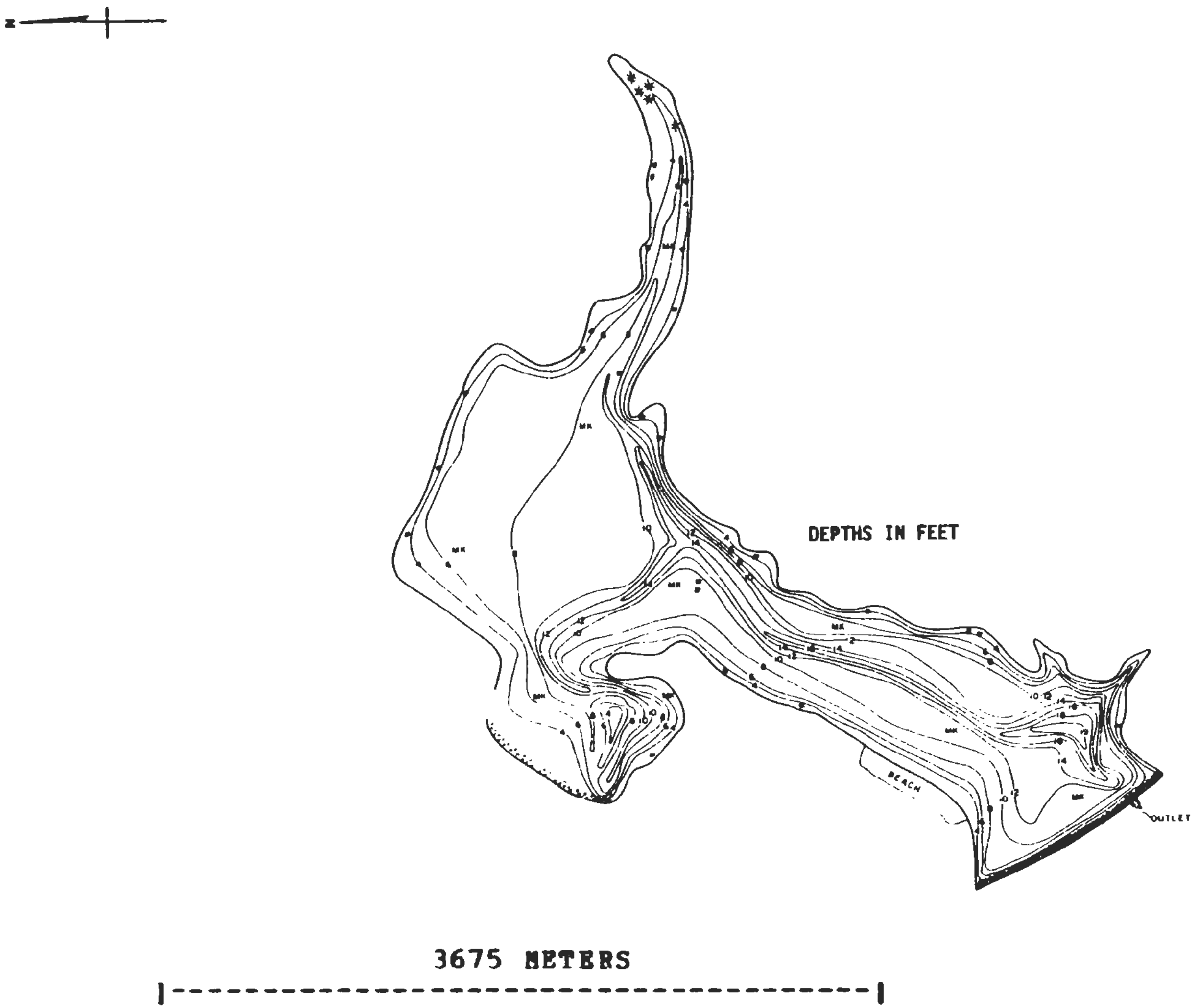
Description of topography and soils in soil associations represented in the watershed

61 Nearly level to moderately sloping (0-9%) prairie and mixed prairie, forest-derived soils developed from pre-Wisconsin till on the Iowan Erosion Surface. Kenyon, Clyde, Floyd, Readlyn, and Bassett soils.

Per cent of shoreline in public ownership 48 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1975 map
Area 16. ha ( 40. A)
Length of shoreline 3125. m ( 10252. ft)
Maximum depth 5.8 m ( 19.0 ft)
Mean depth 2.4 m ( 8. ft)
Volume 384561. cubic meters ( 312. acre-feet)
Shoreline development 2.20    Volume development 1.24
Watershed/lake area ratio 28.4
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 84. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Unnamed
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




LAKE HENDRICKS
Howard County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 4 | 0.6 | 0.08 |
| Chlorophyll a mg/cubic meter | 10 | 75.3 | 14.28 |
| Total phosphorus mg/cubic meter | 10 | 68.3 | 4.23 |
| Kjeldahl nitrogen mg/l | 2 | 0.8 | 0.06 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.06 |
| Nitrate + nitrite nitrogen mg/l | 2 | 1.4 | 0.35 |
| Seston dry weight mg/l | 11 | 17.4 | 1.83 |
| Turbidity JTU | 9 | 11.4 | 1.95 |
| Total hardness mg/l as CaCO3 | 10 | 130.0 | 6.04 |
| Calcium hardness mg/l as CaCO3 | 10 | 83.4 | 5.78 |
| Total alkalinity mg/l as CaCO3 | 10 | 84.4 | 4.99 |
| Dissolved oxygen mg/l | 11 | 10.5 | 0.89 |
| Specific conductance micromhos/cm at 25 C | 10 | 284.0 | 7.18 |
| Sulfate mg/l | 3 | 26.7 | 0.88 |
| Chloride mg/l | 3 | 20.0 | 0.00 |
| Sodium mg/l | 2 | 6.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/10/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.3 | 8.8 | 68.3 | 8.9 | 74.4 |
| 1 | 21.5 | 6.2 | 53.0 | 8.6 | 41.5 |
| 2 | 20.5 | 6.6 | 64.0 | 8.8 | 48.6 |
| 3 | 20.4 | | | | |
| 4 | 20.0 | 1.0 | 100.1 | 7.9 | 28.4 |
| 5 | 18.5 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 170.
Potential nutrient input index =
area watershed in row crops/lake area = 24.0
30.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: tile drainage, conservation tillage, contouring, grass waterways, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
   Class A-primary body contact recreation.
   Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
   Lake Hendricks Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 356. | 8.9 | 22.3 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 820. | 20.5 | 51.3 |
| Swimming | 5210. | 130.3 | 325.6 |
| Pleasure boating | 239. | 6.0 | 14.9 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 11639. | 291.0 | 727.4 |
| Snowmobiling | 1563. | 39.1 | 97.7 |
| Ice skating and cross-country skiing | 590. | 14.8 | 36.9 |
| TOTAL | 20417. | 510.4 | 1276.1 |

Special events at Lake Hendricks contributing to more than normal use include the July 4th fun day (700 people).

IMPAIRMENTS

Swimming may be impaired in Lake Hendricks throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 2 %
Estimated winterkill frequencies: 1 year out of 2
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term

extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

HICKORY GROVE

LOCATION
County: Story    Latitude 41 Deg 59 Min N
Longitude 93 Deg 21 Min W
Township 83 N    Range 22 W    Section 24

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
1611. hectares ( 3982. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 351. | 21.8 |
| 14 | 1261. | 78.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 91.5 | 5.0 | 0.2 | 0.0 | 3.3 |

Description of topography and soils in soil associations represented in the watershed

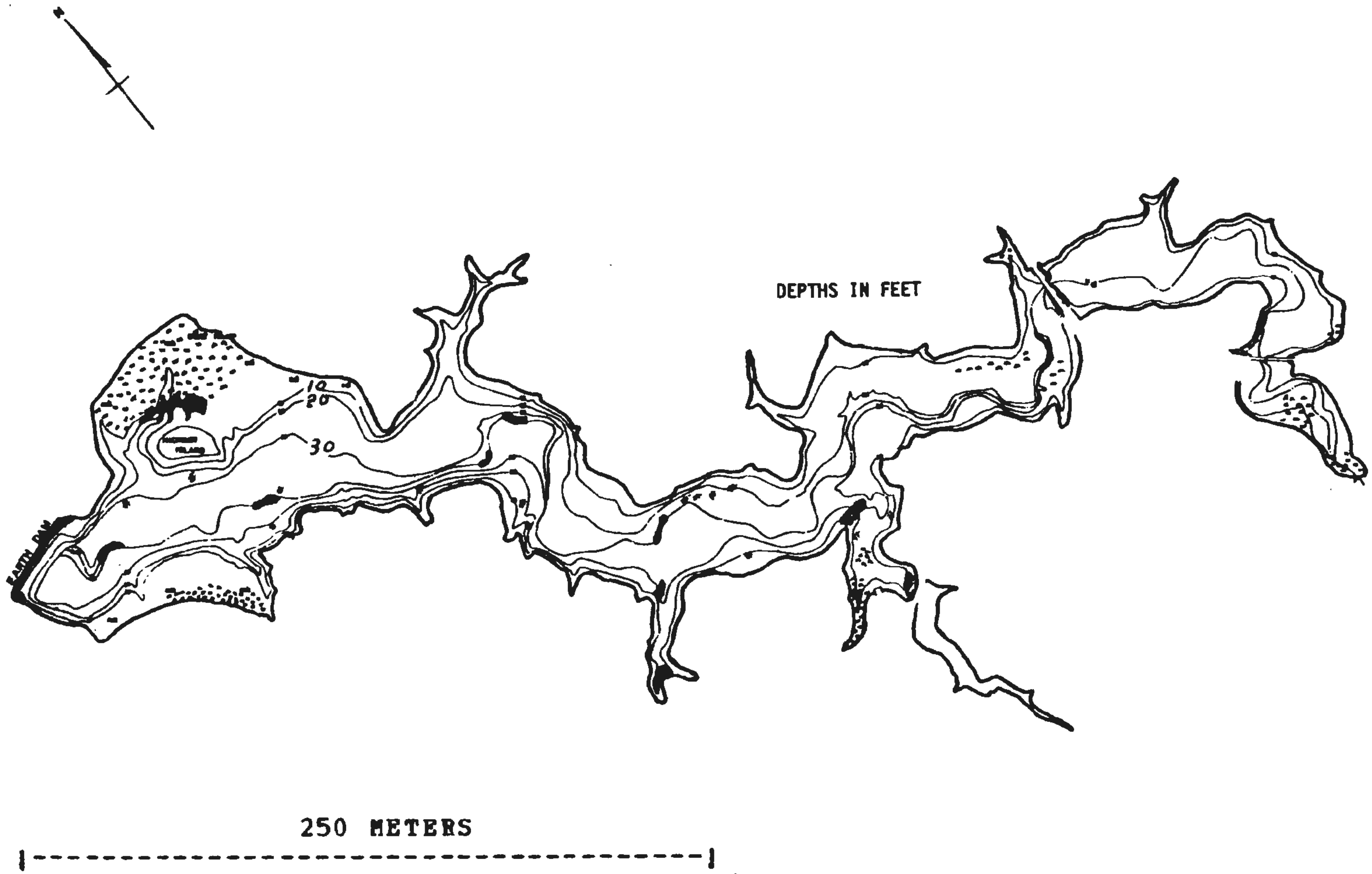
12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 36. ha ( 88. A)
Length of shoreline 8372. m ( 27467. ft)
Maximum depth 13.7 m ( 45.0 ft)
Mean depth 5.0 m ( 16. ft)
Volume 1963068. cubic meters ( 1591. acre-feet)
Shoreline development 3.77 Volume development 1.09
Watershed/lake area ratio 44.8
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Drainage Ditch 75
Outlet: Drainage Ditch 75

312




HICKORY GROVE
Story County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.06 |
| Chlorophyll a mg/cubic meter | 10 | 55.9 | 16.68 |
| Total phosphorus mg/cubic meter | 6 | 61.3 | 8.82 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.05 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.7 | 0.00 |
| Seston dry weight mg/l | 10 | 13.5 | 2.58 |
| Turbidity JTU | 7 | 9.7 | 0.87 |
| Total hardness mg/l as CaCO3 | 6 | 163.3 | 4.28 |
| Calcium hardness mg/l as CaCO3 | 6 | 73.7 | 2.03 |
| Total alkalinity mg/l as CaCO3 | 6 | 110.7 | 2.29 |
| Dissolved oxygen mg/l | 6 | 11.1 | 1.39 |
| Specific conductance micromhos/cm at 25 C | 8 | 321.3 | 7.43 |
| Sulfate mg/l | 5 | 31.0 | 1.54 |
| Chloride mg/l | 6 | 21.9 | 0.30 |
| Sodium mg/l | 3 | 6.0 | 0.00 |
| Potassium mg/l | 3 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.8 | 11.7 | 55.1 | 9.1 | 56.9 |
| 1 | 25.8 | | | | |
| 2 | 24.9 | 7.3 | 49.7 | 8.8 | 45.3 |
| 3 | 23.9 | | | | |
| 4 | 21.0 | 0.1 | 105.9 | 7.7 | 170.6 |
| 5 | 17.8 | | | | |
| 6 | 15.4 | 0.1 | 36.6 | 7.4 | 25.1 |
| 7 | 14.0 | | | | |
| 8 | 12.6 | | | | |
| 9 | 11.6 | 0.0 | 389.8 | 7.3 | 20.2 |
| 10 | 10.8 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 165.
Potential nutrient input index =
area watershed in row crops/lake area = 37.6
30.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Hickory Grove Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 8275. | 94.0 | 229.9 |
| Shore or ice fishing | 18175. | 206.5 | 504.9 |
| Swimming | 22750. | 258.5 | 631.9 |
| Pleasure boating | 12720. | 144.5 | 353.3 |
| Hunting | 5168. | 58.7 | 143.6 |
| Picnicking,camping,other activities prompted by the lake's presence | 54285. | 616.9 | 1507.9 |
| Snowmobiling | 1910. | 21.7 | 53.1 |
| Ice skating and cross-country skiing | 1128. | 12.8 | 31.3 |
| TOTAL | 124411. | 1413.8 | 3455.9 |

Special events at Hickory Grove Lake contributing to more than normal use include an ice drag race (500 people) and a snow festival (500-750 people).

IMPAIRMENTS

Swimming may be impaired in Hickory Grove throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Shoreline erosion may also interfere with shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 29 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Shoreline erosion in Hickory Grove Lake is a serious problem. Shoreline protection with riprap may reduce turbidity and sedimentation in the lake.

Because localized quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is suggsted. While this might be accomplished through the use of chemicals or a White Amur stocking program, the aquatic weed density is relatively small and localized close to shore. Mechanical removal may be the most practical control method; however the cost-effectiveness and suitability of this method should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

HICKORY HILLS LAKE

LOCATION

County: Tama Latitude 42 Deg 16 Min N
Longitude 92 Deg 19 Min W
Township 86 N Range 13 W Section 13

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
299. hectares ( 738. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 77 | 299. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 89.7 | 5.5 | 1.8 | 0.0 | 3.0 |

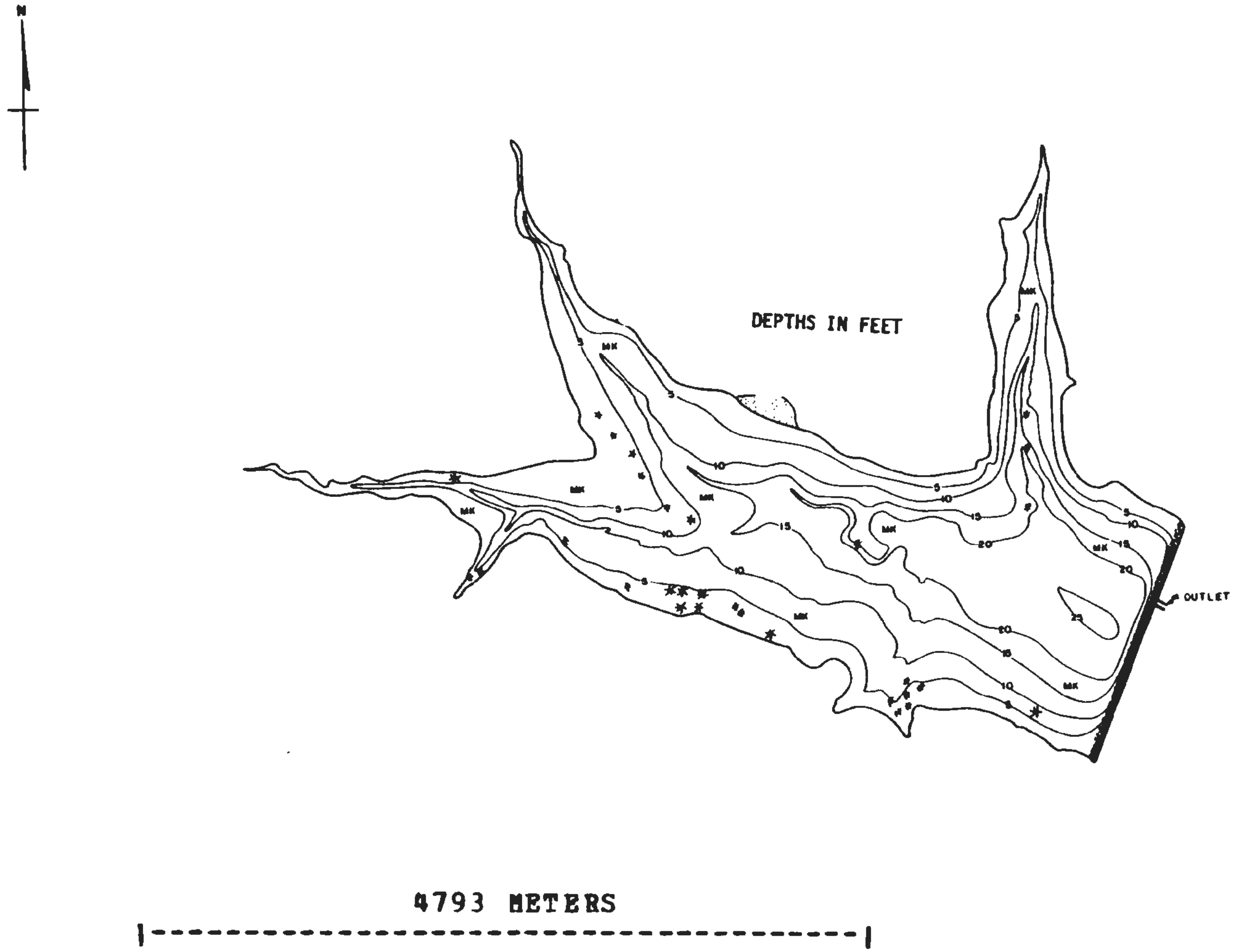
Description of topography and soils in soil associations represented in the watershed

77 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, loess over pre-Wisconsin till or pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, and Kenyon soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1975 map
Area 22. ha ( 54. A)
Length of shoreline 3999. m ( 13120. ft)
Maximum depth 7.6 m ( 25.0 ft)
Mean depth 3.1 m ( 10. ft)
Volume 672436. cubic meters ( 545. acre-feet)
Shoreline development 2.41 Volume development 1.21
Watershed/lake area ratio 13.6
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




# HICKORY HILLS LAKE
Tama County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 5 | 0.4 | 0.07 |
| Chlorophyll a<br>mg/cubic meter | 9 | 120.7 | 15.33 |
| Total phosphorus<br>mg/cubic meter | 9 | 107.8 | 4.02 |
| Kjeldahl nitrogen<br>mg/l | 2 | 1.6 | 0.02 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight<br>mg/l | 10 | 21.9 | 3.31 |
| Turbidity<br>JTU | 8 | 19.3 | 2.33 |
| Total hardness<br>mg/l as $CaCO_3$ | 11 | 122.5 | 2.47 |
| Calcium hardness<br>mg/l as $CaCO_3$ | 9 | 59.3 | 3.09 |
| Total alkalinity<br>mg/l as $CaCO_3$ | 9 | 98.4 | 4.04 |
| Dissolved oxygen<br>mg/l | 8 | 9.8 | 1.10 |
| Specific conductance<br>micromhos/cm at 25 C | 8 | 252.5 | 10.65 |
| Sulfate<br>mg/l | 4 | 19.5 | 1.99 |
| Chloride<br>mg/l | 4 | 7.5 | 0.20 |
| Sodium<br>mg/l | 3 | 3.7 | 0.33 |
| Potassium<br>mg/l | 3 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 1/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.2 | 10.7 | 118.3 | 9.6 | 125.4 |
| 1 | 25.6 | 11.5 | 88.3 | 9.6 | 112.3 |
| 2 | 25.6 | 7.1 | 122.3 | 9.3 | 91.7 |
| 3 | 23.3 | | | | |
| 4 | 20.0 | | | | |
| 5 | 17.8 | 0.0 | 556.9 | 7.5 | 7.5 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 110.
Potential nutrient input index =
area watershed in row crops/lake area = 12.2
77.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, grass waterways, pastureland and pastureland improvement, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Hickory Hills Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1607. | 29.8 | 73.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 4990. | 92.4 | 226.8 |
| Swimming | 13882. | 257.1 | 631.0 |
| Pleasure boating | 117. | 2.2 | 5.3 |
| Hunting | 1307. | 24.2 | 59.4 |
| Picnicking,camping,other activities prompted by the lake's presence | 2591. | 48.0 | 117.8 |
| Snowmobiling | 226. | 4.2 | 10.3 |
| Ice skating and cross-country skiing | 382. | 7.1 | 17.4 |
| TOTAL | 25102. | 464.9 | 1141.0 |

Special events at Hickory Hills Lake contributing to more than normal use include a senior citizen's fish derby (250 people).

IMPAIRMENTS

Swimming may be impaired in Hickory Hills Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. According to Iowa Conservation Commission personnel, White Amur were introduced into the lake in 1978. A turbine type aerator is used during the winter months to prevent anaerobic conditions from developing. I.C.C. personnel consider lake usage to be below its potential due to the dense growth of aquatic vegetation.

Estimated aquatic plant coverage 12 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Various restoration techniques are currently being used in Hickory Hills Lake. A turbine type aerator is being used to maintain dissolved oxygen concentrations. White Amur have been stocked in the lake. Current restrictions on recreational use of the lake due to aquatic plant growth suggest the effectiveness of the White Amur stocking program in Hickory Hills Lake needs to be evaluated.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this

reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE ICARIA

LOCATION

County: Adams    Latitude 41 Deg 3 Min N
Longitude 94 Deg 45 Min W
Township 72 N    Range 34 W    Section 10

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
6795. hectares ( 16791. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 3789. | 55.8 |
| 34 | 3006. | 44.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 69.7 | 22.3 | 4.2 | 0.0 | 3.7 |

Description of topography and soils in soil associations represented in the watershed

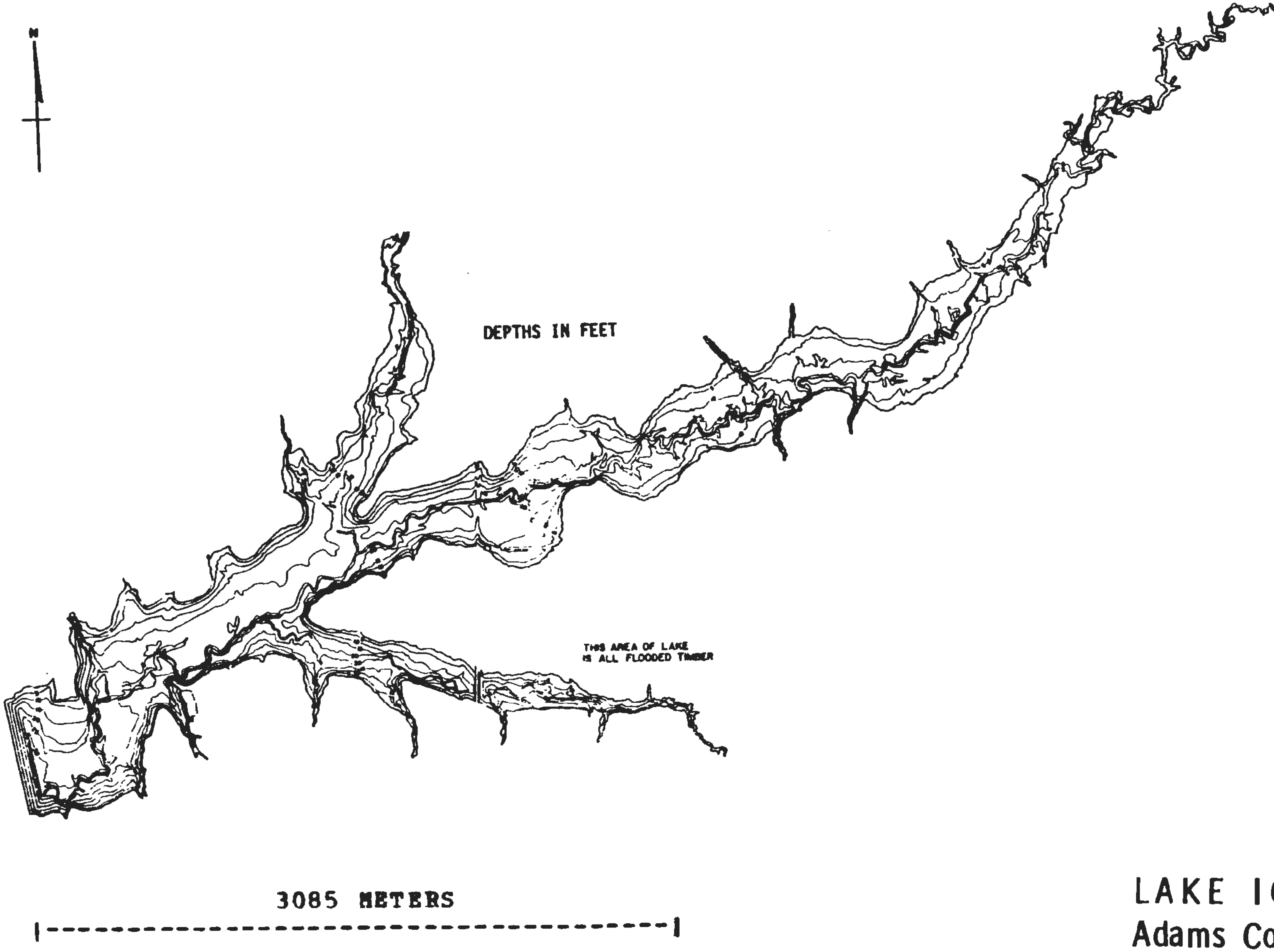
30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

34 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from pre-Wisconsin till, pre-Wisconsin till-derived paleosols, or loess. Shelby, Adair, and Sharpsburg soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1978 map
Area 73. ha ( 180. A)
Length of shoreline 33962. m ( 111425. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 3.2 m ( 11. ft)
Volume 9084581. cubic meters ( 7362. acre-feet)
Shoreline development 5.70    Volume development 1.32
Watershed/lake area ratio 93.1
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 99. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Kemp Cr + 2 Unnamed
Outlet: Kemp Cr




LAKE ICARIA
Adams County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.8 | 0.15 |
| Chlorophyll a mg/cubic meter | 9 | 51.8 | 11.02 |
| Total phosphorus mg/cubic meter | 11 | 54.8 | 2.68 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.05 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.04 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 9 | 11.2 | 1.04 |
| Turbidity JTU | 11 | 8.4 | 1.23 |
| Total hardness mg/l as CaCO3 | 6 | 107.0 | 1.34 |
| Calcium hardness mg/l as CaCO3 | 6 | 73.0 | 0.45 |
| Total alkalinity mg/l as CaCO3 | 9 | 103.6 | 2.44 |
| Dissolved oxygen mg/l | 10 | 8.3 | 0.53 |
| Specific conductance micromhos/cm at 25 C | 10 | 238.5 | 9.66 |
| Sulfate mg/l | 5 | 7.6 | 1.23 |
| Chloride mg/l | 5 | 5.5 | 0.00 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 7/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.3 | 6.9 | 42.1 | 8.2 | 26.9 |
| 1 | 27.3 | 6.5 | 47.5 | 8.3 | 30.7 |
| 2 | 27.1 | 6.5 | 44.1 | 8.1 | 21.7 |
| 3 | 27.0 | | | | |
| 4 | 26.0 | | | | |
| 5 | 24.4 | 1.9 | 91.7 | 7.7 | 13.8 |
| 6 | 23.1 | | | | |
| 7 | 21.8 | 0.3 | 151.3 | 7.6 | 9.4 |
| 8 | 21.1 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 13.20-14.30 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 329.
Potential nutrient input index =
area watershed in row crops/lake area = 16.7
75.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: pastureland and pastureland improvement, conservation planting (trees,grass), conservation tillage, terraces, contouring, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Lake Icaria State Park | Two-cell lagoon; total retention |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
Lake Icaria Recreation Area (County)
Icaria Wildlife Area (State)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 14111. | 78.4 | 193.3 |
| Shore or ice fishing | 14331. | 79.6 | 196.3 |
| Swimming | 14951. | 83.1 | 204.8 |
| Pleasure boating | 33518. | 186.2 | 459.2 |
| Hunting | 13420. | 74.6 | 183.8 |
| Picnicking,camping,other activities prompted by the lake's presence | 56876. | 316.0 | 779.1 |
| Snowmobiling | 1215. | 6.8 | 16.6 |
| Ice skating and cross-country skiing | 1078. | 6.0 | 14.8 |
| TOTAL | 149500. | 830.6 | 2047.9 |

Special events at Lake Icaria contributing to more than normal use include six bass fishing tournaments (125 people).

IMPAIRMENTS

Swimming may be impaired in Lake Icaria during part of the summer because of Secchi depths less than one meter caused by algal populations. According to Iowa Conservation Commission personnel, shoreline erosion (caused by wave action) creates muddy conditions and reduces shoreline access. I.C.C. personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 8 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Shoreline erosion in Lake Icaria is extensive. Riprapping may improve water quality in the lake by reducing the concentration of suspended material in the water column.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this

reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

INDIAN LAKE

LOCATION

County: Van Buren  Latitude 40 Deg 38 Min N  
Longitude 91 Deg 45 Min W  
Township 67 N  Range 8 W  Section 2

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)  
144. hectares ( 356. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 73. | 50.8 |
| 44 | 71. | 49.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 68.4 | 19.4 | 8.5 | 0.0 | 3.7 |

Description of topography and soils in soil associations represented in the watershed

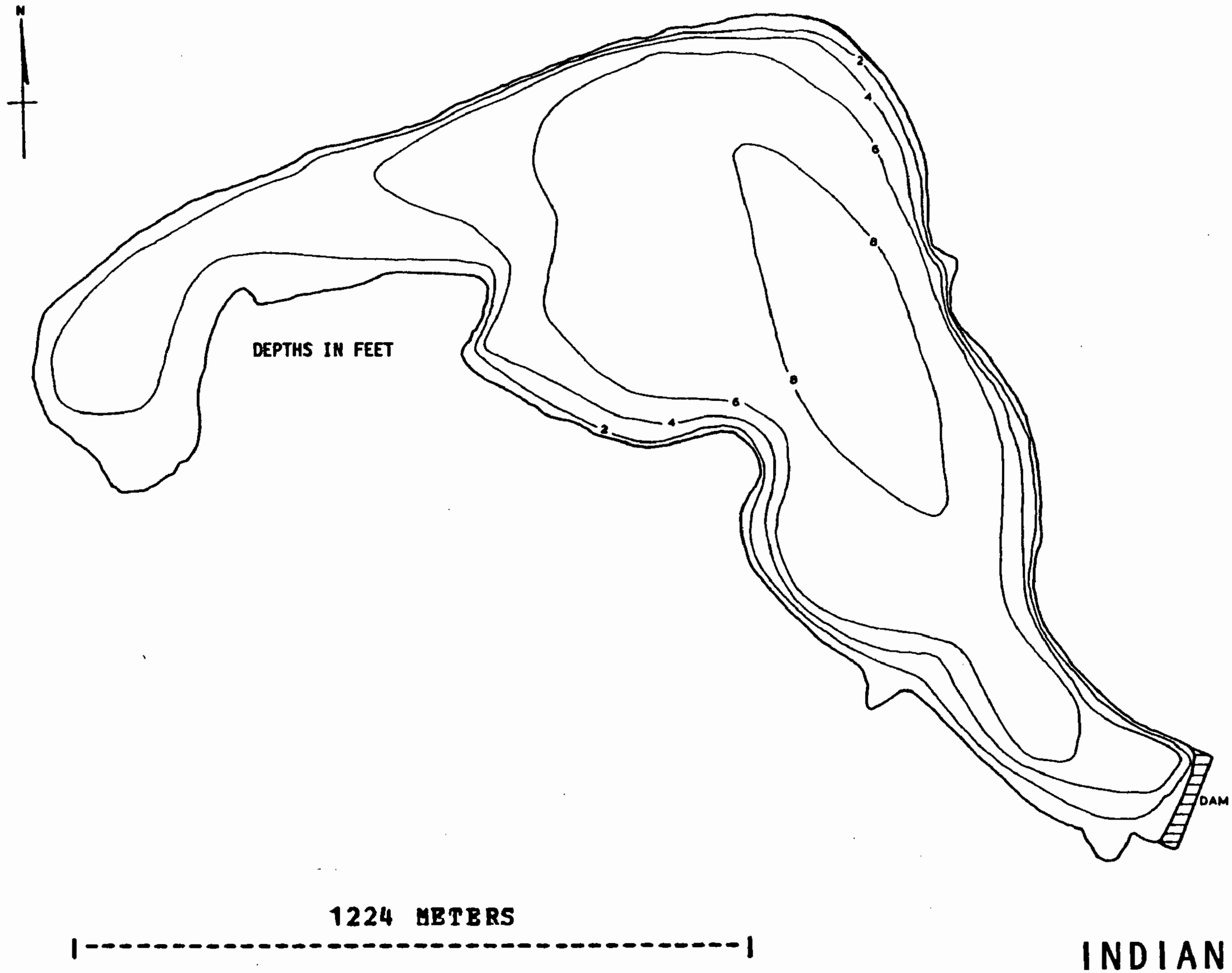
7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

44 Gently to strongly sloping (0-14%) prairie to forest-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Grundy, Pershing, Weller, Keswick, and Lindley soils.

Per cent of shoreline in public ownership 85 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map  
Area 21. ha ( 51. A)  
Length of shoreline 2766. m ( 9075. ft)  
Maximum depth 2.4 m ( 8.0 ft)  
Mean depth 1.5 m ( 5. ft)  
Volume 307925. cubic meters ( 250. acre-feet)  
Shoreline development 1.72  Volume development 1.84  
Watershed/lake area ratio 6.9  
Origin of basin: Impoundment  
Estimated annual precipitation 89. cm  
Estimated annual runoff 18. cm  
Estimated lake evaporation 91. cm  
Thermal stratification? Partial  
Major inflows (named and/or permanent streams)  
None  
Outlet: Unnamed




INDIAN LAKE
Van Buren County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.06 |
| Chlorophyll a mg/cubic meter | 10 | 23.0 | 3.58 |
| Total phosphorus mg/cubic meter | 8 | 62.1 | 6.18 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.0 | 0.01 |
| Seston dry weight mg/l | 10 | 15.5 | 1.63 |
| Turbidity JTU | 9 | 8.3 | 1.07 |
| Total hardness mg/l as $CaCO_3$ | 12 | 127.5 | 3.86 |
| Calcium hardness mg/l as $CaCO_3$ | 11 | 91.8 | 2.59 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 91.6 | 1.66 |
| Dissolved oxygen mg/l | 10 | 8.7 | 0.72 |
| Specific conductance micromhos/cm at 25 C | 10 | 286.0 | 13.64 |
| Sulfate mg/l | 3 | 40.6 | 1.59 |
| Chloride mg/l | 3 | 5.5 | 0.00 |
| Sodium mg/l | 2 | 7.0 | 0.00 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/ 6/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.8 | 11.2 | 58.3 | 9.0 | 31.4 |
| 1 | 26.7 | 11.5 | 60.6 | 9.0 | 37.4 |
| 2 | 25.6 | 3.2 | 94.8 | 8.0 | 39.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 78.
Potential nutrient input index =
area watershed in row crops/lake area = 4.7
75.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation planting (trees,grass).

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Indian Lake Park (City of Farmington)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1901. | 37.3 | 90.5 |
| Shore or ice fishing | 2325. | 45.6 | 110.7 |
| Swimming | 2977. | 58.4 | 141.8 |
| Pleasure boating | 413. | 8.1 | 19.7 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 10441. | 204.7 | 497.2 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 18057. | 354.1 | 859.9 |

IMPAIRMENTS

Swimming may be impaired in Indian Lake throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to a poor fish population.

Estimated aquatic plant coverage 5 %
Estimated winterkill frequencies: 1 year out of 7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this

reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

INGHAM LAKE

LOCATION

County: Emmet  Latitude 43 Deg 19 Min N
Longitude 94 Deg 42 Min W
Township 98 N  Range 33 W  Section 12

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
2789. hectares ( 6892. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 531. | 19.1 |
| 14 | 2258. | 80.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 91.4 | 5.1 | 0.2 | 0.0 | 3.3 |

Description of topography and soils in soil associations represented in the watershed

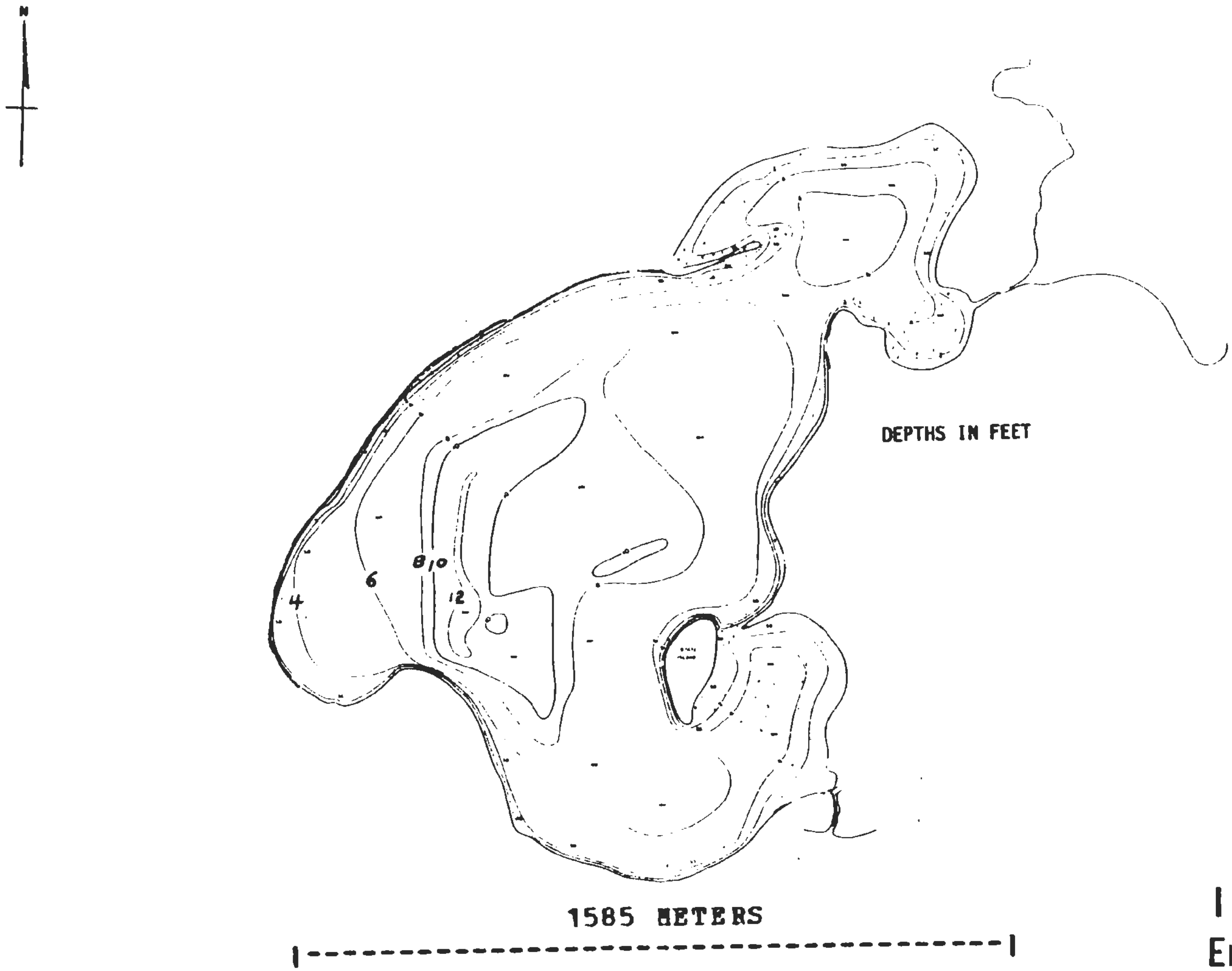
12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

Per cent of shoreline in public ownership 65 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map
Area 153. ha ( 377. A)
Length of shoreline 6816. m ( 22363. ft)
Maximum depth 3.7 m ( 12.0 ft)
Mean depth 1.9 m ( 6. ft)
Volume 2859123. cubic meters ( 2317. acre-feet)
Shoreline development 1.56  Volume development 1.53
Watershed/lake area ratio 18.2
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: None




INGHAM LAKE
Emmet County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.1 | 0.30 |
| Chlorophyll a mg/cubic meter | 9 | 62.1 | 12.80 |
| Total phosphorus mg/cubic meter | 9 | 126.0 | 23.02 |
| Kjeldahl nitrogen mg/l | 2 | 1.7 | 0.04 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 9 | 11.1 | 2.10 |
| Turbidity JTU | 9 | 9.1 | 1.90 |
| Total hardness mg/l as CaCO3 | 11 | 273.5 | 4.26 |
| Calcium hardness mg/l as CaCO3 | 10 | 147.4 | 3.14 |
| Total alkalinity mg/l as CaCO3 | 9 | 122.8 | 3.52 |
| Dissolved oxygen mg/l | 9 | 10.2 | 0.81 |
| Specific conductance micromhos/cm at 25 C | 10 | 500.0 | 10.00 |
| Sulfate mg/l | 3 | 114.5 | 2.29 |
| Chloride mg/l | 3 | 25.5 | 0.00 |
| Sodium mg/l | 2 | 7.5 | 0.50 |
| Potassium mg/l | 2 | 7.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 20.5 | 8.1 | 211.8 | 8.5 | 77.1 |
| 1 | 20.3 | 8.2 | 201.6 | 8.5 | 71.9 |
| 2 | 20.1 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 73.
Potential nutrient input index =
area watershed in row crops/lake area = 16.7
51.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Livestock | Runoff control |
| 250 cattle | Runoff control |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Wolden Recreation Area (County)
Ingham Wildlife Area (State)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2646. | 7.0 | 17.3 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 8239. | 21.9 | 53.8 |
| Swimming | 8843. | 23.5 | 57.8 |
| Pleasure boating | 3198. | 8.5 | 20.9 |
| Hunting | 1070. | 2.8 | 7.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 11420. | 30.3 | 74.6 |
| Snowmobiling | 4775. | 12.7 | 31.2 |
| Ice skating and cross-country skiing | 2692. | 7.1 | 17.6 |
| TOTAL | 42883. | 113.7 | 280.3 |

Special events at Ingham Lake contributing to more than normal use include a winter fishing derby (100-150 people).

IMPAIRMENTS

Swimming may be impaired in Ingham Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 5 %
Estimated winterkill frequencies: 1 year out of 5-7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments

introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE IOWA

LOCATION

County: Iowa Latitude 41 Deg 38 Min N
Longitude 92 Deg 10 Min W

Township 79 N Range 11 W Section 19

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
539. hectares ( 1332. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 46 | 313. | 58.1 |
| 51 | 226. | 41.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 53.3 | 15.2 | 4.1 | 0.0 | 17.4 |

Description of topography and soils in soil associations represented in the watershed

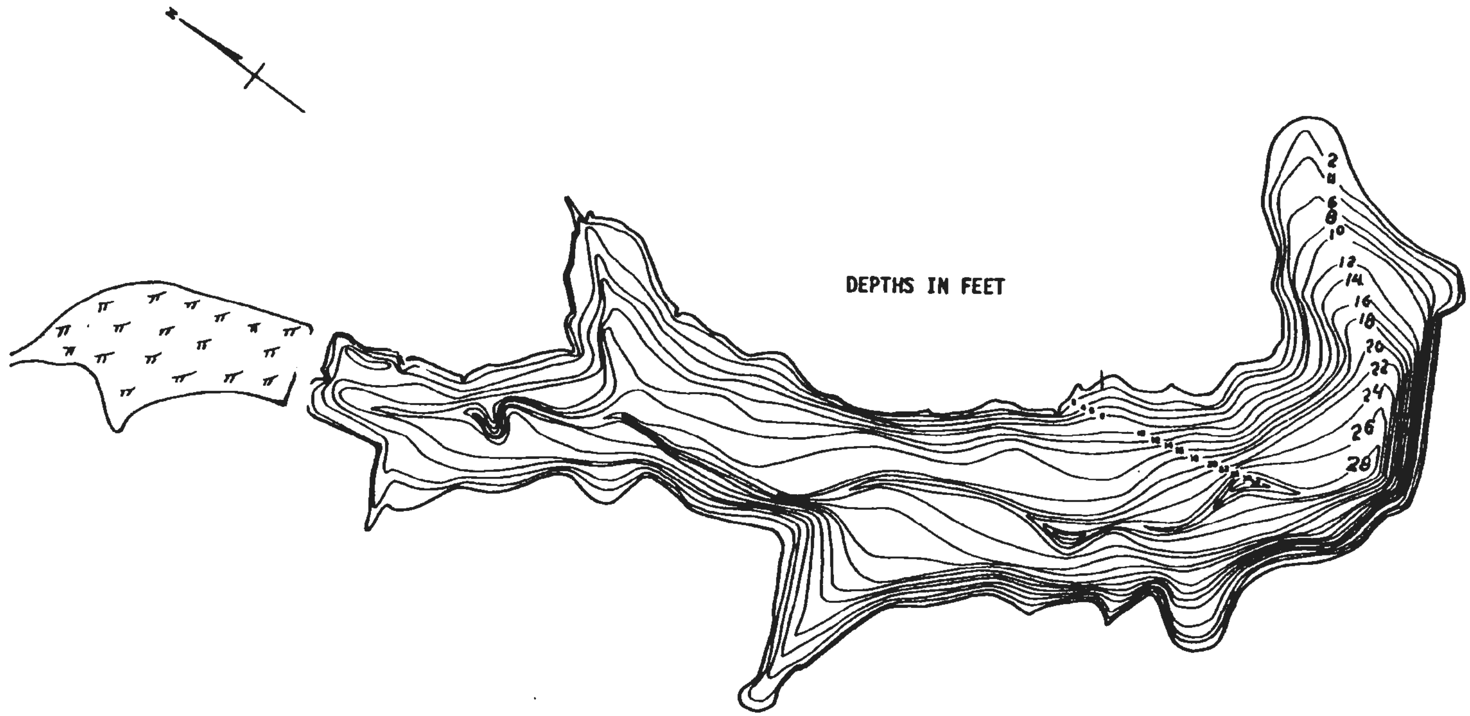
46 Nearly level to strongly sloping (0-14%) prairie to forest-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Otley, Mahaska, Ladoga, Clinton, and Adair soils.

51 Gently sloping to moderately steep (2-18%) prairie to forest-derived soils developed from loess or pre-Wisconsin till. Otley, Clinton, and Lindley soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1978 map
Area 43. ha ( 107. A)
Length of shoreline 4404. m ( 14449. ft)
Maximum depth 9.8 m ( 32.0 ft)
Mean depth 3.6 m ( 12. ft)
Volume 1243483. cubic meters ( 1008. acre-feet)
Shoreline development 2.12 Volume development 1.12
Watershed/lake area ratio 12.5
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 89. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
Pig Cr
Outlet: Pig Cr




918 METERS

LAKE IOWA
Iowa County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 0.5 | 0.06 |
| Chlorophyll a<br>mg/cubic meter | 10 | 90.0 | 10.04 |
| Total phosphorus<br>mg/cubic meter | 10 | 66.3 | 6.46 |
| Kjeldahl nitrogen<br>mg/l | 2 | 1.6 | 0.35 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight<br>mg/l | 9 | 15.2 | 1.47 |
| Turbidity<br>JTU | 9 | 13.7 | 1.98 |
| Total hardness<br>mg/l as CaCO3 | 10 | 94.8 | 0.95 |
| Calcium hardness<br>mg/l as CaCO3 | 10 | 51.6 | 1.02 |
| Total alkalinity<br>mg/l as CaCO3 | 10 | 80.2 | 1.38 |
| Dissolved oxygen<br>mg/l | 10 | 7.9 | 0.72 |
| Specific conductance<br>micromhos/cm at 25 C | 9 | 200.0 | 2.89 |
| Sulfate<br>mg/l | 3 | 12.3 | 0.67 |
| Chloride<br>mg/l | 4 | 11.0 | 0.01 |
| Sodium<br>mg/l | 2 | 7.0 | 0.00 |
| Potassium<br>mg/l | 2 | 3.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/30/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.0 | 11.9 | 119.8 | 9.2 | 137.7 |
| 1 | 25.0 | 8.9 | 64.9 | 9.1 | 105.5 |
| 2 | 24.4 | | | | |
| 3 | 23.9 | 5.3 | 60.1 | 8.4 | 16.5 |
| 4 | 23.3 | | | | |
| 5 | 22.2 | 0.6 | 157.4 | 7.5 | 6.0 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
 Negligible
Estimated erosion rate in region = 13.20-14.30 Tons/Acre/Yr
Potential siltation index =
 (watershed area/lake area) x soil loss rate = 217.
Potential nutrient input index =
 area watershed in row crops/lake area = 8.4
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, contouring, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
 Class A-primary body contact recreation.
 Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
 Iowa County Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2930. | 27.4 | 68.1 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 6755. | 63.1 | 157.1 |
| Swimming | 11725. | 109.6 | 272.7 |
| Pleasure boating | 391. | 3.7 | 9.1 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 25368. | 237.1 | 590.0 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 608. | 5.7 | 14.1 |
| TOTAL | 47777. | 446.5 | 1111.1 |

IMPAIRMENTS

Swimming may be impaired in Lake Iowa throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 33 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is

not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

KENT PARK LAKE

LOCATION
County: Johnson Latitude 41 Deg 44 Min N
Longitude 91 Deg 44 Min W
Township 80 N Range 8 W Section 24

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
266. hectares ( 656. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 57 | 266. | 100.0 |

Estimated land uses (%)

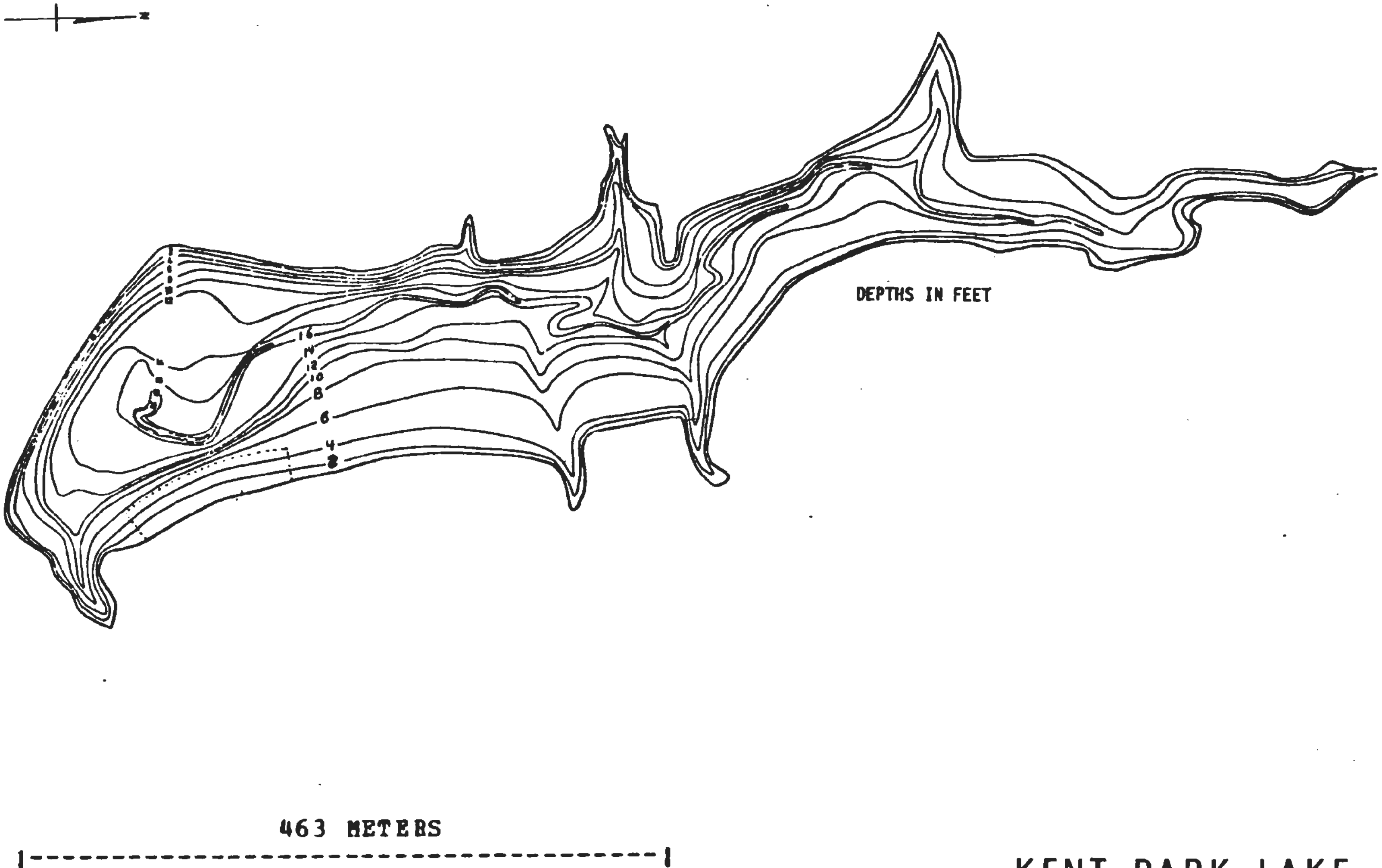
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 10.2 | 3.4 | 2.0 | 0.0 | 84.4 |

Description of topography and soils in soil associations represented in the watershed

57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1977 map
Area 11. ha ( 26. A)
Length of shoreline 2720. m ( 8923. ft)
Maximum depth 6.1 m ( 20.0 ft)
Mean depth 2.3 m ( 8. ft)
Volume 240138. cubic meters ( 195. acre-feet)
Shoreline development 2.36 Volume development 1.12
Watershed/lake area ratio 24.2
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




# KENT PARK LAKE
Johnson County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.07 |
| Chlorophyll a mg/cubic meter | 9 | 39.7 | 4.75 |
| Total phosphorus mg/cubic meter | 8 | 74.1 | 8.94 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.10 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 8 | 16.7 | 3.73 |
| Turbidity JTU | 9 | 7.6 | 1.28 |
| Total hardness mg/l as CaCO3 | 8 | 106.7 | 10.17 |
| Calcium hardness mg/l as CaCO3 | 8 | 58.7 | 6.14 |
| Total alkalinity mg/l as CaCO3 | 8 | 100.7 | 9.86 |
| Dissolved oxygen mg/l | 10 | 8.8 | 0.73 |
| Specific conductance micromhos/cm at 25 C | 8 | 195.9 | 17.66 |
| Sulfate mg/l | 3 | 6.2 | 2.89 |
| Chloride mg/l | 3 | 3.0 | 0.00 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 1.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/29/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.1 | 11.2 | 90.5 | 9.2 | 66.2 |
| 1 | 24.4 | 8.7 | 115.0 | 9.1 | 42.3 |
| 2 | 23.9 | 4.7 | 93.9 | 8.9 | 23.2 |
| 3 | 22.8 | | | | |
| 4 | 21.7 | 0.8 | 167.5 | 8.4 | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 13.20-14.30 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 331.
Potential nutrient input index =
area watershed in row crops/lake area = 2.5
79.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, crop rotation.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| 250 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
F.W. Kent Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1572. | 60.5 | 142.9 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 5525. | 212.5 | 502.3 |
| Swimming | 29619. | 1139.2 | 2692.6 |
| Pleasure boating | 456. | 17.5 | 41.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking, camping, other activities prompted by the lake's presence | 5878. | 226.1 | 534.4 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 1215. | 46.7 | 110.5 |
| TOTAL | 44265. | 1702.5 | 4024.1 |

IMPAIRMENTS

Swimming may be impaired in Kent Park Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel credit aerators for reducing aquatic plant growth in the lake and eliminating problems with low dissolved oxygen concentrations. I.C.C. personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 34 %
Artificial aeration used
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations is recommended. Three aerators are presently being used throughout the year for this purpose.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the

Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE KEOMAH

LOCATION

County: Mahaska    Latitude 41 Deg 17 Min N
                   Longitude 92 Deg 32 Min W

Township 75 N    Range 15 W    Section 24

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
751. hectares ( 1855. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 45 | 90. | 11.9 |
| 46 | 426. | 56.7 |
| 47 | 235. | 31.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 73.9 | 16.1 | 6.9 | 0.0 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

45 Nearly level to gently sloping (0-5%) prairie-derived soils developed from loess. Mahaska, Otley, and Taintor soils.

46 Nearly level to strongly sloping (0-14%) prairie to forest-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Otley, Mahaska, Ladoga, Clinton, and Adair soils.

47 Moderately sloping to very steep (5-30%) forest-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Clinton, Lindley, and Keswick soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map

Area 34. ha ( 84. A)

Length of shoreline 6014. m ( 19730. ft)

Maximum depth 6.7 m ( 22.0 ft)

Mean depth 3.1 m ( 10. ft)

Volume 1044370. cubic meters ( 846. acre-feet)

Shoreline development 2.91    Volume development 1.37

Watershed/lake area ratio 22.1

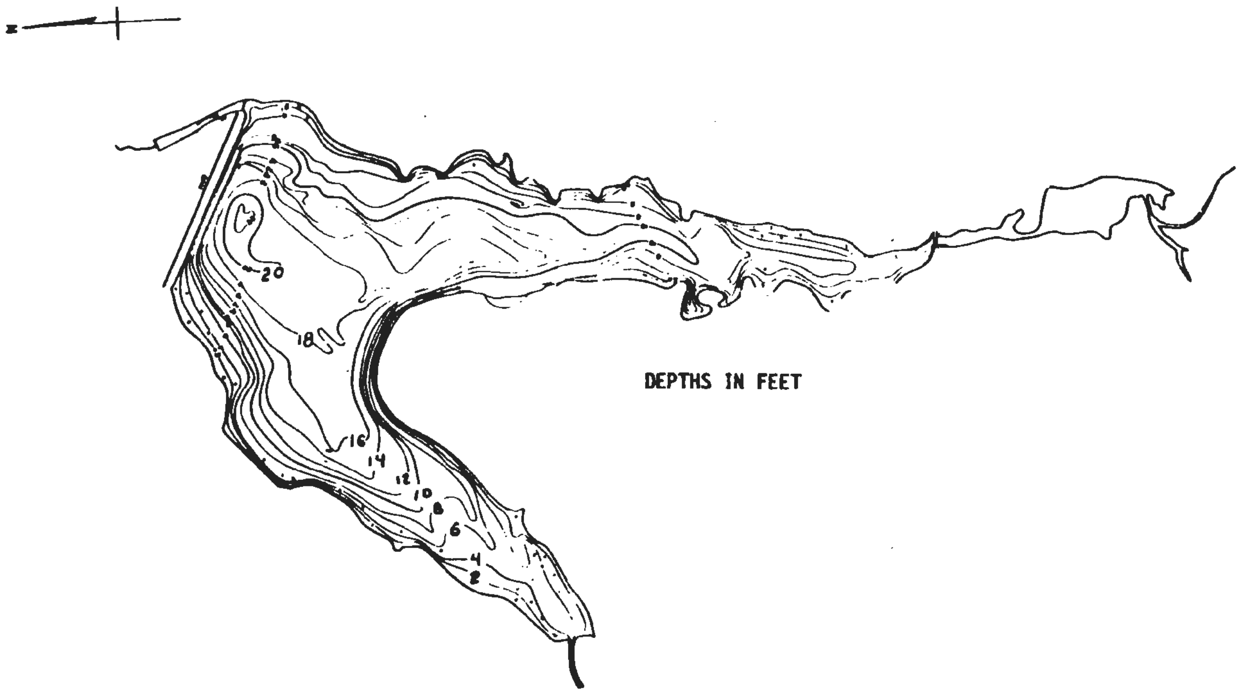
Origin of basin: Impoundment

Estimated annual precipitation 86. cm

Estimated annual runoff 18. cm

Estimated lake evaporation 91. cm

Thermal stratification? Yes




4719 METERS

LAKE KEOMAH
Mahaska County

Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.6 | 0.04 |
| Chlorophyll a mg/cubic meter | 9 | 65.6 | 11.76 |
| Total phosphorus mg/cubic meter | 9 | 86.1 | 6.58 |
| Kjeldahl nitrogen mg/l | 2 | 0.9 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 9 | 18.3 | 1.69 |
| Turbidity JTU | 8 | 12.8 | 1.32 |
| Total hardness mg/l as CaCO3 | 9 | 117.1 | 3.87 |
| Calcium hardness mg/l as CaCO3 | 9 | 68.0 | 2.38 |
| Total alkalinity mg/l as CaCO3 | 8 | 94.2 | 3.15 |
| Dissolved oxygen mg/l | 10 | 8.9 | 1.12 |
| Specific conductance micromhos/cm at 25 C | 10 | 265.0 | 14.16 |
| Sulfate mg/l | 3 | 22.5 | 2.18 |
| Chloride mg/l | 4 | 13.6 | 0.13 |
| Sodium mg/l | 1 | 8.0 | |
| Potassium mg/l | 1 | 6.0 | |

Vertical profile for selected measurements on the sampling date ( 9/ 5/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.2 | 10.5 | 88.5 | 9.1 | 84.6 |
| 1 | 26.1 | 11.0 | 96.4 | 8.9 | 90.6 |
| 2 | 25.6 | 7.9 | 90.5 | 8.9 | 58.8 |
| 3 | 24.4 | | | | |
| 4 | 23.3 | 0.2 | 92.5 | 7.7 | 6.7 |
| 5 | 21.7 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 252.
Potential nutrient input index =
area watershed in row crops/lake area = 16.3
31.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
   Class A-primary body contact recreation.
   Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
   Class C-raw water source for a potable water supply.
This lake is used as a raw water source for
   about 1500 persons at Lake Keomah State Park.

Public parks:
   Lake Keomah State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2562. | 30.5 | 75.4 |
| Shore or ice fishing | 8988. | 107.0 | 264.4 |
| Swimming | 50114. | 596.6 | 1473.9 |
| Pleasure boating | 10739. | 127.8 | 315.9 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 73020. | 869.3 | 2147.6 |
| Snowmobiling | 3558. | 42.4 | 104.6 |
| Ice skating and cross-country skiing | 2429. | 28.9 | 71.4 |
| TOTAL | 151410. | 1802.5 | 4453.2 |

IMPAIRMENTS

Swimming may be impaired in Lake Keomah throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to siltation, turbidity, and poor fishing.

Estimated aquatic plant coverage 2 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments

introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LACEY-KEOSAUQUA LAKE

LOCATION
County: Van Buren  Latitude 40 Deg 43 Min N
Longitude 91 Deg 58 Min W
Township 68 N  Range 10 W  Section 11

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
293. hectares ( 723. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 44 | 104. | 35.4 |
| 38 | 189. | 64.6 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 44.8 | 32.5 | 20.6 | 0.0 | 2.2 |

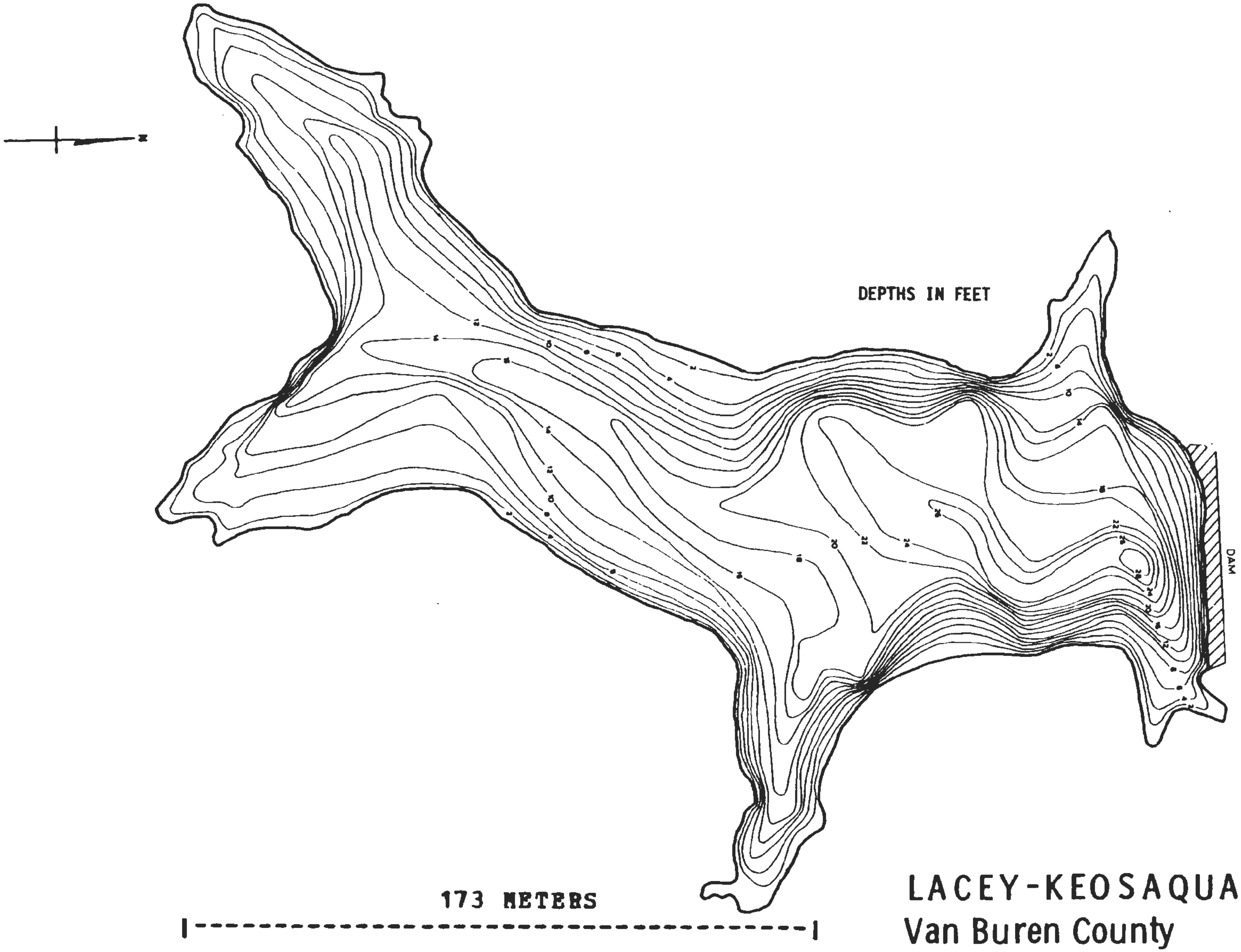
Description of topography and soils in soil associations represented in the watershed

44 Gently to strongly sloping (0-14%) prairie to forest-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Grundy, Pershing, Weller, Keswick, and Lindley soils.

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 25. ha ( 61. A)
Length of shoreline 2095. m ( 6875. ft)
Maximum depth 8.5 m ( 28.0 ft)
Mean depth 3.6 m ( 12. ft)
Volume 318406. cubic meters ( 258. acre-feet)
Shoreline development 1.98  Volume development 1.26
Watershed/lake area ratio 11.7
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




LACEY-KEOSAQUA LAKE
Van Buren County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 2.2 | 0.31 |
| Chlorophyll a mg/cubic meter | 11 | 10.6 | 3.47 |
| Total phosphorus mg/cubic meter | 11 | 29.6 | 13.36 |
| Kjeldahl nitrogen mg/l | 2 | 0.4 | 0.04 |
| Ammonia nitrogen mg/l | 2 | 0.0 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 11 | 3.4 | 0.36 |
| Turbidity JTU | 12 | 3.8 | 0.53 |
| Total hardness mg/l as CaCO3 | 12 | 123.7 | 2.59 |
| Calcium hardness mg/l as CaCO3 | 11 | 92.2 | 2.25 |
| Total alkalinity mg/l as CaCO3 | 14 | 72.0 | 2.11 |
| Dissolved oxygen mg/l | 11 | 7.9 | 0.32 |
| Specific conductance micromhos/cm at 25 C | 11 | 261.4 | 11.99 |
| Sulfate mg/l | 5 | 45.8 | 6.01 |
| Chloride mg/l | 6 | 1.9 | 0.08 |
| Sodium mg/l | 2 | 3.5 | 0.50 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 8/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | ChL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 30.3 | 8.0 | 13.8 | 8.7 | 3.6 |
| 1 | 30.2 | 7.9 | 8.9 | 8.6 | 3.9 |
| 2 | 30.1 | 7.0 | 13.4 | 8.5 | 3.0 |
| 3 | 27.1 | | | | |
| 4 | 21.1 | 5.7 | 162.5 | 8.2 | 37.0 |
| 5 | 14.8 | | | | |
| 6 | 11.7 | | | | |
| 7 | 10.4 | 0.0 | 48.7 | 7.6 | 33.7 |
| 8 | 9.7 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 371.
Potential nutrient input index =
area watershed in row crops/lake area = 14.6
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Lacey-Keosauqua State Park | Water intake filter backwash |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
Lacey-Keosauqua State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2713. | 44.5 | 108.5 |
| Shore or ice fishing | 5599. | 91.8 | 224.0 |
| Swimming | 27056. | 443.5 | 1082.2 |
| Pleasure boating | 2280. | 37.4 | 91.2 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 27690.. | 453.9 | 1107.6 |
| Snowmobiling | 3127. | 51.3 | 125.1 |
| Ice skating and cross-country skiing | 1563. | 25.6 | 62.5 |
| TOTAL | 70028. | 1148.0 | 2801.1 |

IMPAIRMENTS

Recreational activities in Lacey-Keosaqua Lake do not appear to be impaired by poor water quality or aquatic plants. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 20 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE OF THE HILLS

LOCATION

County: Scott          Latitude 41 Deg 31 Min N
                       Longitude 90 Deg 41 Min W

Township 78 N     Range 2 E     Section 36

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
633. hectares ( 1564. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 56 | 432. | 68.2 |
| 57 | 201. | 31.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 75.6 | 15.5 | 5.8 | 0.0 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

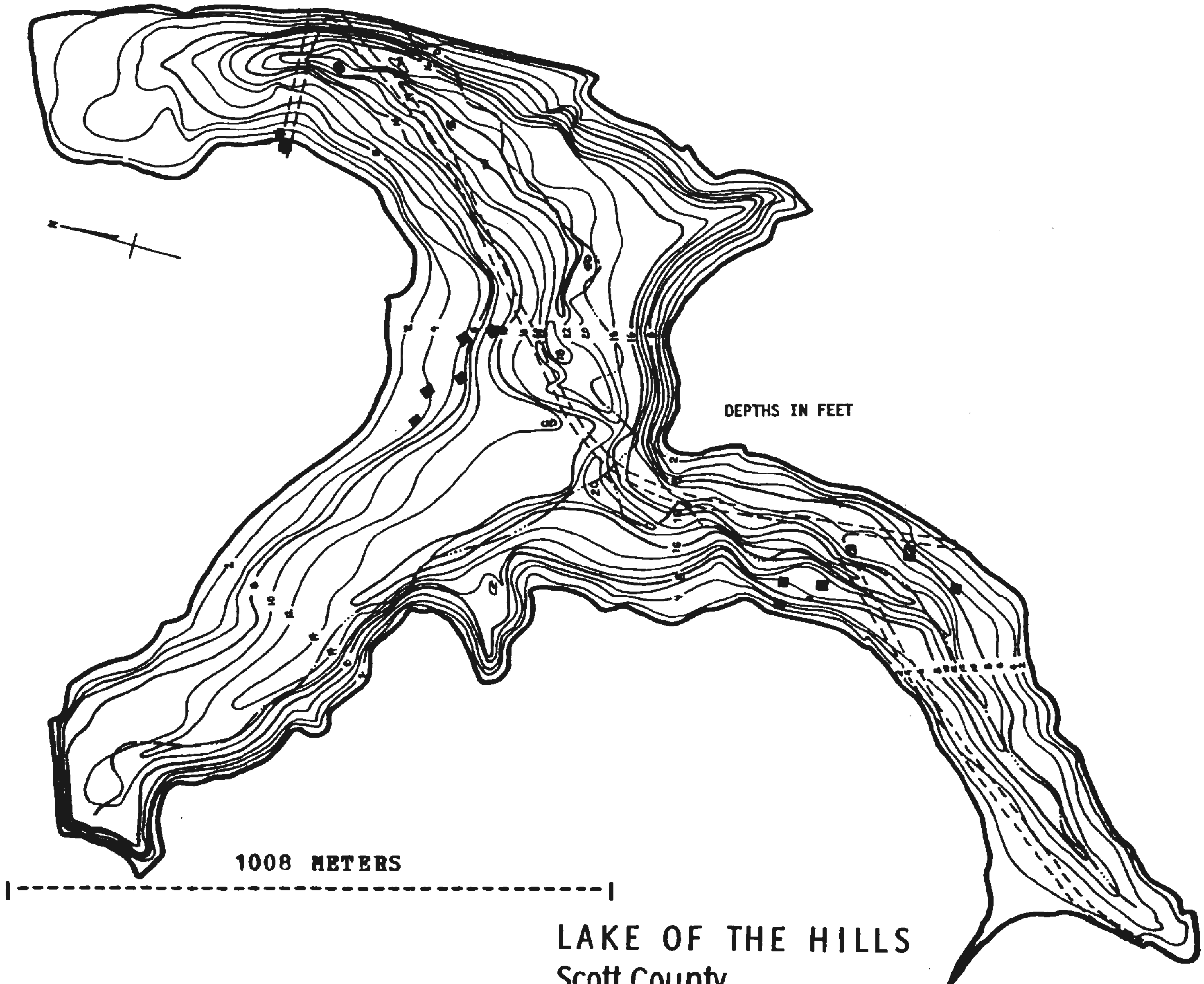
56 Gently to strongly sloping (2-14%) prairie to forest-derived soils developed from loess. Tama, Downs, and Fayette soils.

57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1976 map
Area 23. ha ( 56. A)
Length of shoreline 3883. m ( 12740. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 2.7 m ( 9. ft)
Volume 622377. cubic meters ( 504. acre-feet)
Shoreline development 2.30 Volume development 1.13
Watershed/lake area ratio 27.5
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 20. cm
Estimated lake evaporation 86. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
2 Unnamed
Outlet: Black Hawk Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




LAKE OF THE HILLS
Scott County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.06 |
| Chlorophyll a mg/cubic meter | 9 | 38.3 | 7.46 |
| Total phosphorus mg/cubic meter | 9 | 52.2 | 2.90 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.05 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 8 | 14.6 | 2.17 |
| Turbidity JTU | 8 | 11.1 | 1.10 |
| Total hardness mg/l as CaCO3 | 8 | 178.0 | 10.06 |
| Calcium hardness mg/l as CaCO3 | 8 | 84.7 | 6.26 |
| Total alkalinity mg/l as CaCO3 | 9 | 129.8 | 7.37 |
| Dissolved oxygen mg/l | 9 | 9.4 | 0.78 |
| Specific conductance micromhos/cm at 25 C | 8 | 347.5 | 18.10 |
| Sulfate mg/l | 3 | 43.7 | 5.36 |
| Chloride mg/l | 3 | 18.2 | 0.17 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/30/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 28.8 | 11.1 | 48.4 | 8.9 | 60.6 |
| 1 | 28.9 | 10.5 | 63.5 | 8.9 | 64.4 |
| 2 | 28.9 | | | | |
| 3 | 25.4 | 1.6 | 55.5 | 8.0 | 26.2 |
| 4 | 22.7 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 14.31-27.77 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 603.
Potential nutrient input index =
  area watershed in row crops/lake area = 20.8
 50.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
contouring, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  West Lake Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 9228. | 164.8 | 401.2 |
| Shore or ice fishing | 25967. | 463.7 | 1129.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 3060. | 54.6 | 133.0 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 23331. | 416.6 | 1014.4 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 1128. | 20.1 | 49.0 |
| TOTAL | 62714. | 1119.9 | 2726.7 |

Special events at Lake of the Hills contributing to more than normal use include two fishing derbies (550 people).

IMPAIRMENTS

Water clarity is poor in Lake of the Hills throughout the summer as indicated by Secchi depths less than one meter caused by algal populations and other suspended matter. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to a lack of swimming facilities.

Estimated aquatic plant coverage 26 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will

help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE OF THREE FIRES

LOCATION

County: Taylor    Latitude 40 Deg 43 Min N
Longitude 94 Deg 41 Min W

Township 68 N    Range 34 W    Section 12

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
1466. hectares ( 3622. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 1185. | 80.8 |
| 33 | 281. | 19.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 71.8 | 20.7 | 3.7 | 0.0 | 3.8 |

Description of topography and soils in soil associations represented in the watershed

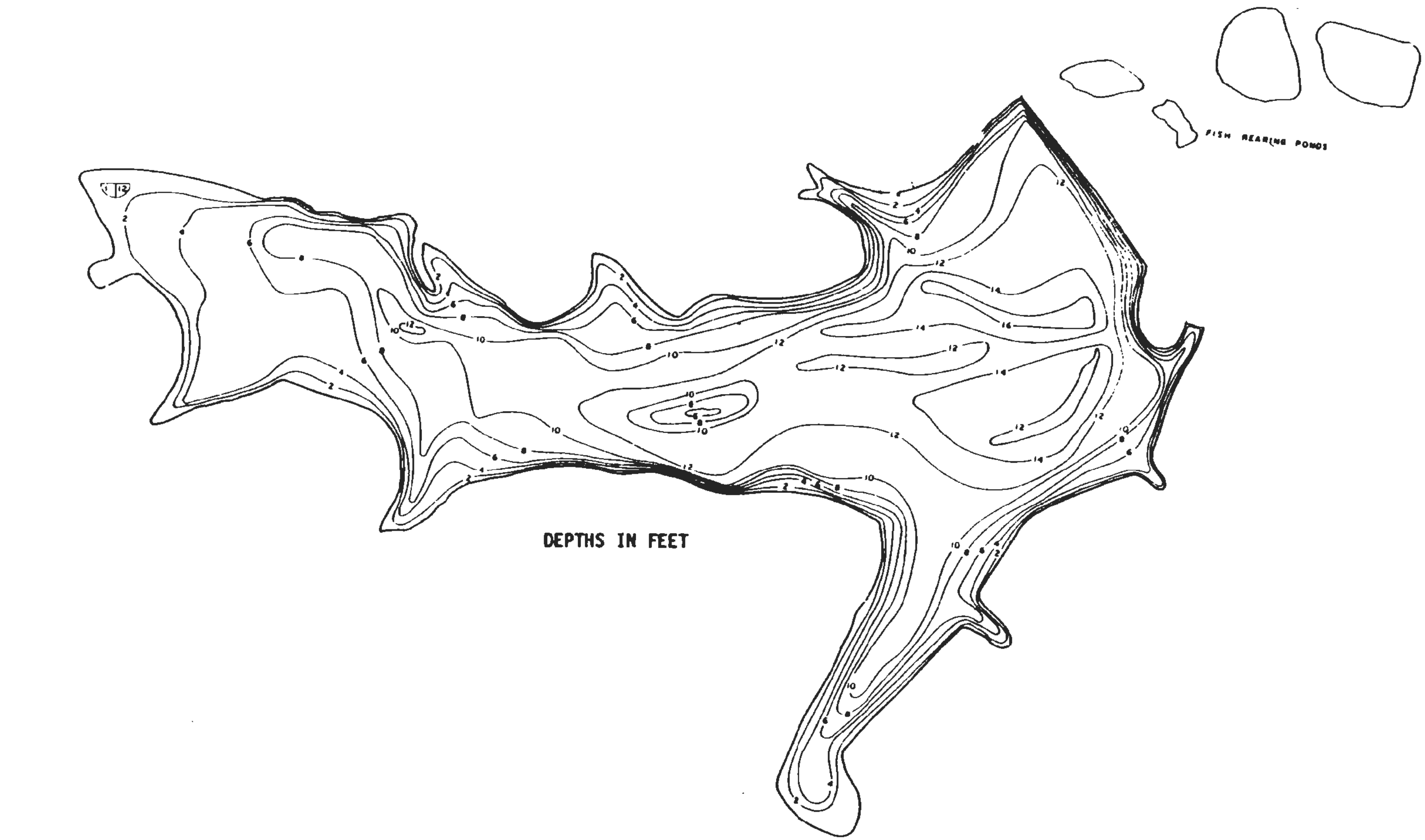
30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

33 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or pre-Wisconsin till-derived paleosols. Sharpsburg, Macksburg, Winterset, and Clarinda soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1971 map
Area 39. ha ( 97. A)
Length of shoreline 4944. m ( 16221. ft)
Maximum depth 4.9 m ( 16.0 ft)
Mean depth 2.6 m ( 8. ft)
Volume 1003650. cubic meters ( 813. acre-feet)
Shoreline development 2.23    Volume development 1.58
Watershed/lake area ratio 37.6
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 99. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




3041 METERS

LAKE OF THREE FIRES
Taylor County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.02 |
| Chlorophyll a mg/cubic meter | 11 | 36.2 | 3.23 |
| Total phosphorus mg/cubic meter | 9 | 69.1 | 1.63 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.12 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.07 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 11 | 15.9 | 0.77 |
| Turbidity JTU | 10 | 12.5 | 0.26 |
| Total hardness mg/l as CaCO3 | 6 | 102.3 | 4.05 |
| Calcium hardness mg/l as CaCO3 | 6 | 75.7 | 2.89 |
| Total alkalinity mg/l as CaCO3 | 11 | 98.2 | 1.56 |
| Dissolved oxygen mg/l | 10 | 7.1 | 0.37 |
| Specific conductance micromhos/cm at 25 C | 9 | 241.1 | 8.03 |
| Sulfate mg/l | 3 | 9.8 | 0.67 |
| Chloride mg/l | 4 | 4.0 | 0.00 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 8/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 28.1 | 7.9 | 62.8 | 8.7 | 43.4 |
| 1 | 28.1 | 7.8 | 69.3 | 8.7 | 37.0 |
| 2 | 26.8 | 7.9 | 76.4 | 8.2 | 22.8 |
| 3 | 23.6 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 9.19-10.79 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 376.
Potential nutrient input index =
  area watershed in row crops/lake area = 27.0
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, gulley control structures/ erosion control structures, conservation tillage, pastureland and pastureland improvement, contouring, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
  Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 2700 persons at Lake of Three Fires State Park.

Public parks:
  Lake of Three Fires State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 3714. | 38.3 | 95.2 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 3283. | 33.8 | 84.2 |
| Swimming | 8465. | 87.3 | 217.1 |
| Pleasure boating | 6489. | 66.9 | 166.4 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 147000. | 1515.5 | 3769.2 |
| Snowmobiling | 69. | 0.7 | 1.8 |
| Ice skating and cross-country skiing | 313. | 3.2 | 8.0 |
| TOTAL | 169333. | 1745.7 | 4341.9 |

IMPAIRMENTS

Swimming may be impaired in Lake of Three Fires throughout the summer because of Secchi depths less than one meter caused by algal populations. Occasional summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 11 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: 1 year out of 15

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will

help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LITTLE SIOUX PARK

LOCATION

County: Woodbury          Latitude   42 Deg  27 Min N
                          r Longitude  95 Deg  48 Min W
Township  88 N        Range 43 W       Section 12

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
5. hectares (   12. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 5. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 72.6 | 13.0 | 9.9 | 0.0 | 4.5 |

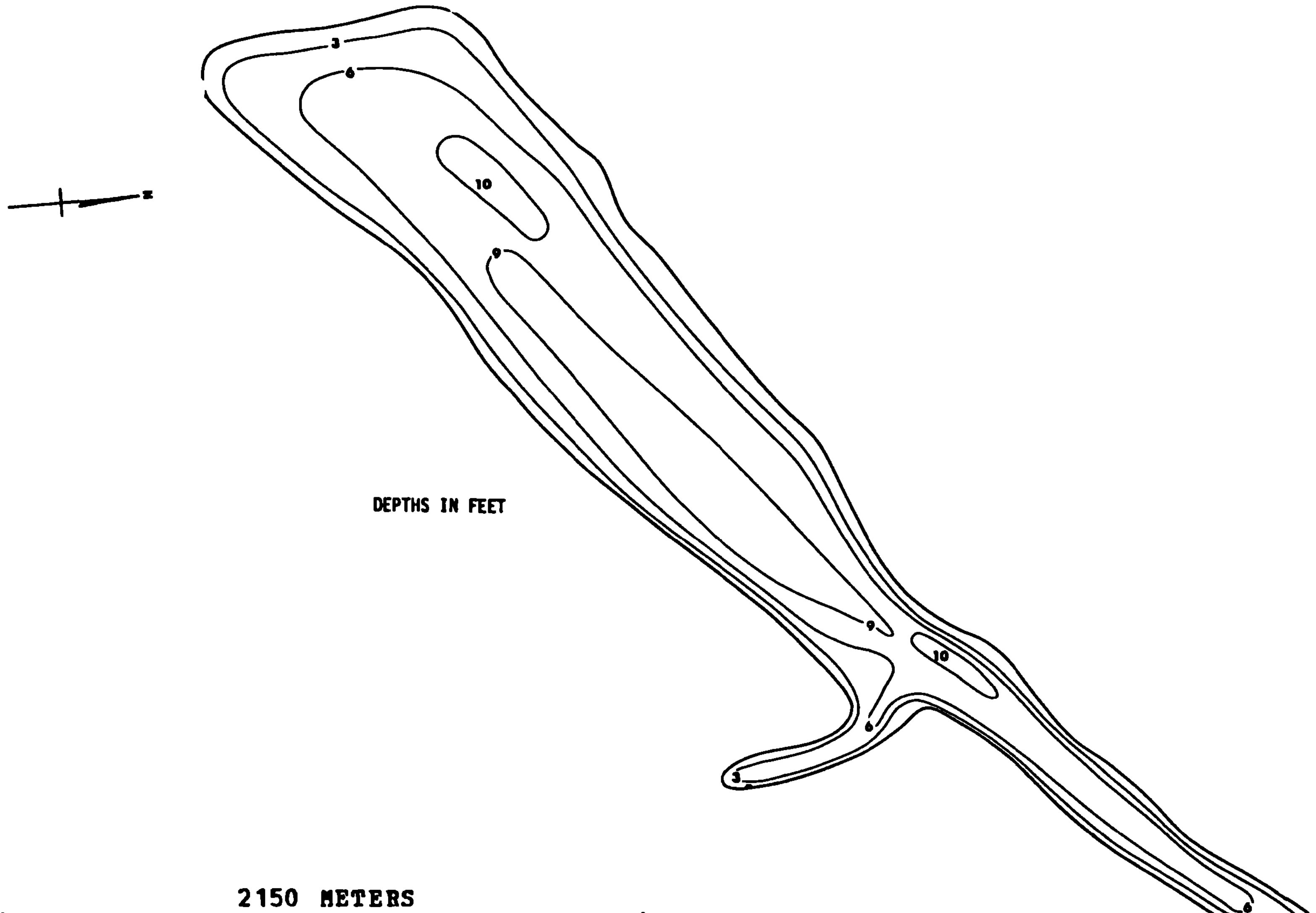
Description of topography and soils in soil associations represented in the watershed

7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area    5. ha (  13. A)
Length of shoreline    1690. m (   5543. ft)
Maximum depth  3.0 m ( 10.0 ft)
Mean depth  1.9 m (  6. ft)
Volume     95238. cubic meters (    77. acre-feet)
Shoreline development  2.11    Volume development  1.84
Watershed/lake area ratio       1.0
Origin of basin: Gravel Pit
Estimated annual precipitation  71. cm
Estimated annual runoff          8. cm
Estimated lake evaporation      97. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: None
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




LITTLE SIOUX PARK
Woodbury County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 2.6 | 0.09 |
| Chlorophyll a<br>mg/cubic meter | 11 | 3.1 | 0.16 |
| Total phosphorus<br>mg/cubic meter | 12 | 15.0 | 1.18 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.3 | 0.04 |
| Ammonia nitrogen<br>mg/l | 2 | 0.0 | 0.01 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight<br>mg/l | 11 | 1.2 | 0.27 |
| Turbidity<br>JTU | 12 | 1.1 | 0.05 |
| Total hardness<br>mg/l as CaCO3 | 11 | 135.8 | 2.62 |
| Calcium hardness<br>mg/l as CaCO3 | 11 | 49.5 | 3.65 |
| Total alkalinity<br>mg/l as CaCO3 | 12 | 128.5 | 3.00 |
| Dissolved oxygen<br>mg/l | 12 | 8.2 | 0.37 |
| Specific conductance<br>micromhos/cm at 25 C | 12 | 228.3 | 3.50 |
| Sulfate<br>mg/l | 7 | 10.0 | 0.59 |
| Chloride<br>mg/l | 7 | 3.3 | 0.10 |
| Sodium<br>mg/l | 2 | 4.0 | 0.00 |
| Potassium<br>mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/16/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 20.9 | 7.1 | 11.3 | 9.2 | 2.7 |
| 1 | 20.9 | 6.8 | 11.3 | 9.2 | 2.9 |
| 2 | 20.9 | 7.4 | 12.0 | 9.1 | 3.5 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 4.
Potential nutrient input index =
area watershed in row crops/lake area = 0.7
0.% of watershed is in approved soil conservation practices.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Little Sioux Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 0. | 0.0 | 0.0 |
| Shore or ice fishing | 4097. | 315.2 | 819.4 |
| Swimming | 5205. | 400.4 | 1041.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 7155. | 550.4 | 1431.0 |
| Snowmobiling | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 16457. | 1265.9 | 3291.4 |

IMPAIRMENTS

Aquatic vascular plant growth in Little Sioux Park may impair boating and shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 100 %
Estimated winterkill frequencies: 1 year out of 10
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in this lake is good; however, the extensive stands of submersed plants interfere with recreational use. The lake's shallowness results in a relatively small capacity to hold dissolved oxygen. Decomposition of aquatic vegetation during the winter months results in anoxic conditions and fish kills. Dredging and control of aquatic vegetation through a White Amur stocking program should alleviate these problems. As an alternative, the symptoms could be treated by artificially aerating the lake during winter months. The first alternative would provide the greatest improvement to the lake; however, aeration would also yield significant benefits.

LITTLE SPIRIT LAKE

LOCATION

County: Dickinson          Latitude  43 Deg 30 Min N
        Jackson,MN         Longitude 95 Deg  8 Min W
Township 100 N     Range 36 W     Section 8

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
669. hectares ( 1654. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 665. | 99.3 |
| 15 | 4. | 0.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 90.5 | 5.8 | 0.3 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

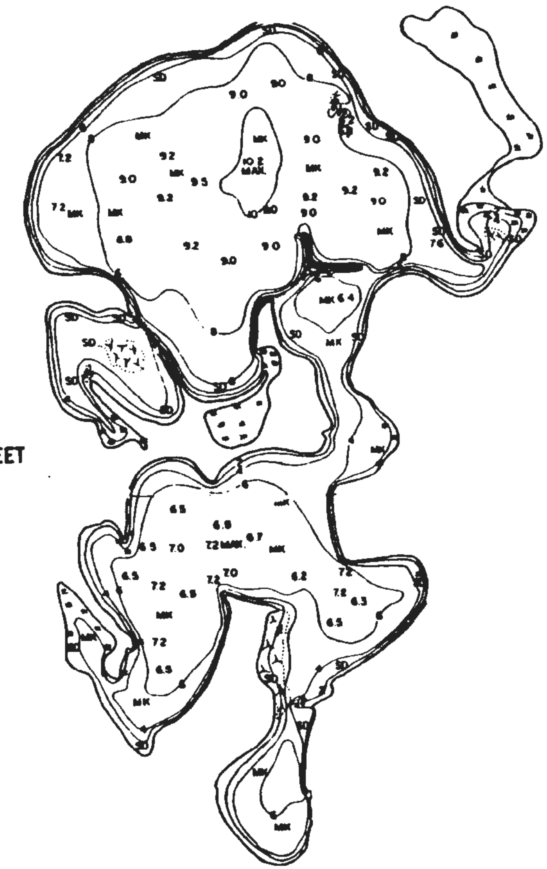
15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 9 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1970 map
Area 250. ha ( 618. A)
Length of shoreline 16251. m ( 53318. ft)
Maximum depth 3.0 m ( 10.0 ft)
Mean depth 1.8 m ( 6. ft)
Volume 4584987. cubic meters ( 3716. acre-feet)
Shoreline development 2.90    Volume development 1.80
Watershed/lake area ratio 2.7
Origin of basin: Natural
Estimated annual precipitation 69. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: To Big Spirit L

DEPTHS IN FEET



15206 METERS

# LITTLE SPIRIT LAKE
Dickinson County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.03 |
| Chlorophyll a mg/cubic meter | 9 | 42.8 | 5.61 |
| Total phosphorus mg/cubic meter | 8 | 115.2 | 16.12 |
| Kjeldahl nitrogen mg/l | 2 | 1.4 | 0.08 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.04 |
| Seston dry weight mg/l | 9 | 15.9 | 2.39 |
| Turbidity JTU | 9 | 9.1 | 0.88 |
| Total hardness mg/l as CaCO3 | 11 | 273.5 | 3.55 |
| Calcium hardness mg/l as CaCO3 | 10 | 109.4 | 5.37 |
| Total alkalinity mg/l as CaCO3 | 9 | 220.3 | 2.49 |
| Dissolved oxygen mg/l | 9 | 8.5 | 0.62 |
| Specific conductance micromhos/cm at 25 C | 9 | 503.9 | 14.09 |
| Sulfate mg/l | 3 | 66.0 | 0.87 |
| Chloride mg/l | 3 | 17.0 | 0.00 |
| Sodium mg/l | 2 | 10.5 | 0.50 |
| Potassium mg/l | 2 | 9.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 19.8 | 6.1 | 155.5 | 8.2 | 61.4 |
| 1 | 19.8 | 6.1 | 159.4 | 8.2 | 63.6 |
| 2 | 19.8 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 11.
Potential nutrient input index =
area watershed in row crops/lake area = 2.4
32.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Hogsback Access

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 13515. | 21.9 | 54.1 |
| Shore or ice fishing | 30789. | 49.8 | 123.2 |
| Swimming | 4604. | 7.4 | 18.4 |
| Pleasure boating | 2640. | 4.3 | 10.6 |
| Hunting | 4399. | 7.1 | 17.6 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 23599. | 38.2 | 94.4 |
| Snowmobiling | 3560. | 5.8 | 14.2 |
| Ice skating and cross-country skiing | 1702. | 2.8 | 6.8 |
| TOTAL | 84808. | 137.2 | 339.2 |

IMPAIRMENTS

Swimming may be impaired in Little Spirit Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 16 %
Estimated winterkill frequencies: 1 year out of 5-7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other

non-point pollutants to the lake. Furthermore, we do not have adequate information to gauge the effectiveness of such a conservation program.

LITTLE WALL LAKE

LOCATION

County: Hamilton Latitude 42 Deg 16 Min N
Longitude 93 Deg 38 Min W

Township 86 N Range 24 W Section 10

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
87. hectares ( 215. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 15 | 87. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 80.7 | 13.4 | 1.7 | 0.0 | 4.2 |

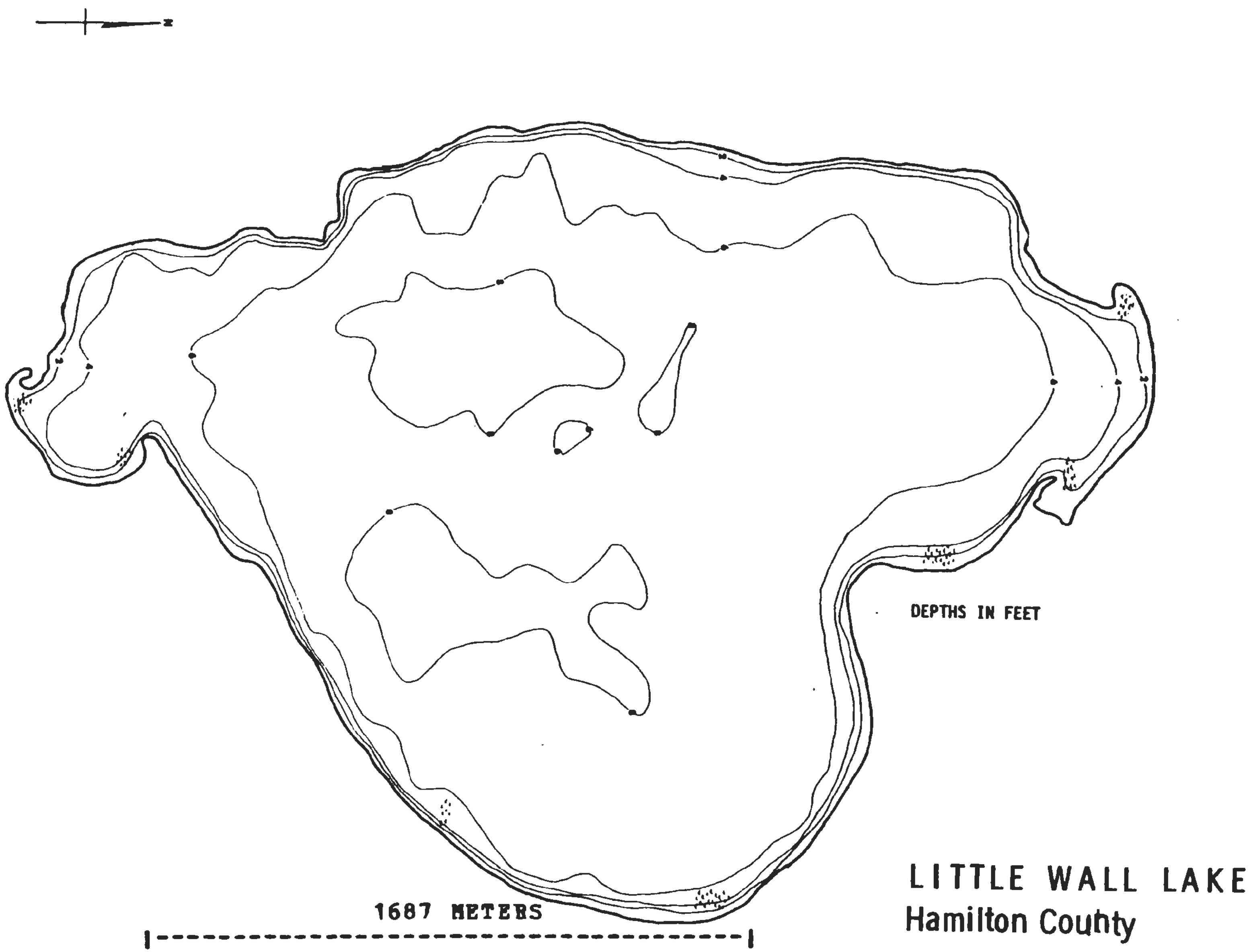
Description of topography and soils in soil associations represented in the watershed

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 74 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 104. ha ( 258. A)
Length of shoreline 4716. m ( 15473. ft)
Maximum depth 1.7 m ( 6.0 ft)
Mean depth 1.3 m ( 4. ft)
Volume 1356354. cubic meters ( 1099. acre-feet)
Shoreline development 1.30 Volume development 2.24
Watershed/lake area ratio 0.8
Origin of basin: Natural
Estimated annual precipitation 76. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 91. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
Supplemental water pumped from Drainage Ditch #71
Outlet: None
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319


N
DEPTHS IN FEET
1687 METERS
LITTLE WALL LAKE
Hamilton County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 1.0 | 0.31 |
| Chlorophyll a mg/cubic meter | 9 | 50.3 | 14.91 |
| Total phosphorus mg/cubic meter | 9 | 171.9 | 17.67 |
| Kjeldahl nitrogen mg/l | 2 | 1.8 | 0.48 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 9 | 14.2 | 4.24 |
| Turbidity JTU | 9 | 7.5 | 1.10 |
| Total hardness mg/l as CaCO3 | 9 | 201.6 | 3.21 |
| Calcium hardness mg/l as CaCO3 | 9 | 82.4 | 1.09 |
| Total alkalinity mg/l as CaCO3 | 9 | 192.3 | 2.35 |
| Dissolved oxygen mg/l | 8 | 7.6 | 0.76 |
| Specific conductance micromhos/cm at 25 C | 10 | 385.0 | 2.36 |
| Sulfate mg/l | 3 | 1.8 | 0.17 |
| Chloride mg/l | 3 | 23.0 | 0.00 |
| Sodium mg/l | 2 | 11.5 | 0.50 |
| Potassium mg/l | 2 | 9.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.5 | 5.2 | 236.5 | 8.2 | 39.1 |
| 1 | 23.0 | 4.9 | 244.7 | 8.2 | 34.8 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 3.
Potential nutrient input index =
area watershed in row crops/lake area = 0.7
56.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Little Wall Lake Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 6984. | 27.1 | 67.2 |
| Shore or ice fishing | 16446. | 63.7 | 158.1 |
| Swimming | 4732. | 18.3 | 45.5 |
| Pleasure boating | 19962. | 77.4 | 191.9 |
| Hunting | 3908. | 15.1 | 37.6 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 66457. | 257.6 | 639.0 |
| Snowmobiling | 7813. | 30.3 | 75.1 |
| Ice skating and cross-country skiing | 2692. | 10.4 | 25.9 |
| TOTAL | 128994. | 500.0 | 1240.3 |

Special events at Little Wall Lake contributing to more than normal use include a snowmobile fun day (500 people) and car races on ice (155 people).

IMPAIRMENTS

Swimming may be impaired in Little Wall Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be at its potential; although boat congestion may be a serious problem.

Estimated aquatic plant coverage 2 %
Estimated winterkill frequencies: 1 year out of 4
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion

terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LOST ISLAND LAKE

LOCATION

County: Palo Alto    Latitude 43 Deg 10 Min N
Clay    Longitude 94 Deg 54 Min W
Township 97 N    Range 34 W    Section 31

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
1838. hectares ( 4541. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 11 | 28. | 1.5 |
| 15 | 1810. | 98.5 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 80.7 | 13.4 | 1.7 | 0.0 | 4.2 |

Description of topography and soils in soil associations represented in the watershed

11 Nearly level and gently sloping (0-5%) prairie-derived upland and terrace soils developed from alluvium. Wadena, Talcot, Flagler, and Saude soils.

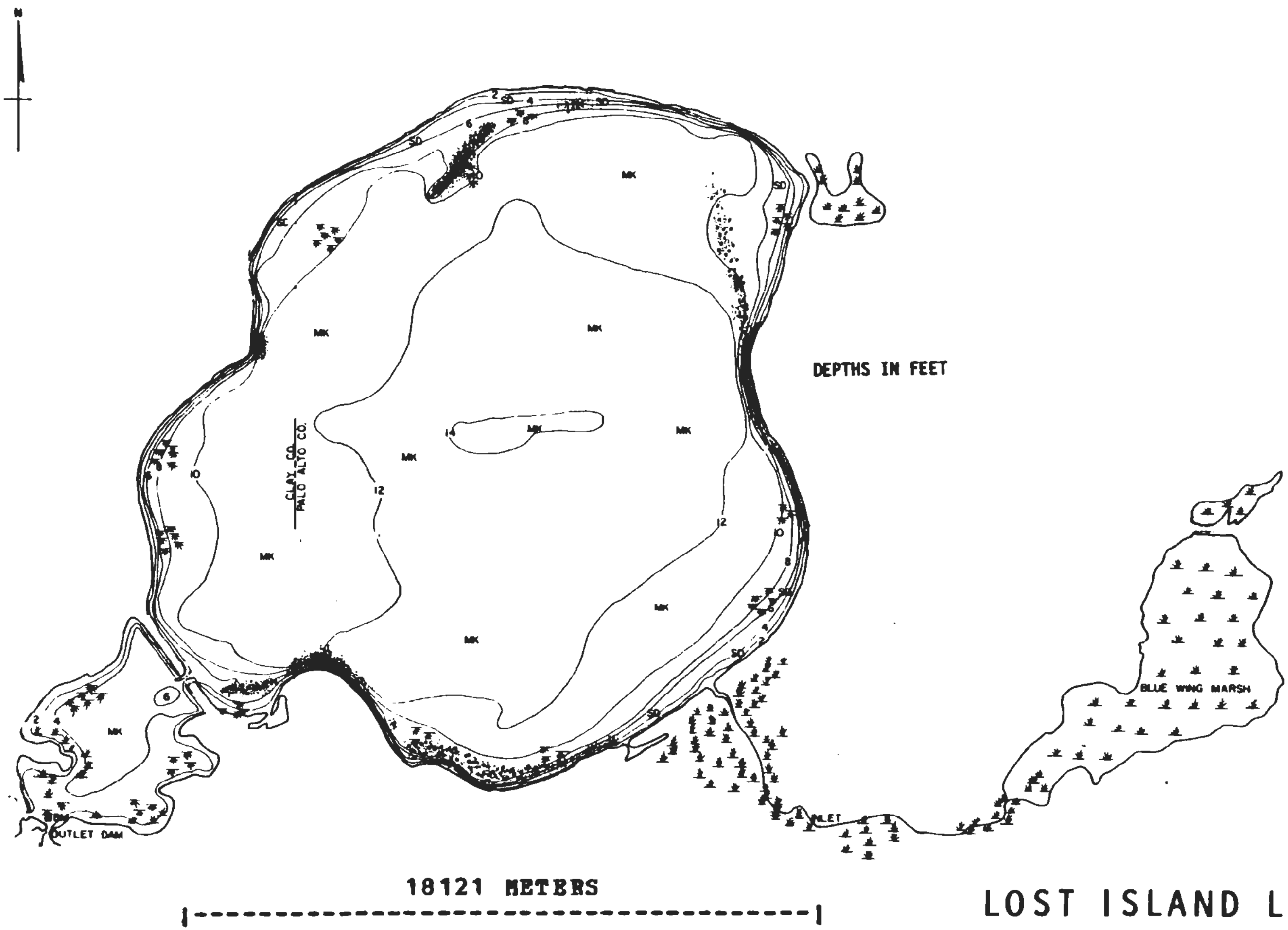
15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 36 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1970 map
Area 474. ha (1170. A)
Length of shoreline 12687. m ( 41624. ft)
Maximum depth 4.3 m ( 14.0 ft)
Mean depth 3.1 m ( 10. ft)
Volume 15882860. cubic meters ( 12871. acre-feet)
Shoreline development 1.58    Volume development 2.16
Watershed/lake area ratio 3.9
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: To Barringer Slough
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

395




# LOST ISLAND LAKE
Palo Alto County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 0.5 | 0.03 |
| Chlorophyll a<br>mg/cubic meter | 9 | 58.2 | 2.62 |
| Total phosphorus<br>mg/cubic meter | 10 | 61.6 | 5.86 |
| Kjeldahl nitrogen<br>mg/l | 2 | 1.5 | 0.10 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight<br>mg/l | 9 | 18.8 | 0.82 |
| Turbidity<br>JTU | 9 | 12.3 | 0.47 |
| Total hardness<br>mg/l as $CaCO_3$ | 10 | 208.0 | 0.52 |
| Calcium hardness<br>mg/l as $CaCO_3$ | 11 | 92.7 | 2.46 |
| Total alkalinity<br>mg/l as $CaCO_3$ | 10 | 184.2 | 0.61 |
| Dissolved oxygen<br>mg/l | 9 | 9.6 | 0.33 |
| Specific conductance<br>micromhos/cm at 25 C | 10 | 385.5 | 7.62 |
| Sulfate<br>mg/l | 3 | 22.7 | 1.01 |
| Chloride<br>mg/l | 3 | 14.3 | 0.17 |
| Sodium<br>mg/l | 2 | 8.5 | 0.50 |
| Potassium<br>mg/l | 2 | 7.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.0 | 8.6 | 60.7 | 8.8 | 51.6 |
| 1 | 21.0 | 8.6 | 67.9 | 8.8 | 49.4 |
| 2 | 21.0 | 8.5 | 55.6 | 8.7 | 49.4 |
| 3 | 20.9 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus at some times,nitrogen at others.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 14.
Potential nutrient input index =
area watershed in row crops/lake area = 2.9
55.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, crop rotation, terraces, contouring.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Cabins along lakeshore | Septic tank inflows |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Huston Park (County)
Grandview Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 8528. | 7.3 | 18.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 25328. | 21.6 | 53.4 |
| Swimming | 39363. | 33.6 | 83.0 |
| Pleasure boating | 4299. | 3.7 | 9.1 |
| Hunting | 1173. | 1.0 | 2.5 |
| Picnicking,camping,other activities prompted by the lake's presence | 157100. | 134.3 | 331.4 |
| Snowmobiling | 4513. | 3.9 | 9.5 |
| Ice skating and cross-country skiing | 1737. | 1.5 | 3.7 |
| TOTAL | 242041. | 206.9 | 510.6 |

IMPAIRMENTS

Swimming may be impaired in Lost Island Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel state that domestic sewage input may be a problem. I.C.C. personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: 1 year out of 15-20
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in Lost Island may be affected by inputs from septic tank systems of nearby cabins and resorts. Dye testing has established that outflow from some septic tanks does enter the lake. In addition to the increased nutrient and organic matter loading to the lake, the potential danger of bacterial contamination to lake users is increased. A sanitary district for the lake has been formed and sewer system plans have been approved. Further action is contingent upon the availability of construction funds. The completion of this system is important to the water quality of this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition,

it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LOWER GAR LAKE

LOCATION
County: Dickinson Latitude 43 Deg 20 Min N
Longitude 95 Deg 7 Min W
Township 99 N Range 36 W Section 32

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
4572. hectares ( 11297. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 1670. | 36.5 |
| 15 | 2389. | 52.2 |
| 12 | 513. | 11.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 85.9 | 9.4 | 1.0 | 0.0 | 3.8 |

Description of topography and soils in soil associations represented in the watershed

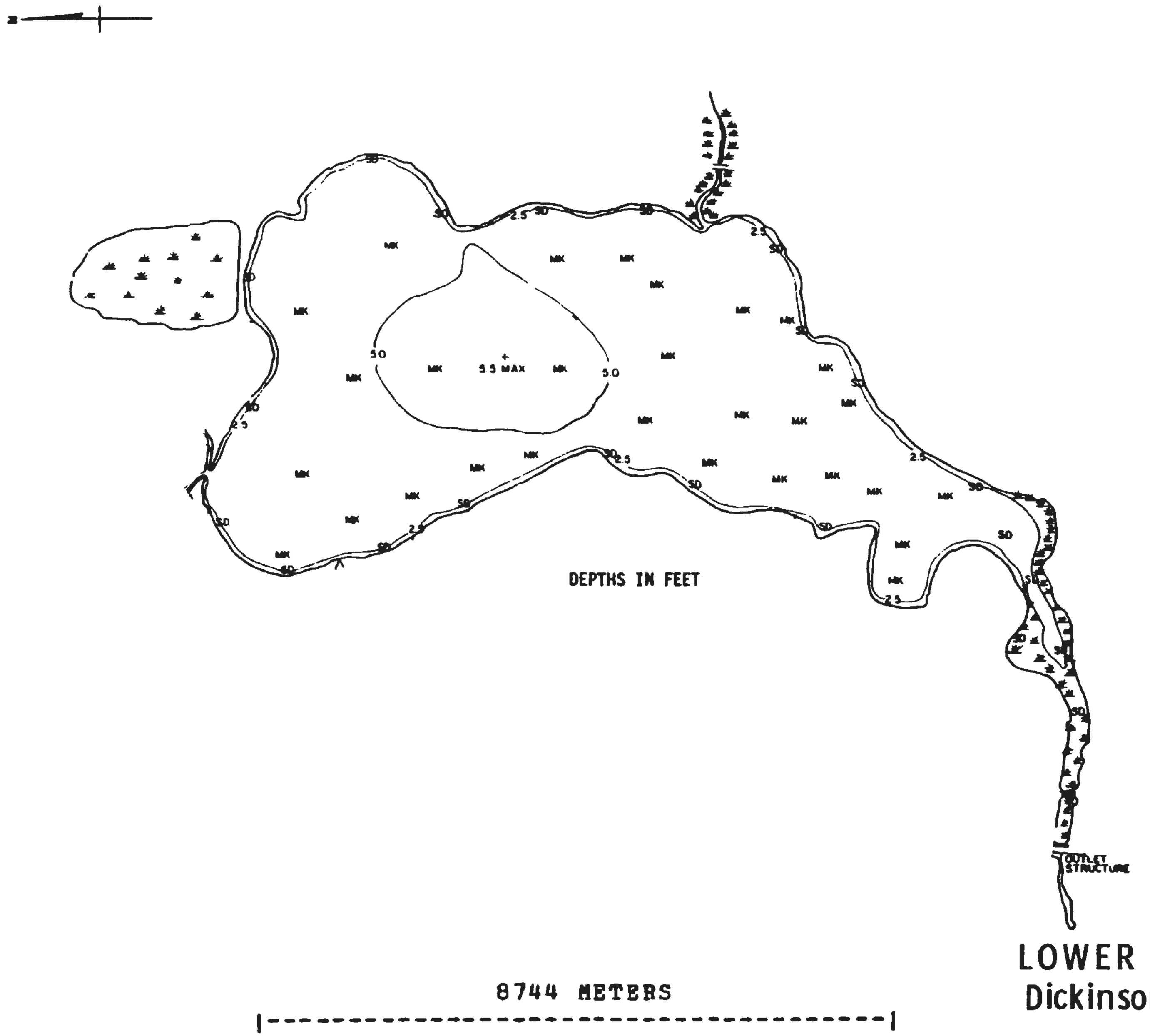
14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

Per cent of shoreline in public ownership 27 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1970 map
Area 102. ha ( 251. A)
Length of shoreline 6129. m ( 20107. ft)
Maximum depth 1.7 m ( 6.0 ft)
Mean depth 1.1 m ( 4. ft)
Volume 1106957. cubic meters ( 897. acre-feet)
Shoreline development 1.71 Volume development 1.95
Watershed/lake area ratio 44.8
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? No




LOWER GAR LAKE
Dickinson County

Major inflows (named and/or permanent streams)
From Minnewashta L + Bull Ditch
Outlet: Milford Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.3 | 0.06 |
| Chlorophyll a mg/cubic meter | 9 | 72.6 | 7.16 |
| Total phosphorus mg/cubic meter | 11 | 168.5 | 6.33 |
| Kjeldahl nitrogen mg/l | 2 | 1.4 | 0.25 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.4 | 0.01 |
| Seston dry weight mg/l | 9 | 59.9 | 9.91 |
| Turbidity JTU | 11 | 34.0 | 3.32 |
| Total hardness mg/l as CaCO3 | 11 | 238.7 | 1.19 |
| Calcium hardness mg/l as CaCO3 | 12 | 119.0 | 1.95 |
| Total alkalinity mg/l as CaCO3 | 10 | 219.3 | 2.72 |
| Dissolved oxygen mg/l | 9 | 6.9 | 0.40 |
| Specific conductance micromhos/cm at 25 C | 10 | 433.5 | 6.71 |
| Sulfate mg/l | 3 | 29.3 | 0.17 |
| Chloride mg/l | 4 | 14.1 | 0.13 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 7.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 18.6 | 5.9 | 161.6 | 8.5 | 47.2 |
| 1 | 18.7 | 5.5 | 169.5 | 8.5 | 57.6 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
        (watershed area/lake area) x soil loss rate = 179.
Potential nutrient input index =
        area watershed in row crops/lake area = 38.5
32.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| 10 hogs | Storage tank |
| 1380 hogs | Storage tank |
| 350 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
   Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
   This lake has also been designated as high quality water and is thus subject to higher standards to protect existing uses.
This lake is not designated as a public water supply.

Public parks:
   Lower Gar Park Access
   Lower Gar Wildlife Area
   Henderson Wildlife Area

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1221. | 4.9 | 12.0 |
| Shore or ice fishing | 3279. | 13.1 | 32.1 |
| Swimming | 1173. | 4.7 | 11.5 |
| Pleasure boating | 1963. | 7.8 | 19.2 |
| Hunting | 604. | 2.4 | 5.9 |
| Picnicking,camping,other activities prompted by the lake's presence | 28924. | 115.2 | 283.6 |
| Snowmobiling | 6943. | 27.7 | 68.1 |
| Ice skating and cross-country skiing | 782. | 3.1 | 7.7 |
| TOTAL | 44889. | 178.8 | 440.1 |

IMPAIRMENTS

Swimming may be impaired in Lower Gar Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills and summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 5 %
Estimated winterkill frequencies: 1 year out of 3-5
Estimated summerkill frequencies: 1 year out of 5-7

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can

make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LOWER PINE LAKE

LOCATION
County: Hardin   Latitude 42 Deg 22 Min N
Longitude 93 Deg 4 Min W
Township 87 N   Range 19 W   Section 4

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
339. hectares ( 837. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 57 | 259. | 76.4 |
| 59 | 80. | 23.6 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 69.9 | 17.4 | 9.8 | 0.0 | 2.8 |

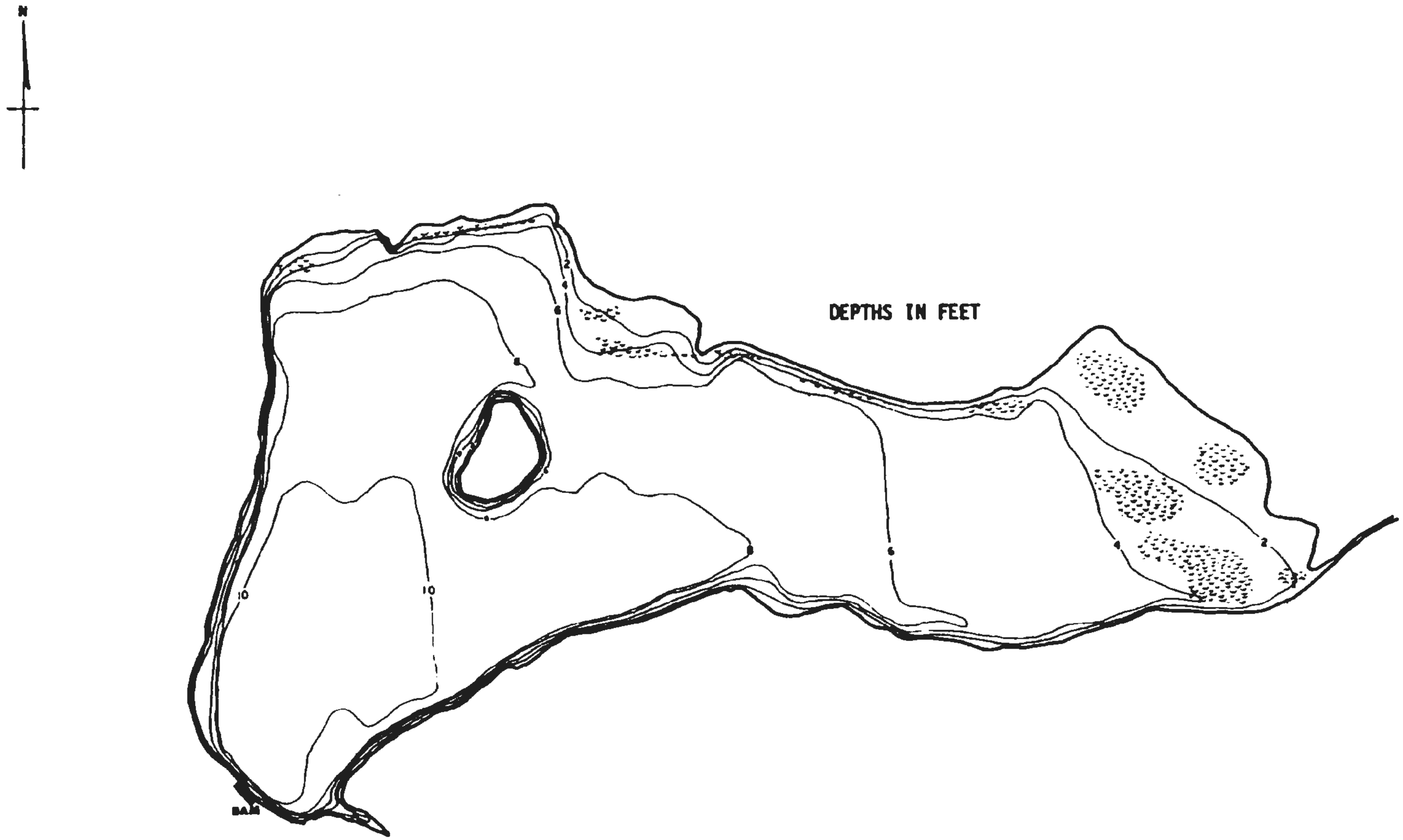
Description of topography and soils in soil associations represented in the watershed

57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

59 Gently to moderately sloping (2-9%) prairie or mixed prairie-forest-derived soils developed from loess or loess over pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, and Downs soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 20. ha ( 50. A)
Length of shoreline 2443. m ( 8016. ft)
Maximum depth 3.0 m ( 10.0 ft)
Mean depth 2.0 m ( 7. ft)
Volume 404509. cubic meters ( 328. acre-feet)
Shoreline development 1.53   Volume development 1.96
Watershed/lake area ratio 16.9
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
From Upper Pine L
Outlet: Pine Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




1172 METERS

# LOWER PINE LAKE
Hardin County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.6 | 0.15 |
| Chlorophyll a mg/cubic meter | 10 | 88.6 | 11.34 |
| Total phosphorus mg/cubic meter | 9 | 82.2 | 10.14 |
| Kjeldahl nitrogen mg/l | 2 | 1.4 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.4 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.9 | 0.02 |
| Seston dry weight mg/l | 10 | 14.1 | 1.48 |
| Turbidity JTU | 9 | 11.3 | 1.29 |
| Total hardness mg/l as CaCO3 | 10 | 176.8 | 5.61 |
| Calcium hardness mg/l as CaCO3 | 10 | 86.6 | 2.53 |
| Total alkalinity mg/l as CaCO3 | 11 | 126.5 | 0.90 |
| Dissolved oxygen mg/l | 10 | 11.2 | 1.26 |
| Specific conductance micromhos/cm at 25 C | 10 | 345.5 | 16.71 |
| Sulfate mg/l | 3 | 27.2 | 1.42 |
| Chloride mg/l | 3 | 19.0 | 0.00 |
| Sodium mg/l | 2 | 4.5 | 0.50 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.6 | 10.1 | 78.1 | 8.5 | 104.0 |
| 1 | 26.1 | 10.0 | 90.3 | 8.6 | 86.4 |
| 2 | 25.6 | 9.8 | 88.3 | 8.3 | 98.0 |
| 3 | 22.2 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 137.
Potential nutrient input index =
area watershed in row crops/lake area = 11.8
40.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, grass waterways, conservation tillage, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Pine Lake State Park | Lagoons |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Pine Lake State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2175. | 43.5 | 108.8 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 30572. | 611.4 | 1528.6 |
| Swimming | 9704. | 194.1 | 485.2 |
| Pleasure boating | 4846. | 96.9 | 242.3 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 43447. | 868.9 | 2172.3 |
| Snowmobiling | 886. | 17.7 | 44.3 |
| Ice skating and cross-country skiing | 191. | 3.8 | 9.5 |
| TOTAL | 91821. | 1836.4 | 4591.0 |

IMPAIRMENTS

Swimming may be impaired in Lower Pine Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating, shoreline fishing, and swimming. Frequent winterkills and summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to an inadequate boat ramp and dense aquatic vegetation.

Estimated aquatic plant coverage 18 %
Estimated winterkill frequencies: 1 year out of 5
Estimated summerkill frequencies: 1 year out of 4

LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term

extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE MACBRIDE

LOCATION

| | | | |
|---|---|---|---|
| County: Johnson | | Latitude | 41 Deg 48 Min N |
| | | Longitude | 91 Deg 34 Min W |
| Township 81 N | Range 6 W | | Section 29 |

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
6558. hectares ( 16205. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 56 | 2856. | 43.5 |
| 57 | 2207. | 33.7 |
| 65 | 1495. | 22.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 76.0 | 14.2 | 5.8 | 0.9 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

56 Gently to strongly sloping (2-14%) prairie to forest-derived soils developed from loess. Tama, Downs, and Fayette soils.

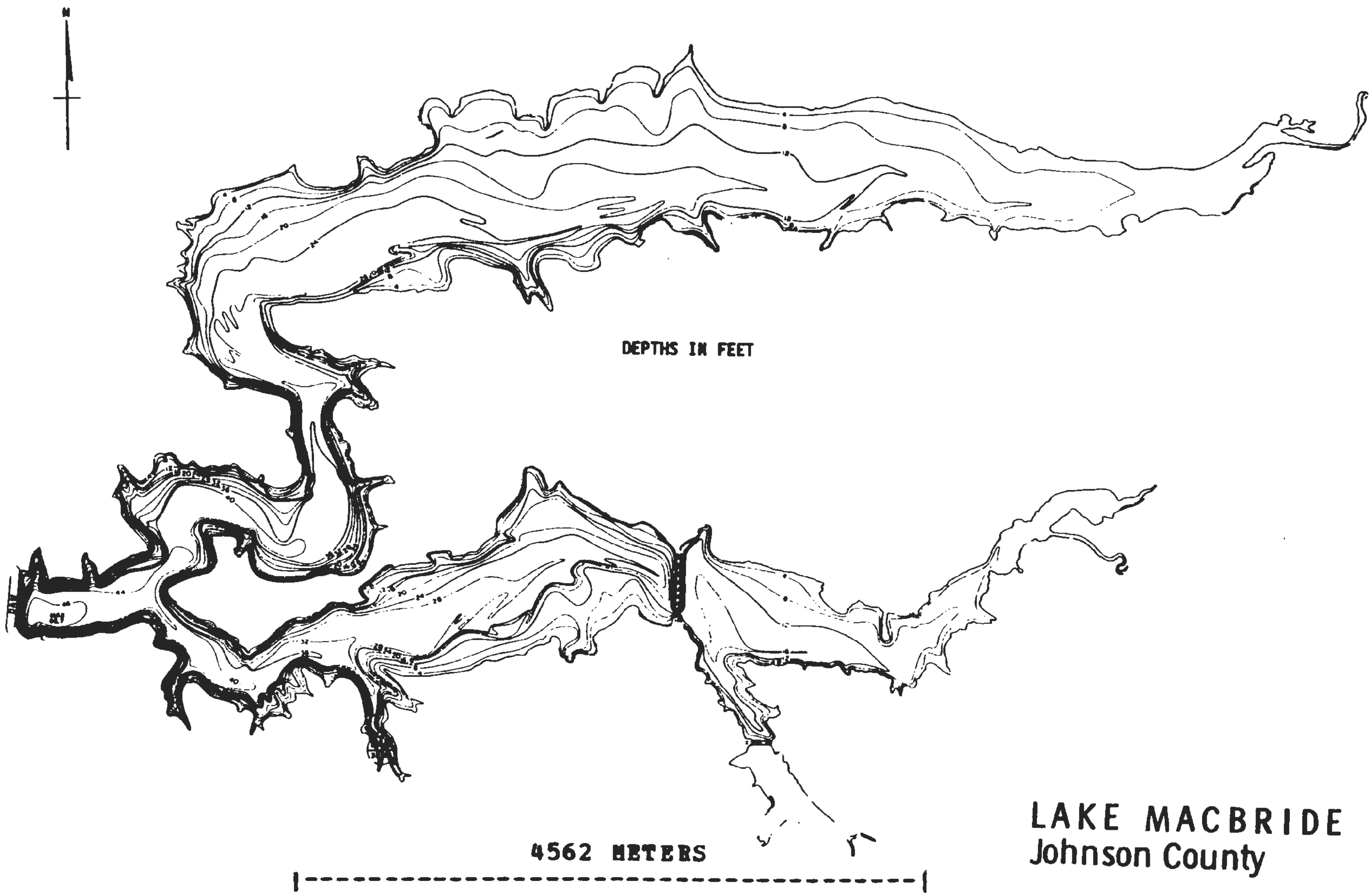
57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

65 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess over pre-Wisconsin till or from pre-Wisconsin till on the Iowan Erosion Surface. Dinsdale, Klinger, Maxfield, Tama, and Kenyon soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map
Area 329. ha ( 812. A)
Length of shoreline 31640. m ( 103807. ft)
Maximum depth 14.3 m ( 47.0 ft)
Mean depth 4.9 m ( 16. ft)
Volume 16203280. cubic meters ( 13131. acre-feet)
Shoreline development 4.92 Volume development 1.03
Watershed/lake area ratio 19.9
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 86. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Mill Cr, Jordan Cr




LAKE MACBRIDE
Johnson County

Outlet: Mill Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.06 |
| Chlorophyll a mg/cubic meter | 10 | 32.5 | 2.56 |
| Total phosphorus mg/cubic meter | 9 | 58.7 | 4.66 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.2 | 0.02 |
| Seston dry weight mg/l | 11 | 13.8 | 1.96 |
| Turbidity JTU | 9 | 7.8 | 0.52 |
| Total hardness mg/l as CaCO3 | 9 | 132.7 | 5.57 |
| Calcium hardness mg/l as CaCO3 | 10 | 77.8 | 4.35 |
| Total alkalinity mg/l as CaCO3 | 11 | 98.0 | 3.86 |
| Dissolved oxygen mg/l | 10 | 9.9 | 0.75 |
| Specific conductance micromhos/cm at 25 C | 13 | 271.5 | 11.37 |
| Sulfate mg/l | 3 | 29.0 | 1.53 |
| Chloride mg/l | 4 | 17.0 | 0.00 |
| Sodium mg/l | 2 | 9.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/29/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.6 | 12.6 | 50.4 | 9.0 | 40.4 |
| 1 | 25.6 | 12.0 | 59.4 | 9.6 | 35.2 |
| 2 | 25.0 | | | | |
| 3 | 24.4 | 11.6 | 59.7 | 9.1 | 40.4 |
| 4 | 23.9 | | | | |
| 5 | 22.8 | 5.3 | 224.1 | 8.5 | 24.7 |
| 6 | 22.2 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 227.
Potential nutrient input index =
  area watershed in row crops/lake area = 15.1
40.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, contouring, terraces, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Solon IA0036978 | Oxidation ditches and sludge handling facility |

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
  Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
  Lake MacBride State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 27361. | 33.7 | 83.2 |
| Shore or ice fishing | 55298. | 68.1 | 168.1 |
| Swimming | 48049. | 59.2 | 146.0 |
| Pleasure boating | 16763. | 20.6 | 51.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 86721. | 106.8 | 263.6 |
| Snowmobiling | 33228. | 40.9 | 101.0 |
| Ice skating and cross-country skiing | 7375. | 9.1 | 22.4 |
| TOTAL | 274795. | 338.4 | 835.2 |

Special events at Lake MacBride contributing to more than normal use include an ice fisheree (2,500 people).

IMPAIRMENTS

Swimming may be impaired in Lake MacBride throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 13 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the

Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE MANAWA

LOCATION
County: Pottawattamie   Latitude 41 Deg 13 Min N
Longitude 95 Deg 51 Min W
Township 74 N   Range 44 W   Section 13

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
1008. hectares ( 2490. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 338. | 33.5 |
| 21 | 377. | 37.4 |
| 22 | 293. | 29.1 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 82.4 | 7.2 | 4.4 | 2.7 | 3.3 |

Description of topography and soils in soil associations represented in the watershed

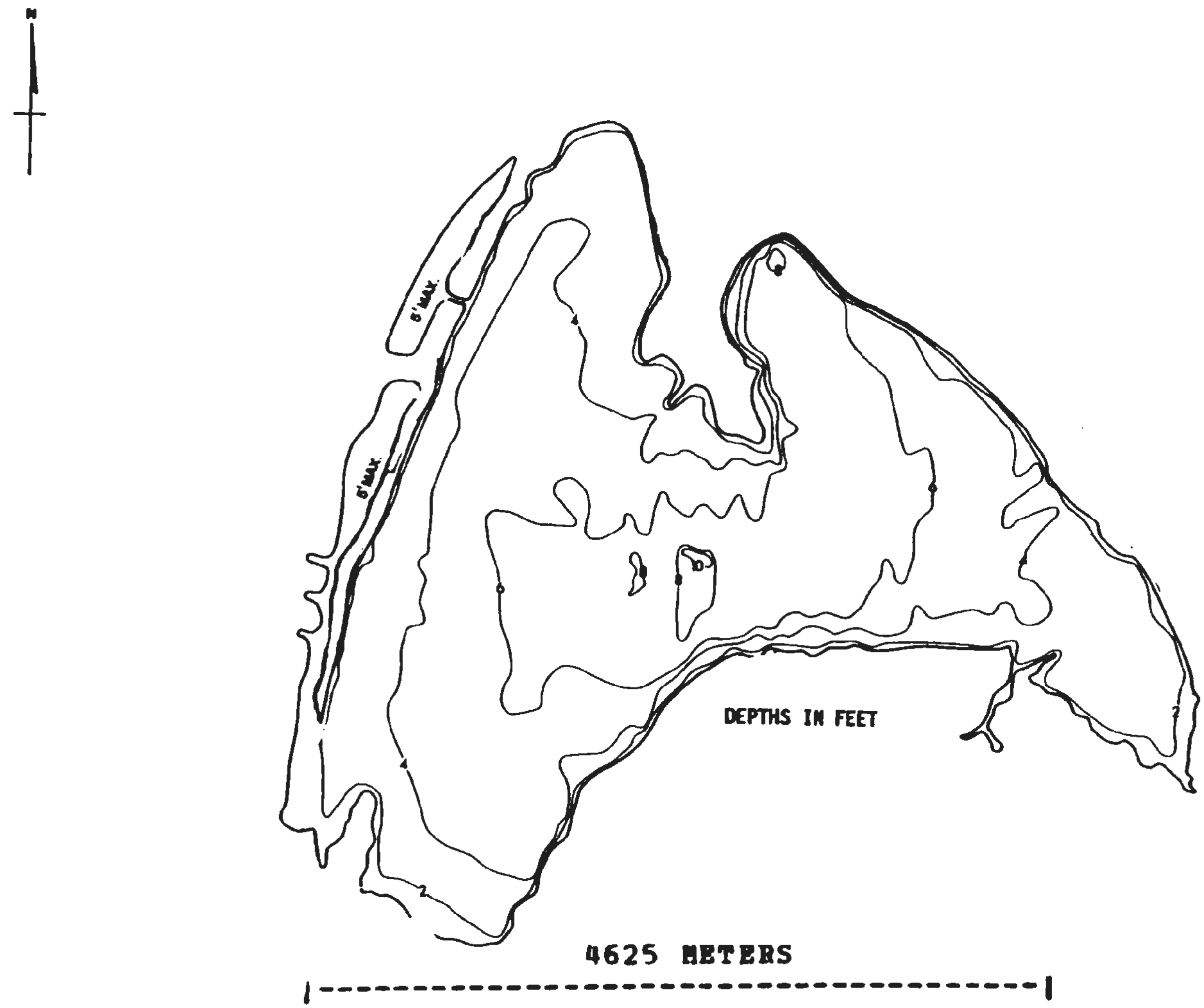
7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

21 Nearly level (0-2%) soils developed from alluvium. Albaton, Haynie, and Onawa soils.

22 Level and nearly level (0-2%) soils developed from alluvium. Luton, Blencoe, Keg, and Salix soils.

Per cent of shoreline in public ownership 88 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1974 map
Area 313. ha ( 772. A)
Length of shoreline 15325. m ( 50280. ft)
Maximum depth 3.0 m ( 10.0 ft)
Mean depth 1.4 m ( 5. ft)
Volume 4250098. cubic meters ( 3444. acre-feet)
Shoreline development 2.46   Volume development 1.36
Watershed/lake area ratio 3.2
Origin of basin: Natural
Estimated annual precipitation 81. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 102. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
Supplemental water from Mosquito Creek.
Outlet: Unnamed




LAKE MANAWA
Pottawattami County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 3 | 0.3 | 0.07 |
| Chlorophyll a mg/cubic meter | 15 | 48.7 | 5.43 |
| Total phosphorus mg/cubic meter | 9 | 117.6 | 6.32 |
| Kjeldahl nitrogen mg/l | 2 | 0.7 | 0.09 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.08 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 10 | 38.7 | 2.43 |
| Turbidity JTU | 9 | 19.0 | 0.85 |
| Total hardness mg/l as CaCO3 | 9 | 188.4 | 4.84 |
| Calcium hardness mg/l as CaCO3 | 9 | 95.6 | 4.54 |
| Total alkalinity mg/l as CaCO3 | 9 | 173.1 | 3.11 |
| Dissolved oxygen mg/l | 9 | 6.8 | 0.33 |
| Specific conductance micromhos/cm at 25 C | 9 | 393.3 | 9.86 |
| Sulfate mg/l | 4 | 37.4 | 0.88 |
| Chloride mg/l | 3 | 15.7 | 0.17 |
| Sodium mg/l | 1 | 19.0 | |
| Potassium mg/l | 1 | 6.0 | |

Vertical profile for selected measurements on the sampling date ( 8/29/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP °C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.0 | 8.5 | 111.5 | 8.7 | 38.2 |
| 1 | 24.0 | 6.2 | 84.3 | 8.5 | 56.1 |
| 2 | 23.8 | 5.8 | 89.4 | 8.6 | 32.9 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 5.
Potential nutrient input index =
area watershed in row crops/lake area = 2.7
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Earling STP IA0025364 | Discharge to Mosquito Creek |
| Earling WTP | Discharge to Mosquito Creek |
| Panama IA0033537 | Septic tank drainage to tile to Mosquito Creek |
| Portsmouth | no discharge |
| Persia STP | no discharge |
| Persia WTP | no treatment |
| Neola IA0021041 | no details |
| Tricenter Comm. Home | lagoon; total retention |
| Underwood IA0036986 | lagoon; discharge to Mosquito Creek |
| Western Electric Co. | Total retention facility |
| Hanson Oil Co. | 2-cell lagoon |
| Iowa Highway Comm. Rest area | Septic tank; no discharge |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.

This lake is not designated as a public water supply.

Public parks:
Lake Manawa State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 7010. | 9.1 | 22.4 |
| Shore or ice fishing | 23120. | 29.9 | 73.9 |
| Swimming | 100971. | 130.8 | 322.6 |
| Pleasure boating | 19329. | 25.0 | 61.8 |
| Hunting | 1889. | 2.4 | 6.0 |
| Picnicking, camping, other activities prompted by the lake's presence | 407817. | 528.3 | 1302.9 |
| Snowmobiling | 955. | 1.2 | 3.1 |
| Ice skating and cross-country skiing | 1737. | 2.3 | 5.5 |
| TOTAL | 562828. | 729.1 | 1798.2 |

Special events at Lake Manawa contributing to more than normal use include several fishing tournaments (20-250 people).

IMPAIRMENTS

Swimming may be impaired in Lake Manawa throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential; boating and swimming use is high while fishing pressure is low.

Estimated aquatic plant coverage 12 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The shallowness of Lake Manawa and the large population of carp in the lake contribute to its poor water quality. Surface runoff and direct precipitation are insufficient to offset water losses due to evaporation and seepage; therefore lake levels are maintained with supplemental water diverted to the lake (on a controlled basis) from Mosquito Creek. Sediment and nutrient rich water from Mosquito Creek contribute to the poor water quality. Lake Manawa is scheduled to undergo lake restoration involving dredging, fishery renovation, and sediment removal from the lake's supplemental water supply.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

MANTENO LAKE

LOCATION
County: Shelby          Latitude 41 Deg 51 Min N
                        Longitude 95 Deg 28 Min W
Township 81 N     Range 40 W     Section 2

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
917. hectares ( 2266. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 20 | 514. | 56.0 |
| 29 | 403. | 44.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 82.2 | 12.7 | 2.1 | 0.0 | 3.0 |

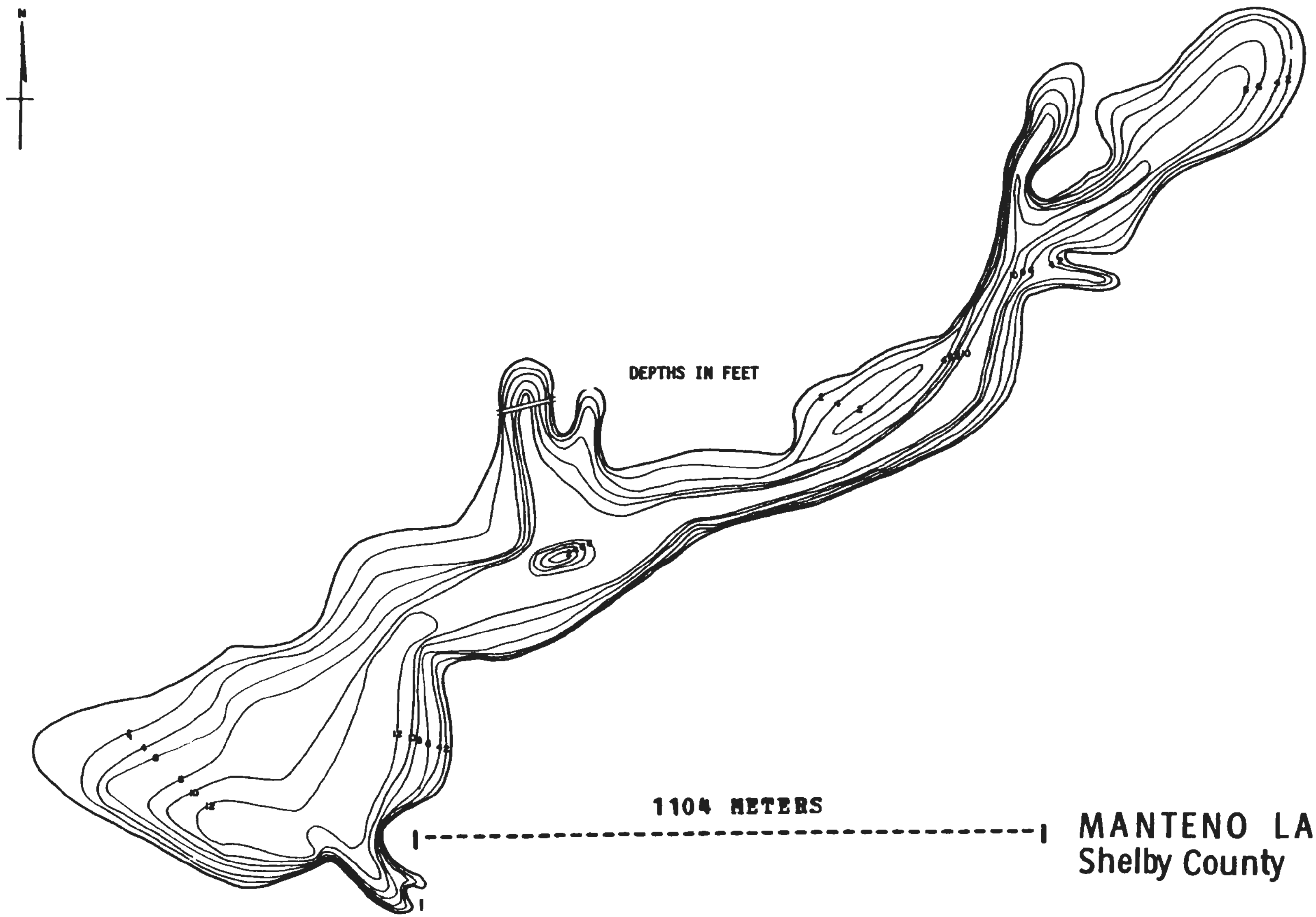
Description of topography and soils in soil associations represented in the watershed

20 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from loess or loess-derived sediments. Ida, Napier, and Monona soils.

29 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess. Monona, Marshall, and Ida soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1978 map
Area 6. ha ( 15. A)
Length of shoreline 2176. m ( 7138. ft)
Maximum depth 3.7 m ( 12.0 ft)
Mean depth 2.0 m ( 7. ft)
Volume 119598. cubic meters ( 97. acre-feet)
Shoreline development 2.51    Volume development 1.64
Watershed/lake area ratio 152.8
Origin of basin: Impoundment
Estimated annual precipitation 76. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 99. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Unnamed
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




MANTENO LAKE
Shelby County

PCLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.0 | 0.05 |
| Chlorophyll a mg/cubic meter | 8 | 84.2 | 22.92 |
| Total phosphorus mg/cubic meter | 5 | 111.6 | 19.81 |
| Kjeldahl nitrogen mg/l | 2 | 0.9 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 8 | 12.9 | 1.63 |
| Turbidity JTU | 6 | 5.9 | 0.68 |
| Total hardness mg/l as $CaCO_3$ | 7 | 151.7 | 0.68 |
| Calcium hardness mg/l as $CaCO_3$ | 7 | 75.1 | 1.30 |
| Total alkalinity mg/l as $CaCO_3$ | 6 | 147.7 | 0.81 |
| Dissolved oxygen mg/l | 7 | 7.3 | 0.68 |
| Specific conductance micromhos/cm at 25 C | 7 | 307.1 | 4.74 |
| Sulfate mg/l | 4 | 8.6 | 0.13 |
| Chloride mg/l | 5 | 6.7 | 0.12 |
| Sodium mg/l | 2 | 6.0 | 0.00 |
| Potassium mg/l | 2 | 8.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 7/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.7 | 7.8 | 97.1 | 8.3 | 112.3 |
| 1 | 25.3 | 7.1 | 103.2 | 8.2 | 54.9 |
| 2 | 24.1 | 4.0 | 106.2 | 7.7 | 71.5 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 3347.
Potential nutrient input index =
area watershed in row crops/lake area = 125.6
30.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| 20 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Manteno Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 352. | 23.5 | 58.7 |
| Shore or ice fishing | 1903. | 126.9 | 317.2 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 3234. | 215.6 | 539.0 |
| Snowmobiling | 35. | 2.3 | 5.8 |
| Ice skating and cross-country skiing | 35. | 2.3 | 5.8 |
| TOTAL | 5559. | 370.6 | 926.5 |

IMPAIRMENTS

Water clarity is poor in Manteno Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Occasional winterkills may limit fishing potential. Chemical renovation of the fish population was done in 1978. Iowa Conservation Commission personnel consider lake usage to be below its potential due to low fishing pressure.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: 1 year out of 15
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is

not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

MARIPOSA LAKE

LOCATION

| | | |
|---|---|---|
| County: Jasper | Latitude 41 Deg 47 Min N | |
| | Longitude 92 Deg 58 Min W | |
| Township 81 N | Range 18 W | Section 32 |

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
233. hectares ( 575. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 56 | 28. | 12.2 |
| 57 | 204. | 87.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 65.7 | 20.0 | 11.5 | 0.0 | 2.8 |

Description of topography and soils in soil associations represented in the watershed

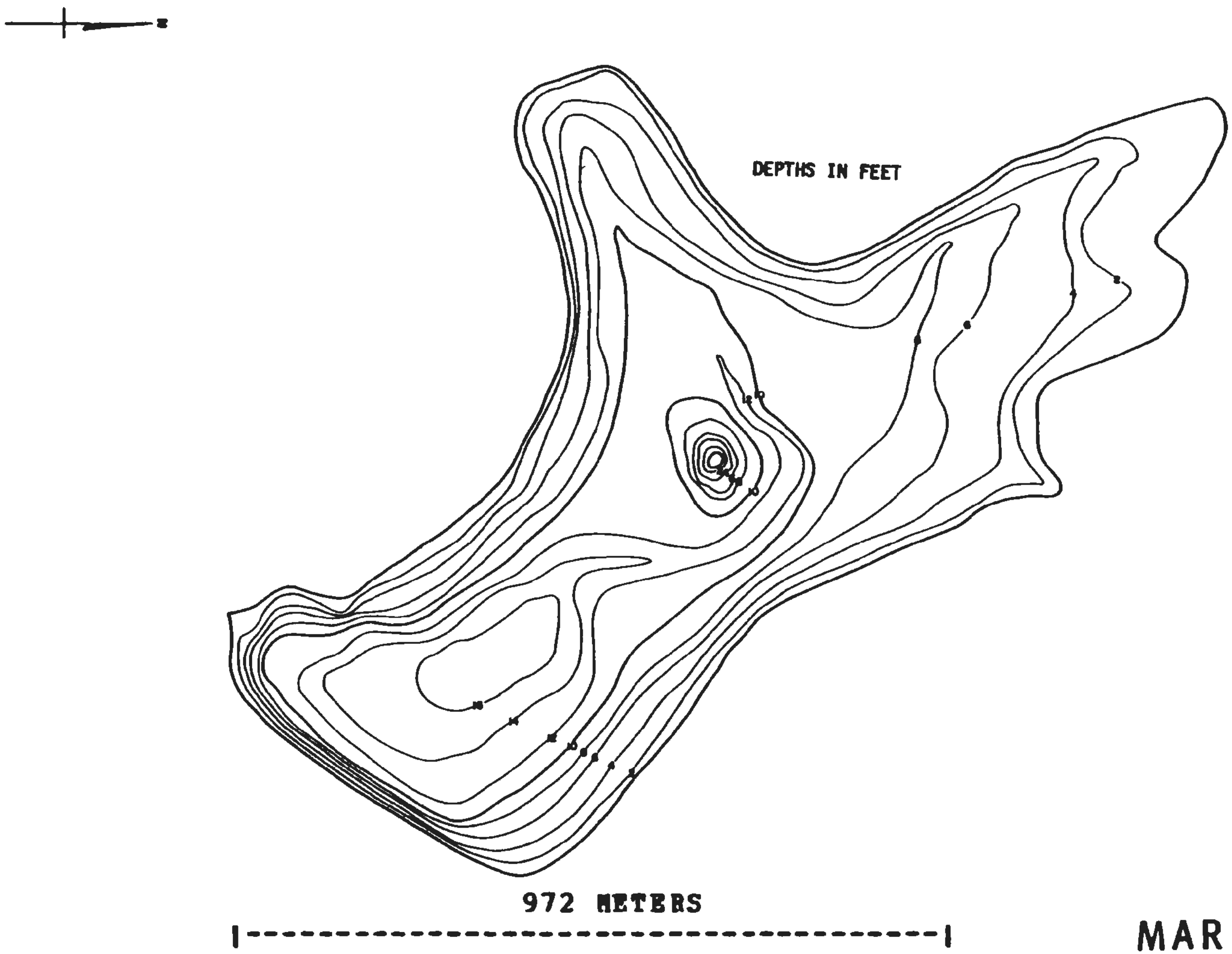
56 Gently to strongly sloping (2-14%) prairie to forest-derived soils developed from loess. Tama, Downs, and Fayette soils.

57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 8. ha ( 19. A)
Length of shoreline 1480. m ( 4854. ft)
Maximum depth 5.2 m ( 17.0 ft)
Mean depth 2.3 m ( 7. ft)
Volume 177158. cubic meters ( 144. acre-feet)
Shoreline development 1.49 Volume development 1.30
Watershed/lake area ratio 29.1
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




MARIPOSA LAKE
Jasper County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.06 |
| Chlorophyll a mg/cubic meter | 9 | 64.5 | 6.67 |
| Total phosphorus mg/cubic meter | 8 | 169.1 | 24.25 |
| Kjeldahl nitrogen mg/l | 2 | 0.7 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 7 | 15.8 | 1.86 |
| Turbidity JTU | 8 | 8.8 | 1.03 |
| Total hardness mg/l as $CaCO_3$ | 8 | 141.0 | 2.14 |
| Calcium hardness mg/l as $CaCO_3$ | 9 | 86.9 | 1.25 |
| Total alkalinity mg/l as $CaCO_3$ | 7 | 124.6 | 1.49 |
| Dissolved oxygen mg/l | 7 | 9.4 | 0.69 |
| Specific conductance micromhos/cm at 25 C | 8 | 273.8 | 9.05 |
| Sulfate mg/l | 3 | 16.3 | 0.67 |
| Chloride mg/l | 3 | 11.3 | 0.17 |
| Sodium mg/l | 2 | 8.5 | 0.50 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.2 | 10.8 | 116.3 | 8.7 | 53.9 |
| 1 | 27.0 | 10.1 | 107.6 | 8.6 | 72.2 |
| 2 | 26.0 | | | | |
| 3 | 24.2 | 0.4 | 148.6 | 7.6 | 37.0 |
| 4 | 14.6 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 638.
Potential nutrient input index =
area watershed in row crops/lake area = 19.1
45.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, contouring, ponds/sediment and water control basins, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Mariposa Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 0. | 0.0 | 0.0 |
| Shore or ice fishing | 4904. | 258.1 | 613.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 10593. | 557.5 | 1324.1 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 208. | 10.9 | 26.0 |
| TOTAL | 15705. | 826.6 | 1963.1 |

Special events at Mariposa Lake contributing to more than normal use include environmental education for six communities (480-500 people), visits from Marshalltown Day Care (150 people), senior citizen groups (70 people), and the YMCA (65 people), as well as a B.S.A. fishing derby (25 people).

IMPAIRMENTS

Water clarity is poor in Mariposa Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Occasional winterkills may limit the fishing potential. White Amur have been stocked to control aquatic vegetation. An aerator is used in the winter to maintain the dissolved oxygen concentration. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 39 %
Artificial aeration used
Estimated winterkill frequencies: 1 year out of 15
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion

terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

MEADOW LAKE

LOCATION

County: Adair    Latitude 41 Deg 23 Min N
                 Longitude 94 Deg 26 Min W

Township 76 N    Range 31 W    Section 17

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
328. hectares ( 811. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 189. | 57.5 |
| 34 | 140. | 42.5 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 69.7 | 22.3 | 4.2 | 0.0 | 3.7 |

Description of topography and soils in soil associations represented in the watershed

30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

34 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from pre-Wisconsin till, pre-Wisconsin till-derived paleosols, or loess. Shelby, Adair, and Sharpsburg soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1971 map

Area 17. ha ( 42. A)

Length of shoreline 3442. m ( 11292. ft)

Maximum depth 7.6 m ( 25.0 ft)

Mean depth 2.8 m ( 9. ft)

Volume 487145. cubic meters ( 395. acre-feet)

Shoreline development 2.35    Volume development 1.12

Watershed/lake area ratio 19.3

Origin of basin: Impoundment

Estimated annual precipitation 81. cm

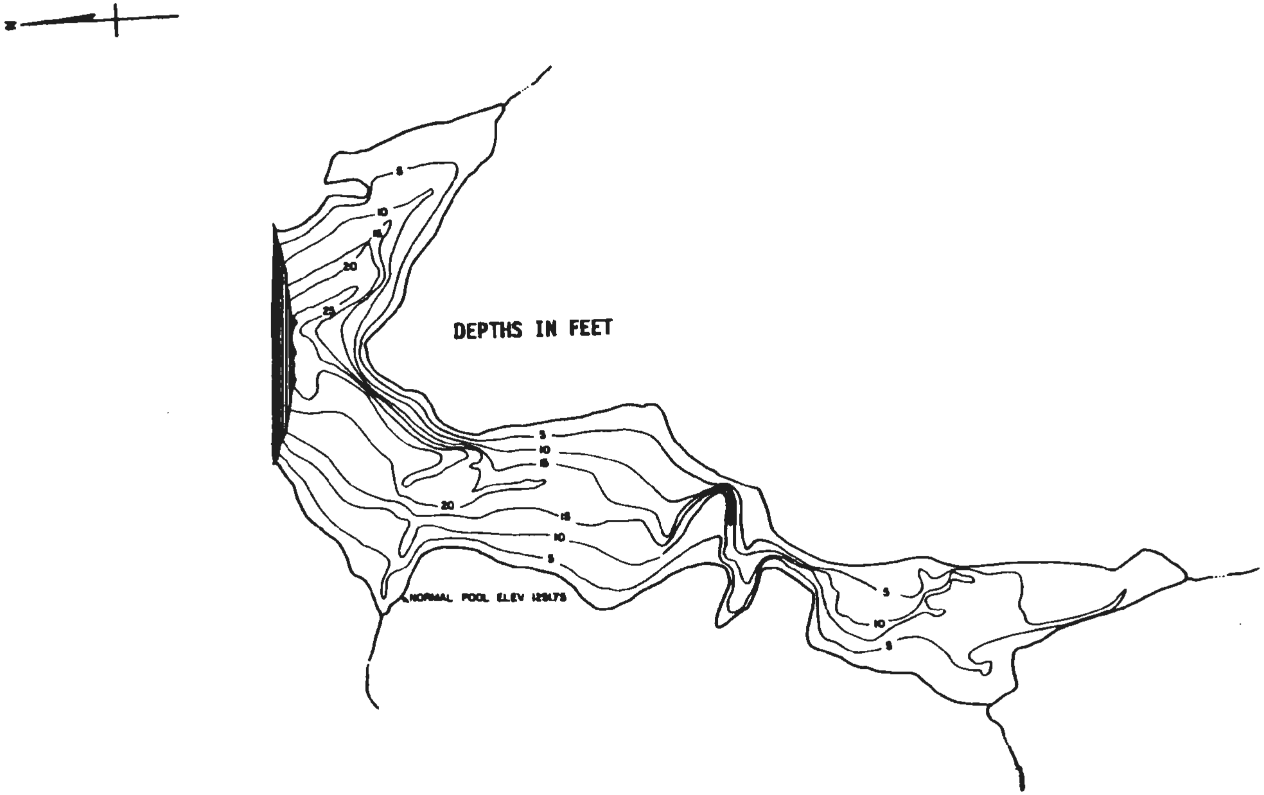
Estimated annual runoff 13. cm

Estimated lake evaporation 97. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)
None

Outlet: Unnamed




12165 METERS

MEADOW LAKE
Adair County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.8 | 0.21 |
| Chlorophyll a mg/cubic meter | 10 | 128.0 | 21.32 |
| Total phosphorus mg/cubic meter | 10 | 127.7 | 17.08 |
| Kjeldahl nitrogen mg/l | 2 | 1.3 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 10 | 20.8 | 2.69 |
| Turbidity JTU | 10 | 16.2 | 2.72 |
| Total hardness mg/l as CaCO3 | 9 | 110.2 | 3.63 |
| Calcium hardness mg/l as CaCO3 | 9 | 71.6 | 3.25 |
| Total alkalinity mg/l as CaCO3 | 10 | 100.8 | 2.37 |
| Dissolved oxygen mg/l | 10 | 7.8 | 0.50 |
| Specific conductance micromhos/cm at 25 C | 10 | 242.5 | 12.41 |
| Sulfate mg/l | 3 | 10.7 | 0.17 |
| Chloride mg/l | 3 | 4.0 | 0.00 |
| Sodium mg/l | 2 | 4.0 | 0.00 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 7/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.5 | 8.1 | 127.5 | 9.0 | 193.1 |
| 1 | 27.5 | 8.0 | 135.6 | 9.0 | 148.2 |
| 2 | 27.5 | 8.0 | 125.8 | 8.8 | 151.2 |
| 3 | 27.4 | | | | |
| 4 | 27.0 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 243.
Potential nutrient input index =
area watershed in row crops/lake area = 13.4
72.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, contouring, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Meadow Lake Wildlife Area (State)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 487. | 11.6 | 28.6 |
| Shore or ice fishing | 3985. | 94.9 | 234.4 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 109. | 2.6 | 6.4 |
| Hunting | 3800. | 90.5 | 223.5 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 655. | 15.6 | 38.5 |
| Snowmobiling | 122. | 2.9 | 7.2 |
| Ice skating and cross-country skiing | 122. | 2.9 | 7.2 |
| TOTAL | 9280. | 221.0 | 545.9 |

IMPAIRMENTS

Water clarity is poor in Meadow Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to low fishing pressure.

Estimated aquatic plant coverage 16 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE MEYERS

LOCATION

County: Winneshiek  Latitude 43 Deg 10 Min N
Longitude 91 Deg 55 Min W

Township 97 N  Range 9 W  Section 33

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
572. hectares ( 1412. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 66 | 340. | 59.5 |
| 68 | 232. | 40.5 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 67.1 | 6.1 | 14.6 | 3.1 | 2.5 |

Description of topography and soils in soil associations represented in the watershed

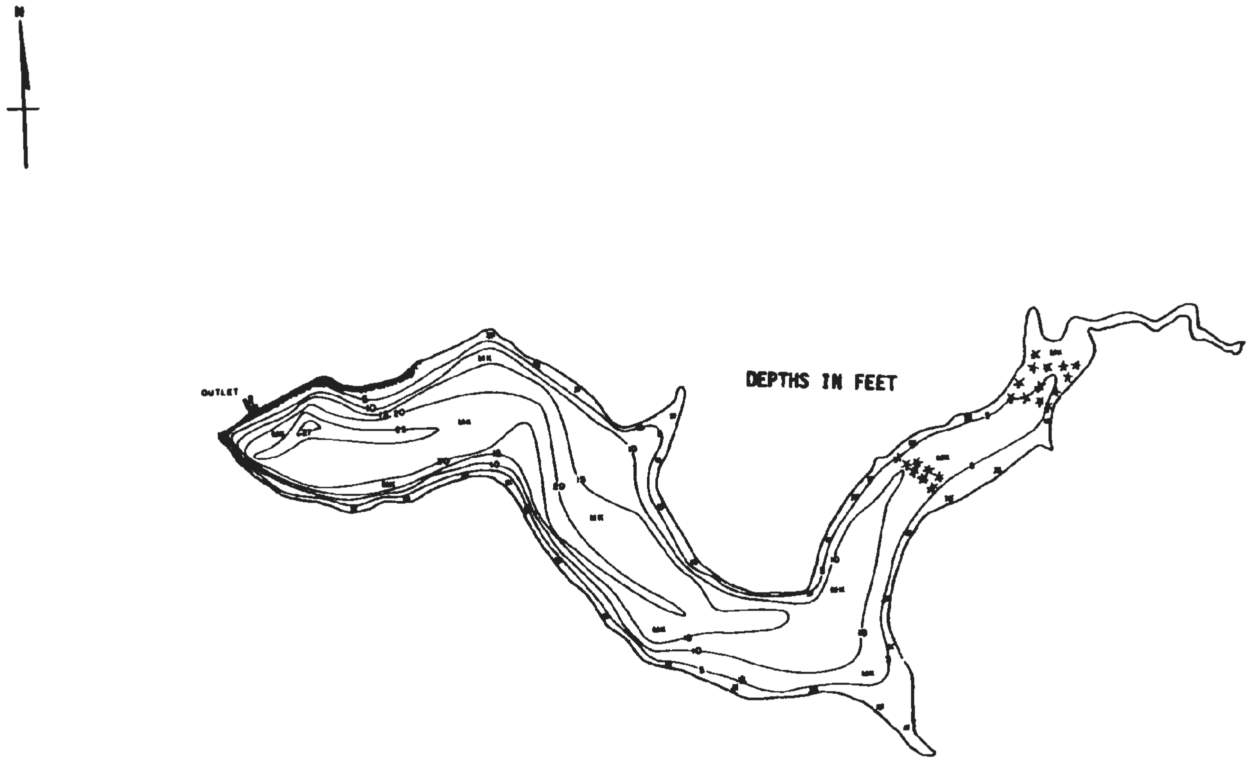
66 Moderately sloping to very steep (5-40%) forest or mixed prairie-forest-derived soils developed from loess or loess over bedrock. Fayette, Downs, Dubuque, and Nordness soils and Steep Rock Land.

68 Gently to strongly sloping (2-14%) prairie and forest-derived soils developed from loess or sediments over bedrock on the border of the Iowan Erosion Surface area and loess areas. Includes small areas of soils developed from pre-Wisconsin till. Winneshiek, Marlean, Rockton, Fayette, and Downs soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1972 map
Area 16. ha ( 40. A)
Length of shoreline 3504. m ( 11497. ft)
Maximum depth 8.2 m ( 27.0 ft)
Mean depth 3.4 m ( 11. ft)
Volume 540689. cubic meters ( 438. acre-feet)
Shoreline development 2.46  Volume development 1.22
Watershed/lake area ratio 35.8
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 84. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Unnamed
Outlet: Unnamed




3105 METERS

# LAKE MEYERS
## Winneshiek County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 4 | 0.7 | 0.13 |
| Chlorophyll a mg/cubic meter | 9 | 61.8 | 23.69 |
| Total phosphorus mg/cubic meter | 8 | 93.5 | 6.86 |
| Kjeldahl nitrogen mg/l | 2 | 0.8 | 0.14 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 1.6 | 0.10 |
| Seston dry weight mg/l | 11 | 20.0 | 3.47 |
| Turbidity JTU | 9 | 12.1 | 1.68 |
| Total hardness mg/l as CaCO3 | 8 | 198.2 | 2.84 |
| Calcium hardness mg/l as CaCO3 | 8 | 121.7 | 4.18 |
| Total alkalinity mg/l as CaCO3 | 7 | 167.1 | 5.40 |
| Dissolved oxygen mg/l | 9 | 8.3 | 0.77 |
| Specific conductance micromhos/cm at 25 C | 9 | 387.8 | 9.83 |
| Sulfate mg/l | 3 | 29.0 | 2.75 |
| Chloride mg/l | 3 | 11.8 | 0.17 |
| Sodium mg/l | 2 | 5.5 | 0.50 |
| Potassium mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.7 | 9.3 | 81.7 | 7.9 | 25.8 |
| 1 | 26.7 | 9.0 | 80.1 | 8.2 | 21.3 |
| 2 | 23.3 | | | | |
| 3 | 21.1 | | | | |
| 4 | 17.8 | 0.5 | 200.4 | 7.9 | 6.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 290.
Potential nutrient input index =
area watershed in row crops/lake area = 24.0
35.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Lake Meyer Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1216. | 30.4 | 76.0 |
| Shore or ice fishing | 2607. | 65.2 | 162.9 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 999. | 25.0 | 62.4 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 3696. | 92.4 | 231.0 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 243. | 6.1 | 15.2 |
| TOTAL | 8761. | 219.0 | 547.6 |

Special events at Lake Meyers contributing to more than normal use include group picnics (500 people) and environmental education (5,000 people).

IMPAIRMENTS

Swimming may be impaired in Lake Meyers throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Iowa Conservation Commission personnel consider lake usage to be below its potential due to competition with the Mississippi River and poor water quality.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE MIAMI

LOCATION

| | | | |
|---|---|---|---|
| County: Monroe | | Latitude | 41 Deg 7 Min N |
| | | Longitude | 92 Deg 51 Min W |
| Township 73 N | Range 17 W | Section 20 | |

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
1512. hectares ( 3735. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 38 | 766. | 50.7 |
| 36 | 746. | 49.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 28.0 | 34.0 | 9.0 | 0.0 | 29.0 |

Description of topography and soils in soil associations represented in the watershed

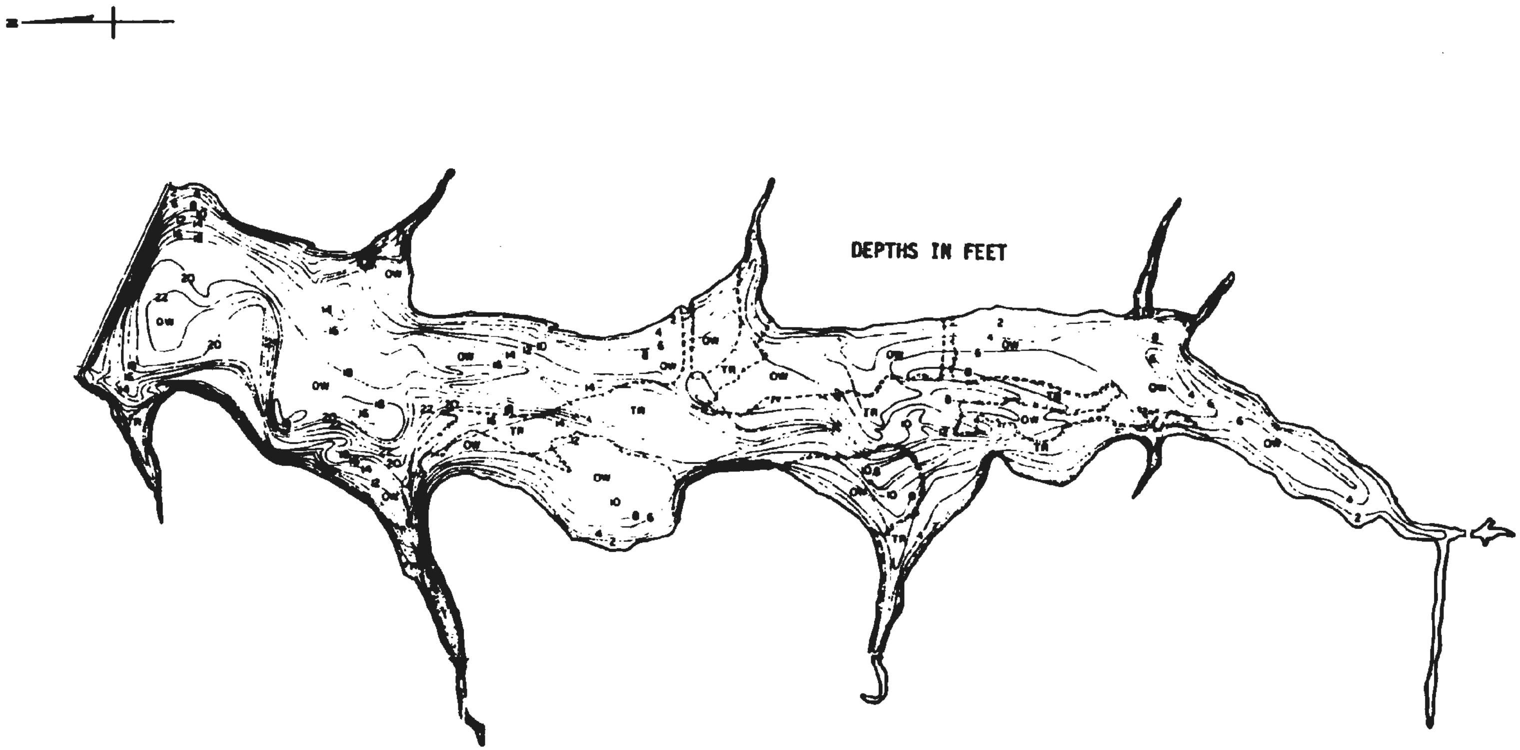
38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

36 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Grundy, Haig, Shelby, and Adair soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1972 map
Area 57. ha ( 140. A)
Length of shoreline 8787. m ( 28829. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 2.9 m ( 10. ft)
Volume 1648106. cubic meters ( 1336. acre-feet)
Shoreline development 3.29 Volume development 1.19
Watershed/lake area ratio 26.5
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 94. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Bluff Cr
Outlet: Bluff Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




8997 METERS

LAKE MIAMI
Monroe County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.8 | 0.11 |
| Chlorophyll a mg/cubic meter | 9 | 42.6 | 9.32 |
| Total phosphorus mg/cubic meter | 9 | 57.1 | 5.94 |
| Kjeldahl nitrogen mg/l | 2 | 0.7 | 0.10 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 9 | 10.3 | 1.46 |
| Turbidity JTU | 9 | 8.1 | 0.70 |
| Total hardness mg/l as $CaCO_3$ | 8 | 132.0 | 3.12 |
| Calcium hardness mg/l as $CaCO_3$ | 9 | 92.4 | 2.05 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 98.0 | 3.83 |
| Dissolved oxygen mg/l | 9 | 8.5 | 1.13 |
| Specific conductance micromhos/cm at 25 C | 9 | 264.4 | 2.82 |
| Sulfate mg/l | 3 | 40.8 | 1.88 |
| Chloride mg/l | 4 | 5.1 | 0.13 |
| Sodium mg/l | 0 | | |
| Potassium mg/l | 0 | | |

Vertical profile for selected measurements on the sampling date ( 8/22/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.3 | 13.2 | 84.0 | 9.2 | 113.8 |
| 1 | 25.8 | | | | |
| 2 | 25.4 | 1.3 | 90.2 | 7.8 | 24.7 |
| 3 | 23.3 | | | | |
| 4 | 22.6 | 0.2 | 57.6 | 7.6 | 7.1 |
| 5 | 21.1 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 13.20-14.30 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 363.
Potential nutrient input index =
area watershed in row crops/lake area = 7.4
81.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, gulley control structures/ erosion control structures, ponds/sediment and water control basins, pastureland and pastureland improvement, conservation planting (trees,grass).

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| 440 hcgs | Sewage lagoon |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Miami Lake Area (County)
Miami Wildlife Area (State)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 4953. | 35.4 | 86.9 |
| Shore or ice fishing | 9247. | 66.0 | 162.2 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 243. | 1.7 | 4.3 |
| Hunting | 730. | 5.2 | 12.8 |
| Picnicking,camping,other activities prompted by the lake's presence | 8165. | 58.3 | 143.2 |
| Snowmobiling | 122. | 0.9 | 2.1 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 23460. | 167.6 | 411.6 |

Special events at Lake Miami contributing to more than normal use include a bass fishing tournament (40 people).

IMPAIRMENTS

Swimming may be impaired in Lake Miami throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to high siltation and an unbalanced panfish population.

Estimated aquatic plant coverage 1 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of

livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

MILL CREEK

LOCATION
County: O'Brien          Latitude   42 Deg  59 Min N
                         Longitude  95 Deg  40 Min W
Township  94 N     Range 41 W     Section  3

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
1456. hectares (  3599. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 6 | 193. | 13.2 |
| 8 | 1264. | 86.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 88.8 | 7.6 | 0.3 | 0.0 | 3.3 |

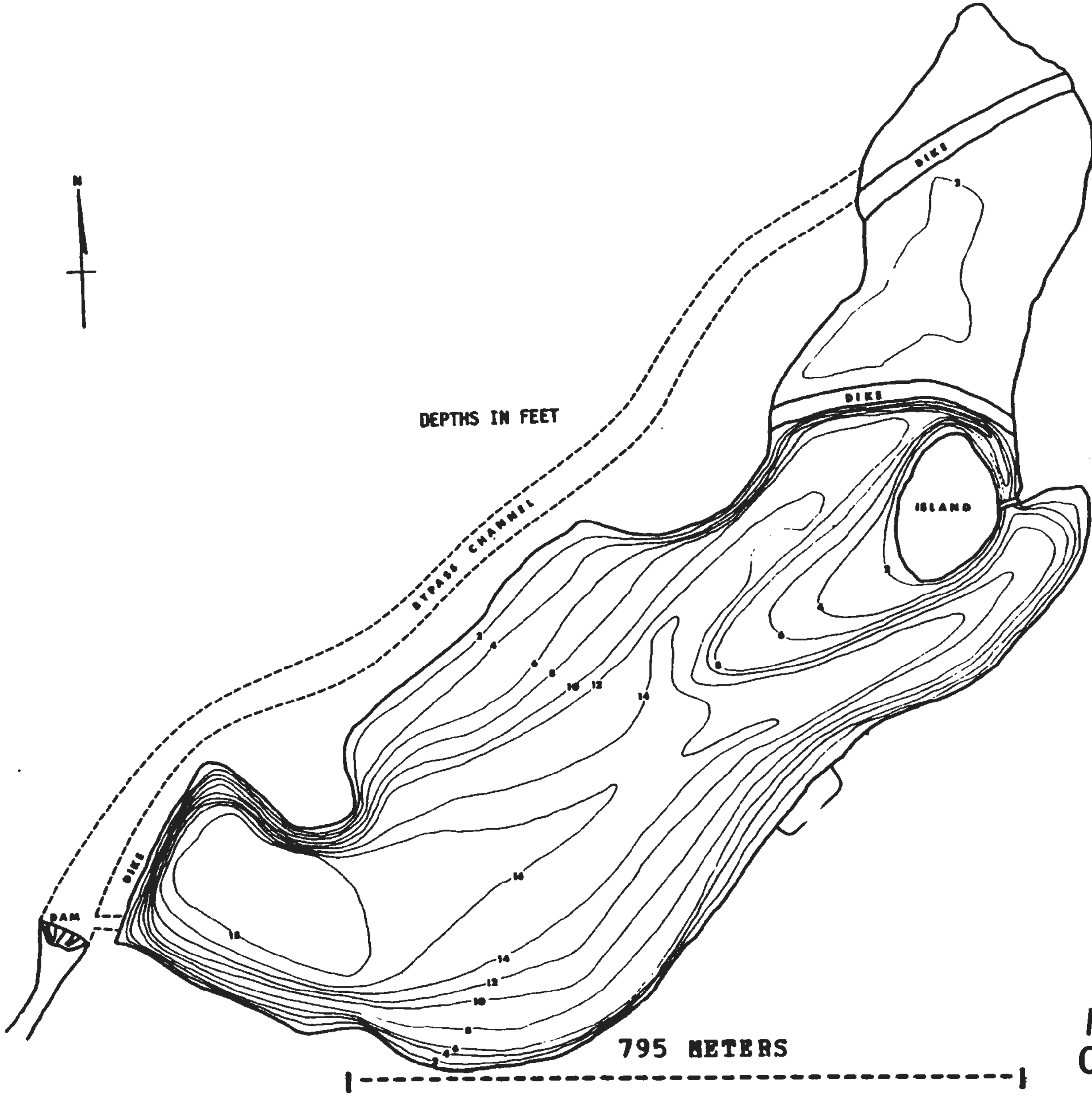
Description of topography and soils in soil associations represented in the watershed

6 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over Wisconsin or pre-Wisconsin till. Galva, Primghar, and Sac soils.

8 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over Wisconsin or pre-Wisconsin till. Galva, Primghar, Marcus, and Sac soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area   12. ha (  30. A)
Length of shoreline   2033. m (   6671. ft)
Maximum depth  3.4 m ( 11.0 ft)
Mean depth  1.5 m (  5. ft)
Volume    178026. cubic meters (   144. acre-feet)
Shoreline development  1.65    Volume development  1.32
Watershed/lake area ratio    121.3
Origin of basin: Impoundment
Estimated annual precipitation  69. cm
Estimated annual runoff          8. cm
Estimated lake evaporation      91. cm
Thermal stratification? No DATA
Major inflows (named and/or permanent streams)
Cole Cr
Outlet: Cole Cr




MILL CREEK
O'Brien County

455

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Mill Creek Lake was not sampled in 1979 because it was drained for a lake restoration project by the O'Brien County Conservation Board. The lake had been heavily silted due to soil erosion in the watershed. Earthmoving equipment was being used to remove sediments. A natural spring and agricultural drainage tiles will be used as future water sources.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Not estimated
Estimated erosion rate in region = 4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 728.
Potential nutrient input index =
area watershed in row crops/lake area = 107.7
70.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, pastureland and pastureland improvement, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| 800 cattle | Runoff control |
| 450 cattle | Runoff control |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Mill Creek State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 3039. | 101.3 | 253.3 |
| Shore or ice fishing | 6274. | 209.1 | 522.8 |
| Swimming | 4763. | 158.8 | 396.9 |
| Pleasure boating | 1146. | 38.2 | 95.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 8510. | 283.7 | 709.2 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 122. | 4.1 | 10.2 |
| TOTAL | 23854. | 795.1 | 1987.8 |

Special events at Mill Creek Lake contributing to more than normal use include a July 4th fly-in breakfast (750-1200 people).

IMPAIRMENTS

Mill Creek is presently undergoing renovation by means of draining, bottom scouring, and jetty and shoreline development. Iowa Conservation Commission personnel state that the lake's major problems in the past were suspended sediments and aquatic plant growth. Swimming and fishing activities were restricted by these problems. Occasional winterkills were also a problem.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: 1 year out of 10-12
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

No specific restoration efforts are recommended for Mill Creek Lake. This lake has been drained and was being dredged during the summer of 1979. The lake will be refilled with water from springs and tile outflows, eliminating silt inputs from soil erosion in the lake's watershed.

LAKE MINNEWASHTA

LOCATION

| | | | |
|---|---|---|---|
| County: Dickinson | | Latitude | 43 Deg 21 Min N |
| | | Longitude | 95 Deg 7 Min W |
| Township 99 N | Range 36 W | | Section 29 |

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
119. hectares ( 295. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 15 | 119. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 74.2 | 12.3 | 1.6 | 8.0 | 3.9 |

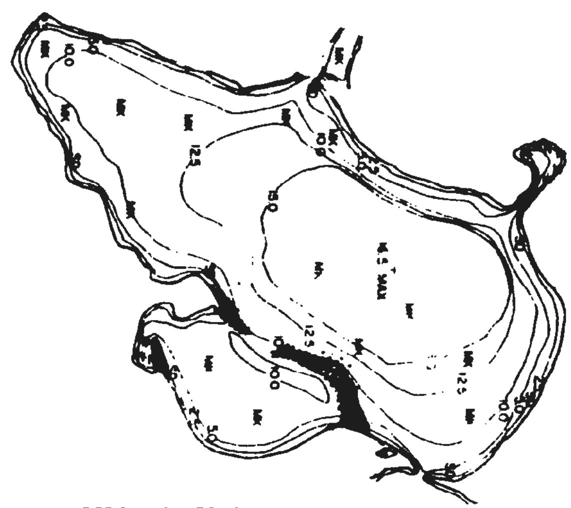
Description of topography and soils in soil associations represented in the watershed

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 21 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1970 map
Area 49. ha ( 122. A)
Length of shoreline 3570. m ( 11711. ft)
Maximum depth 5.2 m ( 17.0 ft)
Mean depth 3.1 m ( 10. ft)
Volume 1548765. cubic meters ( 1255. acre-feet)
Shoreline development 1.43 Volume development 1.81
Watershed/lake area ratio 2.4
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
From Upper Gar L
Outlet: To Lower Gar L
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




8744 METERS

LAKE MINNEWASHTA
Dickinson County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 0.7 | 0.09 |
| Chlorophyll a<br>mg/cubic meter | 9 | 29.6 | 11.05 |
| Total phosphorus<br>mg/cubic meter | 8 | 132.5 | 6.34 |
| Kjeldahl nitrogen<br>mg/l | 2 | 1.3 | 0.04 |
| Ammonia nitrogen<br>mg/l | 2 | 0.2 | 0.02 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.5 | 0.03 |
| Seston dry weight<br>mg/l | 9 | 15.9 | 1.99 |
| Turbidity<br>JTU | 8 | 12.2 | 1.41 |
| Total hardness<br>mg/l as $CaCO_3$ | 9 | 227.8 | 1.27 |
| Calcium hardness<br>mg/l as $CaCO_3$ | 8 | 111.0 | 1.77 |
| Total alkalinity<br>mg/l as $CaCO_3$ | 8 | 202.8 | 1.00 |
| Dissolved oxygen<br>mg/l | 8 | 6.8 | 0.64 |
| Specific conductance<br>micromhos/cm at 25 C | 9 | 421.1 | 5.51 |
| Sulfate<br>mg/l | 3 | 31.0 | 1.76 |
| Chloride<br>mg/l | 3 | 14.5 | 0.01 |
| Sodium<br>mg/l | 2 | 10.0 | 0.00 |
| Potassium<br>mg/l | 2 | 7.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 7/11/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.9 | 8.8 | 119.4 | 8.6 | 85.7 |
| 1 | 23.3 | 8.2 | 124.2 | 8.6 | 81.2 |
| 2 | 23.3 | | | | |
| 3 | 22.2 | 1.6 | 168.3 | 8.2 | 6.0 |
| 4 | 22.2 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 10.
Potential nutrient input index =
area watershed in row crops/lake area = 1.8
32.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| 320 hogs<br>IA0039969 | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake has also been designated as high quality water and is thus subject to higher standards to protect existing uses.
This lake is not designated as a public water supply.

Public parks:
Henderson Wildlife Area

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1785. | 14.6 | 36.4 |
| Shore or ice fishing | 4144. | 34.0 | 84.6 |
| Swimming | 1846. | 15.1 | 37.7 |
| Pleasure boating | 2102. | 17.2 | 42.9 |
| Hunting | 604. | 5.0 | 12.3 |
| Picnicking,camping,other activities prompted by the lake's presence | 2441. | 20.0 | 49.8 |
| Snowmobiling | 6943. | 56.9 | 141.7 |
| Ice skating and cross-country skiing | 782. | 6.4 | 16.0 |
| TOTAL | 20647. | 169.2 | 421.4 |

IMPAIRMENTS

Swimming may be impaired in Lake Minnewashta throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Frequent winterkills and summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 6 %
Estimated winterkill frequencies: 1 year out of 3-5
Estimated summerkill frequencies: 1 year out of 5-7

LAKE RESTORATION RECOMMENDATIONS

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices

recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

MOOREHEAD LAKE

LOCATION

County: Ida — Latitude 42 Deg 22 Min N; Longitude 95 Deg 29 Min W

Township 87 N — Range 40 W — Section 10

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
199. hectares ( 492. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 5. | 2.6 |
| 19 | 194. | 97.4 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 50.6 | 27.8 | 18.2 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

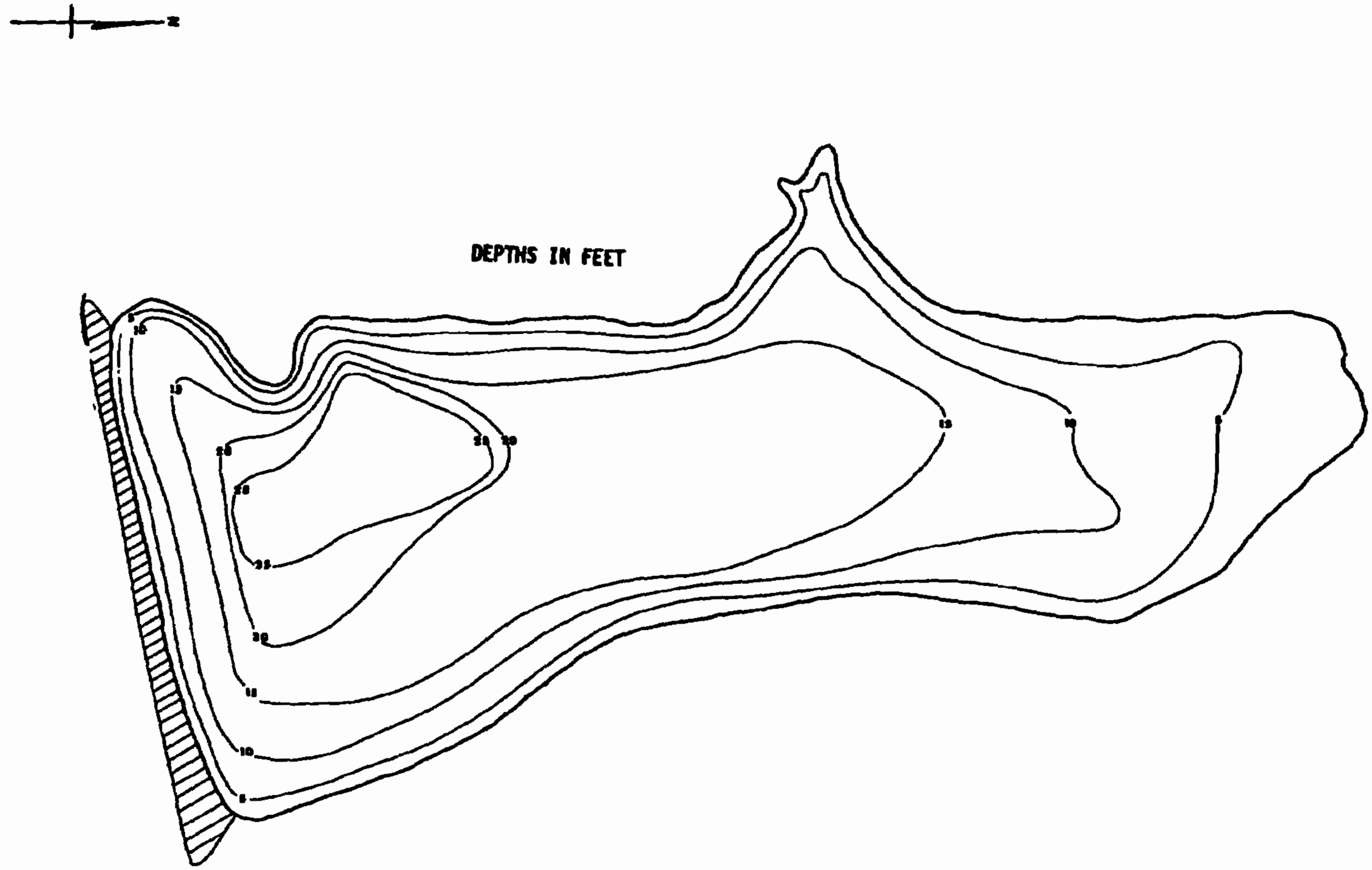
7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

19 Gently sloping to very steep (2-40%+) prairie-derived soils developed from loess or loess-derived sediments. Ida, Napier, Castana, Hamburg, and Monona soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 4. ha ( 10. A)
Length of shoreline 985. m ( 3232. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 3.8 m ( 13. ft)
Volume 157026. cubic meters ( 127. acre-feet)
Shoreline development 1.37 Volume development 1.71
Watershed/lake area ratio 49.8
Origin of basin: Impoundment
Estimated annual precipitation 71. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




562 METERS

MOOREHEAD LAKE
Ida County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.8 | 0.26 |
| Chlorophyll a mg/cubic meter | 8 | 14.6 | 2.09 |
| Total phosphorus mg/cubic meter | 9 | 30.5 | 2.05 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.12 |
| Ammonia nitrogen mg/l | 2 | 0.0 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 10 | 6.4 | 0.75 |
| Turbidity JTU | 9 | 3.2 | 0.33 |
| Total hardness mg/l as CaCO3 | 10 | 193.0 | 2.67 |
| Calcium hardness mg/l as CaCO3 | 11 | 112.7 | 3.11 |
| Total alkalinity mg/l as CaCO3 | 10 | 172.6 | 1.34 |
| Dissolved oxygen mg/l | 10 | 6.3 | 0.27 |
| Specific conductance micromhos/cm at 25 C | 10 | 359.0 | 4.99 |
| Sulfate mg/l | 7 | 29.2 | 3.48 |
| Chloride mg/l | 10 | 6.4 | 0.75 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/16/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 20.9 | 5.7 | 35.3 | 8.3 | 22.1 |
| 1 | 20.9 | | | | |
| 2 | 21.0 | 5.5 | 38.4 | 8.2 | 23.2 |
| 3 | 21.0 | | | | |
| 4 | 21.0 | 5.5 | 40.8 | 8.2 | 18.3 |
| 5 | 19.2 | | | | |
| 6 | 14.4 | 0.0 | 692.8 | 7.3 | 204.3 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 567.
Potential nutrient input index =
area watershed in row crops/lake area = 25.2
75.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Moorehead Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 886. | 88.6 | 221.5 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 3365. | 336.5 | 841.3 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 2517. | 251.7 | 629.3 |
| Snowmobiling | 1128. | 112.8 | 282.0 |
| Ice skating and cross-country skiing | 521. | 52.1 | 130.3 |
| TOTAL | 8417. | 841.7 | 2104.3 |

IMPAIRMENTS

Recreational activities in Moorehead Lake do not appear to be impaired by poor water quality or aquatic plants. Iowa Conservation Commission personnel consider lake usage to be below its potential due to a lack of shelter houses and picnic areas.

Estimated aquatic plant coverage 9 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will

help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

NORMAN TRAIL

LOCATION
County: Adair  Latitude 41 Deg 14 Min N
Longitude 94 Deg 38 Min W
Township 74 N  Range 33 W  Section 3

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
158. hectares ( 390. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 34 | 158. | 100.0 |

Estimated land uses (%)

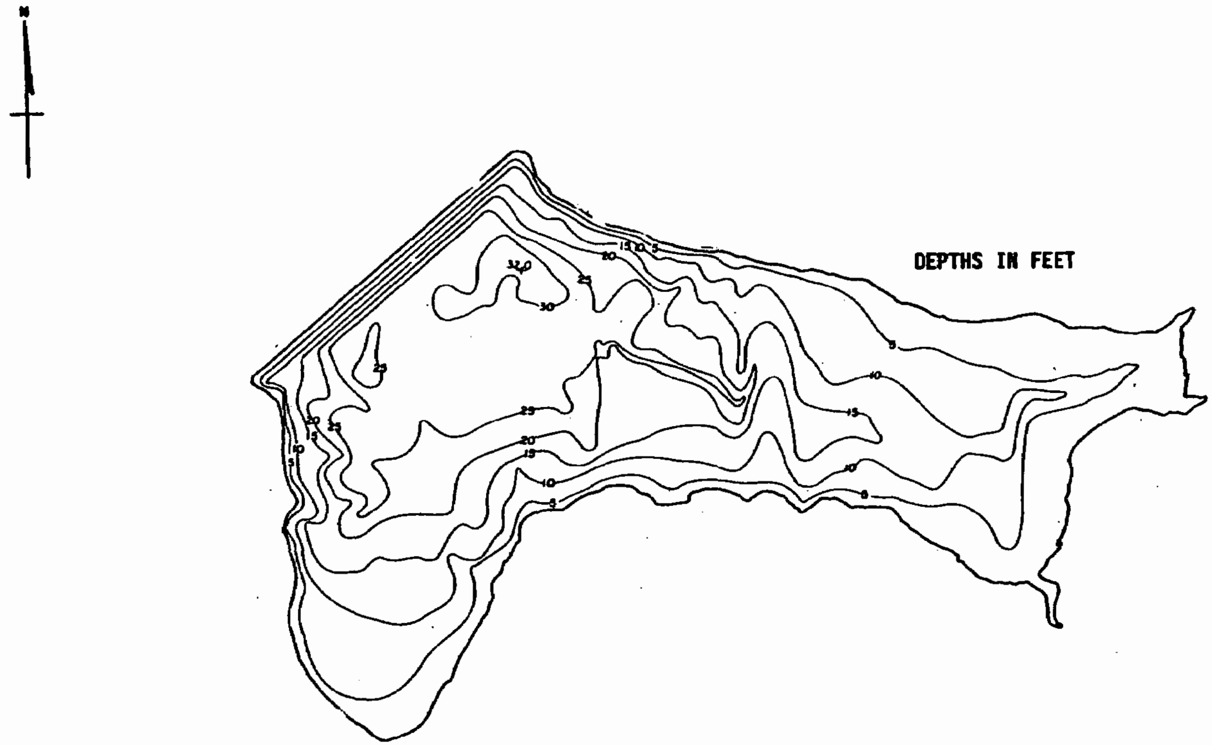
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 69.7 | 23.0 | 3.9 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

34 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from pre-Wisconsin till, pre-Wisconsin till-derived paleosols, or loess. Shelby, Adair, and Sharpsburg soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1976 map
Area 14. ha ( 35. A)
Length of shoreline 2164. m ( 7101. ft)
Maximum depth 9.8 m ( 32.0 ft)
Mean depth 4.2 m ( 14. ft)
Volume 585029. cubic meters ( 474. acre-feet)
Shoreline development 1.63  Volume development 1.29
Watershed/lake area ratio 11.3
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




4435 METERS

MORMAN TRAIL
Adair County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 5 | 2.1 | 0.16 |
| Chlorophyll a<br>mg/cubic meter | 9 | 9.9 | 1.62 |
| Total phosphorus<br>mg/cubic meter | 9 | 25.1 | 1.08 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.6 | 0.02 |
| Ammonia nitrogen<br>mg/l | 2 | 0.2 | 0.04 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight<br>mg/l | 9 | 3.5 | 0.38 |
| Turbidity<br>JTU | 9 | 3.6 | 0.64 |
| Total hardness<br>mg/l as $CaCO_3$ | 11 | 94.7 | 1.27 |
| Calcium hardness<br>mg/l as $CaCO_3$ | 10 | 61.2 | 1.53 |
| Total alkalinity<br>mg/l as $CaCO_3$ | 10 | 87.0 | 1.53 |
| Dissolved oxygen<br>mg/l | 9 | 6.6 | 0.72 |
| Specific conductance<br>micromhos/cm at 25 C | 10 | 219.3 | 9.40 |
| Sulfate<br>mg/l | 5 | 5.8 | 1.22 |
| Chloride<br>mg/l | 7 | 3.5 | 0.00 |
| Sodium<br>mg/l | 2 | 4.0 | 0.00 |
| Potassium<br>mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/ 4/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 24.9 | 7.2 | 26.9 | 8.3 | 17.6 |
| 1 | 24.9 | | | | |
| 2 | 24.8 | 6.1 | 31.7 | 8.3 | 18.5 |
| 3 | 23.6 | | | | |
| 4 | 23.0 | 1.2 | 29.7 | 8.0 | 3.9 |
| 5 | 21.1 | | | | |
| 6 | 18.8 | 0.0 | 40.7 | 7.8 | 13.8 |
| 7 | 17.1 | | | | |
| 8 | 16.4 | 0.0 | 129.1 | 7.5 | 12.3 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 13.20-14.30 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 155.
Potential nutrient input index =
area watershed in row crops/lake area = 7.9
56.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Morman Trail Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1020. | 29.1 | 72.9 |
| Shore or ice fishing | 5102. | 145.8 | 364.4 |
| Swimming | 6207. | 177.3 | 443.4 |
| Pleasure boating | 204. | 5.8 | 14.6 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking, camping, other activities prompted by the lake's presence | 8890. | 254.0 | 635.0 |
| Snowmobiling | 122. | 3.5 | 8.7 |
| Ice skating and cross-country skiing | 122. | 3.5 | 8.7 |
| TOTAL | 21667. | 619.1 | 1547.6 |

Special events at Morman Trail Lake contributing to more than normal use include an ice fishing tournament (60 people).

IMPAIRMENTS

Recreational activities in Morman Trail do not appear to be impaired by poor water quality; however, aquatic plants may interfere with shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below potential due to low population in surrounding area.

Estimated aquatic plant coverage 18 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of

livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

NELSON LAKE

LOCATION
County: Crawford  Latitude 41 Deg 56 Min N
Longitude 95 Deg 35 Min W
Township 82 N  Range 41 W  Section 2

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
243. hectares ( 600. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 20 | 243. | 100.0 |

Estimated land uses (%)

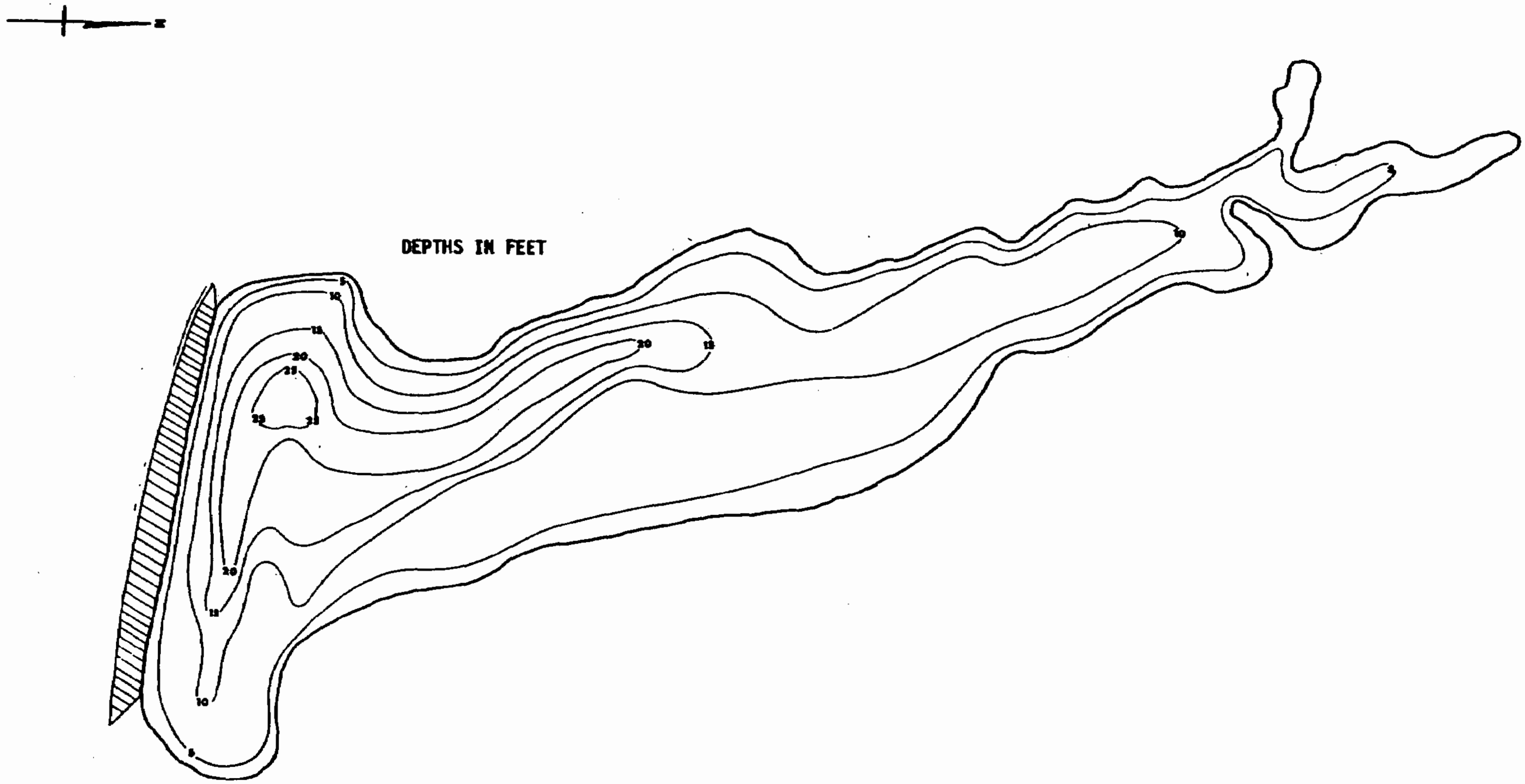
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 78.8 | 15.3 | 3.2 | 0.0 | 2.7 |

Description of topography and soils in soil associations represented in the watershed

20 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from loess or loess-derived sediments. Ida, Napier, and Monona soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 5. ha ( 11. A)
Length of shoreline 1515. m ( 4970. ft)
Maximum depth 7.6 m ( 25.0 ft)
Mean depth 2.8 m ( 9. ft)
Volume 129950. cubic meters ( 105. acre-feet)
Shoreline development 2.00  Volume development 1.12
Watershed/lake area ratio 48.6
Origin of basin: Impoundment
Estimated annual precipitation 74. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




468 METERS

NELSON LAKE
Crawford County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.9 | 0.24 |
| Chlorophyll a mg/cubic meter | 9 | 15.5 | 4.12 |
| Total phosphorus mg/cubic meter | 8 | 90.4 | 26.09 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 9 | 27.4 | 10.26 |
| Turbidity JTU | 8 | 18.4 | 7.92 |
| Total hardness mg/l as CaCO3 | 8 | 187.7 | 4.71 |
| Calcium hardness mg/l as CaCO3 | 8 | 98.0 | 2.42 |
| Total alkalinity mg/l as CaCO3 | 8 | 179.2 | 3.91 |
| Dissolved oxygen mg/l | 7 | 6.6 | 0.67 |
| Specific conductance micromhos/cm at 25 C | 7 | 362.9 | 11.07 |
| Sulfate mg/l | 3 | 17.2 | 0.60 |
| Chloride mg/l | 3 | 4.0 | 0.00 |
| Sodium mg/l | 3 | 9.0 | 0.00 |
| Potassium mg/l | 3 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.0 | 6.3 | 133.1 | 8.0 | 16.8 |
| 1 | 24.8 | | | | |
| 2 | 24.1 | 5.2 | 144.9 | 7.9 | 12.2 |
| 3 | 23.5 | | | | |
| 4 | 22.7 | 4.1 | 236.7 | 7.6 | 7.1 |
| 5 | 18.5 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 1064.
Potential nutrient input index =
area watershed in row crops/lake area = 38.3
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
pastureland and pastureland improvement, terraces, conservation tillage.

PCINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Nelson Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 712. | 64.7 | 142.4 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 1554. | 141.3 | 310.8 |
| Swimming | 6776. | 616.0 | 1355.2 |
| Pleasure boating | 430. | 39.1 | 86.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 2886. | 262.4 | 577.2 |
| Snowmobiling | 313. | 28.5 | 62.6 |
| Ice skating and cross-country skiing | 69. | 6.3 | 13.8 |
| TOTAL | 12740. | 1158.2 | 2548.0 |

IMPAIRMENTS

Swimming may be impaired in Nelson Lake during part of the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Aquatic vascular plant growth may impair boating and shoreline fishing. According to Iowa Conservation Commission personnel, chemical applications are made yearly in July to control aquatic vascular plants and algae. I.C.C. personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 9 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

NINE EAGLES

LOCATION
County: Decatur Latitude 40 Deg 36 Min N
Longitude 93 Deg 46 Min W
Township 67 N Range 25 W Section 18

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
482. hectares ( 1192. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 38 | 482. | 100.0 |

Estimated land uses (%)

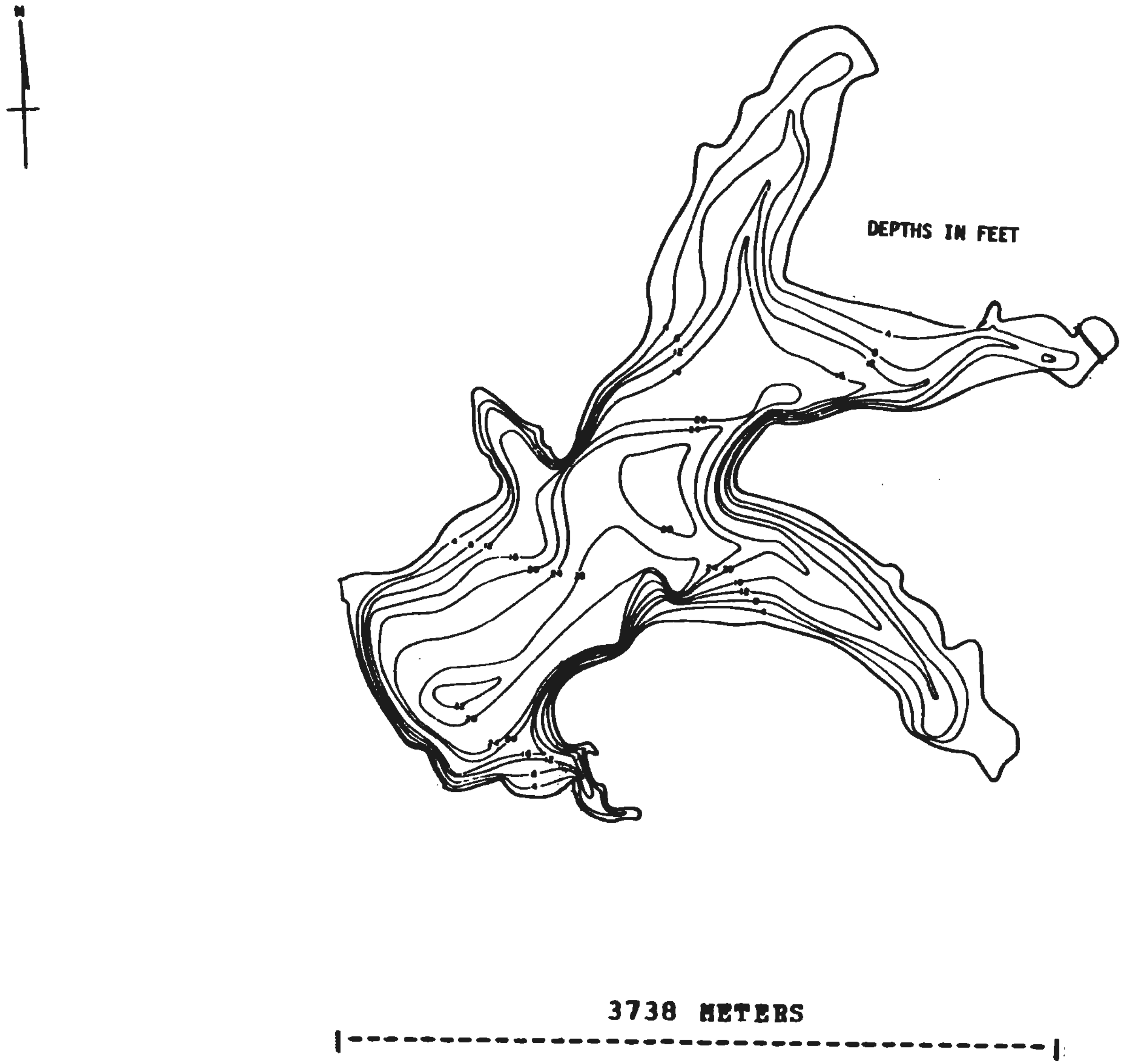
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 34.3 | 36.0 | 28.0 | 0.0 | 1.8 |

Description of topography and soils in soil associations represented in the watershed

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1973 map
Area 27. ha ( 67. A)
Length of shoreline 4254. m ( 13958. ft)
Maximum depth 10.4 m ( 34.0 ft)
Mean depth 4.0 m ( 13. ft)
Volume 1096031. cubic meters ( 888. acre-feet)
Shoreline development 2.30 Volume development 1.17
Watershed/lake area ratio 17.9
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




NINE EAGLES
Decatur County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 2.1 | 0.19 |
| Chlorophyll a mg/cubic meter | 8 | 16.0 | 2.54 |
| Total phosphorus mg/cubic meter | 9 | 25.7 | 4.04 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.04 |
| Ammonia nitrogen mg/l | 2 | 0.0 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.04 |
| Seston dry weight mg/l | 9 | 6.2 | 1.91 |
| Turbidity JTU | 8 | 5.2 | 1.15 |
| Total hardness mg/l as $CaCO_3$ | 8 | 81.7 | 2.81 |
| Calcium hardness mg/l as $CaCO_3$ | 8 | 62.0 | 2.04 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 75.8 | 2.78 |
| Dissolved oxygen mg/l | 10 | 7.7 | 0.62 |
| Specific conductance micromhos/cm at 25 C | 8 | 156.5 | 6.43 |
| Sulfate mg/l | 3 | 1.7 | 0.33 |
| Chloride mg/l | 5 | 1.1 | 0.10 |
| Sodium mg/l | 2 | 2.0 | 0.00 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/21/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.2 | 9.3 | 10.9 | 9.2 | 19.8 |
| 1 | 27.1 | | | | |
| 2 | 26.4 | 9.5 | 22.6 | 9.1 | 26.6 |
| 3 | 24.1 | | | | |
| 4 | 22.6 | 3.2 | 17.1 | 8.0 | 6.0 |
| 5 | 19.2 | 2.8 | 38.7 | 7.8 | 66.6 |
| 6 | 14.2 | | | | |
| 7 | 11.3 | 1.2 | 48.3 | 7.4 | 22.1 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 204.
Potential nutrient input index =
area watershed in row crops/lake area = 6.1
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
pastureland and pastureland improvement, .

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Nine Eagles State Park | One two-cell lagoon, Two one-cell lagoons; total retention |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
Nine Eagles State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 4080. | 60.9 | 151.1 |
| Shore or ice fishing | 7739. | 115.5 | 286.6 |
| Swimming | 17906. | 267.3 | 663.2 |
| Pleasure boating | 5186. | 77.4 | 192.1 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 50000. | 746.3 | 1851.9 |
| Snowmobiling | 300. | 4.5 | 11.1 |
| Ice skating and cross-country skiing | 250. | 3.7 | 9.3 |
| TOTAL | 85461. | 1275.5 | 3165.2 |

Special events at Nine Eagles Lake contributing to more than normal use include a bass fishing tournament (16 people).

IMPAIRMENTS

Recreational activities in Nine Eagles do not appear to be impaired by poor water quality; however, aquatic vegetation may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to few people living in the area.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of

livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

NORTH TWIN LAKE

LOCATION
County: Calhoun          Latitude   42 Deg  29 Min N
                         Longitude  94 Deg  38 Min W
Township 89 N       Range 32 W       Section 33

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
      351. hectares (   867. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 351. | 100.0 |

Estimated land uses (%)

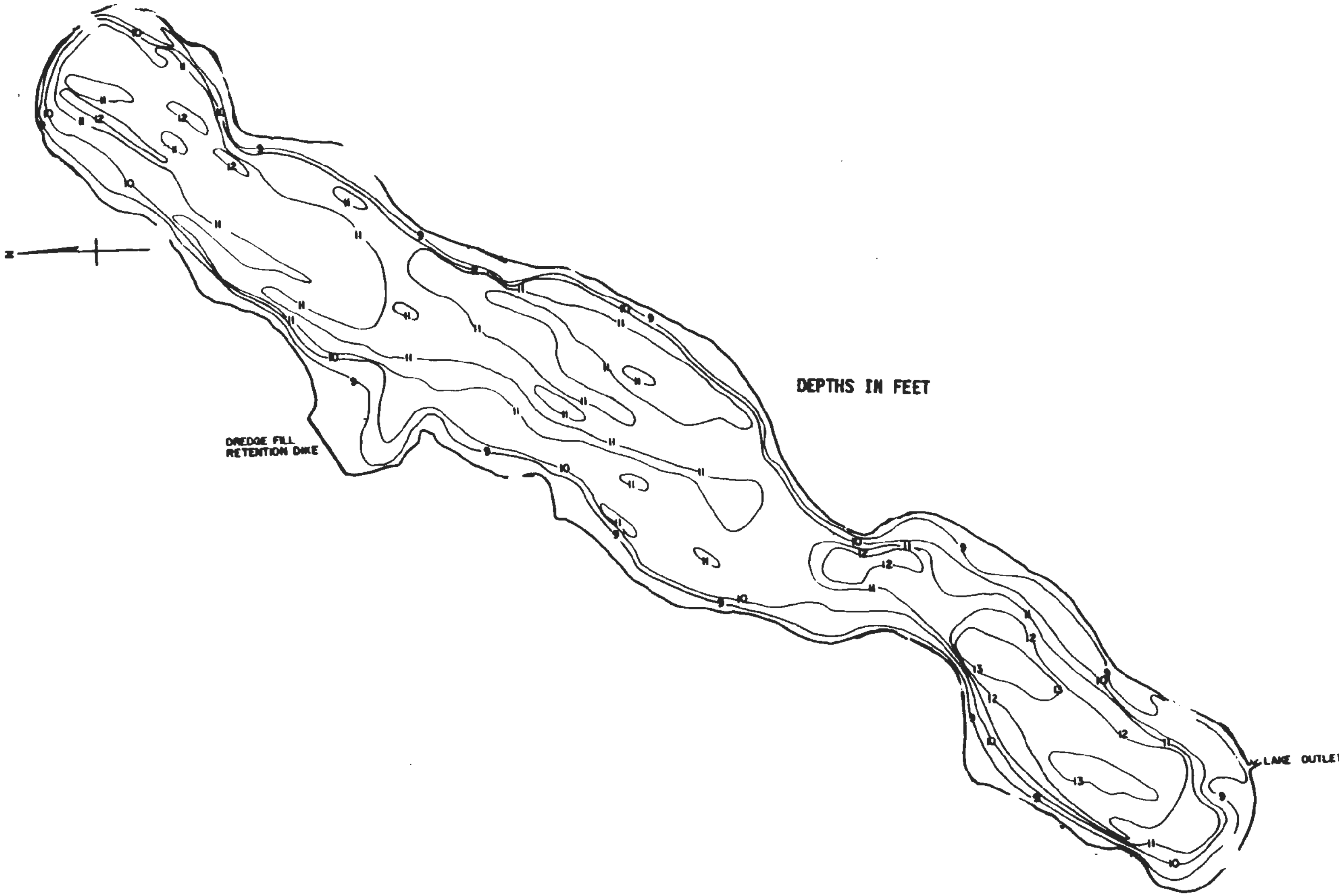
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 90.6 | 5.7 | 0.3 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

Per cent of shoreline in public ownership  24 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1970 map
Area  183. ha ( 453. A)
Length of shoreline   8911. m (  29236. ft)
Maximum depth  4.0 m ( 13.0 ft)
Mean depth  3.0 m ( 10. ft)
Volume   5527167. cubic meters (  4479. acre-feet)
Shoreline development  1.86    Volume development  2.28
Watershed/lake area ratio      1.9
Origin of basin: Natural
Estimated annual precipitation  74. cm
Estimated annual runoff         10. cm
Estimated lake evaporation      94. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
  None
Outlet: Unnamed (To South Twin)
208 Agency:
   Iowa Department of Environmental Quality
   900 East Grand Avenue
   Des Moines, Iowa 50319




23823 METERS

NORTH TWIN LAKE
Calhoun County

489

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.5 | 0.04 |
| Chlorophyll a mg/cubic meter | 9 | 42.2 | 2.41 |
| Total phosphorus mg/cubic meter | 11 | 80.3 | 6.69 |
| Kjeldahl nitrogen mg/l | 2 | 1.6 | 0.30 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.3 | 0.03 |
| Seston dry weight mg/l | 10 | 27.4 | 1.70 |
| Turbidity JTU | 9 | 13.4 | 1.73 |
| Total hardness mg/l as $CaCO_3$ | 9 | 257.3 | 9.33 |
| Calcium hardness mg/l as $CaCO_3$ | 9 | 123.8 | 12.17 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 162.4 | 10.84 |
| Dissolved oxygen mg/l | 9 | 8.4 | 0.87 |
| Specific conductance micromhos/cm at 25 C | 9 | 485.6 | 22.55 |
| Sulfate mg/l | 7 | 85.1 | 1.70 |
| Chloride mg/l | 7 | 24.6 | 0.20 |
| Sodium mg/l | 1 | 5.0 | |
| Potassium mg/l | 1 | 5.0 | |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.3 | 4.9 | 105.7 | 8.3 | 41.2 |
| 1 | 23.3 | 6.4 | 96.7 | 8.3 | 31.4 |
| 2 | 23.3 | 6.2 | 114.0 | 7.8 | 30.7 |
| 3 | 23.3 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 3.
Potential nutrient input index =
area watershed in row crops/lake area = 1.7
4.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, tile drainage, field windbreaks.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Cabins along lakeshore | Septic tank inflows |
| 260 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Featherstone Memorial Park (County)
Twin Lakes State Park
Lake's End Access (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2694. | 5.9 | 14.7 |
| Shore or ice fishing | 12447. | 27.5 | 68.0 |
| Swimming | 6510. | 14.4 | 35.6 |
| Pleasure boating | 9112. | 20.1 | 49.8 |
| Hunting | 326. | 0.7 | 1.8 |
| Picnicking,camping,other activities prompted by the lake's presence | 18004. | 39.7 | 98.4 |
| Snowmobiling | 2172. | 4.8 | 11.9 |
| Ice skating and cross-country skiing | 173. | 0.4 | 0.9 |
| TOTAL | 51438. | 113.5 | 281.1 |

Special events at North Twin Lake contributing to more than normal use include weekly sailboat races (50 people each).

IMPAIRMENTS

Swimming may be impaired in North Twin Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel state that septic tank leakage into the lake may occur. I.C.C. personnel consider lake usage to be above its potential.

Estimated aquatic plant coverage 8 %
Estimated winterkill frequencies: 1 year out of 5
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in North Twin may be affected by inputs from the septic tank systems of nearby cabins. The extent of the problem, and its possible deleterious effects on the lake, have not been determined. In addition to the increased nutrient and organic matter loading to the lake, the potential danger of bacterial contamination to lake users is increased. It is recommended that an initial study be conducted to determine the need for more effective sewage treatment facilities for North Twin Lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

OLDHAM LAKE

LOCATION

County: Monona    Latitude 42 Deg 1 Min N
                  Longitude 95 Deg 47 Min W

Township 83 N    Range 43 W    Section 13

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
279. hectares ( 689. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 20 | 279. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 78.8 | 15.3 | 3.2 | 0.0 | 2.7 |

Description of topography and soils in soil associations represented in the watershed

20 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from loess or loess-derived sediments. Ida, Napier, and Monona soils.

Per cent of shoreline in public ownership 0 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map

Area 6. ha ( 15. A)

Length of shoreline 2871. m ( 9419. ft)

Maximum depth 7.3 m ( 24.0 ft)

Mean depth 3.0 m ( 10. ft)

Volume 183668. cubic meters ( 149. acre-feet)

Shoreline development 3.25    Volume development 1.21

Watershed/lake area ratio 46.5

Origin of basin: Impoundment

Estimated annual precipitation 74. cm

Estimated annual runoff 8. cm

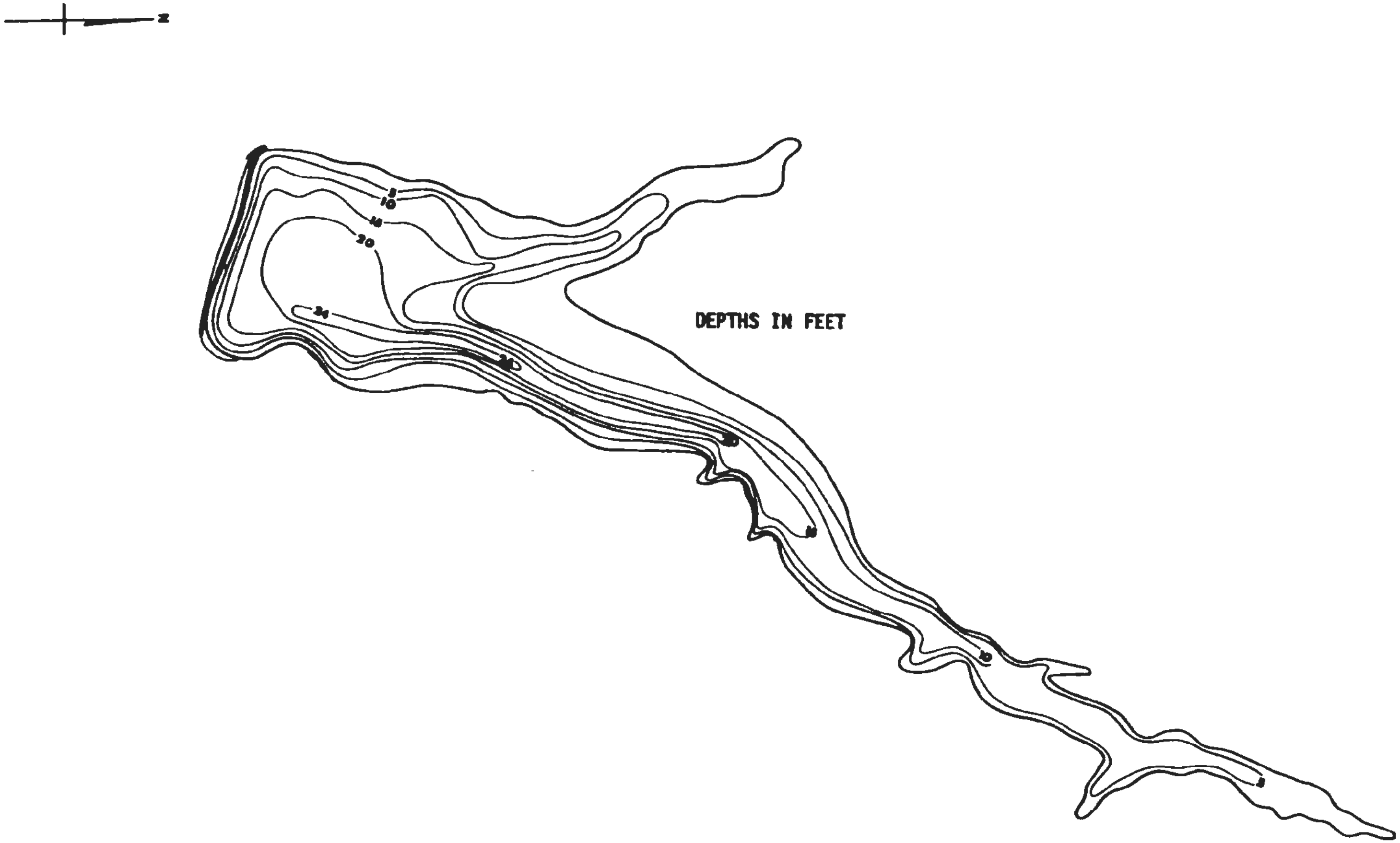
Estimated lake evaporation 97. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)
None

Outlet: Unnamed

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




1512 METERS

# OLDHAM LAKE
## Monona County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 2.0 | 0.25 |
| Chlorophyll a mg/cubic meter | 11 | 4.7 | 0.81 |
| Total phosphorus mg/cubic meter | 9 | 33.4 | 2.04 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.06 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 10 | 4.4 | 0.64 |
| Turbidity JTU | 9 | 2.0 | 0.08 |
| Total hardness mg/l as CaCO3 | 9 | 181.1 | 0.49 |
| Calcium hardness mg/l as CaCO3 | 9 | 104.7 | 1.05 |
| Total alkalinity mg/l as CaCO3 | 9 | 186.7 | 1.20 |
| Dissolved oxygen mg/l | 9 | 6.3 | 0.50 |
| Specific conductance micromhos/cm at 25 C | 8 | 348.8 | 4.41 |
| Sulfate mg/l | 3 | 7.8 | 0.17 |
| Chloride mg/l | 4 | 3.0 | 0.00 |
| Sodium mg/l | 2 | 8.0 | 0.00 |
| Potassium mg/l | 2 | 7.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.8 | 6.5 | 31.2 | 8.1 | 2.2 |
| 1 | 25.8 | | | | |
| 2 | 25.8 | 6.5 | 33.6 | 8.0 | 2.2 |
| 3 | 25.3 | | | | |
| 4 | 22.1 | 0.4 | 47.7 | 7.5 | 12.3 |
| 5 | 18.4 | | | | |
| 6 | 16.1 | 0.0 | 77.0 | 7.4 | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 1018.
Potential nutrient input index =
area watershed in row crops/lake area = 36.6
82.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, contouring, conservation tillage, crop rotation, pastureland and pastureland improvement, conservation planting (trees,grass).

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Oldham Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2323. | 154.9 | 387.2 |
| Shore or ice fishing | 4046. | 269.7 | 674.3 |
| Swimming | 5994. | 399.6 | 999.0 |
| Pleasure boating | 495. | 33.0 | 82.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 4168. | 277.9 | 694.7 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 17026. | 1135.1 | 2837.7 |

Special events at Oldham Lake contributing to more than normal use include an outdoor education program (240 people) and civic organization meetings (120 people).

IMPAIRMENTS

Recreational activities in Oldham Lake do not appear to be impaired by poor water quality or aquatic plants. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 18 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of

livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE ORIENT

LOCATION

County: Adair    Latitude 41 Deg 12 Min N
    Longitude 94 Deg 26 Min W

Township 74 N    Range 31 W    Section 20

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
203. hectares ( 501. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 87. | 42.7 |
| 33 | 116. | 57.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 76.1 | 18.4 | 2.2 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

33 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or pre-Wisconsin till-derived paleosols. Sharpsburg, Macksburg, Winterset, and Clarinda soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1978 map

Area 6. ha ( 16. A)

Length of shoreline 1177. m ( 3862. ft)

Maximum depth 3.7 m ( 12.0 ft)

Mean depth 2.0 m ( 7. ft)

Volume 125777. cubic meters ( 102. acre-feet)

Shoreline development 1.32    Volume development 1.63

Watershed/lake area ratio 33.8

Origin of basin: Impoundment

Estimated annual precipitation 81. cm

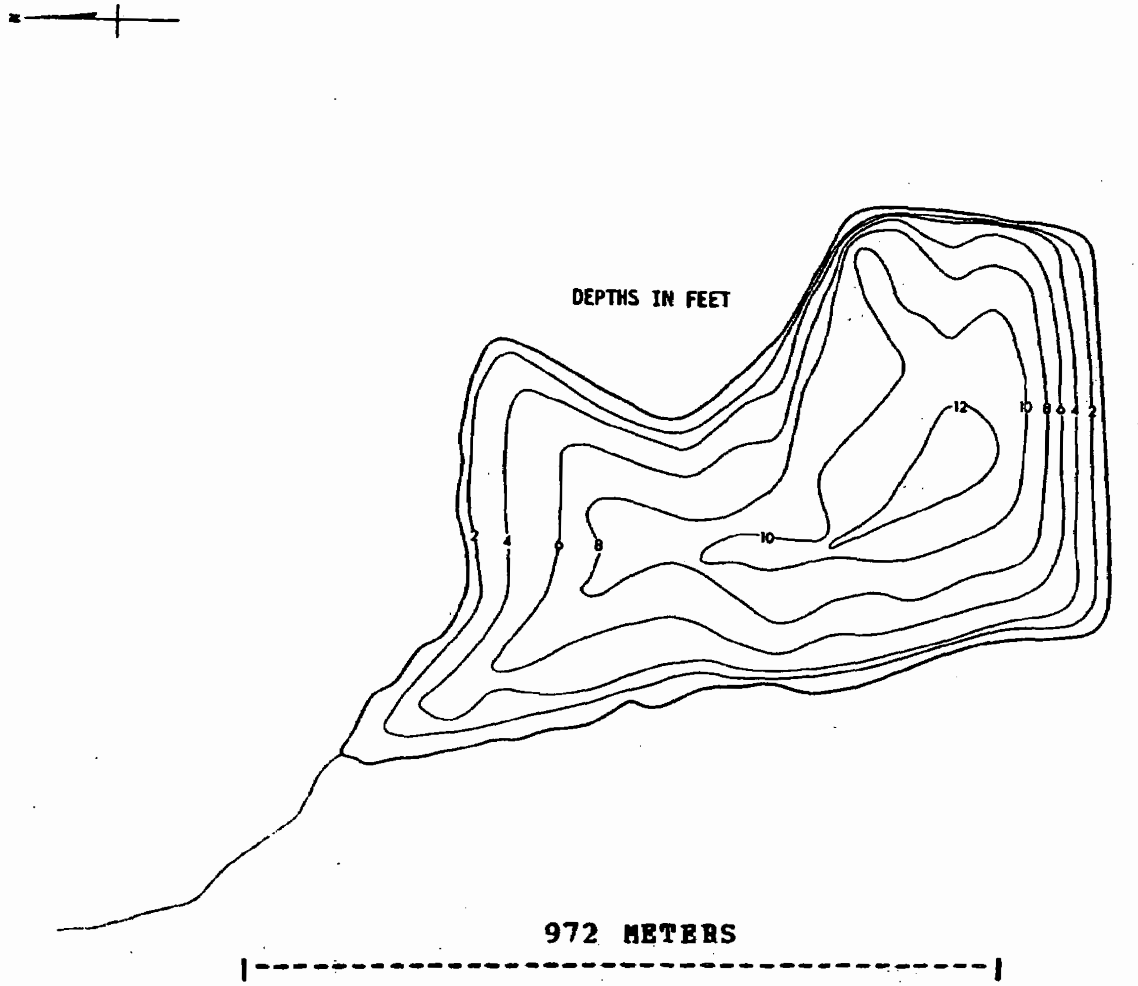
Estimated annual runoff 15. cm

Estimated lake evaporation 97. cm

Thermal stratification? No

Major inflows (named and/or permanent streams)
None

Outlet: Unnamed




LAKE ORIENT
Adair County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.8 | 0.02 |
| Chlorophyll a mg/cubic meter | 11 | 44.8 | 3.21 |
| Total phosphorus mg/cubic meter | 9 | 91.8 | 7.53 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.08 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 11 | 12.4 | 0.31 |
| Turbidity JTU | 10 | 7.2 | 0.57 |
| Total hardness mg/l as CaCO3 | 8 | 122.7 | 0.92 |
| Calcium hardness mg/l as CaCO3 | 8 | 81.0 | 1.36 |
| Total alkalinity mg/l as CaCO3 | 9 | 114.4 | 2.92 |
| Dissolved oxygen mg/l | 11 | 7.8 | 0.17 |
| Specific conductance micromhos/cm at 25 C | 9 | 279.4 | 10.15 |
| Sulfate mg/l | 2 | 0.8 | 0.25 |
| Chloride mg/l | 3 | 11.8 | 0.17 |
| Sodium mg/l | 2 | 6.5 | 0.50 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 7/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.5 | 7.4 | 103.8 | 8.4 | 32.2 |
| 1 | 27.5 | 7.3 | 101.2 | 8.4 | 39.3 |
| 2 | 27.4 | 6.7 | 129.5 | 8.2 | 44.2 |
| 3 | 23.6 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 274.
Potential nutrient input index =
area watershed in row crops/lake area = 25.7
41.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, contouring, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 320 persons at Orient.

Public parks:
Lake Orient (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 491. | 30.7 | 81.8 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 2280. | 142.5 | 380.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 269. | 16.8 | 44.8 |
| Hunting | 426. | 26.6 | 71.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 5102. | 318.9 | 850.3 |
| Snowmobiling | 87. | 5.4 | 14.5 |
| Ice skating and cross-country skiing | 87. | 5.4 | 14.5 |
| TOTAL | 8742. | 546.4 | 1457.0 |

IMPAIRMENTS

Water clarity is poor in Lake Orient throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 15 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the

Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

OTTER CREEK LAKE

LOCATION
County: Tama Latitude 42 Deg 3 Min N
Longitude 92 Deg 31 Min W
Township 84 N Range 14 W Section 31

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
392. hectares ( 969. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 56 | 325. | 82.9 |
| 78 | 67. | 17.1 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 66.3 | 9.4 | 1.8 | 0.0 | 22.5 |

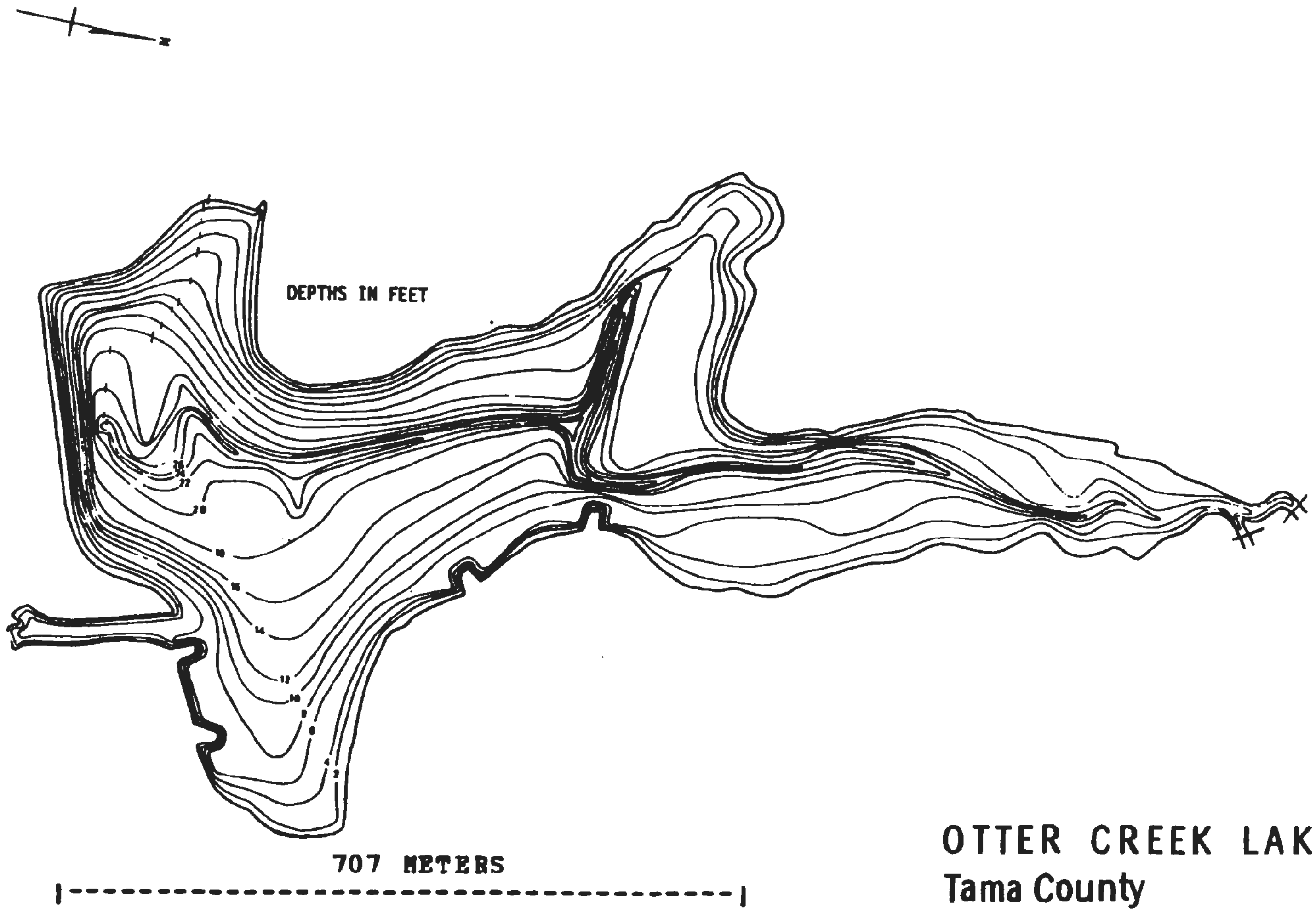
Description of topography and soils in soil associations represented in the watershed

56 Gently to strongly sloping (2-14%) prairie to forest-derived soils developed from loess. Tama, Downs, and Fayette soils.

78 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, Muscatine, and Garwin soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 30. ha ( 74. A)
Length of shoreline 4176. m ( 13701. ft)
Maximum depth 7.9 m ( 26.0 ft)
Mean depth 3.0 m ( 10. ft)
Volume 899061. cubic meters ( 729. acre-feet)
Shoreline development 2.16 Volume development 1.14
Watershed/lake area ratio 13.1
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




OTTER CREEK LAKE
Tama County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.1 | 0.07 |
| Chlorophyll a mg/cubic meter | 8 | 45.5 | 5.11 |
| Total phosphorus mg/cubic meter | 9 | 48.6 | 4.03 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 7 | 8.3 | 0.40 |
| Turbidity JTU | 8 | 5.3 | 0.61 |
| Total hardness mg/l as CaCO3 | 9 | 153.1 | 4.64 |
| Calcium hardness mg/l as CaCO3 | 9 | 87.6 | 2.33 |
| Total alkalinity mg/l as CaCO3 | 8 | 139.0 | 3.65 |
| Dissolved oxygen mg/l | 8 | 8.1 | 0.68 |
| Specific conductance micromhos/cm at 25 C | 8 | 263.1 | 15.32 |
| Sulfate mg/l | 4 | 11.3 | 1.92 |
| Chloride mg/l | 5 | 6.4 | 0.10 |
| Sodium mg/l | 2 | 4.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/30/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.5 | 6.0 | 45.4 | 8.2 | 68.5 |
| 1 | 25.4 | | | | |
| 2 | 25.3 | 5.7 | 48.4 | 8.2 | 21.7 |
| 3 | 25.1 | | | | |
| 4 | 22.8 | 0.9 | 54.4 | 8.1 | 14.2 |
| 5 | 21.6 | | | | |
| 6 | 20.8 | 0.0 | 190.3 | 7.8 | 6.4 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 165.
Potential nutrient input index =
area watershed in row crops/lake area = 8.7
57.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, grass waterways, pastureland and pastureland improvement, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Otter Creek Lake and Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 2137. | 28.9 | 71.2 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 2362. | 31.9 | 78.7 |
| Swimming | 1759. | 23.8 | 58.6 |
| Pleasure boating | 373. | 5.0 | 12.4 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 8628. | 116.6 | 287.6 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 15259. | 206.2 | 508.6 |

IMPAIRMENTS

Swimming may be impaired in Otter Creek Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to shoreline erosion and aquatic plants.

Estimated aquatic plant coverage 18 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because localized quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is suggsted. While this might be accomplished through the use of chemicals or a White Amur stocking program, the aquatic weed density is relatively small and localized close to shore. Mechanical removal may be the most practical control method; however the cost-effectiveness and suitability of this method should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of

livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

OTTUMWA LAGOON

LOCATION
County: Wapello    Latitude 41 Deg 1 Min N
Longitude 92 Deg 25 Min W
Township 72 N    Range 14 W    Section 25

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
903. hectares ( 2231. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 528. | 58.5 |
| 38 | 358. | 39.7 |
| 47 | 16. | 1.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 27.2 | 17.0 | 13.1 | 41.2 | 1.5 |

Description of topography and soils in soil associations represented in the watershed

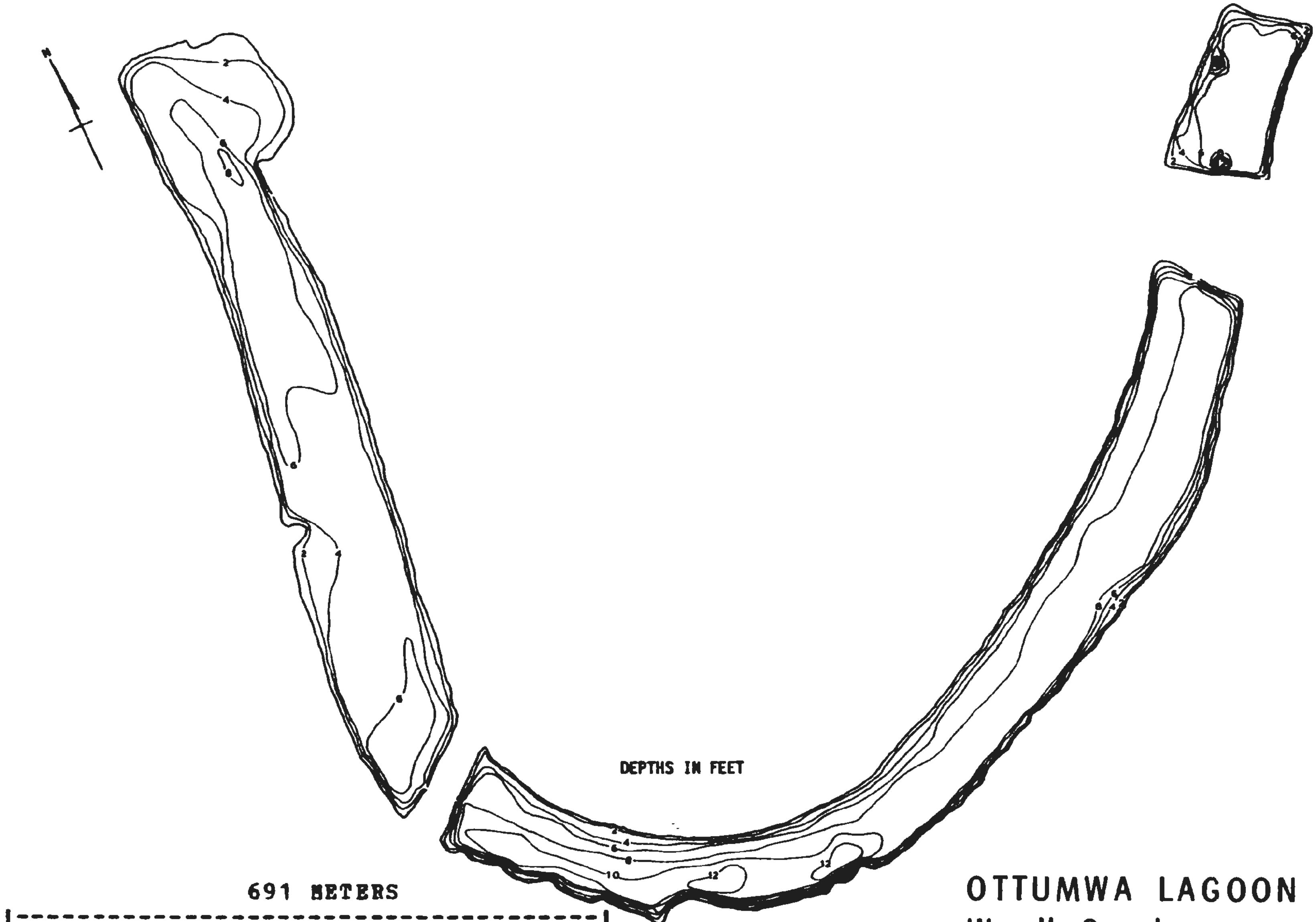
7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

47 Moderately sloping to very steep (5-30%) forest-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Clinton, Lindley, and Keswick soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1975 map
Area 24. ha ( 59. A)
Length of shoreline 3248. m ( 10655. ft)
Maximum depth 3.7 m ( 12.0 ft)
Mean depth 1.9 m ( 6. ft)
Volume 576214. cubic meters ( 467. acre-feet)
Shoreline development 1.65    Volume development 1.53
Watershed/lake area ratio 37.6
Origin of basin: Old river channel
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 91. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
Kettle Creek




OTTUMWA LAGOON
Wapello County

Outlet: Gated outlet to Des Moines River
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.5 | 0.07 |
| Chlorophyll a mg/cubic meter | 11 | 77.3 | 8.28 |
| Total phosphorus mg/cubic meter | 10 | 440.9 | 56.07 |
| Kjeldahl nitrogen mg/l | 2 | 0.7 | 0.03 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 10 | 18.0 | 1.17 |
| Turbidity JTU | 9 | 8.6 | 0.53 |
| Total hardness mg/l as $CaCO_3$ | 11 | 256.0 | 6.27 |
| Calcium hardness mg/l as $CaCO_3$ | 11 | 172.9 | 6.78 |
| Total alkalinity mg/l as $CaCO_3$ | 10 | 193.4 | 7.12 |
| Dissolved oxygen mg/l | 11 | 8.5 | 1.31 |
| Specific conductance micromhos/cm at 25 C | 10 | 563.0 | 13.09 |
| Sulfate mg/l | 3 | 76.2 | 4.88 |
| Chloride mg/l | 3 | 35.7 | 0.17 |
| Sodium mg/l | 2 | 25.5 | 0.50 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 8/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 29.7 | 11.3 | 246.0 | 8.6 | 66.2 |
| 1 | 29.7 | 11.3 | 260.0 | 8.6 | 69.2 |
| 2 | 29.0 | 10.5 | 260.0 | 8.5 | 72.2 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 10.60-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 332.
Potential nutrient input index =
area watershed in row crops/lake area = 7.9
62.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: pastureland and pastureland improvement, landgrading for drainage, crop rotation, contouring, conservation tillage, terraces.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| City of Ottumwa | Sewage via storm sewer during moderate rainfall |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Ottumwa City Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 243. | 4.1 | 10.1 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 4777. | 81.0 | 199.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 65. | 1.1 | 2.7 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 5104. | 86.5 | 212.7 |
| Snowmobiling | 1199. | 20.3 | 50.0 |
| Ice skating and cross-country skiing | 3997. | 67.7 | 166.5 |
| TOTAL | 15385. | 260.8 | 641.0 |

Special events at Ottumwa Lagoon contributing to more than normal use include numerous carnivals and concerts held in the city park.

IMPAIRMENTS

Swimming may be impaired in Ottumwa Lagoon throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel state that storm and domestic sewer overflow may enter the middle lagoon following heavy rains. I.C.C. personnel consider lake usage to be below its potential due to poor fishing and a lack of boat ramps.

Estimated aquatic plant coverage 0.4%
Estimated winterkill frequencies: 1 year out of 5
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in Ottumwa Lagoon may be impaired by various urban inputs. Storm water runoff from the city of Ottumwa enters the lake. Roadway dirt, deicing salt, organic matter, and nutrients are introduced into the lake by this urban runoff. In addition, raw sewage also flows into the lake when hydraulic loading is high during moderate to heavy rainfall periods. Diversion of storm sewer outflow may improve water quality in the lake to some degree by reducing nutrient and organic matter loading. City officials state the input from sanitary sewers could be eliminated by installing new pipe in existing tunnels. Diversion of both storm and sanitary sewers would likely be most effective in improving water quality as well as eliminating the potential danger of bacterial contamination to lake users.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE PAHOJA

LOCATION

County: Lyon    Latitude 43 Deg 23 Min N
                Longitude 96 Deg 28 Min W

Township 99 N    Range 48 W    Section 23

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
1600. hectares ( 3954. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 2 | 1305. | 81.6 |
| 27 | 295. | 18.4 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 88.8 | 7.8 | 0.6 | 0.0 | 2.7 |

Description of topography and soils in soil associations represented in the watershed

2 Gently and moderately sloping (2-9%) prairie-derived soils developed from loess. Moody soils.

27 Gently sloping (2-5%) prairie-derived soils developed from loess. Moody soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map

Area 7. ha ( 16. A)

Length of shoreline 5436. m ( 17835. ft)

Maximum depth 9.1 m ( 30.0 ft)

Mean depth 3.2 m ( 10. ft)

Volume 840372. cubic meters ( 681. acre-feet)

Shoreline development 2.98    Volume development 1.04

Watershed/lake area ratio 228.6

Origin of basin: Impoundment

Estimated annual precipitation 63. cm

Estimated annual runoff 5. cm

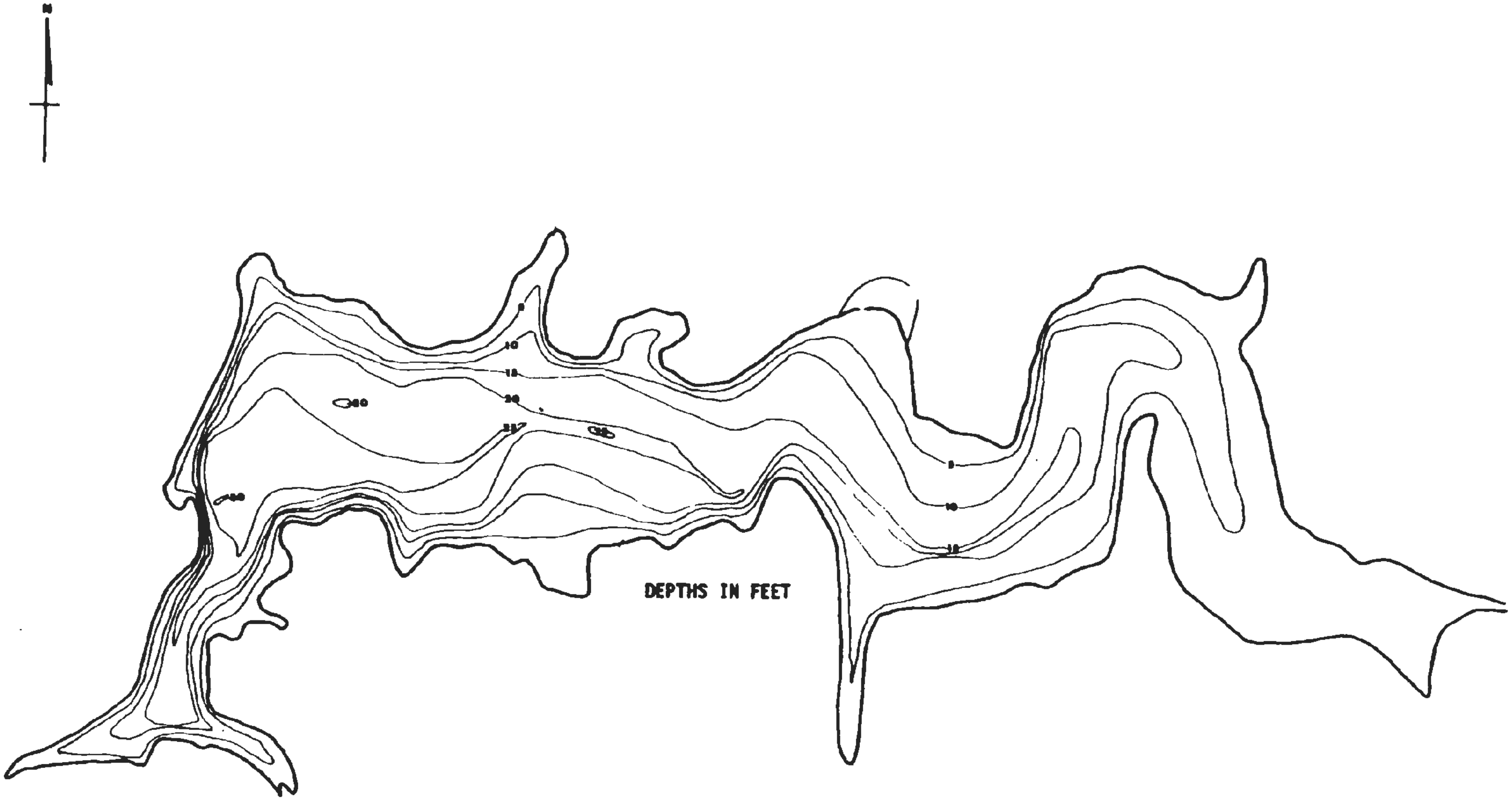
Estimated lake evaporation 91. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)
None

Outlet: Unnamed

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




1382 METERS

LAKE PAHOJA
Lyon County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.5 | 0.20 |
| Chlorophyll a mg/cubic meter | 10 | 17.6 | 8.43 |
| Total phosphorus mg/cubic meter | 8 | 743.7 | 98.50 |
| Kjeldahl nitrogen mg/l | 2 | 1.8 | 0.44 |
| Ammonia nitrogen mg/l | 2 | 0.9 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 1.2 | 0.02 |
| Seston dry weight mg/l | 10 | 6.0 | 1.14 |
| Turbidity JTU | 8 | 3.9 | 0.49 |
| Total hardness mg/l as $CaCO_3$ | 8 | 283.0 | 2.65 |
| Calcium hardness mg/l as $CaCO_3$ | 8 | 171.7 | 6.72 |
| Total alkalinity mg/l as $CaCO_3$ | 10 | 245.9 | 2.09 |
| Dissolved oxygen mg/l | 8 | 6.3 | 1.86 |
| Specific conductance micromhos/cm at 25 C | 8 | 575.0 | 5.98 |
| Sulfate mg/l | 4 | 51.5 | 1.97 |
| Chloride mg/l | 5 | 23.7 | 0.12 |
| Sodium mg/l | 3 | 17.3 | 0.33 |
| Potassium mg/l | 3 | 22.7 | 0.33 |

Vertical profile for selected measurements on the sampling date ( 8/13/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.5 | 4.1 | 696.0 | 8.6 | 25.4 |
| 1 | 22.5 | | | | |
| 2 | 22.5 | 4.1 | 696.0 | 8.6 | 18.3 |
| 3 | 22.5 | | | | |
| 4 | 22.5 | 3.9 | 710.0 | 8.6 | 9.0 |
| 5 | 21.5 | | | | |
| 6 | 19.5 | 0.0 | 1632.0 | 7.9 | 3.7 |
| 7 | 17.9 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 676.
Potential nutrient input index =
area watershed in row crops/lake area = 52.6
80.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
terraces, contouring, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Lake Pahoja Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1032. | 64.5 | 147.4 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 2074. | 129.6 | 296.3 |
| Swimming | 4364. | 272.8 | 623.4 |
| Pleasure boating | 325. | 20.3 | 46.4 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 10130. | 633.1 | 1447.1 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 382. | 23.9 | 54.6 |
| TOTAL | 18307. | 1144.2 | 2615.3 |

IMPAIRMENTS

Swimming may be impaired in Lake Pahoja during part of the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 50 %
Estimated winterkill frequencies: 1 year out of 3-5
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations is recommended. According to the Lyon County Conservation Board, proposed management plans for Lake Pahoja include the installation of aerators in the summer of 1980.

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

PIERCE CREEK POND

LOCATION
County: Page Latitude 40 Deg 50 Min N
Longitude 95 Deg 21 Min W
Township 70 N Range 39 W Section 29

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
1129. hectares ( 2789. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 26 | 1129. | 100.0 |

Estimated land uses (%)

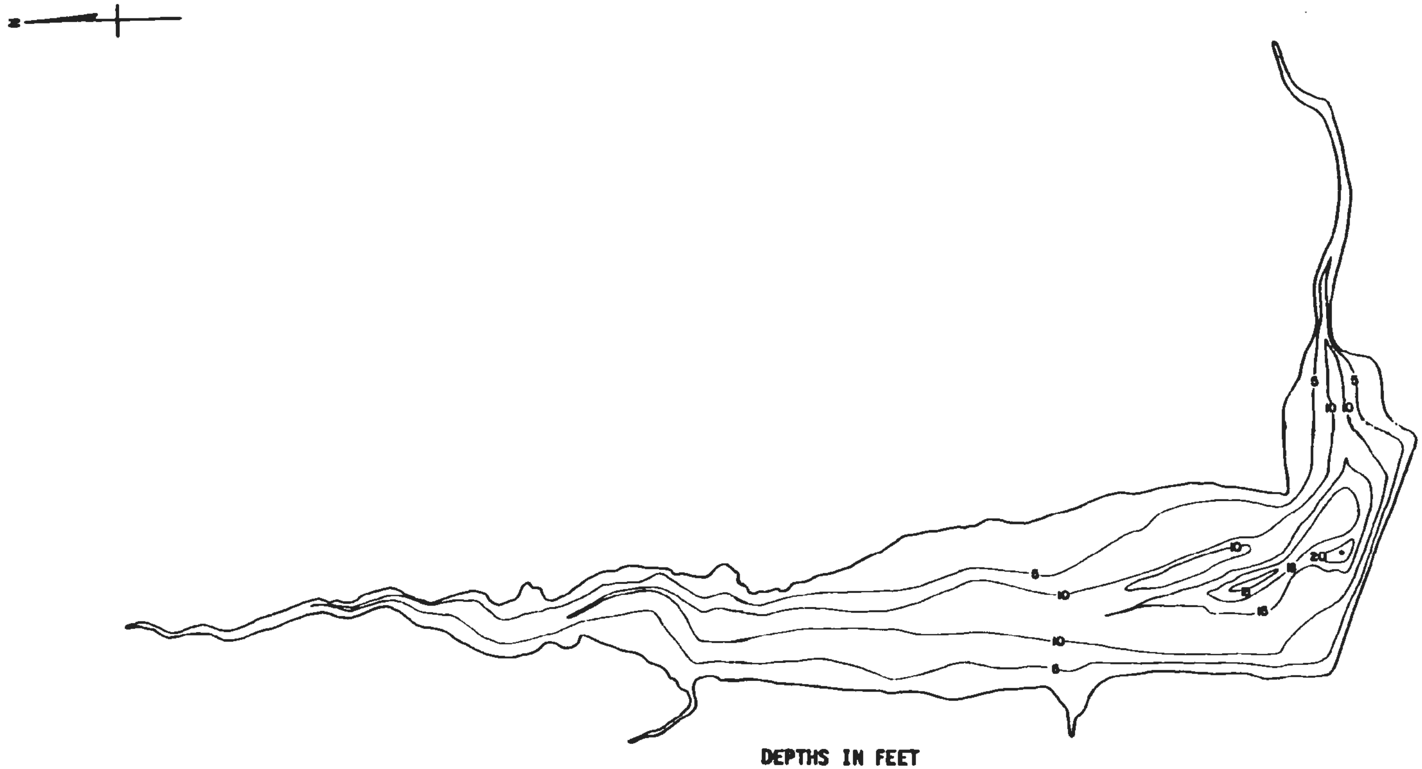
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 88.0 | 8.7 | 0.3 | 0.0 | 3.0 |

Description of topography and soils in soil associations represented in the watershed

26 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess. Marshall soils.

Per cent of shoreline in public ownership 35 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1978 map
Area 14. ha ( 34. A)
Length of shoreline 3787. m ( 12424. ft)
Maximum depth 8.5 m ( 28.0 ft)
Mean depth 2.1 m ( 7. ft)
Volume 292225. cubic meters ( 237. acre-feet)
Shoreline development 2.90 Volume development 0.75
Watershed/lake area ratio 80.6
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 102. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Unnamed
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




3421 METERS

# PIERCE CREEK POND
Page County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.4 | 0.04 |
| Chlorophyll a mg/cubic meter | 8 | 44.2 | 7.83 |
| Total phosphorus mg/cubic meter | 6 | 124.2 | 23.69 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.09 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.5 | 0.02 |
| Seston dry weight mg/l | 8 | 25.4 | 2.27 |
| Turbidity JTU | 6 | 27.2 | 3.67 |
| Total hardness mg/l as $CaCO_3$ | 4 | 131.0 | 5.20 |
| Calcium hardness mg/l as $CaCO_3$ | 4 | 88.0 | 3.56 |
| Total alkalinity mg/l as $CaCO_3$ | 6 | 118.7 | 3.89 |
| Dissolved oxygen mg/l | 8 | 7.8 | 0.82 |
| Specific conductance micromhos/cm at 25 C | 6 | 270.0 | 24.19 |
| Sulfate mg/l | 3 | 6.7 | 0.83 |
| Chloride mg/l | 3 | 3.8 | 0.17 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 7/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 29.4 | 10.1 | 82.2 | 8.6 | 53.9 |
| 1 | 29.2 | 9.8 | 88.3 | 8.6 | 59.9 |
| 2 | 25.2 | | | | |
| 3 | 22.5 | 0.5 | 132.2 | 7.6 | 56.9 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 1016.
Potential nutrient input index =
area watershed in row crops/lake area = 71.0
65.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: crop rotation, pastureland and pastureland improvement, terraces, grass waterways, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
This lake has not yet been classified.
This lake is not designated as a public water supply.

Public parks:
Pierce Creek Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 3236. | 95.2 | 231.1 |
| Shore or ice fishing | 9643. | 283.6 | 688.8 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 894. | 26.3 | 63.9 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 816. | 24.0 | 58.3 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 14589. | 429.1 | 1042.1 |

Special events at Pierce Creek Pond contributing to more than normal use include a Boy Scout camparee (140 people).

IMPAIRMENTS

Swimming may be impaired in Pierce Creek Pond throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Aquatic vascular plant growth may impair boating and shoreline fishing. Shoreline erosion and siltation are significant problems. Iowa Conservation Commission personnel consider lake usage to be below its potential due to a lack of facilities.

Estimated aquatic plant coverage 12 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of

livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

PLEASANT CREEK LAKE

LOCATION
County: Linn            Latitude  42 Deg  7 Min N
        Benton          Longitude 91 Deg 50 Min W
Township 84 N    Range 8 W    Section 6

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
841. hectares ( 2078. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 10. | 1.2 |
| 71 | 831. | 98.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 33.1 | 10.3 | 5.6 | 0.0 | 51.0 |

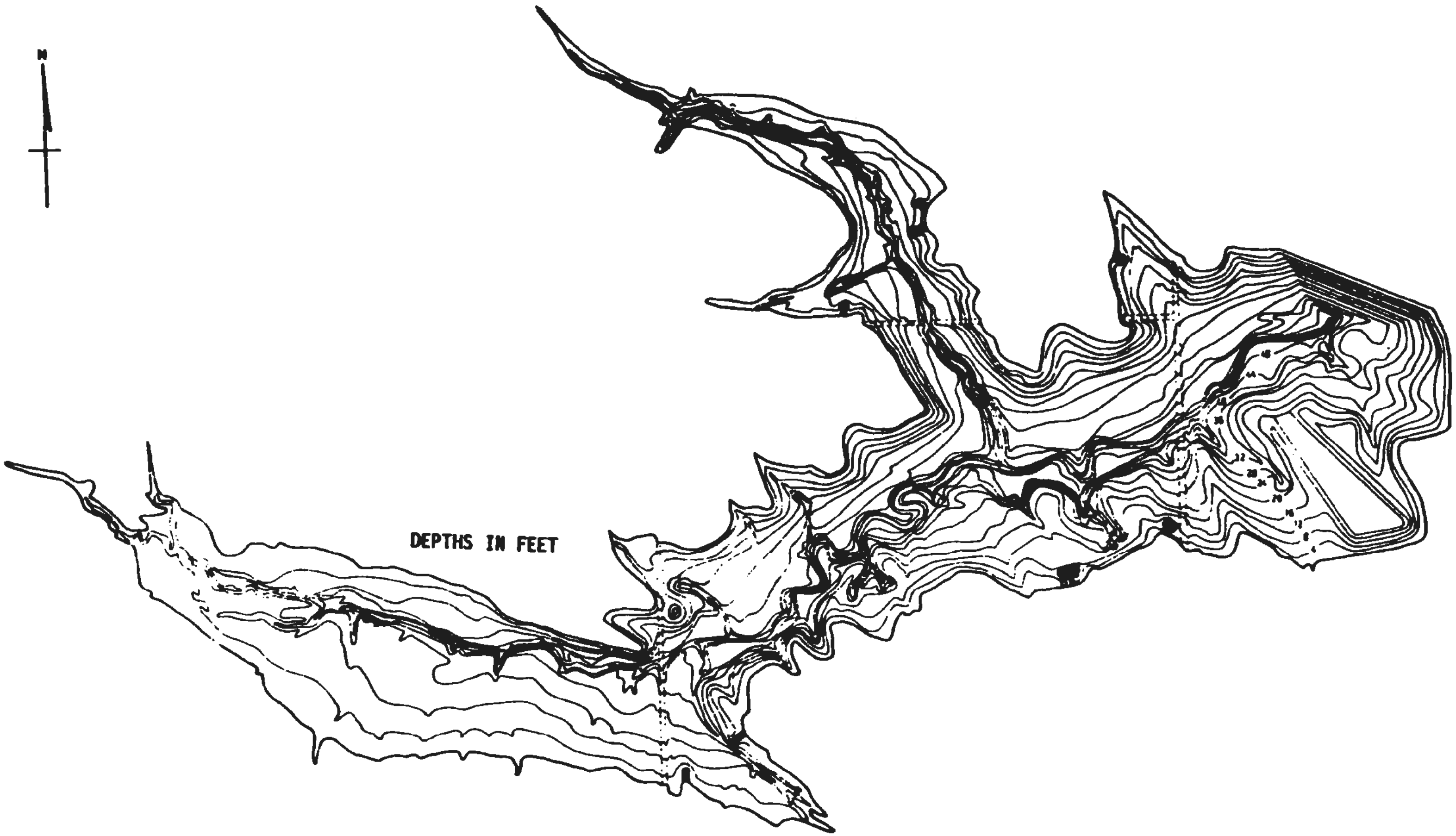
Description of topography and soils in soil associations represented in the watershed

7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

71 Gently and moderately sloping (2-9%) forest-derived soils developed from loess on ridgetops and loess over pre-Wisconsin till or loess over bedrock on moderately steep and steep (14-25%) sideslopes. Fayette and Dubuque soils and Steep Rock Land.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1978 map
Area 165. ha ( 407. A)
Length of shoreline 15061. m ( 49413. ft)
Maximum depth 18.3 m ( 60.0 ft)
Mean depth 5.1 m ( 17. ft)
Volume 8476776. cubic meters ( 6871. acre-feet)
Shoreline development 3.31    Volume development 0.84
Watershed/lake area ratio 5.1
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 86. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




1684 METERS

# PLEASANT CREEK LAKE
Linn County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 2.5 | 0.53 |
| Chlorophyll a mg/cubic meter | 11 | 18.6 | 5.51 |
| Total phosphorus mg/cubic meter | 11 | 58.3 | 8.82 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.11 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.07 |
| Seston dry weight mg/l | 15 | 3.9 | 0.54 |
| Turbidity JTU | 11 | 2.1 | 0.29 |
| Total hardness mg/l as $CaCO_3$ | 13 | 147.5 | 3.22 |
| Calcium hardness mg/l as $CaCO_3$ | 13 | 88.6 | 2.73 |
| Total alkalinity mg/l as $CaCO_3$ | 12 | 128.7 | 2.43 |
| Dissolved oxygen mg/l | 12 | 7.5 | 0.38 |
| Specific conductance micromhos/cm at 25 C | 12 | 318.3 | 8.03 |
| Sulfate mg/l | 6 | 18.8 | 1.32 |
| Chloride mg/l | 7 | 14.8 | 0.10 |
| Sodium mg/l | 2 | 9.5 | 0.50 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 1/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.1 | 8.4 | 56.3 | 8.7 | 49.8 |
| 1 | 26.1 | | | | |
| 2 | 26.1 | 8.3 | 61.3 | 8.7 | 46.8 |
| 3 | 26.1 | | | | |
| 4 | 25.6 | 7.0 | 49.4 | 8.6 | 30.1 |
| 5 | 24.4 | | | | |
| 6 | 22.2 | | | | |
| 7 | 21.1 | 0.1 | 69.5 | 7.6 | 4.4 |
| 8 | 20.0 | | | | |
| 9 | 15.6 | | | | |
| 10 | 12.2 | 0.0 | 143.7 | 7.7 | 2.2 |
| 11 | 10.0 | | | | |
| 12 | 8.9 | | | | |
| 13 | 7.8 | | | | |
| 14 | 7.8 | 0.0 | 550.3 | 7.7 | 1.1 |
| 15 | 7.8 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 31.
Potential nutrient input index =
area watershed in row crops/lake area = 1.7
75.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, contouring, terraces.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Pleasant Creek Recreation Area(State)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 10144. | 24.9 | 61.5 |
| Shore or ice fishing | 27725. | 68.1 | 168.0 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 544. | 1.3 | 3.3 |
| Hunting | 2541. | 6.2 | 15.4 |
| Picnicking, camping, other activities prompted by the lake's presence | 3998. | 9.8 | 24.2 |
| Snowmobiling | 25197. | 61.9 | 152.7 |
| Ice skating and cross-country skiing | 156. | 0.4 | 0.9 |
| TOTAL | 70305. | 172.7 | 426.1 |

IMPAIRMENTS

Recreational activities in Pleasant Creek Lake do not appear to be impaired by poor water quality; however, aquatic vegetation may interfere with boating and fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential because of uncompleted facilities.

Estimated aquatic plant coverage 27 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can

make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

POLLMILLER LAKE

LOCATION
County: Lee    Latitude 40 Deg 43 Min N
    Longitude 91 Deg 26 Min W
Township 68 N    Range 5 W    Section 4

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
92. hectares ( 229. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 38 | 11. | 12.3 |
| 44 | 81. | 87.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 47.1 | 21.8 | 8.2 | 20.9 | 2.1 |

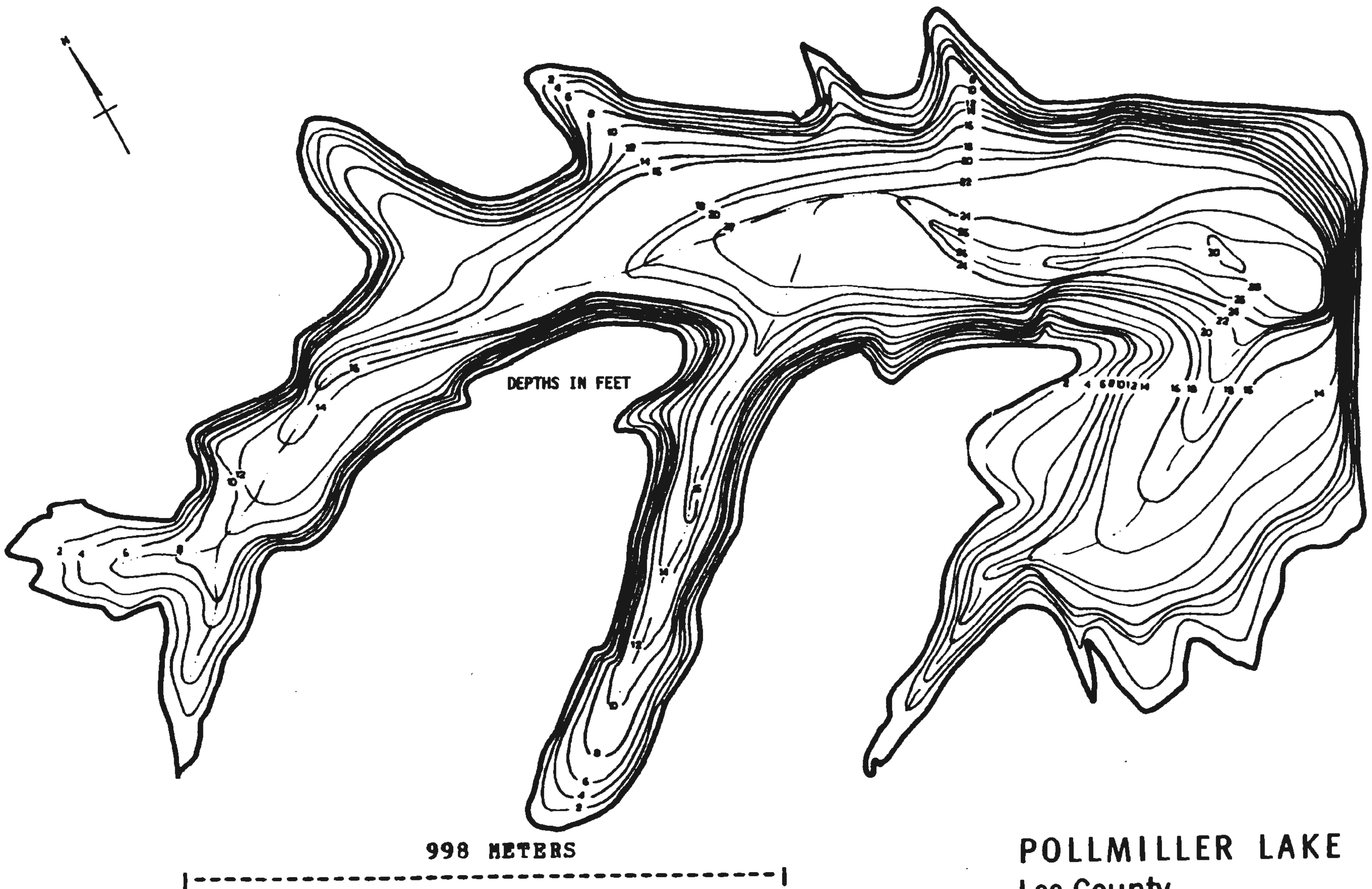
Description of topography and soils in soil associations represented in the watershed

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

44 Gently to strongly sloping (0-14%) prairie to forest-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Grundy, Pershing, Weller, Keswick, and Lindley soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1976 map
Area 7. ha ( 18. A)
Length of shoreline 2503. m ( 8213. ft)
Maximum depth 9.1 m ( 30.0 ft)
Mean depth 3.6 m ( 12. ft)
Volume 262806. cubic meters ( 213. acre-feet)
Shoreline development 2.63    Volume development 1.19
Watershed/lake area ratio 13.1
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




# POLLMILLER LAKE
Lee County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.9 | 0.11 |
| Chlorophyll a mg/cubic meter | 11 | 20.5 | 13.76 |
| Total phosphorus mg/cubic meter | 11 | 36.7 | 4.89 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.07 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 11 | 8.8 | 0.82 |
| Turbidity JTU | 10 | 6.9 | 0.85 |
| Total hardness mg/l as $CaCO_3$ | 10 | 159.8 | 1.17 |
| Calcium hardness mg/l as $CaCO_3$ | 11 | 91.1 | 1.82 |
| Total alkalinity mg/l as $CaCO_3$ | 11 | 124.0 | 0.89 |
| Dissolved oxygen mg/l | 10 | 8.3 | 0.53 |
| Specific conductance micromhos/cm at 25 C | 11 | 360.9 | 10.72 |
| Sulfate mg/l | 5 | 47.0 | 2.27 |
| Chloride mg/l | 6 | 5.8 | 0.42 |
| Sodium mg/l | 3 | 11.7 | 0.33 |
| Potassium mg/l | 3 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/ 6/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.6 | 7.9 | 24.8 | 8.8 | 10.5 |
| 1 | 26.7 | 7.8 | 29.5 | 8.8 | 4.4 |
| 2 | 26.7 | 7.7 | 34.1 | 8.7 | 9.6 |
| 3 | 24.4 | | | | |
| 4 | 19.4 | 1.8 | 49.4 | 7.9 | 26.6 |
| 5 | 13.9 | | | | |
| 6 | 11.1 | | | | |
| 7 | 10.0 | 0.0 | 434.0 | 7.3 | 24.3 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 150.
Potential nutrient input index =
  area watershed in row crops/lake area = 6.2
40.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| West Point IA0043109 | trickling filter/sludge bed |
| West Point WTP IA0002992 & IA0059536 | iron filter backwash to sewage treatment plant |
| Pollmiller Park | Water intake filter backwash |

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  Pollmiller Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 7295. | 405.3 | 1042.1 |
| Shore or ice fishing | 12330. | 685.0 | 1761.4 |
| Swimming | 32575. | 1809.7 | 4653.6 |
| Pleasure boating | 3257. | 180.9 | 465.3 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 16276. | 904.2 | 2325.1 |
| Snowmobiling | 782. | 43.4 | 111.7 |
| Ice skating and cross-country skiing | 608. | 33.8 | 86.9 |
| TOTAL | 73123. | 4062.4 | 10446.1 |

IMPAIRMENTS

Swimming may be impaired in Pollmiller Lake during part of the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can

make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

PRAIRIE ROSE LAKE

LOCATION
County: Shelby Latitude 41 Deg 36 Min N
Longitude 95 Deg 13 Min W
Township 79 N Range 38 W Section 36

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
1859. hectares ( 4594. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 25 | 689. | 37.0 |
| 26 | 1170. | 63.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 81.7 | 13.8 | 1.5 | 0.0 | 3.0 |

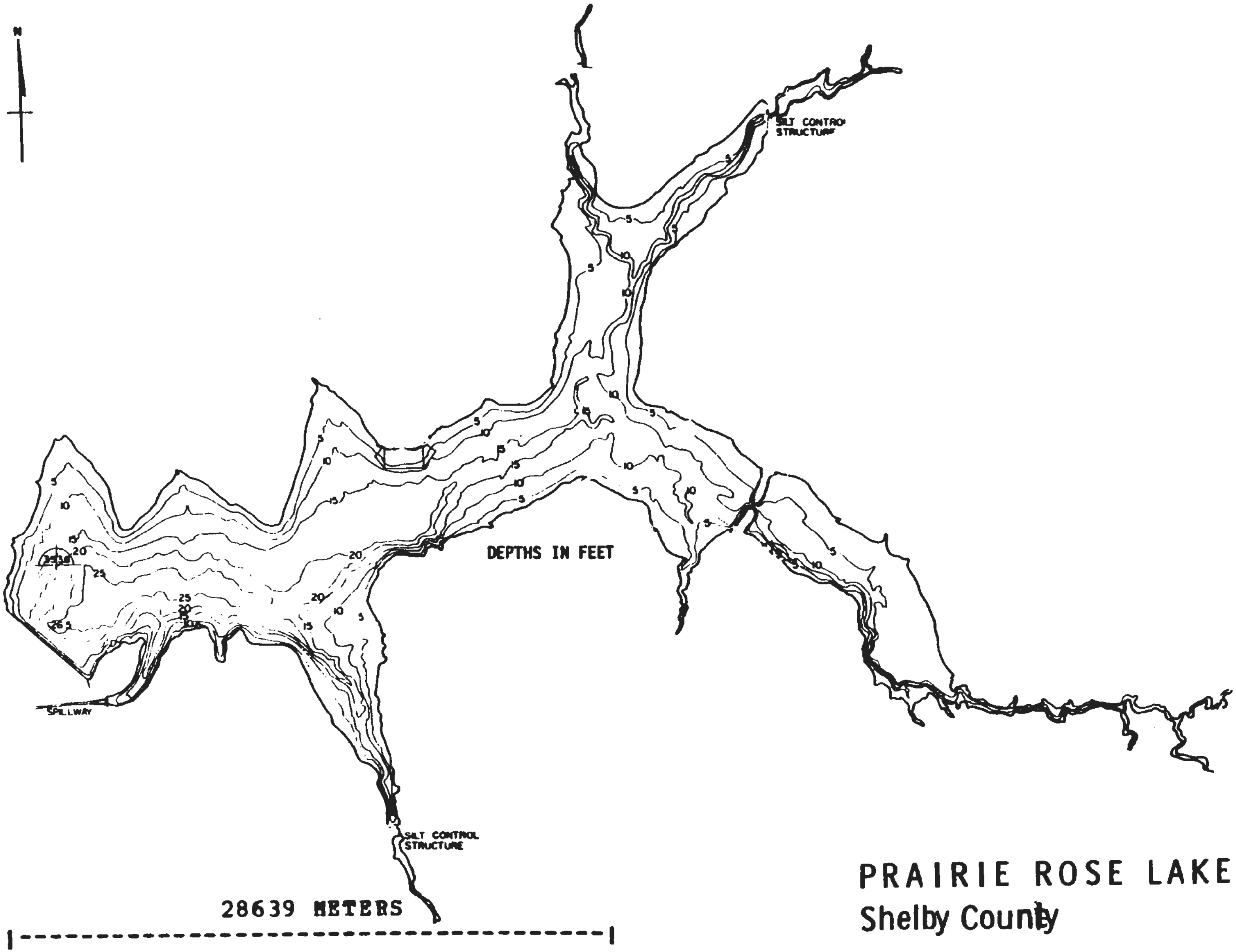
Description of topography and soils in soil associations represented in the watershed

25 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from loess, outcrops of pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Marhsall, Shelby, and Adair soils.

26 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess. Marshall soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1971 map
Area 83. ha ( 204. A)
Length of shoreline 13108. m ( 43006. ft)
Maximum depth 8.2 m ( 27.0 ft)
Mean depth 3.1 m ( 10. ft)
Volume 2570266. cubic meters ( 2083. acre-feet)
Shoreline development 4.07 Volume development 1.13
Watershed/lake area ratio 22.4
Origin of basin: Impoundment
Estimated annual precipitation 79. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 99. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Unnamed
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




PRAIRIE ROSE LAKE
Shelby County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.6 | 0.08 |
| Chlorophyll a mg/cubic meter | 8 | 38.6 | 5.46 |
| Total phosphorus mg/cubic meter | 9 | 95.0 | 5.19 |
| Kjeldahl nitrogen mg/l | 2 | 1.83 | 2.40 |
| Ammonia nitrogen mg/l | 2 | 0.12 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.64 | 0.01 |
| Seston dry weight mg/l | 8 | 25.2 | 3.76 |
| Turbidity JTU | 8 | 14.1 | 1.59 |
| Total hardness mg/l as CaCO3 | 8 | 142.0 | 2.80 |
| Calcium hardness mg/l as CaCO3 | 8 | 80.5 | 2.32 |
| Total alkalinity mg/l as CaCO3 | 9 | 139.3 | 3.84 |
| Dissolved oxygen mg/l | 8 | 7.4 | 0.89 |
| Specific conductance micromhos/cm at 25 C | 9 | 300.0 | 16.14 |
| Sulfate mg/l | 4 | 11.6 | 2.97 |
| Chloride mg/l | 4 | 7.6 | 0.24 |
| Sodium mg/l | 2 | 6.5 | 0.50 |
| Potassium mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 9/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 28.1 | 6.9 | 80.5 | 8.4 | 49.4 |
| 1 | 28.1 | | | | |
| 2 | 28.0 | 6.8 | 85.0 | 8.3 | 52.0 |
| 3 | 28.0 | | | | |
| 4 | 26.2 | 2.4 | 110.5 | 7.8 | 52.4 |
| 5 | 23.5 | 0.4 | 137.7 | 7.6 | 20.2 |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus at some times,nitrogen at others.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 14.31-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 491.
Potential nutrient input index =
area watershed in row crops/lake area = 18.3
35.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Prairie Rose State Park | Total retention lagoon |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
Prairie Rose State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 3929. | 19.3 | 47.3 |
| Shore or ice fishing | 8877. | 43.5 | 107.0 |
| Swimming | 21058. | 103.2 | 253.7 |
| Pleasure boating | 304. | 1.5 | 3.7 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking, camping, other activities prompted by the lake's presence | 9903. | 48.5 | 119.3 |
| Snowmobiling | 122. | 0.6 | 1.5 |
| Ice skating and cross-country skiing | 122. | 0.6 | 1.5 |
| TOTAL | 44315. | 217.2 | 533.9 |

Special events at Prairie Rose Lake contributing to more than normal use include several fishing tournaments (50-250 people).

IMPAIRMENTS

Swimming may be impaired in Prairie Rose Lake throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing.

Estimated aquatic plant coverage 1 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see

section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

RED HAW LAKE

LOCATION
County: Lucas Latitude 41 Deg 0 Min N
Longitude 93 Deg 16 Min W
Township 72 N Range 21 W Section 33

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
363. hectares ( 898. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 36 | 168. | 46.3 |
| 37 | 195. | 53.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 56.5 | 33.4 | 6.6 | 0.0 | 3.5 |

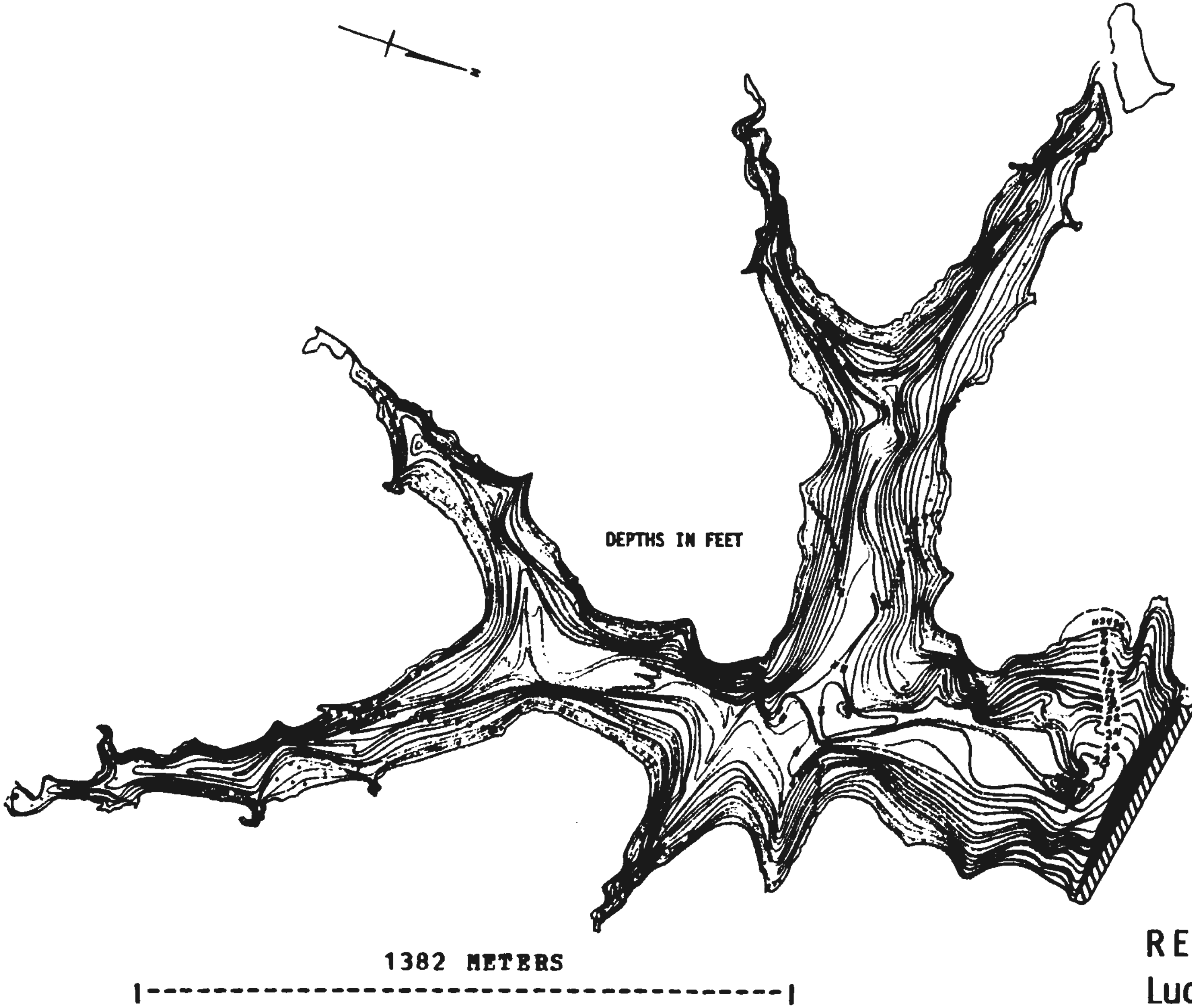
Description of topography and soils in soil associations represented in the watershed

36 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Grundy, Haig, Shelby, and Adair soils.

37 Gently sloping to moderately steep (2-18%) prairie and forest-derived soils developed from pre-Wisconsin till-derived paleosols, pre-Wisconsin till, or loess. Adair, Shelby, Lindley, and Grundy soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1973 map
Area 26. ha ( 64. A)
Length of shoreline 6372. m ( 20906. ft)
Maximum depth 12.2 m ( 40.0 ft)
Mean depth 4.4 m ( 14. ft)
Volume 1169522. cubic meters ( 948. acre-feet)
Shoreline development 3.48 Volume development 1.08
Watershed/lake area ratio 14.0
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 94. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Little Whitebreast Cr
Outlet: Little Whitebreast Cr




RED HAW LAKE
Lucas County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.9 | 0.12 |
| Chlorophyll a mg/cubic meter | 7 | 55.1 | 6.75 |
| Total phosphorus mg/cubic meter | 7 | 37.6 | 1.84 |
| Kjeldahl nitrogen mg/l | 2 | 0.9 | 0.09 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 7 | 11.4 | 0.93 |
| Turbidity JTU | 7 | 9.9 | 0.82 |
| Total hardness mg/l as CaCO3 | 7 | 89.4 | 3.64 |
| Calcium hardness mg/l as CaCO3 | 7 | 62.3 | 3.19 |
| Total alkalinity mg/l as CaCO3 | 7 | 82.9 | 4.07 |
| Dissolved oxygen mg/l | 8 | 8.9 | 0.82 |
| Specific conductance micromhos/cm at 25 C | 8 | 185.0 | 5.90 |
| Sulfate mg/l | 4 | 12.0 | 0.54 |
| Chloride mg/l | 5 | 4.5 | 0.00 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/21/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.0 | 11.0 | 31.4 | 9.2 | 30.3 |
| 1 | 27.0 | | | | |
| 2 | 25.2 | 6.2 | | 8.3 | 53.1 |
| 3 | 22.8 | | | | |
| 4 | 22.2 | 1.1 | 26.3 | 7.8 | 25.8 |
| 5 | 20.9 | | | | |
| 6 | 17.2 | 0.0 | 144.3 | 7.6 | 2.8 |
| 7 | 15.1 | | | | |
| 8 | 13.4 | 0.0 | 590.6 | 7.3 | 4.9 |
| 9 | 12.5 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 14.31-27.77 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 294.
Potential nutrient input index =
  area watershed in row crops/lake area = 7.6
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, pastureland and pastureland improvement, contouring, conservation tillage, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
  Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
  Red Haw State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 3136. | 49.0 | 120.6 |
| Shore or ice fishing | 13627. | 212.9 | 524.1 |
| Swimming | 20626. | 322.3 | 793.3 |
| Pleasure boating | 5426. | 84.8 | 208.7 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 273417. | 4272.1 | 10516.0 |
| Snowmobiling | 1910. | 29.8 | 73.5 |
| Ice skating and cross-country skiing | 782. | 12.2 | 30.1 |
| TOTAL | 318924. | 4983.2 | 12266.3 |

Special events at Red Haw Lake contributing to more than normal use include a bass fishing tournament (12 people).

IMPAIRMENTS

Swimming may be impaired in Red Haw Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 8 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the

Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

ROCK CREEK LAKE

LOCATION

County: Jasper　　Latitude 41 Deg 45 Min N
　　Longitude 92 Deg 50 Min W

Township 80 N　　Range 17 W　　Section 17

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
9912. hectares ( 24493. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 55 | 959. | 9.7 |
| 56 | 4982. | 50.3 |
| 57 | 3971. | 40.1 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 75.3 | 15.2 | 6.4 | 0.0 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

55 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess. Tama and Muscatine soils.

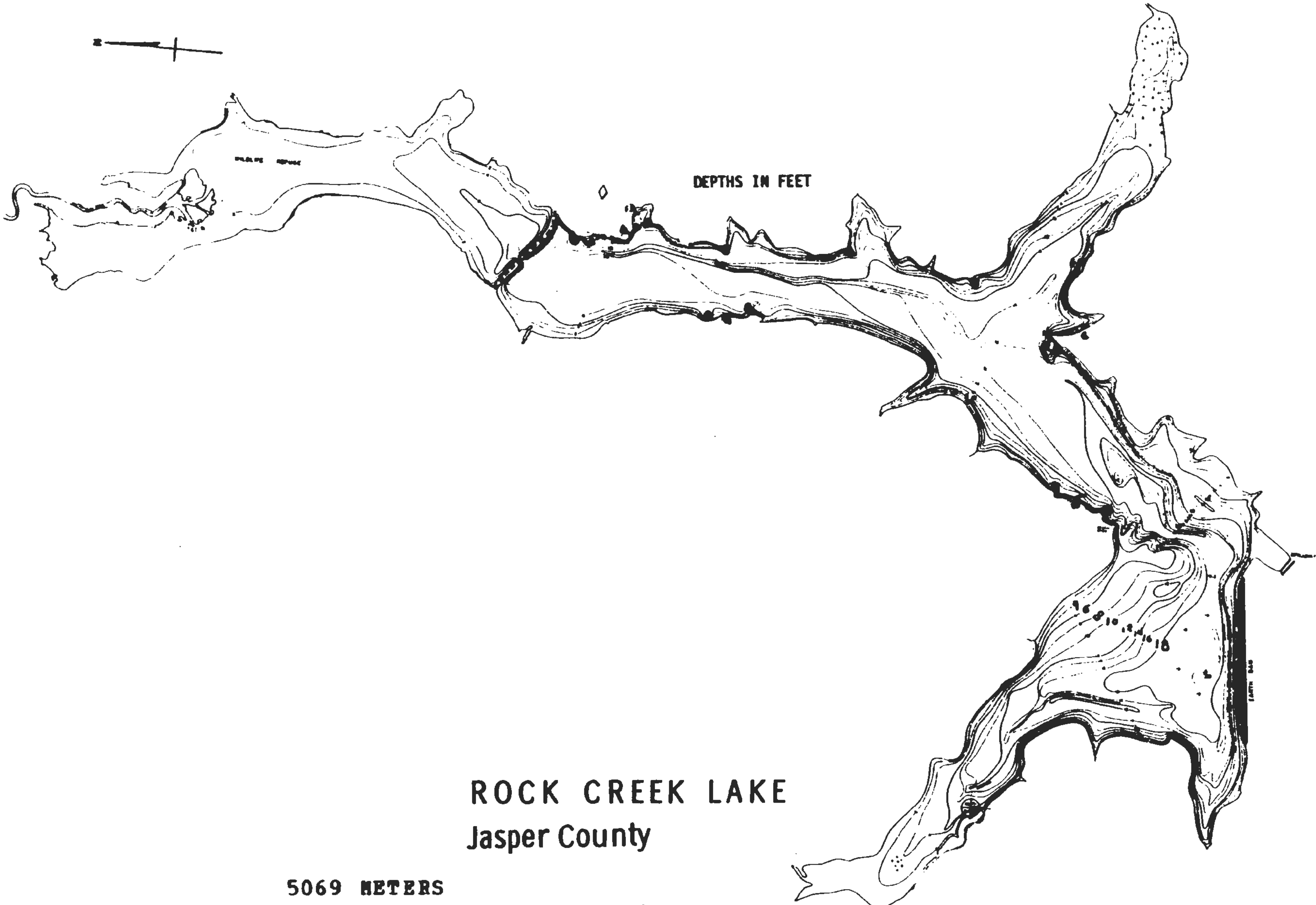
56 Gently to strongly sloping (2-14%) prairie to forest-derived soils developed from loess. Tama, Downs, and Fayette soils.

57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map
Area 244. ha ( 602. A)
Length of shoreline 22765. m ( 74691. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 2.6 m ( 9. ft)
Volume 6426006. cubic meters ( 5208. acre-feet)
Shoreline development 4.11　　Volume development 1.18
Watershed/lake area ratio 40.6
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Rock Cr
Outlet: Rock Cr




ROCK CREEK LAKE

Jasper County

5069 METERS

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.02 |
| Chlorophyll a mg/cubic meter | 10 | 75.9 | 16.86 |
| Total phosphorus mg/cubic meter | 7 | 119.2 | 9.21 |
| Kjeldahl nitrogen mg/l | 2 | 1.0 | 0.03 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.2 | 0.02 |
| Seston dry weight mg/l | 9 | 19.3 | 1.53 |
| Turbidity JTU | 9 | 14.8 | 1.66 |
| Total hardness mg/l as $CaCO_3$ | 10 | 161.4 | 7.11 |
| Calcium hardness mg/l as $CaCO_3$ | 11 | 100.5 | 4.32 |
| Total alkalinity mg/l as $CaCO_3$ | 10 | 135.4 | 4.98 |
| Dissolved oxygen mg/l | 9 | 9.0 | 0.89 |
| Specific conductance micromhos/cm at 25 C | 9 | 310.0 | 12.25 |
| Sulfate mg/l | 3 | 25.0 | 0.33 |
| Chloride mg/l | 3 | 10.0 | 0.00 |
| Sodium mg/l | 2 | 7.5 | 0.50 |
| Potassium mg/l | 2 | 4.0 | 1.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.5 | 9.4 | 133.3 | 8.5 | 106.3 |
| 1 | 26.4 | 9.1 | 124.7 | 8.5 | 87.9 |
| 2 | 26.2 | | | | |
| 3 | 25.3 | 5.3 | 88.1 | 8.1 | 9.0 |
| 5 | 24.5 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 890.
Potential nutrient input index =
area watershed in row crops/lake area = 30.6
26.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, strip-cropping, terraces, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Rock Creek State Park | Two one-cell lagoons; total retention |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
Rock Creek State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 16480. | 27.4 | 67.5 |
| Shore or ice fishing | 41485. | 68.9 | 170.0 |
| Swimming | 20325. | 33.8 | 83.3 |
| Pleasure boating | 8570. | 14.2 | 35.1 |
| Hunting | 4468. | 7.4 | 18.3 |
| Picnicking,camping,other activities prompted by the lake's presence | 110055. | 182.8 | 451.0 |
| Snowmobiling | 3470. | 5.8 | 14.2 |
| Ice skating and cross-country skiing | 955. | 1.6 | 3.9 |
| TOTAL | 205808. | 341.9 | 843.5 |

Special events at Rock Creek Lake contributing to more than normal use include five bass fishing tournaments (500 people), weekly sailboat races (50 people each), and a sailing regatta (500 people).

IMPAIRMENTS

Swimming may be impaired in Rock Creek Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 6 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition,

it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

RODGERS PARK LAKE

LOCATION
County: Benton          Latitude  42 Deg  12 Min N
                        Longitude 92 Deg   5 Min W
Township 85 N       Range 11 W       Section 1

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
779. hectares ( 1924. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 78 | 622. | 79.8 |
| 77 | 127. | 16.3 |
| 80 | 31. | 3.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 89.4 | 6.9 | 0.9 | 0.0 | 2.8 |

Description of topography and soils in soil associations represented in the watershed

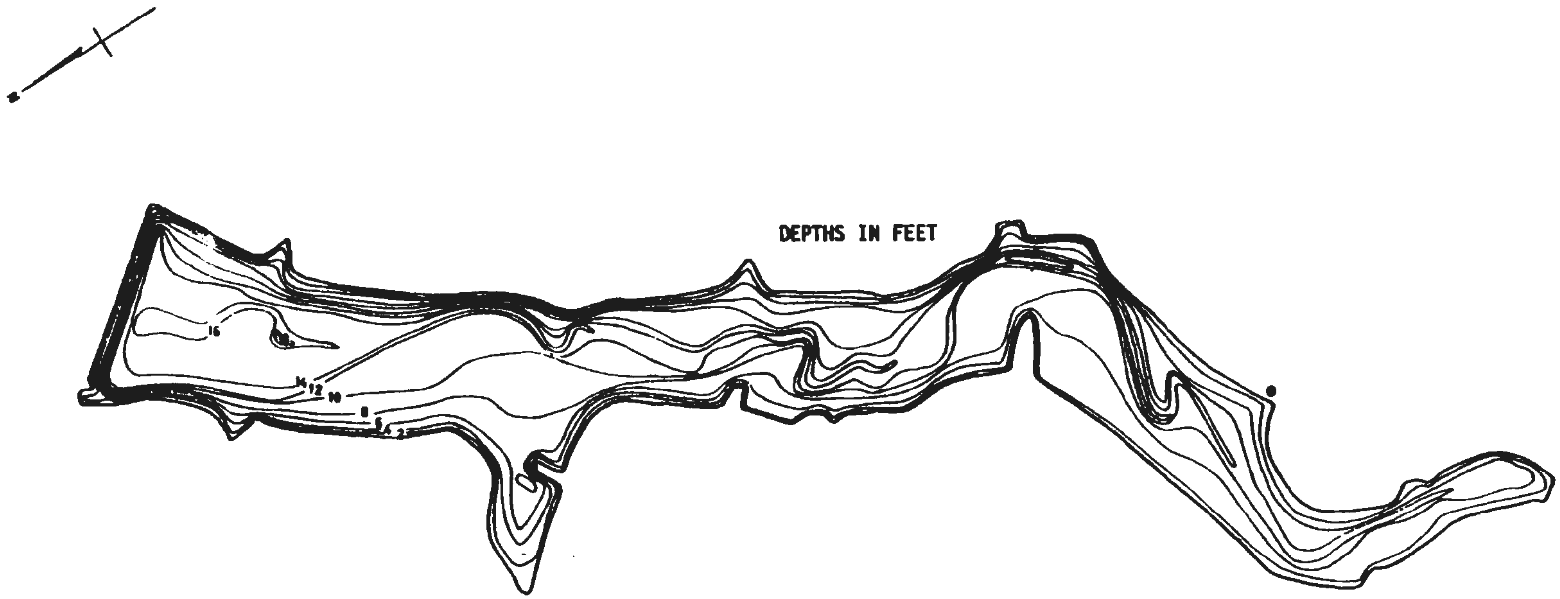
78 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, Muscatine, and Garwin soils.

77 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, loess over pre-Wisconsin till or pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, and Kenyon soils.

80 Gently sloping to steep (2-25%) prairie to forest-derived soils developed from loess on paha. Downs, Seaton, and Tama soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1978 map
Area 9. ha ( 22. A)
Length of shoreline 2628. m ( 8622. ft)
Maximum depth 5.5 m ( 18.0 ft)
Mean depth 2.3 m ( 7. ft)
Volume 198365. cubic meters ( 161. acre-feet)
Shoreline development 2.50    Volume development 1.23
Watershed/lake area ratio 86.6
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 86. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Unnamed




495 METERS

RODGERS PARK LAKE
Benton County

Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 4 | 0.5 | 0.00 |
| Chlorophyll a mg/cubic meter | 8 | 135.0 | 20.86 |
| Total phosphorus mg/cubic meter | 8 | 151.0 | 10.75 |
| Kjeldahl nitrogen mg/l | 2 | 1.1 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 9 | 18.3 | 2.53 |
| Turbidity JTU | 8 | 6.1 | 0.55 |
| Total hardness mg/l as CaCO3 | 8 | 151.2 | 3.14 |
| Calcium hardness mg/l as CaCO3 | 9 | 80.4 | 4.60 |
| Total alkalinity mg/l as CaCO3 | 10 | 110.6 | 4.15 |
| Dissolved oxygen mg/l | 8 | 11.0 | 1.49 |
| Specific conductance micromhos/cm at 25 C | 9 | 324.4 | 10.02 |
| Sulfate mg/l | 3 | 32.8 | 0.17 |
| Chloride mg/l | 3 | 18.0 | 0.00 |
| Sodium mg/l | 2 | 8.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 1/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.7 | 14.6 | 118.6 | 9.0 | 161.7 |
| 1 | 25.6 | 15.7 | 147.3 | 9.1 | 203.6 |
| 2 | 24.4 | 11.1 | 112.7 | 8.8 | 151.2 |
| 3 | 21.1 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 701.
Potential nutrient input index =
area watershed in row crops/lake area = 77.4
80.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: contouring, conservation tillage, terraces.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Rodgers Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 52. | 2.4 | 5.8 |
| Shore or ice fishing | 834. | 37.9 | 92.7 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 235. | 10.7 | 26.1 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 1475. | 67.0 | 163.9 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 191. | 8.7 | 21.2 |
| TOTAL | 2787. | 126.7 | 309.7 |

IMPAIRMENTS

Swimming may be impaired in Rodgers Park Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to the lake's recent construction.

Estimated aquatic plant coverage 9 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other

non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SILVER LAKE

LOCATION
County: Delaware        Latitude  42 Deg  25 Min N
                        Longitude  91 Deg  19 Min W
Township  88 N     Range  4 W     Section 21

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
76. hectares (  187. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 70 | 71. | 93.3 |
| 81 | 5. | 6.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 69.0 | 12.1 | 10.5 | 4.9 | 3.5 |

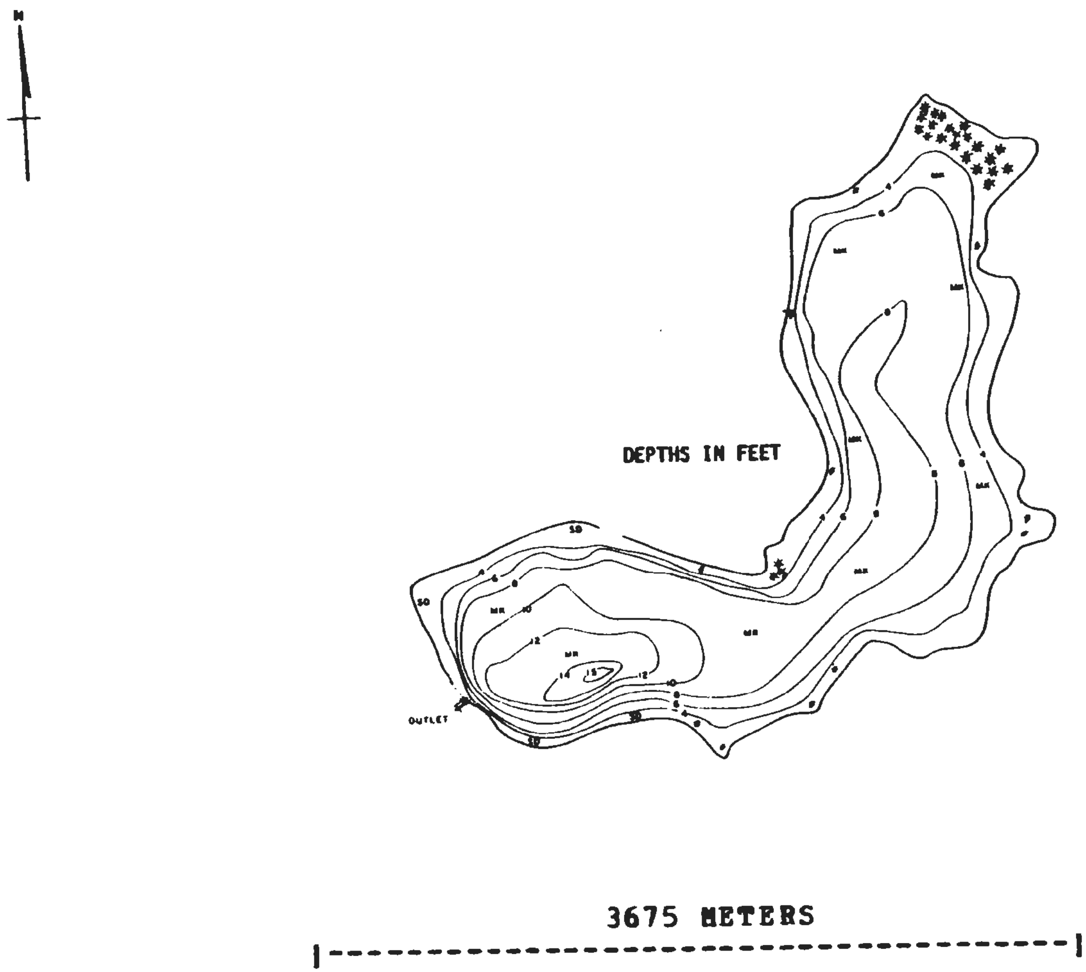
Description of topography and soils in soil associations represented in the watershed

70 Gently to strongly sloping (2-14%) prairie and forest-derived soils developed from loess or eolian sands (some undulating and hilly topography). Sparta, Fayette, Downs, Dickinson, and Backbone soils.

81 Moderately sloping to steep (5-40%) forest-derived soils developed from loess or loess over bedrock. Fayette and Dubuque soils and Steep Rock Land.

Per cent of shoreline in public ownership  38 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1975 map
Area   14. ha (  34. A)
Length of shoreline   2161. m (  7090. ft)
Maximum depth  4.6 m ( 15.0 ft)
Mean depth  1.9 m (  6. ft)
Volume   270396. cubic meters (  219. acre-feet)
Shoreline development  1.64   Volume development  1.28
Watershed/lake area ratio   5.4
Origin of basin: Impoundment
Estimated annual precipitation  89. cm
Estimated annual runoff   18. cm
Estimated lake evaporation   86. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




**SILVER LAKE**
**Delaware County**

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 2.2 | 0.27 |
| Chlorophyll a mg/cubic meter | 8 | 12.9 | 4.34 |
| Total phosphorus mg/cubic meter | 9 | 200.5 | 9.99 |
| Kjeldahl nitrogen mg/l | 2 | 1.1 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 9 | 3.6 | 0.30 |
| Turbidity JTU | 9 | 2.6 | 0.37 |
| Total hardness mg/l as $CaCO_3$ | 11 | 68.4 | 1.79 |
| Calcium hardness mg/l as $CaCO_3$ | 11 | 43.6 | 0.80 |
| Total alkalinity mg/l as $CaCO_3$ | 11 | 59.8 | 1.25 |
| Dissolved oxygen mg/l | 10 | 9.2 | 0.48 |
| Specific conductance micromhos/cm at 25 C | 8 | 160.0 | 16.37 |
| Sulfate mg/l | 2 | 2.5 | 1.50 |
| Chloride mg/l | 4 | 9.0 | 0.00 |
| Sodium mg/l | 2 | 3.0 | 0.00 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/10/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 24.4 | 6.7 | 221.8 | 9.0 | 5.3 |
| 1 | 23.1 | 7.9 | 230.4 | 9.1 | 4.1 |
| 2 | 21.8 | 6.8 | 225.1 | 9.0 | 4.5 |
| 3 | 21.5 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 44.
Potential nutrient input index =
area watershed in row crops/lake area = 3.7
38.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
Silver Lake Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 821. | 24.1 | 58.6 |
| Shore or ice fishing | 3397. | 99.9 | 242.6 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking, camping, other activities prompted by the lake's presence | 1063. | 31.3 | 75.9 |
| Snowmobiling | 1390. | 40.9 | 99.3 |
| Ice skating and cross-country skiing | 69. | 2.0 | 4.9 |
| TOTAL | 6740. | 198.2 | 481.4 |

IMPAIRMENTS

Recreational activities in Silver Lake do not appear to be impaired by high algal populations; however, aquatic vegetation may interfere with boating, fishing, and swimming. Frequent winterkills and occasional summerkills may limit fishing potential. Grass carp have been stocked to control the growth of aquatic vegetation. Aeration is used in the winter to maintain dissolved oxygen concentrations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to aquatic plant and winterkill problems.

Estimated aquatic plant coverage 92 %
Artificial aeration used
Estimated winterkill frequencies: 1 year out of 5
Estimated summerkill frequencies: 1 year out of 10

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SILVER LAKE

LOCATION

County: Dickinson          Latitude  43 Deg  27 Min N
                           Longitude 95 Deg  20 Min W
Township 100 N       Range 38 W       Section 28

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
4490. hectares ( 11094. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 734. | 16.3 |
| 14 | 2148. | 47.8 |
| 15 | 1608. | 35.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 67.7 | 8.0 | 0.8 | 0.0 | 3.6 |

Description of topography and soils in soil associations represented in the watershed

12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

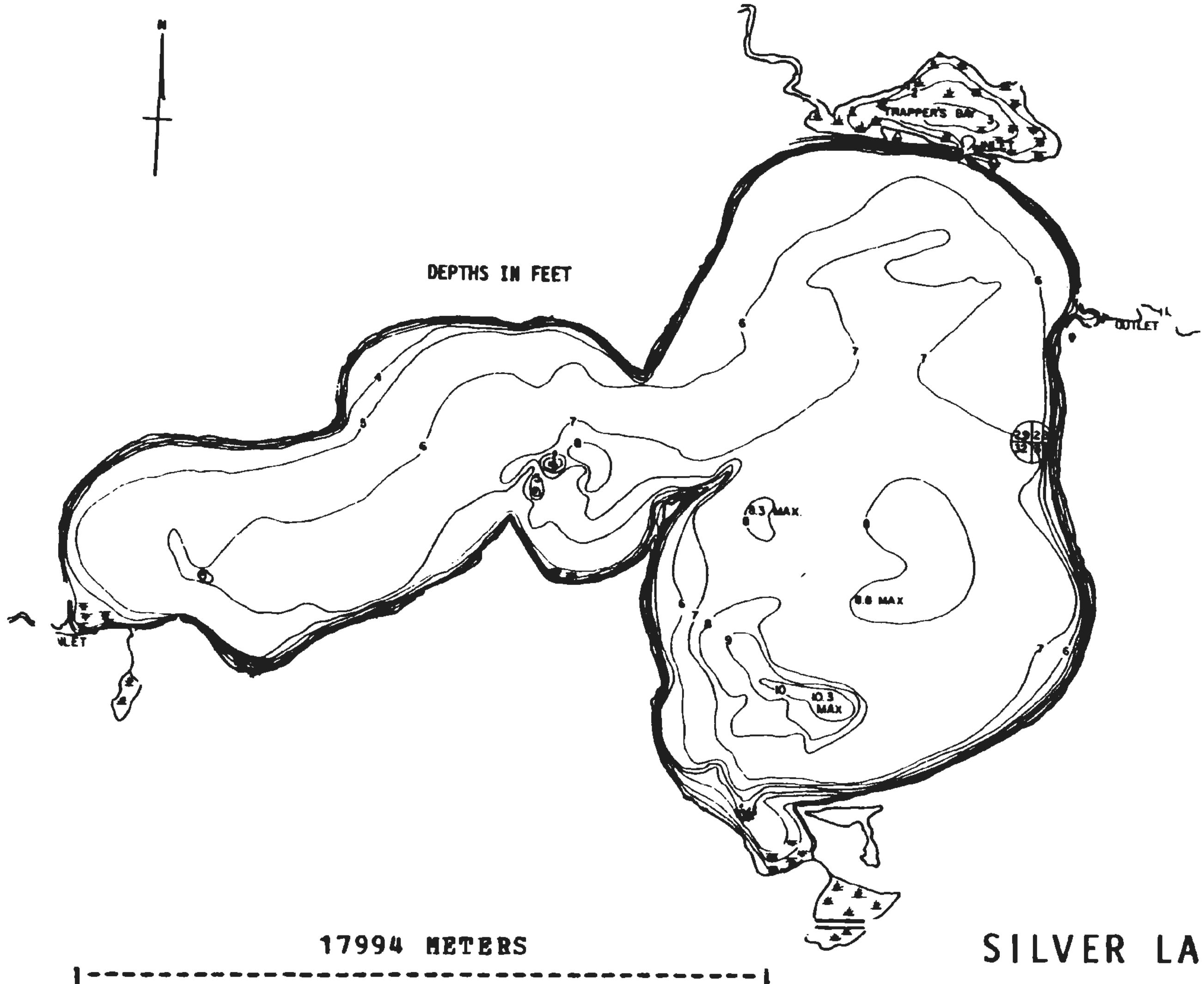
14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership  26 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1971 map
Area  421. ha (1041. A)
Length of shoreline   15462. m (  50730. ft)
Maximum depth  3.4 m ( 11.0 ft)
Mean depth  1.8 m (  6. ft)
Volume   7784362. cubic meters (  6308. acre-feet)
Shoreline development  2.11    Volume development  1.64
Watershed/lake area ratio     10.7
Origin of basin: Natural
Estimated annual precipitation  71. cm
Estimated annual runoff          8. cm
Estimated lake evaporation      89. cm
Thermal stratification? No




SILVER LAKE
Dickinson County

Major inflows (named and/or permanent streams)
West Br Little Sioux R + 1 Unnamed
Outlet: West Br Little Sioux R
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.1 | 0.26 |
| Chlorophyll a mg/cubic meter | 10 | 34.1 | 13.44 |
| Total phosphorus mg/cubic meter | 10 | 97.1 | 11.99 |
| Kjeldahl nitrogen mg/l | 2 | 1.0 | 0.10 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.08 |
| Nitrate + nitrite nitrogen mg/l | 2 | 1.2 | 0.01 |
| Seston dry weight mg/l | 10 | 20.6 | 6.10 |
| Turbidity JTU | 9 | 11.3 | 2.31 |
| Total hardness mg/l as CaCO3 | 9 | 345.8 | 2.93 |
| Calcium hardness mg/l as CaCO3 | 9 | 226.0 | 5.82 |
| Total alkalinity mg/l as CaCO3 | 10 | 162.8 | 4.24 |
| Dissolved oxygen mg/l | 9 | 7.9 | 0.56 |
| Specific conductance micromhos/cm at 25 C | 9 | 620.6 | 9.91 |
| Sulfate mg/l | 3 | 178.7 | 1.67 |
| Chloride mg/l | 3 | 17.5 | 0.00 |
| Sodium mg/l | 2 | 8.5 | 0.50 |
| Potassium mg/l | 2 | 4.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/13/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.2 | 6.2 | 136.7 | 8.3 | 32.9 |
| 1 | 21.2 | 6.3 | 145.4 | 8.3 | |
| 2 | 21.2 | 6.4 | 29.5 | 8.3 | 103.3 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 42.
Potential nutrient input index =
  area watershed in row crops/lake area = 9.2
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, conservation planting (trees,grass).

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| Lake Park IA0036919 | 2-cell lagoon;overflow does not enter lake |

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
  Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 950 persons at Lake Park.

Public parks:
  Trappers Bay
  City Campground and Boat Launch

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 12693. | 12.2 | 30.1 |
| Shore or ice fishing | 27683. | 26.6 | 65.8 |
| Swimming | 3231. | 3.1 | 7.7 |
| Pleasure boating | 1055. | 1.0 | 2.5 |
| Hunting | 2093. | 2.0 | 5.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 5836. | 5.6 | 13.9 |
| Snowmobiling | 2084. | 2.0 | 5.0 |
| Ice skating and cross-country skiing | 1042. | 1.0 | 2.5 |
| TOTAL | 55717. | 53.5 | 132.3 |

IMPAIRMENTS

Swimming may be impaired in Silver Lake during part of the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills and occasional summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to winterkill problems.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: 1 year out of 5-7
Estimated summerkill frequencies: 1 year out of 12-15

LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SILVER LAKE

LOCATION

County: Palo Alto    Latitude 43 Deg 2 Min N
Longitude 94 Deg 53 Min W

Township 95 N    Range 34 W    Section 20

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
3236. hectares ( 7996. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 1681. | 52.0 |
| 15 | 1554. | 48.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 85.8 | 9.4 | 1.0 | 0.0 | 3.8 |

Description of topography and soils in soil associations represented in the watershed

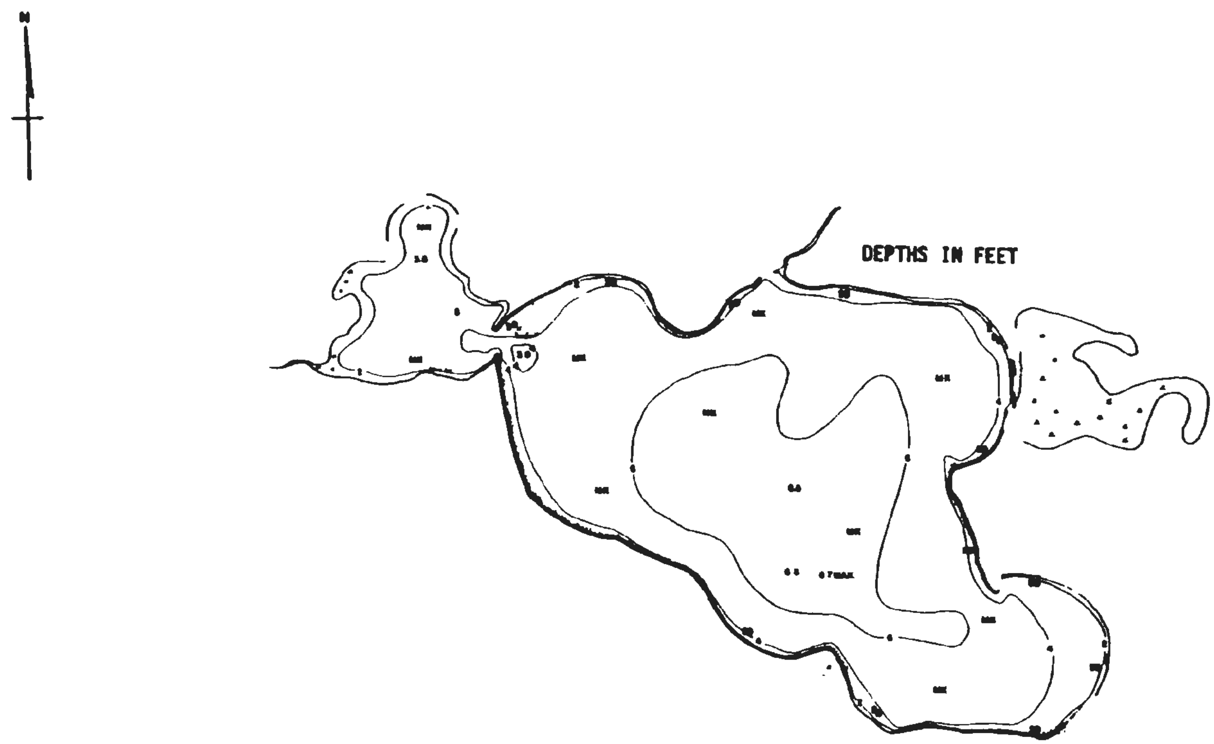
14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 18 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map
Area 269. ha ( 664. A)
Length of shoreline 9821. m ( 32221. ft)
Maximum depth 2.0 m ( 7.0 ft)
Mean depth 1.4 m ( 5. ft)
Volume 3814332. cubic meters ( 3091. acre-feet)
Shoreline development 1.69    Volume development 2.08
Watershed/lake area ratio 12.0
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 91. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
Unnamed
Outlet: Silver Cr




14953 METERS

SILVER LAKE
Palo Alto County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.09 |
| Chlorophyll a mg/cubic meter | 9 | 77.1 | 16.45 |
| Total phosphorus mg/cubic meter | 9 | 222.0 | 22.80 |
| Kjeldahl nitrogen mg/l | 2 | 1.9 | 0.42 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 10 | 26.0 | 3.42 |
| Turbidity JTU | 9 | 10.6 | 0.87 |
| Total hardness mg/l as CaCO3 | 10 | 214.0 | 3.90 |
| Calcium hardness mg/l as CaCO3 | 10 | 124.0 | 6.91 |
| Total alkalinity mg/l as CaCO3 | 9 | 153.8 | 3.49 |
| Dissolved oxygen mg/l | 9 | 8.6 | 0.64 |
| Specific conductance micromhos/cm at 25 C | 10 | 383.0 | 12.74 |
| Sulfate mg/l | 3 | 45.0 | 0.76 |
| Chloride mg/l | 3 | 20.2 | 0.17 |
| Sodium mg/l | 2 | 7.5 | 0.50 |
| Potassium mg/l | 2 | 3.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.3 | 9.2 | 216.3 | 9.0 | 98.0 |
| 1 | 21.2 | 9.4 | 220.5 | 9.0 | 46.8 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 48.
Potential nutrient input index =
area watershed in row crops/lake area = 10.3
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, crop rotation, terraces, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Fish and Wildlife Access
Salton Park and Boat Launch (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 677. | 1.0 | 2.5 |
| Shore or ice fishing | 12979. | 19.5 | 48.2 |
| Swimming | 2345. | 3.5 | 8.7 |
| Pleasure boating | 586. | 0.9 | 2.2 |
| Hunting | 2605. | 3.9 | 9.7 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 11290. | 17.0 | 42.0 |
| Snowmobiling | 3473. | 5.2 | 12.9 |
| Ice skating and cross-country skiing | 2348. | 3.5 | 8.7 |
| TOTAL | 36303. | 54.7 | 135.0 |

IMPAIRMENTS

Swimming may be impaired in Silver Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to winterkills and poor fishing.

Estimated aquatic plant coverage 29 %
Estimated winterkill frequencies: 1 year out of 7-10
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see

section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SILVER LAKE

LOCATION

County: Worth Latitude 43 Deg 29 Min N
Longitude 93 Deg 25 Min W

Township 100 N Range 22 W Section 14

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
1032. hectares ( 2550. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 15 | 387. | 37.5 |
| 114 | 645. | 62.5 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 75.3 | 16.0 | 5.3 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

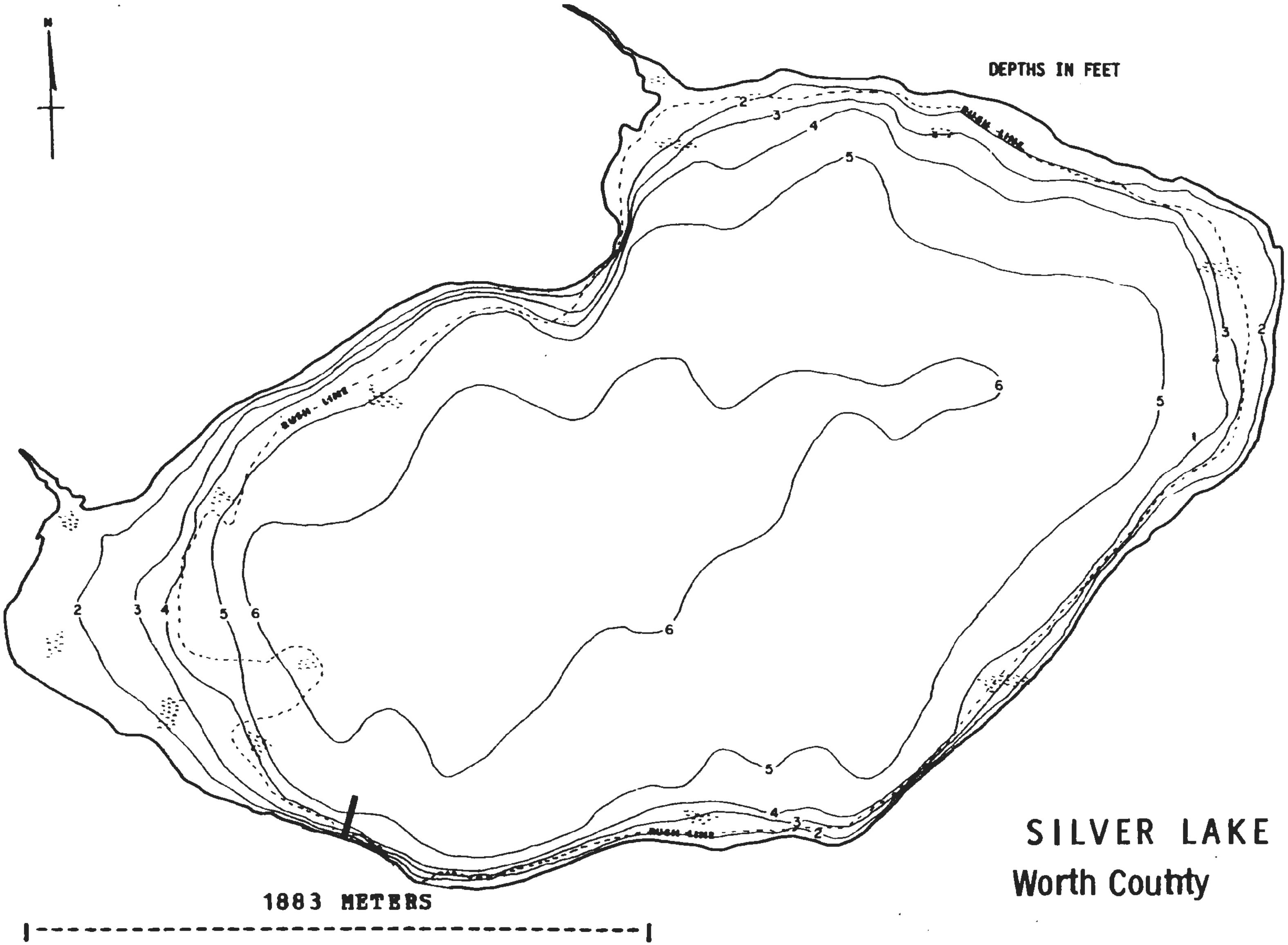
15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

114 Nearly level to moderately sloping (0-9%) prairie and mixed prairie-forest-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Lester, Webster, Okoboji, and Nicollet soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map
Area 128. ha ( 316. A)
Length of shoreline 4118. m ( 13512. ft)
Maximum depth 1.8 m ( 6.0 ft)
Mean depth 1.4 m ( 5. ft)
Volume 1846917. cubic meters ( 1497. acre-feet)
Shoreline development 1.03 Volume development 2.37
Watershed/lake area ratio 8.1
Origin of basin: Natural
Estimated annual precipitation 79. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 86. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
None
Outlet: Drainage Ditch 46




SILVER LAKE

Worth Coutnty

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.07 |
| Chlorophyll a mg/cubic meter | 11 | 100.3 | 18.04 |
| Total phosphorus mg/cubic meter | 11 | 138.6 | 20.60 |
| Kjeldahl nitrogen mg/l | 2 | 1.5 | 0.09 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 11 | 24.4 | 1.90 |
| Turbidity JTU | 10 | 10.8 | 0.74 |
| Total hardness mg/l as $CaCO_3$ | 9 | 140.4 | 4.05 |
| Calcium hardness mg/l as $CaCO_3$ | 9 | 80.7 | 1.63 |
| Total alkalinity mg/l as $CaCO_3$ | 10 | 119.8 | 3.24 |
| Dissolved oxygen mg/l | 9 | 10.4 | 0.79 |
| Specific conductance micromhos/cm at 25 C | 9 | 256.1 | 12.88 |
| Sulfate mg/l | 4 | 5.1 | 1.98 |
| Chloride mg/l | 7 | 13.4 | 0.37 |
| Sodium mg/l | 2 | 3.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.2 | 8.2 | 145.0 | 8.6 | 121.9 |
| 1 | 22.2 | 8.2 | 146.7 | 8.6 | 112.3 |
| 2 | 22.2 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus at some times, nitrogen at others.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 65.
Potential nutrient input index =
area watershed in row crops/lake area = 6.1
76.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage, terraces, crop rotation, contouring.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Silver Lake Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 0. | 0.0 | 0.0 |
| Shore or ice fishing | 452. | 1.4 | 3.5 |
| Swimming | 26. | 0.1 | 0.2 |
| Pleasure boating | 143. | 0.5 | 1.1 |
| Hunting | 912. | 2.9 | 7.1 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 634. | 2.0 | 5.0 |
| Snowmobiling | 365. | 1.2 | 2.9 |
| Ice skating and cross-country skiing | 122. | 0.4 | 1.0 |
| TOTAL | 2654. | 8.4 | 20.7 |

IMPAIRMENTS

Swimming may be impaired in Silver Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to winterkills.

Estimated aquatic plant coverage 25 %
Estimated winterkill frequencies: 1 year out of 2
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see

section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SLIP BLUFF LAKE

LOCATION

County: Decatur    Latitude 40 Deg 39 Min N
Longitude 93 Deg 51 Min W
Township 68 N    Range 26 W    Section 28

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
93. hectares ( 230. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 7 | 9. | 9.8 |
| 38 | 84. | 90.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 38.1 | 33.7 | 26.2 | 0.0 | 2.1 |

Description of topography and soils in soil associations represented in the watershed

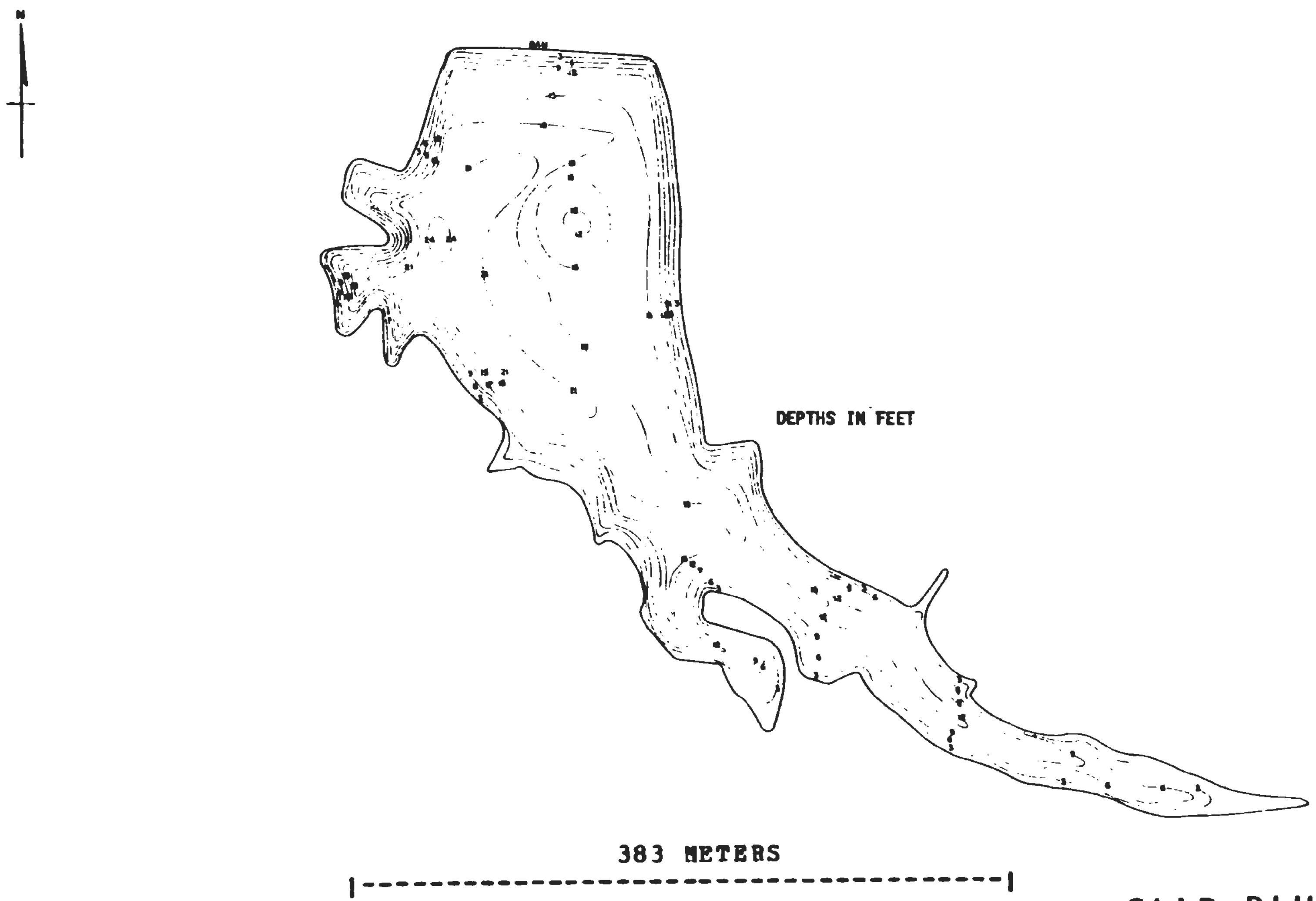
7 Nearly level and gently sloping (0-5%) prairie-derived soils developed from alluvium. Soils on steep adjacent upland slopes are included in some areas. Colo, Zook, and Nodaway soils.

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1975 map
Area 6. ha ( 16. A)
Length of shoreline 2063. m ( 6768. ft)
Maximum depth 7.3 m ( 24.0 ft)
Mean depth 3.8 m ( 12. ft)
Volume 244780. cubic meters ( 198. acre-feet)
Shoreline development 2.29 Volume development 1.55
Watershed/lake area ratio 15.5
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




SLIP BLUFF LAKE
Decatur County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 2.4 | 0.10 |
| Chlorophyll a mg/cubic meter | 9 | 4.6 | 0.70 |
| Total phosphorus mg/cubic meter | 9 | 15.8 | 2.07 |
| Kjeldahl nitrogen mg/l | 2 | 0.4 | 0.03 |
| Ammonia nitrogen mg/l | 2 | 0.04 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 9 | 2.9 | 0.20 |
| Turbidity JTU | 9 | 3.7 | 0.39 |
| Total hardness mg/l as CaCO3 | 11 | 74.4 | 2.71 |
| Calcium hardness mg/l as CaCO3 | 11 | 54.9 | 2.91 |
| Total alkalinity mg/l as CaCO3 | 9 | 64.9 | 2.77 |
| Dissolved oxygen mg/l | 9 | 8.1 | 0.38 |
| Specific conductance micromhos/cm at 25 C | 12 | 144.7 | 5.94 |
| Sulfate mg/l | 4 | 4.5 | 0.94 |
| Chloride mg/l | 4 | 1.4 | 0.13 |
| Sodium mg/l | 2 | 3.0 | 0.00 |
| Potassium mg/l | 2 | 2.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/21/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.6 | 8.4 | 11.3 | 8.7 | 2.6 |
| 1 | 26.6 | | | | |
| 2 | 26.6 | 8.1 | 9.9 | 8.6 | 1.9 |
| 3 | 24.2 | | | | |
| 4 | 23.1 | 5.3 | 15.7 | 8.0 | 3.1 |
| 5 | 19.3 | | | | |
| 6 | 14.1 | 0.0 | 59.3 | 7.4 | 221.5 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
A few sections of shoreline with severe erosion
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 177.
Potential nutrient input index =
area watershed in row crops/lake area = 5.9
91.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Slip Bluff Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 247. | 15.4 | 41.2 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 3374. | 210.9 | 562.3 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 87. | 5.4 | 14.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 4297. | 268.6 | 716.2 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 69. | 4.3 | 11.5 |
| TOTAL | 8074. | 504.6 | 1345.7 |

IMPAIRMENTS

Recreational activities in Slip Bluff Lake do not appear to be impaired by poor water quality or aquatic plants. Iowa Conservation Commission personnel consider lake usage to be below its potential due to occasional periods of high turbidity.

Estimated aquatic plant coverage 4 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will

help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SMITH LAKE

LOCATION
County: Kossuth          Latitude  43 Deg  7 Min N
                         Longitude  94 Deg  14 Min W
Township 96 N     Range 29 W     Section 23

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
446. hectares ( 1102. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 446. | 100.0 |

Estimated land uses (%)

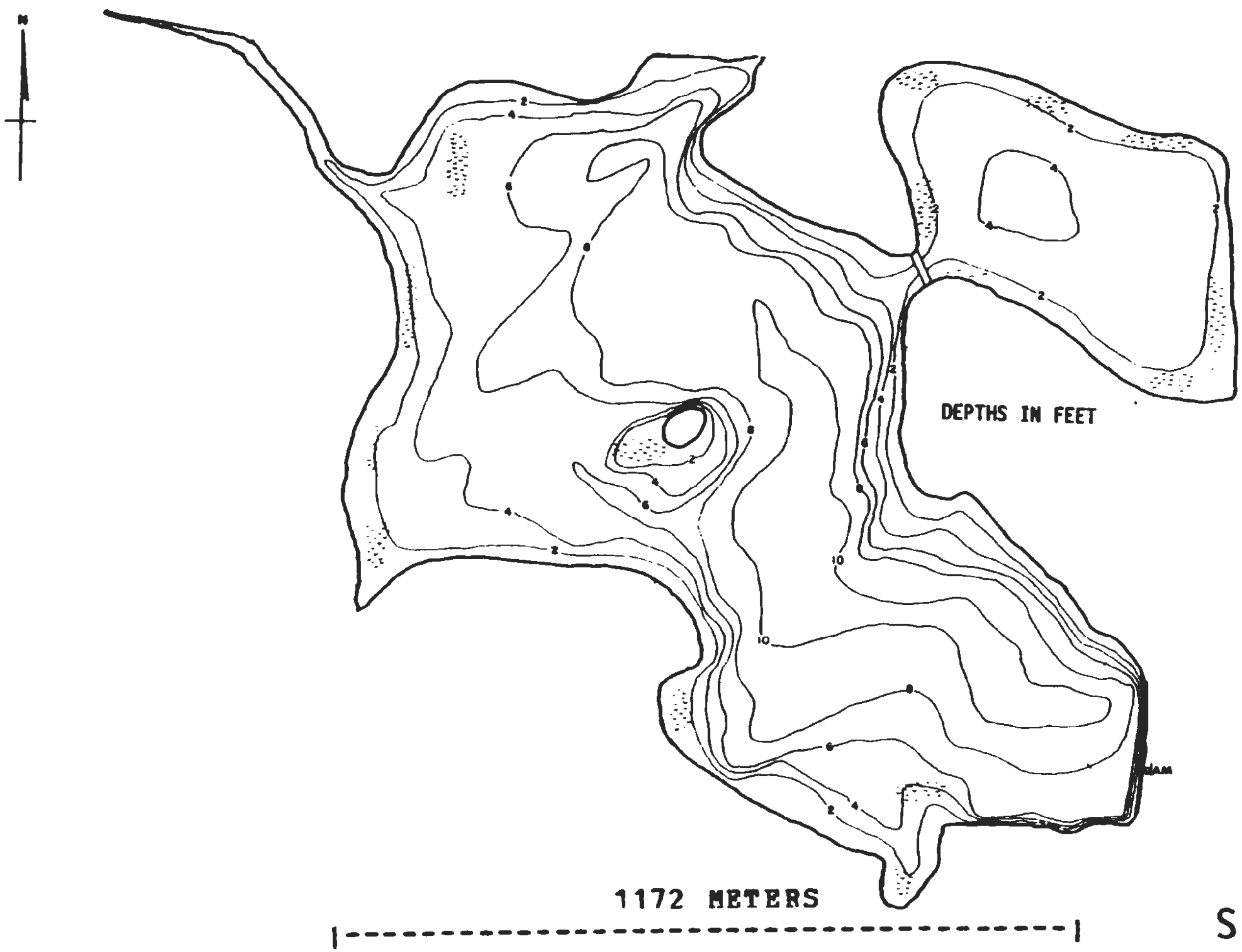
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 94.6 | 2.6 | 0.0 | 0.0 | 2.8 |

Description of topography and soils in soil associations represented in the watershed

12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 24. ha ( 59. A)
Length of shoreline 3148. m ( 10329. ft)
Maximum depth 3.0 m ( 10.0 ft)
Mean depth 1.6 m ( 5. ft)
Volume 388128. cubic meters ( 315. acre-feet)
Shoreline development 1.82   Volume development 1.60
Watershed/lake area ratio 18.6
Origin of basin: Impoundment
Estimated annual precipitation 74. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 89. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




SMITH LAKE
Kossuth County

POLLUTICN ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.5 | 0.09 |
| Chlorophyll a mg/cubic meter | 9 | 91.5 | 10.50 |
| Total phosphorus mg/cubic meter | 9 | 110.2 | 12.79 |
| Kjeldahl nitrogen mg/l | 2 | 1.5 | 0.65 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 4.4 | 0.15 |
| Seston dry weight mg/l | 9 | 20.0 | 0.65 |
| Turbidity JTU | 11 | 13.3 | 1.46 |
| Total hardness mg/l as CaCO3 | 10 | 277.0 | 10.27 |
| Calcium hardness mg/l as CaCO3 | 11 | 185.5 | 8.51 |
| Total alkalinity mg/l as CaCO3 | 11 | 177.1 | 8.13 |
| Dissolved oxygen mg/l | 9 | 10.6 | 0.50 |
| Specific conductance micromhos/cm at 25 C | 10 | 484.0 | 13.49 |
| Sulfate mg/l | 7 | 54.3 | 3.97 |
| Chloride mg/l | 8 | 26.4 | 1.30 |
| Sodium mg/l | 2 | 4.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/23/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.1 | 9.2 | 168.8 | 8.3 | 93.6 |
| 1 | 21.1 | 9.3 | 174.0 | 8.3 | 77.1 |
| 2 | 21.1 | | | | |
| 3 | 21.1 | 9.1 | 134.0 | 8.3 | 83.5 |
| 4 | 20.9 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 0- 3.0 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 28.
Potential nutrient input index =
area watershed in row crops/lake area = 17.6
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  Kossuth County Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 925. | 15.7 | 38.5 |
| Shore or ice fishing | 11641. | 197.3 | 485.0 |
| Swimming | 7667. | 129.9 | 319.5 |
| Pleasure boating | 135. | 2.3 | 5.6 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 21118. | 357.9 | 879.9 |
| Snowmobiling | 739. | 12.5 | 30.8 |
| Ice skating and cross-country skiing | 870. | 14.7 | 36.3 |
| TOTAL | 43095. | 730.4 | 1795.6 |

Special events at Smith Lake contributing to more than normal use include a fishing contest (200 people), camping clubs (250-300 people), and a snowmobile club (30-75 people).

## IMPAIRMENTS

Swimming may be impaired in Smith Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. White Amur have been stocked to control the growth of aquatic vegetation. Iowa Conservation Commission personnel consider lake usage to be above its potential.

Estimated aquatic plant coverage 9 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

## LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will

help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SPRING LAKE

LOCATION
County: Greene            Latitude  42 Deg  4 Min N
                          Longitude 94 Deg 17 Min W
Township 84 N      Range 30 W      Section 25

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
146. hectares ( 361. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 15 | 97. | 66.7 |
| 17 | 49. | 33.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 0.0 | 0.0 | 100.0 | 0.0 | 0.0 |

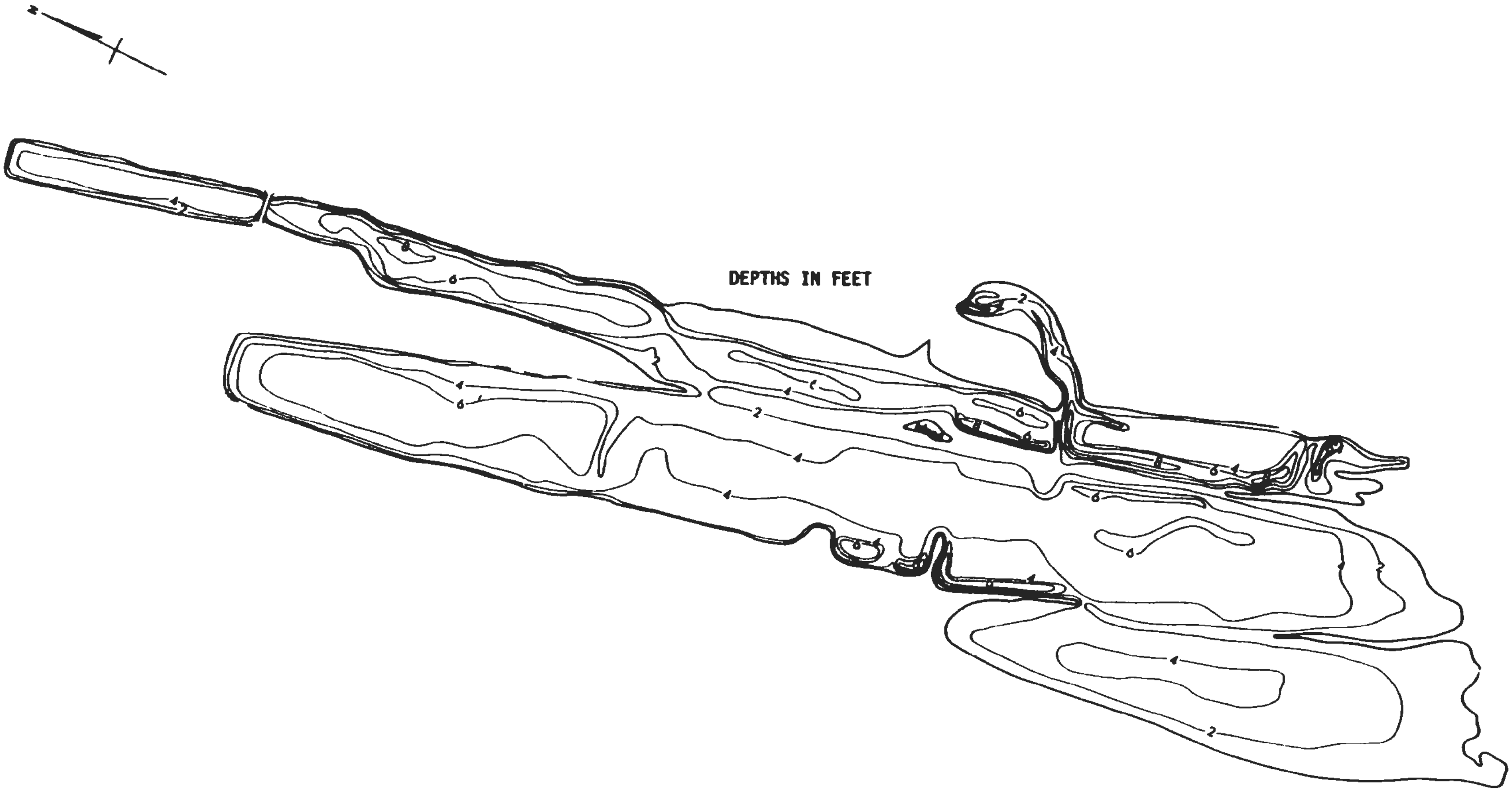
Description of topography and soils in soil associations represented in the watershed

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

17 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Canisteo, Nicollet, Webster, Lester, and Storden soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1977 map
Area 20. ha ( 51. A)
Length of shoreline 4296. m ( 14095. ft)
Maximum depth 2.3 m ( 7.0 ft)
Mean depth 0.9 m ( 3. ft)
Volume 178766. cubic meters ( 145. acre-feet)
Shoreline development 2.68   Volume development 1.16
Watershed/lake area ratio 7.3
Origin of basin: Impoundment
Estimated annual precipitation 79. cm
Estimated annual runoff 13. cm
Estimated lake evaporation 94. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
None
Outlet: To Des Moines River




950 METERS

# SPRING LAKE
Greene County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.4 | 0.10 |
| Chlorophyll a mg/cubic meter | 9 | 5.6 | 1.25 |
| Total phosphorus mg/cubic meter | 10 | 20.4 | 0.87 |
| Kjeldahl nitrogen mg/l | 2 | 0.4 | 0.06 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.07 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 9 | 2.3 | 0.62 |
| Turbidity JTU | 11 | 1.4 | 0.14 |
| Total hardness mg/l as CaCO3 | 11 | 161.6 | 0.71 |
| Calcium hardness mg/l as CaCO3 | 13 | 74.3 | 2.77 |
| Total alkalinity mg/l as CaCO3 | 11 | 100.4 | 1.64 |
| Dissolved oxygen mg/l | 9 | 9.9 | 0.55 |
| Specific conductance micromhos/cm at 25 C | 9 | 340.0 | 10.51 |
| Sulfate mg/l | 3 | 51.3 | 0.67 |
| Chloride mg/l | 3 | 20.3 | 0.17 |
| Sodium mg/l | 2 | 9.0 | 1.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 2/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.4 | 7.8 | 23.1 | 9.5 | 6.4 |
| 1 | 25.4 | 7.9 | 22.7 | 9.5 | 18.2 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 29.
Potential nutrient input index =
area watershed in row crops/lake area = 0.0
0.% of watershed is in approved soil conservation practices.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Spring Lake State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1964. | 38.5 | 98.2 |
| Shore or ice fishing | 1564. | 30.7 | 78.2 |
| Swimming | 6186. | 121.3 | 309.3 |
| Pleasure boating | 5860. | 114.9 | 293.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 12262. | 240.4 | 613.1 |
| Snowmobiling | 243. | 4.8 | 12.1 |

| | | | |
|---|---|---|---|
| Ice skating and cross-country skiing | 695. | 13.6 | 34.8 |
| TOTAL | 28774. | 564.2 | 1438.7 |

IMPAIRMENTS

Recreational activities in Spring Lake do not appear to be impaired by poor water quality; however, aquatic vegetation may interfere with fishing and swimming. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be above its potential.

Estimated aquatic plant coverage 91 %
Artificial aeration used
Estimated winterkill frequencies: 1 year out of 3
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition,

it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SPRINGBROOK LAKE

LOCATION

County: Guthrie          Latitude  41 Deg  47 Min N
                         Longitude 94 Deg  28 Min W

Township 81 N       Range 31 W       Section 33

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
502. hectares ( 1241. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 15 | 196. | 38.9 |
| 18 | 44. | 8.8 |
| 43 | 262. | 52.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 61.1 | 20.8 | 14.7 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

18 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Calcareous soils are common. Clarion, Harps, Canisteo, Webster, and Nicollet soils.

43 Gently sloping to very steep (2-30%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Clinton soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1974 map

Area    5. ha (  14. A)

Length of shoreline    1607. m (   5273. ft)

Maximum depth  4.9 m ( 16.0 ft)

Mean depth  2.4 m (  8. ft)

Volume    131497. cubic meters (   107. acre-feet)

Shoreline development  1.94    Volume development  1.48

Watershed/lake area ratio      100.4

Origin of basin: Impoundment

Estimated annual precipitation  81. cm

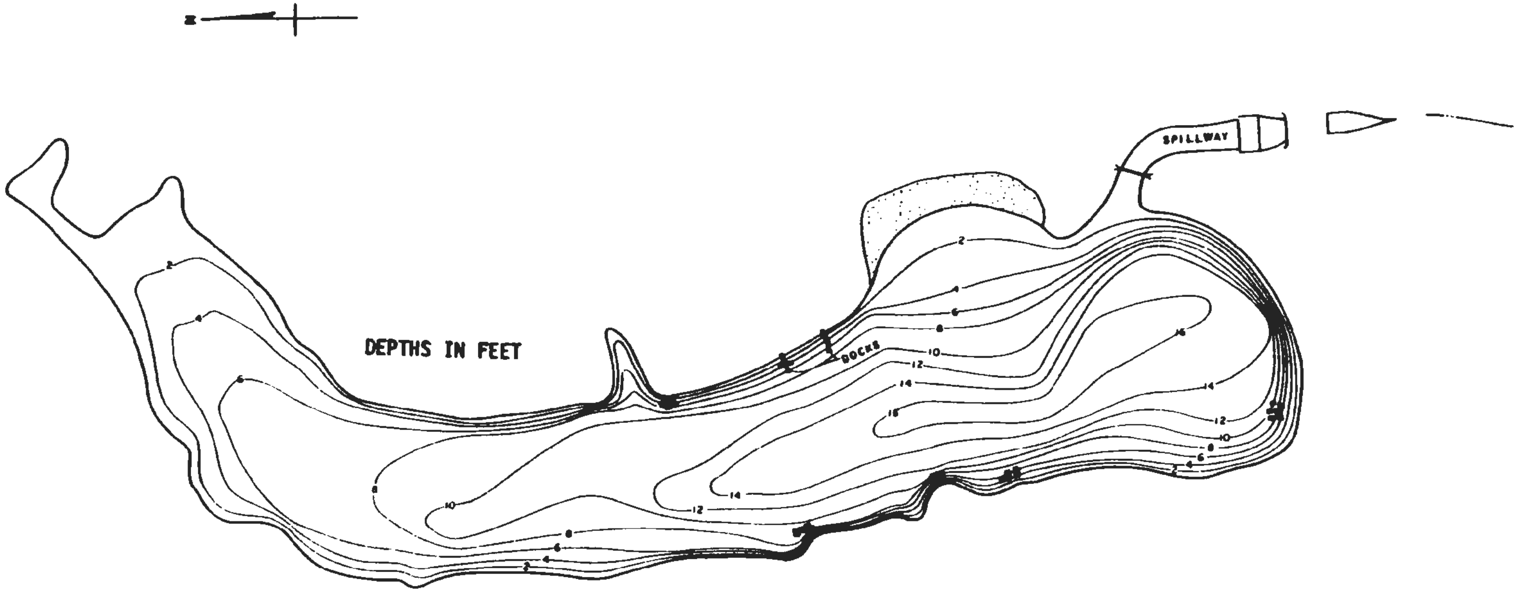
Estimated annual runoff         13. cm

Estimated lake evaporation      97. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)

Springbrook Cr




4093 METERS

# SPRINGBROOK LAKE

Guthrie County

Outlet: Springbrock Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.7 | 0.02 |
| Chlorophyll a mg/cubic meter | 6 | 52.8 | 14.50 |
| Total phosphorus mg/cubic meter | 7 | 67.2 | 6.69 |
| Kjeldahl nitrogen mg/l | 2 | 0.3 | 0.04 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.03 |
| Seston dry weight mg/l | 5 | 19.5 | 1.91 |
| Turbidity JTU | 7 | 8.9 | 0.46 |
| Total hardness mg/l as CaCO3 | 8 | 155.2 | 3.76 |
| Calcium hardness mg/l as CaCO3 | 8 | 89.2 | 6.60 |
| Total alkalinity mg/l as CaCO3 | 9 | 149.1 | 3.39 |
| Dissolved oxygen mg/l | 7 | 8.0 | 1.38 |
| Specific conductance micromhos/cm at 25 C | 7 | 307.1 | 14.43 |
| Sulfate mg/l | 3 | 2.7 | 0.44 |
| Chloride mg/l | 5 | 4.7 | 0.20 |
| Sodium mg/l | 2 | 4.0 | 0.00 |
| Potassium mg/l | 2 | 2.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/ 2/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.3 | 9.1 | 43.2 | 8.7 | 26.2 |
| 1 | 25.7 | 7.1 | 70.5 | 8.5 | 44.2 |
| 2 | 24.7 | 5.6 | 90.0 | 8.2 | 52.8 |
| 3 | 21.6 | | | | |
| 4 | 17.4 | 0.0 | 322.9 | 7.2 | 26.9 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 402.
Potential nutrient input index =
  area watershed in row crops/lake area = 61.3
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage, pastureland and pastureland improvement, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  Springbrook State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 625. | 44.6 | 125.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 5516. | 394.0 | 1103.2 |
| Swimming | 15988. | 1142.0 | 3197.6 |
| Pleasure boating | 790. | 56.4 | 158.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 5027. | 359.1 | 1005.4 |
| Snowmobiling | 382. | 27.3 | 76.4 |
| Ice skating and cross-country skiing | 625. | 44.6 | 125.0 |
| TOTAL | 28953. | 2068.1 | 5790.6 |

IMPAIRMENTS

Swimming may be impaired in Springbrook Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is

not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

STORM LAKE

LOCATION
County: Buena Vista     Latitude   42 Deg  38 Min N
                        Longitude  95 Deg  12 Min W
Township 90 N     Range 37 W     Section 10

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
5573. hectares ( 13770. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 1953. | 35.1 |
| 14 | 3619. | 64.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 92.0 | 4.6 | 0.2 | 0.0 | 3.2 |

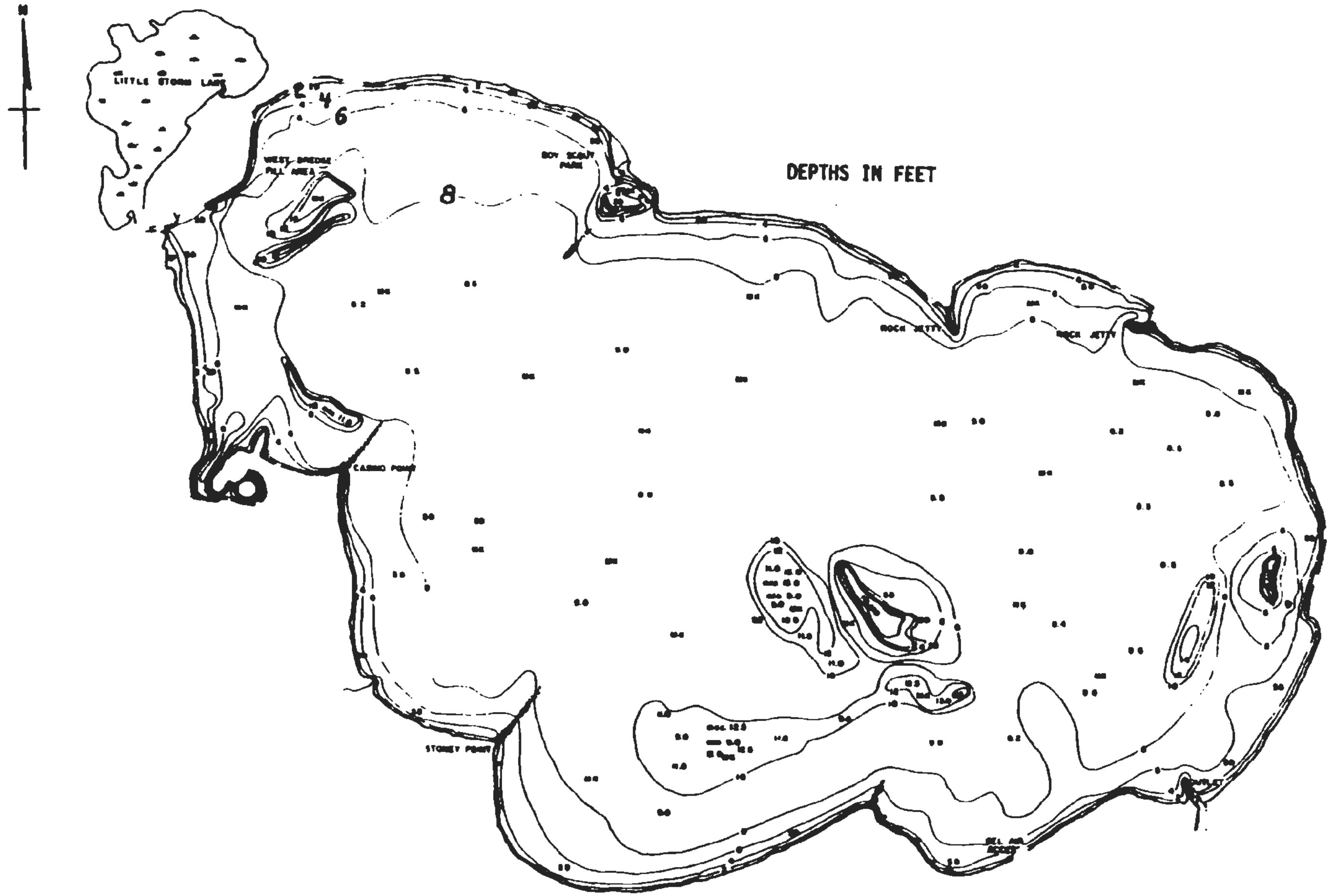
Description of topography and soils in soil associations represented in the watershed

12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

Per cent of shoreline in public ownership 31 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1971 map
Area 1254. ha (3097. A)
Length of shoreline 17114. m ( 56149. ft)
Maximum depth 4.0 m ( 13.0 ft)
Mean depth 2.4 m ( 8. ft)
Volume 30231920. cubic meters ( 24499. acre-feet)
Shoreline development 1.36    Volume development 1.83
Watershed/lake area ratio 4.4
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 94. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
Powell Cr
Outlet: Outlet Cr




12672 METERS

STORM LAKE
Beuna Vista County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.5 | 0.09 |
| Chlorophyll a mg/cubic meter | 9 | 29.6 | 6.70 |
| Total phosphorus mg/cubic meter | 9 | 73.8 | 14.05 |
| Kjeldahl nitrogen mg/l | 2 | 1.3 | 0.68 |
| Ammonia nitrogen mg/l | 2 | 0.3 | 0.09 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.3 | 0.01 |
| Seston dry weight mg/l | 9 | 27.6 | 4.13 |
| Turbidity JTU | 10 | 19.2 | 2.43 |
| Total hardness mg/l as CaCO3 | 10 | 223.6 | 4.20 |
| Calcium hardness mg/l as CaCO3 | 9 | 112.2 | 3.22 |
| Total alkalinity mg/l as CaCO3 | 10 | 128.4 | 2.73 |
| Dissolved oxygen mg/l | 8 | 8.1 | 0.86 |
| Specific conductance micromhos/cm at 25 C | 11 | 477.3 | 13.01 |
| Sulfate mg/l | 3 | 81.5 | 1.26 |
| Chloride mg/l | 3 | 41.0 | 0.00 |
| Sodium mg/l | 2 | 17.0 | 0.00 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/13/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 21.2 | 13.6 | 77.0 | 8.3 | 21.7 |
| 1 | 21.2 | 6.4 | 70.3 | 8.3 | 18.7 |
| 2 | 21.2 | 6.2 | 73.8 | 8.3 | 24.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 4.94- 6.99 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 27.
Potential nutrient input index =
area watershed in row crops/lake area = 4.1
10.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
tile drainage, conservation tillage.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| City of Storm Lake | Sewage via storm sewer due to pumping station inadequacy |
| Livestock? | No controls |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Sunset Park (City)
Starr Park (State)
Chataqua Park (City)
Circle Park (City)
Casino Marina (State)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 6732. | 2.2 | 5.4 |
| Shore or ice fishing | 28640. | 9.2 | 22.8 |
| Swimming | 1432. | 0.5 | 1.1 |
| Pleasure boating | 9335. | 3.0 | 7.4 |
| Hunting | 716. | 0.2 | 0.6 |
| Picnicking,camping,other activities prompted by the lake's presence | 82410. | 26.6 | 65.7 |
| Snowmobiling | 2777. | 0.9 | 2.2 |
| Ice skating and cross-country skiing | 3908. | 1.3 | 3.1 |
| TOTAL | 135950. | 43.9 | 108.4 |

Special events at Storm Lake contributing to more than normal use include July 4th fireworks (3000 people).

IMPAIRMENTS

Swimming may be impaired in Storm Lake throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel state that pollution from the Storm Lake sewer system may enter the lake. I.C.C. personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: 1 year out of 10
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Water quality in Storm Lake may be impaired by various urban inputs. Approximately 50% of the storm water runoff for the city of Storm Lake enters the lake. Roadway dirt, deicing salt, organic matter, and nutrients may be introduced into the lake by this urban runoff. Raw sewage does enter the lake via storm sewers during periods of heavy rainfall because of pumping station inadequacy. In addition to the increased nutrient and organic matter loading to the lake, the potential danger of bacterial contamination to lake users is increased. The replacement of inadequate sanitary sewer equipment and diversion of all storm sewers away from the lake are recommended.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

SWAN LAKE

LOCATION
County: Carroll    Latitude 42 Deg 2 Min N
Longitude 94 Deg 51 Min W
Township 84 N    Range 34 W    Section 31

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
277. hectares ( 685. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 11 | 2. | 0.8 |
| 17 | 93. | 33.4 |
| 26 | 182. | 65.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 87.6 | 8.8 | 0.6 | 0.0 | 3.0 |

Description of topography and soils in soil associations represented in the watershed

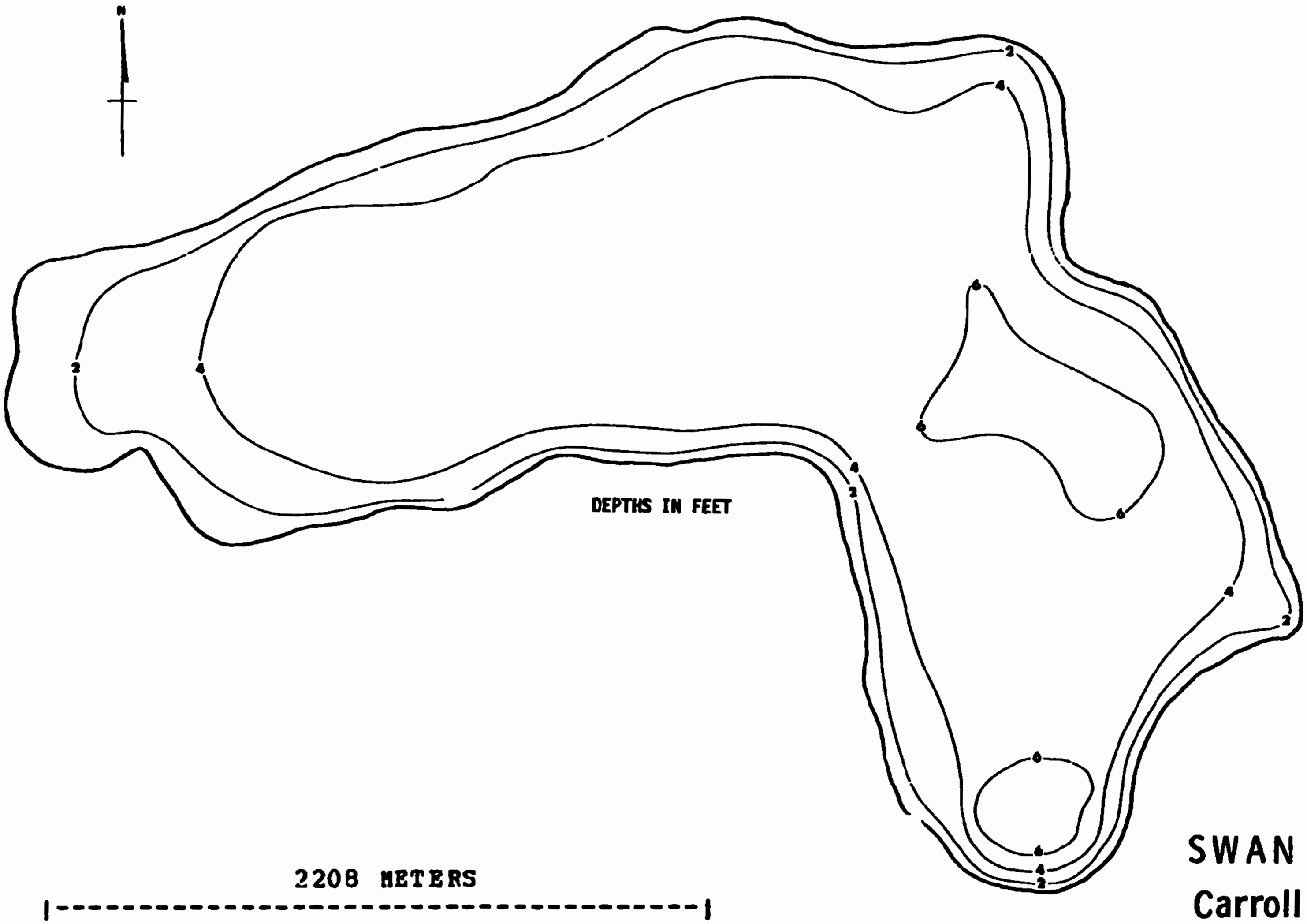
11 Nearly level and gently sloping (0-5%) prairie-derived upland and terrace soils developed from alluvium. Wadena, Talcot, Flagler, and Saude soils.

17 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Canisteo, Nicollet, Webster, Lester, and Storden soils.

26 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess. Marshall soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1952 map
Area 54. ha ( 134. A)
Length of shoreline 3696. m ( 12126. ft)
Maximum depth 1.8 m ( 6.0 ft)
Mean depth 1.3 m ( 4. ft)
Volume 689311. cubic meters ( 559. acre-feet)
Shoreline development 1.42    Volume development 2.08
Watershed/lake area ratio 5.1
Origin of basin: Impoundment
Estimated annual precipitation 76. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 97. cm
Thermal stratification? Partial
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed




SWAN LAKE
Carroll County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.00 |
| Chlorophyll a mg/cubic meter | 11 | 47.2 | 4.90 |
| Total phosphorus mg/cubic meter | 9 | 204.6 | 15.51 |
| Kjeldahl nitrogen mg/l | 2 | 0.9 | 0.17 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.06 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 10 | 19.6 | 1.14 |
| Turbidity JTU | 10 | 10.7 | 1.12 |
| Total hardness mg/l as CaCO3 | 10 | 176.0 | 1.37 |
| Calcium hardness mg/l as CaCO3 | 9 | 102.0 | 3.42 |
| Total alkalinity mg/l as CaCO3 | 9 | 150.9 | 1.01 |
| Dissolved oxygen mg/l | 9 | 6.5 | 0.62 |
| Specific conductance micromhos/cm at 25 C | 10 | 394.0 | 8.52 |
| Sulfate mg/l | 3 | 18.2 | 0.73 |
| Chloride mg/l | 3 | 24.3 | 0.17 |
| Sodium mg/l | 2 | 14.0 | 2.00 |
| Potassium mg/l | 2 | 6.5 | 1.50 |

Vertical profile for selected measurements on the sampling date ( 8/ 2/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.0 | 6.8 | 195.4 | 8.5 | 65.1 |
| 1 | 25.0 | 6.6 | 190.8 | 8.5 | 59.1 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 9.19-10.79 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 51.
Potential nutrient input index =
area watershed in row crops/lake area = 4.5
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, grass waterways, tile drainage, ponds/sediment and water control basins.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Juergen's Prod. & Feed Co. 440 animals | Runoff control Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Swan Lake State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 4862. | 36.3 | 90.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 15515. | 115.8 | 287.3 |
| Swimming | 16925. | 126.3 | 313.4 |
| Pleasure boating | 1347. | 10.1 | 24.9 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 86765. | 647.5 | 1606.8 |
| Snowmobiling | 11494. | 85.8 | 212.9 |
| Ice skating and cross-country skiing | 2383. | 17.8 | 44.1 |
| TOTAL | 139291. | 1039.5 | 2579.5 |

Special events at Swan Lake contributing to more than normal use include a Girl Scout camp (500 people) and a Boy Scout camp (200 people).

## IMPAIRMENTS

Swimming may be impaired in Swan Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills and summerkills may limit fishing potential. Iowa Conservation Commission personnel state that an algal herbicide is applied to control the algal growth. I.C.C. personnel consider lake usage to be below its potential due to frequent fish kills.

Estimated aquatic plant coverage 0 %
Estimated winterkill frequencies: 1 year out of 2
Estimated summerkill frequencies: 1 year out of 5

## LAKE RESTORATION RECOMMENDATIONS

The shallowness of this lake contributes significantly to its water quality problems. Because there is relatively little dilution of nutrient inputs, nutrient concentrations are relatively high leading to high algal concentrations and poor water transparency. The shallowness also facilitates wind resuspension of bottom sediments causing greater internal nutrient loading. The resulting high biological productivity leads to a high oxygen demand. The shallowness of the lake results in a small capacity to hold dissolved oxygen, thus low oxygen concentrations develop causing winter fishkills. Deepening of the water column through dredging and or raised water levels should help to solve the problem. As an alternative, the symptoms of the problem could be alleviated by artificial aeration in the winter to prevent the oxygen concentrations from declining to lethal levels. The first procedure would provide the greatest improvements to the lake; however, the second procedure would also have significant benefits.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

THAYER LAKE

LOCATION
County: Union Latitude 41 Deg 1 Min N
Longitude 94 Deg 4 Min W
Township 72 N Range 28 W Section 22

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
209. hectares ( 516. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 37 | 182. | 87.0 |
| 38 | 27. | 13.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 48.6 | 35.3 | 12.3 | 0.0 | 3.9 |

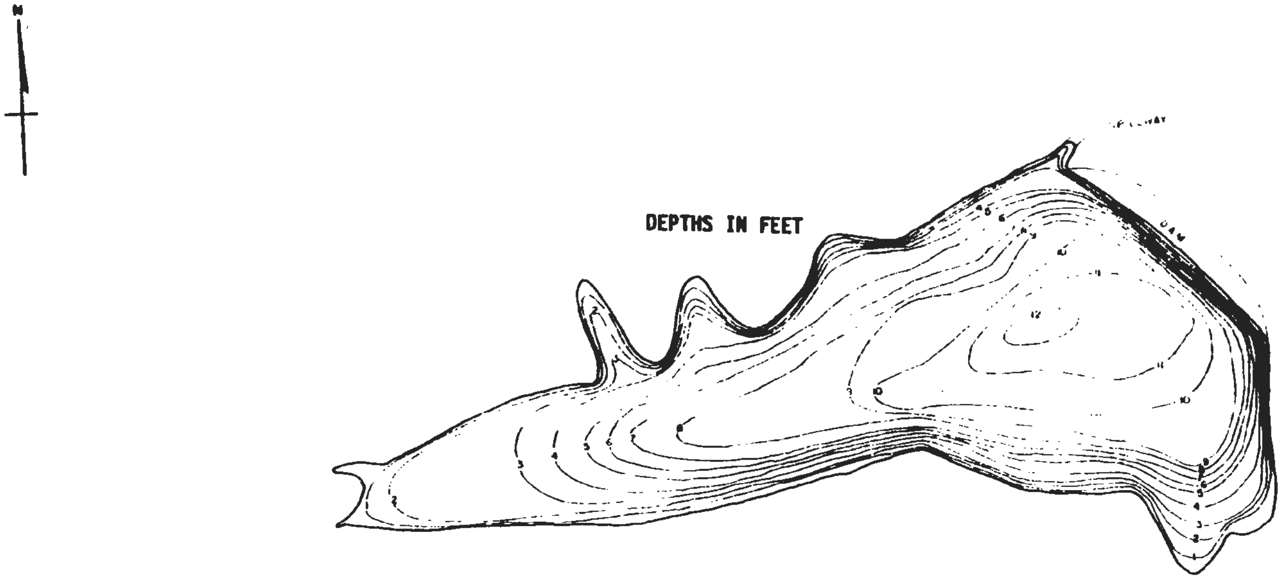
Description of topography and soils in soil associations represented in the watershed

37 Gently sloping to moderately steep (2-18%) prairie and forest-derived soils developed from pre-Wisconsin till-derived paleosols, pre-Wisconsin till, or loess. Adair, Shelby, Lindley, and Grundy soils.

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1972 map
Area 6. ha ( 14. A)
Length of shoreline 1442. m ( 4731. ft)
Maximum depth 3.7 m ( 12.0 ft)
Mean depth 1.9 m ( 6. ft)
Volume 110840. cubic meters ( 90. acre-feet)
Shoreline development 1.70 Volume development 1.59
Watershed/lake area ratio 34.8
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 97. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




3515 METERS

THAYER LAKE

Union County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.9 | 0.02 |
| Chlorophyll a mg/cubic meter | 9 | 21.7 | 4.15 |
| Total phosphorus mg/cubic meter | 8 | 61.7 | 7.82 |
| Kjeldahl nitrogen mg/l | 2 | 0.7 | 0.03 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.08 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.02 |
| Seston dry weight mg/l | 8 | 6.7 | 0.92 |
| Turbidity JTU | 8 | 6.0 | 0.66 |
| Total hardness mg/l as CaCO3 | 6 | 93.7 | 2.89 |
| Calcium hardness mg/l as CaCO3 | 7 | 62.0 | 2.83 |
| Total alkalinity mg/l as CaCO3 | 8 | 89.5 | 2.58 |
| Dissolved oxygen mg/l | 9 | 6.6 | 0.64 |
| Specific conductance micromhos/cm at 25 C | 7 | 250.0 | 9.94 |
| Sulfate mg/l | 2 | 2.0 | 1.00 |
| Chloride mg/l | 3 | 13.0 | 0.50 |
| Sodium mg/l | 2 | 10.0 | 0.00 |
| Potassium mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 8/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 29.2 | 6.3 | 63.2 | 8.4 | 10.9 |
| 1 | 29.2 | 6.1 | 56.0 | 8.4 | 14.0 |
| 2 | 24.8 | 0.7 | 112.2 | 7.8 | 92.4 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 439.
Potential nutrient input index =
area watershed in row crops/lake area = 16.9
50.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, pastureland and pastureland improvement, contouring, terraces, ponds/sediment and water control basins, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Thayer Pond (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 421. | 30.1 | 70.2 |
| Shore or ice fishing | 3609. | 257.8 | 601.5 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 247. | 17.6 | 41.2 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 1914. | 136.7 | 319.0 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 69. | 4.9 | 11.5 |
| TOTAL | 6260. | 447.1 | 1043.3 |

IMPAIRMENTS

Water clarity is poor in Thayer Lake during part of the summer as indicated by Secchi depths less than one meter caused by algal populations and other suspended matter. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to poor fishing and the low population density of people living in the area.

Estimated aquatic plant coverage 25 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can

make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

TRUMBULL LAKE

LOCATION
County: Clay Latitude 43 Deg 11 Min N
Longitude 94 Deg 57 Min W
Township 97 N Range 35 W Section 26

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
18197. hectares ( 44965. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 12 | 6852. | 37.7 |
| 14 | 8227. | 45.2 |
| 15 | 3118. | 17.1 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 90.2 | 5.8 | 0.4 | 0.2 | 3.3 |

Description of topography and soils in soil associations represented in the watershed

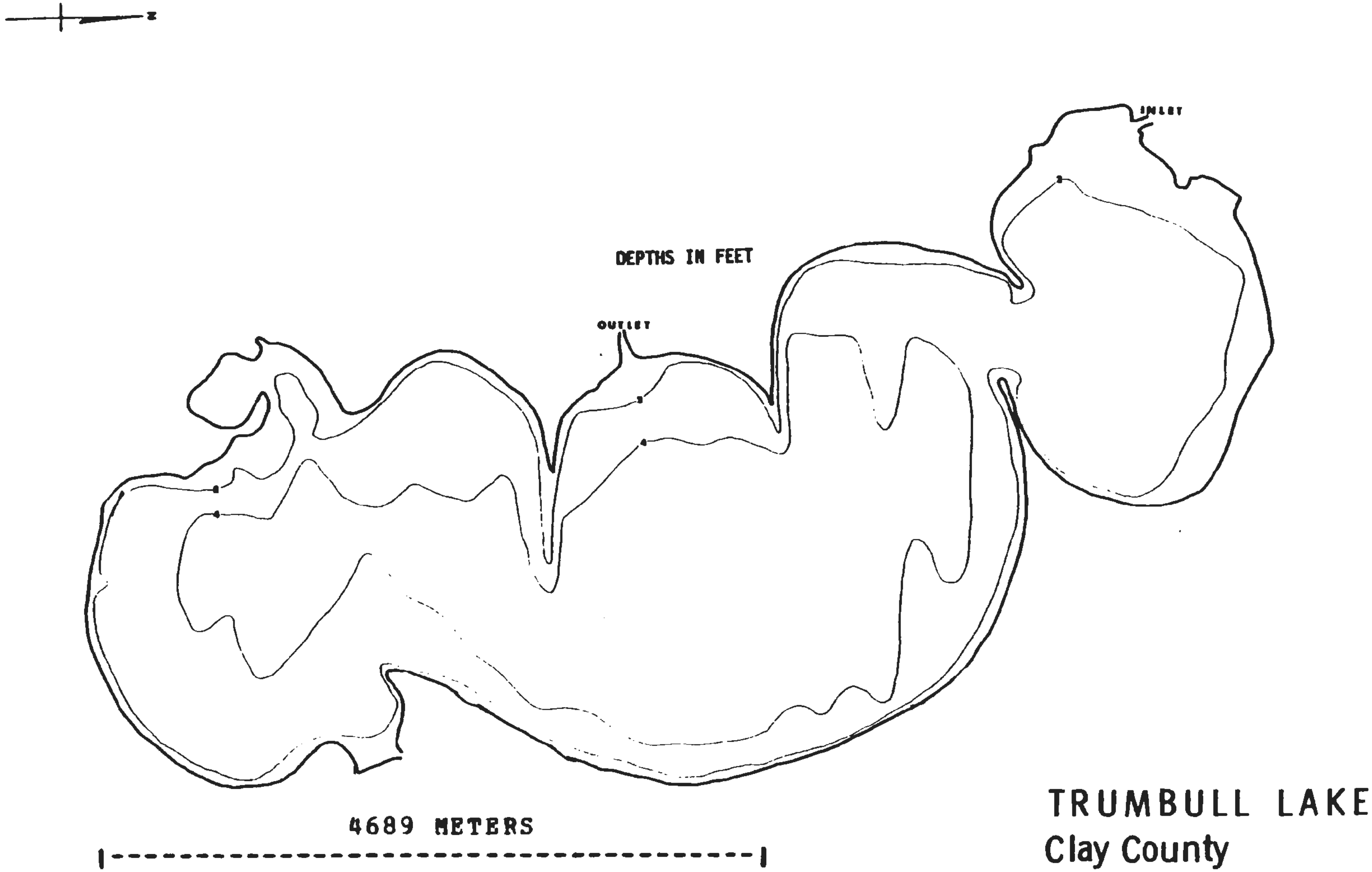
12 Nearly level and gently sloping (0-5%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Depressional and calcareous soils are common. Webster, Okoboji, Canisteo, Clarion, Nicollet, and Harps soils.

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 34 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 479. ha (1183. A)
Length of shoreline 11508. m ( 37756. ft)
Maximum depth 1.2 m ( 4.0 ft)
Mean depth 0.9 m ( 3. ft)
Volume 4411491. cubic meters ( 3575. acre-feet)
Shoreline development 1.48 Volume development 2.27
Watershed/lake area ratio 38.0
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? No




TRUMBULL LAKE
Clay County

Major inflows (named and/or permanent streams)
Drainage Ditch 61
Outlet: Pickerel Run
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.3 | 0.05 |
| Chlorophyll a mg/cubic meter | 11 | 131.3 | 16.23 |
| Total phosphorus mg/cubic meter | 10 | 130.1 | 14.42 |
| Kjeldahl nitrogen mg/l | 2 | 1.2 | 0.25 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 2.3 | 0.12 |
| Seston dry weight mg/l | 10 | 56.6 | 7.45 |
| Turbidity JTU | 10 | 19.1 | 2.15 |
| Total hardness mg/l as CaCO3 | 9 | 209.1 | 13.32 |
| Calcium hardness mg/l as CaCO3 | 9 | 110.0 | 11.51 |
| Total alkalinity mg/l as CaCO3 | 10 | 155.7 | 12.75 |
| Dissolved oxygen mg/l | 8 | 11.6 | 0.67 |
| Specific conductance micromhos/cm at 25 C | 10 | 387.5 | 17.32 |
| Sulfate mg/l | 3 | 28.0 | 1.00 |
| Chloride mg/l | 3 | 24.0 | 0.00 |
| Sodium mg/l | 3 | 6.7 | 0.33 |
| Potassium mg/l | 3 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 19.4 | 10.0 | 205.6 | 8.7 | 149.7 |
| 1 | 19.4 | 10.1 | 199.0 | 8.8 | 149.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 152.
Potential nutrient input index =
  area watershed in row crops/lake area = 34.3
60.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, crop rotation, contouring, pastureland and pastureland improvement, grass waterways, tile drainage, terraces.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Terrill<br>IA0036609 | 2-cell lagoon; 4.12 acres |
| 480 hogs | Storage tank |
| 500 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  Smith Slough Wildlife Area (State)
  Trumbull Lake Wildlife Area (State)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 282. | 0.2 | 0.6 |
| Shore or ice fishing | 2974. | 2.5 | 6.2 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 87. | 0.1 | 0.2 |
| Hunting | 1814. | 1.5 | 3.8 |
| Picnicking,camping,other activities prompted by the lake's presence | 2301. | 1.9 | 4.8 |
| Snowmobiling | 955. | 0.8 | 2.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 8413. | 7.1 | 17.6 |

IMPAIRMENTS

Water clarity is poor in Trumbull Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Occasional winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 32 %
Estimated winterkill frequencies: 1 year out of 7-10
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

TUTTLE LAKE

LOCATION

County: Emmet  Latitude 43 Deg 30 Min N
Martin, MN  Longitude 94 Deg 35 Min W
Township 100 N  Range 32 W  Section 2

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
44441. hectares (109814. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 1MN | 3534. | 8.0 |
| 2MN | 13284. | 29.9 |
| 4MN | 22340. | 50.3 |
| 10MN | 5283. | 11.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 89.3 | 6.9 | 0.6 | 0.0 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

1MN Nearly level (0-2%) loamy soils that are poorly drained and formed in glacial till. Canisteo, Glencoe, Harps soils.

2MN Nearly level (0-3%), poorly drained to moderately drained, dominantly loamy soils that are on lowland flats and on slight rises. Canisteo, Nicollet, Webster soils.

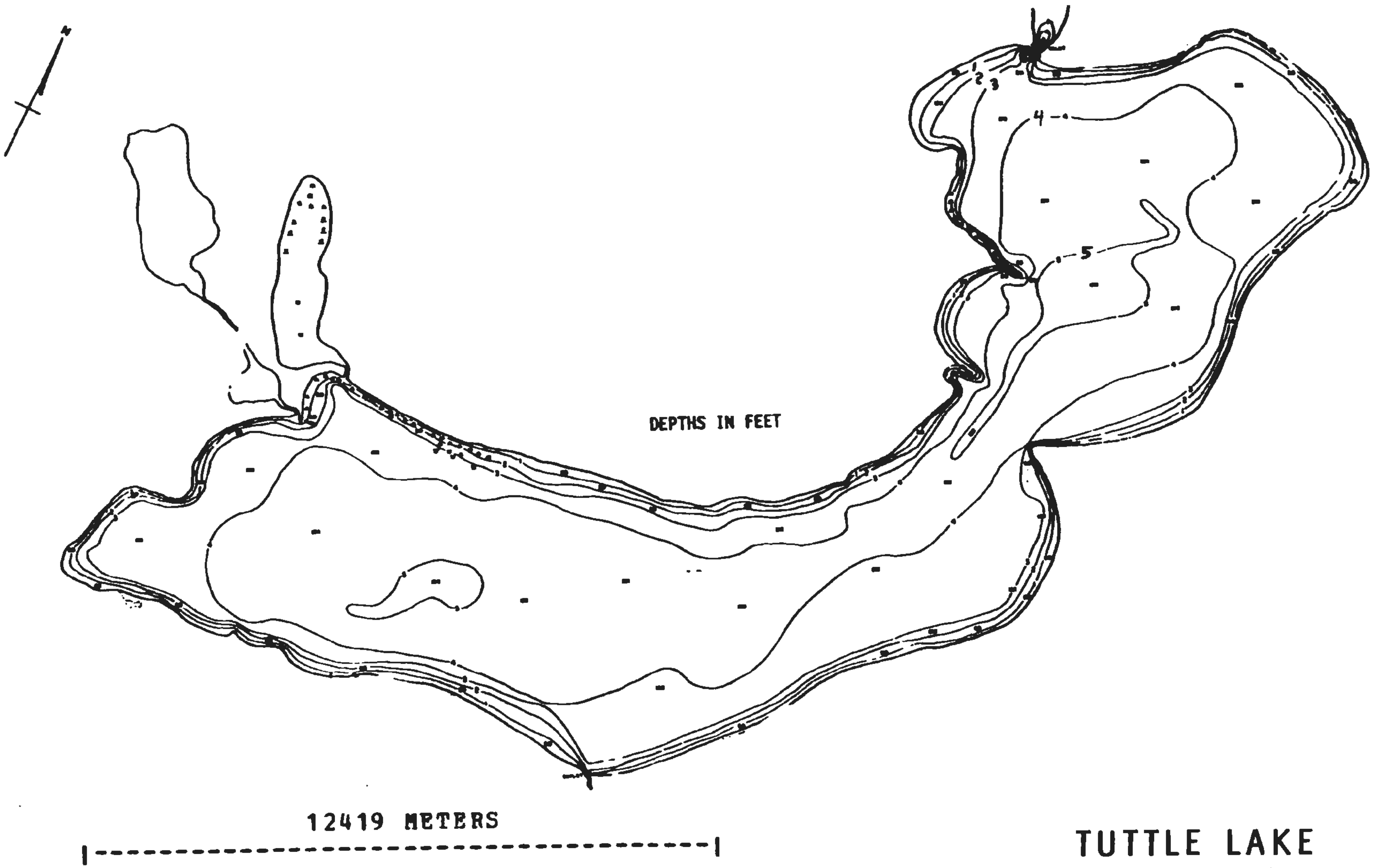
4MN Nearly level to rolling (0-12%), poorly drained and well drained, dominantly loamy soils that are on lowland flats and uplands of glacial till plains. Canisteo, Clarion soils.

10MN Nearly level to very steep (0-50%), poorly drained to well drained, dominantly loamy soils on floodplains, terraces and adjacent steeper slopes. The Coland soils will flood. Coland, Wadena, Swanlake soils.

Per cent of shoreline in public ownership 31 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map
Area 955. ha (2360. A)
Length of shoreline 19407. m ( 63672. ft)
Maximum depth 1.8 m ( 6.0 ft)
Mean depth 1.1 m ( 4. ft)
Volume 10496990. cubic meters ( 8507. acre-feet)
Shoreline development 1.77  Volume development 1.80
Watershed/lake area ratio 46.5




TUTTLE LAKE
Emmet County

Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 10. cm
Estimated lake evaporation 86. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
The Inlet
Outlet: East Br. Des Moines River
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.4 | 0.05 |
| Chlorophyll a mg/cubic meter | 9 | 62.8 | 12.09 |
| Total phosphorus mg/cubic meter | 10 | 196.0 | 20.92 |
| Kjeldahl nitrogen mg/l | 2 | 1.0 | 0.00 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.08 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 9 | 25.9 | 1.07 |
| Turbidity JTU | 10 | 19.3 | 2.82 |
| Total hardness mg/l as CaCO3 | 10 | 280.6 | 16.44 |
| Calcium hardness mg/l as CaCO3 | 9 | 185.8 | 13.36 |
| Total alkalinity mg/l as CaCO3 | 10 | 180.3 | 4.32 |
| Dissolved oxygen mg/l | 8 | 9.3 | 0.86 |
| Specific conductance micromhos/cm at 25 C | 9 | 497.8 | 38.07 |
| Sulfate mg/l | 3 | 55.8 | 0.88 |
| Chloride mg/l | 3 | 22.3 | 0.17 |
| Sodium mg/l | 2 | 5.5 | 0.50 |
| Potassium mg/l | 2 | 4.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 19.5 | 9.1 | 213.2 | 8.5 | 92.8 |
| 1 | 19.4 | 8.9 | 218.7 | 8.4 | 93.6 |
| 2 | 19.0 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 377.
Potential nutrient input index =
area watershed in row crops/lake area = 41.6
29.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Okamanpedan State Park
Tuttle Lake County Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 860. | 0.4 | 0.9 |
| Shore or ice fishing | 4717. | 2.0 | 4.9 |
| Swimming | 860. | 0.4 | 0.9 |
| Pleasure boating | 2163. | 0.9 | 2.3 |
| Hunting | 1823. | 0.8 | 1.9 |

| | | | |
|---|---|---|---|
| Picnicking,camping,other activities prompted by the lake's presence | 16592. | 7.0 | 17.4 |
| Snowmobiling | 6355. | 2.7 | 6.7 |
| Ice skating and cross-country skiing | 504. | 0.2 | 0.5 |
| TOTAL | 33874. | 14.4 | 35.5 |

IMPAIRMENTS

Swimming may be impaired in Tuttle Lake throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Aquatic vascular plant growth may impair boating and shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be below its potential due to winterkill problems.

Estimated aquatic plant coverage 18 %
Estimated winterkill frequencies: 1 year out of 5-7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see

section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

UNICN GROVE LAKE

LOCATION
County: Tama	Latitude 42 Deg 8 Min N
Longitude 92 Deg 43 Min W
Township 85 N	Range 16 W	Section 33

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
2687. hectares ( 6640. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 77 | 488. | 18.1 |
| 78 | 2199. | 81.9 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 90.4 | 6.1 | 0.7 | 0.0 | 2.8 |

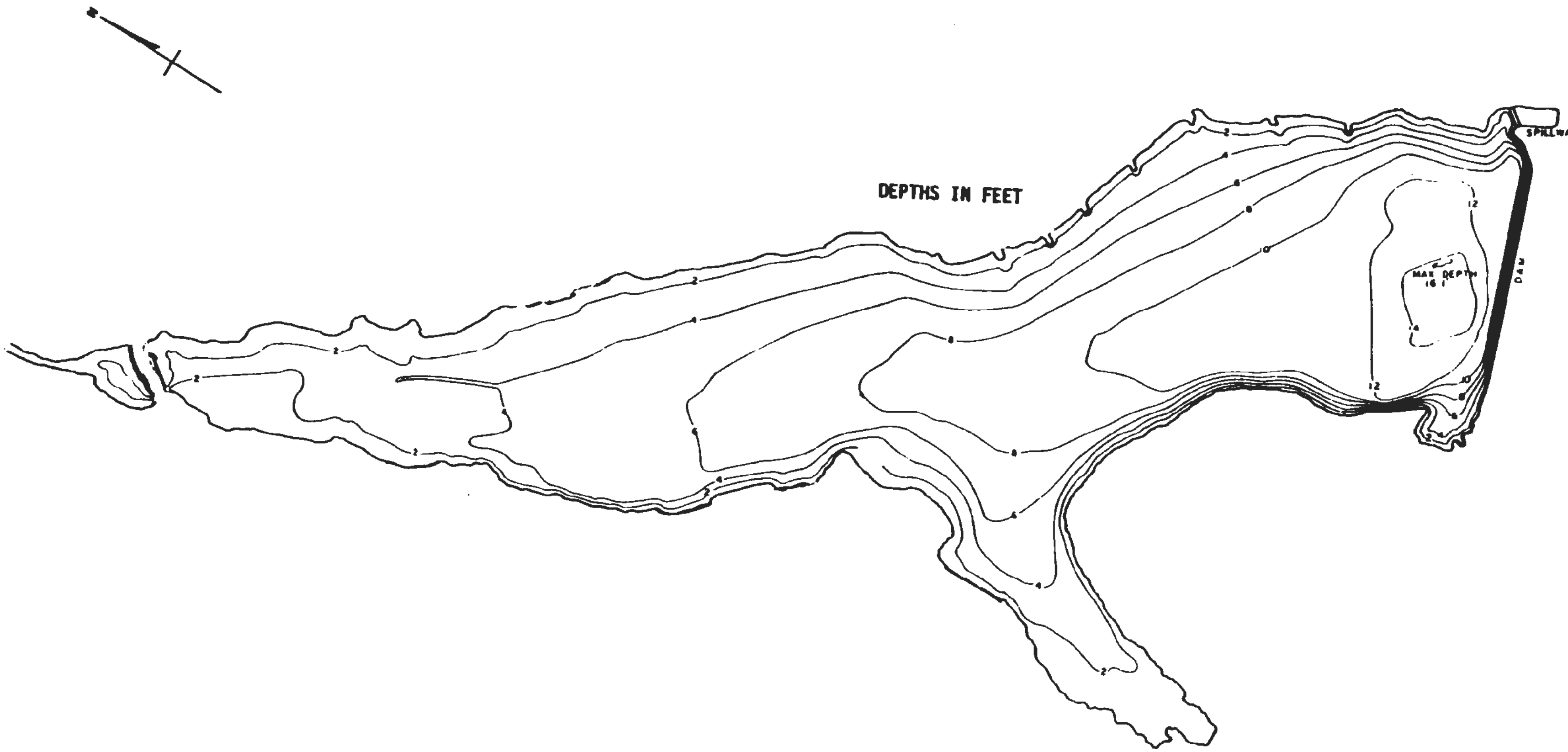
Description of topography and soils in soil associations represented in the watershed

77 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, loess over pre-Wisconsin till or pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, and Kenyon soils.

78 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, Muscatine, and Garwin soils.

Per cent of shoreline in public ownership 68 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1970 map
Area 48. ha ( 118. A)
Length of shoreline 5826. m ( 19115. ft)
Maximum depth 4.9 m ( 16.0 ft)
Mean depth 1.8 m ( 6. ft)
Volume 862597. cubic meters ( 699. acre-feet)
Shoreline development 2.38 Volume development 1.11
Watershed/lake area ratio 56.0
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Deer Cr
Outlet: Deer Cr




12292 METERS

# UNION GROVE LAKE
Tama County

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.5 | 0.09 |
| Chlorophyll a mg/cubic meter | 8 | 108.6 | 17.10 |
| Total phosphorus mg/cubic meter | 9 | 118.6 | 6.01 |
| Kjeldahl nitrogen mg/l | 2 | 1.0 | 0.09 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.6 | 0.01 |
| Seston dry weight mg/l | 10 | 20.3 | 2.08 |
| Turbidity JTU | 11 | 14.9 | 1.58 |
| Total hardness mg/l as $CaCO_3$ | 10 | 147.4 | 4.10 |
| Calcium hardness mg/l as $CaCO_3$ | 9 | 68.7 | 2.16 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 116.9 | 1.57 |
| Dissolved oxygen mg/l | 10 | 9.4 | 1.82 |
| Specific conductance micromhos/cm at 25 C | 10 | 300.0 | 14.12 |
| Sulfate mg/l | 3 | 21.5 | 1.44 |
| Chloride mg/l | 4 | 12.6 | 0.13 |
| Sodium mg/l | 2 | 4.5 | 0.50 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/11/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 24.5 | 17.3 | 114.8 | 9.1 | 202.1 |
| 1 | 22.7 | 17.1 | 134.1 | 9.1 | 137.7 |
| 2 | 22.3 | 15.3 | 115.5 | 9.0 | 162.4 |
| 3 | 21.8 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 453.
Potential nutrient input index =
area watershed in row crops/lake area = 50.6
57.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, terraces, grass waterways, pastureland and pastureland improvement, contouring.

POINT SOURCE POLLUTION

| Source/NPDES # (if any) | Comments |
|---|---|
| 600 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Union Grove State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 17481. | 148.1 | 364.2 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 38874. | 329.4 | 809.9 |
| Swimming | 19317. | 163.7 | 402.4 |
| Pleasure boating | 5559. | 47.1 | 115.8 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 59673. | 505.7 | 1243.2 |
| Snowmobiling | 6080. | 51.5 | 126.7 |
| Ice skating and cross-country skiing | 1563. | 13.2 | 32.6 |
| TOTAL | 148547. | 1258.9 | 3094.7 |

IMPAIRMENTS

Swimming may be impaired in Union Grove Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: 1 year out of 7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because localized quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is suggsted. While this might be accomplished through the use of chemicals or a White Amur stocking program, the aquatic weed density is relatively small and localized close to shore. Mechanical removal may be the most practical control method; however the cost-effectiveness and suitability of this method should be investigated for this lake.

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this

reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

UPPER GAR LAKE

LOCATION
County: Dickinson    Latitude 43 Deg 22 Min N
Longitude 95 Deg 7 Min W
Township 99 N    Range 36 W    Section 29

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
179. hectares ( 442. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 15 | 179. | 100.0 |

Estimated land uses (%)

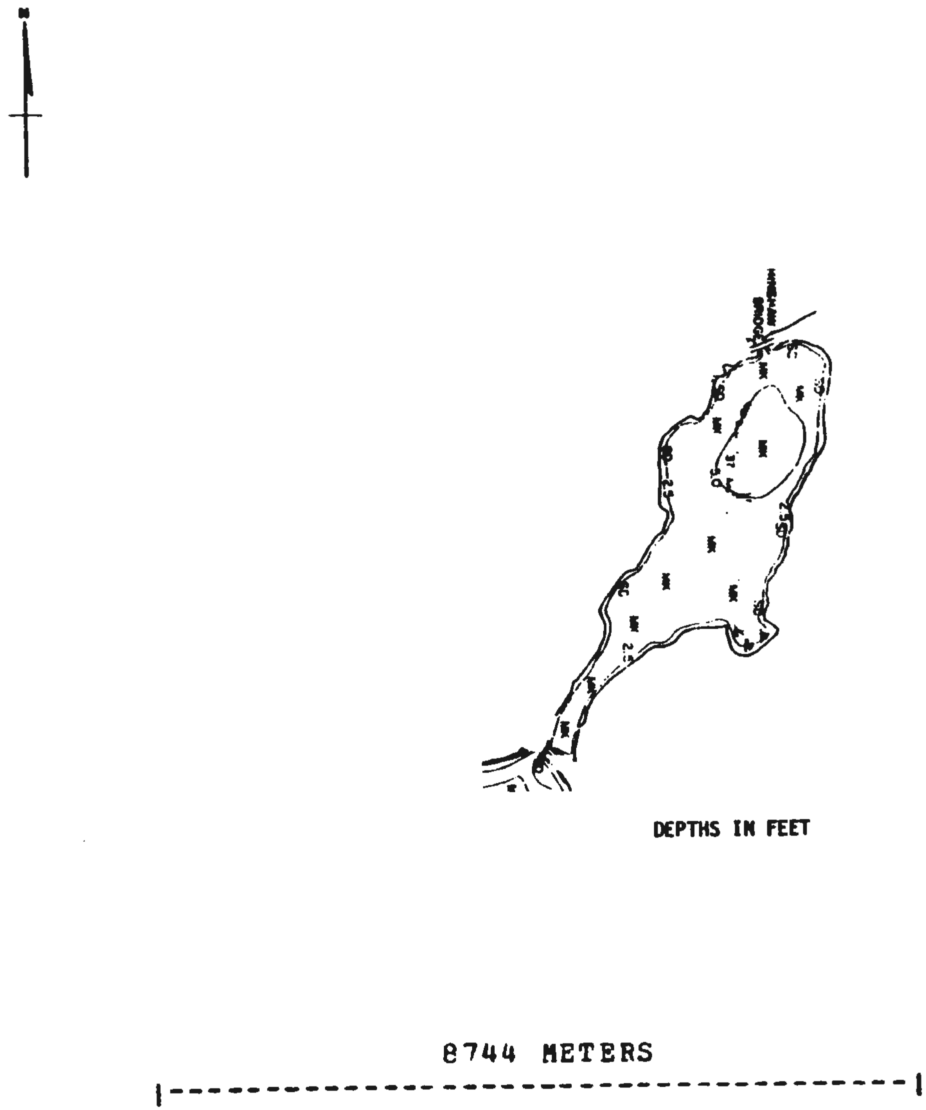
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 73.5 | 12.2 | 1.5 | 8.9 | 3.8 |

Description of topography and soils in soil associations represented in the watershed

15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

Per cent of shoreline in public ownership 9 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1970 map
Area 14. ha ( 36. A)
Length of shoreline 2101. m ( 6892. ft)
Maximum depth 1.5 m ( 5.0 ft)
Mean depth 1.1 m ( 4. ft)
Volume 153968. cubic meters ( 125. acre-feet)
Shoreline development 1.56    Volume development 2.10
Watershed/lake area ratio 12.8
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? No
Major inflows (named and/or permanent streams)
From E. Okoboji
Outlet: To Minnewashta L
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




UPPER GAR LAKE
Dickinson County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.5 | 0.09 |
| Chlorophyll a mg/cubic meter | 9 | 89.5 | 27.24 |
| Total phosphorus mg/cubic meter | 10 | 136.6 | 6.89 |
| Kjeldahl nitrogen mg/l | 2 | 1.0 | 0.27 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.6 | 0.01 |
| Seston dry weight mg/l | 10 | 23.6 | 2.29 |
| Turbidity JTU | 11 | 12.8 | 0.87 |
| Total hardness mg/l as CaCO3 | 9 | 221.3 | 1.45 |
| Calcium hardness mg/l as CaCO3 | 9 | 100.7 | 3.74 |
| Total alkalinity mg/l as CaCO3 | 9 | 197.8 | 0.52 |
| Dissolved oxygen mg/l | 8 | 7.6 | 0.20 |
| Specific conductance micromhos/cm at 25 C | 9 | 414.4 | 4.45 |
| Sulfate mg/l | 3 | 28.5 | 0.01 |
| Chloride mg/l | 4 | 14.6 | 0.13 |
| Sodium mg/l | 2 | 10.0 | 0.00 |
| Potassium mg/l | 2 | 7.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 20.0 | 7.0 | 134.5 | 8.4 | 64.6 |
| 1 | 20.0 | 7.1 | 140.3 | 8.4 | 66.7 |
| 2 | 20.3 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
 Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
 (watershed area/lake area) x soil loss rate = 51.
Potential nutrient input index =
 area watershed in row crops/lake area = 9.4
 32.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
 Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
 This lake has also been designated as high quality water and is thus subject to higher standards to protect existing uses.
This lake is not designated as a public water supply.

Public parks:
 Minnewashta Access

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 812. | 22.6 | 58.0 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 1559. | 43.3 | 111.4 |
| Swimming | 743. | 20.6 | 53.1 |
| Pleasure boating | 1963. | 54.5 | 140.2 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 1885. | 52.4 | 134.6 |
| Snowmobiling | 6943. | 192.9 | 495.9 |
| Ice skating and cross-country skiing | 608. | 16.9 | 43.4 |
| TOTAL | 14513. | 403.1 | 1036.6 |

IMPAIRMENTS

Swimming may be impaired in Upper Gar Lake throughout the summer because of Secchi depths less than one meter caused by algal populations and other suspended matter. Frequent winterkills and summerkills may limit fishing potential. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 12 %
Estimated winterkill frequencies: 1 year out of 3-5
Estimated summerkill frequencies: 1 year out of 5-7

LAKE RESTORATION RECOMMENDATIONS

Because this lake is productive and relatively shallow, dissolved oxygen deficits develop and cause winter and/or summer fishkills. The use of artificial aeration devices to maintain dissolved oxygen concentrations should be considered.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion

terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

UPPER PINE LAKE

LOCATION
County: Hardin          Latitude 42 Deg 23 Min N
                        Longitude 93 Deg 4 Min W
Township 87 N     Range 19 W     Section 4

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
3364. hectares ( 8312. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 57 | 626. | 18.6 |
| 59 | 613. | 18.2 |
| 78 | 2125. | 63.2 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 85.6 | 8.9 | 2.7 | 0.0 | 2.8 |

Description of topography and soils in soil associations represented in the watershed

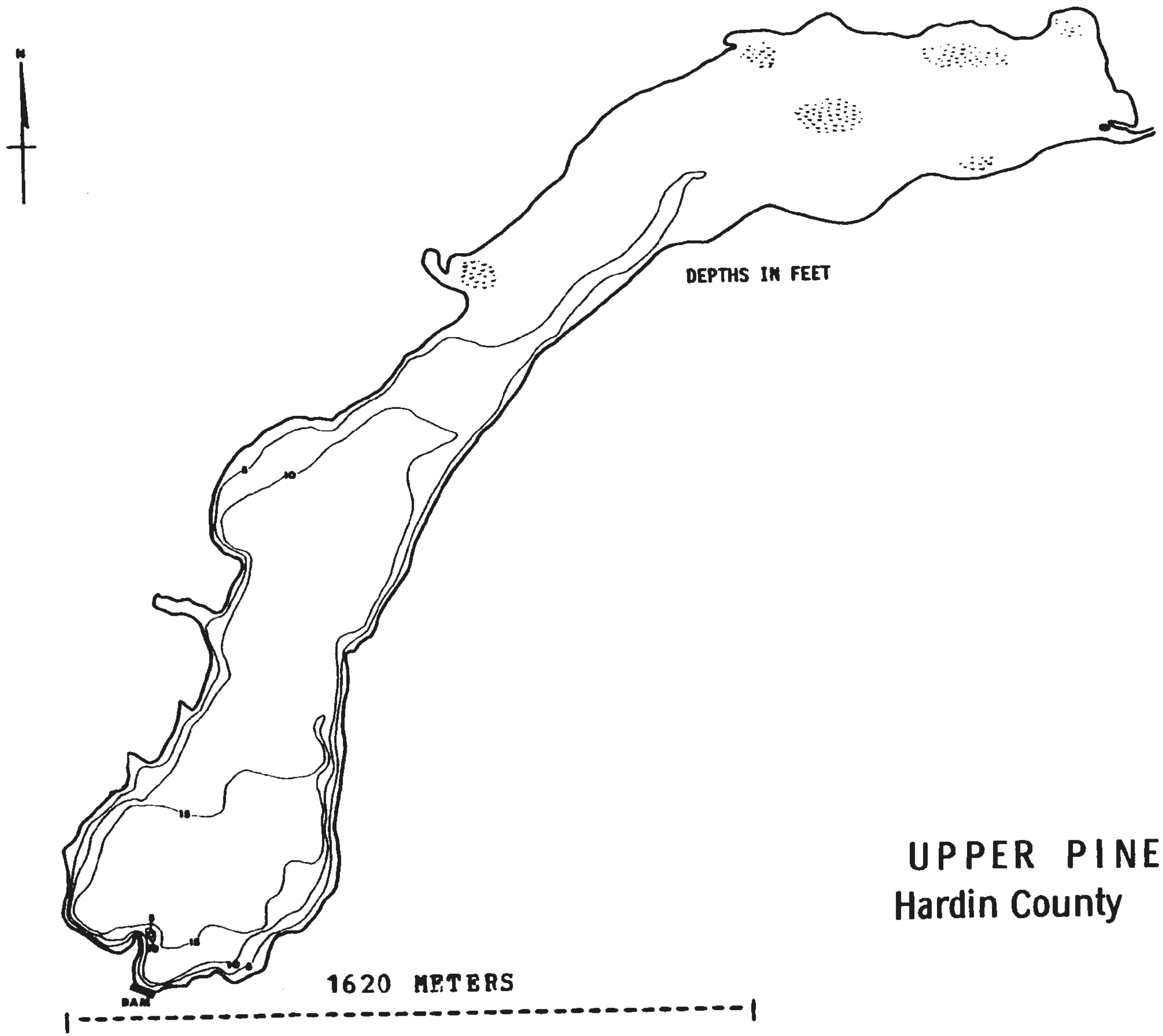
57 Gently sloping to steep (2-25%) forest-derived soils developed from loess or pre-Wisconsin till. Fayette and Lindley soils.

59 Gently to moderately sloping (2-9%) prairie or mixed prairie-forest-derived soils developed from loess or loess over pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, and Downs soils.

78 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or loess over pre-Wisconsin till on the Iowan Erosion Surface. Tama, Dinsdale, Muscatine, and Garwin soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1976 map
Area 28. ha ( 69. A)
Length of shoreline 4131. m ( 13555. ft)
Maximum depth 4.9 m ( 16.0 ft)
Mean depth 2.2 m ( 7. ft)
Volume 605427. cubic meters ( 491. acre-feet)
Shoreline development 2.21   Volume development 1.34
Watershed/lake area ratio 120.1
Origin of basin: Impoundment
Estimated annual precipitation 81. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Pine Cr




UPPER PINE LAKE
Hardin County

Outlet: To Lower Pine L
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.6 | 0.15 |
| Chlorophyll a mg/cubic meter | 9 | 84.3 | 17.18 |
| Total phosphorus mg/cubic meter | 10 | 76.3 | 6.93 |
| Kjeldahl nitrogen mg/l | 2 | 1.4 | 0.03 |
| Ammonia nitrogen mg/l | 2 | 0.2 | 0.11 |
| Nitrate + nitrite nitrogen mg/l | 2 | 3.3 | 0.45 |
| Seston dry weight mg/l | 9 | 11.8 | 1.18 |
| Turbidity JTU | 10 | 9.5 | 0.91 |
| Total hardness mg/l as CaCO3 | 10 | 222.0 | 3.14 |
| Calcium hardness mg/l as CaCO3 | 10 | 128.4 | 2.49 |
| Total alkalinity mg/l as CaCO3 | 9 | 160.9 | 4.15 |
| Dissolved oxygen mg/l | 10 | 10.1 | 1.42 |
| Specific conductance micromhos/cm at 25 C | 9 | 438.9 | 11.48 |
| Sulfate mg/l | 4 | 25.1 | 0.94 |
| Chloride mg/l | 5 | 19.9 | 0.10 |
| Sodium mg/l | 2 | 4.5 | 0.50 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/31/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.6 | 8.0 | 61.3 | 8.3 | 48.6 |
| 1 | 25.6 | 8.7 | 65.2 | 8.2 | 50.1 |
| 2 | 25.6 | 6.9 | 73.2 | 8.2 | 43.5 |
| 3 | 24.4 | | | | |
| 4 | 18.9 | 0.3 | 86.3 | 7.6 | 11.2 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 7.00- 9.18 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 973.
Potential nutrient input index =
  area watershed in row crops/lake area = 102.8
42.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: contouring, strip-cropping, terraces, conservation tillage, gulley control structures/ erosion control structures.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Pine Lake State Park | No details |
| 420 hogs | Storage tank |

LAKE USE ASSESSMENT

Surface water classification(s)
  Class A-primary body contact recreation.
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  Pine Lake State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 6310. | 91.4 | 225.4 |
| Shore or ice fishing | 8577. | 124.3 | 306.3 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 8099. | 117.4 | 289.3 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 82109. | 1190.0 | 2932.5 |
| Snowmobiling | 886. | 12.8 | 31.6 |
| Ice skating and cross-country skiing | 191. | 2.8 | 6.8 |
| TOTAL | 106172. | 1538.7 | 3791.9 |

Special events at Upper Pine Lake contributing to more than normal use include snowmobile rallies (1000 people).

IMPAIRMENTS

Swimming may be impaired in Upper Pine Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Frequent winterkills may limit fishing potential. Iowa Conservation Commission personnel state that the fishery was recently renovated. I.C.C. personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 19 %
Estimated winterkill frequencies: 1 year out of 7
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition,

it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

VIKING LAKE

LOCATION
County: Montgomery      Latitude  40 Deg  58 Min N
                        Longitude  95 Deg  2 Min W
Township  71 N      Range 36 W      Section  6

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
857. hectares ( 2119. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 25 | 560. | 65.3 |
| 26 | 298. | 34.7 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 77.0 | 17.6 | 2.4 | 0.0 | 3.0 |

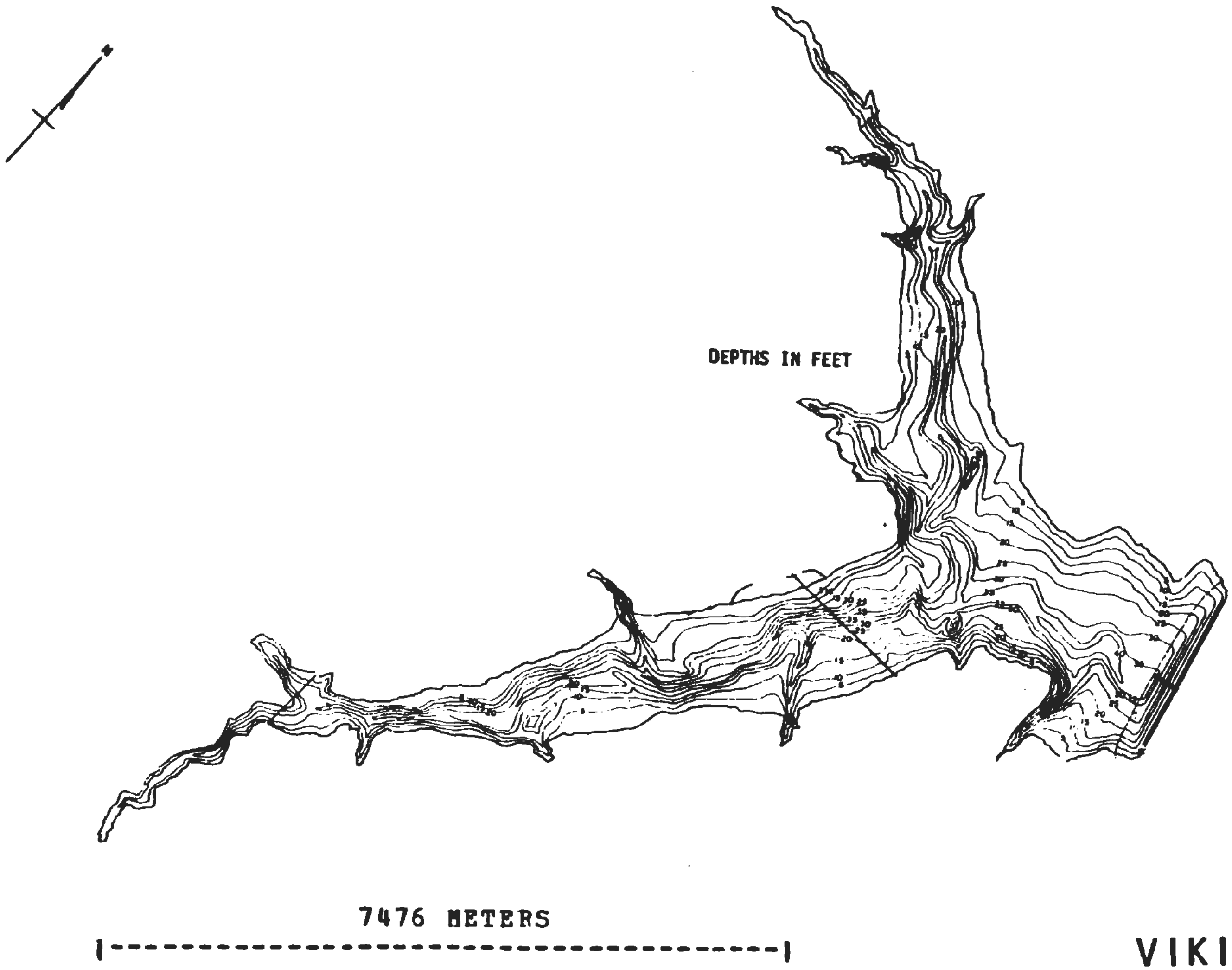
Description of topography and soils in soil associations represented in the watershed

25 Gently sloping to moderately steep (2-18%) prairie-derived soils developed from loess, outcrops of pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Marhsall, Shelby, and Adair soils.

26 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess. Marshall soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1976 map
Area  55. ha ( 137. A)
Length of shoreline  9260. m ( 30380. ft)
Maximum depth 14.6 m ( 48.0 ft)
Mean depth  4.6 m ( 15. ft)
Volume  2540458. cubic meters ( 2059. acre-feet)
Shoreline development  3.51    Volume development  0.94
Watershed/lake area ratio    15.6
Origin of basin: Impoundment
Estimated annual precipitation  84. cm
Estimated annual runoff     13. cm
Estimated lake evaporation   102. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Dunns Cr
Outlet: Dunns Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




VIKING LAKE
Montgomery County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 0.8 | 0.06 |
| Chlorophyll a<br>mg/cubic meter | 9 | 55.6 | 3.17 |
| Total phosphorus<br>mg/cubic meter | 8 | 54.5 | 0.64 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.5 | 0.00 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.03 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight<br>mg/l | 9 | 12.3 | 0.53 |
| Turbidity<br>JTU | 9 | 10.0 | 0.45 |
| Total hardness<br>mg/l as CaCO3 | 7 | 95.4 | 1.05 |
| Calcium hardness<br>mg/l as CaCO3 | 7 | 63.7 | 1.34 |
| Total alkalinity<br>mg/l as CaCO3 | 8 | 96.3 | 1.44 |
| Dissolved oxygen<br>mg/l | 9 | 9.1 | 0.36 |
| Specific conductance<br>micromhos/cm at 25 C | 10 | 219.0 | 12.69 |
| Sulfate<br>mg/l | 3 | 1.7 | 0.60 |
| Chloride<br>mg/l | 5 | 5.6 | 0.10 |
| Sodium<br>mg/l | 2 | 5.0 | 0.00 |
| Potassium<br>mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/ 4/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 26.3 | 8.6 | 53.5 | 9.0 | 61.0 |
| 1 | 26.3 | 9.5 | 54.2 | 9.0 | 58.0 |
| 2 | 25.8 | | | | |
| 3 | 25.7 | 8.5 | 58.7 | 9.0 | 60.6 |
| 4 | 24.3 | | | | |
| 5 | 23.0 | 0.4 | 65.2 | 7.9 | |
| 6 | 22.3 | | | | |
| 7 | 21.2 | 0.0 | 181.9 | 7.7 | 9.8 |
| 8 | 19.0 | | | | |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be nitrogen in April and September.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 10.80-11.97 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 178.
Potential nutrient input index =
area watershed in row crops/lake area = 12.0
76.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, conservation tillage.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Viking Lake State Park | One-cell lagoon; intermittent outflow above the lake |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is not designated as a public water supply.

Public parks:
Viking Lake State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 3963. | 28.9 | 72.1 |
| Shore or ice fishing | 6615. | 48.3 | 120.3 |
| Swimming | 50040. | 365.3 | 909.8 |
| Pleasure boating | 1020. | 7.4 | 18.5 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 34584. | 252.4 | 628.8 |
| Snowmobiling | 122. | 0.9 | 2.2 |
| Ice skating and cross-country skiing | 122. | 0.9 | 2.2 |
| TOTAL | 96466. | 704.1 | 1753.9 |

Special events at Viking Lake contributing to more than normal use include several fishing tournaments (20-150 people).

IMPAIRMENTS

Swimming may be impaired in Viking Lake throughout the summer because of Secchi depths less than one meter caused by algal populations. Aquatic vascular plant growth may impair boating and shoreline fishing. Iowa Conservation Commission personnel consider lake usage to be below its potential due to low fishing pressure.

Estimated aquatic plant coverage 8 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see

section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

LAKE WAPELLO

LOCATION

County: Davis    Latitude 40 Deg 49 Min N
Longitude 92 Deg 35 Min W
Township 70 N    Range 15 W    Section 34

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
2003. hectares ( 4950. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 38 | 1950. | 97.3 |
| 40 | 47. | 2.3 |
| 41 | 6. | 0.3 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 34.9 | 35.8 | 27.3 | 0.2 | 1.8 |

Description of topography and soils in soil associations represented in the watershed

38 Gently sloping to steep (2-25%) forest-derived soils developed from pre-Wisconsin till or loess. Lindley and Weller soils.

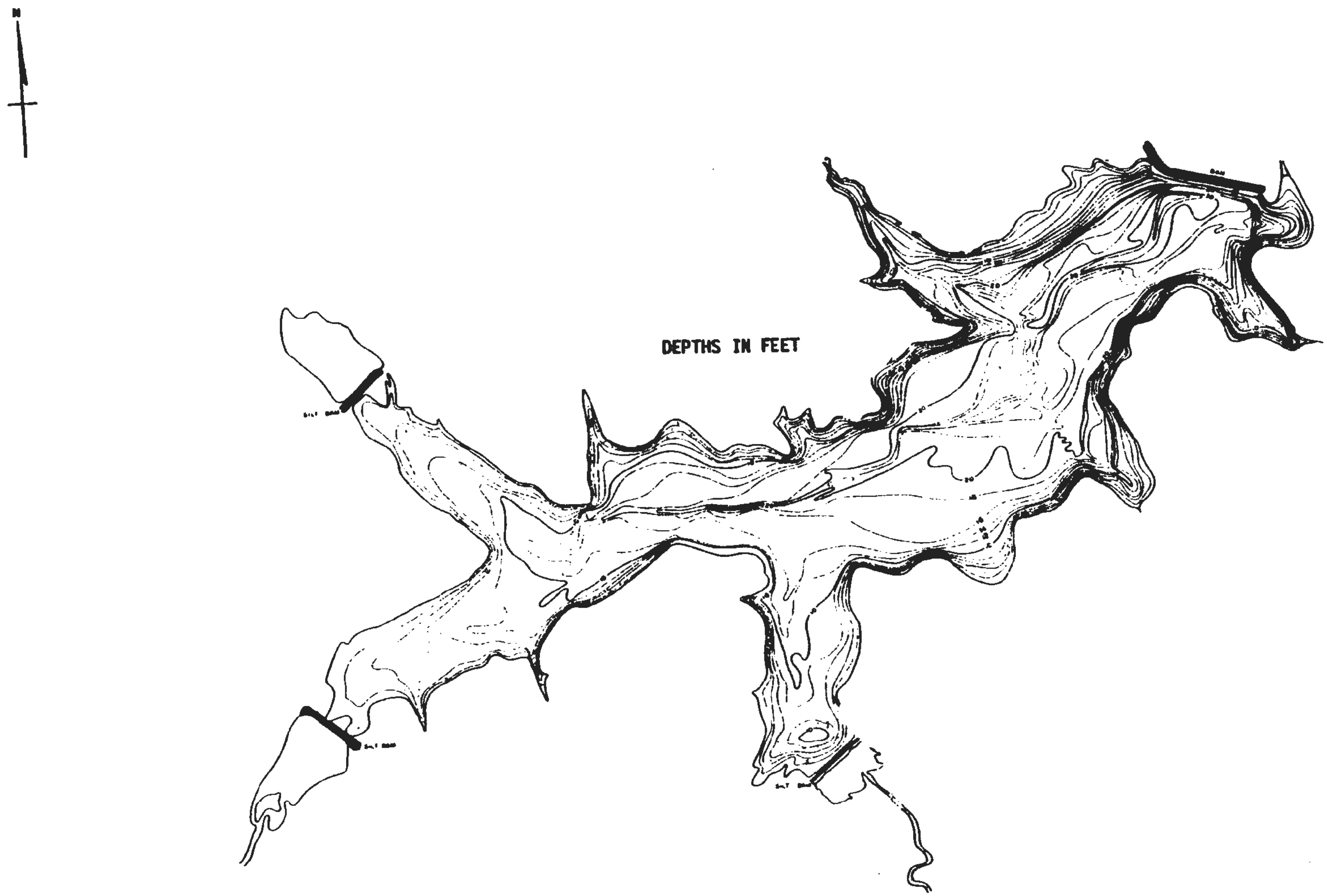
40 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from loess, pre-Wisconsin till-derived paleosols, or pre-Wisconsin till. Seymour, Edina, Clarinda, Adair, and Shelby soils.

41 Gently sloping to moderately steep (2-18%) prairie and forest-derived soils developed from pre-Wisconsin till, pre-Wisconsin till-derived paleosols, or loess. Shelby, Adair, Lindley, and Seymour soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1973 map
Area 117. ha ( 289. A)
Length of shoreline 11437. m ( 37523. ft)
Maximum depth 10.4 m ( 34.0 ft)
Mean depth 3.9 m ( 13. ft)
Volume 4586349. cubic meters ( 3717. acre-feet)
Shoreline development 2.98    Volume development 1.14
Watershed/lake area ratio 17.1
Origin of basin: Impoundment
Estimated annual precipitation 86. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 94. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
Pee Dee Cr




6336 METERS

LAKE WAPELLO
Davis County

Outlet: Pee Dee Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.0 | 0.10 |
| Chlorophyll a mg/cubic meter | 8 | 49.5 | 6.96 |
| Total phosphorus mg/cubic meter | 8 | 49.9 | 4.37 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.03 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.02 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.03 |
| Seston dry weight mg/l | 8 | 11.1 | 1.11 |
| Turbidity JTU | 10 | 10.3 | 1.14 |
| Total hardness mg/l as CaCO3 | 8 | 91.7 | 1.91 |
| Calcium hardness mg/l as CaCO3 | 8 | 67.5 | 2.10 |
| Total alkalinity mg/l as CaCO3 | 8 | 71.0 | 3.30 |
| Dissolved oxygen mg/l | 9 | 8.6 | 0.53 |
| Specific conductance micromhos/cm at 25 C | 8 | 190.9 | 6.30 |
| Sulfate mg/l | 6 | 24.7 | 1.81 |
| Chloride mg/l | 6 | 2.7 | 0.11 |
| Sodium mg/l | 2 | 4.0 | 0.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/22/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 25.1 | 7.8 | 36.0 | 8.5 | 42.3 |
| 1 | 25.0 | | | | |
| 2 | 24.9 | 7.6 | 43.9 | 8.5 | 45.7 |
| 3 | 24.9 | | | | |
| 4 | 23.7 | 0.6 | 38.4 | 7.7 | 11.2 |
| 5 | 22.9 | 1.4 | 43.9 | 7.7 | 8.6 |
| 6 | 21.8 | 1.9 | 87.5 | 7.5 | 7.5 |
| 7 | 18.9 | 0.0 | 230.3 | 7.5 | 4.5 |
| 8 | 16.9 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 216.
Potential nutrient input index =
area watershed in row crops/lake area = 6.0
90.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: pastureland and pastureland improvement, gulley control structures/ erosion control structures, ponds/sediment and water control basins, grass waterways, conservation tillage, conservation planting (trees,grass).

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| Lake Wapello State Park | Water intake filter backwash |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
Class C-raw water source for a potable water supply.
This lake is used as a raw water source for about 1700 persons at Lake Wapello State Park.

Public parks:
Lake Wapello State Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 5253. | 18.2 | 44.9 |
| Shore or ice fishing | 8381. | 29.0 | 71.6 |
| Swimming | 9987. | 34.6 | 85.4 |
| Pleasure boating | 2581. | 8.9 | 22.1 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 35610. | 123.2 | 304.4 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 104. | 0.4 | 0.9 |
| TOTAL | 61916. | 214.2 | 529.2 |

Special events at Lake Wapello contributing to more than normal use include three bass fishing tournaments (90 people).

IMPAIRMENTS

Swimming may be impaired in Lake Wapello during part of the summer because of Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to periodic turbidity and an unbalanced fish population.

Estimated aquatic plant coverage 5 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of

livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

## WEST OKOBOJI

### LOCATION

County: Dickinson — Latitude 43 Deg 23 Min N; Longitude 95 Deg 9 Min W

Township 99 N — Range 37 W — Section 24

### WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
5531. hectares ( 13668. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 14 | 2408. | 43.5 |
| 15 | 2868. | 51.8 |
| 11 | 255. | 4.6 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 83.1 | 9.7 | 1.1 | 2.4 | 3.7 |

Description of topography and soils in soil associations represented in the watershed

14 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Clarion, Webster, Canisteo, and Nicollet soils.

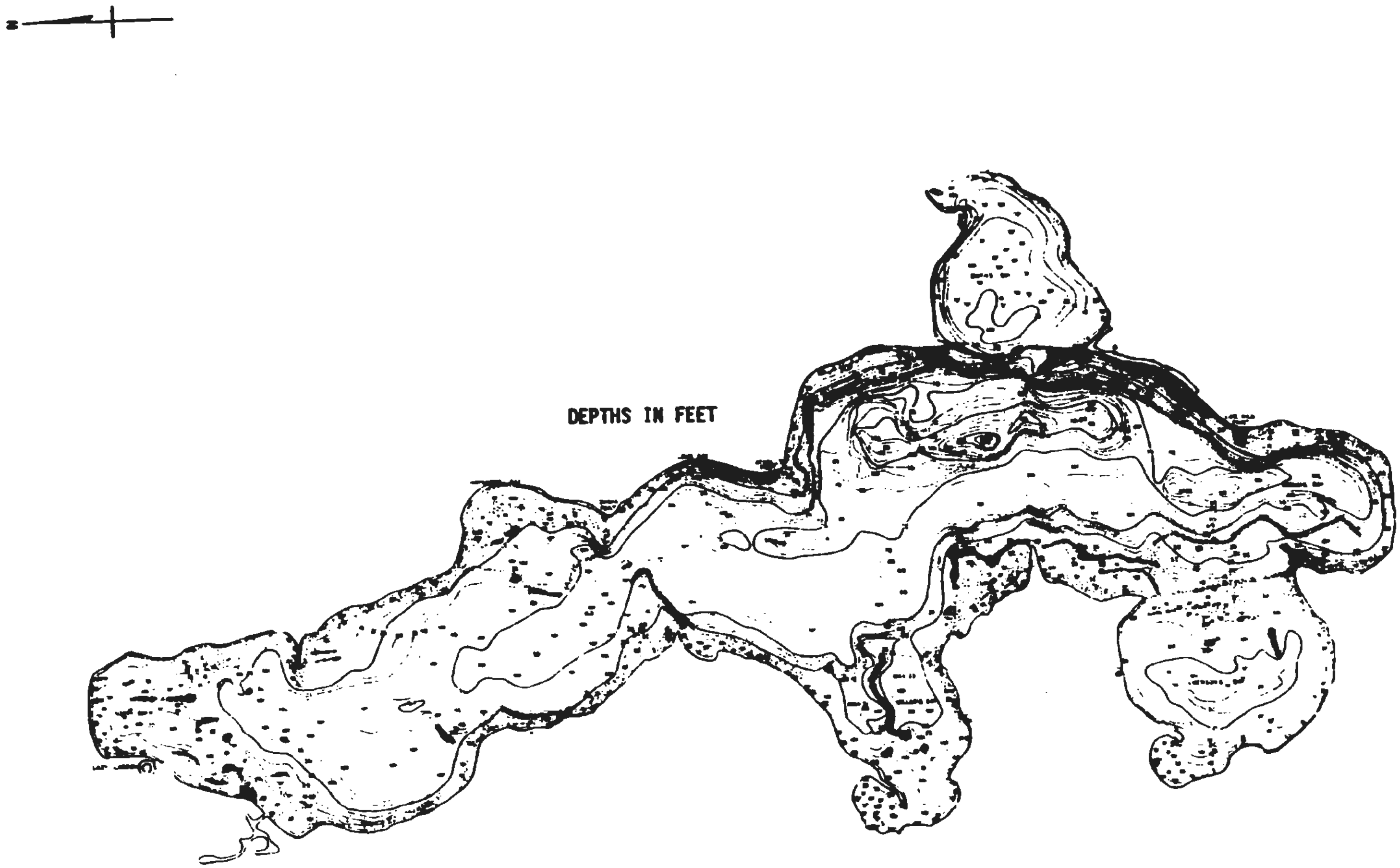
15 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from Wisconsin till on the Cary Lobe. Includes very poorly drained depressional soils. Clarion, Nicollet, Storden, and Webster soils.

11 Nearly level and gently sloping (0-5%) prairie-derived upland and terrace soils developed from alluvium. Wadena, Talcot, Flagler, and Saude soils.

Per cent of shoreline in public ownership 9 %

### PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1970 map
Area 1558. ha (3847. A)
Length of shoreline 31942. m ( 104799. ft)
Maximum depth 41.5 m (136.0 ft)
Mean depth 11.5 m ( 38. ft)
Volume 178578600. cubic meters (144717. acre-feet)
Shoreline development 2.28 Volume development 0.83
Watershed/lake area ratio 3.6
Origin of basin: Natural
Estimated annual precipitation 71. cm
Estimated annual runoff 8. cm
Estimated lake evaporation 89. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None




8490 METERS

# WEST OKOBOJI
Dickinson County

Outlet: To East Ckoboji L
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 7 | 2.9 | 0.20 |
| Chlorophyll a<br>mg/cubic meter | 14 | 6.3 | 0.97 |
| Total phosphorus<br>mg/cubic meter | 14 | 28.5 | 2.29 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.7 | 0.06 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.00 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight<br>mg/l | 15 | 2.4 | 0.26 |
| Turbidity<br>JTU | 12 | 2.3 | 0.23 |
| Total hardness<br>mg/l as CaCC3 | 14 | 219.1 | 0.65 |
| Calcium hardness<br>mg/l as CaCO3 | 12 | 78.2 | 1.03 |
| Total alkalinity<br>mg/l as CaCO3 | 13 | 201.2 | 1.33 |
| Dissolved oxygen<br>mg/l | 12 | 7.2 | 0.26 |
| Specific conductance<br>micromhos/cm at 25 C | 13 | 410.8 | 6.25 |
| Sulfate<br>mg/l | 6 | 26.7 | 0.70 |
| Chloride<br>mg/l | 6 | 10.3 | 0.11 |
| Sodium<br>mg/l | 2 | 10.5 | 0.50 |
| Potassium<br>mg/l | 2 | 9.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/14/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 22.3 | 6.7 | 25.0 | 8.5 | 7.1 |
| 2 | 22.3 | | | | |
| 4 | 22.3 | 7.0 | 21.6 | 8.5 | 7.5 |
| 6 | 22.3 | | | | |
| 8 | 22.3 | | | | |
| 10 | 22.3 | 6.5 | 20.5 | 8.5 | 7.7 |
| 12 | 22.2 | | | | |
| 14 | 21.0 | | | | |
| 15 | 19.5 | | | | |
| 16 | 18.8 | 0.4 | 47.0 | 8.0 | 2.1 |
| 18 | 15.2 | | | | |
| 20 | 14.0 | | | | |
| 24 | 13.2 | 0.0 | 139.0 | 7.9 | 0.9 |
| 28 | 12.8 | | | | |
| 33 | 12.5 | 0.0 | 213.5 | 7.9 | 0.7 |

This lake was included in the National Eutrophication Survey and was classified as eutrophic. The limiting nutrient was determined to be phosphorus at some times, nitrogen at others.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 3.01- 4.93 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 14.
Potential nutrient input index =
area watershed in row crops/lake area = 3.0
32.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: conservation tillage, grass waterways, terraces, ponds/sediment and water control basins, strip-cropping, contouring, pastureland and pastureland improvement.

POINT SOURCE POLLUTION

| Source/NPEDES # (if any) | Comments |
|---|---|
| 150 cattle | Runoff control |

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.

Class C-raw water source for a potable water supply.
This lake has also been designated as high quality water and is thus subject to higher standards to protect existing uses. In addition Lake West Okoboji has been declared an outstanding Iowa lake, and standards and restrictions more stringent than those applied to other antidegradation waters may be applied.

This lake is used as a raw water source for
about 1700 persons at Milford,
about 150 persons at Wahpeton,
about 1600 persons at Okoboji-Arnolds Park,
about 320 persons at the United Methodist Camp and
about 250 persons at Vacation Village.

Public parks:
Emerson Bay Access (State)
Gull Point State Park
Pillsbury Point Area
Pikes Point State Park
Terrace Park Swimming Beach
Triboji Beach (Public)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 23542. | 6.1 | 15.1 |
| Shore or ice fishing | 58118. | 15.1 | 37.3 |
| Swimming | 177698. | 46.2 | 114.1 |
| Pleasure boating | 98756. | 25.7 | 63.4 |
| Hunting | 782. | 0.2 | 0.5 |
| Picnicking, camping, other activities prompted by the lake's presence | 1002032. | 260.5 | 643.2 |
| Snowmobiling | 22567. | 5.9 | 14.5 |
| Ice skating and cross-country skiing | 7813. | 2.0 | 5.0 |
| TOTAL | 1391308. | 361.7 | 893.0 |

IMPAIRMENTS

Recreational activities in West Okoboji do not appear to be impaired by poor water quality; however, aquatic vegetation in small bays may interfere with boating. Iowa Conservation Commission personnel consider lake usage to be at its potential.

Estimated aquatic plant coverage 37 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

## LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

WILLIAMSON POND

LOCATION

County: Lucas | Latitude 41 Deg 6 Min N
Longitude 93 Deg 13 Min W
Township 73 N | Range 21 W | Section 25

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
561. hectares ( 1386. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 35 | 66. | 11.8 |
| 36 | 344. | 61.4 |
| 37 | 150. | 26.8 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 62.7 | 29.8 | 4.4 | 0.0 | 3.1 |

Description of topography and soils in soil associations represented in the watershed

35 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess. Grundy and Haig soils.

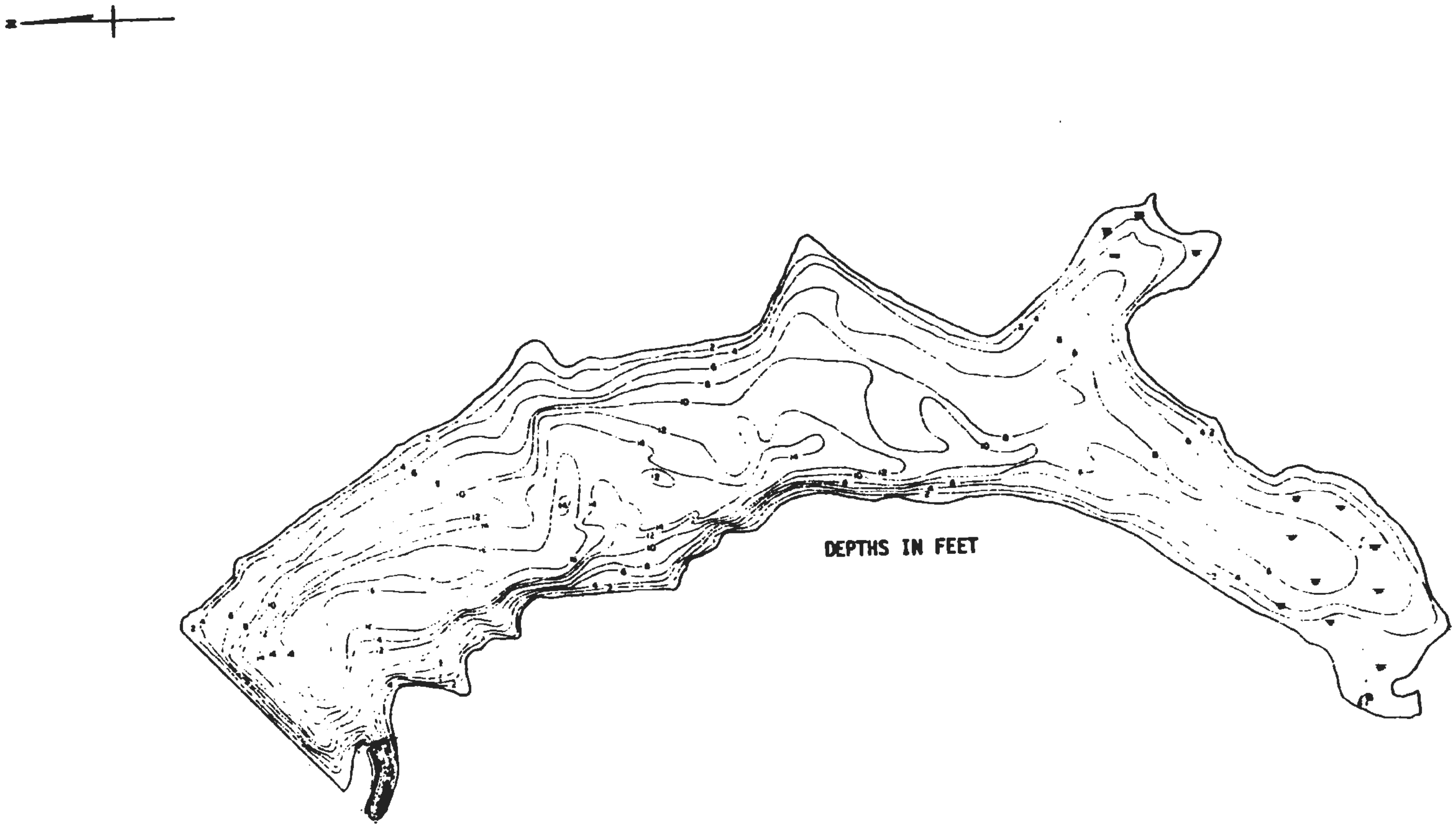
36 Nearly level to strongly sloping (0-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Grundy, Haig, Shelby, and Adair soils.

37 Gently sloping to moderately steep (2-18%) prairie and forest-derived soils developed from pre-Wisconsin till-derived paleosols, pre-Wisconsin till, or loess. Adair, Shelby, Lindley, and Grundy soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1971 map
Area 12. ha ( 30. A)
Length of shoreline 2496. m ( 8189. ft)
Maximum depth 5.5 m ( 18.0 ft)
Mean depth 2.5 m ( 8. ft)
Volume 292583. cubic meters ( 237. acre-feet)
Shoreline development 2.06 Volume development 1.37
Watershed/lake area ratio 46.8
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 94. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
English Cr




120 METERS

**WILLIAMSON POND**
Lucas County

Outlet: English Cr
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 5 | 0.8 | 0.13 |
| Chlorophyll a mg/cubic meter | 9 | 21.4 | 1.82 |
| Total phosphorus mg/cubic meter | 8 | 55.5 | 5.31 |
| Kjeldahl nitrogen mg/l | 2 | 0.6 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight mg/l | 9 | 9.2 | 1.22 |
| Turbidity JTU | 8 | 11.4 | 2.70 |
| Total hardness mg/l as $CaCO_3$ | 9 | 113.6 | 1.59 |
| Calcium hardness mg/l as $CaCO_3$ | 8 | 83.2 | 1.56 |
| Total alkalinity mg/l as $CaCO_3$ | 9 | 99.8 | 2.93 |
| Dissolved oxygen mg/l | 9 | 7.9 | 0.65 |
| Specific conductance micromhos/cm at 25 C | 8 | 213.8 | 3.10 |
| Sulfate mg/l | 3 | 15.8 | 0.33 |
| Chloride mg/l | 3 | 4.7 | 0.17 |
| Sodium mg/l | 2 | 4.0 | 0.00 |
| Potassium mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 7/19/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 28.0 | 7.7 | 49.7 | 8.2 | 9.7 |
| 1 | 25.7 | 7.4 | 65.7 | 8.2 | 29.9 |
| 2 | 23.0 | 0.9 | 138.6 | 7.4 | 4.5 |
| 3 | 21.3 | | | | |
| 4 | 19.6 | | | | |
| 5 | 18.1 | 0.3 | 237.6 | 7.3 | 38.7 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 589.
Potential nutrient input index =
area watershed in row crops/lake area = 29.3
50.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: terraces, pastureland and pastureland improvement, contouring, conservation tillage, crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Williamson Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 169. | 5.6 | 14.1 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 6667. | 222.2 | 555.6 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 2107. | 70.2 | 175.6 |
| Picnicking,camping,other activities prompted by the lake's presence | 26. | 0.9 | 2.2 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 8969. | 299.0 | 747.4 |

## IMPAIRMENTS

Water clarity is poor in Williamson Pond during part of the summer as indicated by Secchi depths less than one meter caused by algal populations and other suspended matter. Iowa Conservation Commission personnel consider lake usage to be below its potential due to turbidity and poor grounds maintenance.

Estimated aquatic plant coverage 11 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

## LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

WILLOW LAKE

LOCATION

County: Harrison    Latitude 41 Deg 46 Min N
                    Longitude 95 Deg 47 Min W

Township 80 N    Range 42 W    Section 6

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
194. hectares ( 479. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 19 | 194. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 50.0 | 28.2 | 18.4 | 0.0 | 3.4 |

Description of topography and soils in soil associations represented in the watershed

19 Gently sloping to very steep (2-40%+) prairie-derived soils developed from loess or loess-derived sediments. Ida, Napier, Castana, Hamburg, and Monona soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1979 map

Area 11. ha ( 26. A)

Length of shoreline 2578. m ( 8457. ft)

Maximum depth 7.3 m ( 24.0 ft)

Mean depth 3.7 m ( 12. ft)

Volume 397852. cubic meters ( 322. acre-feet)

Shoreline development 2.22    Volume development 1.52

Watershed/lake area ratio 17.6

Origin of basin: Impoundment

Estimated annual precipitation 76. cm

Estimated annual runoff 10. cm

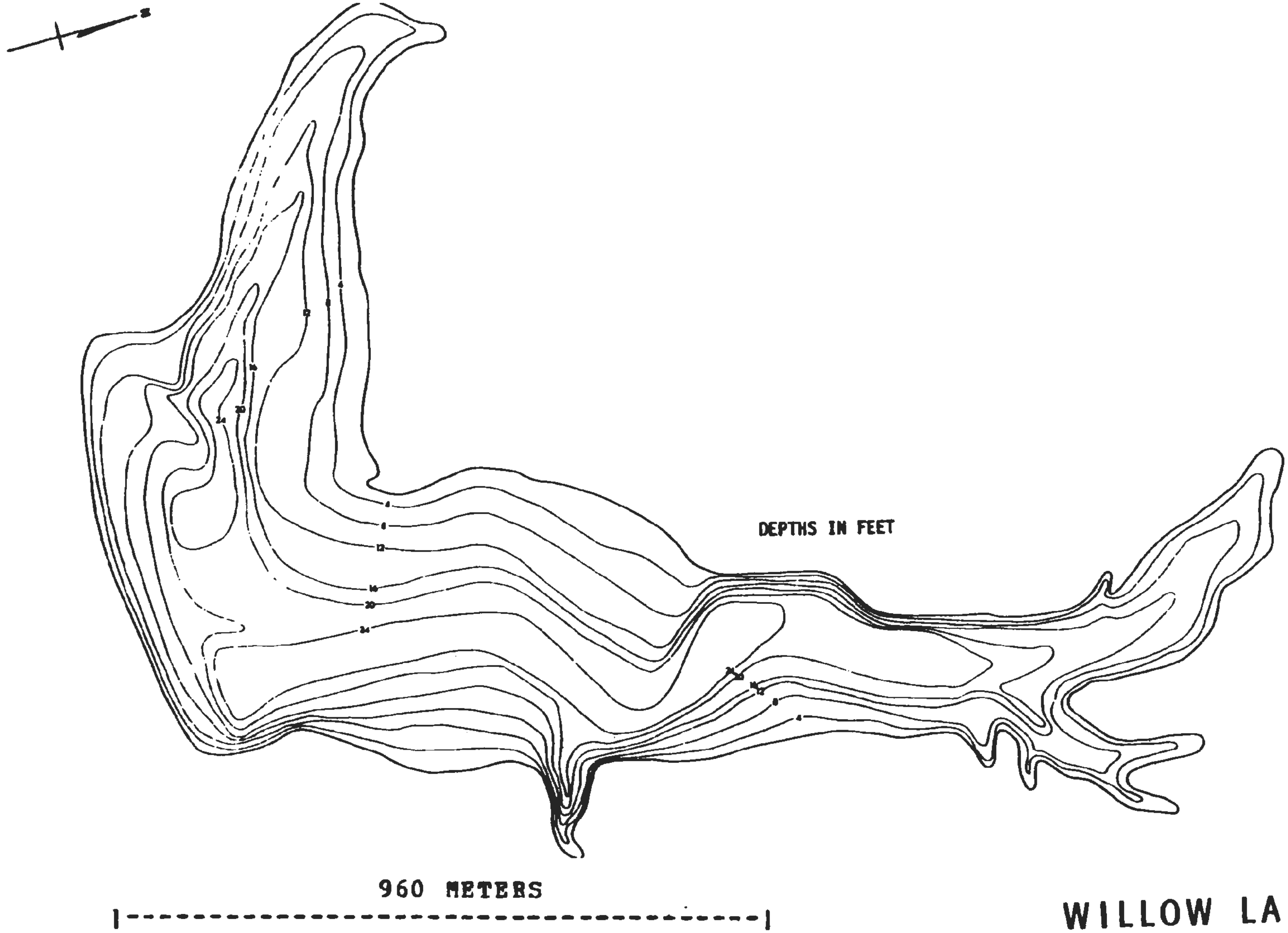
Estimated lake evaporation 102. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)
None

Outlet: Unnamed

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




WILLOW LAKE
Harrison County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 2.8 | 0.60 |
| Chlorophyll a<br>mg/cubic meter | 8 | 9.3 | 2.80 |
| Total phosphorus<br>mg/cubic meter | 7 | 22.3 | 1.18 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.18 | 0.04 |
| Ammonia nitrogen<br>mg/l | 2 | 0.43 | 0.09 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.72 | 0.22 |
| Seston dry weight<br>mg/l | 8 | 2.7 | 0.60 |
| Turbidity<br>JTU | 8 | 1.9 | 0.47 |
| Total hardness<br>mg/l as CaCO3 | 8 | 159.5 | 5.33 |
| Calcium hardness<br>mg/l as CaCO3 | 8 | 78.2 | 4.79 |
| Total alkalinity<br>mg/l as CaCO3 | 8 | 165.5 | 4.26 |
| Dissolved oxygen<br>mg/l | 8 | 6.5 | 0.68 |
| Specific conductance<br>micromhos/cm at 25 C | 9 | 312.2 | 11.28 |
| Sulfate<br>mg/l | 1 | 2.0 | 0.00 |
| Chloride<br>mg/l | 4 | 3.5 | 0.00 |
| Sodium<br>mg/l | 2 | 8.5 | 1.50 |
| Potassium<br>mg/l | 2 | 6.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 9/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 28.4 | 8.0 | 18.6 | 8.7 | 3.5 |
| 1 | 28.4 | | | | |
| 2 | 28.4 | 7.9 | 19.3 | 8.7 | 3.0 |
| 3 | 28.4 | | | | |
| 4 | 25.3 | 1.8 | 19.7 | 8.0 | 2.2 |
| 5 | 20.3 | 1.2 | 212.8 | 7.7 | 214.1 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 15.99-27.77 Tons/Acre/Yr
Potential siltation index =
  (watershed area/lake area) x soil loss rate = 386.
Potential nutrient input index =
  area watershed in row crops/lake area = 8.8
35.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: crop rotation, conservation tillage, contouring, terraces, pastureland and pastureland improvement, gulley control structures/ erosion control structures, conservation planting (trees,grass), fencing and animal exclusion.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
  Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
  Willow Lake Recreation Area (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 808. | 31.1 | 73.5 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 2745. | 105.6 | 249.5 |
| Swimming | 2020. | 77.7 | 183.6 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 547. | 21.0 | 49.7 |
| Picnicking,camping,other activities prompted by the lake's presence | 3884. | 149.4 | 353.1 |
| Snowmobiling | 156. | 6.0 | 14.2 |
| Ice skating and cross-country skiing | 156. | 6.0 | 14.2 |
| TOTAL | 10316. | 396.8 | 937.8 |

IMPAIRMENTS

Recreational activities in Willow Lake do not appear to be impaired by poor water quality; however, aquatic vegetation may interfere with boating and fishing. Iowa Conservation Commission personnel state that grass carp will be stocked to control the aquatic vegetation. I.C.C. personnel consider lake usage to be below its potential due to uncompleted facilities.

Estimated aquatic plant coverage 33 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

Because large quantities of rooted aquatic vegetation interfere with recreational activities in this lake, a program of vegetation control is recommended. While this might be accomplished through mechanical harvest or the use of chemicals, studies in other Iowa lakes have shown that controlled stocking of the imported White Amur at the proper densities can provide biological control. The cost-effectiveness and suitability of White Amur stocking should be investigated for this lake.

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition,

it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

WILSCN LAKE

LOCATICN
County: Lee Latitude 40 Deg 39 Min N
Longitude 91 Deg 29 Min W
Township 68 N Range 6 W Section 36

WATERSHED CHARACTERISTICS
Watershed area(excluding lake surface)
17. hectares ( 42. acres)

Scil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 38 | 17. | 100.0 |

Estimated land uses (%)

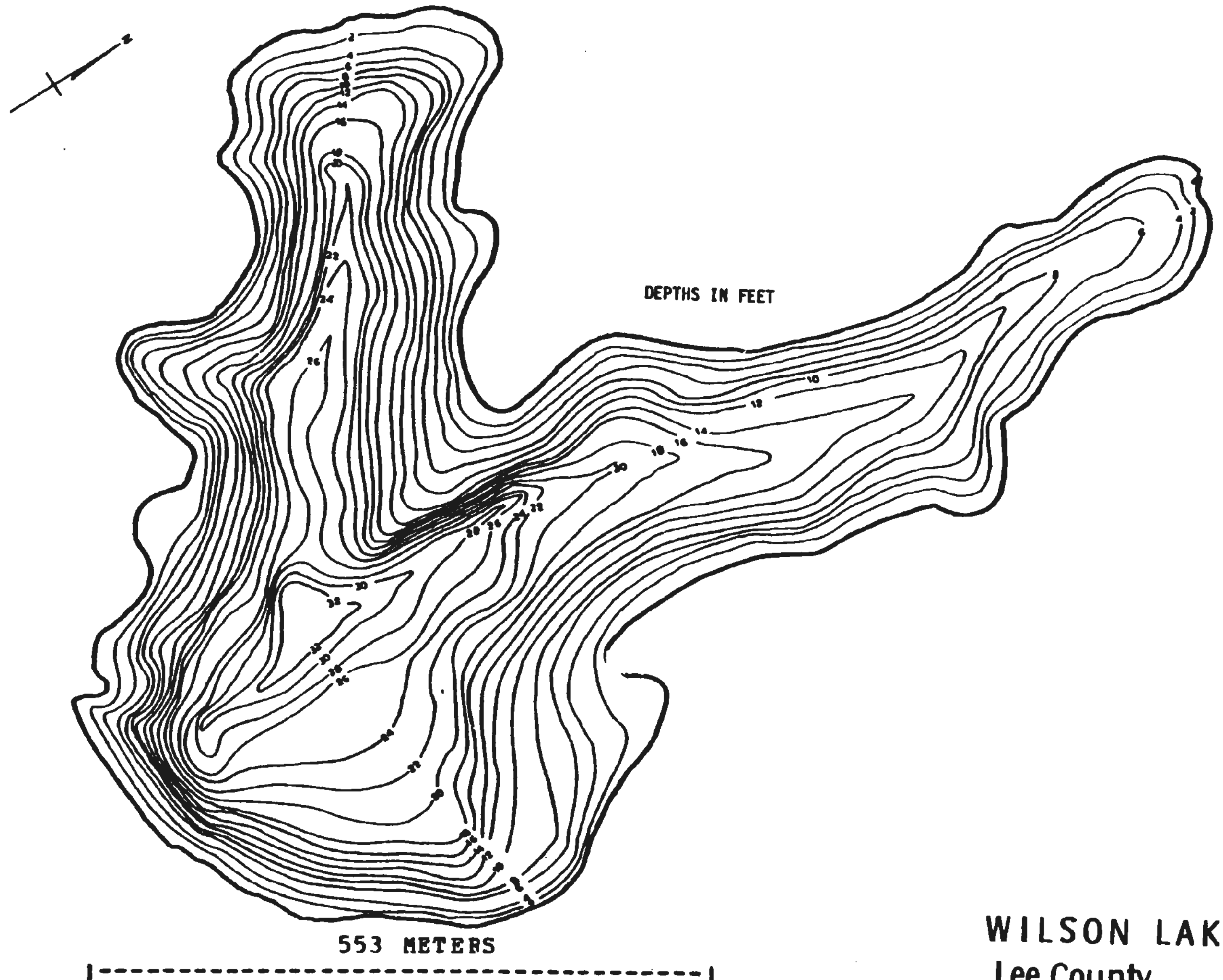
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 34.3 | 36.0 | 28.0 | 0.0 | 1.8 |

Description of topography and soils in soil associations represented in the watershed

38 Gently sloping to steep (2-25%) forest-derived soils developed frcm pre-Wisconsin till or loess. Lindley and Weller soils.

Per cent of shoreline in public cwnership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1979 map
Area 3. ha ( 8. A)
Length of shoreline 1036. m ( 3400. ft)
Maximum depth 9.8 m ( 32.0 ft)
Mean depth 3.8 m ( 12. ft)
Vclume 107009. cubic meters ( 87. acre-feet)
Shoreline development 1.74 Volume development 1.16
Watershed/lake area ratio 5.7
Origin of basin: Impoundment
Estimated annual precipitation 89. cm
Estimated annual runoff 18. cm
Estimated lake evaporation 91. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: 3 Unnamed
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




WILSON LAKE

Lee County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 1.9 | 0.09 |
| Chlorophyll a mg/cubic meter | 10 | 4.3 | 1.35 |
| Total phosphorus mg/cubic meter | 11 | 12.2 | 1.43 |
| Kjeldahl nitrogen mg/l | 2 | 0.5 | 0.12 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.03 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.05 |
| Seston dry weight mg/l | 9 | 3.3 | 0.22 |
| Turbidity JTU | 12 | 2.7 | 0.15 |
| Total hardness mg/l as CaCO3 | 11 | 102.9 | 0.87 |
| Calcium hardness mg/l as CaCO3 | 10 | 82.2 | 1.05 |
| Total alkalinity mg/l as CaCO3 | 12 | 89.2 | 1.11 |
| Dissolved oxygen mg/l | 11 | 6.9 | 0.41 |
| Specific conductance micromhos/cm at 25 C | 12 | 226.7 | 5.82 |
| Sulfate mg/l | 4 | 17.4 | 0.38 |
| Chloride mg/l | 4 | 1.5 | 0.00 |
| Sodium mg/l | 2 | 4.0 | 1.00 |
| Potassium mg/l | 2 | 3.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 9/ 6/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 23.3 | 8.2 | 10.6 | 8.7 | 9.0 |
| 1 | 26.7 | 8.3 | 11.6 | 8.6 | 10.2 |
| 2 | 26.7 | 7.9 | 12.2 | 8.6 | 11.8 |
| 3 | 26.7 | | | | |
| 4 | 23.3 | 2.6 | 13.6 | 7.8 | 5.1 |
| 5 | 17.2 | | | | |
| 6 | 12.2 | 0.3 | 33.8 | 7.5 | 13.1 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 11.98-13.19 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 71.
Potential nutrient input index =
area watershed in row crops/lake area = 1.9
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
crop rotation.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Wilson Lake County Park

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1270. | 158.8 | 423.3 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 2845. | 355.6 | 948.3 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 277. | 34.6 | 92.3 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 6620. | 827.5 | 2206.7 |
| Snowmobiling | 608. | 76.0 | 202.7 |
| Ice skating and cross-country skiing | 608. | 76.0 | 202.7 |
| TOTAL | 12228. | 1528.5 | 4076.0 |

IMPAIRMENTS

Recreational activities in Wilson Lake do not appear to be impaired by poor water quality or aquatic plants. Iowa Conservation Commission personnel consider lake usage to be below its potential.

Estimated aquatic plant coverage 3 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is

not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

WILSON LAKE

LOCATION
County: Taylor — Latitude 40 Deg 50 Min N; Longitude 94 Deg 33 Min W
Township 70 N — Range 32 W — Section 28

WATERSHED CHARACTERISTICS
Watershed area (excluding lake surface)
58. hectares ( 144. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 33 | 58. | 100.0 |

Estimated land uses (%)

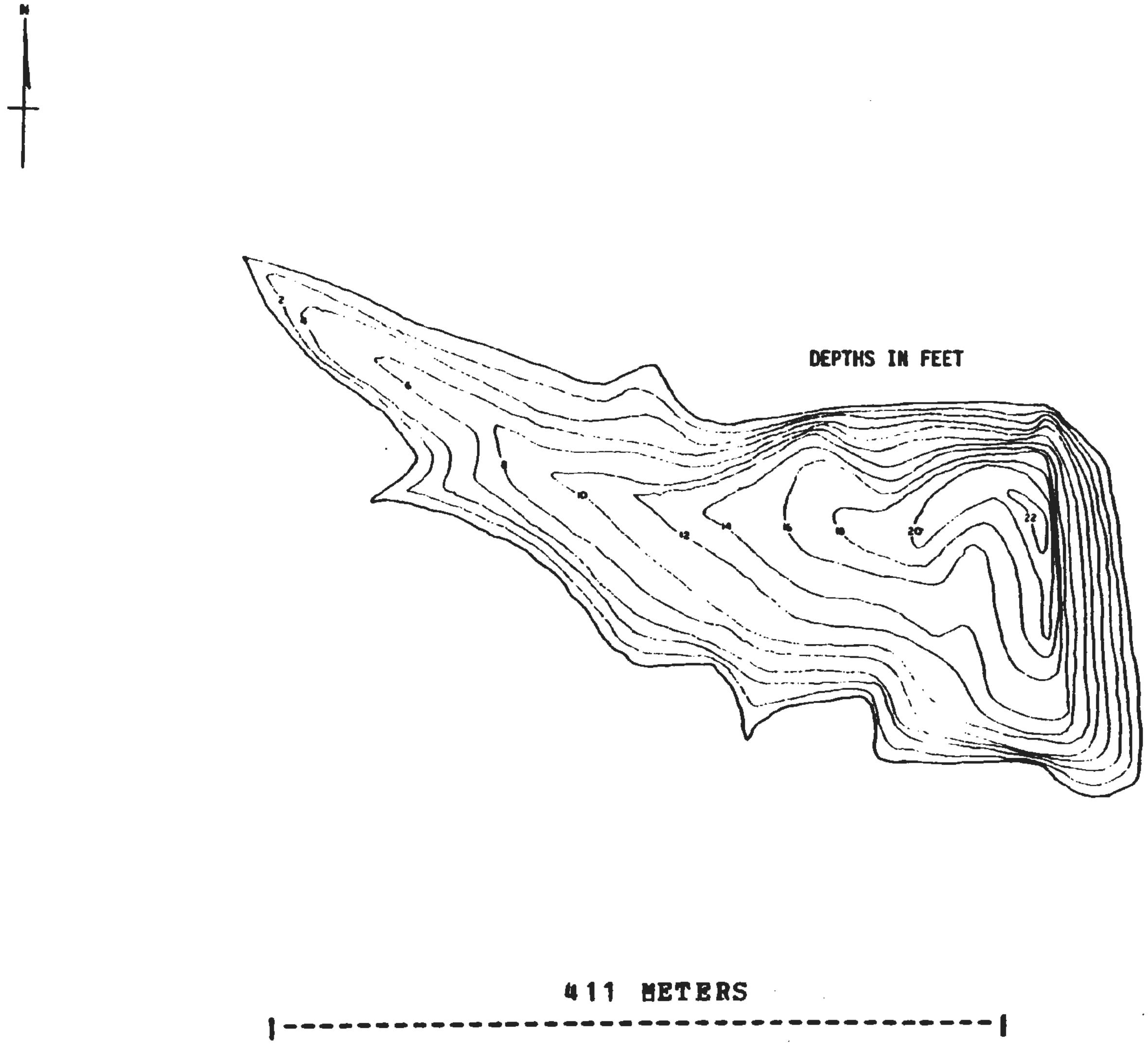
| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 80.9 | 15.8 | 0.4 | 0.0 | 2.9 |

Description of topography and soils in soil associations represented in the watershed

33 Nearly level to moderately sloping (0-9%) prairie-derived soils developed from loess or pre-Wisconsin till-derived paleosols. Sharpsburg, Macksburg, Winterset, and Clarinda soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE
Measurements from 1977 map
Area 7. ha ( 17. A)
Length of shoreline 1429. m ( 4689. ft)
Maximum depth 6.7 m ( 22.0 ft)
Mean depth 2.8 m ( 9. ft)
Volume 198128. cubic meters ( 161. acre-feet)
Shoreline development 1.52 Volume development 1.25
Watershed/lake area ratio 8.3
Origin of basin: Impoundment
Estimated annual precipitation 84. cm
Estimated annual runoff 15. cm
Estimated lake evaporation 99. cm
Thermal stratification? Yes
Major inflows (named and/or permanent streams)
None
Outlet: None
208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




WILSON LAKE
Taylor County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 0.5 | 0.04 |
| Chlorophyll a mg/cubic meter | 13 | 52.4 | 6.30 |
| Total phosphorus mg/cubic meter | 11 | 59.8 | 2.93 |
| Kjeldahl nitrogen mg/l | 2 | 0.8 | 0.02 |
| Ammonia nitrogen mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.1 | 0.00 |
| Seston dry weight mg/l | 13 | 17.9 | 2.27 |
| Turbidity JTU | 11 | 13.0 | 0.98 |
| Total hardness mg/l as CaCO3 | 6 | 97.3 | 3.29 |
| Calcium hardness mg/l as CaCO3 | 6 | 70.3 | 2.89 |
| Total alkalinity mg/l as CaCO3 | 11 | 95.6 | 1.81 |
| Dissolved oxygen mg/l | 12 | 7.3 | 0.55 |
| Specific conductance micromhos/cm at 25 C | 11 | 224.4 | 9.09 |
| Sulfate mg/l | 3 | 1.8 | 0.17 |
| Chloride mg/l | 4 | 4.0 | 0.00 |
| Sodium mg/l | 2 | 5.0 | 0.00 |
| Potassium mg/l | 2 | 4.5 | 0.50 |

Vertical profile for selected measurements on the sampling date ( 8/ 8/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 28.3 | 8.1 | 54.0 | 8.9 | 60.2 |
| 1 | 28.3 | 8.5 | 55.7 | 8.9 | 61.0 |
| 2 | 28.3 | 8.3 | 54.7 | 8.9 | 58.5 |
| 3 | 23.9 | | | | |
| 4 | 21.4 | 0.0 | 83.2 | 7.3 | 16.1 |
| 5 | 19.8 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 9.19-10.79 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 83.
Potential nutrient input index =
area watershed in row crops/lake area = 6.7
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
crop rotation, conservation tillage, terraces.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Wilson Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 100. | 5.9 | 14.3 |
| Shore or ice fishing | 3000. | 176.5 | 428.6 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking, camping, other activities prompted by the lake's presence | 8100. | 476.5 | 1157.1 |
| Snowmobiling | 50. | 2.9 | 7.1 |
| Ice skating and cross-country skiing | 50. | 2.9 | 7.1 |
| TOTAL | 11300. | 664.7 | 1614.3 |

IMPAIRMENTS

Water clarity is poor in Wilson Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to a lack of boat ramps.

Estimated aquatic plant coverage 8 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other

non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

WINDMILL LAKE

LOCATION

County: Taylor    Latitude 40 Deg 44 Min N
                  Longitude 94 Deg 50 Min W

Township 69 N    Range 35 W    Section 36

WATERSHED CHARACTERISTICS

Watershed area (excluding lake surface)
242. hectares ( 598. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 30 | 242. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 69.7 | 21.8 | 4.5 | 0.0 | 4.0 |

Description of topography and soils in soil associations represented in the watershed

30 Gently to strongly sloping (2-14%) prairie-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Sharpsburg, Shelby, and Adair soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1977 map

Area 10. ha ( 24. A)

Length of shoreline 1524. m ( 5000. ft)

Maximum depth 6.7 m ( 22.0 ft)

Mean depth 3.0 m ( 10. ft)

Volume 288409. cubic meters ( 234. acre-feet)

Shoreline development 1.39    Volume development 1.34

Watershed/lake area ratio 24.2

Origin of basin: Impoundment

Estimated annual precipitation 86. cm

Estimated annual runoff 15. cm

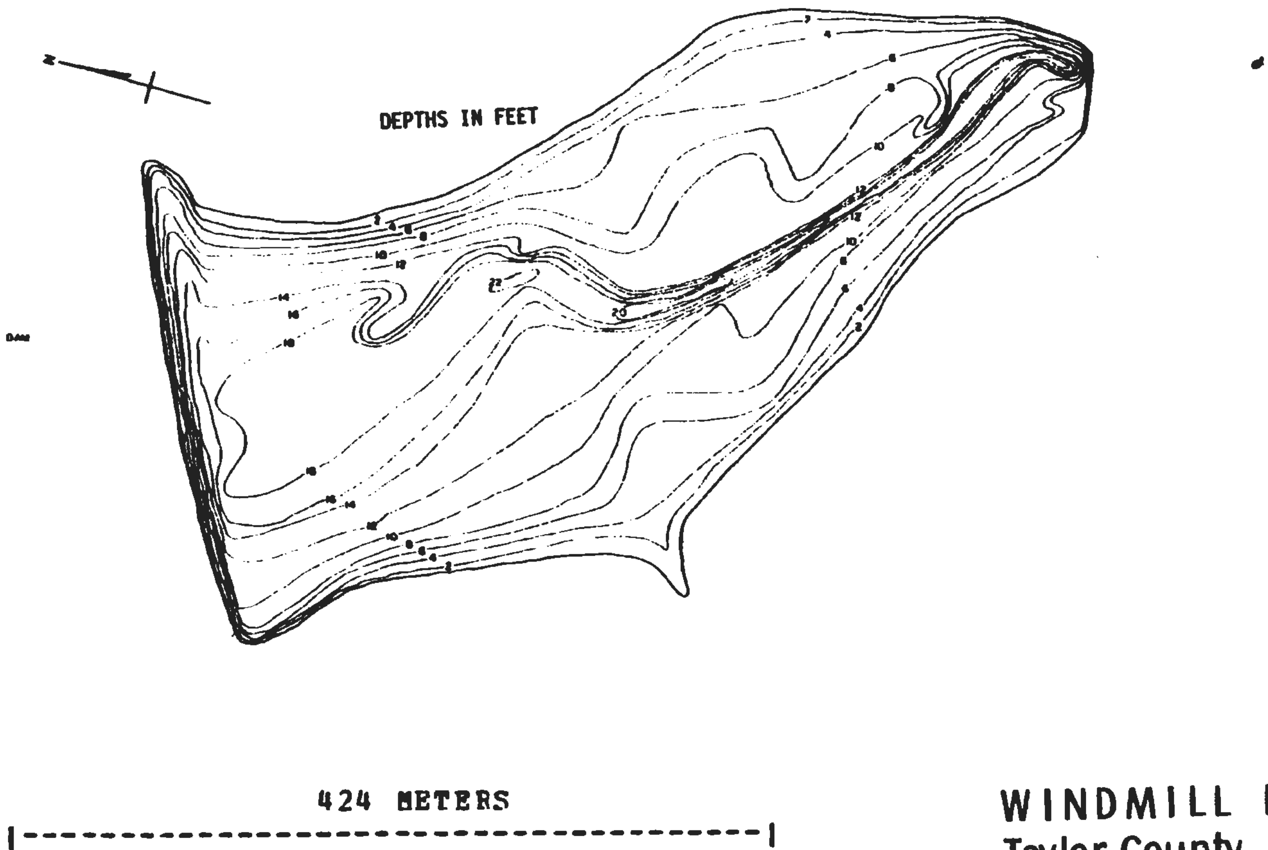
Estimated lake evaporation 102. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)
Unnamed

Outlet: Unnamed

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




WINDMILL LAKE
Taylor County

POLLUTION ASSESSMENT
Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth<br>meters | 6 | 0.4 | 0.05 |
| Chlorophyll a<br>mg/cubic meter | 10 | 110.3 | 14.05 |
| Total phosphorus<br>mg/cubic meter | 11 | 127.7 | 8.46 |
| Kjeldahl nitrogen<br>mg/l | 2 | 0.7 | 0.01 |
| Ammonia nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Nitrate + nitrite nitrogen<br>mg/l | 2 | 0.1 | 0.01 |
| Seston dry weight<br>mg/l | 10 | 22.0 | 1.98 |
| Turbidity<br>JTU | 9 | 19.6 | 1.87 |
| Total hardness<br>mg/l as $CaCO_3$ | 7 | 83.7 | 2.97 |
| Calcium hardness<br>mg/l as $CaCO_3$ | 7 | 54.9 | 2.72 |
| Total alkalinity<br>mg/l as $CaCO_3$ | 10 | 82.8 | 2.13 |
| Dissolved oxygen<br>mg/l | 11 | 6.6 | 0.28 |
| Specific conductance<br>micromhos/cm at 25 C | 9 | 196.9 | 10.09 |
| Sulfate<br>mg/l | 3 | 2.0 | 0.76 |
| Chloride<br>mg/l | 5 | 2.9 | 0.10 |
| Sodium<br>mg/l | 2 | 5.0 | 0.00 |
| Potassium<br>mg/l | 2 | 5.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 8/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 27.9 | 7.7 | 113.2 | 9.4 | 156.4 |
| 1 | 27.9 | 7.7 | 110.8 | 9.4 | 118.3 |
| 2 | 27.9 | 7.7 | 109.8 | 9.4 | 145.2 |
| 3 | 25.2 | | | | |
| 4 | 22.3 | 0.3 | 126.8 | 8.0 | 11.6 |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
  Negligible
Estimated erosion rate in region = 9.19-10.79 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 242.
Potential nutrient input index =
area watershed in row crops/lake area = 16.9
90.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office: pastureland and pastureland improvement, conservation tillage.

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Windmill Lake (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 356. | 14.8 | 35.6 |
| Shore or ice fishing | 3587. | 149.5 | 358.7 |
| Swimming | 0. | 0.0 | 0.0 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |

| | | | |
|---|---|---|---|
| Picnicking, camping, other activities prompted by the lake's presence | 9251. | 385.5 | 925.1 |
| Snowmobiling | 50. | 2.1 | 5.0 |
| Ice skating and cross-country skiing | 50. | 2.1 | 5.0 |
| TOTAL | 13294. | 553.9 | 1329.4 |

IMPAIRMENTS

Water clarity is poor in Windmill Lake throughout the summer as indicated by Secchi depths less than one meter caused by algal populations. Iowa Conservation Commission personnel consider lake usage to be below its potential due to a lack of boat ramps.

Estimated aquatic plant coverage 17 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

The water quality of this lake, like all lakes, is strongly influenced by the materials that are washed into it through its tributary streams. Silt from soil erosion in the watershed is detrimental to the lake in several ways. It contributes to the filling of the basin making the lake more shallow in the near term and hastening the basin's long term extinction. Plant nutrients such as phosphorus and ammonia nitrogen and several pesticides are carried into the lake attached to soil particles. Following storm events, sediments introduced into the lake reduce light transparency, may interfere with sight-feeding fish and the development of fish eggs, and may smother gill-breathing invertebrates. For this reason a strong soil conservation program is recommended for this watershed utilizing the best management practices recommended by the local soil conservation service office (see section on non-point pollution for this lake). In addition, it is recommended that steps be taken to reduce the amounts of livestock wastes reaching tributary streams. Research on the Iowa great lakes has indicated small livestock concentrations in areas with direct drainage to streams or tile lines can make significant contributions to the nutrient budgets of downstream lakes. The use of practices such as diversion terraces above feedlots, lagoons to catch feedlot runoff, and spray irrigation of surplus water from such lagoons can significantly reduce the nutrient contributions from this source. The above land use recommendations are made on the basis they will help improve the water quality in the lake and slow down the filling of the lake with sediments. They will help protect the lake from future degradation; however, it is not possible to state the degree such a program might increase the water quality in the lake. There are insufficient data on the present inputs of sediments, nutrients, and other

non-point pollutants to the lake. Furthermore we do not have adequate information to gauge the effectiveness of such a conservation program.

YEN-RUO-GIS LAKE

LOCATION

County: Keokuk Latitude 41 Deg 23 Min N

Longitude 92 Deg 12 Min W

Township 76 N Range 12 W Section 24

WATERSHED CHARACTERISTICS

Watershed area(excluding lake surface)
11. hectares ( 27. acres)

Soil Associations within watershed

| Assoc # | area ha | % of total |
|---|---|---|
| 47 | 11. | 100.0 |

Estimated land uses (%)

| Cropland | Pasture | Forestry | Towns | Other |
|---|---|---|---|---|
| 55.3 | 26.0 | 16.3 | 0.0 | 2.5 |

Description of topography and soils in soil associations represented in the watershed

47 Moderately sloping to very steep (5-30%) forest-derived soils developed from loess, pre-Wisconsin till, or pre-Wisconsin till-derived paleosols. Clinton, Lindley, and Keswick soils.

Per cent of shoreline in public ownership 100 %

PHYSICAL CHARACTERISTICS OF LAKE

Measurements from 1976 map

Area 4. ha ( 9. A)

Length of shoreline 1066. m ( 3496. ft)

Maximum depth 7.3 m ( 24.0 ft)

Mean depth 2.8 m ( 9. ft)

Volume 104190. cubic meters ( 84. acre-feet)

Shoreline development 1.56 Volume development 1.15

Watershed/lake area ratio 2.8

Origin of basin: Gravel Pit

Estimated annual precipitation 86. cm

Estimated annual runoff 18. cm

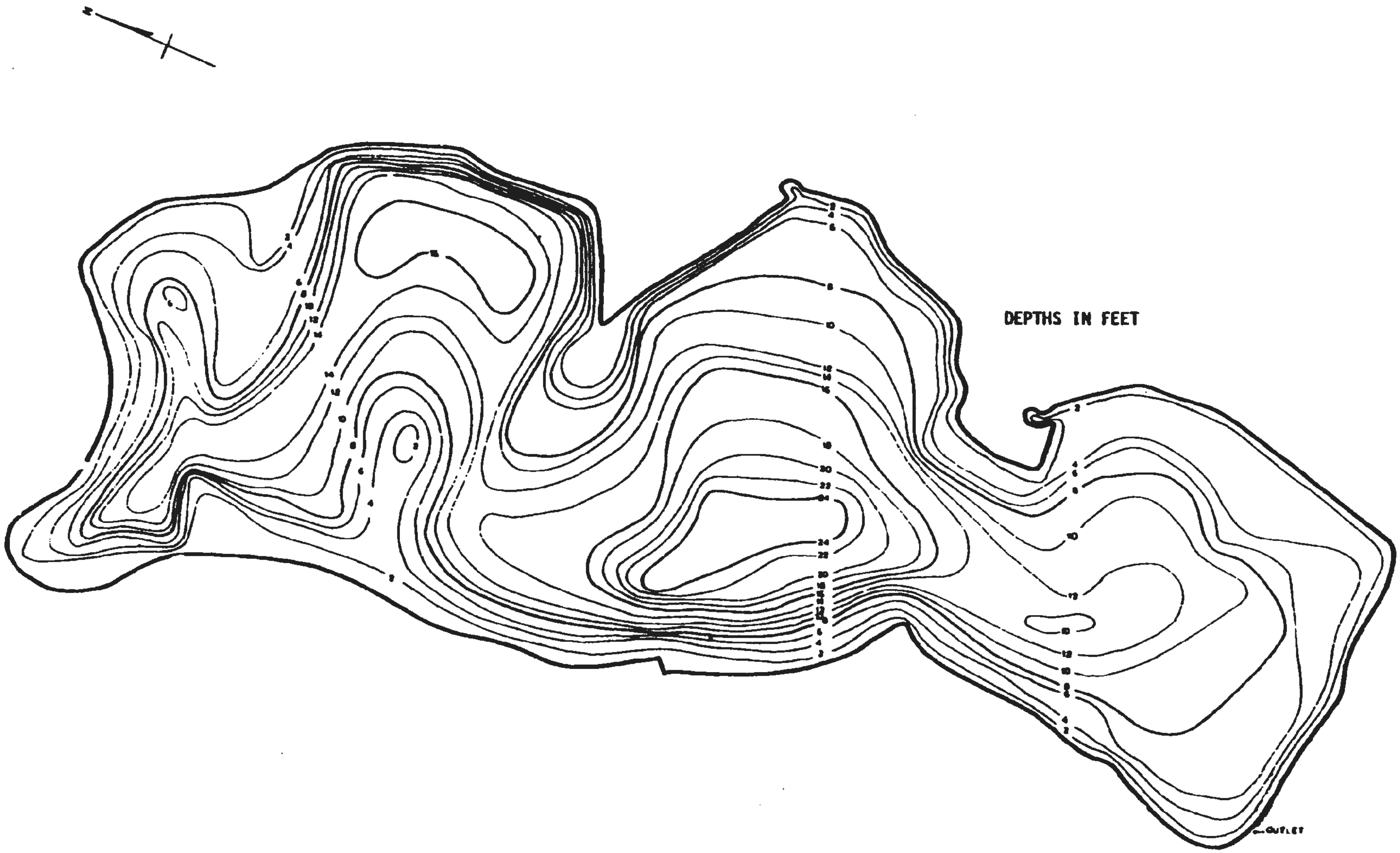
Estimated lake evaporation 91. cm

Thermal stratification? Yes

Major inflows (named and/or permanent streams)
None

Outlet: None

208 Agency:
Iowa Department of Environmental Quality
900 East Grand Avenue
Des Moines, Iowa 50319




968 METERS

YEN-ROU-GIS LAKE
Keokuk County

POLLUTION ASSESSMENT

Data from lake survey in the summer of 1979. Each lake was sampled at least 3 times. Averages are for samples in the upper mixed zone of the lake.

| PARAMETER | SAMPLE SIZE | MEAN | STANDARD ERROR |
|---|---|---|---|
| Secchi disc depth meters | 6 | 2.5 | 0.29 |
| Chlorophyll a mg/cubic meter | 6 | 3.9 | 0.77 |
| Total phosphorus mg/cubic meter | 10 | 13.6 | 1.35 |
| Kjeldahl nitrogen mg/l | 2 | 0.4 | 0.01 |
| Ammonia nitrogen mg/l | 2 | 0.05 | 0.00 |
| Nitrate + nitrite nitrogen mg/l | 2 | 0.05 | 0.01 |
| Seston dry weight mg/l | 10 | 3.6 | 0.49 |
| Turbidity JTU | 12 | 2.5 | 0.26 |
| Total hardness mg/l as $CaCO_3$ | 10 | 330.5 | 3.30 |
| Calcium hardness mg/l as $CaCO_3$ | 10 | 224.6 | 3.27 |
| Total alkalinity mg/l as $CaCO_3$ | 12 | 80.7 | 1.46 |
| Dissolved oxygen mg/l | 10 | 7.7 | 0.13 |
| Specific conductance micromhos/cm at 25 C | 11 | 605.5 | 12.75 |
| Sulfate mg/l | 4 | 212.3 | 1.88 |
| Chloride mg/l | 4 | 2.5 | 0.00 |
| Sodium mg/l | 2 | 4.5 | 0.50 |
| Potassium mg/l | 2 | 4.0 | 0.00 |

Vertical profile for selected measurements on the sampling date ( 8/ 9/79) with the most pronounced stratification (if any).

| DEPTH m | TEMP C | OXYGEN mg/l | TOTAL P mg/cu m | pH | CHL a mg/cu m |
|---|---|---|---|---|---|
| 0 | 32.7 | 8.0 | 8.9 | 8.3 | 2.2 |
| 1 | 32.6 | 7.9 | 10.3 | 8.3 | 2.4 |
| 2 | 32.6 | | | | |
| 3 | 31.2 | 7.8 | 12.4 | 8.3 | 3.0 |
| 4 | 28.5 | | | | |
| 5 | 22.6 | | | | |
| 6 | 17.9 | 0.4 | 15.5 | 7.6 | 8.8 |
| 7 | 14.4 | | | | |

This lake was not included in the National Eutrophication Survey. The trophic state based on 1979 survey is eutrophic.

NON-POINT POLLUTION SOURCES

Shoreline erosion:
Negligible
Estimated erosion rate in region = 14.31-27.77 Tons/Acre/Yr
Potential siltation index =
(watershed area/lake area) x soil loss rate = 60.
Potential nutrient input index =
area watershed in row crops/lake area = 1.5
100.% of watershed is in approved soil conservation practices.
Best management practices recommended by local SCS office:
conservation planting (trees,grass).

POINT SOURCE POLLUTION

No point sources identified

LAKE USE ASSESSMENT

Surface water classification(s)
Class A-primary body contact recreation.
Class B(W)-wildlife, warmwater aquatic life, secondary body contact.
This lake is not designated as a public water supply.

Public parks:
Yen-Ruo-Gis Park (County)

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 1286. | 142.9 | 321.5 |

| | | | |
|---|---|---|---|
| Shore or ice fishing | 7183. | 798.1 | 1795.8 |
| Swimming | 6338. | 704.2 | 1584.5 |
| Pleasure boating | 0. | 0.0 | 0.0 |
| Hunting | 0. | 0.0 | 0.0 |
| Picnicking,camping,other activities prompted by the lake's presence | 16502. | 1833.6 | 4125.5 |
| Snowmobiling | 0. | 0.0 | 0.0 |
| Ice skating and cross-country skiing | 0. | 0.0 | 0.0 |
| TOTAL | 31309. | 3478.8 | 7827.3 |

IMPAIRMENTS

Recreational activities in Yen-Rou-Gis Lake do not appear to be limited by poor water quality; however, aquatic vegetation may interfere with shoreline fishing. Iowa Conservation Commission personnel state that grass carp have been stocked to control aquatic vegetation. I.C.C. personnel consider lake usage to be above its potential.

Estimated aquatic plant coverage 10 %
Estimated winterkill frequencies: rare if ever
Estimated summerkill frequencies: rare if ever

LAKE RESTORATION RECOMMENDATIONS

This lake's water quality is not significantly impaired. Lake Yen-rou-gis has a small watershed/surface area ratio and is a former limestone pit. The lake receives little surface runoff. Consequently, sediment and nutrient inputs are relatively small. White Amur have been stocked in Lake Yen-rou-gis.

Total lake uses for all 107 lakes in this study

Estimates of total annual lake use made by Iowa Conservation Commission district fisheries biologists based on a combination of existing records and professional judgement.

| ACTIVITY | TOTAL | USE/ACRE | USE/HECTARE |
|---|---|---|---|
| Fishing | | | |
| From boats | 530998. | 13.8 | 34.2 |
| Shore or ice fishing | 1389585. | 36.2 | 89.5 |
| Swimming | 1686941. | 44.0 | 108.6 |
| Pleasure boating | 671254. | 17.5 | 43.2 |
| Hunting | 113637. | 3.0 | 7.3 |
| Picnicking,camping,other activities prompted by the lake's presence | 6341788. | 165.3 | 408.4 |
| Snowmobiling | 288221. | 7.5 | 18.6 |
| Ice skating and cross-country skiing | 122432. | 3.2 | 7.9 |
| TOTAL | 11144850. | 290.6 | 717.7 |