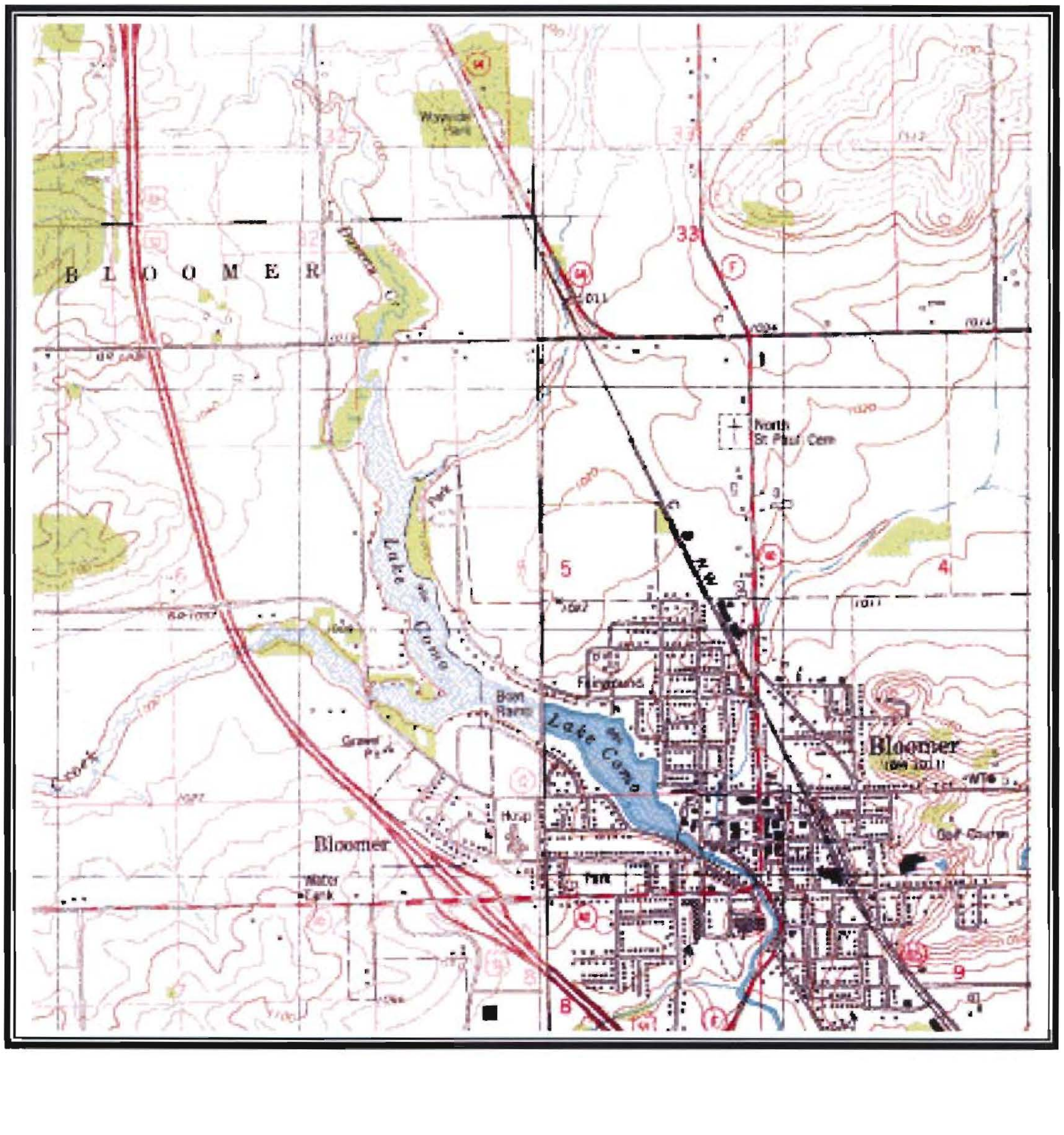
LAKE COMO CONDITION ASSESSMENT



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CHAPTER 1: INTRODUCTION

1-1 BACKGROUND

Lake Como is a 98-acre impoundment of Duncan Creek located in the city of Bloomer in Chippewa County, Wisconsin. It is a mostly urbanized, shallow and fertile water body situated in a large and agriculturally dominated watershed. The lake is recognized as an important natural resource for the community, and is considered a regional asset of environmental, recreational and economic significance. Lake Como is known and used primarily for fishing, peaceful relaxation, wildlife and scenic enjoyment, and limited boating opportunities.

Unfortunately, there is concern among residents and lake users with problems such as degrading water quality, excessive sedimentation, nuisance aquatic weed and algae growth, declining fishery habitat, and restricted motor boat accessibility, among others. These problems have prompted the Bloomer Community Lake Association and the city of Bloomer to conduct a variety of investigations in the hope of gaining a greater understanding of the resource and its many challenges.

The Association subsequently authorized the development of this Condition Assessment for the purpose of compiling and evaluating all existing and readily ascertainable data pertaining to the lake and its watershed. This effort is intended to lay the foundation for the development of a Comprehensive Lake and Watershed Management Plan.

1-2 SCOPE OF WORK

A number of studies were conducted on Lake Como over the last decade. These studies included aquatic plant and fishery inventories, limited water quality testing, and extensive analyses related to the structural condition and performance of the Bloomer Dam. Information obtained through these earlier studies can provide valuable baseline data necessary for diagnosing problems and recommending appropriate management actions.

The purpose of this project is to synthesize and interpret all available findings, conclusions and recommendations presented in these earlier studies. Consequently, the Association will be better able to understand the present condition of Lake Como, as well as more accurately diagnose the root causes of problems that impair the health, use and enjoyment of this important public resource. All findings and conclusions are based on the accuracy and thoroughness of information furnished by the Association. (A list of these informational sources is provided in the References section of this report.) The following Condition Assessment is also meant to identify any critical information gaps that could inhibit the selection of cost-effective management solutions. Should this prove to be the case, specific recommendations would be made on how these data deficiencies can be rectified in the quickest and least expensive manner.

The Condition Assessment fulfills the first of a two-phased approach to develop a Comprehensive Lake and Watershed Management Plan. The second and final project phase shall involve the evaluation and recommendation of applicable management strategies, which will help guide protection and improvement efforts on Lake Como over the next several years. Dredging, mechanical weed harvesting, aeration, herbicide treatments, fishery habitat enhancements, lake-use zoning, and non-point source pollution control measures are just some of the strategy options that shall be investigated using the baseline information contained within this report. Following the completion of both project phases, the chosen course of action will ultimately be based upon the Association's current budget constraints, identified management priorities, and other factors.

CHAPTER 2: CONDITION ASSESSMENT

2-1 LOCATION

Lake Como is an impounded section of Duncan Creek, situated within the city of Bloomer, Woodmohr Township, Chippewa County, Wisconsin (Township 30 North, Range 9 West, Sections 5-8). The city of Bloomer is located about 30 miles north of Eau Claire, Wisconsin, and about 100 miles east of Minneapolis and St. Paul, Minnesota. The adjoining watershed that drains surface water to the lake is situated generally to the north of Lake Como. It consists of the Upper and Middle Duncan Creek and Como Creek Sub-watersheds located in Northwest-Central Wisconsin. A Lake Como location map is presented below as Figure 1.

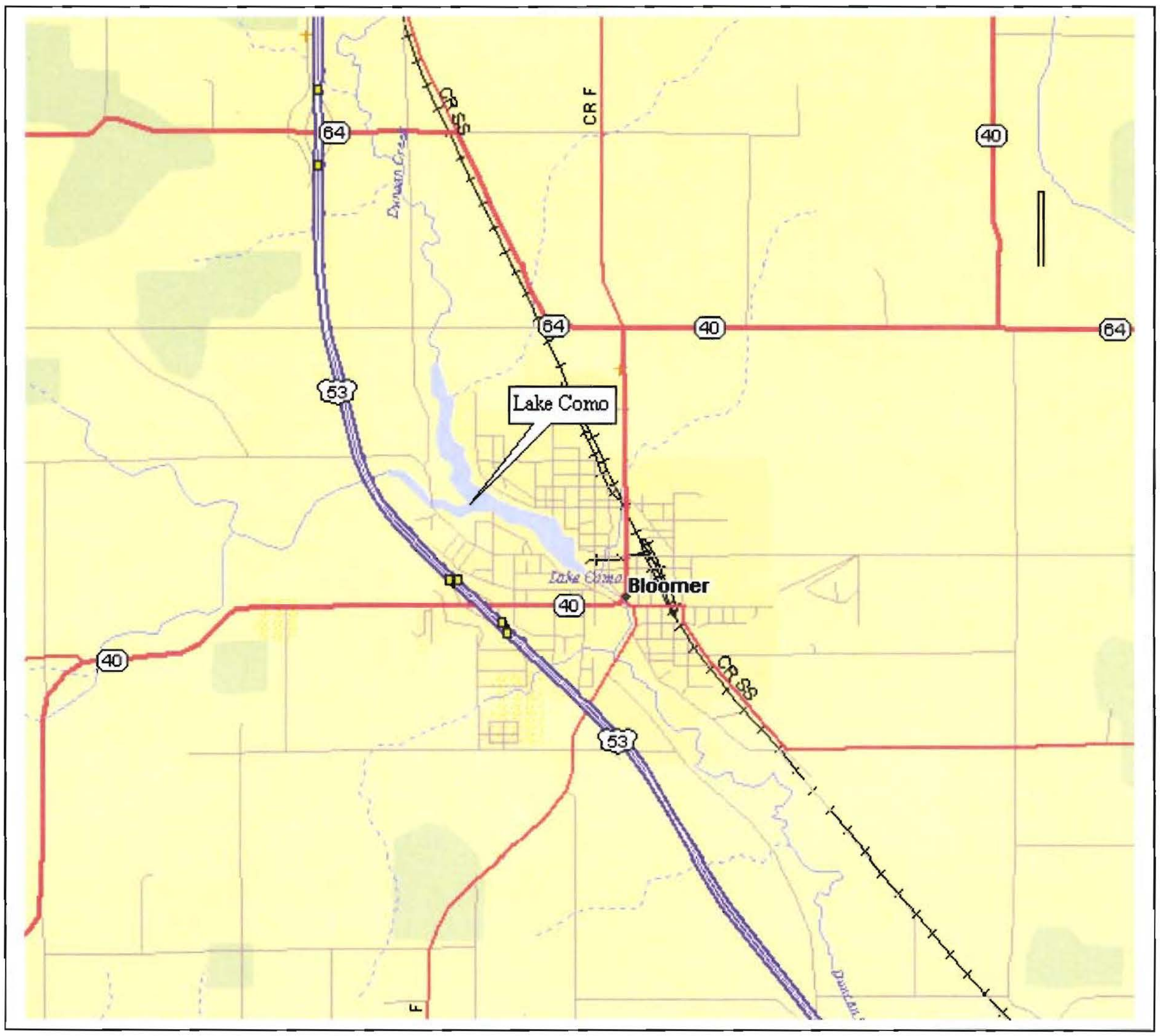


Figure 1: Location Map of Lake Como

2-2 WATERSHED DESCRIPTION

DEFINITION & BOUNDARIES

Water resource professionals often claim lakes are reflections of their watersheds. This is because the health and quality of a lake is directly linked to the condition of the land that drains surface water to the lake, also known as a watershed. A watershed is the total land area that is capable of shedding surface runoff to a particular water body. Its outermost boundary is defined by topographic high points on the adjoining landscape, and can be visualized as a giant bathtub with the lake situated where the drain is located. The watershed area is delineated from the lake's outlet and includes the surface area of the lake. The larger the watershed area, the more water it is able to collect and convey downstream as overland surface flow, also known as stormwater runoff.

Lake Como is situated within about a 50-square mile watershed, consisting of the upper and middle Duncan Creek and Como Creek sub-watersheds. It is a component of the larger, 193-square mile Duncan Creek Drainage Basin as illustrated in Figure 2 below. The upper Duncan Creek sub-watershed is 20.5 square miles and is located in the headwater area of Duncan Creek. The middle Duncan Creek sub-watershed is 13.8 square miles and is located downstream of the upper Duncan sub-watershed and directly above Lake Como. The Como Creek sub-watershed is 12.1 square miles, is located southwest of the Village of Bloomer, and includes Lake Como. Como Creek, which flows northeasterly 2.8 miles to Lake Como, is the only perennial stream in this sub-watershed (Nonpoint Source Control Plan, 1993).

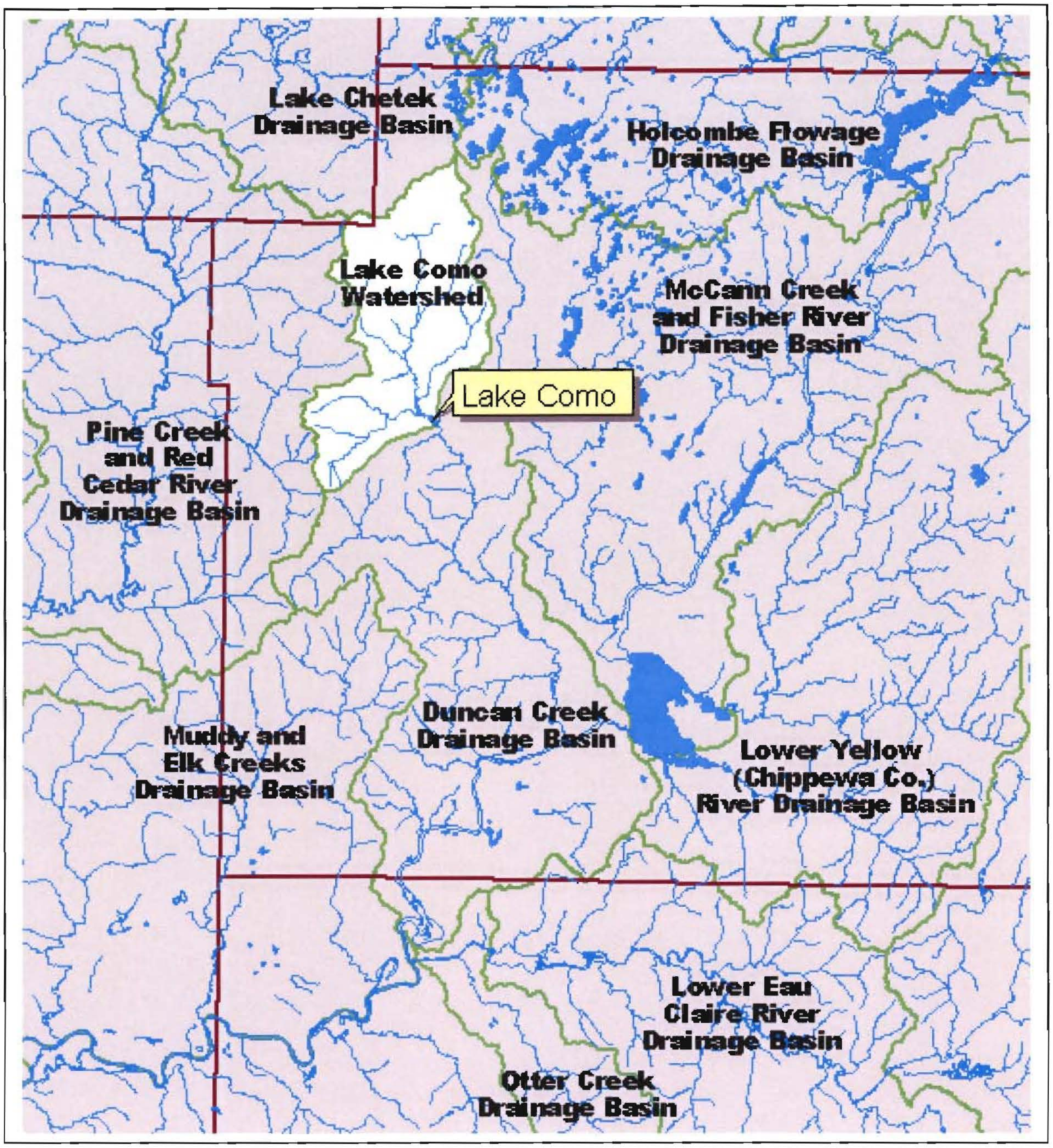


Figure 2: Lake Como Watershed and Adjoining Drainage Basins

Physical Setting

The types of land uses and land cover in the watershed can be a significant influence on the health and quality of Lake Como. The Lake Como watershed is comprised mainly of field crops (43%), forest (25%), grassland (21%), and open water and wetland storage areas (9%). Table 1 presents a detailed breakdown of these land uses and cover types. An accompanying land-use map is illustrated as Figure 3.

Table 1: **Land uses and cover types in the Lake Como Watershed.**

Land Use	Land-use Subcategory	Acres	Percent of Total Area
Urban/Developed	High Intensity	32.9	0.11%
Urban/Developed	Low Intensity	261.8	0.89%
Agriculture	Herbaceous/Field Crops	12,563.2	42.82%
Grassland	Grassland	6,109.5	20.82%
Forest	Coniferous	91.8	0.31%
Forest	Broad-leafed/Deciduous	7,169.0	24.43%
Forest	Mixed Deciduous/ Coniferous	36.7	0.13%
Open Water	Open Water	131.4	0.45%
Wetland	Emergent/Wet Meadow	942.1	3.21%
Wetland	Lowland Shrub	977.9	3.33%
Wetland	Forested	532.6	1.82%
Barren	Barren	107.4	0.37%
Shrubland	Shrubland	372.1	1.27%

Source: GEODISC 2.1, a Geographic Information Datasharing CD-ROM produced by the Wisconsin Department of Natural Resources, Bureau of Enterprise Information Technology and Applications, Geographic Services Section (WiDNR/GEO). These notes were last updated on January 29, 1998.

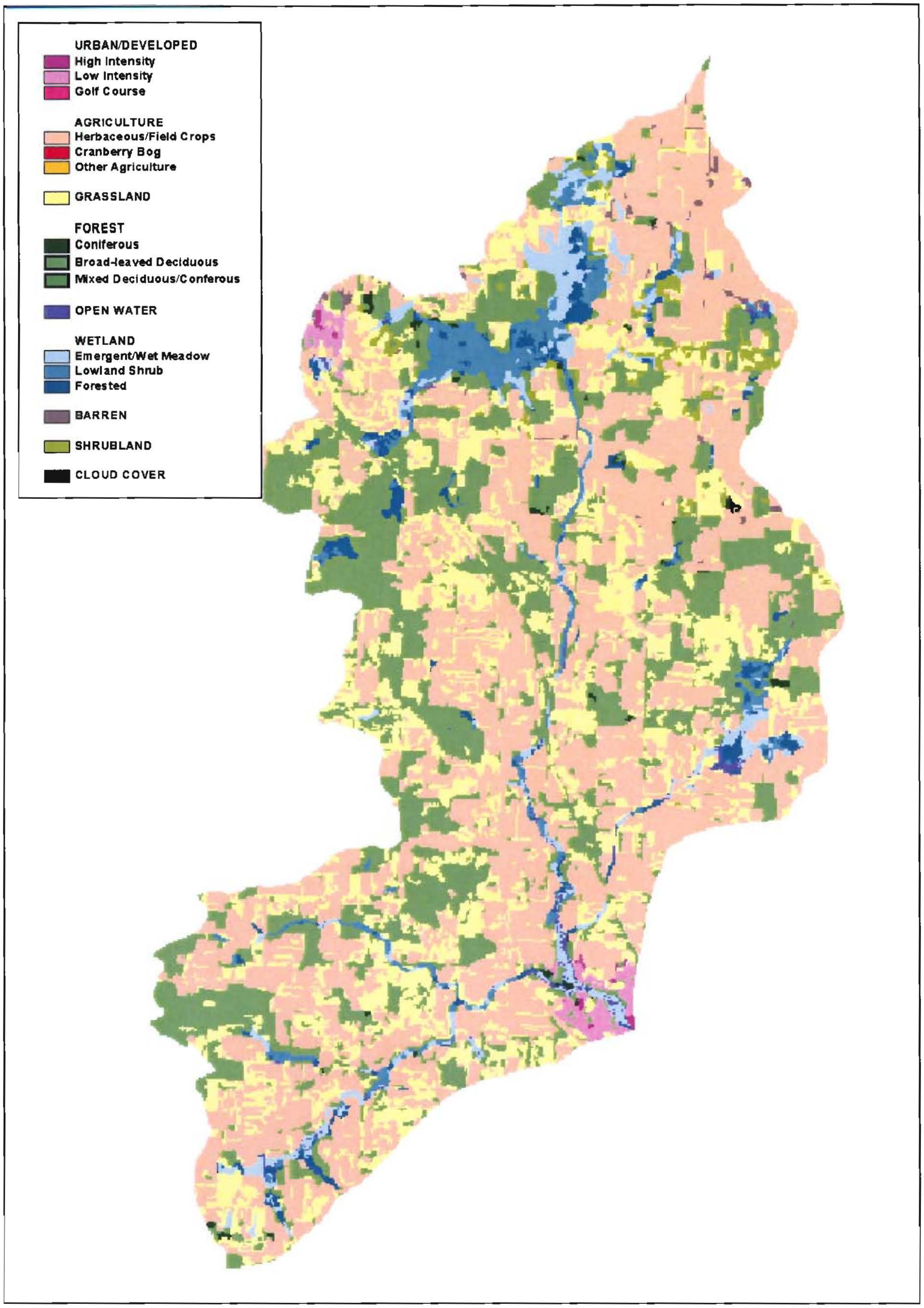


Figure 3: Lake Como Watershed Land Uses

The distributions of stream segments are characteristic of a dendritic drainage pattern, formed in a bedrock-controlled landscape. On average, the slope of intermittent streams is an order of magnitude larger than the slope of perennial streams. Average stream gradient is eight feet per mile, with the watershed's upper reaches being dominated by high quality, Class I brook trout streams. The lake itself is classified as a warm-water sport fishery due to hydrologic modifications from the impoundment and urban development. Normal annual precipitation is 31 inches, with surface water flowing generally north to south. Basin topography is low with rolling hills and numerous wetlands and lakes, typical of glacial topography with a reworked moraine. A map illustrating topographic and hydrographic features in the Lake Como Watershed is presented in Figure 4 below.

Regional soils consist primarily of the Billet-Rosholt-Oesterle association. These soils are described as deep, nearly level to sloping, well drained to somewhat poorly drained, loamy soils on outwash plains and stream terraces. The geology of the larger Duncan Creek Basin consists of glacial drift overlying Cambrian aged sandstone and Precambrian aged igneous and metamorphic rocks. The glacially deposited sand and gravel occur as moraine deposits in the northern half of the basin (Lake Como watershed area), and as broad outwash plain in the east. The sand and gravel are highly variable in terms of material, ranging from significant clays to large diameter sand and gravel. Two aquifers supply 100% of the potable water for homes, industries and municipalities. These include the shallower (30-60 feet), sand and gravel aquifer, and the underlying sandstone aquifer that ranges in thickness from 100-200 feet (Nonpoint Source Control Plan, 1993).

Watershed-To-Lake Surface Area Ratio

Watershed-to-lake surface area ratios are used to estimate the level of influence the surrounding landscape has on water quality. As the size of the watershed increases in relation to the size of the lake, the greater the likelihood of pollutants entering the lake via stormwater runoff. This runoff is generated from snowmelt, precipitation and groundwater-derived discharge that does not evaporate or infiltrate into the soil. Instead, it collects on the landscape and is eventually funneled down gradient toward a receiving water body, transporting everything it can pick up and carry from the watershed to the lake. The actual amount of pollutants delivered depends on watershed size, soil type, topographic relief, land-use practices, and runoff flow characteristics.

Lake Como lies at the terminus of an approximately 50-square-mile watershed that drains mostly farmland. The lake has a 0.153 square-mile surface area, which equates to a watershed-to-lake surface area ratio of nearly 327:1. Lakes with ratios greater than 10:1 are shown to more commonly experience water quality problems when compared to lakes with smaller ratios. This is especially true in developed watersheds that are dominated by fertile, easily eroded soils, and where poor land-use practices produce excess runoff and erosion. Knowing the size of a particular watershed, as well as its defining topographic features, soil types and land uses will offer clues as to how much management effort will need to be focused in these critical upland areas.

Lake Como shows evidence of degraded water quality conditions due to the influx of excessive nutrients and sediment pollution from the outlying watershed. Since the lake will continue to receive most of its water from stream discharge, it is important to properly manage watershed land use to improve water quality conditions in Lake Como.

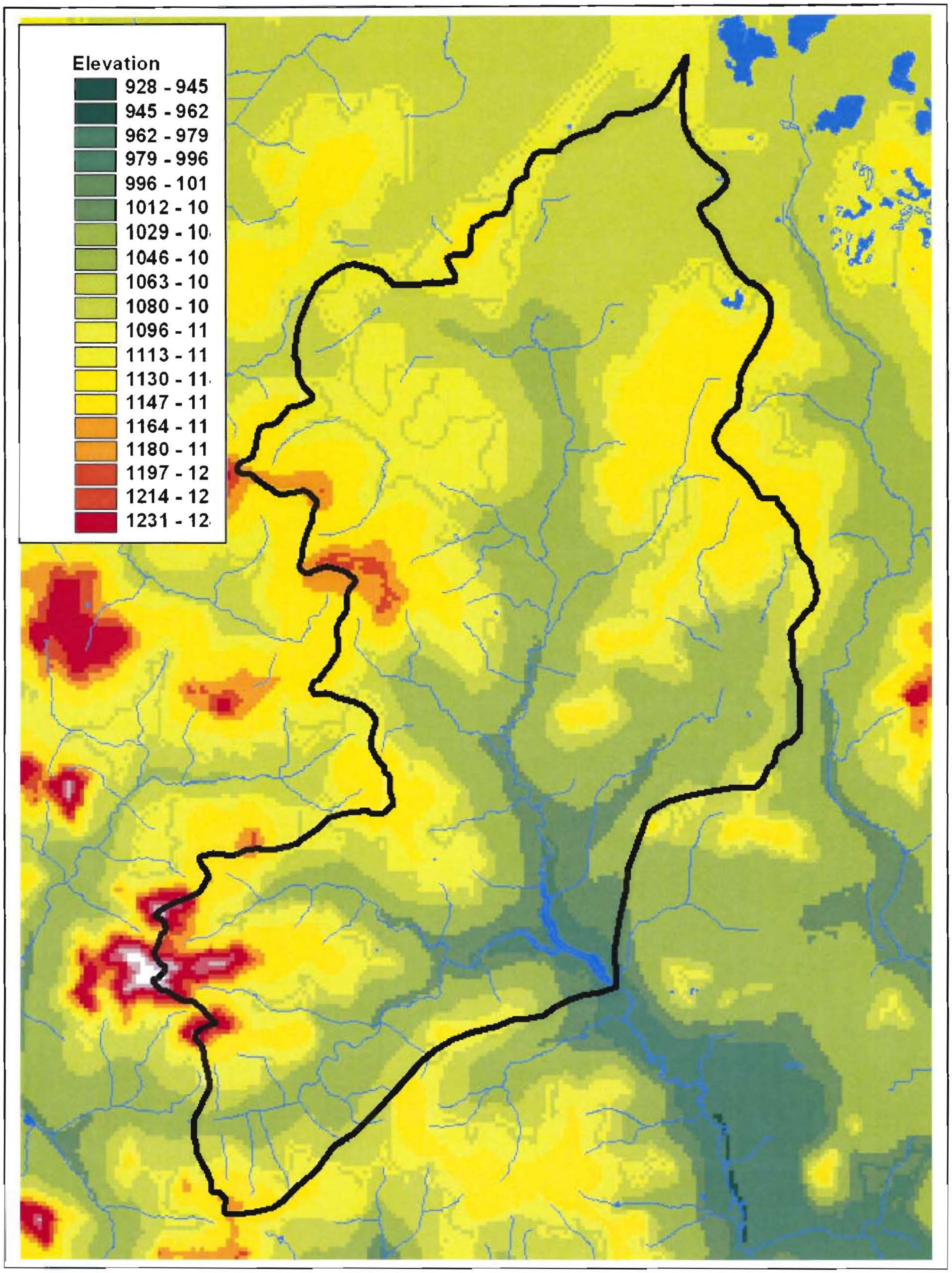


Figure 4: Lake Como Watershed Topography and Hydrography

2-3 LAKE DESCRIPTION

OVERVIEW

Lake Como is a 98-acre, shallow, artificially impounded drainage lake on Duncan Creek with a maximum depth of six feet (Schreiber, 1992). The lake receives most of its surface water from an extensive, agriculturally dominated watershed. Shallow water depths in conjunction with high nutrient inputs from the surrounding watershed have resulted in a highly eutrophic water body as classified by the lake Trophic Status Index. As a result, the lake suffers from abnormally elevated nutrient concentrations, algal blooms, dense duckweed growth, sedimentation, and turbid water. Lake Como is managed as a warm water sport fishery consisting of largemouth bass, northern pike, and a variety of panfish as the primary species (Nonpoint Source Control Plan, 1993). In terms of recreation, it is mostly used for fishing, swimming, waterfowl hunting, peaceful relaxation, and limited boating. The city maintains a swimming beach, public fishing pier, and two boat landings, one of which is improved. The majority of the shoreline is developed and located in the city of Bloomer, and the remainder is agricultural. A topographic map and aerial photo of the Lake Como area are presented below as Figures 5 and 6, respectively.

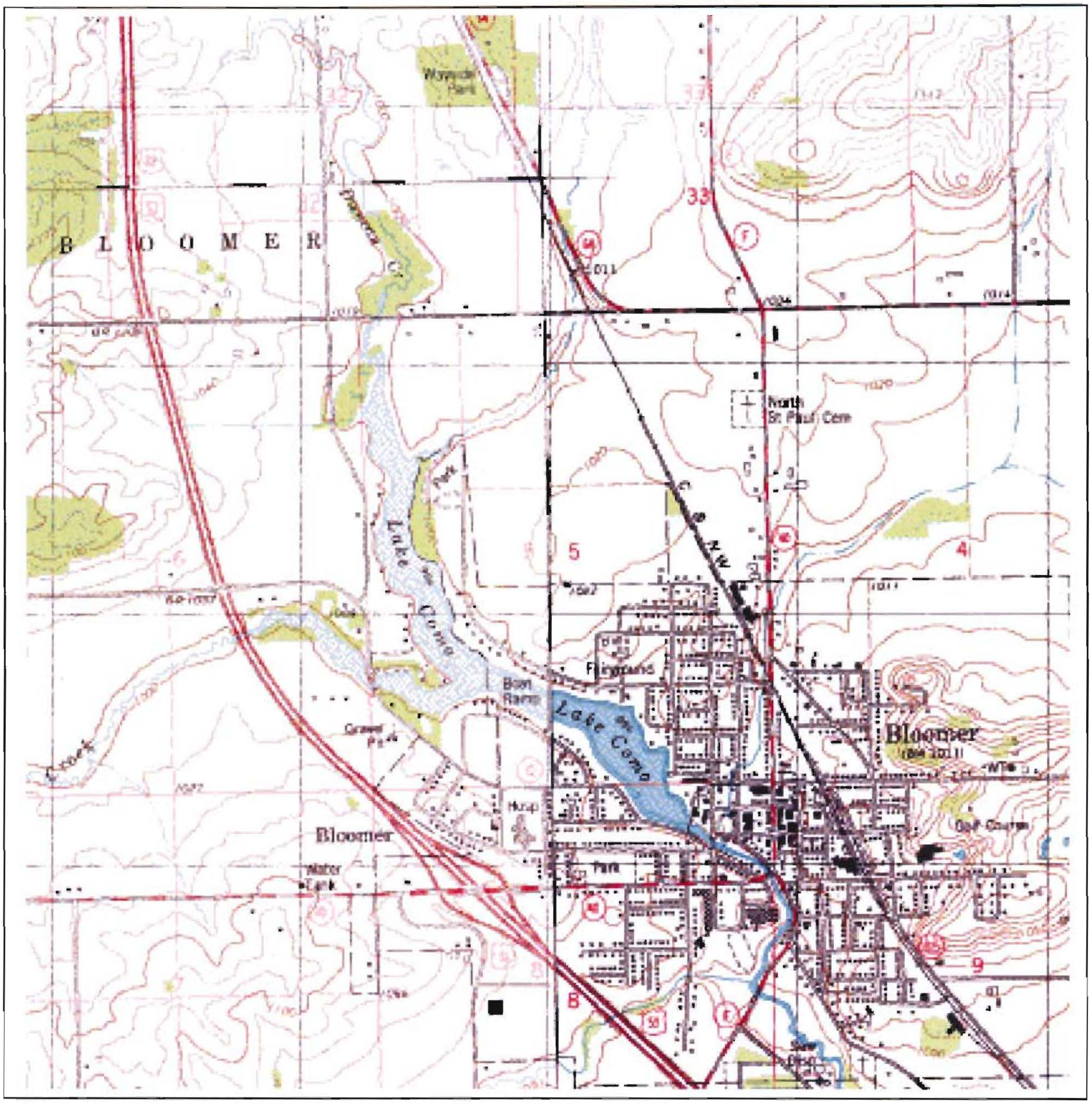


Figure 5: Topographic Map of Lake Como Area

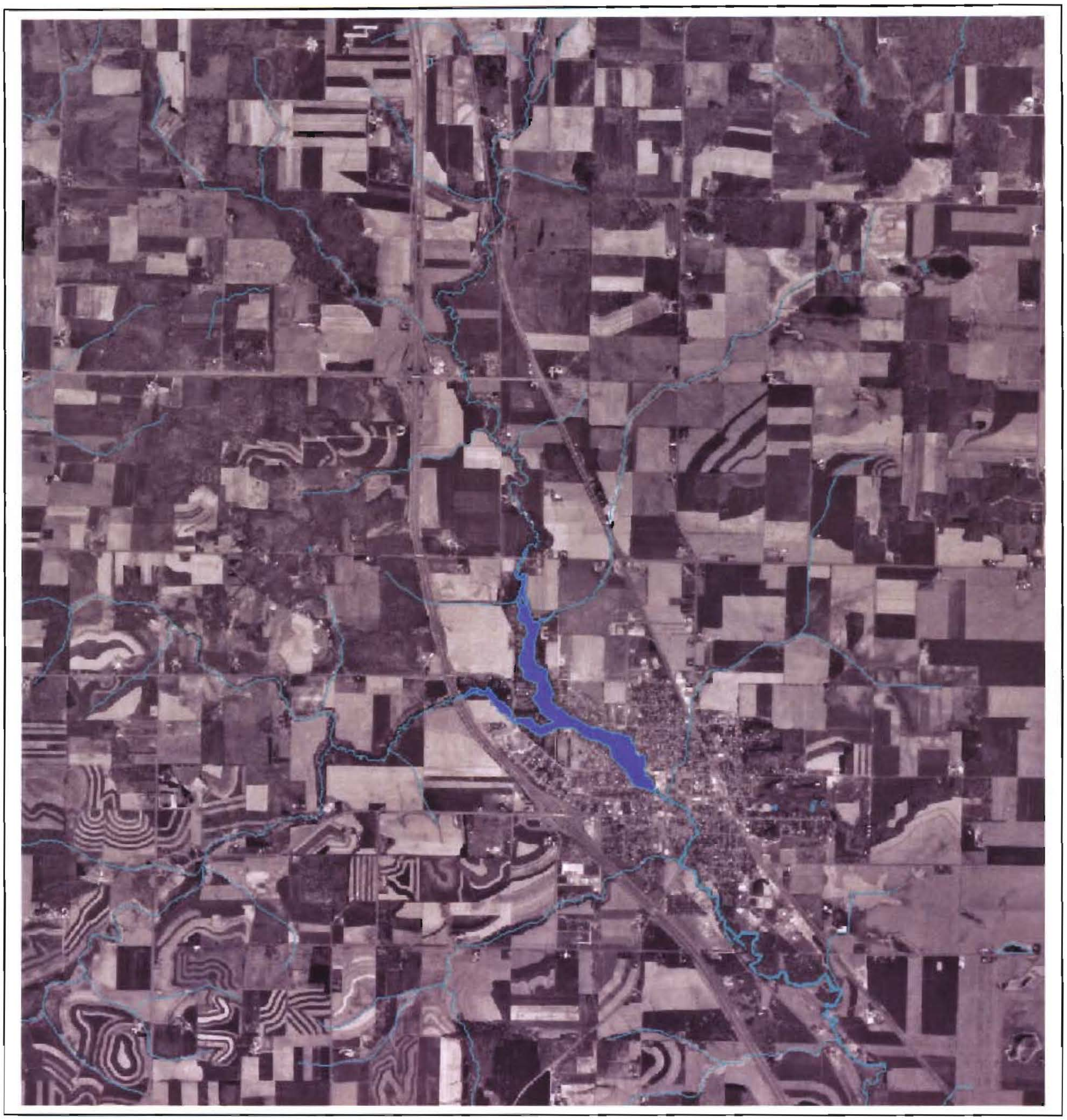


Figure 6: 1996 Aerial Photograph of Lake Como Area

LAKE TYPE

Lakes may be classified according to their primary source of water, and how that water enters and leaves the water body. Drainage lakes like Lake Como receive most of their water from the watershed in the form of stream drainage. These lakes have a prominent inlet and outlet that serve to move water through the system. Lake Como has two significant inlets—Duncan and Como Creeks. Duncan Creek enters the north end of the lake, while Como Creek enters the west-central portion of the lake. There is also a small intermittent tributary that enters the lake to its north. Drainage lakes are referred to as artificial lakes, impoundments or flowages when a dam is responsible for at least one-half of their maximum depth—as is the case with Lake Como.

Knowledge of lake types is important when attempting to identify and address various water quality and quantity problems. By examining the different sources and quality of water that recharge a lake, it becomes much easier to pinpoint the root causes of water quality impairments. For example, if stream discharge provides the major source of water, nutrient levels are often high and water exchange takes place more rapidly. These lake types have the most variable water quality, depending on the amount of runoff and human activity in the watershed. Conversely, if groundwater is the major water source, the lake is usually well buffered against acid rain, contains low to moderate amounts of nutrients, and has fairly slow water exchange rates. This includes all groundwater drainage lakes and some seepage lakes. Local septic systems or groundwater contamination could cause water quality problems in these lake systems.

MORPHOMETRY

Lake morphometry (or bathymetry) describes a lake's physical dimensions. Lake Como's physical characteristics include lake volume (343 acre-feet of water - estimated), surface area (98 acres), shoreline length (5.25 miles), mean depth (3.5 feet – estimated) and maximum depth (6 feet). It has a gradually sloping bottom, with the deepest point occurring along the thread of the old river channel near the lake's center. The lake is 1.53 miles long and only 0.35 mile wide, with 60% of the lake less than three feet deep (WCD, 1961). Its small width and geographic orientation translate into a relatively short fetch. Fetch describes the maximum distance across a lake that would be subjected to the effects of prevailing winds. Longer fetches generally result in more pronounced, wind-induced mixing events. However, despite a short fetch, Lake Como's shallow water depths mean that less wind energy is needed to effectively mix and aerate the lake.

Surface area, maximum and mean water depths, basin shape, shoreline length, water volume, and other physical measurements can offer many clues as to how a lake should appear and function in a natural state. For example, a lake's morphometry will dictate how well its water column is able to mix and self-aerate. The extent to which the water mixes affects the lake's water quality and ability to support a diversity of aquatic life. The complete mixing of a lake's water column is called "turnover." While shallow lakes tend to continuously mix or turn over throughout the year due to wind and wave action, deeper lakes turn over less frequently—typically as a result of seasonal temperature changes or large storm events. This is because deeper lakes undergo a process known as thermal stratification.

2-4 WATER QUALITY ASSESSMENT

THERMAL STRATIFICATION

Thermal stratification occurs in deep lakes during stable weather conditions when the water column forms horizontal water layers of varying temperatures and densities. As air temperatures rise in the spring, a temperature-density "barrier" begins to form in deeper water bodies between the warmer, lighter surface water that is heated by solar energy and the underlying denser, colder water. This barrier is marked by a sharp temperature gradient called the thermocline. The zone where the thermocline occurs is known as the metalimnion. It separates the warmer, less dense, upper zone of water called the epilimnion, from the cooler, more dense, lower zone called the hypolimnion. Summer stratification generally occurs in lakes where depths are greater than 20 feet. However, depending on their shape, small lakes can stratify even if they are less than 20 feet deep. In larger lakes, the wind may continuously mix the water to a depth of 30 feet or more.

Lakes may also undergo a second stratification period during the winter months. Because water density peaks at 39°F, winter stratification develops with a temperature difference of only 7°F between the top and bottom (32°F right below the ice versus 39°F on the lake bottom). This explains why ice floats and forms at the water's surface. The ice layer at the surface helps maintain stratification by preventing wind from mixing the water column. The ice also helps insulate the water beneath it, which prevents deeper lakes from freezing solid.

The temperature and density of the water column will be fairly consistent from top to bottom in both the early spring and late fall. The uniform water density allows the lake to mix completely, replenishing the bottom water with dissolved oxygen and recycling nutrients up to the surface. This destratification process is called spring and fall turnover. Algal blooms often proceed turnover events in stratified, eutrophic lakes when nutrients are suddenly infused into the upper photic zone of the lake.

It is important to note that lakes experiencing strong thermal stratification are frequently subject to oxygen depletion in the hypolimnion. As algae, plant debris and other organic material fall into the hypolimnion to decay, oxygen becomes depleted to the extent that anaerobic conditions may develop. A strong sulfur odor is frequently associated with such waters. This oxygen deficiency can stress a cool water fishery, and may cause the mobilization of phosphorus from nutrient-rich bottom sediment into the overlying water. During turnover, the fertile bottom water is then mixed throughout the water column, creating a situation that favors nuisance algal blooms.

Lake Como is considered polymictic, meaning it rarely stratifies and experiences multiple mixing events throughout the year. Although Lake Como could potentially become very weakly stratified during the mid-summer period, it should remain fairly well mixed on a year-round basis. Consequently, the lake does not likely form an extensive hypolimnetic zone, nor would it likely suffer from the effects of oxygen depletion caused by strong thermal gradients.

The Army Corps of Engineers conducted a study titled "Lake Como at Bloomer, Wisconsin, Hydraulic and Thermal Study", which was a computer modeling study, documented in a November 2001 report. The purpose of the study was to evaluate the efficacy of modifying the lake bottom and reconfiguring the outlet in the interest of reestablishing a cold water fishery in the downstream reach of Duncan Creek. The modeling program CE-QUAL W2 version 2.0, was chosen by the modeling team, to evaluate the hydraulic and temperature characteristics of Lake Como for both the Base Conditions as well as various Future Scenario Conditions. Basically the modeling compared inflow and outflow temperatures for base conditions versus various combinations of dredging and gate/weir configurations. The modeling concluded that Scenarios outlined in Plan B and Plan E gave the best results in terms of temperature reduction. Plans B and E are outlined as follows:

Plan B: Outflows from 1 meter wide Sluice Gate and 1 meter wide weir at WSEL 2.75.
Withdrawals take 0.5 meters from Lake Bottom and the weir at Segment 16
1 meter wide x 1 meter deep dredged channel for upper branch 1 segments (2-9)
2 meter wide x 1 meter deep dredged channel for lower branch 1 segments (10-16)
1 meter wide x 1 meter deep dredged channel for branch 2 segments (19-27)
Constant Gate Opening of 0.1 meters

Plan E: Outflows from 1 meter wide Sluice Gate and 1 meter wide weir at WSEL 2.75.
Withdrawals take 0.5 meters from Lake Bottom and the weir at Segment 16
1 meter wide x 1 meter deep dredged channel for upper branch 1 segments (2-9)
2 meter wide x 1 meter deep dredged channel for lower branch 1 segments (10-16)
1 meter wide x 1 meter deep dredged channel for branch 2 segments (19-27)
Variable Gate Opening

The study conclusions mentioned that the study did not attempt to address the issue of whether the temperature reductions are significant enough to justify the dredging costs that will be needed in order to achieve them. The conclusions also mentioned that the study "should be acceptable in terms of quantifying relative differences between the Base Conditions and the Future Scenarios." and "Given that there were no observed flows and temperatures for Lake Como, this model can not be considered to be calibrated. If observed flows and temperatures are gathered, then the model can be calibrated and verified so that temperatures can be computed, with some confidence."

Hydraulic Residence Time & Flushing Rate

The average length of time water remains in a lake is called the retention time, or hydraulic residence time. It is primarily determined by lake size, water source, and watershed size. Rapid water exchange (flushing) rates allow nutrients to be passed through the lake quickly. Such lakes respond best to management practices that decrease nutrient input. Drainage systems and impoundments—like Lake Como—fit this category. Conversely, longer retention times occur in seepage lakes with no surface outlets. Nutrients that accumulate over a number of years in lakes with long retention times can be recycled annually with spring and fall mixing. Thus, the effects of watershed protection may not be apparent for a number of years, and in-lake nutrient control strategies are often warranted. Nevertheless, lakes with long retention times tend to have the best water quality since they are also usually deeper with smaller watersheds.

Residence time is an important factor in algal growth. Increased residence time could lead to algal blooms in Lake Como. Changes in residence time should be taken into account in management decisions for Lake Como.

Trophic Status Index

Eutrophication is a term used to define the aging process of a lake, and describes the primary productivity response of a lake to nutrient enrichment. Water bodies that receive excessive amounts of nutrients, such as phosphorus and nitrogen, are most likely to become eutrophic systems. Once in the lake, these excess nutrients increase fertility levels and contribute to murky water conditions, algal blooms or nuisance weed growth—the symptoms of eutrophication.

A lake's trophic state describes its degree of eutrophication or level of primary productivity. Lakes can be classified as either oligotrophic, mesotrophic or eutrophic. Oligotrophic lakes are generally clear, deep and free of weeds or algal blooms. They are low in nutrients and are not capable of supporting large fish populations. At the opposite end of the spectrum, eutrophic lakes have poor water clarity, are high in nutrients, and support a large biomass of aquatic plants and animals. They are usually either weedy or subject to frequent algal blooms, or both. Although capable of supporting large fish populations, these lakes are also susceptible to oxygen depletion. Devoid of oxygen in late summer, the hypolimnions of many eutrophic lakes become intolerable to cold water fishes and cause phosphorous cycling from bottom sediments. Large rough fish populations (e.g. carp) are commonly found in eutrophic lakes. Mesotrophic lakes lie between the oligotrophic and eutrophic stages. It is important to recognize that a natural aging process occurs in all lakes that cause them to become shallower and increasingly eutrophic over time. However, human activity can accelerate the eutrophication process by allowing greater quantities of nutrients to enter the lake and at much faster rates.

A lake's Trophic Status Index (TSI) is determined by correlating three water quality parameters--phosphorus concentration, chlorophyll *a* concentration and water transparency values. **The TSI for Lake Como indicates it is highly eutrophic.** This means the lake is characterized by high nutrient concentrations, high levels of primary productivity, and poor water clarity. The TSI plot exhibits a discrepancy between total phosphorus and the other water quality parameters, suggesting that chlorophyll a and Secchi depth values should be higher based on the phosphorus values. This discrepancy is likely due to the short water retention time in the impoundment (about 24 hours) that prevents excessive algal blooms from occurring. Algae growth may also be inhibited by shading from dense duckweed growth on the surface (Schreiber, 1992).

Trophic levels and associated Trophic State Indexes of Wisconsin lakes based on chlorophyll a, Secchi depth, and total phosphorus values are presented in Table 2 below.

Table 2: Trophic classification of Wisconsin lakes based on total phosphorus, chlorophyll a, and Secchi depth values.

(Adapted from Lillie and Mason, 1983.)

Trophic Level	Trophic State Index	Total Phosphorus (mg/l)	Chlorophyll *a* (ug/l)	Secchi Depth (meters)
Eutrophic				
------------------------	-----------50----------	--------0.017----------	-----------7.4----------	-----------2.0----------
Mesotrophic				
------------------------	-----------40----------	--------0.005----------	-----------2.0----------	-----------4.0----------
Oligotrophic				

Limiting Nutrient

Phosphorus (P) and nitrogen (N) are the two nutrients that most directly influence plant and algae growth; the extent of which depends on the relative abundance and availability of each nutrient. These nutrients usually enter lakes in the form of polluted runoff that may contain sediment, manure, pet waste, chemical fertilizers, and organic debris, among other materials. The erosion of stream banks, construction sites, shorelines and farmland all contribute sediment and nutrients to downstream lakes. Failing septic systems on smaller, heavily developed lakes with small flushing rates can also contribute significantly to nutrient-loading problems. Septic contributions are not considered a significant problem on Lake Como.

Plants need both phosphorus and nitrogen to grow. However, phosphorus minimization is generally the focus of lake-management programs because it is (1) most frequently the limiting nutrient that controls the rate of algae growth, and (2) it is easiest to manipulate since the element has no gaseous component in its biogeochemical cycle. N:P ratios are used to determine which nutrient most "limits" or controls algae productivity by comparing the relative availability of each nutrient within the water column. A limiting nutrient is an element that is critical to the growth of primary producers, but is found in short supply relative to other required elements found in a particular water body. Because the essential nutrient is in short supply, it effectively limits the amount of primary productivity the lake is capable of supporting. A N:P ratio greater than 15:1 near the water surface may generally be considered phosphorus limiting; a ratio from 10:1 to 15:1 indicates a transition situation; and a ratio less than 10:1 usually indicates nitrogen limitation. Lakes with intermediate ratios could be limited from time to time by either element, but by reducing phosphorus availability, phosphorus could be made the limiting factor.

An N:P ratio of 8.5:1 was computed for Lake Como using 1991 water quality data. Because the N:P ratio is less than 10:1, nitrogen appears to be the limiting nutrient for algae growth in Lake Como (Schreiber, 1992). This is not typical since phosphorus is the key nutrient affecting the amount of algae and weed growth in the vast majority of Wisconsin's lakes.

The lake bottom may also be a significant source of phosphorus. Phosphorus is commonly released from nutrient-rich bottom sediment as a result of physical disturbance, high pH levels, and/or anoxic conditions. This phosphorus may cause noxious algal blooms, especially when it is mixed throughout the water column during the summer growing season. Knowledge of the phosphorus content of sediment in various locations along the lakebed is useful in identifying potential "hot spots" that are most likely to contribute the largest amounts of nutrients to the lake. This information can be used to determine whether management techniques such as dredging and alum treatments will effectively correct a potential in-lake, nutrient-recycling problem. Sediment cores are generally taken at certain locations in a lake to better characterize the depth and distribution of nutrient-rich bottom sediments.

In addition, total phosphorus concentrations at the top and bottom of the water column can be compared. These measurements can suggest whether phosphorus is actually collecting in the anoxic hypolimnion (if present) from sediment releases during the summer stratification period. Because Lake Como is so shallow, phosphorus release due to stratification-induced anoxia is not a serious concern.

When phosphorus concentrations exceed 0.025 mg/l at the time of spring turnover in natural lakes and impoundments, these water bodies may occasionally experience excess growth of algae or other aquatic plants. In hard water lakes where limestone is dissolved in the water, marl (calcium carbonate) precipitates and falls to the bottom. These marl formations absorb phosphorus, reducing its overall concentration as well as algae growth. Hard water lakes often have clear water, but may be weedy since rooted aquatic plants can still get phosphorus from the sediments. This would not be the case for Lake Como given that it is considered a soft water lake according to available water quality data.

Phytoplankton (Aglae)

Phytoplankton, more commonly known as algae, describes free-floating, microscopic plant life. Algae are the primary producers that form the base of the aquatic food chain. The amount of sunlight and nutrients that are available in a lake, among other factors, will dictate algae abundance. In eutrophic lakes, high nutrient fertility can cause nuisance algal blooms that make the water appear very green and murky. Blue green algae (cyanobacteria) are even known to produce a floating green scum thick enough to shade out aquatic plants. High concentrations of wind-blown algae may accumulate on shorelines where they die and decompose, causing noxious odors, unsightly conditions and oxygen depletion.

Controlling nuisance algae populations in lakes is a difficult undertaking. Because algae are microscopic plants that are free-floating and even free-swimming in the water column, managing the whole lake rather than just the problem areas is usually necessary. Since algae populations are caused by high nutrient concentrations, attempting to eliminate algae by attacking it directly with algacides (chemical herbicides) is a short-term solution that may become a costly management approach over the long run. The best way to manage excessive algae is to both reduce the flow of nutrients into the lake, and control the availability of nutrients that are already contained within the lake.

Chlorophyll *a*, the green pigment found in all photosynthesizing organisms, is commonly used as an indicator of algal biomass. Chlorophyll *a* values for Lake Como during the summer months are generally indicative of a eutrophic system (Schreiber, 1992).

Water Clarity

Water transparency measurements are taken with a device known as a Secchi disc, which is used to evaluate the clarity of a lake's water column. A Secchi disc is an eight-inch-diameter, black-and-white patterned plate that is lowered into the water until it reaches a depth at which it is no longer visible from the water surface. The recorded depth can be compared to values from other lakes and used as an indicator of overall water clarity.

Generally, sunlight can penetrate to a depth equal to 1.7 times the Secchi depth. The depth to which light is able to penetrate, defined as the photic zone, roughly coincides with the depth where there is enough oxygen to support fish and other aquatic life. Transparency may be affected by factors such as turbidity (suspended sediment and particulate matter), water color, and free-floating algae cells. Secchi depth measurements are often used in conjunction with chlorophyll ***a*** and total phosphorus concentrations to determine a lake's trophic state and overall water quality condition.

Secchi measurements taken on Lake Como typically range from 0.6 to 1.4 meters (Schreiber, 1992). These measurements are indicative of a fairly turbid water column in comparison to similar lakes. Non-point source pollution and the re-suspension of bottom sediment are believed to contribute to the poor water clarity conditions.

WATER QUALITY INDEX

Lillie and Mason (1983) classified all Wisconsin lakes using a random data set collected in the months of July and August. The water-quality index that was developed is based on surface total-phosphorus and chlorophyll *a* concentrations and Secchi depths. Applying the water-quality index to Lake Como revealed that the measured surface total-phosphorus concentrations (0.25 mg/l summer mean), Secchi transparency (0.92 meter summer mean), and chlorophyll *a* concentrations (33.5 ug/l summer mean) were all generally indicative of "very poor" water quality. These findings were based on available data collected between 1987 and 1995 (STORET, 1987-95). Table 3 shows the total phosphorus, chlorophyll *a* and Secchi depth ranges that correspond with each water quality ranking. Typical value ranges for Lake Como's 1987-95 monitoring period are highlighted. Table 4 shows the relative condition and percent distribution of Wisconsin impoundments that exhibit various total phosphorus, chlorophyll *a* and Secchi depth ranges. Once again, typical value ranges for Lake Como's 1987-95 monitoring period are highlighted.

Table 3: Water quality index for Wisconsin impoundments statewide based on total phosphorus, chlorophyll a and Secchi depth values.

(Adapted from Lillie and Mason, 1983)

Water Quality Index	Total Phosphorus (mg/l)	Chlorophyll a ([g/l)	Secchi Depth (meters)
Excellent	<0.001	<0.4	>6
Very good	0.001-0.007	0.4-1.2	3.0-6.0
Good	0.007-0.023	1.2-2.8	2.0-3.0
Fair	0.023-0.044	2.8-9.6	1.5-2.0
Poor	0.044-0.134	9.6-22.2	1.0-1.5
Very poor	>0.134	>22.2	<1.0

Table 4: Relative condition and percent distribution of central Wisconsin lakes within various parameter ranges.

Parameter	Relative Condition	% distribution of impoundments statewide within parameter ranges
Total-phosphorus (mg/l)		
<0.010	Best condition	6
0.010-0.020	▼	17
0.020-0.030	▼	20
0.030-0.050	▼	23
0.050-0.100	▼	17
0.100-.0150	▼	9
>0.150	Worst condition	8
Chlorophyll a (ug/l)		
0-5	Best condition	12
5-10	▼	33
10-15	▼	11
15-30	▼	21
>30	Worst condition	22
Secchi depth (feet)		
>19.7	Best condition	0
9.8-19.7	▼	3
6.6-9.8	▼	13
3.3-6.6	▼	43
<3.3	Worst condition	41

DISSOLVED OXYGEN & TEMPERATURE

Dissolved oxygen is one of the most critical factors affecting lake ecosystems, and is essential to all aquatic organisms that require aerobic conditions to survive. The solubility of oxygen is dictated by water temperature. Basically, the colder the water temperature, the more oxygen it is able to hold in solution. Dissolved oxygen is also more abundant in water that is well mixed and in greater contact with the atmosphere. Areas in a lake that support photosynthesis will further enhance dissolved oxygen levels during daylight hours. This helps explain why oxygen levels fluctuate throughout the water column depending on variables such as time of day, water depth, clarity and temperature. When dissolved oxygen concentrations become depleted, the survival of fish and other oxygen-dependent aquatic life becomes compromised. The water quality standard for oxygen in "warm water" lakes like Como is 5.0 mg/l, which is the minimum amount of oxygen needed for most fish to survive and grow.

As discussed earlier, the amount of oxygen present within the hypolimnion of deeper lakes plays an important role in the mobilization of nutrients from the bottom sediments into the surrounding water column. Phosphorus can be chemically converted into a more soluble state and released from bottom sediments when the overlying water becomes devoid of oxygen, or anoxic. These anoxic conditions commonly occur within the hypolimnions of deeper, eutrophic lakes where the rate of decomposition and bacterial respiration exceeds the rate of photosynthesis and natural aeration. For instance, as thermal stratification isolates the hypolimnion from the atmosphere, the surface supply of oxygen from the atmosphere is sealed off. The remaining dissolved oxygen is often rapidly consumed when respiration rates increase due to excessive decomposition of organic material that settles to the bottom. As anoxia develops, phosphorus contained in the sediments chemically converts into a more soluble state, migrating from the sediments to the surrounding water. When the lake eventually destratifies (mixes), any nutrients that were released from the bottom sediments are transported throughout the water column where they become available for algae growth. It should be noted that anoxic conditions are also capable of developing in weedy, shallow lakes, especially during non-daylight hours when bacterial and microbial respiration is likely to exceed photosynthesis.

Vertical profiles of water temperature and dissolved oxygen in Lake Como exhibit no abnormalities and are sufficient to support a diversity of aquatic life. However, it is unknown whether dissolved oxygen concentrations become depleted during non-daylight hours as respiration exceeds photosynthesis. Water temperature, on the other hand, is shown to vary considerably depending on whether measurements are taken upstream or downstream of the impoundment. According to data collected in June of 1995, mean water temperatures were 17.1 degrees Celsius in Duncan Creek above Bloomer, 16.5 degrees Celsius in Como Creek above Lake Como, and 25.9 degrees Celsius below Lake Como. These data show that the impoundment has a significant warming effect.

Temperature and dissolved oxygen readings were also taken at the STH 40 bridge location on Como Creek in June of 1991. Water quality at the STH 40 site was considered unsuitable for a coldwater fishery. A maximum stream temperature of 27.8 degrees Celsius was recorded, which is above the lethal limit for brook or brown trout. Low dissolved oxygen levels were also recorded at the STH 40 site, including a minimum dissolved oxygen concentration of 3.8 mg/l that occurred between June 26-29, 1991. The recorded dissolved oxygen levels were well below the Wisconsin water quality standard of 6.0 mg/l for trout streams. The cause of the low dissolved oxygen and high temperature conditions was not determined, but could be the result of upstream beaver dams.

pH

pH measures the concentration of hydrogen ions in a lake. Lower pH waters have more hydrogen ions and are more acidic than higher pH waters. A pH of 0 indicates that a particular water sample is highly acidic, while a pH of 14 suggests a highly basic sample (7 is considered neutral). Every 1.0 unit change in pH represents a tenfold change in hydrogen ion concentration. Therefore, a lake with a pH of 6 is ten times more acidic than a lake with a pH of 7.

Low pH is shown to increase the solubility of certain metals that can become toxic in higher concentrations, such as aluminum, zinc and mercury. It is also harmful to the survivability of fish and other aquatic organisms. In Wisconsin, pH ranges from 4.5 (acid bog lakes) to 8.4 (hard water, marl lakes). Lakes having good fish populations and productivity generally have a pH between 6.7 and 8.2. Lower pH lakes are often found in the northern part of the state where acid rain has a greater impact on surface waters due to the limited buffering capacity of regional soil types. Natural, unpolluted rainfall is relatively acidic, and typically has a pH of between 5 and 6. However, rainfall varies from a pH of 4.4 in southeastern Wisconsin to nearly 5.0 in northwestern Wisconsin. Fortunately, naturally acidic precipitation is usually neutralized as it is exposed to acid-buffering carbonates in the environment.

The amount of dissolved carbon dioxide in a lake, which is influenced by photosynthesis and respiration processes, generally affects pH levels. For instance, as carbon dioxide levels increase, pH will correspondingly decrease, and vice versa. Available water chemistry data indicate that the pH of Lake Como can range from a low of 7.0 to a high of 10.4 (Schreiber, 1992). In 1991, the lake had a summer mean pH of 9.4. pH values appear to increase throughout the warmer months, which could be attributed to a steady increase in biological productivity. These values, however, should not pose any problems for aquatic life. Acidity effects on different fish species are presented in Table 5 below.

High pH can also effect nutrient loading in lakes. High pH is a factor that is known to cause phosphorous release from the bottom sediments.

Table 5: Effects of acidity on fish.

(Adapted from Olszyk, 1980)

Water pH	Effects
6.5	Walleye spawning inhibited
5.8	Lake trout spawning inhibited
5.5	Smallmouth bass disappear
5.2	Walleye, burbot, lake trout disappear
5.0	Spawning inhibited in many fish
4.7	Northern pike, white sucker, brown bullhead, pumpkinseed sunfish, rock bass disappear
4.5	Perch spawning inhibited
3.5	Perch disappear
3.0	Toxic to al fish

Alkalinity & Hardness

A lake's hardness and alkalinity are each affected by the types of minerals found within the watershed's soils. Hardness and alkalinity increase the more the lake water comes into contact with minerals containing bicarbonate and carbonate compounds. These compounds are usually found with two hardness ions: calcium and magnesium. If a lake receives groundwater from aquifers containing limestone minerals such as calcite and dolomite, hardness and alkalinity will be high. High levels of hardness (>150 mg/l) and alkalinity can cause marl (calcium carbonate) to precipitate out of the water. Hard water lakes tend to be more productive and support larger quantities of fish and aquatic plants than soft water lakes. They are also usually located in watersheds with fertile soils that add phosphorus to the lake. As a balancing mechanism, however, phosphorus precipitates with marl, thereby controlling algae blooms. If the soils are sandy and composed of quartz or other insoluble minerals, or if direct rainfall is a major source of lake water, hardness and alkalinity will be low. Lakes with low amounts of alkalinity are more susceptible to acidification by acid rain and are generally unproductive.

Based on 1991 water quality data, Lake Como is a soft-water lake (27 mg/l $CaCO_3$) with low alkalinity and "high" sensitivity to acid rain due to its minimal acidification buffering capacity. Table 6 shows relative hardness levels for lakes with varying concentrations of calcium carbonate ($CaCO_3$). Table 7 shows relative sensitivity levels of lakes to acid rain based on alkalinity values. Lake Como's relative values are highlighted.

The alkalinity and hardness data reviewed in this assessment was limited. Additional data and other considerations may reveal that Lake Como is not sensitive to acid rain.

Table 6: Categorization of hardness by mg/l of calcium carbonate ($CaCo_3$).

Level of Hardness	Total Hardness as mg/l $CaCO_3$
Soft	0-60
Moderately hard	61-120
Hard	121-180
Very Hard	>180

Table 7: Sensitivity of lakes to acid rain based on alkalinity values.

(Adapted from Taylor, 1984)

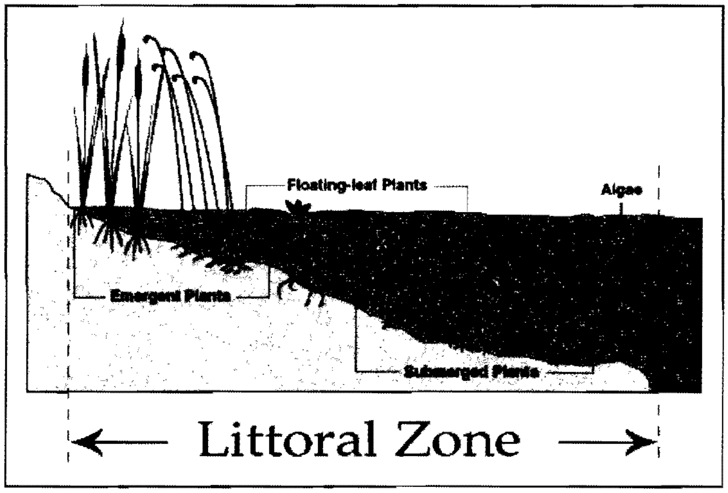
Sensitivity to Acid Rain	Alkalinity (ppm $CaCO_3$)	Alkalinity (ueq/l $CaCO_3$)
High	0-2	0-39

Moderate	2-10	40-199
Low	10-25	200-499
Nonsensitive	>25	>500

2-5 ECOLOGICAL ASSESSMENT

LITTORAL ZONE

The relative abundance, distribution and types of rooted aquatic plants (macrophytes), fish, and other aquatic organisms provide an excellent indicator of lake quality. This is why the shallow, biologically rich areas on a lake are so important. These areas represent the lake's littoral zone. The depth at which sunlight is able to penetrate the water column in quantities necessary to promote photosynthesis determines the extent of the littoral zone. Like a rainforest, it is where you will find the greatest biological diversity.



The littoral zone's counterpart is the deep, open water pelagic zone. Uniformly shallow lakes like Como will usually have insignificant pelagic zones when compared to their vast littoral areas. However, deeper lakes that have extensive, irregular shorelines with lots of small bays and narrow channels may also support large littoral zones. Macrophytic vegetation dominates both these types of systems, especially under conditions of good water clarity and nutrient-rich bottom sediments. Lake Como's littoral zone occupies most of the lake's total surface area. As a result, the lake has natural limitations that will preclude any lake uses that require large areas of deep and unobstructed open water.

BOTTOM SUBSTRATE & SEDIMENT PROFILE

The bottom morphometry of Lake Como is characterized as gradually sloping. Sediment type was documented during a 1991 aquatic plant inventory of Lake Como. According to the inventory findings, the majority of sampling sites had soft silt and organic sediment that provides favorable habitat for aquatic plant growth. The percentage of sampling sites with each sediment type was as follows: 58.1% silt, 19.4% muck, 16.1% sand, 3.2% gravel, and 3.2% rock (Borman, 1992).

The U.S. Army Corps of Engineers (Corps of Engineers) recently compiled sediment profiles of Lake Como. Sediment volumes were greatest within lake segments that widest sections of the lake that were furthest from the confluence of an incoming stream. The sediment probes were conducted along 26 cross section lines that were spread out along the long axis of the lake. From the sediment probes the Corps of Engineers determined and recorded the depth of the water and the thickness of the sedimentation.

Some core samples were submitted to laboratory for chemical analysis and physical properties tests. Ten samples were submitted for analyses of total kheldahl nitrogen (TKN), total organic carbon (TOC), and grain size distribution (sieve and hydrometer). Two samples were submitted for analyses of metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc), ammonia nitrogen, total phosphorus, percent solids, semivolatiles, and Aroclor.

Of the samples that were analyzed for TOC the maximum TOC content was 5%, and the minimum TOC was 2%. The average TOC content was 3%. These same samples had a maximum TKN concentration of

4,500 milligrams per kilogram (mg/kg), a minimum TKN of 240 mg/kg, and an average TKN of 1,620 mg/kg. The samples had a percent solid maximum of 62.7%, minimum of 35.1%, and average of 50.45%.

Results from the grain size analyses indicated that the 10 samples varied in composition. Five of the samples had less than 25% sand and greater than 75% fines (silt and clay). The other five samples ranged in sand content from 35.6% to 68.7%.

Based on the sediment probing performed by the Corps of Engineers, Ramaker & Associates, Inc. has made estimates of the average depth and amount of sedimentation of Lake Como. The average water depth of Lake Como (water surface to top of sediment) is 4.4 feet. The average depth from the lake surface to the bottom of the sediment (base of unconsolidated sediments) is 6.5 feet. Therefore the average thickness of the sediment is 2.1 feet. Based on these estimates, and the previously stated lake area of 98 acres, the volume of the lake bed, (volume occupied by water and unconsolidated sediment) is 633 acre-feet, and the volume of water in the lake is 429 acre-feet. The volume of sediment is estimated to be 206 acre-feet.

NOTE: These estimates are based on an average of all Corps of Engineers sediment probes. It is apparent that more probes were conducted in the deeper areas of the lake. The probes may not reflect a symmetrical grid-pattern. These results may be skewed and show an average depth and volume that is somewhat greater than the actual lake depth and volume.

Aquatic Plant Community

A diversity of native aquatic vegetation is the foundation of a healthy and balanced lake ecosystem, and is necessary for maintaining good water quality and wildlife habitat conditions. Plants assimilate nutrients and other potential pollutants, stabilize bottom sediment, oxygenate the water during photosynthesis, provide shelter and spawning habitats for fish, act as refuges for zooplankton (algae consumers), and serve as food sources for wildlife. Aquatic plant growth is limited by factors such as sunlight availability, water quality, lake morphometry and sediment type. Examples of beneficial native plants include water lilies, bulrushes and certain pondweeds. Eurasian watermilfoil, on the other hand, is a nuisance species that is not native to Wisconsin. Under the right conditions, such exotic invaders will out-compete native plants and form monotypic stands of dense vegetation. This prolific growth can eventually reduce biological diversity and restrict recreational use of the water.

The diversity, density and distribution of aquatic plants can offer a great deal of insight in terms of water quality condition, habitat quality and potential recreational impairments. Degraded lakes are disturbed ecosystems characterized by too much or too little aquatic vegetation that is usually dominated by non-native, invasive "weeds" (or exotic species). An absence of vegetation usually leads to poor water quality and a loss of fish and wildlife habitat. This situation favors an increase in algae growth and a reduction in water clarity. A different set of problems occurs when non-native aquatic weeds become overly abundant. This situation reduces native plant diversity, impedes certain recreational functions of the lake, stunts fish growth, and can cause dramatic fluctuations in dissolved oxygen levels. The decomposition of plant material is also shown to release nutrients that were previously tied up in the living plant tissues. Isolated areas in a lake where either native plant growth is sparse or a nuisance weed condition exists are excellent indicators of localized disturbances. Disturbances can be in the form of pollution, sedimentation, shallow-water motor boat impacts, or the over aggressive chemical eradication and/or over harvesting of plant beds.

During a 1991 aquatic plant inventory, 10 aquatic plant species were found in and around the lake using the rake-sampling methodology developed by Jessen and Lound (1962). These plants are listed in Table 8 below.

Table 8: Aquatic plant species found in Lake Como during 1991 aquatic plant inventory.

Scientific Name	Common Name	Plant Type
Ceratophyllum demersum	Coontail	Submergent
Elodea canadensis	Common waterweed	Submergent
Lemna minor	Small duckweed	Floating-leaf
Nitella sp.	Nitella	Submergent
Phalaris arundinacea	Reed canary grass	Emergent
Potamogeton nodosus	Longleaf pondweed	Submergent
Potamogeton pusillus	Small pondweed	Submergent
Sparganium androcladum	Burreed	Emergent
Scirpus validus	Softstem bulrush	Emergent
Typha latifolia	Broadleaf cattail	Emergent

The above species are all tolerant of very eutrophic, light limiting conditions and high siltation rates. Aquatic plants were found growing at 93.5% of all sampling sites in Lake Como. Duckweed was found at 93.6% of the sampling sites. Large mats of duckweed covered over half the surface area of the lake at the time of the inventory. The abundance of this plant indicates nutrient-rich water since it relies exclusively on dissolved nutrients for its survival. The pervasive duckweed mats and filamentous algae (58.1% of sampling sites) create an obstruction for recreational uses of the water as well as aesthetic problems. In addition, the shading caused by these extensive mats creates a poor environment for light-sensitive submergent plants. Common waterweed and coontail were found at 74.2% and 38.7% of the sites, respectively. These species are shade tolerant and often grow in thick stands, providing poor fish habitat and navigation problems. Longleaf pondweed was found at 25.8% of the sampling sites. The aquatic plants with the highest frequency of occurrence in the study (duckweed, common waterweed and coontail) also had moderate to high density ratings, meaning they were encountered often and in abundant stands. The frequency of occurrence and average density documented for each plant species during the inventory is shown in Table 9 below.

Table 9: Frequency of occurrence and average density rankings for aquatic plants found in Lake Como during 1991 aquatic plant inventory.

	Frequency of Occurrence (%)				Mean Density (ranked from 0-5)			
Species	All Sites	0-1.5' Sites	1.5-5' Sites	5-10' Sites	All Sites	0-1.5' Sites	1.5-5' Sites	5-10' Sites
Coontail	38.71	38.46	46.15	20.00	2.08	2.00	2.00	3.00
Common waterweed	74.19	69.23	92.31	40.00	3.74	4.00	3.75	2.50
Small duckweed	93.55	100.00	92.31	80.00	2.66	3.15	2.67	1.00
Nitella	9.68	0.00	15.38	20.00	2.33	0.00	2.50	2.00
Reed canary grass	9.68	23.08	0.00	0.00	2.33	2.33	0.00	0.00
Longleaf pondweed	25.81	30.77	30.77	0.00	1.63	1.00	2.25	0.00
Small pondweed	9.68	7.69	15.38	0.00	1.67	1.00	2.00	0.00
Burreed	3.23	7.69	0.00	0.00	4.00	4.00	0.00	0.00
Broadleaf cattail	6.45	15.38	0.00	0.00	3.00	3.00	0.00	0.00

Aquatic plants can survive in water depths receiving at least one-percent sunlight penetration. This critical depth generally equates to about 1.7 times the observed Secchi depth. The predicted maximum rooting depth of Lake Como, based on 1991 average summer Secchi readings, was 6.3 feet. The observed, maximum rooting depth was 6.0 feet. Although these findings suggest poor water clarity conditions, submergent vegetation had still managed to colonize all depth strata of the lake. Shallow water depths, above average pH levels, and high nutrient concentrations in both the water column and bottom substrate are primary factors contributing to the prolific growth. While abundant plant growth is not necessarily always problematic, it can cause wide, daily fluctuations in dissolved oxygen levels during the summer. Even though plants produce oxygen during the day, they reverse their process at night and consume oxygen. A study done in during the summer of 1999 showed dissolved oxygen dropped to near or just below the 5.0 mg/l water quality standard established to protect fish and other aquatic life. These low readings were found in the bay where Como Creek enters the lake as well as portions of the main lake body (Borman, 1992).

Fishery

The presence of relatively undisturbed, natural shorelines and extensive wetland areas enhance the spawning and nursery habit for game fish. Shoreland wetlands and abundant aquatic plant growth also provide refuge and cover while maintaining good water quality conditions. Unfortunately, overly dense plant growth can prevent predator fish from grazing on smaller fish. This situation leads to the overpopulation and stunting of panfish populations. Protecting high-quality plant communities while controlling the spread of non-native species will benefit the fishery as a whole. Other improvement strategies include harvest restrictions, creation of edge habitat in weed-choked locations, maintaining good water clarity, and protecting wetlands and natural shorelines.

Duncan Creek (above Lake Como): The upper headwaters of Duncan Creek is classified as a Class I brook trout stream. A fish survey conducted in 1989 found 1,023 brook trout ranging from <3 to 12.4 inches. The stream bottom is primarily sand and silt, with gravel in the riffle areas. The stream corridor is wooded and much of it is in State Fishery Area. Overhanging grasses, in-stream macrophytes and fallen trees provide trout cover. The stream HBI was 4.38 (very good) and the Habitat Rating was "good". The stream in this reach has few limiting factors or pollutant sources except for a few small barnyards near the streambank.

Como Creek: Como Creek is classified as a Class I brook trout stream. A 1977 fish survey found brook trout at 5 of 8 stations (trout were not present in the three headwater stations). A fish survey conducted in 1991 at the furthest downstream station found nine brook trout ranging from 4.5 to 12 inches. The stream has a HBI of 5.86 (fair) and Habitat Rating of "good". Como Creek has a shifting sand substrate with some gravel riffle areas in the upstream reaches. The stream is low-gradient and much of the corridor is wetland with extensive tag alder growth along its streambanks (Schreiber, 1992).

Lake Como: The lake supports a warm water fishery with largemouth bass and panfish as the primary sport fishes. The following assessment was reprinted from a DNR fisheries report that was issued in August 2001:

Twelve fish species were collected in a fishery survey conducted by the DNR in spring 2000: Largemouth bass, northern pike, bluegill, black crappie, yellow perch, pumpkinseed sunfish, black bullhead, yellow bullhead, white sucker, golden shiner, brook trout and central mudminnow. Northern pike, white sucker and bluegill were the most abundant species in the lake. The size and age structure of northern pike, largemouth bass, bluegill, black crappie and yellow perch populations were indicative of unbalanced populations. While larger, older fish dominate the largemouth bass population, the northern pike, bluegill, black crappie and yellow perch populations appeared skewed to smaller, younger individuals. The size structure of the bluegill population has not changed much in 35 years. Angler harvest may be impacting the size structure of northern pike, bluegill and black crappie populations. Growth rates of northern pike and largemouth bass are slower than average growth rates of other Wisconsin lakes, while most age classes of bluegill have faster than average growth rates. The total, annual mortality rate for mid- to older-age bluegill is high compared to rates reported in other Wisconsin lakes. The mortality rate for older largemouth bass is low compared to other Wisconsin lakes.

The lake has a very high density of northern pike, but the size (small) and age (young) structure of the population is indicative of an unbalanced populaton. Since their introduction in the mid-1980s, their population has increased dramatically. The 2000 catch rate was 15.5 times greater than when northern pike were first discovered in 1985. Juvenile northern pike have been found in the headwaters of Duncan Creek, and are expected to spawn in the creek where emergent vegetation is prevalent. Northern pike are believed to be a threat to the brown trout fishery, and may also be impacting yellow perch, golden shiner, white sucker and largemouth bass populations in the lake. Catch rates for yellow perch, golden shiner and white sucker dropped 91%, 99% and 61%, respectively, from 1985 to 2000. Despite a reduction in catch rate, white suckers have been found in large numbers since the first fish survey and remain very abundant. A concern exists that their high numbers could impact populations of more desirable fish in the lake by competing for food with panfish and small gamefish.

Lake Como has a long-standing reputation of providing an excellent largemouth bass fishery. Since the 1960s, the population changed from one dominated by small and mid-size fish to one dominated by larger individuals. A density of fish greater than or equal to 14 inches is present, which is partially the result of the 14-inch minimum size limit enacted in 1989. A low representation of 4-7 year old bass indicates poor recruitment from 1993-1996 and/or that predation of young bass is so extreme that recruitment cannot compensate for predation losses. With the high density of predators in the lake, it is very likely that predation is the major factor controlling bass recruitment. This lack of young to middle-aged bass puts the future of the bass population in jeopardy (Kurz, 2001).

Table 10 below presents the findings and recommendations of DNR fishery surveys historically conducted on Lake Como.

Table 10: Findings and recommendations by DNR fishery biologists (1954-2001).

Survey Date	DNR Comments
1954	*Findings:* First fish survey conducted on the lake. Few gamefish found even though walleye and largemouth bass had been stocked in the lake at various times from 1938 to 1953. There was an overpopulation of golden shiners and white suckers. Largemouth bass were present. Sparse, mostly emergent vegetation present. Other species surveyed include black crappie, yellow perch, bluegill, pumpkinseed sunfish, and yellow bullhead. Angling pressure by local anglers was considered heavy. *Recommendations:* Drawdown and chemically treat the lake to remove undesirable fish species (e.g. white suckers and golden shiners) that are competing with largemouth bass. This was to be followed up with stocking. These measures were not implemented.
Spring, 1961	*Findings:* Survey addressed a request to stock muskellunge to reduce an abundant, slow-growing panfish population. Fish species collected included largemouth bass, bluegill, perch, pumpkinseed sunfish, black crappie, yellow bullhead, white suckers and golden shiners. Excellent largemouth bass and panfish populations with normal growth rates were found. Crappies were low in number while perch populations were high. Destruction and removal of shoreline fish habitat (natural vegetation, logs, brush) was cited as a problem. *Recommendations:* Muskellunge stocking was not recommended since it could harm the upstream trout fishery.
Spring, 1965	*Findings:* Survey conducted at request of Bloomer Rod & Gun Club over concerns that fishing success had dropped off considerably. Found excellent largemouth bass and panfish populations. Species composition was similar to 1961 survey. Black crappie numbers were increasing while perch populations decreased. Above average growth rates found in largemouth bass and panfish species. Heavy fishing pressure by local anglers. Sedimentation cited as a major problem. *Recommendations:* No active management recommended. Stocking of muskellunge not considered necessary, and believed to be a threat to Duncan Creek trout populations.
Fall, 1976	*Findings:* Panfish numbers are abundant but lower numbers of largemouth bass observed, possibly due to the 1975 drawdown. 3,000 largemouth bass fingerlings were stocked to supplement remaining population. Golden shiners were very abundant. Perch and white sucker numbers were also fairly high. Sedimentation still cited as a problem, along with the removal of natural shoreline habitat. Duckweed and pondweed were common but lily pads and cattails were becoming scarce. *Recommendations:* No active management recommended.
Spring, 1985	*Findings:* Netting survey conducted in response to concerns regarding the introduction of northern pike by anglers in 1984. Species composition was similar to prior surveys with the exception of northern pike and brook trout. Golden shiners and white suckers were still very abundant. Due to the timing of the survey, the catch of bluegill and largemouth bass was low. Good quality panfish populations were present in the lake. *Recommendations:* Drawdown the lake 16-24 inches after water temperatures reached 52 degrees to strand and desiccate northern pike eggs. It is not known if this was ever attempted.
Spring, 2000	*Findings:* 12 species were found during the survey. Largemouth bass averaged 1.8 inches smaller compared to the state average sizes for the same age fish. *Recommendations:* None.
2001	*Findings:* Northern pike and largemouth bass growth rates are slow with below average size when compared with weight. Bluegill and crappie show normal growth rates and sizes for this area. Yellow perch, golden shiner and white sucker populations are down due to increased population of northern pike.

Recruitment, growth and mortality are affected by numerous community dynamics, including but not limited to predator-prey interactions, food availability, interspecies composition, habitat quality, and the impact of angler harvest. Largemouth bass size structure has increased due to the 14-inch minimum size limit enacted in 1989. However, it is believed that northern pike may be feeding on young largemouth bass as opposed to bluegill due to body shape preferences. In addition, largemouth bass are cannibalistic, and may be further increasing predation on younger year classes. A lack of young to middle-aged largemouth bass does not bode well for the future of the bass population. Larger bluegills are also becoming scarce, possibly due to intense angler harvests over the winter or by largemouth bass predation. Yellow perch numbers are on the decline, probably due to northern pike predation. White suckers are very abundant, and are the predominant fish species immediately downstream of Lake Como. They provide a food source for gamefish but also act as competitors for food (Kurz, 2001).

The quality of fish habitat has declined over time. This includes the loss of shallow water habitat, as well as sedimentation and accumulation of nutrients that have decreased water depth and increased productivity in the impoundment. The impoundment also increases water temperatures and pH levels in downstream reaches to the detriment of a potential trout fishery.

2-6 BLOOMER MILL DAM

The Village of Bloomer was settled in 1855. Historical records indicate that the first timber dam was installed on Lake Como around 1860 for the purpose of powering a sawmill. It was later rebuilt under the Milldam Act and used to operate a gristmill. In the 1900s, the resulting impoundment was used for the cutting of ice for refrigeration. The dam was rehabilitated several times, and is now owned and operated as a concrete gravity structure by the City of Bloomer solely for recreational purposes.

The U.S. Army Corps of Engineers completed a Dam Failure Analysis in 1989. The purpose of the study was to provide the State and the affected community with quantitative information that could be used for emergency planning efforts in the event of a dam failure. It was also meant to serve as a database in any efforts to upgrade the dam to meet current design and safety standards. Based on 1978 data, the analysis claimed that the reservoir created by the dam had a storage capacity at normal pool of 200 acre-feet and at maximum pool of 945 acre-feet. The recreational pool surveyed at 995.1 feet above the National Geodetic Vertical Datum, and there was a 2,050 cubic feet per second gated spillway capacity at normal pool elevation. The river channel downstream of the dam and within Bloomer ranged in width from 40-1,300 feet, while the floodplain varied from 350-1,150 feet in width. The average gradient along this reach of the river was determined to be approximately three feet per mile.

In a 1992 inspection report, the Wisconsin Department of Natural Resources ordered the city to either upgrade or remove the dam within 10 years to meet Wisconsin Administrative Code NR 333 standards for high hazard dams. The report documented structural problems and inadequate spillway capacity to handle a 1,000-year flood event. A 1999 opinion survey was conducted to garner resident input on the issue of whether to repair or remove the dam. The survey results revealed a much higher level of acceptance for keeping Lake Como than for removing the dam. Acceptance levels for each alternative dropped as cost became more of a factor, but overall findings remained unchanged. The community eventually approved the repair of the dam in a special referendum. Drawing down the lake and repairing the dam was estimated to cost between $1.3 and 1.8 million based on bids received in January of 2002. The drawdown and dam repairs were already underway during the completion of this report.

CHAPTER NOTE:
A summary of the lake and watershed's physical, chemical, biological & demographic characteristics is included in Table 11 below.

Table 11: Summary of physical, chemical and biological characteristics.

PHYSICAL DESCRIPTION (LAKE)	
Location:	City of Bloomer, Woodmohr Township, Northwest-Central Wisconsin (T30N, R9W, S5-8)
Origin of lake:	Artificial impoundment of Duncan Creek
Lake type:	Shallow, artificial, drainage lake
Primary water source:	Stream drainage
Bottom substrate:	Mostly silt, muck and sand
Number of significant inlets:	2 (Duncan & Como Creeks)
Number of outlets:	1 (regulated via mill dam)
Surface area:	98 acres (0.153 square miles)
Length/width:	1.53/0.35 miles
Shoreline length:	5.25 miles
Shoreline development factor:	3.76 (circle=1; number increases as shore irregularity increases)
Mean depth:	3.5 feet (estimated)
Maximum depth:	6.0 feet (historically documented range: 6-15 ft.)
Volume:	343 acre-feet (estimated)
Primary water source:	Stream drainage
Flushing rate:	Rapid
Hydraulic residence time:	Short
Thermal stratification:	Polymictic (assumed)
PHYSICAL DESCRIPTION (WATERSHED)	
Watershed area:	50 square miles
Watershed-to-lake surface area ratio:	327:1
Sub-watersheds:	Upper/middle Duncan Creek and Como Creek
Direction of regional surface water flow:	South
Dominant watershed land use:	Agriculture (interspersed with forest and grassland)
Degree of shoreline development:	High
Wetland acreage:	2,449 acres (State); 1,551 acres (Federal)
Soils:	Billet-Rosholt-Oesterle association
Topography:	Gently rolling to flat
Average stream gradient	8 feet/mile
Public lake access:	Swimming beach, fishing pier, and two boat landings
CHEMICAL & BIOLOGICAL DESCRIPTION	
Nitrogen to phosphorus ratio:	8.5:1 (1991 data)
Limiting nutrient:	Nitrogen
Trophic status:	Eutrophic
Water quality indices:	Total phosphorus ("very poor"); chlorophyll *a* ("very poor"); Secchi transparency ("very poor to poor")
Nutrient sensitivity:	Low
Hardness:	Soft water
Alkalinity:	Low
Acidification sensitivity:	High
Fishery type:	Warm water
Total fish species (2000):	12 (3 gamefish, 4 panfish, 5 rough fish)
Major sport fishes:	Largemouth bass, northern pike, panfish
Maximum predicted rooting depth (1991):	6.3 feet
Maximum observed rooting depth (1991):	6.0 feet

Total aquatic plant species (1991):	10 (5 submergent, 1 floating-leaf, 4 emergent)

CHAPTER 3: PROBLEM ANALYSIS

3-1 INFORMATION GAPS

PUBLIC INPUT T – LAKE-USER OPINION SURVEYS

Actively involving the public is important in facilitating the identification and prioritization of desired lake uses and problems. In addition, public involvement helps educate users about the lake ecosystem, their role in contributing to certain problems, and the actions they can take to eliminate or reduce the severity of these problems. Greater understanding and awareness of problems will generally lead to increased cooperation in their solution and thus a greater likelihood of program success.

We recognize that lakes cannot be all things to all people at all times, and that lake uses often conflict and must be separated. Therefore, desired lake uses and values must be prioritized based on considerations such as level of lake resident support, and the feasibility of attainment given the natural limitations of the aquatic environment. Prioritizing is commonly used to resolve mutually exclusive recreational desires and management goals. It also reduces the likelihood that any random interest group would be able to unduly influence the decision-making process by making false claims of "need" or "resident support."

Public input was gathered during a 1999 survey regarding the fate of the Bloomer Mill Dam. The survey revealed a majority interest in repairing the dam, and provided some limited information on lake-use preferences. For instance, the survey showed that the most popular activities on Lake Como were enjoying the scenery, watching wildlife and fishing, respectively. It also showed that, aside from cost, water quality and environmental issues were the top factors considered during the dam-removal debate. With the exception of the 1999 Bloomer Mill Dam survey, public opinions pertaining to lake-use preferences and perceived problems were not available for analysis. This information gap should be rectified using a follow-up opinion survey. The survey should cover the full spectrum of possible topics and concerns, including water quality, fisheries, aquatic plants, recreation, wildlife habitat, land use, pollution and management efforts--just to name a few. The survey could be used to identify and rank preferred lake uses, management priorities and future courses of action. It could also be used to determine people's general feelings regarding the lake, their impression of the overall management policies, and whether there were any suggestions regarding new policies or ideas for improving the lake. Finally, survey results are often helpful when contemplating specific protection and rehabilitation techniques that might benefit the resource.

WATERSHED INVENTORY

The Association would benefit from the completion of a detailed watershed inventory. Watershed inventories are used to evaluate the current state of land use, identify sources of nonpoint source pollution, and estimate the relative contributions of these pollutant sources. Polluting industries, poor farming practices, highly erodible slopes, cattle grazing and barnyard locations, construction sites, and urban stormwater discharge points are some potential problem sites that would be flagged during a watershed inventory. Once these locations are identified, the Association would be better able to target monitoring and management efforts.

Critical sites can also be identified in and around the lake that might warrant special protections due to their ecological sensitivity or significance. Wetlands, undeveloped shorelines or stream banks, rare habitats, springs and important groundwater recharge areas are just a few examples of possible critical sites that might be targeted for conservation easements or other protection measures. Combining a watershed inventory with nutrient modeling through a phosphorus budget is a common strategy used to quantify sources of pollution so management techniques can be properly selected and targeted.

The County may have completed a land-use study. This data should be reviewed during future phases of lake assessment efforts. this information was not received from the Association during the preparation of the condition assessment.

Water Quality & Biological Testing

Although a great deal of water quality and biological information has been collected on Lake Como over the years, the quality and type of data were often inconsistent. Incomplete or inconsistent data records can make it difficult if not impossible to accurately assess current conditions and diagnose problems. The following is a list of information needs that should be collected on a regular basis:

- Temperature and dissolved oxygen profiles of the water column. Used to assess seasonal stratification (if applicable) and potential threats to aquatic life.
- Basic water quality parameters such as inflow/outflow rates, pH, total phosphorus, total nitrogen, chlorophyll a, Secchi transparency, alkalinity, hardness, turbidity, suspended solids, water temperature and oxygen concentrations. Sampling sites should include Como and Duncan Creeks upstream of the impoundment, and over the deepest point on Lake Como.
- Aquatic plant inventories. These studies should be completed at least every several years to evaluate aquatic plant community trends. The next inventory should be performed after the completion of this year's drawdown.
- Fishery inventories. Excellent records already exist through the DNR. This effort should be continued at least every few years.

3-2 PROBLEM OVERVIEW

Many factors can negatively influence the health and quality of a lake. Irresponsible shoreline and watershed development, wetland drainage, habitat destruction, exotic species infestations, and lake-use pressures are just some of the factors that might contribute to any number of problems and recreational impairments. Each of these situations is capable of upsetting the stability of a balanced ecosystem and producing a variety of undesirable consequences. Separating the root cause of a particular problem from its more observable symptoms is the key to a successful and cost-effective lake management program.

Although Lake Como is an impoundment of two Class I trout streams (Duncan and Como Creeks), it has unfortunately become very eutrophic and plagued with several associated problems. These problems include turbid water, degraded habitat quality, high sedimentation rates, shallow water depths, excessive algae and aquatic plant growth, and unbalanced fish populations. Because the dam impounds streams that have primarily agricultural watersheds, Lake Como acts as a giant settling basin for nutrients, sediment and other pollutants originating from these subwatersheds. There are also several city storm sewers that discharge directly into the lake carrying additional nutrients and sediment. The high siltation rates are reducing the life of the impoundment by filling in the lake bottom with depositional material. High nutrient loading combined with the shallow depth of the lake contribute to yearly algal blooms and an abundance of aquatic plants with low species diversity. The pervasive duckweed mats and filamentous algae in Lake Como create an obstruction for recreational uses of the water as well as aesthetic problems. In addition, the shading caused by these extensive mats and turbid waters creates a poor environment for light-sensitive submergent plants that are of benefit to the lake. The impoundment's impacts are observed in the degraded water quality and fish populations of Duncan Creek downstream of the dam.

Eutrophication & Nonpoint Source Pollution

Cultural eutrophication caused by non-point source pollution (e.g. sediment and nutrient loading from the surrounding watershed) is arguably the most significant problem affecting Lake Como today. Eutrophic waters are those that are severely impacted by nutrient enrichment and excessive productivity. Surface waters located within larger watersheds that are urbanized, intensively farmed, or face strong development pressures are at the highest risk of exhibiting eutrophication problems. Symptoms include nuisance algal blooms, excessive weed growth, declining species diversity, poor water clarity and/or mucky lake bottoms. Eutrophication problems are caused by external nutrient loading from the watershed, and/or internal nutrient recycling from the lake itself. Identifying the relative nutrient contributions (e.g. phosphorus and nitrogen) from each source is usually necessary before the right management strategy can be formulated to control this problem.

External nutrient loading is the influx of eroded soil, fertilizers, polluted runoff, organic debris and other material from the surrounding watershed to the receiving water body. This material is delivered to the lake primarily as stormwater runoff, and may contain large amounts of phosphorus and other nutrients that fuel algal blooms and weed growth. Unregulated construction sites, poor farming practices, irresponsible fertilizer applications, loss of upstream wetlands, vegetative clear-cutting, and eroding shorelines and drainage ditches are just some of the more common factors that can increase nutrient inputs to the lake. This is especially true in the absence of proper measures that are designed to limit stormwater runoff and control soil erosion.

Water bodies with large watershed-to-lake surface area ratios (>10:1) are much more likely to experience water quality problems due to nutrient loading from the adjacent landscape. Since Lake Como has a ratio of approximately 327:1, activities occurring in the watershed will typically have a great influence on water quality and the level of primary productivity. Consequently, external loading is believed to be responsible for the vast majority of nutrient inputs to Lake Como.

Protecting and managing the watershed is paramount to maintaining the health and quality of Lake Como. Erosion-control measures known as Best Management Practices (BMPs) are used to control the sources of external nutrient loading. BMPs include grassed waterways, vegetative buffers, reduced tillage, field stripcropping, contour cropping, nutrient management, shoreline erosion control, and wetland restoration. The sources of external nutrient loading should be addressed before any in-lake management techniques are implemented. If not, in-lake management efforts will not be as effective over the long run, especially if external nutrient loading is significant.

Internal nutrient loading, also called in-lake nutrient recycling, occurs when nutrients are released from the lake bottom or by the life cycles of aquatic plants and organisms. This process is usually more significant in lakes with smaller watersheds and longer hydraulic retention times. Hydraulic retention describes the length of time a given volume of water remains in the lake before it is able to be replenished by new water entering the system. When this timeframe is short, in-lake nutrient recycling is less likely to account for a significant proportion of the total nutrient loading to the lake. Lake Como has a short hydraulic retention time, and therefore is not as prone to internal nutrient recycling problems. Furthermore, since Lake Como is believed to remain fairly well mixed, it should not be very susceptible to internal phosphorus release.

Although common, an anoxic hypolimnion as typically found in deeper, eutrophic lakes is not the only area known to cause large-scale, in-lake phosphorus releases. The shallow, littoral zone of many lakes is also shown to contribute to internal phosphorus recycling as a result of anoxia, sediment disturbance and elevated pH. Anoxic conditions may develop in shallower areas during non-daylight hours when respiration exceeds photosynthesis, causing phosphorus to be released from near shore areas. Also, sediment disturbance from wind and wave action and motor boating activity may re-suspend bottom sediment that is rich in phosphorus, increasing nutrient availability in the water column. Finally, pH levels may increase as carbon dioxide concentrations are depleted during photosynthesis. These high pH conditions are shown to be a mechanism for phosphorus release due to complex biochemical processes. These processes are not well studied on Lake Como, so it is unknown how much they contribute to overall nutrient loading.

Developing a phosphorus budget is usually recommended to more accurately identify the actual sources of internal nutrient loading, especially before an expensive management technique is considered which may not target the actual problem area.

Water Quality & Habitat

As mentioned in the preceding section, sediment and nutrient loading from the surrounding watershed has the greatest influence on Lake Como's water quality. Phosphorus levels in Lake Como are excessive, and most of the nutrient load likely comes from the Como Creek subwatershed. Although nutrient loading reductions are desirable, it is not expected that measurable changes in trophic condition will occur in the impoundment. However, by controlling the sources of these pollutants, the expected improvements should allow the water resources to reach their potential. For instance, reduced nutrient concentrations in the lake may reduce the density of duckweed and algae growth, which would benefit summer users. Reducing the sediment load would improve habitat conditions, reduce turbidity, and extend the useful life of the lake.

In addition to the pollutants that flow into waterways and streams, added problems are occurring due to degradation of valuable stream banks. Erosion and instability of stream banks is a problem that results in increased sedimentation and removal of important habitat for aquatic life, especially trout. Sedimentation of pools and filling in of spawning substrate in riffle areas are the results of stream bank erosion. The filling in of riffle areas reduces the reproductive success of trout by reducing oxygen levels in stream bottoms. Sedimentation of stream bottoms also reduces the abundance and diversity of invertebrates that constitute a valuable fish food resource. Finally, stream bank erosion can have an impact on water temperatures by causing channel widening and increased warming of the water. Bank erosion can essentially create a larger water surface in the stream channel that is exposed to the sun and decreases the stream velocity that adds to the warming effect. Slower moving water also means that sediment is much more likely to settle and accumulate at these wide points (Nonpoint Source Control Plan, 1993).

Irresponsible development, especially within the critical shoreland zone, is another issue of concern that impacts water quality and habitat. The removal of native vegetation along stream banks and the Lake Como shoreline for development is an ongoing problem. Uncontrolled cattle grazing and regular flooding only exacerbates the situation by increasing erosion rates and pollutant transport to the lake.

Aquatic Plant & Algae Growth

Lake Como is dominated by a low diversity of aquatic plants that can tolerate light-limiting, eutrophic conditions. These plants include floating mats of small duckweed (Lemna minor) and submergent plants like common waterweed (Elodea canadensis) and coontail (Ceratophyllum demersum). Such species are also shown to be tolerant of fluctuating water levels and high siltation rates. In addition, filamentous algae is abundant, indicating high nutrient concentrations in the water column.

Lake Como is an ecosystem with two alternative stable states of equilibrium—algae dominated or rooted aquatic plant dominated. Algae and aquatic plant abundance represent two ecological variables that are inextricably linked. This relationship makes it difficult if not impossible to manipulate one variable without dramatically affecting the other variable. For example, reducing or eliminating algae growth will result in improved water clarity, enhancing sunlight penetration through the water column and, thus, plant growth. Conversely, eliminating plant growth will free up nutrients and create conditions favorable for increased algae growth. The elimination of aquatic vegetation removes the lake's ability to stabilize its own bottom sediment and assimilate the nutrients that fuel algal blooms. It also reduces the amount of structural habitat used by algae-consuming zooplankton. As you can see, it is very easy to trade one problem for another if special precautions are not taken.

A majority of the desired lake uses and values will be supported if a reduction in nuisance weed growth is achieved strictly to facilitate public navigation and create edge habitat for the benefit of the fishery. In general, the Association is advised to enact programs that control nuisance "weeds" while maintaining a diversity of native plant species.

CHAPTER 4: OVERVIEW OF PAST RECOMMENDATIONS

4-1 INTRODUCTION

A number of studies were conducted on Lake Como in recent years that offer a wealth of advice for rectifying certain problems. A review of some of the major recommendations would benefit the Association as it prepares to explore potential management options as part of Phase II of the development of a Comprehensive Lake and Watershed Management Plan.

4-2 RECOMMENDATIONS FROM PRIOR STUDIES

The following is an abbreviated list of some of the recommended actions that were presented in previous studies and assessments conducted on Lake Como:

Fishery Management

- Stock and manage Lake Como as a largemouth bass and panfish fishery.
- Remove northern pike and white suckers during drawdown.
- Conduct occasional one-foot drawdown to strand and desiccate northern pike eggs after spawning.
- Discontinue the stocking of northern pike to prevent predation on trout and younger year classes of largemouth bass.
- Lower water temperature before it is released downstream to restore cold-water trout fishery.
- Restore near-shore habitat such as emergent vegetation, brush, trees and submerged logs to provide fish spawning, feeding and refuge sites.
- Dredge the lake bottom if it would create a more diverse depth profile to maximize habitat diversity. (Notes: Regardless of dredging process chosen, a drawdown will have a major impact on the fishery. In addition, dredging could increase hydraulic residence time, eliminate aquatic plant growth, and increase short-term turbidity, all of which could produce nuisance blue-green algae blooms.)
- Conduct regular fishery surveys, especially after any major stocking or management efforts.
- Impose angling restrictions for 3-5 years following any stocking effort.

Aquatic Plant & Algae Management

- Protect existing aquatic and wetland plant diversity.
- Consider harvesting, use of sea curtains, seining, sediment screens, drawdowns and dredging as aquatic plant management options.
- Make any decisions about aquatic plant management in the context of lake usage and the functional values of the aquatic plants for fish, wildlife and water quality.
- Harvest channels or use sediment screens to create openings within dense stands of common waterweed. While the aquatic plant community does offer fish habitat, some beds of common waterweed are too dense to allow passage of larger fish.
- Reduce nutrient loading to the lake to control duckweed. A change in nutrient content of the water can eventually reduce duckweed populations since they are entirely dependent on nutrients in the water. However, their ability to store nutrients for prolonged periods and over-winter in a dormant state under the ice makes control difficult. Physical removal with harvesters and seines or containment with sea curtains can offer some short-term relief with a long-term goal of nutrient-reduction as a more permanent solution.

Nonpoint Source Pollution Management

- Stabilize eroding stream banks & eliminate streamside cattle grazing.
- Purchase or acquire conservation easements to protect vegetative buffers in riparian zones.
- Develop and implement a construction site erosion control ordinance for the Bloomer urban area that includes activities not currently regulated.
- Develop and implement a stormwater management plan for the Bloomer urban area with special provisions designed to address control of water temperature in Duncan Creek.
- Control upland soil erosion to T and leave grassed waterways vegetated.
- Do not alter, drain or fill existing wetlands or ditch streams.

CHAPTER 5: SUMMARY

Lake Como is a valuable natural resource to the community and popular recreational destination. Primary activities conducted on the lake include fishing, peaceful relaxation, scenic enjoyment, swimming, and limited boating opportunities—among others. Unfortunately, the lake is faced with a number of management challenges. Lake Como is a small (98 acres), shallow (6-ft. maximum depth) and highly eutrophic impoundment in a large (~50-square mile), agriculturally dominated watershed. It acts as a regional settling basin, and is consequently plagued with the effects of non-point source pollutant loading. Problems include high sedimentation rates, shallow water depths, nuisance plant and algae growth, poor water clarity, unbalanced fish populations, and a deterioration of fish and wildlife habitat. A high flushing rate and large drainage area support watershed over in-lake management activities if long-term results are to be achieved.

The lake is managed as a warm-water sport fishery, with largemouth bass, northern pike and panfish being the primary gamefish species. The water column remains warm and well mixed throughout most of the year due to the shallow water depth. Aquatic plant diversity is relatively low, with small duckweed, common waterweed and coontail being the dominant species. Filamentous algae are also common. These species are all tolerant of light-limiting, eutrophic conditions, as well as fluctuating water levels and high siltation rates. A short residence time in combination with shading from dense duckweed mats reduces the potential for significant algal blooms despite high nutrient concentrations.

In general, prior studies recommend restoring near-shore habitat, as well as managing stormwater runoff and associated nonpoint source pollution that is impairing the resource. Sediment and nutrient loading from the watershed is the primary issue of concern and has the largest impact on lake quality. To rectify continuing information gaps, the Association is advised to:

1) Perform regular water quality and biological monitoring to establish trend data and help diagnose future problems;
2) Conduct a watershed inventory to identify critical areas and attempt to quantify sources of nonpoint source pollution; and
3) Evaluate resident and lake-user opinions regarding the condition and management of the resource to establish action priorities.

It is also recommended that the Association initiate Phase II in the development of a Comprehensive Lake Management Plan. This phase would include the evaluation of applicable management strategies that could be employed to address the identified problems.

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