Part 2

Feasibility Study of Lake Vermilion

Vermilion County, Danville, Illinois

INTRODUCTION

Pursuant to the information collected and the conclusions derived from the Diagnostic Study (Part 1) of this report, a Feasibility Study was undertaken to investigate potential alternatives for restoring the water quality and enhancing the recreational and aesthetic qualities of Lake Vermilion, and to develop a management plan for consideration as a Phase II Clean Lakes Program implementation project. The Illinois EPA funded 60 percent of the study under the Illinois Clean Lakes Program (ICLP), with the remaining 40 percent funding contributed by the Consumers Illinois Water Company. The Illinois Environmental Protection Agency was also responsible for grant administration and program management. Cochran & Wilken, Inc. performed the Feasibility Study with assistance from the Consumers Illinois Water Company, the Illinois State Water Survey, the Illinois Department of Natural Resources, the USDA Natural Resources Conservation Service, The Vermilion County Soil and Water Conservation District, and the Illinois Environmental Protection Agency.

A. Identification of Water Quality and Use Impairment Problems

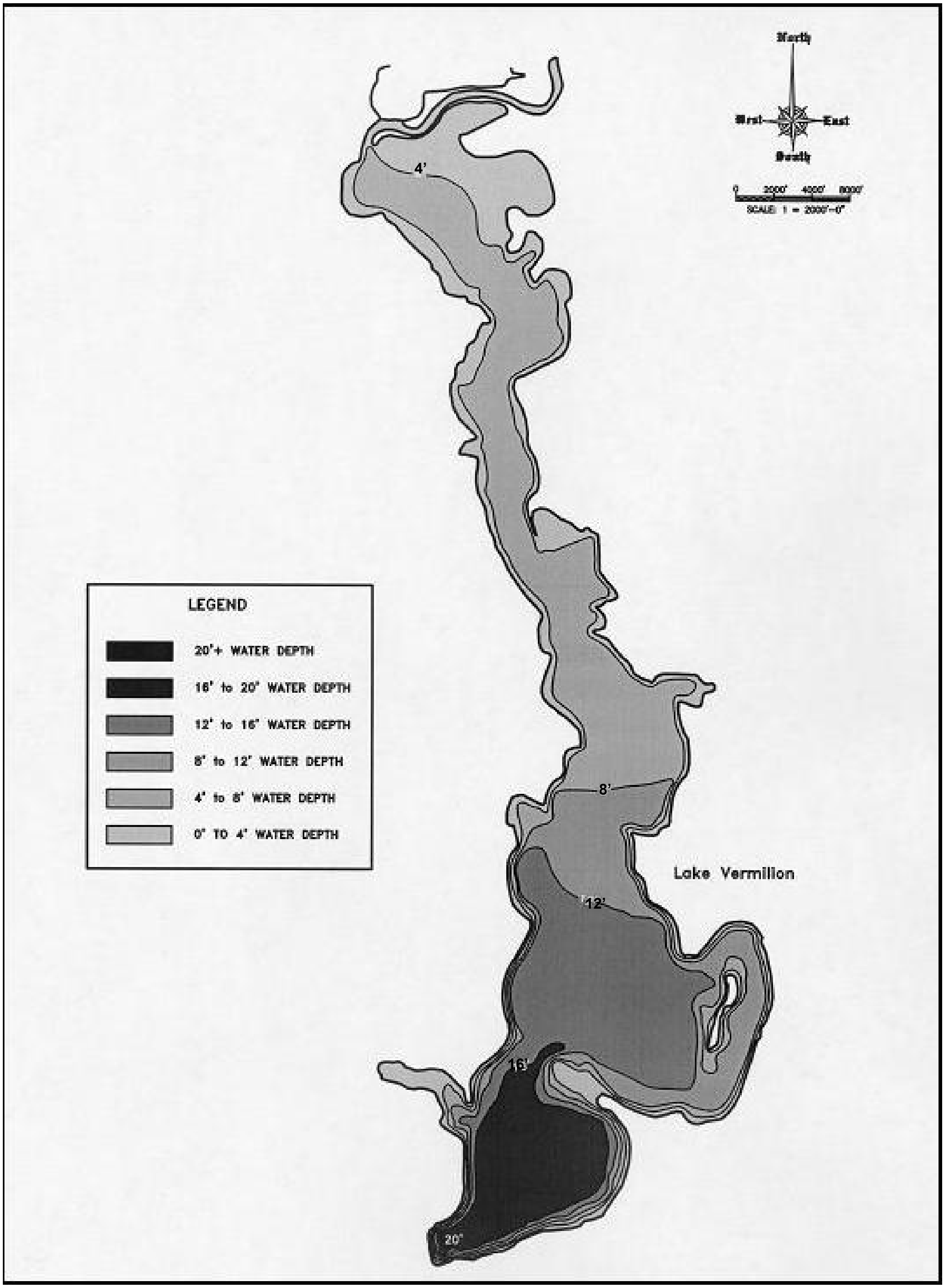
The following discussion is a summary of the water quality and use impairment problems in Lake Vermilion that were identified in the diagnostic section of this report.

1. Sedimentation and Shallow Water Depths

The most recent lake sedimentation survey, which was conducted in the summer of 1998, revealed that approximately 5,238 acre-feet (8,450,622 cubic yards) of accumulated sediment were present in the lake. This represents a total capacity or volume loss of approximately 39.7 percent from the original 1925 capacity. In the upper end of the lake from segment 11 through 20, approximately 2,093 acre-feet (3,376,700 cubic yards) have accumulated and have contributed to shallow water conditions ranging from 1.0 to 6.0 feet in depth. However, the actual volume loss in the upper end of the lake is difficult to estimate due to the increased dam height and normal water surface elevation (increased from 576.0 to 582.2 feet NGVD in 1991). Prior to this increase in dam and spillway height, much of the sediment in the upper end of the lake was exposed at normal pool levels and terrestrial vegetation was becoming established.

The accumulated sediments, which are high in organic content and nutrient rich from watershed and atmospheric influxes as well as the deposition of dead and decaying algal and macrophyte material, create a loosely compacted substrate over the entire bottom of the lake. This loose bottom sediment can be resuspended by bottom feeding fish, high wind conditions, boat turbulence, and storm flows. As a result of this sediment-induced turbidity, the water quality in Lake Vermilion can be impacted by elevated suspended solids levels and decreased water transparencies. Removal of these excessive accumulated sediments, particularly in the shallow upper end of the lake, would provide improved fish spawning habitat by restoring more desirable bottom conditions, and would provide improved trapping capability for suspended solids and nutrients entering the lake. The following bathymetric map (Figure 1) represents the existing hydrographic conditions and clearly shows the extent and location of the shallow water depths within the lake.

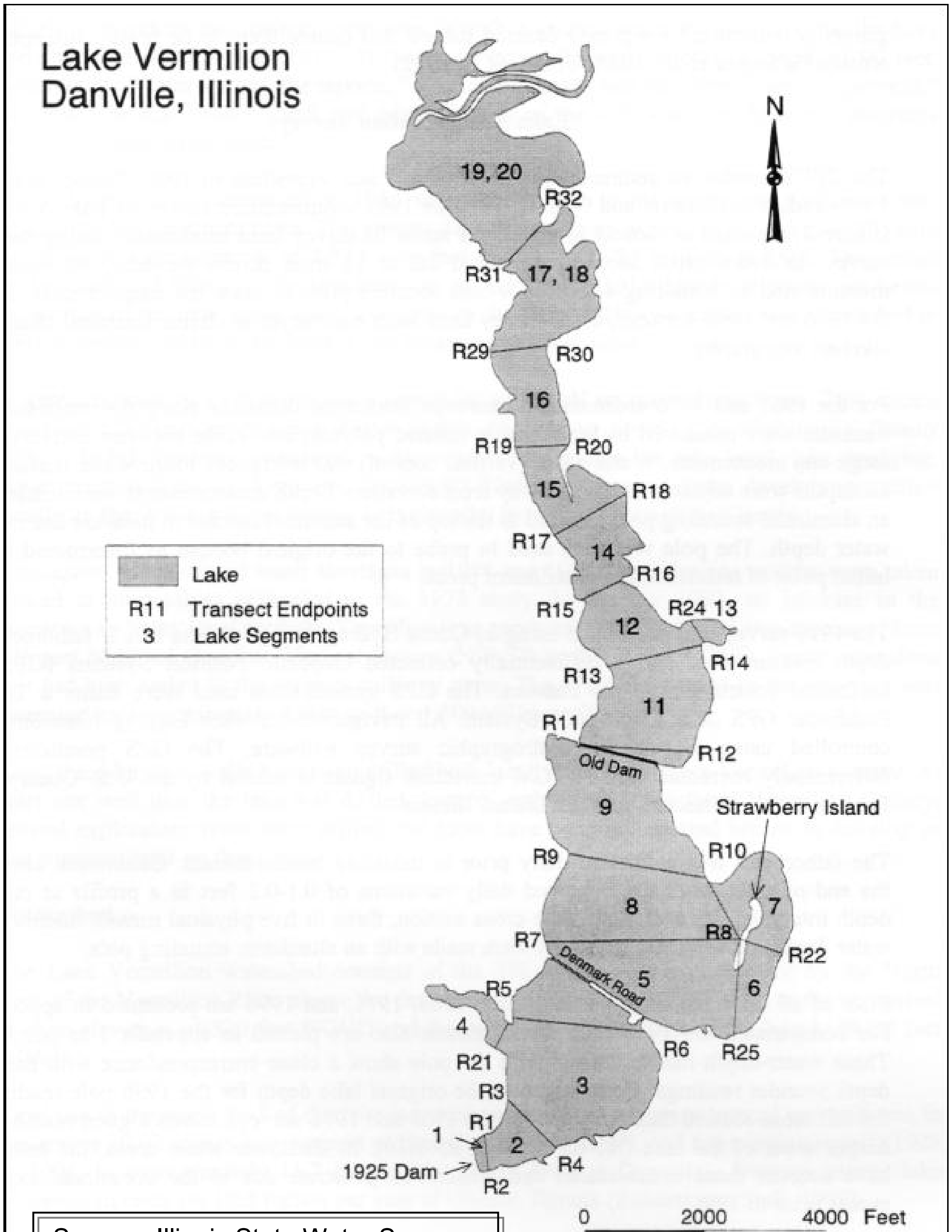
Figure 1. Bathymetric Map of Lake Vermilion



Source: Illinois State Water Survey, 1999

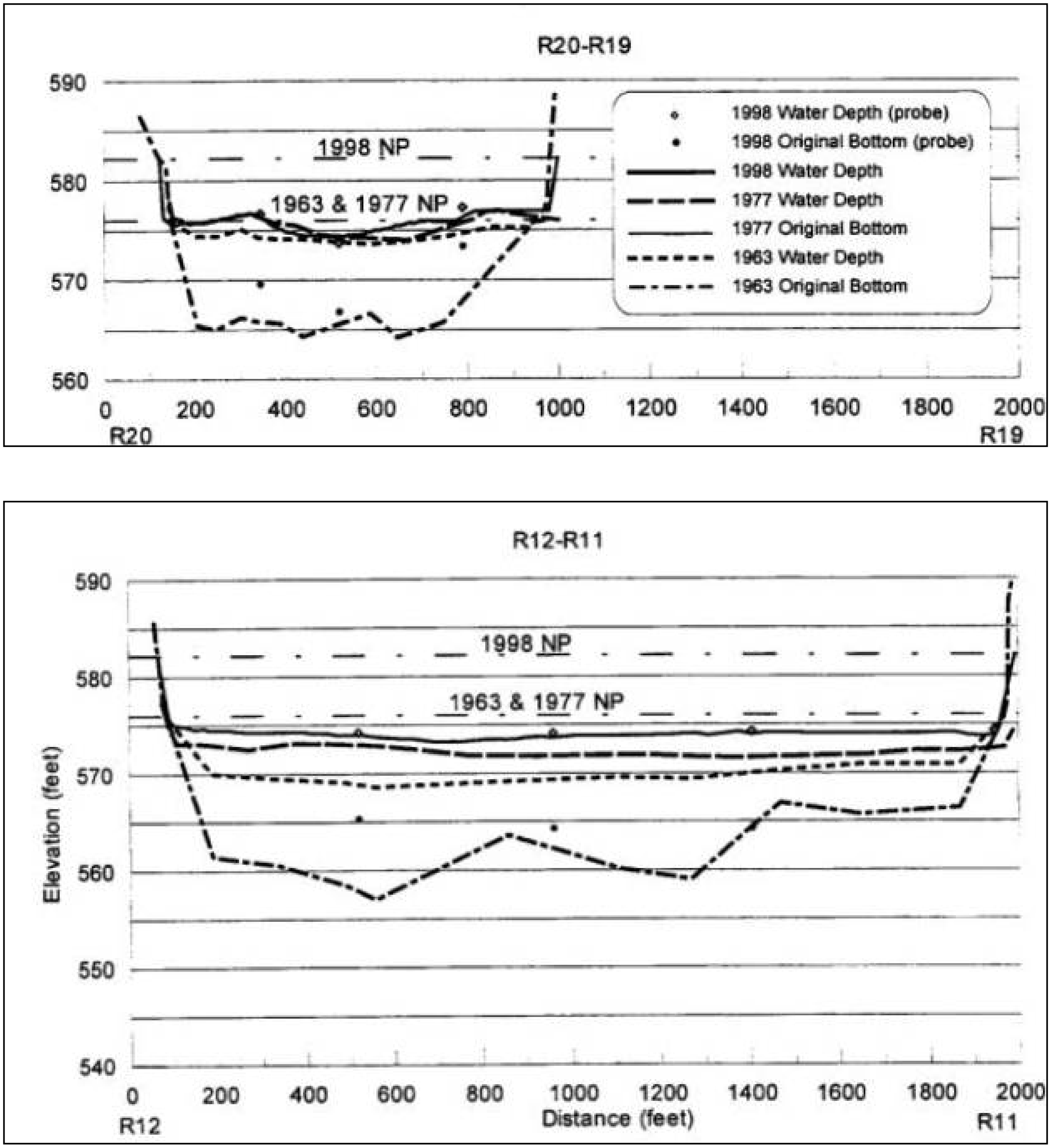
The following map (Figure 2) shows the location of the survey transects and lake segments that were completed by the Illinois State Water Survey during the 1998 Sedimentation Survey of Lake Vermilion. This graphical representation was necessary to evaluate the sediment distribution within the lake and to determine where the critically shallow water areas were located.

Figure 2. Sediment Survey Transect Locations



Source: Illinois State Water Survey

Figure 3. Representative Sediment Cross Sections in Upper End of Lake



Source: Illinois State Water Survey

Table 1. Historical Lake Volume and Capacity Loss Summary

Lake Segment ID	ISWS Transects Bordering Lake Segment	1925 Cross Section Volume acre-ft	1998 Cross Section Volume acre-ft	1925-1998 Estimated Capacity Loss acre-ft	1925-1998 Estimated Capacity Loss Percent
1	Dam - R1/R2	64	45	19	29.0%
2	R1/R2 - R3/R4	441	303	137	31.2%
3	R3/R4 - R5/R6	2,035	1,475	560	27.5%
4	Inflow - R21/R5	137	71	66	48.2%
5	Road - R7/R8	2,272	1,580	692	30.5%
6, 7	R25/R8 - R8/R10	549	425	125	22.7%
8	R7/R8 - R9/R10	1,782	1,110	671	37.7%
9	R9/R10 - R11/R12	1,870	994	876	46.8%
11	R11/R12 - R13/R14	1,070	472	598	55.9%
12	R13/R14 - R15/R16	521	254	267	51.3%
13	Inflow - R14/R24	35	13	22	62.4%
14	R15/R16 - R17/R18	351	197	154	44.0%
15	R17/R18 - R19/R20	397	203	195	49.0%
16	R19/R20 - R29/R30	445	212	233	52.3%
17, 18	R29/R30 - R31/R32	570	287	283	49.6%
19, 20	R31/R32 - Inflow	672	330	341	50.8%
Totals		13,209	7,971	5,238	39.7%

Note: Lake Surface Area is approximately 878 acres

If the estimated capacity prior to raising the spillway in 1992 was 9,810 acre-ft., then the percent capacity loss would be significantly higher than shown above; particularly for segments 11 through 16.

2. Turbid Water

As noted previously in the Diagnostic Study portion of this report, turbidity or murkiness is affected primarily by the presence of suspended solids such as soil particles, resuspended bottom sediments, and both living and dead plant/animal matter. During the lake's primary recreational use period (April through September), water clarity, as measured by a Secchi disk, was consistently less than 28 inches. Transparency typically ranged between 12 and 24 inches, as reflected in the average transparencies for the recreational use periods. The aesthetics of the lake are also reduced by the brown, green and/or murky water appearance. Increased turbidity can also inhibit the growth of aquatic vegetation by limiting light penetration into the water column. The macrophyte survey indicated that the population of rooted, aquatic vegetation was sparse and/or degraded.

The factors that have contributed to the turbidity of Lake Vermilion's water include excessive phytoplankton growth, a degraded macrophyte community, watershed runoff, shoreline erosion, and bottom sediment resuspension. Analyses of phytoplankton during the year of baseline monitoring indicated high counts of algae in the water column. Among the three monitoring sites, the average standing crops ranged from a low of 6,399 to 23,601 algal units per milliliter, and the predominant algae present was the nuisance, blue-green species (particularly *Gomphosphaeria lacustris* and *Anacystis montana*). During the months of June and July, blue-green algae accounted for 67.4 to 98.3 percent of the total algal population for all sample sites, thus exhibiting clear species dominance. The blue-greens are considered especially undesirable with regards to aesthetics because of their tendency to form as scum and mats, and are not a desirable food source for aquatic species.

Chlorophyll *a* concentrations support the high phytoplankton populations as determined from the laboratory analyses. For Site 1, the chlorophyll *a* concentrations for the current monitoring year data averaged 31.4 um/L and exceeded 55 um/L on several occasions. Chlorophyll *a* (corrected) concentrations in excess of 55 um/L are considered to be hypereutrophic, which indicates a nutrient rich state that exceeds lake demands and can result in excess algal production and lake water quality degradation.

Watershed runoff has invariably contributed a significant portion of the sediment and nutrient (phosphorus and nitrogen) loading to the lake, particularly from agricultural row crop surfaces, which are the predominant land use. Shoreline erosion also contributes suspended sediment loadings to the lake and helps to increase the amount of turbidity and degraded water quality. Bottom sediments disturbed by wind, waves, and the feeding activity of common carp, and catfish can also contribute to increased turbidity. Fine grained particles can remain suspended in the water column for extended periods of time, and resuspended sediments may also release nutrients into the water column, thereby contributing to increased algal growth. Sediment resuspension and turbidity resulting from wind and wave action in shallow, near-shore areas was evident and has reduced the aesthetic enjoyment of Lake Vermilion.

3. Shoreline Erosion

In September of 2002, a field survey was conducted by Cochran & Wilken, Inc. to evaluate the extent of shoreline erosion that has occurred in order to determine the extent of its contribution to lake water degradation. Shoreline erosion impairs lake usage and access by increasing turbidity, decreasing storage capacity, and/or damaging valuable lakeshore property. The loss of shoreline soils may also jeopardize the stability of infrastructure such as bridges, roads, docks, etc. In addition, shoreline loss reduces the overall aesthetic appeal of the lake.

The survey was completed using the three-category classification scheme developed by Illinois EPA (see Appendix C). The methodologies used during the survey rated erosion severity by vertical measurements of the eroded zones. An estimate was made to determine the horizontal length of each eroded zone and a vertical measurement was recorded and applied to the following criteria: a bank height of 1.0 to 3.0 feet was classified as slight; greater than 3.0 feet and less than 8.0 feet was classified as moderate; and greater than 8 feet was classified as severe.

. It was determined that approximately 3,686.6 meters (12,095 ft.) of shoreline has experienced some degree of erosion. The extent of the erosion varied from slight to severe, and has occurred along both the east and west shorelines of the lake. However, the severe erosion in areas with high, vertical banks has occurred primarily along the west shoreline. Approximately 1,654.8 meters (5,429 ft.) of shoreline was found to have severe erosion, 707.7 meters (2,322 ft.) exhibited moderate erosion and 1,324.1 meters (4,344 ft.) of shoreline was found to have slight erosion. According to the 2002 survey, approximately 16.04% of the 22.98 km (14.28 mi.) shoreline is unprotected and has been negatively impacted by wind and wave erosion. Although the shoreline erosion is significant in many areas, it is important to note that much of the visible erosion has occurred since the lake level was raised in 1992. Prior to the spillway modification completed to raise the lake level, it is likely that earlier shoreline erosion has been covered by water and cannot be easily quantified. Therefore, only the recently eroded shoreline can be accounted for. In addition to contributing sediment and turbidity to the lake, uncontrolled shoreline erosion has reduced valuable shoreline property and has impacted aesthetic appeal.

Shoreline erosion can be caused by wind and wave action, pedestrian traffic, water level drawdown, and a lack of near-shore vegetation. The general absence of near-shore vegetation or offshore rocks allows wind induced wave energy to reach the unprotected soils. Since there are many areas with near vertical slopes in excess of 8 to 10 feet in height, the undercutting action of wind and boat waves can induce sudden, substantial slope failures to occur. There has been approximately 3,809.1 meters (12,497 ft.) of shoreline stabilization implemented in selected areas of the lake. However, very little of the protected shoreline has been in areas of severe erosion and high vertical banks (see Figures 4 and 5).

Figure 4. Examples of Severe Shoreline Erosion at Lake Vermilion

Figure 4 (cont.)

4. Unbalanced Aquatic Vegetation Growth

The plant community, which includes both macrophyte vegetation (plants visible and identifiable to the naked eye) and algae, is an extremely important component of a balanced lake ecosystem. Algae are plants that are typically microscopic and are either free-floating or attached. Although individual algae are microscopic in size, they are often visible when large numbers are present due to their green or blue-green color. The free-floating algae or phytoplankton are most commonly found in shallow eutrophic reservoirs such as Lake Vermilion. Algae can provide food for aquatic insects, zooplankton and fish, and can also provide oxygen, which is beneficial to all organisms. However, an overabundance of phytoplankton can result in adverse effects such as: shading out and limiting the growth of submersed macrophytes; algae blooms and surface scums that detract from lake aesthetics; night time respiration and/or rapid algal die-offs that can deplete dissolved oxygen levels and severely stress the fish population.

As mentioned previously, the algal population was rather extensive during the 2000-2001 baseline-monitoring year reaching bloom conditions throughout the summer. Algae growth is stimulated by high concentrations of nutrients in the water column. When bloom conditions frequently occur, the increased turbidity reduces light penetration, which in turn limits macrophyte growth. Measurements of phosphorus and inorganic nitrogen obtained during the baseline-monitoring year did not fall below the levels shown to contribute to nuisance algae growth, such as 0.01 mg/l for inorganic phosphorus and 0.30 mg/l for inorganic nitrogen (Sawyer, 1952).

The sources of Lake Vermilion's high in-lake nutrient concentrations include inflow from watershed runoff, internal regeneration, waterfowl and atmospheric deposition. The nutrient budget that was developed from data obtained during the 1999-2000 monitoring year indicates that watershed runoff provided nearly all of the phosphorus and nitrogen influx to the lake. These nutrients were transported from various upland sources such as agricultural row crop fields, the adjacent forested and urban areas.

Internal regeneration was estimated to have contributed a very small percentage of the total phosphorus and nitrogen influx due to the regularly circulated or mixed conditions as a result of high flow conditions within the primarily riverine reservoir system. This flow induced lake aeration and circulation has tended to limit the release of nutrients as a result of anoxic conditions during the summer stratification period.

Aquatic macrophyte growth has been observed to be sparse and limited in most areas of the lake, with the most significant density and diversity located in the shallow, protected northeast section of the lake. Although various species were present in shallow near-shore areas of the lake, the population density was generally minimal to sparse as a result of the turbid, low transparency water. Secchi depth readings ranged from 8 to 28 inches at Site 1 (downstream near dam) and from 10 to 16 inches at Site 5 (upstream). The plant species that were observed during the 2000 aquatic macrophyte survey (listed in order of relative dominance or percent occurrence) included Arrowhead (87.92%), Cattails (7.81%), Water Willow (3.71%), Water Lily (0.33%), Coontail

(0.185%), Sago Pondweed (0.03%), and Curlyleaf Pondweed (0.03%). Observations made by Cochran & Wilken, Inc. in the flooded upper end of the lake (Sept. 2002) included creeping water primrose, spatterdock, large leaf pondweed and additional areas of established water lily beds.

Limited amounts of rooted aquatic macrophytes in the littoral zone or shallow near-shore area are considered to be beneficial to a lake ecosystem in many ways. These benefits include food, protective cover and spawning areas for fish, waterfowl, insects and some mammals; oxygen production and bottom stabilization; shoreline protection through wave dissipation; and interception of suspended particles in the water column. The sparse and limited population of aquatic macrophytes is primarily a result of increased algal turbidity and extended water level drawdowns. High nutrient availability has allowed algal growth to become excessive, thus contributing to a decrease in water transparency.

Extended water level drawdowns can be very effective for controlling macrophyte growth by exposing the plants and root systems to dry, freezing conditions for a period sufficient to kill the plants. However, the large drainage area and relatively continuous inflow of water makes extended water level drawdowns at Lake Vermilion unfeasible. The following photographs (Figure 5) show examples of the aquatic plant species observed in the shallow, protected areas located at the north end of the lake.

5. Unbalanced Fishery and Aquatic Community

Lake Vermilion is considered to have a reasonably good fishery. Ongoing fisheries management efforts have included a regular supplemental stocking program and the enforcement of sport fishing regulations with an emphasis on catch and release, length restrictions, creel limits and fishing methods. Although various species such as muskie, walleye and largemouth bass have been stocked in the lake annually through an agreement with IDNR, only largemouth bass are now stocked in order to supplement and maintain the existing population.

Figure 5. Typical Emergent and Floating Aquatic Plants at Lake Vermilion

Recent population and creel census surveys indicate that some of the management objectives are being met. The 2001 population survey indicated that the largemouth bass population was good according to typical evaluation criteria. Although the Catch per Hour was 41 versus 72 for the 1997 survey, the Proportional Stock Density (PSD), Relative Stock Density (RSD), Relative Weight and Average Weight ratings were all within acceptable management plan ranges. Channel catfish sampling results were similar to largemouth bass where the Catch per Hour was less but other evaluation criteria were in a range considered to be good. However, crappie and bluegill exhibited fair results with unacceptable population densities.

Although the fish population appears to be generally acceptable as a result of management efforts and a successful catch and release program, degraded water quality conditions and a lack of suitable aquatic habitat has stressed the existing population. With improvements to water quality, clarity and habitat, Lake Vermilion can achieve and maintain an improved and stable fish population.

B. Objectives of the Lake Management Plan

The goal of the lake management plan for Lake Vermilion is to address the problems identified in the previous section, to protect and enhance existing lake uses, to increase recreational access and opportunities, and to improve the overall water quality. The lake management plan objectives that have been determined are shown as follows:

Comprehensive Lake Water Quality Objectives

1. Reduce the amount of sediment being delivered to the lake.
2. Remove accumulated sediment that has caused shallow water depths in the upper (north) end of the lake.
3. Improve water quality for aesthetics and to support a more balanced aquatic plant community.
4. Stabilize and protect eroded shoreline areas.
5. Improve fisheries population and habitat.

The following recreational use improvements will be achieved by addressing the comprehensive water quality objectives listed above.

1. Preserve and enhance existing lake uses for public water supply, fishing, swimming, boating and aesthetics.
2. Increase local interest by increasing water clarity and improving water quality.
3. Increase the areas available for recreational uses by maintaining and/or increasing the depth in the upper reaches of the lake.
4. Increase the populations and growth of game fish in the lake by improved habitat, combined with an enhanced stocking and fisheries management program.

C. Alternatives for Achieving the Lake Management Plan Objectives

Each of the lake management plan objectives listed above have several alternative approaches or solutions that have been considered. These restoration and protection alternatives are described below with a summary of which would be most feasible for Lake Vermilion. For most of the objectives, there are one or more restoration alternatives that clearly stand out relative to cost, benefits and/or feasibility. Although taking no action whatsoever is also an alternative, the long-term cost of no action is often too high. Delaying any necessary actions could lead to much more expensive projects at a later date as a result of continued degradation and lake eutrophication.

Objective #1: Reduce the amount of sediment and nutrients being delivered to the lake.

Alternative Actions

The Vermilion County Soil and Water Conservation District and the USDA-Natural Resources Conservation Service office located in Danville has worked very closely with agricultural producers in the watershed to promote no-till and conservation tillage practices. Recent estimates indicate that approximately 98 percent of land in the watershed is eroding at less than the tolerable amount (T). The NRCS has estimated that the average amount of gross erosion from the Lake Vermilion watershed is approximately 2.5 tons per acre, which is almost an acceptable soil loss level according to guidelines set forth in the T by 2000 Program. The predominantly gentle to moderate slopes in the Lake Vermilion watershed are not highly erosive, but have been subject to sheet (raindrop splash and shallow overland flow) and rill erosion (concentrated flow of water in small micro-channels), which have in turn contributed to gradual lake degradation. According to Vermilion County SWCD estimates, there are approximately 1,500 acres of highly erodible land and 30,000 acres of potentially highly erodible land in the watershed. It has also been estimated that 19.2 percent of the land in the watershed has not been adequately protected from soil erosion.

According to the sedimentation survey completed in 1998, an average of approximately 115,837 cubic yards of sediment have been deposited in the lake annually since it was constructed. According to the results of the sediment survey, the capacity loss rate (0.54 percent per year) and watershed sediment yield rate (0.40 tons per acre/year) of the lake and its watershed over the 1925-1998 period are about average for Illinois impoundment lakes (ISWS, 1999). Although the annual capacity loss rate of 0.54 percent was considerably lower than previous capacity loss estimates (ISWS, 1963 and 1977) as a result of raising the spillway elevation, the estimated capacity loss rate would have been 0.84 percent per year if the sediment volume were referenced to the lake volume prior to the 1992 spillway modification.

Since there is a high degree of participation in conservation tillage practices in the predominantly gentle sloping watershed, two additional practices that could be considered include grassed waterways and streamside filter strips. When implemented in conjunction with conservation tillage, these agricultural Best Management Practices (BMP) have been very effective at reducing sediment yield to waterways.

Filter strips are typically a strip of native grasses, trees and/or shrubs that border a stream. They act to slow water flow and allow contaminants like sediment, fertilizers and pesticides to collect in the vegetated buffer zone. The trapped nutrients are utilized by the vegetation, and cleaner filtered water is allowed to enter the stream and lake. According to the "Lake and Reservoir Restoration Guidance Manual" (USEPA, 1990), properly installed and maintained filter strips or stream side buffer zones are capable of filtering or trapping from 67 to 84 percent of sediment and nutrients from sheet runoff on 4 percent slopes. The NRCS has found that the optimum width for most installations is approximately 66 feet on both sides of the stream.

Grassed waterways are very effective at preventing gully erosion. They force storm water runoff water to flow down the center of an established grass strip while minimizing soil erosion during the process. Besides preventing gully erosion, grass waterways can be effective filters that trap sediment and nutrients. However, they can lose their effectiveness if too much sediment builds up in the waterway. In order to maintain maximum effectiveness, they should be implemented with other practices such as conservation tillage, filter strips, etc.

In addition to the watershed BMP's described above, another alternative that can be considered for trapping sediment and nutrients is a sedimentation basin that allows storm runoff to be retained and settle out before reaching the main body of the lake. An impoundment is typically constructed with an earthen and/or rock dam that allows excess water to flow over a spillway and then gradually release impounded water through a slotted drop inlet structure with an overflow weir and a debris screen to prevent clogging. In addition to a major sediment and nutrient retention basin constructed on a main tributary or across a narrow section of the upper end of the lake, many smaller sedimentation basins could be constructed across smaller tributaries located further upstream of the lake.

Proposed Actions

According to the USDA-NRCS District Conservationist, an Illinois EPA 319 (Non-Point Source Pollution Control Program) Project has been developed that will include the implementation of various conservation measures designed to reduce soil erosion and nutrient delivery to the Vermilion River system. The major components of the 319 Project include public education programs, upstream sediment and nutrient retention basins, conventional BMP's (Best Management Practices), and demonstration plots showing proper nutrient management. These conventional BMP's (i.e. terraces, conservation tillage, vegetated buffer strips, water and sediment control basins, grass waterways, etc.) will supplement those tracts of land that were not treated or included as part of the existing Conservation Cost Program C-2000 Grant.

It is estimated that the cost of implementing these additional BMP's will be approximately $40,000 with a 60 percent cost share rate. The sediment and nutrient retention basins will be effective at treating as much as 60 percent of the entire watershed. The estimated cost for the 20 proposed structures is $350,000. A major component to the program includes contacting landowners and farm operators to increase awareness of resource management systems and how they may be used to improve water quality and reduce soil erosion. Since education and willing participation is a critical component of any successful program, an effort will be made to increase knowledge and awareness of environmental impacts that can be incurred as a result of inadequately treated sewage discharges and the incorrect use of nutrients and pesticides. The education and technical assistance will primarily be targeted to watershed residents who have soil, water, plant and resource problems that require assistance. These efforts will include educational and informational material, public meetings, demonstration plots, tours and site visits.

Objective #2: ***Remove accumulated sediment that has caused shallow water depths in the north end of the lake.***

Alternative Actions

The major alternatives for removing sediment accumulation in the upper end of Lake Vermilion include extended water level drawdown, mechanical dredging and hydraulic dredging. According to the most recent sedimentation survey (ISWS, 1999), there are approximately 71.8 acre-feet (115,837 cubic yards) deposited in the lake annually.

a. Lake Water Level Drawdown and Compaction

Lowering the water level and allowing the sediment to dry and consolidate is an alternative for restoring lost water depths in some lakes. However, this treatment alternative is generally a limited solution for excessive sediment deposits. In order to assure optimum drying and compaction, the water level would have to be substantially lowered for a sufficient period of time longer than the current drawdown period. According to a study completed by Fox et al. (1977), approximately 170 days of exposure to drying conditions would produce a sediment consolidation ranging from 7 to 50 percent, with water losses ranging from 40 to 50 percent. It would be anticipated that the sediment found in the upper arms of Lake Vermilion would fall in the median range, and would thus be expected to consolidate approximately 25 percent.

In order to effectively reduce sediment volume in the upper end of Lake Vermilion, water levels would have to be lowered approximately six (6) feet or more for the entire drawdown period. If a drawdown were extended long enough to optimize sediment consolidation, water depths in the upper end of the lake may be increased by as much as one to one and one-half feet. However, a drawdown extended well into the spring or even into the summer would be nearly impossible to implement because of the extremely large watershed drainage area. If it were possible, an extended drawdown may have many negative impacts to the aquatic community and would impact the recreational use of the lake.

b. Mechanical Dredging

There are several methods of mechanical dredging or excavation presently available. The lake can either be dredged at normal pool with a dragline, or the water level could be lowered enough to allow low ground pressure excavation equipment into the dry lakebed. There are several advantages to dry lakebed excavation as compared to hydraulic or dragline dredging, such as the elimination of excessive turbidity or resuspended solids, and a smaller quantity of material to remove due to consolidation and compaction. However, there are many disadvantages and problems that could be encountered. Although water level drawdown could be accomplished easily during the annual fall drawdown, the length of time required for the sediment to dewater and consolidate sufficiently enough to support excavation equipment may take longer than expected if frequent rainfall events occur. Although, this method could be accomplished for a limited dredging project at Lake Vermilion in the shallow upper (north) end of the lake where sediment thickness typically ranges from 2.3 to 6.8 feet, we do not feel that it is a feasible option since the watershed drains an extremely large area and would likely cause flooding problems within the dredging area.

Another method of mechanical dredging could be accomplished with a dragline while the lake water level is at normal pool. This is accomplished by extending excavating equipment from shore, or by mounting the equipment on a barge. This method is more practical for smaller lakes or when a large quantity of rocks or debris is anticipated. Removal of accumulated lake sediment is inefficient and can leave high percentages of material behind. Disposal of the sediment is also very inefficient and labor intensive since it must be handled several times. Once the sediment is removed from the lake, it must be placed on a barge or a truck and transported to the retention site. This repeated handling is generally not cost effective, and can result in sediment losses during transfer. Equipment access for the removal and placement of dredged sediment would also have a negative impact on the lake shoreline. Therefore, mechanical dredging with a dragline would not be considered as a feasible sediment removal method.

c. Hydraulic Dredging

Hydraulic dredging involves a centrifugal pump mounted on a pontoon or hull, which uses suction to pull the loose sediment off the bottom and pump it through a polyethylene pipeline to a sediment retention area. Generally, a cutterhead is added to the intake of the suction line in order to loosen the accumulated or native sediment for easy transport and discharge. A slurry of sediment and water, generally ranging between 10 and 15 percent solids (by weight), can be pumped for distances as much as 10,000 to 15,000 feet with the use of a booster pump. The efficiently pumped sediment slurry must be discharged into a suitably constructed earthen dike-walled containment area with adequate storage capacity. The sediment containment or retention area must be properly designed to allow sufficient retention time for the sediment particles to settle throughout the project, and allow the clear decant or effluent water to flow through the outlet structure back to the lake.

One of the advantages of hydraulic dredging is the efficiency of sediment handling. The removal, transport and deposition is performed in one operation, which minimizes expenses and potential sediment losses during transport. Another advantage is that the lake does not have to be drained, and most areas can remain open for public use. Most hydraulic dredges are considered portable and are easily moved from one site to another. They are extremely versatile and are capable of covering large areas of the lake by maneuvering with their spud anchorage system and moving the discharge pipeline when necessary.

Proposed Actions

The proposed alternative for removing accumulated sediment from the upper end of Lake Vermilion is by hydraulic dredging. This method would effectively remove approximately 1,276,292 cubic yards of sediment from lake segments 11,12,13,14,15, 16, 17, and 18 (see Figure 6). This quantity is based on removing an average of three feet of accumulated sediment within these areas in order to restore water depth and storage capacity in the reservoir.

Table 2. Summary of Sediment Volumes in Shallow Upper End of Lake

Lake Segment	Sediment Volume (acre-ft.)	Sediment Volume (cubic yds.)	Avg. Sediment Thickness (ft.)	% Removed with 3' Avg. Dredge Cut	Sediment Volume to Remove (cy)
17, 18	283	456,572	4.9	61.22%	279,534
16	233	375,906	6.8	44.12%	165,841
15	195	314,599	6.3	47.62%	149,809
14	154	248,453	4.8	62.50%	155,283
13	22	35,493	4.9	61.22%	21,731
12	267	430,759	6.7	44.78%	192,877
11	598	964,771	9.3	32.26%	311,217
Total	1,752	2,826,554			1,276,292

Although there is a significant amount of sediment that has been deposited in the northern half of the lake, the additional water depth provided by raising the spillway elevation in 1992 has reduced the immediate need for a large-scale sediment removal project. However, based on the annual sediment load typically being transported into the lake, it is imperative to begin planning for the future dredging requirement. Water depths only range from one (1) to eight (8) feet throughout the northern half of the lake from segment 11 to segment 20. Since the northernmost section of the lake (segments 19 and 20) is primarily flooded timber and pre-spillway modification floodplain, it has not been included in any sediment removal estimates. This area is relatively shallow and is gradually developing into a wetland ecosystem. The gradual decomposition of dead timber and the accumulation of sediment has allowed various species of aquatic plants to become established. Since there is an extensive area of old timber remnants, incoming storm flows spread out into the flooded area and the velocity of the inflow slows down enough to allow suspended sediment to settle in the flooded upper end.

Table 3. Estimated Sediment Removal Costs

	Task Description	Estim. Cost
a)	Dredging - 1,276,292 cy of sediment from the shallow north end ($1.75/cy)	$2,233,511
b)	Dredge and Pipeline Mobilization	$300,000
b)	Land Acquisition; Approx. 100 acres	$500,000
c)	Sediment Retention Site Construction	$960,000
d)	Engineering Services for Design, Permitting, Surveying, Dredging & Construction	$350,000
e)	Retention Site Reclamation, including engineering	$200,000
	Total Estimate of Probable Costs	**$4,543,511**
	Total including 10% Contingency	**$4,997,862**

Normally, a maximum dredge cut depth of 8 to 10 feet is considered to be a suitable depth at which to deepen a lake. This maximum cut depth provides navigational access, minimizes sediment resuspension and controls aquatic vegetation growth. We recommend extending the maximum dredge cut depth at Lake Vermilion to 10 feet in order to provide additional storage volume in the upper end of the lake (segments 18 and 19), which will extend the useful lifespan of the project and provide a long-term benefit to the lake.

Approximately 40.5 hectares (100.0 acres) of land would be required for the retention and dewatering facility. There are several potential sites located to the north, east and west of the upper end of the lake. The dredged sediment can be beneficially reused as fertile agricultural soil and/or fill, thus maintaining the value of the land.

This sediment removal option would provide the most cost effective improvement in water quality and recreational benefits by removing most of the soft, accumulated sediment from the upper end of the lake. The removal of nutrient rich sediment and detritus will also improve and expand aquatic habitat for fish, macro-invertebrates and other aquatic organisms.

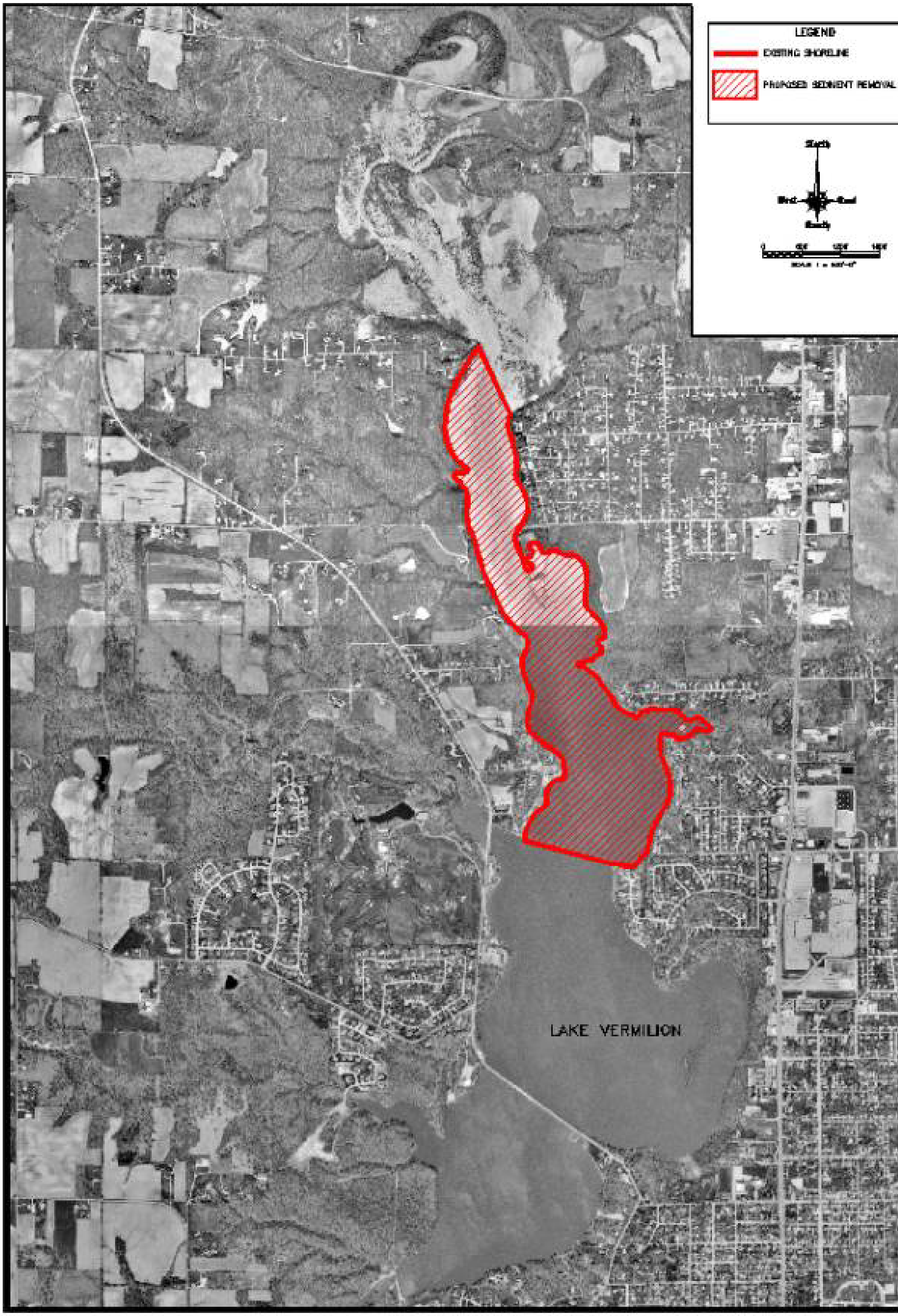


FIGURE # 6 PROPOSED SEDIMENT REMOVAL AREA

Objective #3: Improve water quality for aesthetics and to support a more balanced aquatic plant community

Alternative Actions

There are several alternatives that can be considered for improving water quality in the lake, which would help to improve aesthetics and support a more balanced aquatic plant community. The aquatic plant community, which includes both algae and rooted macrophytes, has suffered due to high nutrient availability, decreased water clarity or Secchi depth, and repeated water level drawdowns each fall for fisheries management. The high nutrient availability, which is primarily nitrogen and phosphorus, has provided ample stimulation for excessive algal growth. As a result of the increased algal turbidity and decreased water clarity, nuisance blue-green algae have become the dominant species by being able to out-compete other more desirable algae species. Many species of blue-greens have the ability to regulate buoyancy and therefore can elevate themselves to the optimum level of light transparency. In addition to this capability of buoyancy regulation, many blue-greens, have the ability to fix nitrogen when available concentrations are limited. Nitrogen gas (N2) is always dissolved in lake water since it constitutes about 80 percent of the atmospheric gases, but most true algae cannot use it to satisfy their nitrogen demands. Some Cyanophyta (blue-green algae) species can convert nitrogen gas into ammonia by a process called nitrogen fixation.

In addition to the unbalanced algae population, macrophyte vegetation density and diversity has become limited and sparse as a result of the increased algal turbidity that has prevented light from penetrating adequately into the water column.

The primary alternatives for improving water clarity and restoring a more balanced aquatic vegetation population include reducing nutrient availability, restructuring the algae population so that blue-greens are not dominant, and reducing the amount of suspended sediment entering the lake during significant storm events.

Nutrients such as nitrogen and phosphorus can be controlled and reduced in many ways such as: implementing watershed best management practices in the watershed (discussed in Objective #1); minimizing internal regeneration during the summer stratification period; minimizing wind resuspension in shallow, sparsely vegetated areas of the lake.

As discussed previously, external loading of nutrients from watershed sources can be reduced by implementing vegetated filter strips, grassed waterways, constructing nutrient and sediment retention basins, and implementing a nutrient management program.

Internal regeneration of nutrients has been estimated to be a very minor component of the overall nutrient budget since summer stratification does not typically develop for extended periods due to the re-occurring natural mixing process, which occurs as a result of nearly continuous movement of water that flows into the lake from a very large drainage area and through the six-foot gates at the spillway. Since the water is used for public water supply purposes, the spillway gates are operated to allow the downstream intakes to withdraw a continuous supply. This near continuous flow pattern apparently mixes the water within the deeper portion of the reservoir and limits the internal release of nutrients by maintaining oxygenated conditions near the bottom.

There are several types of destratification or artificial circulation systems available. The mechanical type system typically consists of a floating platform structure with a submerged motor driven propeller that causes a mixing of lake water at all depths. Another potential system is one that consists of a floating wind powered circulator that draws anoxic water from near the bottom through a vertical induction pipe and discharges this water outward at the surface of the lake. The upper and lower water currents caused by the induction and discharge of anoxic water would promote lake mixing. Another type of system that would be suitable for lake destratification would be an efficiently designed compressed air system capable of lake mixing, so that the thermally stratified layer would be eliminated and a better distribution of dissolved oxygen would occur throughout the water column.

Water clarity can also be improved by minimizing wind resuspension of sediment and nutrients in shallow water areas. This resuspension can be controlled or reduced by re-establishing a rooted aquatic macrophyte community (see Figure 7) and by removing soft accumulated sediment from the upper end of the lake. Sediment removal has been discussed thoroughly in a previous section.

Figure 7. Representative Aquatic Plant Growth

Other potential alternatives for reducing nutrient concentrations are nutrient diversion, dilution and flushing, artificial circulation, discharge of hypolimnetic water, and phosphorus inactivation/precipitation. Due to the morphometric and hydrologic features of the lake, it would be technically unfeasible and expensive to undertake a diversion or flow routing system for the control of nutrients. Dilution and flushing has been effective at reducing the concentration of nutrients in the water column by adding nutrient poor water. Flushing reduces algal biomass by increasing the loss rate of cells. However, dilution and flushing are not considered as acceptable alternatives for Lake Vermilion due to the lack of suitable groundwater resources. Discharge of surface water is currently being employed, which apparently induces a sufficient amount of artificial circulation. Furthermore, hypolimnetic discharges are normally not a feasible solution because anoxic conditions normally occur during the summer thermal stratification period when water conservation is critical due to lack of precipitation and excessive water loss from evaporation.

Phosphorus inactivation and precipitation are techniques used to lower concentration of phosphorus in the water column by either precipitating it out or preventing its release from sediments. Aluminum sulfate or sodium aluminate is added to the lake surface in order to precipitate the phosphorus to the lake bottom. Additional aluminum sulfate is added to form a barrier to prevent phosphorus release from the sediment. This alternative is not considered to be feasible since the predominant source of phosphorus loading to the lake stems from the watershed, and dissolved phosphorus concentrations were extremely low in relation to total phosphorus.

Proposed Actions

There are several alternatives that should be implemented in order to improve water quality for aesthetics and to support a more balanced aquatic plant community. The first action is continued and increased soil conservation practices in the watershed that would reduce and minimize sediment delivery to the lake. Since much of the phosphorus entering the lake is bound to sediment, any action that involves controlling sediment delivery will also control phosphorus levels. There has been a considerable amount of work done in the watershed to control erosion and runoff, and should be continued in order to insure reduced nutrient levels. Nutrient management practices should be followed throughout the watershed in order to minimize the amount of nitrate leaching. Since much of the watershed is agricultural with widespread use of subsurface field tiles for drainage, proper management of fertilizer applications will gradually decrease the amount of nitrogen being transported via drain tiles to the streams that enter the lake.

Third, the resuspension of soft sediment in the shallow water of the upper end of the lake has been previously addressed with recommendations for removal by dredging. Once nutrient concentrations are lowered and water clarity is improved, there will be a gradual re-establishment of a desirable diversity and growth of rooted macrophytes, which will also minimize sediment resuspension in shallow water. Stabilizing eroded shoreline areas will also help lower turbidity and is discussed in the following section.

Objective #4: Stabilize Eroded Shoreline Areas

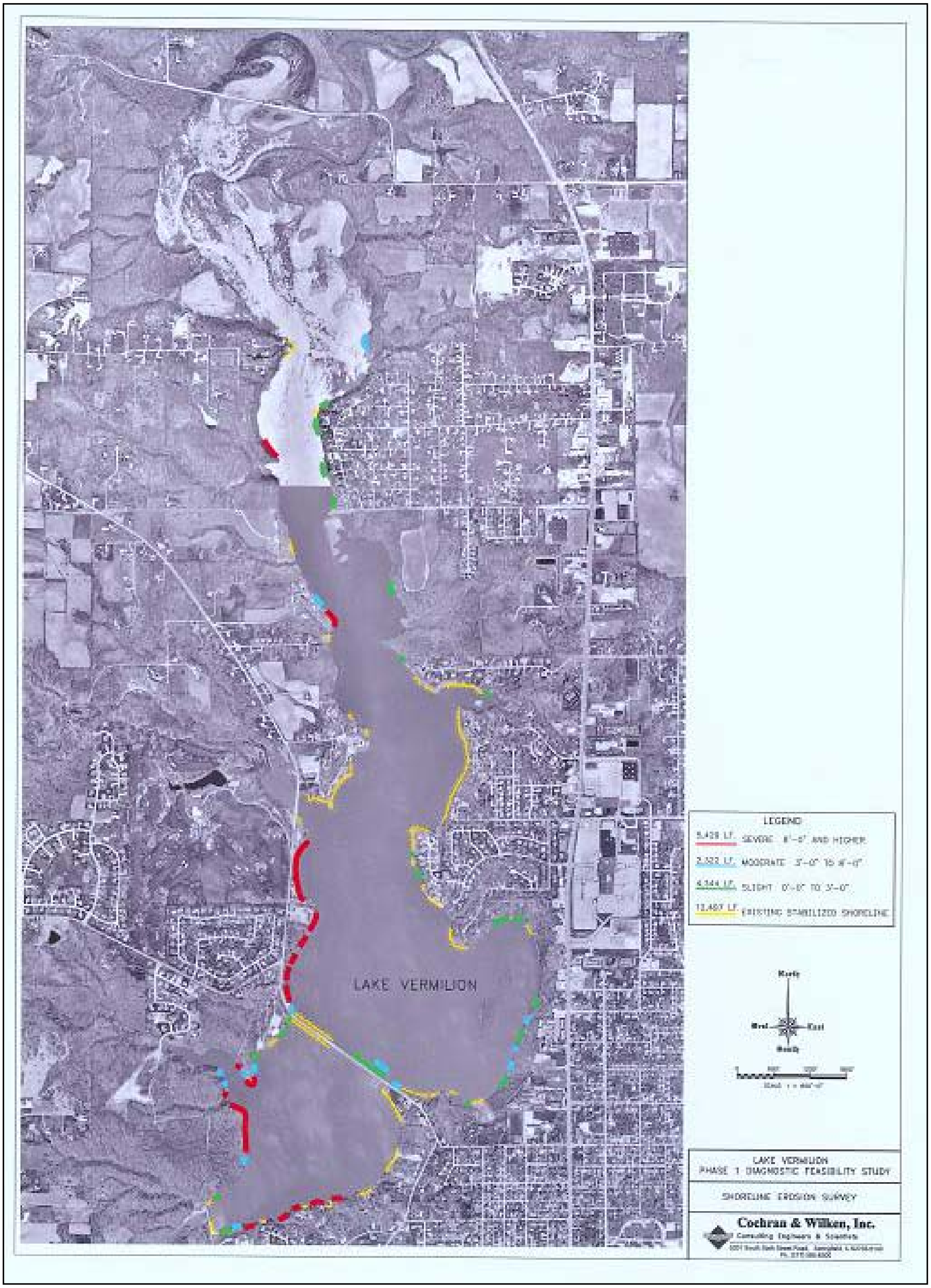
The uncontrolled erosion of shoreline areas is another source of sediment to the lake. As previously described, there are a number of factors that contribute to shoreline erosion at Lake Vermilion including easily erodible shoreline soil types, fluctuating water levels, heavy visitor usage, lack of nearshore aquatic vegetation and/or rock breakers, and exposure to waves generated by strong northerly and southerly winds.

<u>Alternative Actions</u>

Although there has been approximately 12,500 feet of riprap shoreline stabilization work completed at Lake Vermilion, there is still a significant amount of eroded shoreline that is still in need of stabilization (see Figure 8). Of the total amount of eroded shoreline, there are approximately 5,429 linear feet of severe erosion areas and 2,322 linear feet of moderate shoreline erosion. The typical form of erosion observed at these locations was an exposed and undercut bank that gradually allows the upper reaches of the shoreline slope to collapse. Photographs of these areas are shown in Appendix C

Technology has developed many new products to control erosion and has improved the older methods. The following were considered when deciding the best approach for the Lake Vermilion shorelines; riprap (both crushed stone and rounded glacial stone) with filter rock or filter fabric, lunker structures, erosion mats, plastic and natural geowebs, gabions, railroad ties, interlocking concrete blocks and natural vegetative stabilization. Vegetative covering is a method of shoreline stabilization that can provide protection by reducing wave action and by binding the soil with roots. In addition to the erosion control benefits, vegetative stabilization requires little or no maintenance, is aesthetically pleasing, provides habitat and is cost effective.

Figure 8. Proposed Shoreline Stabilization Areas



A potential substitute for riprap in areas of moderate erosion (bank heights ranging from 3 to 8 feet) could be emergent vegetation plantings, if the area adjacent to the shoreline is gently sloping for at least 10 feet before dropping off into deeper water. The plantings would be protected by a fiber roll consisting of natural, biodegradable materials. The fiber roll is anchored out from the shoreline in 1 to 2 feet of water and acts as a protective boom against wave action until the vegetation plantings can become firmly established.

Riprap is one alternative to solve the erosion problems witnessed on the banks of Lake Vermilion, most of which are between three to eight feet and greater in height. The advantages of riprap include its reliable longevity, ease of installation and relatively inexpensive cost over large areas. All riprap should be installed using either filter stone or filter fabric to prevent washout from behind the installed riprap (see figures 9 and 10).

Figure 9. Riprap Shoreline Protection with Geotextile Fabric

Figure 10. Example of a Riprap Breakwater for Shoreline Protection

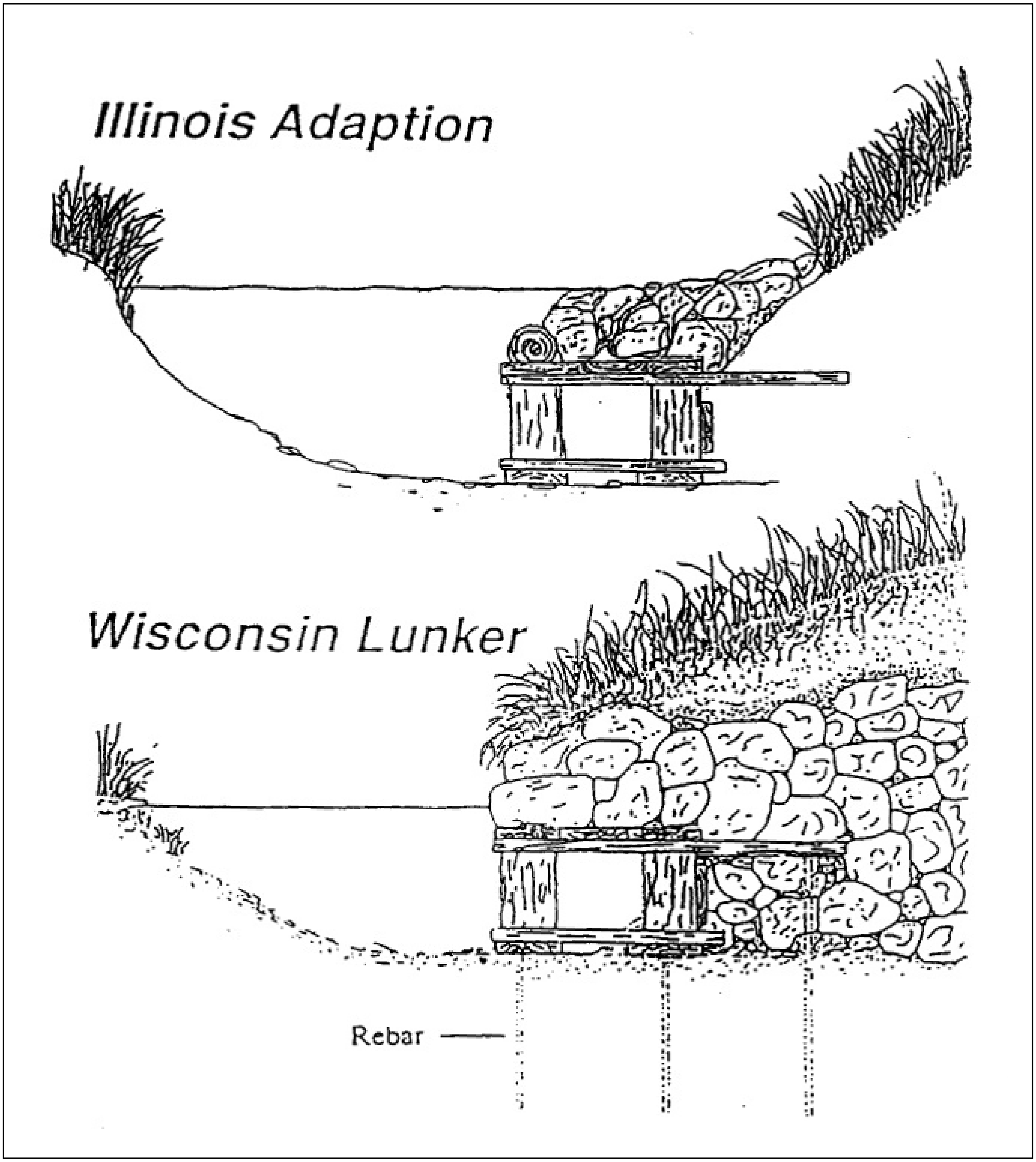
Proposed Actions

As a result of the shoreline erosion survey, it has been determined that the following stabilization measures should be implemented. Riprap and filter fabric should be used for all severely and moderately eroded shoreline, which is a total of approximately 7,751 linear feet. Riprap should be placed along the undercut bank of the shoreline two (2) feet below and two (2) feet above normal pool (spillway elevation) at a 2 to 1 slope. When possible, bare areas above the riprap would be graded to a 3 to 1 horizontal to vertical slope and seeded. However, the eroded shoreline at Lake Vermilion is typically bordered by wooded growth at or near the shoreline. Thus, flattening the slope of the shoreline will be generally difficult or impractical in most cases. Once the toe of the slope is protected from further undercutting, by structural and/or vegetative methods, the eroded slope will gradually slough until a state of equilibrium is reached. The estimated cost for 7,751 feet of riprap stabilization using Gradation RR4 broken stone riprap is approximately $40 per linear foot.

In areas where there is moderate erosion and/or heavy visitor use, vegetative approaches alone may not be capable of preventing further shoreline erosion. Structural barriers such as bulkheads, riprap, or lunker structures would be needed. Lunker structures are typically constructed of two inch oak planks. The planks form upper and bottom layers so that the interior is open to water flow at both ends and on the lakeside of the structure (Figure 11). Lunker structures would be constructed along the base of eroding banks that are situated near high use day areas or picnic sites. The ideal locations would typically be where shoreline bottom slopes are steeper and drop off into deeper water quickly. The lunker structures would supplement shoreline stabilization methods implemented on adjacent sides, and would provide fish habitat as well as bank stabilization. Costs of lunker installations are typically $45 to $55 per linear foot, including labor and prairie grass seeding. Approximately five (5) lunkers totaling 100 linear feet would have an estimated installation cost of $5,000. The Illinois adaptation is more applicable to the conditions found at Lake Vermilion

In areas that have been categorized as having slight bank erosion (approximately 4,344 linear feet), emergent vegetation in shallow nearshore areas would be encouraged and managed in order to minimize wave action on shore, thus protecting eroded banks from further undercutting. The estimated cost of implementing a combination of bio-technical (riprap and vegetation) shoreline stabilization and encouraging near shore emergent growth (i.e. water willow, bulrush, cattail, etc.) is $30 per linear foot. If one-half of the slightly eroded shoreline (approx. 2,172 linear feet) receives appropriate vegetative protection and is managed properly, the total cost would be approximately $65,160.

Figure 11 – Lunker Structure Illustration



The Consumers Illinois Water Company will complete ongoing management requirements. A summary of the proposed shoreline stabilization costs for Lake Vermilion are shown in Table 4 as follows:

Table 4. Proposed Shoreline Stabilization Costs

Degree of Erosion	Length of Shoreline	Stabilization Method	Estimated Cost
Severe	5,429 l.f.	Riprap	$ 217,160
Moderate	2.322 l.f.	Riprap	$ 92,880
Slight	1,450 l.f.	Riprap & Vegetative	$ 65,160
Various	5 ea.	Lunker Structures	$ 5,000
Total Estimated Shoreline Stabilization Cost			$ 380,200
Engineering Design and Permitting			$ 57,030
Total cost including engineering design and permitting (15%)			**$ 437,230**

Shoreline stabilization work on this scale will require a Joint Application Permit from the Army Corps of Engineers, the Illinois Environmental Protection Agency and the Illinois Department of Natural Resources, particularly for riprap placed as fill material beneath the normal water level. The benefits of shoreline stabilization would include reduced sediment loading and turbidity, improved aesthetic appearance and prevention of further loss to valuable shoreline.

Objective #5: Improve Fisheries Population and Habitat

Alternative Actions

Although the fish population at Lake Vermilion is considered to be good with several imbalances and negative conditions such as excessive blue-green algae, sparse vegetation growth and stunted panfish populations, there are many areas that could be improved. Fisheries management efforts have included supplemental stocking, size regulations and catch limits, and annual water level drawdowns in order to reduce smaller fish and increase the sizes of individuals. However, with the degraded water quality and clarity, the decline of the macrophyte community and loss of littoral zone habitat, there has been an impact to the overall balance and health of the fish population. As discussed previously, nutrients entering the lake must be controlled and minimized in order to improve water clarity and allow macrophytes to become re-established. The decrease in available nitrogen and phosphorus, combined with a well designed aeration system for artificial circulation will help to diversify the algae population and shift it away from blue-green dominance which will in turn benefit the fish population. The most recent population survey indicated an increase in the carp population, which is a very opportunistic and competitive fish species that thrives in shallow, turbid conditions. In fact, most population surveys that include electroshocking as a sampling method do not reflect the true population present because carp are very evasive. Since they are bottom feeders, they also contribute to turbidity by stirring up loose bottom sediments.

The alternative actions include continued supplemental stocking, fishing regulations and drawdowns as recommended in the IDNR fisheries management plan. However, certain modifications and additions need to be included in order to achieve optimum results. Artificial circulation and aeration, as discussed previously, would help to shift the algae population away from blue-green dominance. Watershed best management practices geared towards controlling soil erosion and nutrient delivery can help to improve water quality. A re-established macrophyte population will help provide desirable shallow water habitat. A modified drawdown program can help to achieve the larger individual fish so desired by the fishing community, while benefiting the macrophytes and reducing the opportunities for carp infestation.

<u>Proposed Actions</u>

The fishery at Lake Vermilion will certainly benefit from the improved water quality from reduced nutrient inputs, and from the continued supplemental stocking and fishing regulations currently in effect. Although the implementation of soil conservation measures in the watershed through the EPA 319 Program will only slightly improve water clarity, it will allow for a slightly more diverse algae population and will help to promote a more desirable macrophyte vegetation growth.

In addition to a rejuvenated macrophyte population for fish habitat and cover, it is recommended that additional habitat structures should be installed. Rather than placing evergreen trees, which decompose quickly and can introduce unwanted nutrients into the lake, other more durable methods are recommended such as wooden log cribs, concrete block or rock rubble piles, stake beds, plastic structures, bundled piping, etc. are recommended (see Figure 12 and 13). The estimated costs are approximately $250 each for log cribs, AquaCribs © and/or AquaMats. It is recommended that a minimum of 20 or more structures or structure groupings be located installed under the direction of the IDNR fisheries biologist. The total cost for the structures is estimated to be $10,000 including planning, engineering and technical consultation.

Figure 12. Fish Habitat Structure Alternatives

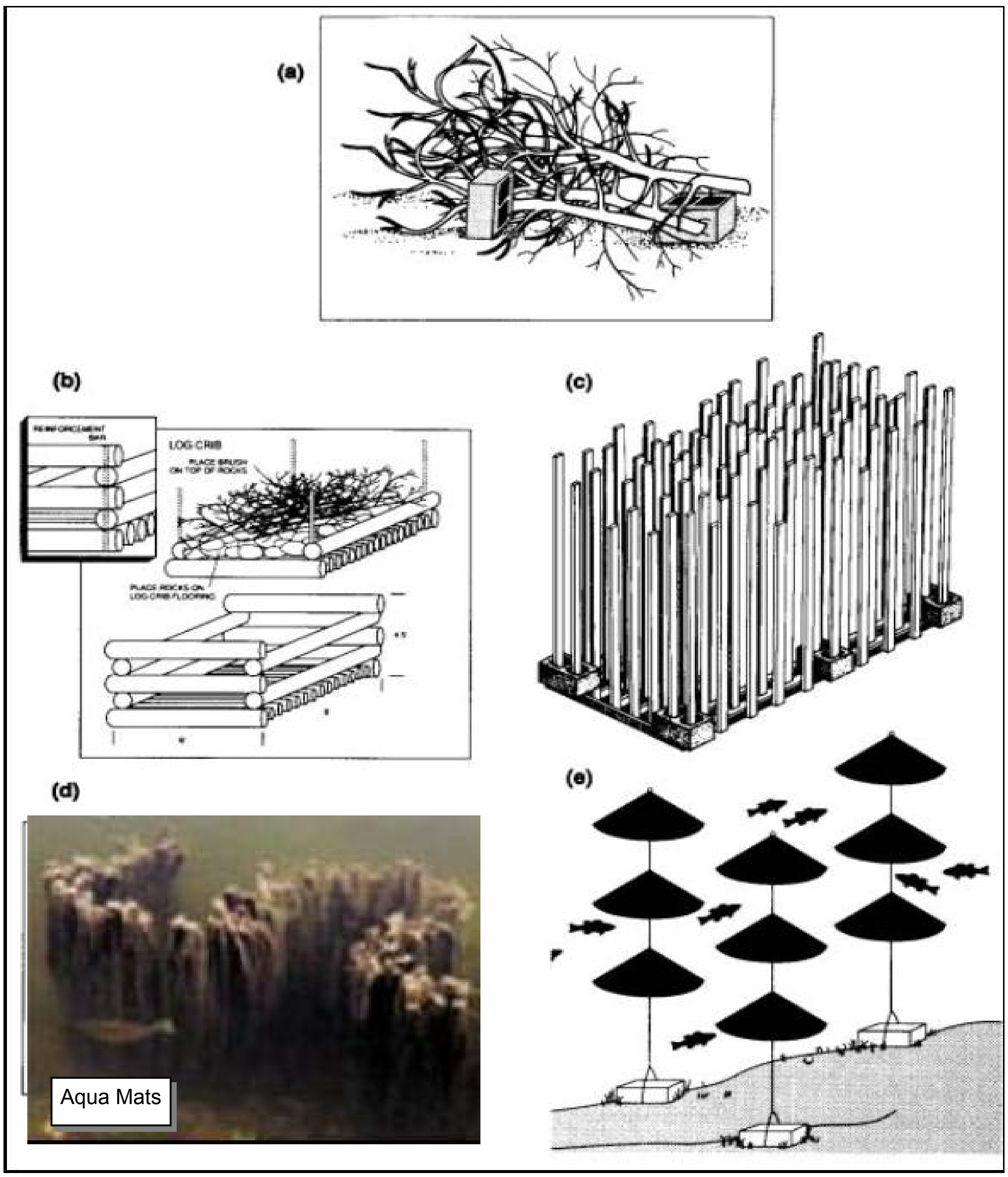


Figure 13. Log Crib and AquaCribs© Fish Habitat Structures

D. Benefits Expected from Implementation of Lake Management Plan

Once implemented, the recommended alternatives in the proposed lake management plan will generate a wide range of water quality improvements and recreational use benefits for Lake Vermilion, which include:

1) A reduction in the amount of sediment and nutrients entering the lake. It is estimated that changes in tillage practices and the manipulation of conservation practices in the watershed, combined with the construction of the upstream sediment basins will reduce the incoming sediment load by approximately 40 percent (NRCS and Cochran & Wilken, Inc.). This would reduce the average annual sediment load as determined by the sediment survey from 71.8 acre-feet to 43.1 acre-feet annually, plus an additional reduction from the implementation of shoreline stabilization.
2) Although not recommended for immediate implementation as part of this Clean Lakes project, the removal of accumulated sediment from the upper end of the lake will provide an increased lifespan of recreationally usable water depth. It is estimated that by removing approximately 1,276,292 cubic yards of accumulated sediment from the shallow, upper end of the lake, combined with a reduced sediment load from the watershed, that the usable lifespan of the lake will be greatly increased.
3) Stabilized shoreline areas in order to reduce sediment loading and to prevent further degradation and loss of valuable shoreline. An estimated 9,201 feet of shoreline is proposed for stabilization out of a total of 12,095 feet of eroded shoreline. This will stabilize 76 percent of the eroded shoreline and reduce sediment loading and turbidity. More importantly, it will protect valuable shoreline for continued recreational enjoyment.
4) A more balanced aquatic vegetation community with a more diverse algae population that is no longer dominated by nuisance blue-greens and an increased macrophyte growth in the littoral zone for aquatic habitat. The reduction in sediment loading will also reduce phosphorus loading considerably

since most phosphorus entering the lake is bound to sediment particles. Nitrogen concentrations will be reduced by the implementation of streamside filter strips and grass waterways, combined with nutrient management.

5) A more balanced fish population through improved water quality, an enhanced management program and expanded fish habitat. The more diverse algal population will provide a better food source for zooplankton and grazers, which will in turn benefit the entire fish population. A healthier, more balanced vegetation community will provide improved habitat and the fish habitat structures will also benefit the fish population and fishing opportunities.

6) Improved water quality for better aesthetics. The removal of nutrient rich sediment and the reduction of nutrients entering the lake, together with the habitat improvements and shoreline stabilization will improve the water clarity and overall water quality of the lake. These improvements will provide increased aesthetic enjoyment to the user population.

Table 5 shows the current use estimates for Lake Vermilion, along with the projected use and benefits following the lake restoration program. Prior studies completed by the Illinois DNR Planning Division have estimated that a 20 percent increase in total lake usage can be expected with the implementation of a lake restoration program that will improve and protect water quality, fisheries and recreational opportunities. The economic value was calculated using a multiplier of 1.5 as suggested by Griffith and Associates (1990). It is estimated that the proposed restoration program will generate a total of $1,161,000 in economic benefits over a ten year period, and does not include the probable increase in revenues for area merchants as a result of greater lake usage.

A report prepared by JACA Corporation (1980) for the USEPA assessed the economic benefits derived from 28 projects in the Section 314 Clean Lake Program. The report found that a total return in benefits of $4.15 per total project dollar was realized. The projects produced benefits in 12 categories that included recreation, aesthetics, flood control, economic development, fish and wildlife, agriculture, property value, public health, public water supply, education, research and development cost, and pollution reduction. The report also indicated that while many benefits could not be measured in monetary terms, the success of many Clean Lakes Program projects appears to have been a catalyst for other community activities.

Table 5. Projection of Benefits

Recreational Use	Baseline Usage(a)	Projected Usage(a)	Change in Usage(a)	Value of Baseline Usage(b)	Value of Projected Usage(b)	Value of Annual Increment(b)	Value of Benefit(c) (10 Year)	Total Economic Benefit Using 1.5 Economic Multiplier
Combined Usage	50,000	60,000	10,000	$387,000	$464,400	$77,400	$774,000	$1,161,000

I.e. fishing, boating, picknicking, swimming and aesthetic enjoyment

Note: Value of Baseline Usage based on an average of the estimated values for each of the recreational uses listed. The estimated baseline usage was provided by Consumer's Illinois Water Co. and the predominant usage categories are typically boating and fishing.

(a) - in annual user days unless otherwise noted
(b) - in current dollars
(c) - net present value over duration of benefits

Source: Source: Consumer's Illinois Water Company
Illinois DNR Planning Division
Griffith and Associates

E. Phase 2 Monitoring Program

Table 6 presents the proposed water quality monitoring program for a one year period following completion of the proposed lake restoration activities. This program is essentially the same as that conducted under the Phase I study except that no sediment or fish samples will be analyzed.

Table 6. Proposed Phase 2 Water Quality Monitoring Program for Lake Vermilion

Parameter	Sampling Frequency
Total Phosphorus	M,S,T
Dissolved Phosphorus	M,S
Ammonia-Nitrogen	M,S,T
NO_2 +NO_3 -Nitrogen	M,S,T
Kjeldahl-Nitrogen	M,S,T
Total Suspended Solids	M,S,T
Volatile Suspended Solids	M,S
Turbidity	M,S
PH	M,S
Alkalinity	M,S
Conductivity	M,S
Chlorophyll a, b, c	M,S
Phytoplankton	M,S
Transparency - Secchi Disc	M,S
Diss. Oxygen/Temperature Profile	M,S

All parameters except Chlorophyll (a, b, c), Phytoplankton, Secchi Transparency and Dissolved Oxygen/Temperature Profiles will be taken one foot below the surface at Sites 1, 2, and 3, and one foot above the bottom at Site 1.

Key: M = monthly sampling (12 times per year by Consumers Illinois Water Co.)
S = special summer (Apr., June, July, Aug., & Oct. by Illinois EPA)
T = Storm event tributary sampling (as required by Consumers Illinois Water Co. and Cochran & Wilken, Inc,)

F. Budget and Schedule

The projected schedule for the Phase 2 Restoration Project is based on the due date of December 31 for the actual Phase 2 application. The completed Phase 1 Report will serve as informational backup for the Phase 2 application. The Illinois EPA will review the application in the winter of 2003 and Phase 2 Grant approval will be anticipated by March of 2003. The estimated costs and proposed budget for the Phase 2 Restoration Program are summarized in Table 7. The proposed work schedule shown in Table 8 is based upon the assumption that the ICLP program grant award would be made in March 2003, which would allow a Project start date of May 2003. The restoration alternatives would be implemented primarily in 2003 and 2004, with post restoration monitoring being completed in the year 2005.

Table 7. Proposed Budget for Phase 2 Restoration and Protection Program

	Proposed Restoration Alternative	Estimated Cost	Funding Source(s)
1.	Watershed Protection		
a)	Filter Strips, Terraces, Grassed Waterways, Nutrient Mgmt., Education,)	N/A	USDA CRP Program (Cost not in Phase 2 Budget)
b)	Sediment and Nutrient Basins (20)	N/A	Cons. Ill. Water Co. and IEPA
	Total Watershed Protection Cost		
4.	Shoreline Stabilization		Cons. Ill. Water Co. and IEPA
a)	Severe – Riprap (5,429 L.F.)	$217,160	Cons. Ill. Water Co. and IEPA
	Moderate – Riprap (2,322 L.F.)	$ 92,880	Cons. Ill. Water Co. and IEPA
	Slight – Riprap and Vegetative (1,450 L.F.)	$ 65,160	Cons. Ill. Water Co. and IEPA
c)	Lunker Structures (5 @ $1,000 ea.)	$ 5,000	Cons. Ill. Water Co. and IEPA
d)	Engineering and Permitting (15%)	$ 57,030	Cons. Ill. Water Co. and IEPA
	Total Shoreline Stabilization Cost	**$ 437,230**	
5.	Fisheries Management		
a)	Fish Habitat Structures	$ 8,000	Cons. Ill. Water Co. and IEPA
b)	Engineering	$ 2,000	Cons. Ill. Water Co. and IEPA
c)	Supplemental Stocking, Surveys, etc.	N/A	IL DNR and Cons. Ill. Water Co
	Total Fisheries Management Cost	**$ 10,000**	
6.	Lake Restoration Technical Consultation And Phase 2 Report	$ 35,000	Cons. Ill. Water Co. and IEPA
7.	Phase 2 Sampling, Monitoring and Lab Anal. by IEPA & Consumers Illinois Water Co.	$ 10,000	Cons. Ill. Water Co. and IEPA (labor costs for sampling/monit.)
8.	Public Education Program with Info. Pamphlet	$ 5,000	Cons. Ill. Water Co. and IEPA
	Total Other (items 6, 7 and 8))	**$ 50,000**	
	Proposed Consumers Illinois Water Share	**$ 248,615**	
	Proposed Illinois EPA Share	**$ 248,615**	
	Total Proposed Phase 2 Budget	**$ 497,230**	

Table 8. Proposed Project Implementation Schedule

	2003									2004												2005												2006											
Activity	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Implementation of Watershed Land Treatment Practices		x	x	x	x	x	x	x						x	x	x	x	x	x	x						x	x	x	x	x	x	x						x	x	x	x	x	x	x	
Shoreline Stabilization		x	x	x	x	x	x							x	x	x	x	x	x																										
Fish Habitat Structures			x	x	x	x	x								x	x	x	x	x																										
Fisheries Management Surveys, Stocking, Habitat, etc.		x	x	x	x	x	x	x					x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	
Public Education Program		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Post Restoration Water Quality Sampling and Monitoring																									x	x	x	x	x	x	x	x	x	x	x	x									
Prepare Final Phase II Report																																					x	x	x	x	x	x	x	x	x
IEPA Grant Administration	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

G. Sources of Matching Funds

The Consumers Illinois Water Company will be the primary provider of matching funds for a $497,230 Illinois Clean Lakes Program grant for the restoration and protection of Lake Vermilion and it's watershed. Since a percentage of direct assistance will be provided for installation and management of certain alternatives such as shoreline stabilization, sediment removal, fish habitat structures, etc., any related labor costs may be documented and submitted by the Consumers Illinois Water Company as an in-kind source of match money.

Soil conservation practices implemented in the Lake Vermilion watershed will be funded through the EPA 319 Non-Point Source Pollution Control Program and the USDA Conservation Reserve Program (CRP) and administered by the local Vermilion County Soil and Water Conservation District. Therefore, participating landowners will provide matching funds and the USDA CRP Program will provide the remaining grant funds. This program will provide up to 60% matching funds for implementing filter strips, terraces and grassed waterways, plus additional monetary incentives for the landowner.

H. Relationship to Other Pollution Control Programs

It is the intent of the Illinois Clean Lakes Program that Phase 1 Studies and Phase 2 restoration projects should be coordinated with all other applicable programs of other agencies that deal with water-related environmental concerns. State of Illinois Clean Lakes Program funds are generally limited to those projects that apply an integrated watershed management approach toward improving and protecting the lake's water quality and recreational opportunities.

As stated in the previous section of the Diagnostic Study entitled "Water Quality," staff members of the Consumers Illinois Water Company have been monitoring Lake Vermilion as part of Illinois EPA's Volunteer Lake Monitoring Program since 1977. Also, staff members from Illinois EPA have also monitored Lake Vermilion as part of Illinois EPA's Ambient Monitoring Program since 1977. The proposed Phase 2 restoration project is consistent with Illinois EPA's Illinois' "Nonpoint Source Management Program Report," which has been developed to provide an overview of ongoing and new program initiatives to address the water resource problems identified in the "Illinois Water Quality Report," which is updated biannually. Illinois EPA was required to develop and maintain these two reports as a result of Section 319 of the Clean Water Act.

The Illinois Department of Natural Resources has provided ongoing fisheries management assistance since 1977 through an agreement between the Consumers Illinois Water Company and Illinois DNR.

The Vermilion County Soil and Water Conservation District and the USDA Natural Resources Conservation Service continues to provide assistance to landowners in the watershed related to soil and nutrient conservation, and has committed to providing assistance in implementing the watershed land treatment practices through the Conservation Reserve Program.

I. Public Participation Summary

At the beginning of the project in Spring of 2000, a large project sign was installed adjacent to the boat launch on the west side of the lake in order to inform the public of the Clean Lakes Program - Phase 1 Diagnostic/Feasibility Study being undertaken. In addition to the informative sign that was clearly visible to the public, an article was placed in the Danville Commercial-News and in the Danville News-Gazette describing its purpose and intent, which also included an estimated completion date as to when the Study would be submitted to Illinois EPA for review and presented to the Consumers Illinois Water Company. After a meeting with Consumers Illinois Water Company officials in November 2002 to discuss the findings and recommendations, a public notice was placed in the Danville Commercial-News and in the Danville News-Gazette in order to present the findings of the Study and to solicit any questions and/or comments from the local lake user population. There were questions regarding water quality, sediment removal, shoreline erosion, fisheries and watershed conditions. All questions were positive and informational, particularly with regard to logistics and implementation.

J. Operation and Maintenance Plan

If awarded a Phase 2 Clean Lakes Program grant, the Consumers Illinois Water Company will be responsible for the operation and maintenance of all recommended alternatives such as the shoreline stabilization, sediment removal and lake deepening, fisheries management and watershed land treatment practices. Shoreline erosion control measures will be inspected annually and repaired or replanted as required by the Consumers Illinois Water Company. Watershed land treatment practices will be coordinated by the Consumers Illinois Water Company with the Vermilion County Soil and Water Conservation District and the local USDA Natural Resources Conservation District. They will be inspected annually to insure continued effectiveness and participation in the CRP Program. Fisheries management activities will be continued by the Illinois Department of Natural Resources fisheries biologist on an annual basis. The Consumers Illinois Water Company will cooperatively monitor the coordination of the fish habitat structures in cooperation with the Illinois Department of Natural Resources.

K. Permit Requirements

Sediment removal from the upper end of the lake will require a Joint Application Permit from the U.S. Army Corps of Engineers (COE), the Illinois Environmental Protection Agency (IEPA) and the Illinois Department of Natural Resources (IDNR). Since it is recommended to remove the sediment hydraulically while the lake is at normal pool, a Section 401 Water Quality Certification from the Illinois EPA for discharging the clarified effluent water back to the lake will also be needed. Since an upland retention and dewatering site will be required for placement of the dredged sediment, a Phase I Archeological Survey will be required and submitted to the Illinois Historic Preservation Agency to insure that no significant cultural resources are present. Structural shoreline stabilization work will also require a Joint Application Permit from the U.S. Army Corps of Engineers and can be included as part of the 404 Permit required for sediment removal. Coordination and consultation with the Illinois Department of Natural Resources, Illinois Environmental Protection Agency, USDA Natural Resources Conservation Service, and the U.S. Fish and Wildlife Service will also be necessary. The permit application process will be initiated after the Phase 1 report is completed, and approval for funding of the Phase 2 Implementation Project is granted.

L. Environmental Evaluation

Will the project displace people?

The project will not displace any people from residences or places of business.

Will the project deface existing residences or residential areas?

The project will have no adverse visual impacts on residential areas. All in-lake and shoreline stabilization requirements will be completed within Consumer's Illinois Water Co. boundaries. No watershed land treatment practices will impact residential areas.

Will changes in established land use patterns or an increase in development pressure?

The project will not likely lead to changes in established land use patterns as the predominant restoration area is located within the limits of Lake Vermilion.

Will the project affect prime agricultural land or activities?

There will be no permanent negative impacts on prime agricultural lands from the project. Soil conservation measures applied in the watershed will help maintain soil fertility and control erosion on agricultural lands.

Will the project adversely affect parkland, public land, or scenic land?

Lake Vermilion and the surrounding land will have enhanced recreational, environmental and aesthetic value as a result of the proposed project.

Will the project adversely affect land or structures of historic, architectural, archeological, or cultural value?

In order to acquire a permit to construct a sediment retention and dewatering pond for the future storage of dredged sediment, a Phase I Archeological Survey will be completed to insure that no cultural resources are present.

Will the project lead to a significant long-range increase in energy demands?

There will be no long-term increase in energy demands as a result of the project.

Will the project adversely affect short-term or long-term ambient air quality?

No long-term increase in traffic volume is expected as a result of this project. Occasional short-term increases may occur during the installation of structural shoreline stabilization techniques. All construction equipment is expected to comply with noise and air pollution standards. Very few areas are bordered by residential development. Effects outside the immediate area of the implementation activities are not anticipated.

If the project involves the use of in-lake chemical treatment, will it cause short-term or long-term adverse impacts?

No long-term adverse impacts are expected from the proper application of herbicide to selectively control excessive aquatic vegetation for public access and/or fisheries management purposes.

Will the project involve modification or construction in floodplain areas?

Shoreline stabilization practices would occur within the 100-year floodplain, which borders the lake. Structural shoreline stabilization and protection practices will be primarily utilized, and the planting of terrestrial and nearshore emergent and submergent species resistant to erosive forces will be utilized when possible. There will eventually be accumulated sediment removed from the upper end of the lake, and will be completed separately from the Clean Lakes Program work..

If the project involves physically modifying the lake shore, its bed, or its watershed, will the project cause any short-term or long-term adverse impacts?

No long-term adverse impacts will result from project activities. Shoreline erosion control practices may involve regrading and/or installation of structural practices such as riprap. There may be short-term impacts such as higher localized turbidity, restricted access in certain areas during construction and minimal landscape damage from heavy equipment.

Will the proposed project have a significant adverse effect on fish and wildlife, wetlands, or other wildlife habitat?

No significant adverse effects on fish and wildlife, wetlands, or other wildlife habitat will occur as a result of this project.

Will the project adversely impact threatened or endangered species?

No threatened or endangered plants or wildlife species will be affected by this project.

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