Part 2

Lake and Watershed Management Plan

Carlinville, Macoupin County, Illinois

## INTRODUCTION

Pursuant to the information collected and the conclusions derived from the Diagnostic Study (Part 1) of this Report, a Lake and Watershed Management Plan (Part 2) was developed by investigating potential alternatives for restoring the water quality and enhancing the recreational and aesthetic qualities of Lake Carlinville and its watershed. This plan should facilitate future implementation of recommendations and serve as a vehicle for additional funding through the Nonpoint Source Pollution Control Program or Illinois Clean Lakes Program. The U.S. EPA funded 56 percent of Part 2 under a Section 319 Grant, with the remaining 44 percent funding contributed by the City of Carlinville. While the U.S. EPA provided funding, the Illinois EPA was responsible for grant administration and program management. HDR | Cochran & Wilken, Inc. (HDR | CWI) completed the Feasibility Study, with assistance from the City of Carlinville, the Macoupin County Soil and Water Conservation District, United States Department of Agriculture - Natural Resources Conservation Service, Illinois Department of Natural Resources, and the Illinois EPA.

## A. IDENTIFICATION OF WATER QUALITY AND USE IMPAIRMENT PROBLEMS

Current and historical data discussed in the Diagnostic Section (Part 1) served as the basis for the following discussions, which summarize the impairments for Lake Carlinville and its watershed.

### 1. Soil Erosion and Excess Nutrient Loading

Excessive erosion significantly contributes to sediment and nutrient loadings entering Lake Carlinville. The prevailing land use types (agriculture and forest) and practices dictate much of the soil erosion and nutrient transport processes within the Lake Carlinville watershed. Of the nearly two-thirds of the watershed in agricultural production, soybeans and small grains tend to be the only crops that are tilled conservatively (Limno-Tech, 2005 and USDA-NRCS personal communication, 2006). Forested regions of the watershed are sources of soil erosion and nutrient transport as well. For the nearly one-fourth of the watershed that is forested, many gullies and ravines are present. Ephemeral and gully erosion sediment delivery rates range from 75 to 90%. Streambank and lake shoreline erosion have high sediment and nutrient delivery rates within the Lake Carlinville watershed, as nearly all of the eroded soils are deposited within the receiving waters (i.e., Honey Creek and Lake Carlinville). The primary sources of soil erosion within the watershed are sheet and rill erosion (mostly from agricultural or crop land) and the sediment and nutrient delivery from ephemeral gully erosion and combined gully, streambank, and shoreline erosion. Ephemeral gully and gully erosion tend to occur along the transition area between fields and forests and within the forested areas of the watershed.

Another source of erosion in the watershed is erosion along Honey Creek, the major tributary to Lake Carlinville. Streambank erosion along Honey Creek and subsequent sediment delivery to Lake Carlinville has been documented (USDA-NRCS, 1996 and 2003), although no measured streambank erosion data has been gathered for Honey Creek (Ford personal communication, 2006). Before initiating specific streambank stabilization projects, Honey Creek must be evaluated to determine the various levels of streambank erosion and to prioritize problem areas by the severity of erosion.

Similar to streambank erosion, shoreline erosion along Lake Carlinville is another source of sediment and nutrient transfer to the lake. Lake shoreline erosion can be caused by the following activities or actions: wind and wave action, pedestrian and livestock traffic, water level fluctuations caused by either drought or periodic lake level draw downs, and a lack of near-shore vegetation. Shoreline erosion impairs lake usage and access by increasing lake turbidity, decreasing lake storage capacity, and damaging valuable lakeshore property. The loss of shoreline soils may also jeopardize the stability of infrastructure, such as bridges, roads, and docks. The 2006 shoreline erosion survey determined that approximately 5,703 meters (18,709 ft.) had experienced some degree of erosion, which varied from slight to severe.

The horizontal length of each eroded zone was estimated and a vertical measurement was applied to the following criteria: a bank height of 1.0 to 3.0 ft. was classified as slight, greater than 3.0 ft. and less than 8.0 ft. was classified as moderate, and greater than 8 ft. was classified as severe. Approximately 341 meters (1,118 ft.) of shoreline was found to have severe erosion, 1,293 meters (4,243 ft.) exhibited moderate erosion, and 4,068 meters (13,348 ft.) of shoreline was found to have slight erosion. According to the 2006 shoreline erosion survey, approximately 54.4% of the 10.5 km (6.52 miles) shoreline was unprotected and has been negatively impacted by erosion. The typical form of erosion observed at these locations was an exposed and undercut bank that, throughout time, will gradually allow the upper reaches of the shoreline slope to collapse. Photographs illustrating shoreline erosion at Lake Carlinville are shown in Appendix D.

**2. Excessive Lake Sedimentation**

An estimated 1,425,009 cubic yards of sediment have been deposited throughout the lake between 1939 and 2006. This volume of accumulated sediment represents an approximate 37.6 percent water storage capacity loss for the entire lake over its 67-year history. Most of the accumulated sediment is located throughout the upper end of the lake, where Honey Creek enters the lake.

Accumulated sediments are generated from erosion within the watershed, as well as from the decomposition of dead and decaying plant (i.e., algae, macrophytes, and trees) and animal matter (i.e., fish) within the lake. By their origin, these sediments are high in organic content and are nutrient rich, which create a loosely compacted substrate over the bottom of the lake. This loose, low density bottom sediment can be resuspended by bottom feeding fish, high wind conditions, boat turbulence, and storm inflows. As a result, the water quality in Lake Carlinville has been impacted by elevated suspended solids levels and decreased water transparencies.

Excessive sedimentation can negatively impact any lake that serves as a public water supply or that is used for recreational purposes, as there is the possibility of burying intake structures, reducing the lake's original water storage capacity, contributing to shallow water depths, and impacting aquatic habitat. Reservoir sedimentation is a natural process that can be accelerated or slowed by human activities in the watershed. In most cases, agricultural and developmental activities in the watershed increase sediment delivery to the lake due to increased exposure of the soil material to erosive forces.

**3. Degraded Water Quality**

Soil erosion and nutrient transport from the watershed have degraded Lake Carlinville water quality. Excessive sediment and nutrients in the lake have also been connected to various lake water quality issues. Water quality concerns include chemical and physical conditions such as excessive solids (discussed previously), phosphorus, manganese, and high turbidity.

As mentioned in the Diagnostic Section, Lake Carlinville was placed on the 303(d) list of impaired waters for phosphorus and manganese in 2006. Other impairments identified were total suspended solids and algae, although there are no standards for these parameters. In 2006, a TMDL study was initiated for the Macoupin Creek Watershed, which includes the Lake Carlinville watershed. Illinois EPA (2006) determined that the potential sources contributing to Lake Carlinville's impairments are: natural background and seasonal hypolimnetic anoxia for manganese; and agricultural runoff and seasonal hypolimnetic anoxia for total phosphorus. Lake Carlinville's status on the 303(d) list is a result of available data indicating that at least one designated use is not being supported or is threatened (Illinois EPA, 2006).

The sources of Lake Carlinville's high in-lake nutrient concentrations include inflows from the agricultural watershed runoff, resuspension of sediment, seasonal internal regeneration from anoxic lake bottom sediments, both living and dead plant/animal matter within the lake, stream bank and shoreline erosion, and atmospheric deposition. The phosphorus and nitrogen nutrient budgets representing the 2006-07 monitoring year indicate that watershed runoff provided the majority of the phosphorus and nitrogen influx to the lake. Internal regeneration was estimated to a minor contribution to the total phosphorus and nitrogen influxes.

In addition to water quality impairments identified by the 303(d) list, turbidity or murkiness is another water quality issue that affects Lake Carlinville. During the lake's primary recreational use period from April through September, water clarity averaged 19.6-inches at Site 1, 16.6-inches at Site 2, and 11.5-inches at Site 3 in 2006. As a reference, the Illinois EPA swimming guidelines suggest that a Secchi depth of 24 inches fully supports recreational swimming. Turbidity can be affected by the presence of suspended solids such as soil particles, resuspended bottom sediments, and both living and dead plant/animal matter. The aesthetics of the lake are 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. It is likely that turbidity is the main reason the 2006 aquatic macrophyte survey for Lake Carlinville showed a very sparse aquatic macrophyte population.

The factors that have contributed to Lake Carlinville's poor water quality include runoff from a primarily agricultural watershed, large quantities of accumulated lake sediment and nutrients, excessive phytoplankton growth (particularly blue-green algae), and streambank and lake shoreline erosion. The Lake Carlinville watershed is highly agricultural, which often reflects higher soil gross erosion rates and higher sediment and nutrient delivery ratios. Compared to other land use types, agricultural fields tend to erode more easily due to their increased exposure to wind and precipitation. Streambank and shoreline erosion add to the amount of sediment and nutrients being transferred to the lake. Fine-grained particles (i.e., silt and clay) from erosion can remain suspended in the water column for extended periods of time. Resuspended sediments may also release nutrients into the water column, thereby contributing to increased turbidity and algal growth. Sediment resuspension and turbidity resulting from wind and wave action in shallow, near-shore areas was evident and has reduced the aesthetic quality of Lake Carlinville.

Historical and Phase 1 phytoplankton data indicate high counts of algae in Lake Carlinville, which increases overall lake turbidity. During the summer months, blue-green algae (Cyanophyta) tends to be the dominant algal taxa within Lake Carlinville. The blue-greens are considered especially undesirable for aesthetics because of their tendency to form scum and mats, and are not a desirable food source for most aquatic organisms (i.e., zooplankton and small fish). In addition, blue-greens can become toxic and can cause taste and odor problems, which can complicate water treatment and impact the public water supply.

**4. Unbalanced Aquatic Vegetative Community**

The aquatic plant community within Lake Carlinville includes aquatic macrophytes (i.e., plants visible and identifiable to the naked eye) and phytoplankton (i.e., algae). Both are an extremely important component of a balanced lake ecosystem. Algae can provide food for aquatic insects, zooplankton and fish, and oxygen, which is beneficial to all organisms. However, an overabundance of phytoplankton (algae) can result in adverse effects such as: increasing overall lake turbidity; shading out and limiting the growth of macrophytes; algal blooms and surface scums that detract from lake aesthetics; night time algal respiration and/or rapid algal die-offs that can deplete dissolved oxygen levels and severely stress the fish population.

Algal growth is stimulated by high concentrations of nutrients in the water column. Measurements of inorganic phosphorus and inorganic nitrogen obtained during the Phase 1 monitoring period were generally above the levels known to contribute to nuisance algal growth, (0.01 mg/l for inorganic phosphorus and 0.30 mg/l for inorganic nitrogen (Sawyer, 1952)). The Phase 1 data shows that the algal population was excessive during the 2006-07 monitoring year, reaching bloom conditions throughout most of the summer. When bloom conditions occur, the algal induced turbidity reduces light penetration throughout the water column and adversely impacts macrophyte growth.

Within Lake Carlinville, phytoplankton or blue-green algae populations dominate over aquatic macrophytes, as well as beneficial algal populations. The over abundance of these nuisance microscopic plants has been linked to several documented cases of taste and odor problems in the public water supply. Excessive lake turbidity and phytoplankton dominance have also stunted the lake's aquatic macrophyte population, as only two species were observed within the lake. The 2006-aquatic plant survey for Lake Carlinville identified water willow (*Decodon verticillatus*) and creeping water primrose (Jussiaea repens var. glabrescens) as the only macrophyte species encountered in the lake. These emergent species were generally found to inhabit shallow waters less than 2 feet deep. No submerged (underwater) species were encountered during the aquatic plant survey. Turbidity along the littoral zones is the primary reason for the sparse and limited aquatic macrophyte population densities within Lake Carlinville. Sporadic aquatic plant populations could secondarily be attributed to high nutrient levels that contribute to phytoplankton dominance.

**5. Unbalanced Fishery**

Excessive sedimentation and lack of suitable habitat and spawning areas are the main contributors to the fair to poor fishery at Lake Carlinville (Pontnack personal communication, 2006). Excessive nutrient levels and the sparse aquatic macrophyte population have also contributed to a diminished sport fish population. The District 14 IL DNR fisheries biologist has reported that no fish have been stocked within Lake Carlinville since 1994 due to the existing lake conditions. Population and creel census surveys completed every three years by IL DNR fisheries biologists indicate that the largemouth bass, bluegill, and white crappie populations within the lake have been variable and that undesirable fish species such as black bullhead catfish, warmouth, yellow bullhead catfish, common carp, yellow bass, and green sunfish have become well established (Pontnack personal communication, 2006).

## B. OBJECTIVES OF THE LAKE CARLINVILLE WATERSHED PLAN

Like most lakes and reservoirs, Lake Carlinville reflects its watershed. Thus, many of the identified lake and watershed impairment issues are often interrelated. The goal of the Lake Carlinville Watershed Plan is to address the problems identified in the previous section, to protect and enhance existing lake and watershed uses, to increase recreational access and opportunities, and to improve the overall water quality of the lake. The watershed plan objectives listed below have been determined based on the impairments discussed previously.

1. Improve Water Quality
2. Enhance Lake Aesthetics and Recreational Opportunities
3. Promote Lake and Watershed Restoration

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

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

## C. ALTERNATIVES FOR ACHIEVING THE WATERSHED PLAN OBJECTIVES

Each of the objectives listed in Section B has several alternative approaches or solutions that have been evaluated and considered. These restoration and management alternatives are described within Section C. Recommended actions for the Lake Carlinville Watershed Plan are summarized in Table 28 (page 113), which also includes ranges of unit costs, proposed units, ranges of estimated costs, estimated load reductions, and financial and technical assistance. For most of the objectives, there are one or more alternatives that clearly stand out relative to cost, benefits, and 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 more expensive projects at a later date as a result of continued lake degradation (eutrophication) and inflation of project costs.

**Objective #1: Improve Water Quality**

The sediment and nutrients entering the lake and the accumulated sediment at the bottom of the lake both contribute to poor water quality and should be addressed before other alternatives are considered. In order to improve water quality in Lake Carlinville and the surrounding watershed, a combination of proactive and retroactive approaches will be necessary. The sources of accumulated sediment in the lake include runoff from the watershed, eroded stream banks in the watershed, and eroded lake shoreline. The best way to manage the accumulation of sediment is to implement measures in the watershed that will reduce the amount of sediment entering the lake. This includes implementing best management practices (BMPs) throughout the watershed and stabilizing the lake shoreline to prevent erosion. In addition to preventing sediment from entering the lake, removal of accumulated sediment will be necessary. To this end, the following actions items have been identified to improve water quality throughout the Lake Carlinville watershed.

A. Reduce the Amount of Sediment and Nutrients Entering the Lake;
B. Remove Accumulated Sediment from the Lake; and
C. Stabilize and Protect Eroded Lake Shoreline Areas.

***Action Item A. Reduce the Amount of Sediment and Nutrients Entering the Lake***

Alternative Actions

Reducing nonpoint source pollution from the watershed is perhaps the most important action item because it is a measure that will protect the lake for many generations. Alternatives listed for Action Item A protect the lake by managing sources of nonpoint pollution (e.g., unprotected soil in agricultural fields, eroding land, and excess fertilizer application). Due to the wide variety of watershed management alternatives and BMPs, Action Item A was subdivided into two groups: non-structural and structural alternatives.

The US EPA's Handbook for Developing a Watershed Plan to Restore and Protect Our Water (2005) defines ***non-structural practices*** as "any practice that prevents or reduces runoff problems in receiving waters by reducing the generation of pollutants and managing runoff at the source. This type of practice may be included in a regulation or may involve voluntary pollution prevent devices." For this study, the following non-structural alternatives and BMPs were considered:

- Nutrient Management Plans
- Crop Rotations
- Conservation Tillage Practices
- Conservation Buffers
- Inspect and Upgrade Septic Systems
- Changing Landscaping Practices
- Livestock Exclusion

The US EPA's Handbook for Developing a Watershed Plan to Restore and Protect Our Water (2005) defines ***structural practices*** as "a practice, such as a stormwater basin or streambank fence, that requires construction, installation, and maintenance." For this study, the following structural alternatives and BMPs are evaluated and considered:

- Restoration of Riparian Corridors
- Stabilization of Eroded Streambeds and Streambanks
- Grassed Waterways
- Water and Sediment Control Basins and Ponds
- Sediment and Nutrient Control Basin
- Gully/Grade Stabilization Structures

**Non-Structural Alternatives and BMPs**

**Nutrient Management Plans** are voluntary measures designed to minimize nutrient losses from agricultural lands. Historically, the NRCS and SWCD has provided assistance with the development of nutrient management plans. The NRCS (2001) defines nutrient management plans as “managing the amount, source, placement, form, and timing of the application of nutrients and soil amendments.” The focus of nutrient management plans is to increase the efficiency with which applied nutrients are utilized by crops (US EPA, 2003). Strategically applying fertilizers and soil amendments to the watershed reduces nutrient loads to Honey Creek and Lake Carlinville.

The University of Illinois at Urbana-Champaign (2005) has identified the following steps in developing nutrient management plans:

- Assess the natural nutrient sources (soil reserves and legume contributions)
- Identify fields or areas within fields that require special nutrient management precautions
- Assess nutrient needs for each field by crop
- Determine quantity of nutrients that will be available from organic sources, such as manure or industrial or municipal wastes
- Allocate nutrients available from organic sources
- Calculate the amount of commercial fertilizer needed for each field
- Determine the ideal time and method of application
- Select nutrient sources that will be most effective and convenient for the operation

Studies conducted by the U.S. Department of Agriculture have demonstrated that average annual phosphorus application rates were reduced by 36 lbs/acre when nutrient management practices were adopted (U.S. EPA, 2003). Nutrient management is generally effective, but most phosphorus containing fertilizer is applied to the surface of the soil and is subject to transport (NRCS, 2006). In an extensively cropped watershed such as Lake Carlinville, the loss of even a small fraction of the fertilizer-applied phosphorus can have a significant impact on water quality.

The U.S. EPA (2003) estimates that developing a nutrient management plan varies from $6 to $20/acre. For the purposes of this study, a cost of $15 per acre was used. These costs are often offset by the savings associated with using less fertilizer and fuel. For example, the U.S. EPA (2003) reported that improved nutrient management on cornfields led to a savings of approximately $3.60/acre during a study in Iowa.

**Crop Rotations** or utilizing cover crops keeps agricultural land under vegetative cover year round or as much as possible. Crop rotation is another management alternative method that can reduce erosion and subsequent soil and nutrient transport within the watershed. As an added benefit, vegetative cover also increases water infiltration and decreases runoff. Rotating crops reduces water and wind erosion and can improve crop yields by recycling nutrients. This practice will ultimately reduce soil and nutrient loadings to Honey Creek and Lake Carlinville.

Crop rotations include: pasture or hayland planting, cover crops, conservation cover, and planting warm or cool season grasses. Cover crops include grasses, legumes or small grains grown between regular grain crop production periods for the purpose of protecting and improving the soil (on line Purdue, 1998). Legumes have an added benefit of adding nitrogen to the soil to reduce the need for commercial fertilizers. Conservation cover, a type of land cover, establishes and maintains perennial vegetation on lands retired or removed from agricultural production. Conservation cover can be a variety of different species depending on long term objectives of the land user and the needs of target wildlife species. Conservation cover reduces soil erosion and sedimentation, improves water quality by acting as a filter to remove chemicals and other nutrients, and creates or enhances wildlife habitat (USDA-NRCS, 2005).

The following list published by the NRCS represents approximate costs required to implement various crop rotations (NRCS, 2003).

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| Pasture and Hayland planting per acre | $170.00 |
| Fencing per linear foot | $2.00 |
| Cover Crops per acre | $25.00 |
| Conservation Cover per acre | $70.00 |
| Warm Season Grass per acre | $188.00 |
| Wildlife Habitat per acre | $200.00 |

**Conservation Tillage Practices** include any tillage and planting system that maintains at least 30 percent crop residue after planting and harvesting. Examples of conservation tillage include no till, ridge till, and mulch till. Advantages of conservation tillage over conventional systems can include fuel and labor savings, lower machinery investments and repair costs, and long-term benefits to soil structure and fertility (USDA, 1996). Soil and nutrient load reductions are achievable through conservation tillage, as soil erosion and transport are reduced. Conservation tillage practices are defined by USDA (1996) as the following:

- No Till - The soil is left undisturbed from harvest to planting except for nutrient injection. Planting or drilling is in a narrow seedbed or slot created by coulters, row cleaner, disk openers, in-row chisels, or roto-tillers. No till generally includes 50 percent or more residue after planting.
- Ridge Till - The soil is left undisturbed from harvest to planting except for nutrient injection. Planting is in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between the ridges. Ridge till generally includes 30 to 50 percent residue after planting.
- Mulch Till - The soil is disturbed before planting. Tillage tools, such as chisels, field cultivators, disks, sweeps, or blades are used. Mulch till generally includes 30 percent or more residue after planting.

Conservation tillage is an important tool used to reduce sheet and rill erosion within agricultural fields. Using continuous no till methods can reduce soil loss by 75 percent over conventional methods. The NRCS (2003) recommends that row crops grown on slopes greater than 5 percent (i.e., B slopes or greater) should be continuously no tilled. Conservation tillage practices have been reported to reduce total phosphorus loads by 45 percent (U.S. EPA, 2003). A wide range of costs has been reported for conservation tillage practices, ranging from $12 per acre to $83 per acre (1998 dollars) in capital dollars (U.S. EPA, 2003). For no till, the *Illinois Agronomy Handbook for Machinery and Labor* lists costs that range from $36 to $66 per acre (UIUC, 2005). For the purposes of this study, a median cost of $50 per acre was used for conservation tillage. Many of the initial capital costs associated with conservation tillage may be off set by reduced operating fuel costs (i.e., labor, lower machinery investments and repair costs).

**Conservation Buffers** include a wide array of BMPs: buffer strips, field borders, filter strips, vegetative barriers, and riparian buffers. Ultimately, conservation buffers reduce soil erosion on sloping ground and provide refuge and nesting cover for wildlife. Buffers are optimized when they include a mixture of native warm-season grasses, native cool-season grasses, and legumes (NRCS, 2003). Generally, field borders are planted on the north and west edges of fields to serve as natural wind breaks and snow fences. The NRCS recommends that field borders at a minimum be at least 30 feet wide to provide erosion reduction and wildlife habitat benefits. It is recognized that one of the biggest drawbacks for many farmers would be the loss of acreage for production. However, in fields that border wood lands and riparian areas along Honey Creek, the bushel per acre will likely be minimal, as the trees typically shade out and uptake most of the available water. The cost to plant half cool-season and half warm-season grasses with legumes is estimated at approximately $500 per acre (NRCS, 2003).

**Inspecting and Upgrading Septic Systems** is a practice that ensures wastewater is properly disposed of and not transferred to the lake. Septic systems are common in rural communities, where centralized wastewater treatment systems are not economical. Most of the residences and facilities within the Lake Carlinville watershed utilize septic systems to treat domestic wastewater from toilets, wash basins, bathtubs, washing machines, and other water consumptive items. Due to their widespread use and high volume discharges, septic systems have the potential to pollute groundwater, lakes, and streams. Typical pollutants in household wastewater are nitrogen, phosphorus, and disease causing bacteria and viruses (Center for Watershed Protection, 2006). Unlike other non-stormwater discharges, septic systems are not regulated under the EPA's National Pollution Elimination Discharge System program (NPDES) but are approved by local and state health departments.

While the Macoupin County Health Department oversees the installation of new septic systems, inspections and routine maintenance on existing septic systems are voluntary and are the responsibility of homeowners. The U.S. EPA (2001) recommends that septic systems should be inspected every three years. Prior to new or renewal lease agreements, the City of Carlinville requires that each lake site provide written verification that the septic or holding tank system has been inspected and is in working order (personal communication Bellm, 2006). Routine inspections, maintenance, and replacement/upgrades of septic and holding systems would help reduce pollutant loads within the Lake Carlinville watershed. The estimated cost of a septic system inspection ranges from $100 to $300 (personal communication, Bussman 2007).

**Changing Landscaping Practices** includes a variety of techniques that specifically reduce the likelihood that excess sediment and nutrients could be transferred to the lake. In areas that are adjacent to receiving waters, such as Honey Creek or Lake Carlinville, improved landscape practices can help reduce erosion and subsequent soil and nutrient loadings. Changes in landscaping practices can be implemented at various levels within the community (i.e., leased lake lots and the City's maintenance department). Most of the occupants on Lake Carlinville currently mow the grass down to the water's edge. Allowing native vegetation to grow near the stream banks and shorelines (especially on steep slopes) would create conservation buffers or vegetated buffer strips that trap or reduce sediment and nutrient loadings in runoff. Utilizing fertilizers with no phosphorus will also reduce loadings. These operation and maintenance requirements could be included within the lake lease agreements. As an added benefit, allowing vegetation to grow long near the lake may reduce maintenance costs for the City. This alternative is an excellent way to preserve the lake at little to no cost.

**Livestock Exclusion** consists of preventing livestock from accessing natural waterways by installing fencing, stream crossings, and providing alternate watering sources. Data within the Macoupin Creek Watershed Report (NRCS, 2003) suggest that nearly a dozen livestock (i.e., cattle and hog) operations are present within the Lake Carlinville watershed. Stream corridors in particular are places where livestock inhabit, as these areas are generally highly productive, providing water and plenty of forage. Unless carefully managed, livestock can over use waterways and create significant disturbances. The main impact to waterways from livestock is loss of vegetative cover from overgrazing, which accelerates streambank erosion. For larger livestock operations, fecal material can increase nutrient and bacterial loads, which impairs stream water quality and can also reduce dissolved oxygen levels (NRCS, 2003).

Limiting livestock access to Honey Creek and other waterways within the Lake Carlinville watershed would help to reduce streambank erosion and nutrient and bacterial loadings within the watershed. Two alternatives have been suggested by the NRCS (2003) to exclude livestock from waterways: installing an alternate watering facility and fencing or installing fencing to limit creek access and constructing creek crossings.

Option #1 - Alternate water facility and fencing

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| Costs: | Water tanks/troughs | $125.00 each |
| | 1.5-inch water lines & trenching | $2.50 per foot |
| | Woven wire fencing | $2.00 per foot |

Option #2 - Install fencing and limited crossings to access creek

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|---|---|---|
| Costs: | Woven wire fencing | $2.00 per foot |
| | Limited crossing access | $1,500 per structure |

**Structural Methods**

**Restoration of Riparian Corridors** consists of re-establishing areas that were previously forested and have been cleared or altered due to human activities. Riparian corridors are ecosystems that border streams, lakes, and watercourses. Generally, they contain three major elements: a stream channel, a floodplain, and a transitional area to uplands. Riparian corridors provide critical functions such as the cycling of nutrients, filtering contaminants from runoff, absorbing and gradually releasing floodwaters, maintaining fish and wildlife habitats, recharging groundwater, and maintaining stream flows (NRCS, 2003).

In *The Upper Macoupin Creek - Watershed Restoration Action Strategy*, the NRCS stated that nearly two-thirds of the riparian corridors within the Macoupin Creek watershed (which includes Lake Carlinville) had been cleared and were now used for agriculture. Most of these farmed areas are located on steeper slopes, which have increased sheet, rill, and gully erosion and subsequent nutrient and sediment loadings to adjacent waterways. Restoring these forested natural buffer areas will help reduce sediment and nutrient loading within the Lake Carlinville watershed. The NRCS (2003) estimates that the cost to restore riparian corridors to native vegetation is approximately $500 per acre.

**Silviculture Practices** include a variety of activities aimed toward maintaining a high quality forest. Specifically, selective tree thinning has been identified to modify the canopy in heavily forested areas in the Lake Carlinville watershed. The NRCS (1996) reported that the upland forests were comprised of white and red oak and shagbark hickory, while bottomland forests included silver maple, sycamore, cottonwood, American elm, and green ash. These historical accounts of the upland and bottomland forests with the Lake Carlinville watershed will likely require forest management to insure their longevity.

In general, oaks and hickories compete with faster growing maples and other smaller, more shade tolerant species for sun light. As maples invade and mature, it becomes increasingly difficult for preferred canopy species such as oaks and hickories to become established. Selective tree removal or thinning can promote growth of preferable species by removing less desirable, usually smaller trees. This process can influence the growth and quality of the larger canopy layer trees and allow sun light to reach the underlying herbaceous and shrub layers that serve to stabilize soil on steep slopes. Selective tree thinning projects have been initiated by the Medford District Bureau of Land Management (MDBLM) in the Elk Creek Watershed for an estimated cost of $560 to $1000 per acre (MDBLM, 2003). This cost includes removing trees less than eight inches in diameter to reach a 50 percent canopy cover, piling, and burning. Other riparian restoration projects have been implemented along the Illinois River at a cost of approximately $4000 per acre (MDBLM, 2007). Selective tree thinning and management will insure that the forests will remain healthy and continue to reduce erosion within the watershed for generations to come. Forest management will help sustain the lower gross erosion and subsequent sediment and nutrient delivery rates that are characteristic of forested land uses, although management activities within the watershed should be carefully considered and planned in order to minimize erosion as activities are completed.

**Stabilization of Eroded Streambeds and Streambanks** consists of installing structural measures to prevent extreme erosion in unstable areas. Streambed and streambank erosion has been identified as a significant source of solids and nutrients within the Lake Carlinville watershed (NRCS, 1996 and 2003). Sediment derived from streambed and streambank erosion increases sediment and nutrient loadings within the watershed that ultimately decrease the water quality and storage capacity of Lake Carlinville. Reviewing the USGS topographic maps and aerial photography for the Lake Carlinville watershed suggests that streambed and streambank erosion along the approximate 12 miles of Honey Creek is a vast issue.

HDR | CWI concurs with the NRCS (2003) assessment that inventories and surveys should be completed along Honey Creek to identify and prioritize eroded streambeds and streambanks. Inventories and surveys can be completed by conducting low-level helicopter flights using Geographic Information Systems (GIS) referencing imbedded video footage of a stream channel, or by “ground-truthing,” where specific sites of interest are field examined and verified. To identify and prioritize eroded streambeds and streambanks along Honey Creek the costs would be approximately $15,000 to $20,000. It should be noted that stream access to Honey Creek is somewhat limited. Intermittent creek flows, steep riparian slopes, and a limited number of roadways make entry into Honey Creek challenging. These physical constraints may complicate stream bank surveys and subsequent stabilization attempts. In addition, the lack of suitable access to Honey Creek will likely increase stream bank stabilization unit costs.

While various methods can be utilized to stabilize eroded streambeds and streambanks, the NRCS (2003) recommended rock riffle grade controls to address streambed erosion (i.e., channel downcutting and channel widening). Rock riffle controls consist of loose rock fills placed in the channel to restore a “riffle” and “pool” sequence. Riffles are typically placed at intervals of one riffle for every 6 bankfull widths. This riffle to pool sequence and spacing enables a stable stream to transport the water and sediment from the watershed most efficiently. The approximate cost of $100 per ton for RR-5 stone including materials, trucking, and placement was used for estimation purposes. Riffle construction costs will vary according to stream height and width. Streambank stabilization and enhancement can include installing riprap revetments for stone-toe protection, planting deep root vegetation, and adding bendway weirs and barbs. Estimates to design and construct rip-rap revetments are estimated at $100 per linear foot, with an estimated one ton of rip-rap per linear foot of eroded stream bank. The unit costs per linear foot of streambank stabilization may vary depending on access to Honey Creek (i.e., limited access) and the severity of erosion (HDR | CWI experience, 2007.)

**Grassed Waterways** can be very effective for preventing gully erosion. They force storm water runoff to flow down the center of an established grass strip, while minimizing soil exposure and subsequent erosion during the process. In addition to 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 optimal effectiveness, grassed waterways should be implemented with other practices such as conservation tillage and conservation buffers. Grassed waterways cost approximately $1,800 per acre and have annual maintenance costs of roughly $25 per acre for mowing and $300 per acre for burning (NRCS, 2003).

**Water and Sediment Control Basins** (WASCOBs), also referred to as dry dams, are earth embankments constructed across a slope and a minor waterway to form a sediment trap and water detention basin. They trap water and sediment runoff from cropland and reduce gully erosion by controlling flows within the drainage area. WASCOBs have several benefits including reducing waterway and gully erosion, sediment trapping, reducing and managing on-site and downstream runoff, and improving downstream water quality (NRCS, 2003). These structures tend to work best when other BMPs such as conservation tillage and crop rotations are use concurrently. For the purposes of this study, WASCOB structures are estimated at $2,500 each (McCandless personal communication, 2007).

**Ponds** or small impoundments can be constructed along minor waterways and ravines as an alternative to WASCOBs. Ponds trap sediment and nutrients and can provide habitat and recreational opportunities. For the purposes of this study, ponds construction of ponds is estimated to be approximately $50,000 per acre based on previous HDR | CWI experience. This cost includes clearing, earth work, discharge structure, riprap slope protection, and seeding.

**Sediment and Nutrient Control Basins** are designed to capture a large amount of the sediment and nutrients in runoff during storm events. In 1996, the USDA-NRCS published the *Lake Carlinville Watershed Plan and Environmental Assessment*. The primary recommendation within the NRCS report was a wetland sediment detention basin across the upper arm of Lake Carlinville along the main stem of Honey Creek. The proposed control basin would have intercepted approximately 95 percent of the drainage area from the Lake Carlinville watershed. The preliminary design was completed by NRCS engineering and included a seven-foot high gabion structure constructed across the entire width of the reservoir (approximately 500 feet). During periods of average rainfall, water would pass through a conduit. High flows would be temporarily impounded behind the gabion structure (allowing sediment and nutrients to be deposited) before passing over the dam (NRCS, 1996 and 2002). NRCS engineering estimated an annual average of three high flow events. Figure 30 illustrates the approximate location of the proposed NRCS dam and the extent of the sediment and nutrient control basin.

In 1996, the NRCS calculated that the proposed sedimentation basin would have an estimated 70 percent trapping efficiency and was designed to trap approximately 50 years worth of sediment (i.e., 341 acre-feet of sediment). The total project costs in 1996 were $554,600 with a $296,000 Federal share from a PL-566 grant and $258,600 as the local share. The average annual costs were estimated at $56,300 and included $12,200 for operation, maintenance, and replacements (NRCS, 1996 and 2002). The proposed sedimentation basin was not constructed, possibly because flood easements required for the project could not be obtained from private landowners (personal communication Bellm, 2006).

HDR│CWI believes that the costs to design and construct the proposed sedimentation basin will be considerably more than the 1996 amount of $554,600. At an estimated annual inflation rate between 3% and 4%, the sedimentation basin could cost as much as $840,000. In the current regulatory climate, additional permitting and mitigation could be necessary that may not have been required in 1996. These additional requirements would also increase the overall costs.

**Gully/Grade Stabilization Structures** are installed to prevent gully erosion by controlling the grade in areas that have naturally or artificially formed a channel or are likely to form a channel if not stabilized. They are typically necessary in areas that receive concentrated runoff or have steep slopes, such as riparian areas adjacent to Lake Carlinville. Several varieties of grade stabilization structures (i.e., stockade post structures; post, weir, and brush structures; post-weir structures; and rock grade stabilization structures) could be constructed to minimize gully erosion. For the purposes of this study, a median cost for gully stabilization structure of $40 per linear foot was used based on previous HDR **|** CWI experience.

**Drainage Water Management** is the practice of using water control structures in a main, sub-main, or lateral field tile drainage system to vary the depth of the drainage outlet. In this process the water table must rise above the outlet depth for drainage to occur, which can be altered by a control structure. The depth of the control structure can be raised or lowered depending on the season and conditions (Frankenberger et al., 2006). Frankenberger (2006) and Evans et. al., 2003 suggest median load reductions for total nitrogen to be approximately 45 percent. Reductions for solids and total phosphorus are expected to be minor.

- The structures can be raised after harvest to limit drainage outflow and reduce the delivery of nitrate to ditches and streams during the off-season.
- The structures can also be lowered in the early spring and again in the fall so the drain can freely flow before field operations (i.e., planting and harvest) occur.
- The structures can also be raised after planting and spring operation have been completed to create a potential to store water for crops to utilize during the midsummer (i.e., raises the water table).

The practice of drainage water management is only suitable on fields that need drainage (e.g., the upper portion of Lake Carlinville watershed, where slopes are one percent or less). These areas are shown in light green in Figure 3 (Part 1) and represent a large portion of the watershed. One water control structure can typically control from 10 to 20 acres. Studied have found reductions in annual nitrate load in drain flow vary from 15 to 75 percent, depending on location, climate, soil type, and cropping practice. The cost for water control structures varies from $500 to $2,000, depending on height, size of drainage tile, structure design, and manufacturer. Installation costs are typically about $200 per structure but can increase depending on site-specific conditions. Assuming surface grades are flat enough for one structure per 20 acres, installation costs are expected to be approximately $100 per acre (Frankenberger et al., 2006).

**Urban land management** can be important in watersheds that have a high percentage of urban land use. Since urban land comprises only 1% of the Lake Carlinville watershed, best management practices for urban land are not emphasized in the Watershed Plan. For the small areas that may benefit from urban land management, including the Lake Williamson community, the following practices could be considered: street sweeping, erosion control plantings, infiltration structures, retention basins, runoff controls, sediment filters, vegetative swales, storm water management, and zoning.

Proposed Actions

Table 28 provides a summary of proposed lake and watershed management alternatives for the entire watershed, as well as potential costs, load reductions, and resources for financial and technical assistance. A combination of non-structural and structural watershed management alternatives and BMPs should be implemented throughout the watershed over the next ten years. Specific locations for BMPs are proposed for the City and privately owned properties that were observed during the study (Figure 30); however, general locations are targeted for BMPs throughout the majority of the watershed that was not accessible during the study. A phased implementation approach is recommended in which specific locations identified in this report should be targeted for the first phase of implementation. The first phase should be used as a tool to demonstrate implementation of various BMPs and promote implementation of BMPs on privately owned land in the upper end of the watershed. Once additional cooperating landowners are identified, specific locations for implementation of additional BMPs can be identified and incorporated into the next phase of implementation.

Table 28. Lake Carlinville Watershed Plan & Implementation Summary

| Recommended Actions & Management Practices | | Estimated Costs: Range of Unit Costs | Units Proposed | Range of Estimated Costs | | Estimated Load Reductions ***: Sediment (tons/yr) | Nitrogen (lbs/yr) | Phosphorus (lbs/yr) | Implementation Assistance: Financial Assistance | Technical Assistance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1. SPECIFIC RECOMMENDATIONS & MANAGEMENT PRACTICES FOR THE LAKE CARLINVILLE WATERSHED** | | | | | | | | | | |
| **A. SPECIFIC WATERSHED ALTERNATIVES - Action Item A** | | | | **Low** | **High** | | | | | |
| **City Property** | Conservation Tillage | $45 to $55 per acre | 75 Acres | $3,375 | $4,125 | 74.0 | 160.0 | 80.0 | City, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Cover Crops | $20 to $30 per acre | 75 Acres | $1,500 | $1,875 | 118.0 | 261.0 | 131.0 | City, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Nutrient Management Plans | $15 to $20 per acre | 75 Acres | $1,125 | $1,500 | NA | 39.2 | 3.2 | City, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Inspect & Update Septic & Holding Tanks | $100 to $300 | Lake properties | ** | ** | ** | ** | ** | City & Homeowners | Local Contractor |
| | Modify Landscaping Practices | ** | Lake properties | ** | ** | ** | ** | ** | City, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Conservation Buffers | $400 to $600 per acre | 15 Acres | $6,000 | $9,000 | 64.0 | 210.0 | 113.0 | City, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Water & Sediment Control Basins | $2,000 to $3,000 each | 5 Structures | $10,000 | $15,000 | 395.0 | 475.0 | 240.0 | City, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Sediment & Nutrient Control Basin (1996 NRCS Design) | $845,000 to $925,000* | 1 Structure | $845,000 | $925,000 | 12,306.0 | 17,200.0 | 5,200.0 | City, NRCS, SWCD, US EPA, & IL EPA | HDR \| CWI & NRCS |
| | Gully/Grade Stabilization Structures | $40 to $50 per linear foot | 7,000 Linear feet | $280,000 | $350,000 | 756.0 | 1,519.0 | 756.0 | City, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI |
| **Private Property** | Side-Channel Sediment & Nutrient Control Basin | $50,000 to $60,000 per acre | 5 Acres (17.5 Acre-Feet) | $250,000 | $300,000 | 253.0 | 344.0 | 104.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI |
| | Pond | $50,000 to $55,000 per acre | 1 Acre | $50,000 | $55,000 | 844.0 | 95.0 | 48.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI, NRCS & SWCD |
| | Water & Sediment Control Basin | $2,000 to $3,000 each | 1 Structure | $2,000 | $3,000 | 115.0 | 95.0 | 48.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Gully/Grade Stabilization Structures | $40 to $50 per linear foot | 800 Linear Feet | $32,000 | $40,000 | 48.0 | 95.0 | 48.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI |
| | Conservation Buffers | $400 to $600 per acre | 10 Acres | $4,000 | $6,000 | 551.0 | 110.0 | 55.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Conservation Tillage | $45 to $55 per acre | 60 Acres | $2,700 | $3,300 | 76.0 | 230.0 | 123.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Grassed Waterways | $1,500 to $2,000 per acre | 2.5 Acres | $3,750 | $5,000 | 32.0 | 60.0 | 32.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| **Subtotal** | | | | **$1,491,450** | **$1,718,800** | | | | | |
| **B. SPECIFIC LAKE ALTERNATIVES - Action Items B, C, and D** | | | | **Low** | **High** | | | | | |
| **City Property** | Lake Shoreline Stabilization via Riprap Revetments[†] | $75 to $85 per linear foot | 4,000 to 5,000 linear feet | $300,000 | $425,000 | 525.0 | 1,049.0 | 525.0 | City, US EPA & IL EPA | HDR \| CWI |
| | Sediment Removal via Hydraulic Dredging [†] | $6.25 to $7.00 per cubic yard | 500,000 to 750,000 $yd^3$ | $3,125,000 | $5,250,000 | 33,422.4 | 1,091,610.1 | 109,161.0 | City, IL EPA | HDR \| CWI |
| | Restructure Lake Fish Population | $20,000 to $275,000 | NA | $20,000 | $275,000 | NA | NA | NA | City & IL DNR | IL DNR |
| | Fish Habitat Structures | $250 to $750 each | 10 Structures | $2,500 | $7,500 | NA | NA | NA | City & IL DNR | IL DNR |
| **Subtotal** | | | | **$3,447,500** | **$5,957,500** | | | | | |
| **C. OTHER RECOMMENDATIONS - Action Items E and F** | | | | **Low** | **High** | | | | | |
| | Watershed & Lake Coordinator(s) | $10,000 to $20,000 per yr. (part time) | NA | $10,000 | $20,000 | NA | NA | NA | City, US EPA | HDR \| CWI |
| | Educational and Informational Programs | $8,000 to $12,000 | NA | $8,000 | $12,000 | NA | NA | NA | City, US EPA & IL EPA | HDR \| CWI |
| | Survey Eroded Streambanks of Honey Creek | $15,000 to $20,000 | NA | $15,000 | $20,000 | NA | NA | NA | City, US EPA & IL EPA | HDR \| CWI |
| | Monitoring Program (sampling & analysis) | $13,000 to $20,000 | NA | $13,000 | $20,000 | NA | NA | NA | City & US EPA | HDR \| CWI |
| | IL EPA Post Implementation Report | $40,000 to $60,000 | NA | $40,000 | $60,000 | NA | NA | NA | City & US EPA | HDR \| CWI |
| **Subtotal** | | | | **$86,000** | **$132,000** | | | | | |
| **Total** | | | | **$5,024,950** | **$7,808,300** | | | | | |

| Watershed Management Practices | | Range of Unit Costs | Units Proposed | Range of Estimated Costs | | Sediment (tons/yr) | Nitrogen (lbs/yr) | Phosphorus (lbs/yr) | Financial Assistance | Technical Assistance |
|---|---|---|---|---|---|---|---|---|---|---|
| **2. GENERAL RECOMMENDATIONS FOR THE LAKE CARLINVILLE WATERSHED - Action Item A** | | | | **Low** | **High** | | | | | |
| **Private Property** | Conservation Tillage - Mulch Till | $40 to $50 per acre | 500 Acres | $20,000 | $25,000 | 712.0 | 1,424.0 | 712.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Conservation Tillage - No Till | $40 to $50 per acre | 500 Acres | $20,000 | $25,000 | 1,482.0 | 3,160.0 | 1,580.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Crop Rotations | $20 to $30 per acre | 500 Acres | $10,000 | $15,000 | 1,127.0 | 2,323.0 | 1,162.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Septic & Holding Tank Inspect & Upgrade | $100 to $300 | Watershed properties | ** | ** | ** | ** | ** | City, landowner, US EPA, IL EPA, NRCS & SWCD | Local Contractor |
| | Changing Landscape Practices | ** | Watershed properties | ** | ** | ** | ** | ** | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Water & Sediment Control Basins | $2,000 to $3,000 each | 20 Structures | $40,000 | $60,000 | 848.0 | 192.0 | 96.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Drainage Water Management | $1,500 to $2,000 per acre | 200 Acres | $300,000 | $400,000 | 184.0 | 4,950.0 | 360.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Silviculture Practices | $1,000 to $4,000 per acre | 50 Acres | $50,000 | $200,000 | 385.0 | 306.0 | 154.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Grassed Waterways | $1,500 to $2,000 per acre | 50 Acres | $75,000 | $100,000 | 1,050.0 | 2,150.0 | 1,050.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Nutrient Management Plans | $15 to 20 per acre | 500 Acres | $7,500 | $10,000 | NA | 262.0 | 22.3 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Pasture | $150 to $200 per acre | 200 Acres | $30,000 | $40,000 | 1,280.0 | 654.0 | 484.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Wildlife Habitat | $180 to 220 per acre | 200 Acres | $36,000 | $44,000 | 1,410.0 | 918.0 | 550.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Conservation Buffers | $400 to $600 per acre | 500 Acres | $200,000 | $300,000 | 636.0 | 1,889.0 | 1,013.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Livestock Exclusion | $5,000 to $8,000 per area | 4 Livestock Areas | $20,000 | $32,000 | 18.4 | 496.0 | 160.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Restoration of Riparian Corridors | $400 to $600 per acre | 50 Acres | $20,000 | $30,000 | 385.0 | 306.0 | 154.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | NRCS & SWCD |
| | Stream Bed stabilization | $5,000 to $7,500 per structure | 10 Structures | $50,000 | $75,000 | 83.0 | 114.0 | 34.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI |
| | Stream Bank stabilization | $100 to $110 per LF | 2,000 LF | $200,000 | $220,000 | 454.0 | 908.0 | 454.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI |
| | Ponds | $50,000 to $55,000 per acre | 10 Ponds | $500,000 | $550,000 | 532.0 | 96.0 | 48.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI, NRCS & SWCD |
| | Gully/Grade Stabilization Structures | $40 to $50 per linear foot | 5,000 LF | $200,000 | $250,000 | 795.0 | 1,595.0 | 795.0 | City, landowner, US EPA, IL EPA, NRCS & SWCD | HDR \| CWI |
| **Total** | | | | **$1,778,500** | **$2,376,000** | | | | | |

* Cost was increased by an annual inflation rate between 3% to 4% above the 1996 NRCS preliminary design estimated cost of $554,600.
** Costs & load reductions vary depending on work required.
*** Load reduction estimates are not additive. Additional load reduction information is included in Appendix F.
[†] Including engineering costs

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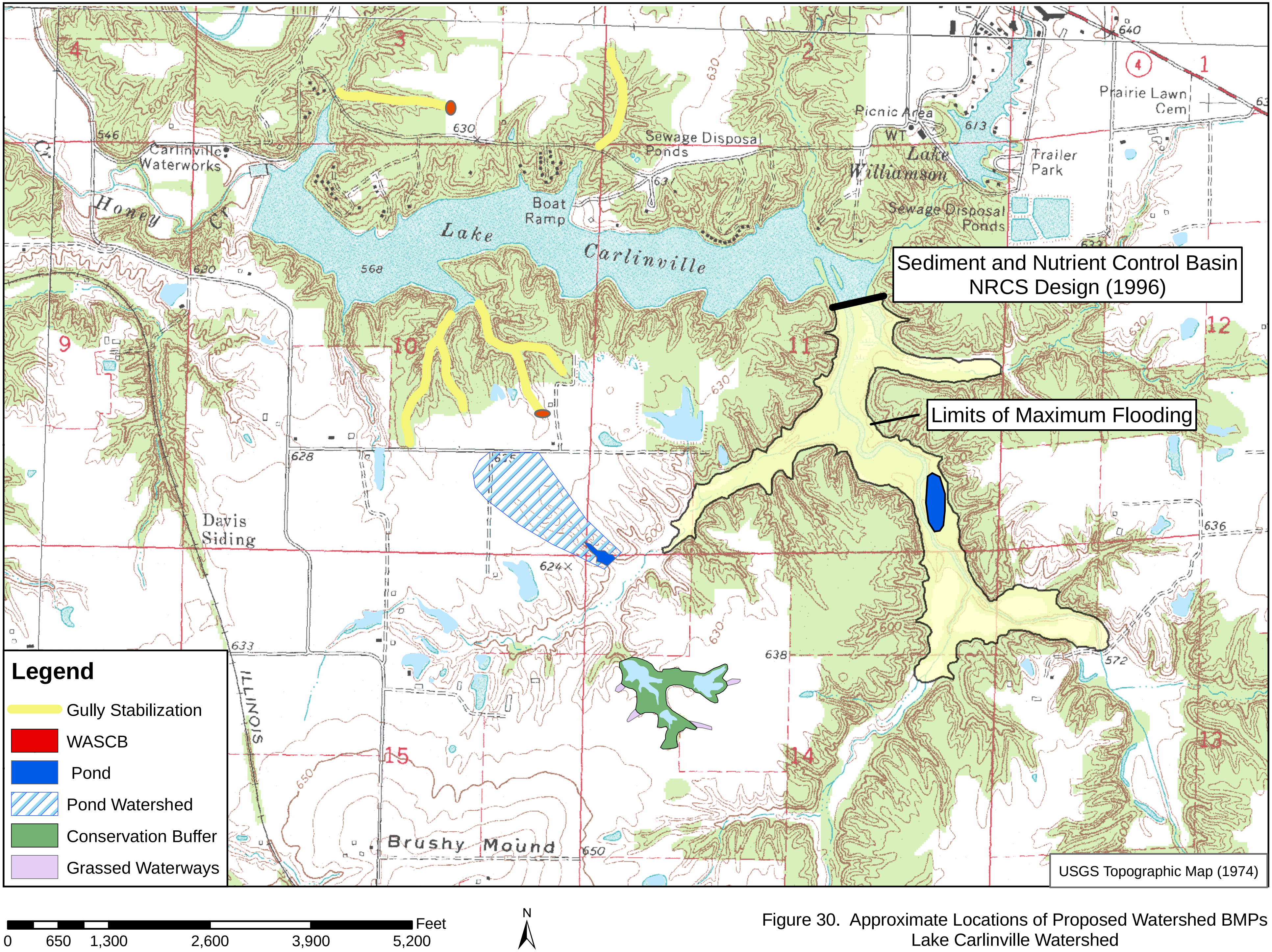



Figure 30. Approximate Locations of Proposed Watershed BMPs
Lake Carlinville Watershed

## Recommendations for City-owned property adjacent to Lake Carlinville

As the owner and steward of Lake Carlinville, the City of Carlinville should take the lead by implementing watershed management alternatives and BMPs on City-owned land in the lower end of the watershed. This action would send a message to the community that the City is serious about the restoration of Lake Carlinville and its watershed. To facilitate implementation of projects on City-owned land, potential project locations were identified for the following non-structural and structural watershed management alternatives:

- the 1996 NRCS sediment and nutrient control basin,
- gully/grade stabilization structures - approx. 7,000 linear feet,
- agricultural land management practices on approx. 75 acres of fields,
- water and sediment control basins (5 structures),
- inspecting and upgrading septic and holding tanks on lake properties, and
- modifying landscaping practices on lake properties.

## Recommendations for Privately-owned properties near Lake Carlinville

HDR | CWI toured a privately owned property located along the east end of Lake Carlinville. Along the east side of Honey Creek is a 5 to 6 acre area (southeast corner of Section 11 of T9N and R7W) that could be developed as a side-channel sediment and nutrient control basin and enhanced to create a wildlife habitat area for water fowl. Essentially, the basin would be designed to retain flood waters and trap sediment and nutrients. A sketch of the proposed pond location is illustrated in Figure 30.

HDR | CWI visited a second private property where several watershed BMPs, such as dry dams and conservation tillage practices, were already implemented. Several potential pond locations along ravines north of an unnamed tributary of Honey Creek were evaluated (southwest corner of Section 11 of T9N and R7W). A potential outline of the proposed pond and associated watershed is illustrated in Figure 30. The representative for the private landowner stated that the pond(s) could serve as a watering source for the livestock. Separate from providing an alternate watering source for cattle, the pond would provide load reductions for the watershed by trapping sediment and nutrients generated from runoff and gully erosion.

HDR | CWI met a third private landowner (northwest corner of Section 14 of T9N and R7W) that had constructed a pond in which several algal blooms had occurred shortly after filling the pond. The pond was surrounded by sloping agricultural fields with few to no conservation buffers, filters strips, or grassed waterways. Adding these watershed features, as a buffer between the pond and the agricultural fields, would enhance the pond and wildlife (Figure 30). As an added benefit, these structures, along with improved farming practices (i.e., conservation tillage), would reduce loadings to the small pond and the larger Lake Carlinville watershed. Since this pond drains to the lake, direct benefits for to Lake Carlinville would result from these actions.

**General recommendations for the Lake Carlinville watershed**

Aside from the aforementioned private landowners, public participation during this study was minimal. Restricted access to private property made evaluating existing conditions for site-specific watershed management projects challenging; however, HDR|CWI was able to conduct a tour of the Lake Carlinville watershed from public roadways (Figure 31). In addition to field surveys, remote sensing with GIS, aerial photography, topographic mapping, land cover types, and soil surveys was used to evaluate the Lake Carlinville watershed. Despite the watershed information that was analyzed, site-specific watershed projects were not proposed, as it may be difficult to obtain land easements that are required to implement watershed management practices. It is important to note that watershed BMPs located on privately owned lands can be achieved and should be pursued. Given their local presence and knowledge, the local NRCS and SWCD offices will be critical allies in these endeavors. A watershed coordinator (see Action Item F) can also help with this task.

Although specific locations for BMP implementation throughout the entire watershed are not identified in this report, data that can be used to target troublesome areas are included. For example, Figure 31 shows all the lakes and streams throughout the watershed. During the watershed survey, streambank erosion was noted at almost every road and stream crossing. These areas would be good candidates for streambank stabilization. Good land management practices are most important in areas adjacent to any water body, especially those areas with highly erodable land

(HEL) (Figure 32). Figure 32 also shows areas with steep slopes that are designated for agricultural use. These areas are highly susceptible to sediment and nutrient transfer to the adjacent water body. Figures 3 and 7 (pages 21 and 31 in Part 1) can be used to further target locations and types of BMPs to be implemented. Forest management, gully stabilization, and streambank stabilization should be considered for red areas in Figure 3, which represent very steep slopes. Nutrient management plans, crop rotations, and conservation tillage practices should be considered for all agricultural areas shown in Figure 7.

Although general areas for implementing BMPs can be identified using methods discussed previously, it is important to note that some of these areas may already have BMPs implemented. Given the limited public participation and land access, it was not possible to distinguish areas that currently have BMPs in place. As a result, a general approach was taken for proposing management alternatives within the watershed. Cost estimates and load reductions were developed and calculated for the watershed management alternatives listed below with the assumption that those management measures would be implemented over time as cooperating landowners are identified.

Watershed management alternatives and BMPs:

- Nutrient Management Plans - 500 acres
- Crop Rotations - 900 acres
- Conservation Tillage Practices - 1,000 acres
- Conservation Buffers - 500 acres
- Inspect and Upgrade Septic Systems
- Changing Landscaping Practices
- Livestock Exclusion - 4 livestock facilities
- Restoration of Riparian Corridors - 50 acres
- Silviculture Practices – 50 acres
- Stabilize Eroded Streambeds (10 structures) & Streambanks (2,000 linear ft)
- Grassed Waterways - 50 acres
- Water and Sediment Control Basins and Ponds - 20 structures and 10 Ponds
- Gully/Grade Stabilization Structures - 5,000 linear feet
- Drainage Water Management – 200 acres

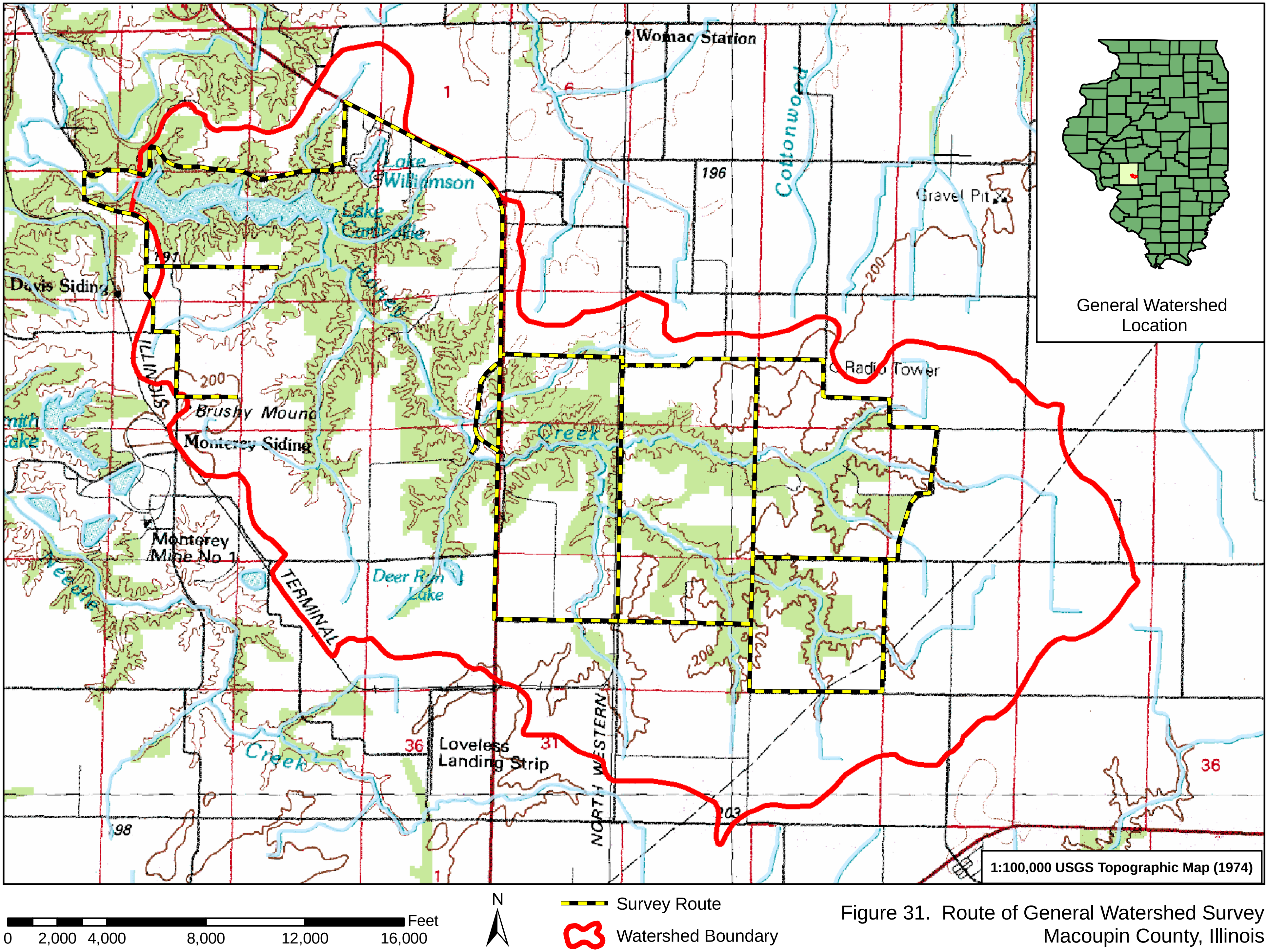



Figure 31. Route of General Watershed Survey
Macoupin County, Illinois

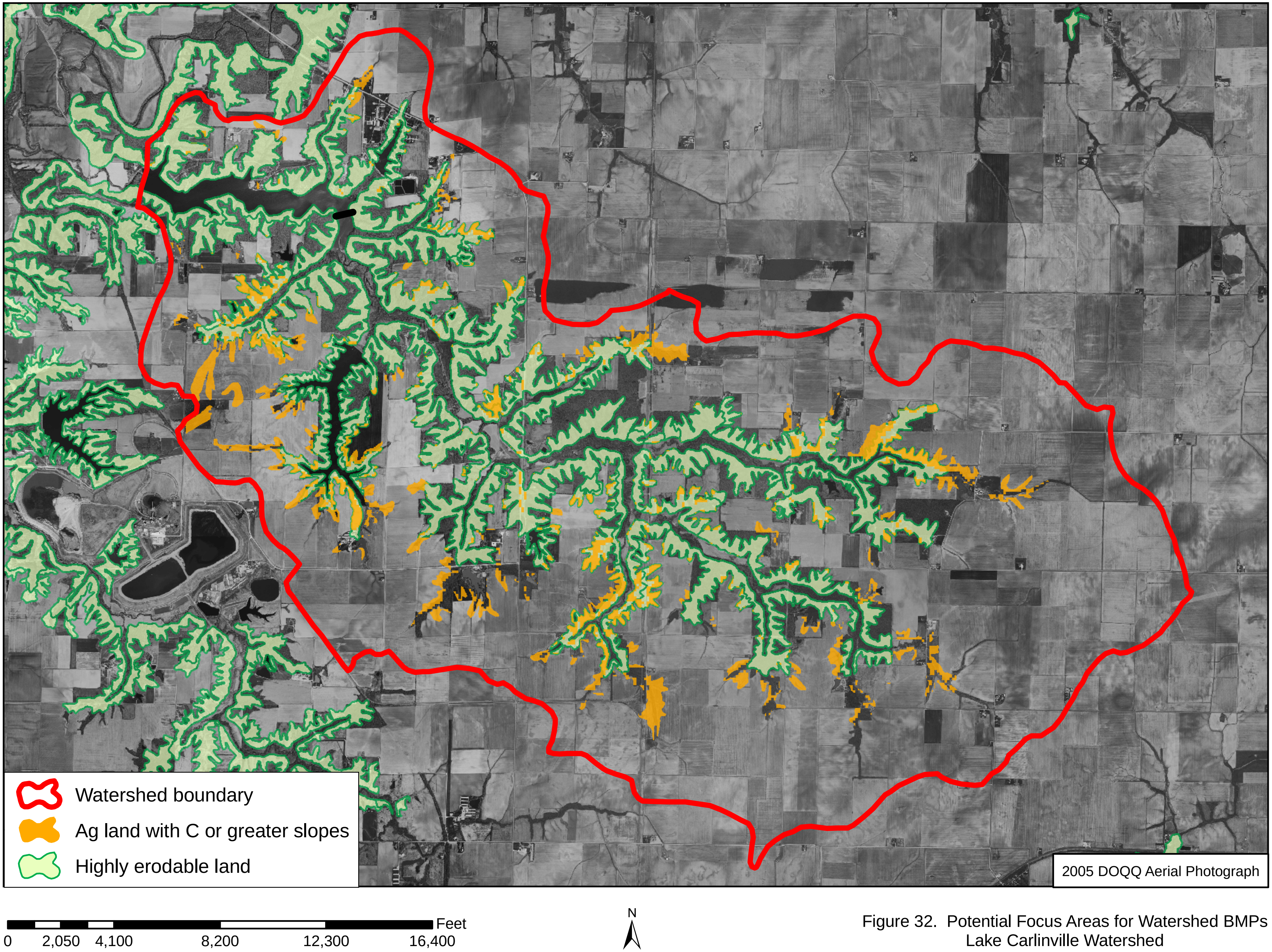



Figure 32. Potential Focus Areas for Watershed BMPs
Lake Carlinville Watershed

***Action Item B.  Remove Accumulated Sediment from the Lake***

<u>Alternative Actions</u>

According to the 2006 accumulated sediment volume as discussed in Part 1, an estimated 1,425,009 cubic yards of sediment have been deposited over the 67-year history of the lake.  This estimated volume of accumulated sediment suggests that an average of approximately 21,269 cubic yards of sediment have been deposited on annual basis.  The major alternatives for removing sediment in Lake Carlinville include extended water level drawdown, mechanical dredging, and hydraulic dredging.

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 poor solution when excessive sediment deposits are present. In order to assure optimum drying and compaction, the water level would have to be substantially lowered for a sufficient period of time.  According to a study completed by Fox et al. (1977), approximately 180 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 is anticipated that the sediment found in the upper portion of Lake Carlinville 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 Carlinville, water levels would have to be lowered significantly.  This is not possible due to the reservoir's relatively linear morphology and hydrologic regime.  Furthermore, a drawdown extended well into the spring or even into the summer months would be nearly impossible to implement because of the extremely large watershed drainage area from Honey Creek and its tributaries.  If it were possible, an extended drawdown may have many negative impacts to the public water supply, aquatic community and the recreational use of the lake.  Due to these limitations, an extended drawdown and compaction would not be the best option to address the accumulated sediment at Lake Carlinville.

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. The length of time required for the sediment to dewater and consolidate sufficiently enough to support excavation equipment may take longer than expected, especially if frequent rainfall events occur. Although this method can sometimes be accomplished at selected areas in the shallow upper ends of a lake, it is not a feasible option for this lake since the Lake Carlinville 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 in this manner is inefficient and can leave high percentages of material behind. Transportation and storage 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 storage area. 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 a feasible sediment removal method for Lake Carlinville.

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 or more with the use of booster pump(s). 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 are 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 recreation and 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 and select bays of Lake Carlinville is hydraulic dredging. Table 28 includes a range of estimated costs, estimated load reductions, and technical and financial assistance requirements for sediment removal via hydraulic dredging. Prioritizing dredging areas to target the more impacted shallow areas is critical to reducing the total dredging volume, as it provides a more cost-effective alternative than removing all of the accumulated material from the entire lake.

The most critical dredging locations include segments #6 through #15 from the sedimentation survey (see Figure 24 in Part 1), where 49 percent of the lake's original storage capacity has been lost in the upper end of the lake. The total estimated sediment volume in these prioritized locations is approximately 686,910 cubic yards. Additional sediment removal is recommended in the deep basin area located east of the water supply intake; however, specific volumes cannot be estimated without a sediment survey that targets that area. During the engineering design phase, a detailed and updated sedimentation survey should be completed prior to bidding and implementation. Strategically removing as much accumulated sediment as practical from within this critical area of the lake will help restore lake water quality by removing deposited materials and an internal nutrient source. In addition, water depths and storage capacity can be restored in the upper end of the lake. The estimated quantity of accumulated sediment in the upper end of the lake is significant enough that funding availability will likely dictate the quantity of material that is ultimately dredged. Therefore, Table 29 lists three options with varying opinions of cost have that have been developed following a "good, better, and best" format to illustrate hydraulic dredging possibilities for Lake Carlinville.

Table 29. Lake Sediment Removal Options and Probable Costs

| Option | Option 1 | Option 2 | Option 3 |
|---|---|---|---|
| Dredging Area (Segments)* | 6 through 15 | 7 through 15 | 9 through 15 |
| Approx. Cubic Yards Removed | 686,910 | 495,146 | 226,723 |
| Sediment Retention Site Costs | $686,910 | $495,146 | $340,084 |
| Dredging Costs (incl. mobilization) | $2,747,640 | $2,228,157 | $1,133,615 |
| Subtotal | $3,434,550 | $2,723,303 | $1,473,699 |
| 10% Estimating & Construction Contingency | $343,455 | $272,330 | $147,370 |
| 15% Engineering & Permitting | $566,701 | $408,495 | $221,055 |
| Total | $4,344,706 | $3,404,128 | $1,842,124 |

*Variations in dredging areas may include selective deepening with in the area near the dam and water intake.

For the purpose of this report, sediment removal Option #2 (i.e., 495,146 cubic yards) is the minimum dredging volume recommended for Lake Carlinville. In the upper portions of the lake, a maximum dredge cut depth of 8 to 10 feet or at least to the hard, original bottom (which ever comes first) is recommended. This maximum cut depth will minimize sediment resuspension post-dredging, which will in turn increase recreational access, improve water quality and clarity, extend the useful lifespan from the project, and provide a long-term benefit to the lake. The removal of a minimum of 495,146 cubic yards of accumulated sediment would restore nearly 13 percent of the lake's original-1939 volume. Once removed, the volume that was once occupied by sediment would provide additional lake water storage capacity. Using a conversion rate where one cubic yard occupies nearly 202 gallons of water, removing this volume would essentially provide 100,019,492 gallons of additional storage capacity. The City of Carlinville has a peak daily water demand of approximately 1.45 MGD (Shaw personal communication, 2006), which translates to an average of 44 million gallons per month. Removing 495,146 cubic yards from Lake Carlinville would equate to more than a two-month water supply for the City. This added storage capacity would be invaluable during drought conditions.

If hydraulic dredging takes place, land will be required for the construction of a retention facility that will store and dewater dredged sediment. The dredged sediment can be beneficially reused as fertile agricultural soil and/or fill, thus maintaining the value of the land. The amount of land required for this facility is directly proportional to the quantity of sediment that is dredged. For recommended sediment removal Option #2, it is estimated that approximately 17 to 25 hectares (42.0 to 61.8 acres) will be required for a suitable retention and dewatering site. The largest dredge quantity proposed (Option #1) would typically require between 24 to 36 hectares (59.3 to 89.0 acres) and the smallest dredge quantity proposed (Option #3) would require between 7.5 to 11.5 hectares (18.5 to 28.4 acres). The retention and dewatering site(s) should be located within the watershed so that water can drain back into the lake. Further evaluation and analysis will be required to find a suitable retention site location. Costs for the land required for the retention site are not included with the opinions of probable costs listed above. It is important to note that if multiple small sites are required, costs will be higher than those listed. An existing pond located immediately south of the lake was utilized for storing a small, undetermined volume of dredged material during the 1970s. This pond may be suitable for the recommended dredging project depending on space availability and the extent of physical modifications necessary. In addition, an existing agricultural field adjacent to this City owned pond may be suitable for construction of a sediment storage and dewatering facility.

Costs may also be higher if polymers or flocculants are necessary to accelerate settling within the settling basin. The presence of excessive sodium within the Piasa soils of the Herrick-Piasa-Virden soil association of the Lake Carlinville watershed may impact the lake's turbidity by allowing fine clay colloidal particles to remain in suspension in the lake's water column. This phenomenon, if present, will likely require the use of a polymer or floccing agent to treat and reduce the effluent discharge suspended solids concentrations in order to meet the Illinois EPA effluent water quality standards. The addition of a floccing agent for effluent treatment will impact dredging unit costs.

### ***Action Item C. Stabilize and Protect Eroded Lake Shoreline Areas***

Alternative Actions

Many products have been developed to control shoreline erosion and older methods have been improved. The following were considered when deciding the best approach for stabilizing the Lake Carlinville shorelines: riprap (both crushed stone and rounded glacial stone) with bedding stone or filter fabric, erosion mats, plastic and natural geowebs, gabions, railroad ties, interlocking concrete blocks, and natural vegetative stabilization. Vegetative covering can provide protection by reducing wave action and by binding the soil with roots. In addition to the erosion control benefits, vegetative stabilization methods have the ability to absorb and assimilate nutrients from runoff and, once established, require little or no maintenance since plants reproduce and often spread naturally. For the correct application, these more natural stabilization measures are aesthetically pleasing, provide habitat, and can be cost effective.

For slightly eroded areas with gently sloping littoral zones and no large direct wave action, plant species such as prairie cord grass (*Spartina pectinata*) can be used. Prairie cord grass is an emergent, herbaceous perennial that is native to North America and has been proven to be excellent for erosion control with dense beds and deep root systems, up to 2 ft. into the ground. The species is often found near water and wet areas, does well in poor soils, and tolerates seasonal flooding. The plant can spread aggressively, up to two feet per year (Michigan State University Extension, 1999). Prairie cord grass plugs can be planted within sand bags (approximately 2 ft. long by 1 ft. wide each) or within biodegradable fiber rolls and placed across the toe of the eroded bank. The sand bags would provide immediate shoreline protection along with a medium to hold the plantings in place until they could get established and rooted into the shoreline. This natural form of shoreline stabilization would establish native plants for erosion control and enhance habitat for wildlife (Erosion Control, 2000).

Riprap is another shoreline stabilization alternative that has proven to be very effective for reducing and preventing erosion. Riprap with underlying geotextile filter fabric would be ideal to address the moderately (3 to 8 ft. bank heights) and severely (>8 ft. bank heights) eroded banks of Lake Carlinville. 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 (Figure 33).

Figure 33. Examples of Riprap Shoreline Protection

Shoreline Revetment

Offshore Breakwater

Proposed Actions

As a result of the shoreline erosion survey, the following shoreline stabilization recommendations have been developed. Riprap and filter fabric should be used for moderately and severely eroded shoreline and should be placed via barge or mechanical riprap boat 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 should be graded to a 3 to 1 horizontal to vertical slope and seeded. However, the eroded shoreline at Lake Carlinville is typically bordered by wooded growth at or near the shoreline and flattening the slope of the shoreline may be difficult or impractical in most cases. Once the toe of the slope is protected from further undercutting by structural methods, the eroded slope will gradually slough until a state of equilibrium is reached. The estimated base cost of shoreline stabilization using gradation RR4 broken limestone riprap is approximately $60 per linear foot, plus allowances for contingencies, engineering, and permitting.

For areas of shoreline with gentle slopes and shallow littoral areas that have been categorized as having slight bank erosion, emergent vegetation (i.e., prairie cord grass or other native emergent aquatic plants) with sandbags could be used in order to minimize wave action on shore and protect eroded banks from further undercutting. The estimated cost of implementing vegetative plantings for erosion control and shoreline stabilization is $20 per linear foot.

The current lengths of shoreline erosion within Lake Carlinville may be too large to be addressed simultaneously. Therefore, shoreline stabilization projects should be prioritized and completed based on the level of need in a series of phases. Subsequent shoreline surveys are recommended to monitor and prioritize further lake shoreline erosion. This approach will more effectively utilize available funding from grants and cost-share sources to target the severely and moderately eroding shoreline areas that are most susceptible to erosion by being exposed to waves generated by prevailing winds. The prioritized areas should include moderate and severe erosion areas that are most susceptible to additional erosion. All of the severely eroded shoreline (1,118 lineal feet) and approximately half of the moderately eroded shoreline (2,122 lineal feet) should be stabilized in the first phase. The stabilization of moderately eroded shoreline shall be prioritized according to severity of undercutting and exposure to maximum wind fetches and wave action. For select slightly eroded areas, vegetative plantings (approximately 1,000 linear feet) are suggested.

Shoreline stabilization work on this scale will require a Joint Application Permit from the Army Corps of Engineers (COE), the Illinois EPA, and the Illinois Department of Natural Resources (IL DNR), particularly for riprap placed as fill material beneath the normal water level. The benefits of shoreline stabilization would include reduced sediment and nutrient loading, reduced turbidity, expanded shoreline habitat, improved aesthetic appearance, and prevention of further loss of valuable shoreline. Table 28 includes a range of estimated costs, estimated load reductions, and technical and financial assistance requirements for lake shoreline stabilization.

***Other Alternatives to Improve Water Quality***

Alternative Actions

The primary alternatives for improving water clarity and restoring a more balanced aquatic vegetation population include reducing solid and nutrient loadings from the watershed on a continuous basis, altering nutrient availability, restructuring the algae population so that blue-greens are not dominant, and reducing the amount of suspended sediment and nutrients entering the lake during significant storm events. Nutrients such as phosphorus and nitrogen can be controlled and reduced in many ways such as: implementing best management practices in the watershed and the construction of an in-lake sediment and nutrient control basin (Action Item A); minimizing internal nutrient regeneration and sediment resuspension occurrences via hydraulic dredging or re-establishing a rooted aquatic macrophyte community (Action Item B); and the stabilization of eroded shoreline (Action Item C). Action items A, B, and C were identified as the best strategies for improving water quality; however, additional alternatives were considered and are discussed below.

Other potential alternatives for reducing nutrient concentrations include nutrient diversion, dilution and flushing, discharge of hypolimnetic water, phosphorus inactivation/precipitation, and artificial circulation. Due to the lake's linear morphometry and the hydrologic features of its extensive watershed, it would be technically unfeasible and expensive to implement a diversion or flow routing system for the control of nutrients. Dilution and flushing has been shown to be 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 acceptable alternatives for Lake Carlinville due to the lack of suitable groundwater resources. Hypolimnetic discharges are normally not a feasible solution for reservoirs, since anoxic conditions typically occur during the summer months when water conservation is critical due to lack of precipitation and excessive water loss from evaporation. In addition, the release of anoxic waters to Honey Creek from Lake Carlinville would have negative impacts on the biota within the creek/stream.

Phosphorus precipitation and inactivation are techniques used to lower the concentration of phosphorus in the water column by either precipitating it out or preventing its release from sediments. Aluminum sulfate (alum) can be added to the lake surface in order to precipitate the phosphorus to the lake bottom. Additional alum can be added to form a barrier in order to prevent or minimize phosphorus release from the sediment during anoxic conditions. Properly applied alum treatments can result in relatively long-term reductions of phosphorus in lakes where inflowing sources of phosphorus have been sufficiently controlled and the resuspension of bottom sediments is minimal but these issues are a concern for Lake Carlinville. The cost of alum treatments typically ranges from $2,475 to $3,700 per hectare ($1,000 to $1,500 per acre). Since the total surface area of Lake Carlinville is approximately 168 acres, the cost for a whole lake alum treatment would range from $168,000 to $252,000 for a single treatment. However, the lake’s expansive drainage area will continue to produce significant sediment and nutrient loadings and the lake’s linear morphometry and rapid hydraulic residence time would also limit the effectiveness of alum treatments. Therefore, it appears highly unlikely that alum would be a suitable long-term alternative for controlling phosphorus concentrations within Lake Carlinville.

Artificial aeration or destratification of lakes during the summer thermal stratification period is a practice commonly used to improve water quality conditions (i.e., increase dissolved oxygen concentrations). The primary improvements in water quality that may be attained as a result of artificial aeration or destratification are reduced nutrient loading from bottom sediments, reduced blue-green algal dominance leading to a more desirable and diverse algal population, improved ecological diversity, and increased oxygen levels and chemical oxidation of substances in the entire water column.

The two primary methods of lake aeration/destratification include artificial circulation and hypolimnetic aeration. Any system that is designed to mix or circulate the lake or provide aeration without maintaining the normal thermal structure is classified as an artificial circulation technique. Systems within this category include compressed air and/or mechanical devices capable of lifting anoxic hypolimnetic water and circulating oxic surface waters in order to evenly distribute oxygenated water throughout the lake. A compressed air system is typically used to initiate rising air bubbles sufficient to reach the surface and flow out horizontally. The cold, dense water eventually sinks to a level of equal density and eventually establishes a whole lake mixing, if the system is sufficiently sized and designed. Hypolimnetic aeration is a method of providing dissolved oxygen to the bottom waters of a lake without disrupting the normal pattern of thermal stratification, which is typically reserved for deepwater lakes. For Lake Carlinville, artificial circulation would be a suitable alternative to improve lake water quality and to restructure the algal population.

Based on findings of Lorenzen and Fast (1977), a suitable system for the approximately 50 acres near Site #1 and the public water supply intake at Lake Carlinville should be capable of providing compressed air in the range of 32.5 to 65 CFM. Thus, an air injection (diffuser) system is a viable option for Lake Carlinville. The system includes an on-shore air compressor that delivers air through lines connected to diffusers located near the bottom of the lake. The rising air bubbles cause water in the hypolimnion (cold, bottom layer) to rise into the epilimnion (warm, surface water layer). As this occurs, the colder hypolimnetic water reaches the surface and mixes with the warmer epilimnetic water. If the aeration system is adequately designed, the process continues and ultimately mixes the metalimnion (layer between epilimnion and hypolimnion) with the epilimnion and hypolimnion. Eventually, the dissolved oxygen and temperature profile are nearly equal throughout the lake. Potential advantages and disadvantages to operation of an artifical circulation system are listed below (reported by Kothandaraman and Evans, 1983).

Potential advantages include:

1. Increased oxygen concentrations at the sediment/water interface can significantly reduce the rate of nutrients (i.e., phosphorus) released from the sediment.
2. Benthic flora and fauna populations are typically more diverse and abundant under well-oxygenated conditions, which can impart better food supplies for game/sport fish species.

3. A shift in algal populations may occur with a decrease in undesirable blue-green species. This is partly a result of lowering the water temperatures; blue-green algae are most tolerant of high surface water temperatures.
4. Oxidation of reduced organic and inorganic materials occurs. This is particularly advantageous to water supply lakes because taste, odor and color problems caused by iron, manganese, and hydrogen sulfide are minimized.
5. Evaporation rates can be reduced during summer months as a result of lower surface water temperatures.
6. Artificial destratification often results in increased water clarity.
7. Maintaining a sufficient dissolved oxygen level under ice cover may reduce occurrence of wintertime fish kills.

Potential disadvantages include:

1. An increased heat budget can be caused in the lake that slightly lowers the temperature of the upper waters, whereas deep waters may be warmer by as much as 15$^o$ to 20$^o$C, approximately the same temperature as the surface.
2. There may be a temporary increase in water turbidity resulting from the resuspension of bottom sediments.
3. Most investigations have resulted in a reduction of blue-green algae, but in some instances, there was little or no effect.
4. The oxygen demand of resuspended sediments may result in low dissolved oxygen concentrations, at least temporarily, that may be harmful to the fish.
5. Aeration may cause supersaturation of nitrogen gas, creating a potential danger for fish from gas bubble disease.

<u>Proposed Actions</u>

Internal regeneration of phosphorus and nitrogen within Lake Carlinville is estimated to be a relatively minor component of the overall nutrient budgets, as the lake does not typically stratify for extended periods (due to the relatively shallow water depths of the lake). In addition, the lake is periodically mixed as a result of prevailing winds and the large volumes of runoff that flow into the relatively linear (i.e., riverine) lake from a large drainage area. This flow pattern during normal summer weather conditions mixes the water within deeper portions of the reservoir and helps to limit the internal release of nutrients by maintaining oxygenated conditions near the bottom for most of the year. The exception to this periodic mixing may occur during exceptionally dry seasons. Considering these conditions, installation of an aeration system within the lower portion of Lake Carlinville would only be recommended in the event that accumulated sediments are removed near the water supply intake and if water quality improvements are not seen as a result of implementing Action Items A, B, and C. Given the known accumulated sediment levels near the dam, spillway, and public water supply intake, installing an aeration system prior to sediment removal could exacerbate sediment re-suspension, which could subsequently increase lake algal blooms and taste and odor issues within the public water supply.

A lake aeration system could potentially increase oxygen levels (reducing seasonal hypolimnetic anoxia) and reduce the dominance of blue-green algae to allow for a more diverse and desirable algal population, but is not considered a high priority at this time. Increased dissolved oxygen concentrations within the lower portion of the lake should improve lake water quality as fewer internal nutrients and taste and odor compounds are generated. Improved water quality and fewer taste and odor issues should benefit the public water supply. However, seasonal hypolimnetic anoxia does not appear to be a prolonged issue based on Phase 1 water quality data. It is possible that similar benefits may be achieved by implementing the previously mentioned action items. If aeration is considered in the future, a compressed air destratification system is recommended for approximately 50 acres near the water supply intake structure of Lake Carlinville. The system includes weighted air hoses and high efficiency diffusers with a well-ventilated and sound proofed air compressor house. This type of system, including engineering design, has an estimated cost of $80,000 to $100,000 installed.

**Objective #2: Enhance Lake Aesthetics & Recreational Opportunities**

As the previous action items are addressed, lake aesthetics and recreational opportunities will drastically improve; however, additional actions can be taken to further improve the fish population in Lake Carlinville. Similar to the combination of actions to address Objective 1, the following actions items were identified to enhance the aesthetics and recreational opportunities at Lake Carlinville.

A. Reduce the Amount of Sediment and Nutrients Entering the Lake
B. Remove Accumulated Sediment from the Lake
C. Stabilize and Protect Eroded Lake Shoreline Areas
D. Restructure Existing Fish Population

***Action Item D. Restructure Existing Fish Population***

<u>Alternative Actions</u>

IL DNR fisheries staff has made suggestions to remove accumulated silt from the upper end of the lake and then restructure the fish population (Pontnack personal communication, 2006). Attempting to restructure the existing fish population without implementing the previous objectives will likely have limited results. Therefore, any attempts at restructuring the fish population should be made after the following conditions are addressed.

- Reduce delivery of excess sediment and nutrient loads to the lake in order to improve water quality and subsequently improve fish habitat and spawning opportunities (Action Item A);
- Remove accumulated sediments in shallow fish spawning or breeding waters, which will remove an internal loading source and subsequently improve habitat and spawning opportunities (Action Item B);
- Stabilize eroded shoreline areas to reduce sediment and nutrient loadings near the shoreline, which will improve shallow water habitat and spawning areas (Action Item C); and
- Improve water quality to support a more balanced vegetative community and increase aquatic macrophyte population, which will improve food sources and fish habitat (Action Items A - C).

Until the aforementioned lake and watershed alternatives are implemented, the District 14 IL DNR fisheries biologist recommends no changes to the existing fisheries management plan. The current management plan includes sampling and monitoring, and enforcement of current fishing regulations (Pontnack personal communication, 2006.) The following IL DNR management practices and regulations should be continued: 1) two poles per angler with line fishing only; 2) channel catfish - six fish daily creel limit; and 3) spring fish population survey consisting of electrofishing and gill net sampling (every third year or as State budget funding allows).

In the event that water quality and habitat conditions improve within Lake Carlinville, several alternatives have been identified to address fish population imbalances within Lake Carlinville.

1) Periodic or annual lake drawdowns during the winter months to consolidate forage fish and to promote their predation;
2) Electro-shocking and selectively harvesting/removing undesirable fish species from the lake;
3) Stocking top predators (hybrid striped bass) to increase predation of undesirable fish species;
4) Opening the lake to commercial fishing in order to harvest/remove undesirable fish species from the lake;
5) Remove all existing fishing regulations on the lake to remove undesirable fish species;
6) Eradication of the entire fish population using a piscicide and "starting over" through stocking;
7) Installing fish attractors/habitat structures to provide cover, and concentrate fish to improve angler opportunities; or
8) Nothing – allow lake fish population to continue to develop, as is.

Proposed Actions

Periodic lake draw downs to promote increased fish predation, electro-shocking and selectively harvesting undesirable fish, and stocking top predators may have limited success in restructuring the fish population in Lake Carlinville. Many of the undesirable fish species (i.e., black bullhead catfish, warmouth, yellow bullhead catfish, common carp, yellow bass, and green sunfish) are bottom feeders that can approach sizes where existing stunted predator populations may have difficulty consuming them or the undesirable fish are predators themselves. Selectively harvesting through electro-shocking, stocking top predators, and opening up the lake to commercial fishing will have varying costs to cover the fish disposal and stocking costs and costs to offset potential losses to commercial fishers, as the cost per pound is often less than the cost of fishing. Removing the existing fish regulations may allow the public to remove undesirable species from the lake at no cost; however, this may be a very slow process.

Given the variability of the aforementioned alternatives, the IL DNR fish biologist for Lake Carlinville feels that the most effective treatment may be eradicating the existing population with an aquatic pesticide or piscicide (e.g., rotenone) and then re-stocking the lake with largemouth bass, bluegill, redear sunfish, channel catfish, and if conditions allow, white crappie. However, there is no guarantee that this effort will prevent undesirable fish species from becoming established again in the future. As a public water supply lake, the application of a piscicide to eradicate the existing fish population could have a negative backlash. To help answer potential questions from concerned citizens, information may need to be distributed to inform and educate the public. In the event that the City of Carlinville decides to restructure the Lake Carlinville fish population through the application of rotenone, the City would need to obtain a permit from the Illinois EPA for application of an aquatic pesticide or piscicide to Lake Carlinville. The permit would be issued by the Illinois EPA Public Water Supplies Permit Section. A licensed piscicide applicator (i.e., IL DNR) would be required to apply the rotenone.

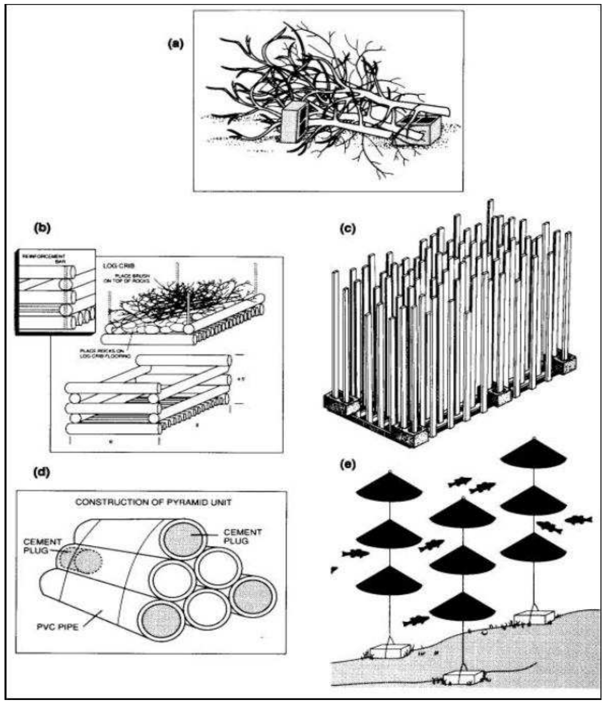
To ensure that nearly all fish in the lake are eradicated, the IL DNR recommends a concentration of 9 parts per million (ppm) of rotenone. To achieve this concentration, an application rate of approximately 3 gallons per acre-foot of lake volume would be required (Pontnack personal communication, 2007). With an estimated lake volume of 1,378 acre-feet and rotenone costs varying from $55 to $60 per gallon, the chemical costs for Lake Carlinville could vary from $230,000 to $255,000. To increase the effectiveness of the rotenone, IL DNR recommends applying the treatment in July or preferably August, typically when fish eggs are not present. During the rotenone application and treatment, the City of Carlinville will have to draw water from Lake Carlinville II for a period of time until the rotenone degrades and naturally attenuates. IL DNR estimates that this natural attenuation period could last one to two weeks depending on the rotenone concentration applied. To reduce unit costs and increase treatment effectiveness, a slight draw down of the lake prior to treatment is suggested. This could be detrimental to the public water supply if drought conditions arise during draw down. Additional costs associated with eradicating the lake fish population include the handling and subsequent disposal of fish bodies.

After the existing Lake Carlinville fish population has been eradicated, IL DNR fish biologists would re-stock Lake Carlinville at a nominal cost. IL DNR recommends the following re-stocking densities for Lake Carlinville (Pontnack personal communication, 2007):

- Largemouth Bass - 100 1”-2” fish per acre
- Bluegill - 350 1”-2” fish per acre
- Redear Sunfish - 150 1”-2” fish per acre
- Channel Catfish - 100 1”-2” fish per acre
- White Crappie - 100 1”-2” fish per acre (if lake conditions allow)

To further enhance the re-stocked fish population, fish attractor/habitat structures should be installed within the lake to provide cover and concentrate fish to improve angler opportunities. 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, and bundled piping. The estimated costs are anticipated to vary from $250 to $750 for each structure. It is recommended that structures or structure groupings be located and installed under the direction of the IL DNR District Fisheries Biologist. The total cost for the structures is estimated to be as much as $5,000. Examples of potential fish attractors/habitat structures are shown in Figure 34.

Figure 34.  Fish Attractor/Habitat Structure Alternatives




Each of the alternatives presented to address restructuring fish population imbalances have merit, but it is important to note that no one alternative will accomplish all the goals.  Final selection may consist of a combination of alternatives, which could be influenced by the success of actions implemented to improve the lake's aquatic habitat.  Other items to consider in selecting alternatives to restructure the fish population may include the availability of local and state resources and public perception.

**Objective #3: Promote Lake and Watershed Restoration**

The following actions items were identified to promote collaboration and cooperation between the City of Carlinville, private landowners, and the lake users prior to and during implementation of the Lake Carlinville Watershed Plan.

E. Conduct Informational and Educational Programs

F. Identify Watershed Coordinator(s)

The following proposed actions are intended to inform and educate the public about watershed and lake issues, to change the practices of current and future generations, and coordinate future watershed and lake restoration projects. Due to the wide variety of ways the City of Carlinville could encourage project support and the fact that an evaluation of alternative actions applies to situations where one action will be chosen, only proposed actions are discussed in this section.

Proposed Actions

***Action Item E. Conduct Informational and Educational Programs***

Informational and educational (I/E) programs will increase the public's awareness of various lake and watershed issues, educate stakeholders on the process of lake and watershed restoration, and promote future involvement. I/E programs should be implemented on various levels throughout the community (i.e., schools, scouts, and local government) in order to engage people with various ages and interests. Programs and/or activities that could aid in public outreach are described below. While some of these activities may take place in the Carlinville area, it is important to also plan activities that target stakeholders in the upper end of the watershed.

Three potential audiences that could be targeted with public outreach materials and activities include children and organized youth groups, citizens interested in preserving water quality or the environment, and stakeholders that have the ability to implement projects in the watershed. Outreach materials may be obtained through agencies that promote environmental awareness and stewardship, such as Illinois EPA, Illinois DNR, NRCS, and Macoupin County SWCD. Alternatively, materials specific to the Lake Carlinville watershed can be created by a City representative, environmental consultant, or another designated person (see Action Item F).

Providing teaching materials for science classrooms, conducting field trips to project sites, developing small projects that can be implemented by scouts or other youth groups (i.e., planting trees on Arbor Day or Earth Day), and demonstrations at a lake or watershed festival can be used in combination to target the younger generation. In order to encourage children to talk with their parents about the environment, flyers can be sent home from school with children. Contacting a classroom or youth group to develop an educational brochure would be one way to distribute information with a personal touch. The IL EPA sponsored Lake Education Assistance Program (LEAP) is a great resource to aid in getting children involved with lake and watershed educational activities.

The general public and watershed stakeholders can be reached by distributing educational materials or having a festival that would not only raise public awareness of lake and watershed restoration, but motivate stakeholders to implement projects on their own land. Interested parties in the general public may include homeowners in the City's tax base that use water from Lake Carlinville, and recreational lake users that would like to see an improvement in lake aesthetics or sport fishing. Hosting a festival at Lake Carlinville would be a great way to get the general public involved by teaching all ages about lake impairments and restoration activities and also providing an opportunity to distribute information about current impairments and upcoming projects.

In order to target stakeholders in the upper end of the watershed, another activity such as a barbeque or field trip to a demonstration plot could be held to help promote implementation of lake and watershed best management practices. The City is encouraged to develop a demonstration plot that can be used as a tool to demonstrate commitment to lake and watershed restoration and display a variety of BMPs that others can consider implementing on their own land. Additionally, a demonstration plot on private property would promote stakeholder participation. Educational materials for stakeholders should focus on encouraging land practices that will reduce nonpoint source pollution and funding opportunities specific to managing agricultural and forested land since these are the major land uses within the Lake Carlinville watershed. Developing a brochure that summarizes the Lake Carlinville Watershed Plan may be useful for targeting the general public and watershed stakeholders. An initial sum of $15,000 is proposed to develop various community I/E programs, including a brochure that can be mailed to the public and distributed at activities within the watershed.

***Action Item F. Identify Lake and Watershed Coordinator(s)***

The prioritization, implementation, and completion of the projects listed within the Lake Carlinville Watershed Plan will require oversight by the City of Carlinville. A lake and watershed coordinator is needed to identify additional project locations and manage projects through their various phases (i.e., planning, permitting, design, and construction). Therefore, HDR│CWI recommends that the City have a dedicated person(s) assigned or hired on a part-time basis to oversee lake and watershed restoration activities. Since stakeholder participation was limited during this study, it will be critical to have someone local to the area to aid with identifying areas and cooperating stakeholders for future projects. Several options include 1) the current lake commission; 2) a City employee or member of the City council; or 3) a consultant/technical expert (e.g., SWCD employee). Another option would include engaging the lake commission in planning, decision making and creating awareness, but also contracting a consultant to help secure funding and implement projects identified within this report. A range of $10,000 to $20,000 per year may be necessary for this effort. The responsibilities of this person(s) will include developing and distributing educational materials and/or programs, aiding in identification of potential project locations and cooperative landowners, coordinating with landowners that will be implementing projects, preparing grant applications, and overseeing projects for which grants are awarded.

## D. BENEFITS EXPECTED FROM IMPLEMENTATION OF WATERSHED PLAN

The ecological, social, and economic benefits of watershed management and lake restoration can extend over many generations. Continuous management of Lake Carlinville and its watershed can improve various recreational opportunities, increase community property values and the local tax base, reduce or prevent future increases in water treatment costs, and provide habitat for game fish and other wildlife. Once implemented, the proposed actions from the Lake Carlinville Watershed Plan will reduce sediment and nutrient loadings to the lake and generate a wide range of water quality improvements, which will produce recreational use benefits and enhance the public water supply. Specific benefits in relation to completion of each objective in the Lake Carlinville Watershed Plan are listed in Table 30.

Table 30. Potential Benefits Expected from Implementing the Lake Carlinville Watershed Plan

| Objectives | Action Items | Benefits Expected from Lake Carlinville Watershed Plan Objectives |
|---|---|---|
| #1 Improve Water Quality | A- Reduce the Amount of Sediment and Nutrients Entering the Lake; | Prevent loss of valuable land and protect agricultural fields |
| | | Prolong benefits of sediment removal |
| | | Progress toward satisfying TMDL requirements (51% phosphorus load reduction) |
| | | Remove Lake Carlinville from the 303(d) list of impaired waters |
| | | Prevent further lake degradation, thus increasing property values |
| | B- Remove Accumulated Sediment from the Lake | Increase lake water depths and navigation of the lake |
| | | Reduce internal regeneration of nutrients from bottom sediments |
| | | Reduce resuspension of sediments |
| | C- Stabilize and Protect Eroded Lake Shoreline Areas; | Improve aquatic macrophyte and fish habitat |
| | | Enhance aquatic macrophyte habitat |
| | | Reduce (or prevent future increases) water treatment costs |
| | | Enhance lake aesthetics & recreational opportunities, including benefits of Objective #2 |
| | | Decrease frequency of taste and odor problems in public water supply |
| | | Increase lake dissolved oxygen concentrations |
| | | Reduce blue-green algal dominance and encourage diverse, beneficial algal populations |
| #2 Enhance Lake Aesthetics and Recreational Opportunities | Accomplish Items A, B, and C; and | Decrease presence of undesirable rough fish |
| | | Increase sportfish population |
| | D- Restructure Existing Fish Population | Increase property values |
| | | Draw more visitors to the Lake Carlinville area |
| #3 Promote Lake and Watershed Restoration | E- Conduct Informational and Educational Programs | Inform stakeholders about technical and financial assistance available |
| | | Increase stakeholders' interest in maintaining the environment around them |
| | | Provide opportunities for public to learn more about lake and watershed issues |
| | F- Identify Watershed Coordinator | Promote collaboration between the City of Carlinville, private landowners and lake users |
| | | Increase likelihood that the Lake Carlinville Watershed Plan will be successful |

Overall, the reduction of sediment and nutrients entering the lake and the removal of nutrient rich lake bottom sediments, together with various habitat improvements and shoreline stabilization will improve water quality and aid in the restoration of Lake Carlinville. Improved water quality and clarity will improve the public water supply and also enhance lake recreation and aesthetics. These improvements will be reflected by economic benefits such as increased property values, economic development, and revenues for merchants in the local community.

Table 31 shows the current use estimates for Lake Carlinville, along with the projected use benefits following implementation of the watershed plan. Prior studies completed by the IL 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 has the potential to generate a total of $1.37 million in economic benefits over a ten-year period, which 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 Lakes Program. The report found that a total return in benefits of $4.15 per total project dollar was achieved. 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 31. Projection of Economic 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 | 59,200 | 71,040 | 11,840 | $458,208 | $549,850 | $91,642 | $916,416 | $1,374,624 |

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

Source: NRCS, 1996
Illinois DNR Planning Division
Griffith and Associates

## E. BUDGET AND SCHEDULE

The Lake Carlinville Watershed Plan Budget is contained within Table 28. Recommended actions and management practices within the watershed plan are divided into two groups. Group #1 includes specific recommended watershed and lake actions and management practices on City-owned property (i.e., Lake Carlinville and property surrounding the lake) and other areas located near Lake Carlinville where HDR|CWI was permitted to access private property. Group #2 consists of actions and practices that are proposed for the areas of the Lake Carlinville watershed that were not accessed during field surveys.

Rather than committing to a fixed budget and schedule (i.e., where funding and restoration projects are specified beforehand), a more open and flexible approach is proposed. This approach will consist of preparing separate, individual 319-grant applications (annual August 1 deadline) that are based on the findings and recommendations of the Lake Carlinville Watershed Plan (Table 28, page 113). This "phased" approach will allow individual projects to be completed in a reasonable time frame, as funding becomes available.

Several general criteria are suggested in selecting and prioritizing projects within the Lake Carlinville Watershed Plan. Priority should be given to projects located on publicly-owned lands or on lands in which private landowners are cooperative and willing to implement projects and/or management practices. Generally, projects on publicly-owned land have fewer issues with land access and acquisition. Additional consideration should be given to those projects and management alternatives that will have the greatest impact on reducing sediment and nutrient (particularly phosphorus) loadings to the lake (see estimated load reductions in Table 28).

Removing accumulated lake sediments will enhance and increase the longevity of several other lake projects. HDR|CWI recommends lake sediment removal before the following activities are considered: sediment and nutrient control basin, lake aeration, and restructuring the fish population. In order minimize maintenance of accumulated sediments and materials in the control basin, the City should consider implementing various BMPs in the lower portion of the watershed, which is in close proximity to Lake Carlinville. For the other areas within the Lake Carlinville watershed, projects and practices should be implemented and completed as cooperative private landowners are identified and project match funds are available. Overall, a ten-year implementation schedule is estimated for the Lake Carlinville Watershed Plan in Table 32. The recommended actions of the watershed plan are grouped in the implementation schedule by objective.

Table 32.  Recommended Implementation Schedule for Lake Carlinville Watershed Plan

| | | 2008 | | | | 2009 | | | | 2010 | | | | 2011 | | | | 2012 | | | | 2013 | | | | 2014 | | | | 2015 | | | | 2016 | | | | 2017 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Recommended Actions** | **Time-Frame** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** |
| **Objective # 1 Action Items** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reduce Sediment and Nutrients Entering the Lake * | On-Going | 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 |
| City Property & Private Landowners Near Lake Carlinville | Short-Term | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | |
| Watershed Between Lake Carlinville & West of Route 4 | Mid-Term | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | |
| Watershed East of Route 4 | Long-Term | | | | | | | | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | |
| Stabilize and Protect Eroded Lake Shoreline Areas | Short-Term | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | |
| Survey Streambanks of Honey Creek | Mid-Term | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | |
| Remove Accumulated Sediment - Hydraulic Dredging | Mid-Term | | | | | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | | | |
| Construct Sediment & Nutrient Control Basin | Mid-Term | | | | | | | | | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Objective # 2 Action Items** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Restructure Lake Carlinville Fish Population | Long-Term | | | | | | | | | | | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| **Objective # 3 Action Items** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Identify Watershed & Lake Coordinator(s) | Short-Term | X | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conduct Educational & Informational Programs | On-Going | 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 |
| Continue Water Quality Monitoring | On-Going | 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 |
| Complete US EPA & IL EPA Grant Applications and Reports | On-Going | 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 |

* Conserv. Tillage, Crop Rotation, Conserv. Buffers, Nutrient Management Plans, Inspect/Upgrade Septic System, Changing Landscape Practices, & Livestock Exclusion from Waterways, Water & Sediment Control Basins, Drainage Water Management, Silviculture Practices, Gully/Grade Stabilization Structures, Grassed Waterways, Ponds, Restororation of Riparian Corridors, and Stream Bed & Stream Bank Stabilization

## F. MEASURING PROGRESS AND MONITORING WATER QUALITY

As projects within the watershed plan are implemented, it is important to have targets and subsequent methods to measure progress. For systems such as Lake Carlinville where eutrophication and sediment are major problems, the US EPA (2005) recommends the following indicators to measure progress in reducing pollutants:

*Eutrophication:*

- Phosphorus loads
- Number of nuisance algal blooms
- Transparency of lake or Secchi transparency depth
- Frequency of taste and odor problems in water supply
- Hypolimnetic dissolved oxygen in lake

*Sedimentation:*

- Total suspended solid concentrations and loads
- Raw water quality at drinking water intake
- Frequency & degree of dredging of impoundments & water supply intakes

Due to the qualitative nature of the load reduction indicators above, quantitative measurable milestones were developed to assist with implementation of the Lake Carlinville Watershed Plan. Together, the indicators and measurable milestones can be used to monitor progress and determine the effectiveness of the implemented watershed plan. Measurable milestones, estimated time frames, and estimated load reductions are listed for each proposed action (Table 33). While larger projects can be divided into phases, some projects will be completed at one time and do not have measurable milestones.

It should be noted that the rate in which loads can be reduced and measurable milestones can be achieved are often dependent on the nature of the pollutants. Unlike pathogens, which tend to die off quickly once the source is removed, management practices and erosion controls designed to reduce phosphorus loadings often do not have immediate observed effects. In cases where phosphorus is the problem, measurable milestones or changes may take years to demonstrate a response to watershed management practices.

Table 33.  Measurable Milestones for Lake Carlinville Watershed Plan

| Recommended Actions | Measurable Milestones | Estimated Time Frame | Estimated Load Reductions Sediment (tons/yr) | Nitrogen (lbs/yr) | Phoshorus (lbs/yr) | General Load Reduction Indicators |
|---|---|---|---|---|---|---|
| **A - Reduce the amount of sediment and nutrients entering the lake** | | | | | | |
| Nutrient Management Plans | 250 Acres | 3 to 5 years | NA | 131 | 12 | Reduction in soil erosion within watershed |
| Crop Rotations | 250 Acres | 3 to 5 years | 564 | 1,162 | 581 | |
| Conservation Tillage | 250 Acres | 3 to 5 years | 741 | 1,580 | 790 | Reduced TSS & P loads to Lake Carlinville |
| Conservation Buffers | 50 Acres | 3 to 5 years | 64 | 189 | 101 | |
| Septic & Holding Tank Inspections & Upgrades | Lake properties | 2 to 3 years | ** | ** | ** | Reduction in freq. taste & odor problems in public water supply |
| Changing Landscape Practices | Lake properties | 3 to 5 years | ** | ** | ** | |
| Livestock Exclusion from Waterways | 2 locations | 3 to 5 years | 10 | 248 | 80 | |
| Gully/Grade Stabilization Structures | 1,000 linear feet | 3 to 5 years | 159 | 319 | 159 | Improved public water supply |
| Ponds | 2 Ponds | 3 to 5 years | 106 | 19 | 10 | |
| Grassed Waterways | 25 Acres | 3 to 5 years | 525 | 1,075 | 525 | Increased Secchi transparency depths |
| Restoration of Riparian Corridors | 25 Acres | 3 to 5 years | 193 | 153 | 77 | |
| Silviculture Practices | 25 Acres | 3 to 5 years | 193 | 153 | 77 | Increased in hypolimnetic DO |
| Drainage Water Management | 100 Acres | 3 to 5 years | 92.0 | 2,475.0 | 180.0 | |
| Stream Bed & Bank Stabilization | 500 linear feet | 3 to 5 years | 114 | 227 | 114 | Increased Secchi transparency depths |
| Water & Sediment Control Basins | 10 Structures | 3 to 5 years | 424 | 96 | 48 | |
| Sediment & Nutrient Control Basin | Constructed Basin | 5 to 8 years * | 12,306 | 17,200 | 5,200 | Reduced number of algal blooms in lake |
| **B - Remove Accumulated Sediment from the Lake** | | | | | | Improved aquatic and fish habitat |
| Lake Sediment Removal | 500,000 cu. yds. | 4 to 7 years | 33,422 | 1,091,610 | 109,161 | |
| **C - Stabilize and Protect Eroded Shoreline Areas** | | | | | | |
| Lake Shoreline Stabilization | 2,200 linear feet | 3 to 5 years | 263 | 525 | 263 | |

* To be completed after sediment removal.
** Load reductions vary.  Additional load reduction information is included in Appendix F.

As recommended actions and alternatives within the Lake Carlinville Watershed Plan are implemented and completed, additional monitoring and reporting is recommended to document and demonstrate progress (i.e., meeting the proposed TMDL reductions). Several of the federal and state EPA grant programs have monitoring and project reporting requirements to assess and document the effectiveness of implemented projects and management practices. Monitoring will also help track watershed plan progress so that adjustments can be made, if necessary. A range of $13,000 to $20,000 for sample analyses and $40,000 to $60,000 for additional project reporting is recommended for budgeting purposes.

The Illinois EPA conducts two lake monitoring programs and three stream monitoring programs. The Ambient Lake Monitoring Program (ALMP) samples approximately 50 lakes annually, the Volunteer Lake Monitoring Program (VLMP) encompasses sampling at more than 170 lakes per year, the 213-station Ambient Water Quality Monitoring Network samples rivers and streams statewide, the Intensive Basin Survey Program surveys major watersheds on a five-year basis, and the Facility-Related Stream Survey Program conducts approximately 20-30 stream assessments each year. The Illinois EPA's ALMP considers Lake Carlinville as a core lake and thus the lake is sampled every four years (Borland Lau personal communication, 2006). Lake Carlinville is strongly encouraged to participate in the VLMP to help monitor and document changes in lake water quality. Any of the existing Illinois EPA sampling programs could be used to monitor the progress of the Lake Carlinville Watershed Plan.

The City of Carlinville is also encouraged to conduct additional monitoring to assess sources of pollutants and evaluate changes in water quality. Table 34 presents a proposed water quality monitoring program for a one-year period following implementation of the proposed lake and watershed restoration activities. This program is similar to the Phase 1 water quality monitoring program; however, no organics, metals, sediment or fish samples will be analyzed.

Table 34. Water Quality Monitoring Program

| 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 |

Key: M = monthly in-lake and tributary sampling (12 times per year by the City of Carlinville)
S = summer in-lake and tributary sampling (Apr., June, July, Aug., & Oct. by Illinois EPA)
T = Storm event tributary sampling (by the City of Carlinville/HDR│CWI, as required)

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.

Collectively the AMLP, VLMP, and supplemental water quality monitoring programs will provide data and information to assist in making future lake and watershed management decisions. The monitoring data will aid in evaluating the efficiency of management alternatives and help to identify alternatives that could be expanded to meet the proposed load reductions set forth by the TMDL (i.e., 51 percent phosphorus reduction or a total phosphorus load allocation of 172.17 kg/month).

## G. FINANCIAL AND TECHNICAL ASSISTANCE

Implementing and completing the recommended actions and management practices within the Lake Carlinville Watershed Plan will likely require multiple funding sources and grant programs. Several funding sources have been identified to initiate voluntary or incentive-based lake and watershed restoration programs. In addition, the following technical resources may be useful in the consultation, planning, permitting, implementation, and construction phases for the Lake Carlinville Watershed Plan:

- City of Carlinville
- Macoupin County
- Illinois Environmental Protection Agency
- United States Environmental Protection Agency
- USDA - Natural Resources Conservation Service
- Macoupin County Soil and Water Conservation District
- Farm Service Agency
- Illinois Department of Natural Resources
- US Army Corps of Engineers - St. Louis District

Generally, the US EPA (Section 319 – Nonpoint Source Pollution Control Program) will help sponsor lake and watershed restoration projects with 60 percent cost match. The remaining 40 percent cost match would be put forth by local sources (i.e., the City of Carlinville) or the state of Illinois (i.e., Clean Lakes program). Some of the larger-scale restoration projects may be more challenging to implement and may require additional funding, potentially from the NRCS, SWCD, or IL DNR. It is important to note that dredging is an expensive and large-scale project that the Illinois EPA does not typically help finance. If a dredging project were to take place, the City of Carlinville would be primarily responsible for funding; however, the Illinois EPA Clean Lakes Program has assisted in financing some components associated with dredging projects such as engineering, permitting, and retention site construction.

Clean Water Act Section 319 grants are administered to address nonpoint source pollution (http://www.epa.state.il.us/water/financial-assistance/non-point.html). Section 319 of the Clean Water Act provides Federal funding for the implementation of approved nonpoint source (NPS) management programs. Funding under these grants has been used in Illinois to finance projects that demonstrate cost-effective solutions to NPS issues and problems. Projects must address water quality issues relating directly to NPS pollution. Section 319 funds can be used to implement watershed management plans, develop information/education programs, and install best managements practices

(BMPs) within watersheds. The 319-grant application period is from June 1 through August 1. The maximum Federal funding available is sixty percent, and the typical implementation period is limited to two years, unless otherwise approved.

Conservation 2000 (http://www.epa.state.il.us/water/conservation-2000/) funds numerous programs across three state natural resource agencies (i.e., Illinois EPA, Illinois Department of Agriculture, and the Illinois Department of Natural Resources). Conservation 2000 is a multi-year, $100 million initiative designed to take a broad-based, long-term ecosystem approach to conserving, restoring, and managing Illinois' natural lands, soils, and water resources. This program includes the Priority Lake and Watershed Implementation Program (PLWIP), the Lake Education Assistance Program (LEAP), and the Illinois Clean Lakes Program (ICLP). PLWIP supports approximately four to five projects annually, with each project having a maximum allowance of $40,000. According to the IL EPA website, LEAP funds are available to all school children whether they attend public or private schools, and for grades from kindergarten through graduate school. Funds are also available to not-for-profit organizations, such as lake associations, scouting groups, parks, and communities. LEAP has approximately $50,000 in available funding per year. The maximum award per school and/or organization is $500 per application period. ICLP Phase 2 grants are accessible to any lake owner who has completed an ICLP Phase 1 study. Fifty percent of the Phase 2 study cost is provided by the state ICLP with the lake owner and/or other sources providing the remaining portion. The maximum amount of state funds is $300,000 for any Phase 2 project. Grant availability in any given year will depend on the level of ICLP funding appropriated by the state legislature.

Another component of Conservation 2000 is the Conservation Practices Program (CPP) (http://www.agr.state.il.us/Environment/conserv/index.html). The CPP focuses on conservation practices (i.e., terraces, filter strips, and grass waterways) that are aimed at reducing soil loss on Illinois cropland to tolerable levels. Illinois Department of Agriculture distributes funding for the cost-share program to Illinois' Soil and Water Conservation Districts, which prioritize and select projects. Organizations, governmental units, education institutions, non-profit groups, and private individuals may apply for grants though the CPP.  Construction costs for BMPs are divided between the state and landowners.

The Conservation Reserve Program (CRP) is administered by the Farm Service Agency (FSA) (http://www.nrcs.usda.gov/programs/crp/).  CRP provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in a environmentally beneficial and cost-effective manner.  The FSA manages CRP and the NRCS provides technical land eligibility determinations, conservation planning, and practice implementation.

The Wetlands Reserve Program (WRP) sponsored by the NRCS is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property (http://www.nrcs.usda.gov/programs/wrp/).  The NRCS provides technical and financial support to help landowners with their wetland restoration efforts.  The goal of this program is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program.  This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

The Environmental Quality Incentive Program (EQIP) sponsored by NRCS (general information at http://www.nrcs.usda.gov/PROGRAMS/EQIP/; Illinois information at http://www.il.nrcs.usda.gov/programs/eqip/) is a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals.  EQIP offers financial and technical assistance to eligible participants to install or implement structural and management practices on eligible agricultural land.  EQIP may cost-share up to seventy-five percent of the costs of certain conservation practices.  Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive.

Wildlife Habitat Incentives Program (WHIP) is an NRCS program for developing and improving wildlife habitat, primarily on private lands (http://www.nrcs.usda.gov/Programs/whip/).  It provides both technical assistance and cost-share payments to help establish and improve fish and wildlife habitat.

## H. RELATIONSHIP TO OTHER POLLUTION CONTROL PROGRAMS

It is the intent of the Illinois Clean Lakes Program and the US EPA 319 Program that all studies and projects are coordinated with 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. The proposed watershed and lake restoration projects are consistent with Illinois EPA's "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." The Illinois EPA was required to develop and maintain these reports as a result of Section 319 of the Clean Water Act. The following projects and programs demonstrate that there is a collaborative effort between the City of Carlinville, state and county agencies, and private landowners to preserve the Lake Carlinville watershed.

In addition, to programs discussed in the previous section, two state agencies participate by providing water quality monitoring and fish management for Lake Carlinville. As stated in Part 1 of this report, Lake Carlinville has been a part of the Illinois EPA's Ambient Lake Monitoring Program since the late 1970s. Honey Creek is monitored on a continuous basis as well. The Illinois DNR has provided ongoing fisheries management assistance and stocking prior to 1995 through an agreement between the City of Carlinville and Illinois DNR.

While state agencies provide valuable lake management assistance, the Macoupin County SWCD and the NRCS continue to provide assistance to landowners in the watershed related to soil and nutrient conservation, and have been committed to providing assistance in implementing best management practices in the watershed through programs mentioned previously such as CRP, WHIP and WRP. Furthermore, the NRCS office in Carlinville published two reports in 1996 and 2003 entitled, *Lake Carlinville Watershed Plan and Environmental Assessment* and *Upper Macoupin Creek - Watershed Restoration Action Strategy*, respectively. The first NRCS report provided a general inventory of the Lake Carlinville watershed and served as the basis for a proposed sediment basin along Honey Creek at the upper of the lake. The second NRCS report evaluated the entire Macoupin Creek watershed, including the Lake Carlinville sub-watershed. The Macoupin Creek report provided a comprehensive inventory of the Macoupin Creek watershed, developed a list of resource concerns, and identified and evaluated various watershed implementation action strategies. These previous studies have provided value information for the City of Carlinville and private landowners and created awareness that will be beneficial to the implementation phase of the Lake Carlinville Watershed Plan.

Illinois EPA has also provided valuable information for the Lake Carlinville watershed by conducting a TMDL study. Section 303(d) of the Clean Water Act requires States to define impaired waters and identify them on a list, referred to as the 303(d) list. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Daily Maximum Loads (TMDLs) for water bodies that are not meeting designed uses under technology based controls. The TMDL process establishes the allowable loading of pollutants or quantifiable parameters for a water body based on the relationship between pollution sources and in-stream conditions. This allowable loading represents the maximum quantity of the pollutant that the water body can receive without exceeding water quality standards.

In 2006, Lake Carlinville (IL_RDG) was listed on Illinois Section 303(d) List of Impaired Waters as a water body that is not meeting its designated uses and numerical water quality standards (Illinois EPA, 2006). Impairments for Lake Carlinville are listed in Table 35.

Table 35. List of Impairments for Lake Carlinville

| | |
|---|---|
| Assessment Unit ID | IL_RDG |
| Size (Acres) | 168 |
| Listed for | **Manganese**, **total phosphorus**, total suspended soilds, & aquatic algae |
| Use Support[1] | Aquatic Life (F), Fish consumption (X), Public and food processing water supplies (N), Primary contact (X), Secondary contact (X), Aesthetic quality (N) |

[1] F = Fully supprting, N = not supporting, and X = not assessed.
Illinois EPA, 2006

The TMDL pollutants of concern for Lake Carlinville are manganese and total phosphorus. Illinois EPA (2006) determined that the potential sources contributing to the lake's impairments are: natural background and seasonal hypolimnetic anoxia for manganese, and agricultural runoff and seasonal hypolimnetic anoxia for total phosphorus. While hypolimnetic anoxia is a contributor to manganese and phosphorus concentrations, it does not appear to be a major issue. The water quality standard for total phosphorus to protect aquatic life and aesthetic quality uses in Illinois lakes is 0.05 mg/L. The water quality standard for manganese in Illinois waters designated as public and food processing water supplies is 150 μg/L. These standards were used as targets for the TMDL. The total phosphorus load allocation established by the TMDL is 172.17 kg total phosphorus/month or 5.64 kg total phosphorus/day. The English unit equivalents for these load allocations are approximately 0.190 US tons/month (380.0 lbs/month) or 0.006 US tons/day (12.5 lbs/day). Table 36 summarizes the total phosphorus load allocation for Lake Carlinville as determined by the TMDL.

Table 36. TMDL Total Phosphorus Load Allocation for Lake Carlinville

| | kg/month | tons/month | pounds/month |
|---|---|---|---|
| Maximum P Load Lake Carlinville to Maintain Water Qual. Std. | 191.3 | 0.211 | 421.7 |
| 10% Margin of Safety | -19.13 | -0.021 | -42.2 |
| Total Phosphorus Load Allocation | 172.17 | 0.190 | 379.5 |

Illinois EPA, 2007

The TMDL target for manganese is set as a total phosphorus concentration of 0.05 mg/L (Illinois EPA, 2006). The objective is to maintain hypolimnetic dissolved oxygen concentrations above zero, because the only way to control manganese is limiting the release of manganese from lake sediments during periods when there is no dissolved oxygen in lake bottom waters (i.e., summer stratification period). The lack of oxygen in lake bottom sediments is presumed to be due to sediment oxygen demand resulting from the effects of nutrient enrichment, as there are no point source discharges to the lake. For this reason, attainment of the total phosphorus standard is expected to result in oxygen concentrations that will reduce sediment manganese influx to natural background levels.

While TMDLs have only been developed for pollutants that have numerical water quality standards, measures implemented to control TMDLs for these pollutants will likely reduce other pollutants as well. For example, controls that reduce phosphorus loads in the Lake Carlinville watershed (i.e., runoff or stream bank erosion) would also reduce sediment loads (i.e., total suspended solids) delivered to the lake, as phosphorus BMPs are similar to sediment BMPs.

## I. PUBLIC OUTREACH

Periodic public meetings were held during the process of developing the Lake Carlinville Watershed Plan. All meetings were open to the public and held at Carlinville City Hall. The public and local officials were notified via public mailings, local newspaper announcements, and through the project website. HDR│CWI obtained contact information from the City and the SWCD. Information for all of the landowners within the Lake Carlinville watershed was obtained from the Macoupin County Recorder's Office. Each public meeting consisted of a presentation followed by a question and answer session. Public meeting discussion topics included an overview of lake and watershed concepts, description of lake and watershed impairments, brief explanations of best management practices to address impairment issues, the need for local community involvement, and implementation strategies. A reporter from the Enquirer-Democrat, a local newspaper in Carlinville, attended many of the public meetings. The local newspaper published several articles that summarized the public meetings. Appendix E includes copies of public mailings, meeting presentations, lists of public meeting attendees, and copies of articles published in the Enquirer-Democrat.

Periodic public meetings and project mailings, a project website, and local newspaper coverage served as the informational and educational components during the Phase 1 Study period. In addition, HDR│CWI attended a city council meeting and a lake commission meeting to discuss project goals with the City. While interest in joining a local stakeholder committee was limited, HDR│CWI was able to interact with several landowners on a personal level by surveying their land to observe land practices and provide alternatives to current practices.

## J. OPERATION AND MAINTENANCE

The City of Carlinville will be responsible for the operation and maintenance of all recommended actions and projects within the Lake Carlinville watershed. Recommended watershed management practices will be coordinated by the City of Carlinville with the Macoupin SWCD and NRCS. Implemented management practices will be inspected annually to ensure continued effectiveness. Fisheries management activities will be continued by the Illinois DNR fisheries biologist every third year.

## K. PERMIT REQUIREMENTS

Sediment removal from Lake Carlinville will require a Joint Application Permit from the U.S. Army Corps of Engineers (COE), the Illinois EPA and the 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. With an upland retention and dewatering site being required for placement of the dredged sediment, a Phase 1 Archeological Survey will be required and submitted to the Illinois Historic Preservation Agency to ensure that no significant cultural resources are present. A dam construction and operating permit may also be required from the IDNR, Office of Water Resources for the sediment storage and dewatering impoundment.

Structural shoreline stabilization work will also require a Joint Application Permit from the U.S. Army COE and can be included as part of the 404 Permit required for sediment removal. Coordination and consultation with the IDNR, Illinois EPA, NRCS, 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 either a 319-grant and/or a Phase 2 Implementation Project is granted.

## L. ENVIRONMENTAL EVALUATION

### Will the project displace people?

None of the recommended actions and projects in the Lake Carlinville watershed plan is expected to displace any people from residences or places of business.

**Will the project deface existing residences or residential areas?**

None of the recommended actions and projects in the Lake Carlinville watershed plan is expected to adversely impact existing residence or residential areas. Most watershed management practices and all in-lake activities will be completed within the City of Carlinville boundaries or on agricultural areas owned by private landowners. No watershed land treatment practices are expected to impact residential areas.

**Will the project likely lead to changes in established land use patterns or an increase in development pressure?**

The implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan is not expected to change the established land use patterns or increase development pressure.

**Will the project affect prime agricultural land or activities?**

The implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan are not expected to affect prime agricultural land or activities in a negative way. Recommended watershed management practices are intended to help maintain soil fertility, reduce erosion and minimize subsequent sediment and nutrient delivery from agricultural lands.

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

The implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan are not expected to adversely affect parkland, public land, or scenic lands.

**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 1 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 to occur from any of the through the implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan.

Sediment removal via hydraulic dredging may require a polymer or flocking agent to treat and reduce the effluent discharge suspended solids concentrations in order to meet the Illinois EPA effluent water quality standards. The polymer to be used is food grade and therefore no short-term or long-term adverse impacts are expected.

The application of a rotenone (a piscicide) is suggested to eradicate the existing Lake Carlinville fish population. IDNR has stated that the recommended rotenone dosage should naturally attenuate within one to two weeks. To avoid and potential short-term impacts, water from Lake Carlinville II should be used as a temporary public water supply.

**Will the project involve modification or construction in floodplain areas?**

A review of the Federal Emergency Management Agency (FEMA) Flood Hazard Boundary Map for Community-Panel Number 1709300006A (effective January 6, 1978) suggests that none of Lake Carlinville watershed is not located within a special flood hazard area. Therefore, it is anticipated that the implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan will not involve any modifications or construction within floodplain areas.

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

No long-term adverse impacts are expected from the implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan. The implementation of watershed various management practices, lake shoreline stabilization, lake sediment removal, and a in-lake sediment and nutrient control basin may have relatively short-term impacts (i.e., through construction) such as higher localized turbidity, restricted access in certain areas, 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 are expected to occur through the implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan.

**Will the project adversely impact threatened or endangered species?**

No threatened or endangered plants or wildlife species are expected to be impacted through the implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan.

**Will the project affect currently identified water quality pollutants?**

Water quality pollutants should be reduced through implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan. Specific results will depend on the action.

**Will the project affect short-term and long-term water quality conditions throughout the Lake Carlinville watershed?**

Water quality conditions should be improved through implementation and completion of the recommended actions and projects in the Lake Carlinville watershed plan. Specific results will depend on the action.

**Will the project affect social attitudes on the importance of clean water in the Lake Carlinville watershed?**

Social attitudes on the importance of clean water in the Lake Carlinville watershed should be affected in a positive way, especially as a direct result of implementing Action Item E.