MALCOLM PIRNIE

LAKE LEMON WATERSHED MANAGEMENT PLAN

LAKE LEMON CONSERVANCY DISTRICT

JANUARY 2002

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Lake Lemon Conservancy District

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We, the members of the Lake Lemon Conservancy District Board of Directors, on the 16th day of January 2002, do hereby approve and agree to pursue recommendations for implementation of this Lake Lemon Watershed Management Plan prepared by the Lake Lemon Watershed Planning Committee.

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MARTY MANN, VICE-CHAIR.

DENNIS FRIESEL, TREASURER

FRANK FLESER, DIST. I_

LARRY RITTER, DIST. II

BILL WINKLE, DIST. IV

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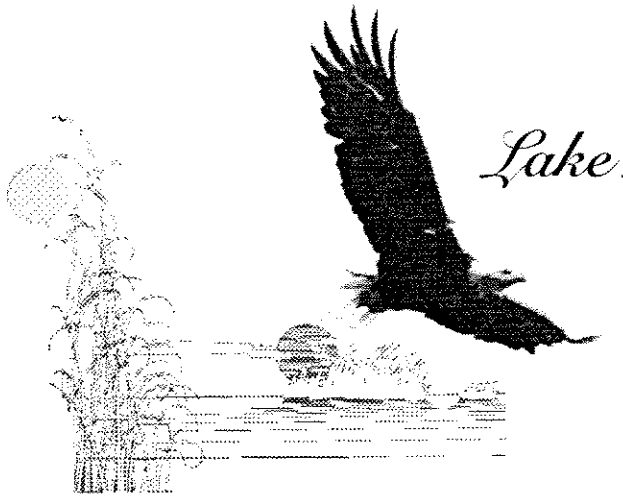

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ACKNOWLEDGEMENTS

Development of the Lake Lemon Watershed Management Plan was accomplished because of the commitment and cooperation of many watershed stakeholders. Numerous individuals and organizations provided assistance during the development of this report.

Special recognition is warranted however, for the following:

- Indiana Department of Environmental Management provided funding for the development of the Lake Lemon Watershed Management Plan from the Clean Water Act, Section 104(b)(3) Grant # CP975064-01;

- Paul Amico – who provided leadership during the initial phases of this project; and

- Ethel Wilkerson – who provided expert knowledge of the watershed characteristics and facilitated project resources among multiple partners.

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LIST OF ACRONYMS

AGNPS ..... Agricultural Non-Point Source Model

AMSL ..... Above Mean Sea Level

BMP ..... Best Management Practice

CBU ..... City of Bloomington Utilities

CWA ..... Clean Water Act

FEMA ..... Federal Emergency Management Agency

GIS ..... Geographic Information System

HUC ..... Hydrologic Unit Code

IU ..... Indiana University

IDEM ..... Indiana Department of Environmental Management

IDNR ..... Indiana Department of Natural Resources

K ..... Soil Erodibility Factor

LARE ..... Lake and River Enhancement Program

LLCD ..... Lake Lemon Conservancy District

LLWPC ..... Lake Lemon Watershed Planning Committee

NRCS ..... Natural Resources Conservation Service

NGT ..... Nominal Group Technique

LIST OF ACRONYMS (CONTINUED)

RC&D ..... Resource Conservation and Development

SPEA ..... School of Public and Environmental Affairs

SRP ..... Soluble Reactive Phosphorous

SWCD ..... Soil and Water Conservation District

TP ..... Total Phosphorous

TSI ..... Trophic State Index

USDA ..... US Department of Agriculture

US EPA ..... US Environmental Protection Agency

USGS ..... US Geological Survey

WMP ..... Watershed Management Plan

EXECUTIVE SUMMARY

The Lake Lemon Watershed Management Plan (WMP) was developed to address water quality concerns, specifically excessive sedimentation in the eastern region of Lake Lemon. This report outlines a plan for action to restore and protect water resources of the Lake Lemon watershed. Objectives of the management plan are to enhance stakeholder knowledge, identify and prioritize issues of concern, develop a consensus for action, and enable both public and private stakeholders to be eligible for restoration program funding. The watershed management approach will yield cost-effective and long-term solutions that reduce non-point sources of pollution in the Lake Lemon watershed.

Lake Lemon is situated in portions of Monroe and Brown Counties near Unionville, Indiana. The reservoir was constructed in 1956 to provide the City of Bloomington its primary source of drinking water. Today, Lake Lemon is used for recreation and as an alternative drinking water supply for the City of Bloomington. The reservoir's watershed encompasses 71 square miles, with 51% forested and only 6% cultivated for agriculture. Steep slopes and highly erodible silt loam soils that are found in the Beanblossom Creek corridor contribute to persistent sedimentation in Lake Lemon.

The Lake Lemon Watershed Planning Committee (LLWPC) was organized in 1999 to oversee the development of the watershed management plan. Both public and private stakeholders participated in the planning process. Citizens identified and prioritized six critical water quality issues of concern.

These publicly identified and prioritized issues of concern include:

- Reservoir sedimentation;
- Over abundant aquatic vegetation;
- Failing septic systems;
- Streambank erosion;

- Bacterial contamination; and
- Flooding.

The watershed restoration plan with specific recommendations for immediate action include:

- Convene Watershed Steering Committee – no direct costs;
- Obtain necessary permits for the Lake Lemon east end sedimentation/ restoration project – estimated project construction costs are $2.2 million;
- Submit an application to the Indiana Department of Environmental Management for Clean Water Act Section 319 grant for a streambank stabilization and demonstration project – estimated demonstration project costs are $250,000; and
- Submit an application to the Federal Emergency Management Agency for a Hazard Mitigation Grant Program for a flood impact and mitigation study – estimated project costs are $250,000.

1.0 INTRODUCTION

1.1 OBJECTIVES

The Lake Lemon Watershed Management Plan (WMP) was developed to address water quality concerns affecting the conditions and use of Lake Lemon and its watershed. The Lake Lemon Watershed Planning Committee (LLWPC) was organized to facilitate technical review and public participation during the development of the WMP.

Objectives of the Lake Lemon WMP include:

- Summarize key watershed physical features, conditions and land use activities;
- Identify and prioritize watershed issues of concern;
- Recommend potential solutions with estimated costs;
- Develop a watershed restoration plan of action; and
- Enable watershed stakeholders, both public and private, to become eligible for state and federal conservation and restoration program funding.

1.2 BACKGROUND

Lake Lemon was constructed in 1956 for use as the primary drinking water supply source for the City of Bloomington, Indiana. The Lake Lemon watershed is located in Central Indiana and is the area upstream from the reservoir that drains about 71 square miles of mostly forested land cover (Figure 1). Today, the reservoir is also used for wildlife habitat, boating, fishing, recreation, and as Bloomington's alternate drinking water supply source. In the late 1970's, the reservoir's water quality became noticeably degraded from sedimentation, poor water clarity, and the widespread infestation of Eurasian water milfoil (*Myriophyllum spicatum*).

In 1995, local residents organized and formed the Lake Lemon Conservancy District (LLCD) to restore the safety, welfare and recreational value of the reservoir. LLCD desires to restore navigation, recreation, aesthetics and water quality by restoring sediment laden portions of the reservoir's eastern region end and several coves. LLCD recognizes that dredging the sediment only corrects the symptom, but does not protect the reservoir from further sedimentation. LLCD, City of Bloomington Utilities (CBU), and the Indiana Department of Environmental Management (IDEM) collaborated to develop a watershed management plan that outlines a complementary plan of action to restore, protect and prevent further soil erosion in the Lake Lemon watershed.

1.3 PROJECT SCOPE

Primary tasks to develop the Lake Lemon Watershed Management Plan include the following:

- Task 1 – Organize watershed planning team;
- Task 2 – Conduct public awareness campaign;
- Task 3 – Conduct watershed characterization;
- Task 4 – Identify and prioritize issues of concern;
- Task 5 – Identify possible solutions and associated costs; and
- Task 6 – Select Solutions Through Consensus.

2.0 WATERSHED CHARACTERIZATION

2.1 BRIEF HISTORY

Early settlers in the 19th Century tried to cultivate and farm the steeply sloping and highly erodible rocky soils of the Upper White River watershed. Unlike the gently rolling and more productive soils of the Lower White River drainage basin, the steep slopes in the upper watershed were abandoned for agricultural purposes. The watershed's agriculturally productive soils are mostly found along the gently sloping terrain directly adjacent to Beanblossom Creek and tributaries. Most agricultural land is used for hay or small grain with a limited amount of row crop production. Beginning in 1929, much of the steeply sloping and eroding abandoned land was purchased by the state of Indiana. Since then, about 5,000 acres of the most severely degraded landscape was reclaimed, reforested and resulted in the formation of Yellowwood and Morgan-Monroe State Forests (IDEM, 2001).

2.2 LAKE LEMON

Lake Lemon is a 1,650-acre reservoir situated in portions of Monroe and Brown counties near Unionville, Indiana (Figure 2). The reservoir is oriented length-wise east to west and segmented in three regions by Riddle and Reed Point peninsulas. The reservoir's 14.9 miles of shoreline encompass an average 4.5 billion gallons of water. Lake Lemon is relatively shallow with an average depth of 9.7 feet and maximum depth of 28 feet near the dam. A dam and spillway are located at the reservoir's western end at an elevation of 630 feet above mean sea level (Zogorski et al., 1986).

Excessive Eurasian water milfoil (*Myriophyllum spicatum*) impacted as much as 75% of the reservoir's surface area especially in shallow areas less than ten feet deep. About 100 surface acres of the reservoir's eastern region is filled in with sediment from

Beanblossom Creek (Appendix A; Photo 1). Lake Lemon's water quality is degraded by dense aquatic vegetation, seasonally elevated levels of phosphorous, suspended sediments, and isolated areas of elevated fecal coliform bacteria concentrations (Jones, 1992; Jones and Clark, 200; and Hoffman, 2000). The reservoir's water quality impairs recreational uses, aesthetics, safety and water quality standards as a potential drinking water supply source for the City of Bloomington (Jones, 1992).

2.3 LAKE LEMON WATERSHED

The Lake Lemon watershed is located near Central Indiana (Figure 1). The watershed encompasses about 71 square miles in portions of Monroe and Brown Counties, with less than 1% or only 0.2 square miles in Johnson County. The majority of the land area is located in Brown County with 62.5 square miles (87.9%) in the watershed. Only 8.4 square miles (11.8%) of the drainage basin is located in Monroe County (Table 1).

The Lake Lemon watershed is classified as an 11-digit hydrologic unit code (HUC) and numbered 05120202-010[1]. The Lake Lemon watershed is comprised of four separate smaller sub-watersheds (14-digit HUC). These sub-watersheds range from 13 square mile for the North Bear Fork Beanblossom Creek to as much as 21.4 square miles for lower Beanblossom Creek – Lick/ Bear Creek sub-watershed. Both the Beanblossom Creek Headwaters and Lake Lemon sub-watersheds are about the same area of 18.4 square miles (Table 1).

[1] Hydrologic Unit Code (HUC) is a hierarchical hydrologic classification system developed by the US Geological Survey, Water Resources Council. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to fourteen digits based on the levels of classification in the hydrologic unit system (Seaber et al., 1987). Small drainage basins have larger HUC classification codes and larger watersheds have smaller HUC codes. For example, the Ohio River basin is a regional two-digit HUC (05) and the Lake Lemon Watershed is a 11-digit HUC.

2.3.1 Beanblossom Creek

Beanblossom Creek originates near the town of Spearsville, Indiana in Brown County. The stream flows southerly to the confluence with East Fork Creek, north of State Road 45. At this junction, Beanblossom Creek flows westerly through the towns of Beanblossom, Helmsburg and Trevlac before discharging into Lake Lemon. Beanblossom continues at the outflow of the Lake Lemon spillway located on the northwest end of the reservoir where it flows north and discharges into Honey Creek (IDEM, 2001).

2.3.2 Ecoregion

The Lake Lemon watershed is situated within the Norman Upland ecoregion. This ecoregion is characterized by unglaciated, deeply dissected hills with narrow valleys, and medium to high stream gradients. Native vegetation was Oak-Hickory forest on uplands, and Beech forest in the valleys. The current land use is typically forested with Oak, Virginia pine, and Beech-Maple (IDEM, 2001).

2.3.3 Climate

The climate of Central Indiana is characterized as humid continental with temperatures fluctuating between seasons. Average annual precipitation is approximately 42 inches with an annual average of 12 to 14 inches of runoff. Annual average snowfall is 14 inches. Temperatures range between and average low of 19° F to 38° F in January to an average high of 64° F to 87° F in July (IDEM, 2001).

2.3.4 Topography

The Lake Lemon watershed is typified as hilly and rugged with steep slopes that drain into V-shaped ravines or narrow valleys with relatively flat bottoms (Zogorski, 1986). Lake Lemon watershed elevations range from approximately 600 feet above mean sea level (AMSL) near the reservoir's dam, to as high as 1,050 feet

AMSL on the extreme southeastern rim of the watershed at the headwaters of East Fork Beanblossom Creek (Figure 3).

Slopes in the watershed range from relatively flat (less than 5%) along lower Beanblossom Creek, to slopes greater than 20% along the northern periphery of the watershed. Slopes between 5-10% are most prevalent throughout the watershed (Table 2). Some of the steeper slopes are found directly around Lake Lemon (Figure 4). The highest percent,2.2%, of slopes steeper than 20% are found in the Lower Beanblossom Creek – Lick/Bear Creeks sub-watershed (Table 2).

2.3.5 Soils

There are four major soil associations in the Lake Lemon watershed (Figure 5):

- Berks-Wellston-Trevlac;
- Stendal-Haymond-Steff;
- Pekin-Chetwynd-Bartle; and
- Hickory-Cincinnati-Rossmoyne associations.

A common characteristic among all the soils of the watershed is their relatively high soil erodibility. The soil erodibility factor, *K*, provides an indication of the inherent erodibility of the soil. Soil erodibility is directly related to a soil's infiltration capacity and structural stability. Soils with *K* factors exceeding 0.3 are classified as being more easily eroded with low infiltration rates (Brady, 1990). All generalized soil associations in the Lake Lemon watershed have soil erodibility ratings greater than 0.37.

The Berks-Wellston-Trevlac soils association represents about 49.6% (35.3 mi^2), of the Lake Lemon watershed (Table 3). The distribution of these soils is varied and can be found along the watershed's southern border and larger portions in the northwest region. A small section (6.9mi^2) is located in the extreme eastern portion of

the Beanblossom – Headwaters sub-watershed (Figure 5). Berks-Wellston-Trevlac soils are moderate to steeply sloping, well-drained soils. They are formed from wind deposited and weathered material and originate from shale, siltstone, and sandstone material. The average erodibility value for this association is 0.3, and ranges between 0.17 for Berks soils to 0.37 for Wellston and Trevlac soils (USDA, 1990).

The Stendal-Haymond-Steff soil association covers only 4.3mi^2 (6.0%) of the Lake Lemon watershed (Table 3). However, these highly erodible soils are situated along the low-lying flood plain corridor of Beanblossom Creek (Figure 5). The Stendal soil series is deep, somewhat poorly drained, moderately permeable soil found on flood plains. These soils were formed in silty alluvial deposits on slopes less than 2% (USDA, 1990). The Stendal soil association has an average *K* of 0.38. Therefore, the lower Beanblossom Creek stream channel is situated in soils highly susceptible to erosion.

2.3.6 Land Cover

The Lake Lemon watershed is mostly forested, especially in the southern and western regions (Figure 6). Forests represent about 71.7% (51.0mi^2) of the watershed area (Table 4). Forested land is distantly followed by agricultural land use where pasture and row cropland combined represents only 23.2% of the watershed (16.5 mi^2). Brown County ranks 91 out of 92 Indiana Counties for corn and soybean production, and ranks 78th in hay production (USDA, 1997; and IDEM, 2001). Pasture and hay production are more common than row crop agricultural where both are typically cultivated in the flat narrow flood plain valleys (Figure 6). Livestock production in Brown County ranks last of all 92 Indiana Counties (USDA, 1997; and IDEM, 2001).

2.3.7 Land Ownership

More than 90% (64.2 mi^2) of the Lake Lemon watershed is privately owned (Table 5). Most of the publicly owned land is located on forested land toward the

western region of the watershed (Figure 7). Morgan-Monroe and Yellowwood State Forests comprise about 4,399.6 acres, only 9.7%, of the watershed. The Lick /Bear Creeks sub-watershed has the highest percentage of state forest property (32.7%). Yellowwood State Forest represents the majority of parkland at 3,764.8 acres (85.6%) of all State of Indiana owned property in the watershed (Table 5).

2.3.8 State Forests

Yellowwood State Forest is named for a tree common in the middle-south region of the continental United States but rare in the northern latitude of Indiana. The yellowwood tree (*Cladrastic kentukea*) has bright yellow heartwood that is hard and dense. The tree flowers abundantly but only every three to five years in the spring. Less than 200 acres in the forest support the yellowwood tree on north facing slopes and deep ravines near the Crooked Creek Lake. The forest was created in 1940 by the federal government which deeded the land to Indiana in 1956. During this period of time, over 2,000 abandoned and eroded acres were planted to pine, black locust, black walnut, white and red oak (IDEM, 2001).

Morgan-Monroe State Forest was established in 1929 and lies in the northeast corner of Monroe County (Figure 7). Primitive camping, hiking, fishing, horse trails and hunting are permitted in both parks. Panning for gold is also permitted but the use of a pick, shovel or sluice is not allowed because of the concern for the impact to water quality (IDEM, 2001).

2.3.9 Population

About 14,100 people lived in Brown County in 1990 and only an additional 800 people moved into the county between 1990 and 2000. Brown County population is expected to grow marginally 2.12% to 14,400 by 2020. Monroe County however, is projected to increase 20.3% from 118,900 people in 2000 to an estimated 131,100 people by 2020 (IDEM, 2001).

2.3.10 Wastewater Treatment Plants

Four sewage treatment plants are located throughout the Lake Lemon watershed (Figure 8). These plants treat and seasonally discharge a cumulative average flow of 0.04 million gallons per day (mgd), or approximately 40,000 gallons per day (gpd) (Table 6). The small seasonal discharges from these systems suggest their impacts are negligible on receiving streams (Jones, 1992).

3.0 LAKE LEMON CONSERVANCY DISTRICT

3.1 CONSERVANCY DISTRICT FORMATION

During the early 1990's, residents and property owners living near Lake Lemon became concerned that the City of Bloomington Utilities (CBU) would abandon, close or even drain the reservoir. Residents were concerned for the health, safety and welfare of those who use and benefit from the recreational value of the reservoir (LLCD, 1996). In 1995, the Circuit Court of Monroe County (Cause Number 53C05-9410-CP-01187) in accordance with the Indiana Conservancy Act IC 14-33 officially formed the Lake Lemon Conservancy District (LLCD).

The purpose of the Lake Lemon Conservancy District is to:

> *"...include operating, maintaining and improving water-based recreational opportunities provided by Lake Lemon and developing recreation facilities where feasible in connection with beneficial water management all of which will benefit and be conducive to the health, safety and welfare of the property owners surrounding Lake Lemon and the general public" (LLCD, 1996).*

The City of Bloomington Utilities retains ownership of Lake Lemon and leases it to the Conservancy District with the stipulation that the District manage the reservoir consistently with its designated potential use as an alternate drinking water supply source for the City of Bloomington (Jones, 1992).

3.2 WATER QUALITY PROJECTS

Since 1996, LLCD and CBU have effectively teamed to help restore, enhance and protect the quality of water in Lake Lemon. This partnership has completed an impressive series of projects that include:

- Fish management survey;
- Annual water quality monitoring program with Indiana University;
- Volunteer lake monitoring program;
- Shoreline stabilization projects;
- An aquatic plant management plan;
- Exotic invasive aquatic plant control;
- Nuisance wildlife management plan;
- East End Design Study; and
- Public education and outreach.

3.2.1 Fish Management Survey

A fish management survey collected and analyzed twenty-seven different fish species (Aquatic Control, Inc., 2001). Results of the survey indicate that yellow bass (28%), blue gill (25%), gizzard shad (14%), white crappie (8%), and largemouth bass (6%) were the most common fish species in the reservoir. The study concluded that the majority of fish populations were balanced and show good levels of reproduction.

Fish management recommendations include:

- Encourage maximum harvest of blue gill and yellow bass species;
- Continue control of Eurasian milfoil;
- Maintain a 14-inch minimum length limit on largemouth bass;
- Reduce the tournament pressure on the fishery;
- Request anglers to complete a creel census form; and
- Continue the development of the watershed management plan to decrease turbidity of the water column.

3.2.2 Water Quality Monitoring

Since 1997, LLCD has contracted with the Indiana University School of Public and Environmental Affairs (SPEA) to monitor and evaluate water quality condition in Lake Lemon. The program monitors the reservoir semi-annually for twelve water quality parameters and determines the lake's Trophic State Index (TSI)[2]. The LLCD provides funds for this program to obtain quality data. Long-term water quality data can be analyzed and provide a better understanding of changes in water quality.

3.2.3 Volunteer Lake Monitoring Program

LLCD participates in the Indiana Clean Lakes Program, Volunteer Lake Monitoring Program. This program utilizes Secchi Disk depth measurements to monitor the reservoir's water transparency. Secchi Disks provide an inexpensive method of measuring water transparency, which is directly affected by the amount of suspended sediments and algae in the water. Transparency data collected biweekly during the summer months is compiled and used to record water quality trends within Lake Lemon.

3.2.4 Shoreline Stabilization

A shoreline stabilization study identified nine sites around Lake Lemon totaling 2,829 linear feet of eroding shoreline requiring immediate restoration (Commonwealth Biomonitoring, Inc., 1997). The study identified one parcel of privately owned property where 444 linear feet of "extreme" shoreline erosion occurred. The property owner has since then, stabilized the shoreline and paid for the restoration costs. The remaining eight sites and 2,385 shoreline feet are owned by the City of Bloomington. In 1997, LLCD and CBU initiated a shoreline stabilization restoration program and have received more than $300,000 for shoreline stabilization

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[2] TSI is a numerical index representing a lake's productivity status. Higher TSI scores indicate elevated biomass production typically because of higher nutrients in the lake (Jones, 1992).

from the Indiana Department of Natural Resource's (IDNR) Lake and River Enhancement Program (LARE)[3]. The stabilization of all 2,829 feet of shoreline and an additional 950 feet will be completed by 2002.

3.2.5 Aquatic Plant Management Plan

LLCD facilitated the development of a comprehensive aquatic plant management plan completed in 2000 for the restoration, control and management of abundant nuisance aquatic plants. The goal of the Aquatic Plant Management Plan is to, "...better understand plant management and to blend plant management goals with the recreational and ecological needs of the Lake Lemon community" (Hoffman, 2000). The management plan recommended LLCD use annual chemical control methods to manage nuisance and invasive aquatic vegetation.

3.2.6 Exotic Invasive Aquatic Plant Control

Based on recommendations of early reservoir diagnostic studies, LLCD funds and maintains an annual program that treats dense aquatic vegetation with herbicides. LLCD spends about $30,000 annually for chemical treatment to help control invasive Eurasian water milfoil, spatterdock and American lotus. In 2000, LLCD received a cost-share grant from IDNR's LARE program to control the growth of Eurasian water milfoil.

3.2.7 Nuisance Wildlife Management Plan

LLCD initiated development of a nuisance wildlife management plan for the control of beaver, muskrat, Canada geese, and zebra mussels. Objectives of the plan were to develop nuisance wildlife management protocols and protect the lake from exotic species' infestations (Wilkerson, 2002).

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[3] LARE is a statewide conservation program offered by the Indiana Department of Natural Resources, Division of Soil Conservation. The Division provides technical and financial assistance to reduce non-point source pollution from entering the state's surface waters.

Recommendations for wildlife management include:

- Monitoring the presence of nuisance populations;
- Control of goose populations via annual egg treatments; and
- Increase nuisance and exotic wildlife management education for reservoir residents and users.

3.2.8 Reservoir Sedimentation/ Restoration Design Study

Based on recommendations of previous reservoir diagnostic studies, LLCD initiated steps to secure state funding for a reservoir sedimentation/restoration preliminary design study (Zogorski et al., 1986; and Jones, 1992). In 1999, LLCD and CBU applied and received a federal Clean Water Act (CWA) Section 104(b)(3) grant from the Indiana Department of Environmental Management (IDEM) for a sedimentation/ restoration preliminary design study.

Goals of the study include:

- Address existing sedimentation at the east end of the reservoir and propose a method to deal with future sedimentation;
- Improve water quality in the reservoir by relocating existing sediments;
- Restore fish and wildlife habitat; and
- Address navigational concerns by improving the current channel and reopening the original channel (Schneider, 2001).

A series of meetings between Schnieder Corporation, LLCD, IDNR and IDEM were held to review the engineering analyses findings and examine potential solutions. All restoration options were designed with a capacity to retain about 8 to 10 years of sediment at deposition rates of 8,000 to 10,000 cubic yards per year. The recommended reservoir restoration solution recommended is the creation of elevated islands with suitable interior wetlands using a fiberglass piling containment system.

This system is currently used for shoreline stabilization around the reservoir (Schneider, 2001).

3.2.9 Watershed Management Plan

As part of the reservoir sedimentation/restoration preliminary design study, the LLCD also received federal CWA Section 104(b)(3) funding from IDEM to develop a watershed management plan. The purpose of the plan is to better understand causes and sources of sedimentation and identify solutions that restore eroded areas and prevent further erosion. As part of the watershed management planning process, the LLCD and CBU initiated and facilitated the development of the Lake Lemon Watershed Planning Committee (LLWPC). This committee is the organization for watershed stakeholders to participate in the characterization, issues identification, and long-term management of the Lake Lemon watershed.

3.3 EDUCATION AND OUTREACH PROGRAMS

The LLCD participates in variety of education and outreach programs. These programs enable the District to continually provide new information to the community about issues affecting the reservoir and techniques individual citizens can do to help protect Lake Lemon.

3.3.1 Boy Scouts of America

Members of the LLCD staff serve as advisors for Eagle Scout Projects for a Boy Scout Troop that meets regularly on Lake Lemon at the Boys and Girls Club of Bloomington adjacent to Riddle Point Park. LLCD encourages projects that help improve the ecological condition of the lake and the surrounding area. Completed Eagle Scout projects include the stabilization of eroding shoreline around Riddle Point

Park and construction of wood duck nesting boxes that were placed on City of Bloomington property around the reservoir.

3.3.2 Guest Lecturers

LLCD staff conducts guest-lecture presentations for courses at the Indiana University, School of Public and Environmental Affairs. Topics included exotic aquatic plant management, reservoir sedimentation, recreation conflicts, watershed management, and water quality issues affecting Lake Lemon.

3.3.3 Waterfowl Observation Platform

In 1999, the Sassafras Audubon Society partnered with LLCD to build a waterfowl observation platform in the Little Africa Nature Preserve overlooking Lake Lemon. Native grass and sedge species were planted to provide food and habitat for wildlife. LLCD provided the construction material and the Sassafras Audubon Society provided labor to build the observation platform.

3.3.4 Quarterly Newsletters

Lake Lemon Conservancy District publishes and distributes about 500 copies of the Lake Lemon Newsletter to freeholders of the LLCD. The newsletter is published quarterly to inform and educate residents of surrounding Lake Lemon about important issues such as upcoming activities, exotic aquatic species management and best management practices for living near the reservoir.

4.0 LAKE LEMON WATERSHED PLANNING COMMITTEE

4.1 WATERSHED PARTNERSHIP

The Lake Lemon Watershed Planning Committee (LLWPC) was formed in May 2000 to provide direction, assistance, resources, technical review and, most importantly, local knowledge through public participation. Quarterly meetings of the LLWPC were organized to coordinate local resources, technical review and public awareness and participation. Meeting minutes were recorded and are provided in this plan (Appendix C).

4.1.1 Representatives

The LLWPC consists of representatives from local, state and federal agencies, universities and citizens. There were eighteen watershed stakeholder representatives who participated at quarterly meetings at various stages during the development of the watershed management plan (Table 7).

4.1.2 Vision

Lake Lemon is a safe, recreational reservoir capable of meeting drinking water quality needs.

4.1.3 Mission

The mission of the Lake Lemon Watershed Planning Committee is to facilitate development of a watershed management plan and implement recommended water quality restoration and protection measures through effective public and private collaboration.

4.1.4 Objectives

Objectives of the planning committee include:

- Identify of the issues of concern;
- Prioritize of the issues of concern;
- Identify of technically feasible solutions;
- Select applicable solutions for the issues of concern; and
- Provide technical review of the watershed management planning document.

4.1.5 Public Outreach

A fundamental element of a successfully developed and implemented watershed management plan is the participation of the watershed citizenry. Prior to each meeting, the LLWPC advertised planning meeting locations and schedules through local newspapers and the LLCD newsletter. In addition, the LLWPC presented the key findings and issues of concern with the watershed stakeholders at the Brown County public library on August 1, 2001 (Appendix D).

5.0 ISSUES IDENTIFICATION AND PRIORTIZATION

5.1 OVERVIEW

The process of identifying and prioritizing issues of concern for the Lake Lemon watershed involved a review of existing environmental data and reports; input from the Lake Lemon Watershed Planning Committee (LLWPC); and public participation. Existing environmental geo-spatial data was compiled and modeled in a geographic information system (GIS). Results were used to characterize, identify and map critical features of Lake Lemon's watershed. A technical review and analysis of existing studies was summarized and presented to the LLWPC. The LLWPC facilitated watershed tours to investigate and better understand critical areas of concern identified during the technical review. Finally, the watershed public participated in the identification and prioritization of issues of concern. Results of this process were used to document the public's prioritized issues of concern, evaluate potential solutions and develop an implementation plan.

5.2 IDENTIFICATION OF ISSUES OF CONCERN

An interactive presentation that summarized Lake Lemon's watershed features and previously documented issues of concern was delivered to interested stakeholders at the Brown County public library on August 1, 2001 (Appendix D). Following the presentation, representatives of the Hoosier Heartland Resource Conservation & Development (RC&D) used the Nominal Group Technique (NGT)[4] to identify and later prioritize the watershed community's issues of concern (Appendix E).

[4] NGT allows a group to quickly come to consensus on the relative importance of issues, problems, or solutions by completing individual importance rankings into a group's final priorities.

Participating Lake Lemon watershed citizens identified a total of 24 issues of concern, recommendations, and potential solutions that ranged from *"reservoir sedimentation"* to *"shoreline erosion funding for private landowners"* and *"dredging Possum Trot Creek"* (Table 8). However, the public later prioritized only eight of the twenty-four as critical water quality issues of concern. Three issues of the originally identified 24 issues were not prioritized and the remaining thirteen (13) issues were recommended as potential solution (Table 9).

5.3 PRIORITIZED ISSUES OF CONCERN

Lake Lemon watershed citizens prioritized only eight of the initial twenty-four issues of concern. Among the eight prioritized concerns, issues five *"alternative methods of treating aquatic plants"* and number eight *"drastic erosion and sedimentation on North Shore Drive and Ice Box Cove"* were aggregated into similarly prioritized issues of concern such as the *"over abundant aquatic vegetation"*, *"streambank erosion"* and *"sedimentation"*.

The watershed citizens identified and prioritized the following critical issues of concern and are:

- Reservoir sedimentation;
- Overabundant aquatic vegetation;
- Failing septic systems;
- Streambank erosion;
- Bacterial contamination; and
- Flooding.

5.3.1 Reservoir Sedimentation

Results of the public meeting ranked sedimentation of Lake Lemon as the leading issue affecting water quality (Table 9). Since construction of Lake Lemon, as much as 520,000 cubic yards of sediment have accumulated in the reservoir's eastern region (Appendix A: Photo 1). Based on the current 50-year life of Lake Lemon, the sedimentation rate is 8,000 to 10,000 cubic yards per year (Schneider, 2001). Lake Lemon's overall capacity loss rate is 0.17 percent per year; however the capacity loss rate from sedimentation in the eastern region is ten times higher at 1.7 percent per year. This volume loss significantly reduces the reservoirs nominal life rate from 400 years to 80 years. Earlier studies suggest that sedimentation rate in the eastern region of the lake is "great enough to be of concern and requires management" (Zogorski et al., 1986). Causes of excessive sedimentation to the reservoir are derived from agricultural, forestry, construction, streambank and shoreline erosion. Shoreline erosion around Lake Lemon causes significant property damage and contributes to the sedimentation of the reservoir (Appendix A: Photos 4 and 5).

In 1992, the Agricultural Nonpoint Source Model (AGNPS) was used to identify critical erosion areas of concern in the watershed (Jones, 1992). Model results indicate that agricultural land in the upper reaches is a significant source of soil erosion compared to other land uses. The largest relative areal sediment yields were highest in the North Fork Beanblossom Creek sub-watershed above Big Thunder Creek (0.071 tons/ acre) and Hoppers Branch Creek sub-watershed (0.076 tons/ acre). Agricultural land use is more common in both sub-watersheds especially along the stream corridors. AGNPS model results estimated 0.68-tons/acre/ year were derived from soil erosion within the watershed and deposited into the reservoir (Hartke and Hill, 1974). However, the erosion delivery rate is substantially low when compared to a statewide mean annual soil loss rate of 11.3 tons/acre/ year (Wischmeier, 1976). Additional significant sources of sediment were noted, but not quantified, along the mainstem of the Beanblossom Creek streambank corridor (Jones, 1992) Details for streambank erosion assessment are described in Section 5.2.4.

5.3.2 Over Abundant Aquatic Vegetation

The overabundant growth of aquatic vegetation was prioritized as the second most problematic issue affecting the reservoir's water quality (Table 9). In 1986, Eurasian water milfoil (*Myriophyllum spicatum*) was the primary nuisance species affecting recreation, swimming, boating, wildlife viewing and fishing (Appendix A: Photos 2 and 3) (Zogorski et al., 1986). By 2000, three new aquatic plant species were identified as potentially problematic and include the American Lotus, Spatterdock (*Nuphar lutea*) and Purple Loosestrife (*Lythrum salicaria*) (Hoffman, 2000).

Although excessive aquatic vegetation occurs in shallow areas of the reservoir, this problem is more symptomatic of sediment accumulation that enables aquatic vegetation habitat. Sediment provides a favorable rooting media and the shallow conditions allow sunlight penetration for the growth and overabundance of aquatic vegetation (Glander, 1982).

A second feasibility study preformed in 1990 examined changes in Lake Lemon's water quality since the 1986 diagnostic study. The study reiterated the four issues of concern articulated in the earlier diagnostic study (over abundant aquatic vegetation, reservoir sedimentation, shoreline erosion, and elevated fecal coliform bacteria). Unlike the previous study that reported low levels of phosphorous in the water column, soluble reactive phosphorous (SRP), total phosphorous (TP) and ammonia-N (NH_4) had increased since the 1986 study (Jones, 1992). The reservoir's nutrient increase was attributed to the bacterial decomposition by-product of excessive organic matter, resultant low dissolved oxygen concentrations and phosphorous chemical release from the sediment in the reservoir's water column (Jones, 1992). Thus, Lake Lemon's elevated nutrient levels are derived from the existing nutrient bank contained where the nutrients are released by the reservoir's decaying vegetation thereby, becoming both a source and cause of the reservoir's over abundant aquatic vegetation.

Excessive sedimentation from streambank erosion and reservoir shoreline erosion are the leading causes of the favorable environment conducive for aquatic vegetative growth.

5.3.3 Failing Septic Systems

Failing septic systems were ranked as the public's third highest priority issue of concern (Table 9). Improperly installed and poorly maintained on-site septic systems lead to failing systems. Many of the older on-site septic systems were installed when the houses were used exclusively as summer homes. Since then, many homes have become permanent residences resulting in overloading and malfunctioning of septic system's capacity to adequately treat effluent (Zogorski et al., 1986). Moreover, only about 5 percent of Lake Lemon's shoreline soils are classified as moderately suitable for on-site septic systems (Jones, 1992).

Although specific sources could not be traced, previous water quality analytical studies conducted by researchers at the Indiana University identified the Chitwood Addition and lower Beanbloossom Creek areas of the reservoir as exceeding Indiana's water quality standard for fecal coliform bacteria (Zogorski, et al., 1986; and Jones, 1992). A common source of fecal coliform bacteria is derived from inadequately treated sewage effluent. Fecal coliform bacteria contamination is further described in Section 5.2.5. 5.3.5

5.3.4 Streambank Erosion

Streambank erosion is a serious problem in the lower portions of Plum, Possum Trot and Beanblossom Creeks (Appendix A: Photos 11 and 12). The watershed citizens prioritized streambank erosion as the fourth highest issue of concern. However, streambank erosion is potentially the leading source of the sediment to Lake Lemon's east end. Streambank erosion is caused by seasonal high velocity floodwaters that erode and gouge the highly erodible deep and silty alluvial

streambank soils (Jones, 1992). Silty and sandy deposits from the streambank erosion are found in the lower reaches of Beanblossom Creek (Appendix A: Photo 14).

On April 11, 2001, the LLWPC with representatives of IDNR, IDEM and NRCS toured the watershed to examine critical areas in need of restoration. Significant streambank erosion to lower Beanblossom Creek occurs along State Route 45 midway between Trevlac and Helmsburg. The watershed tour group identified this site as in need of immediate restoration because, in part, of the concern for safety from the severe streambank erosion damage to State Road 45. Attempts to protect the road from further damage are evident from the concrete and debris strewn across the streambank (Appendix A: Photos 15 and 16). The LLWPC recognizes that streambank erosion causes not only water quality problems for Lake Lemon but is also a significant safety concern for residents traveling State Route 45 in the Lake Lemon watershed.

5.3.5 Bacterial Contamination

The Indiana fecal coliform water quality standard for full-body recreational water contact is 200 fecal coliform bacteria colonies per 100 mL of water. Stream sample analyses results indicate fecal coliform levels were typically below the state's full body recreational standard. The higher rate of incidences where fecal coliform exceeded water quality standards occurred in Bear Creek and near the mouth of Beanblossom Creek at Lake Lemon (Zogorski et al., 1986). Approximately 105 stream miles are classified as *"partially supporting"* for swimmable, or full body contact, designated use. The cause of the partial attainment status was attributed to pathogens, e.g. fecal coliform and *E. coli*. However, the source of bacterial contamination causing the partial attainment status was listed as unknown (IDEM, 1998). Four wastewater treatment plants discharge into Beanblossom Creek (Table 6). However, they are considered relatively insignificant to the total nutrient and bacterial contamination to Lake Lemon (Jones, 1992).

Typical Lake Lemon fecal coliform bacteria counts are within the Indiana water quality standards for full-body recreational contact. Scattered and isolated incidences of elevated fecal coliform bacteria were detected near the Chitwood Addition and lower section of Beanblossom Creek that does exceed water quality standards. Specific sources of the fecal coliform bacteria could not be traced (Zogorski et al., 1986, and Jones, 1992). Failing septic systems in the Chitwood Addition area are believed to be sources of the isolated bacterial contamination because of the older on-site septic systems and poorly suitable soils for on-site septic treatment systems (Jones, 1992).

5.3.6 Flooding

The watershed citizens prioritized flooding as sixth issue of concern. Flooding is a concern for public safety in Trevlac and along State Route 45 (Table 9). The seasonal flooding was previously idetnified as a possible cause of the reservoir's sedimentation problem from the flood water's gouging of stream banks (Jones, 1992). A serious flood event causing damage to Trevlac occurred in October 2000 during the development of the watershed management plan (Appendix A: Photos 17 and 18). Discussion of this topic among LLWPC and the public meeting participants led to the understanding that the flooding could be a leading cause of the streambank erosion, reservoir sedimentation and fecal coliform bacteria from runoff of inundated livestock operations (Appendix A: Photo 17). At this time, causes and sources of the flooding are not known and require further study.

6.0 POTENTIAL SOLUTIONS

6.1 OVERVIEW

Potential solutions to restore, enhance and protect Lake Lemon's water resources from non-point sources of pollution require a dual management approach. In all cases, public education, understanding and participation must be facilitated for successful program implementation. This dual approach includes:

> ***Watershed management:*** implementation of site specific best management practices (BMPs) within the watershed to prevent on-site and downstream resource degradation, and
>
> ***In-Lake Restoration***: management controls and restoration techniques to improve water quality after it becomes problematic within the reservoir (Zogorski et al., 1986).

This chapter examines a variety of watershed-based and in-lake management practices and strategies that, when implemented, will help Lake Lemon attain desired water quality goals.

6.2 PROGRAMMATIC SOLUTIONS

Collaboration, education and planning were common themes for potential solutions identified and prioritized by the watershed citizens (Table 8). These solutions are more large-scale and programmatic in nature that requires the coordination and cooperation among the various agencies responsible for Indiana's natural resource management.

The watershed citizens identified the following programmatic potential solutions:

- Alternative methods of treating aquatic plants;

- Identify and secure shoreline erosion funding for private landowners;
- Educate landowners in the watershed;
- Develop a master plan for Brown and Monroe Counties that addresses water quality legislation;
- Personal practices of land users and effects on water quality;
- Work with landowners along Beanblossom Creek;
- Contact leadership with the Federal Emergency Management Agency (FEMA); and
- Have LLCD work with IDNR, SWCD and NRCS on projects.

A watershed council formed of Lake Lemon watershed stakeholders was proposed as early as 1986 (Zogorski et al., 1986). The Lake Lemon Watershed Planning Committee (LLWPC) was organized, in part, because of this recommendation. The Lake Lemon Conservancy District has taken a leadership role in the watershed to implement recommended restoration projects identified in the 1986 comprehensive diagnostic and feasibility study.

6.3 BEST MANAGEMENT PRACTICE SOLUTIONS

The primary mechanisms to control non-point source pollution are called best management practices (BMPs). BMPs are a means of preventing or reducing the availability, release or transport of substances that degrade surface or ground water. A single management practice or combination of practices situated in a specific location to mitigate a specified problem is considered "best" in the context of controlling non-point sources of pollution (Barton, 1999).

A matrix of BMPs and their relative effectiveness was developed for this report to identify specific solutions that can be used to mitigate non-point source pollution

(Table 10). Best management practices reviewed are limited to those BMPs that are eligible for technical and cost share assistance from the US Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS).

Results of the matrix analysis reveal the following BMPs most suitable for meeting Lake Lemon water quality goals.

- Nutrient management (590)[5];
- Streambank and shoreline stabilization (580); and
- Waste management systems (312).

Specific BMP solutions are evaluated below for potential implementation in the Lake Lemon watershed (Table 11).

6.4 RESERVOIR SEDIMENTATION MANAGEMENT

Managing excessive sedimentation in the east end of Lake Lemon requires a multi-phased implementation approach. Elements of the phased approach include restoration, stabilization, and prevention. Measuring the effectiveness of the various sedimentation mitigation measures includes documenting and managing information about the implementation of individual BMP measures and the continuation of annual water quality analyses conducted by the School of Public and Environmental Affairs (SPEA) of the University of Indiana.

6.4.1 Reservoir Sedimentation Restoration Project

A Lake Lemon Sedimentation and Restoration preliminary reservoir dredging design study recommended the creation of either elevated islands filled with adjacent dredged material or removing the dredged sediment material to one of three locations

[5] USDA-Natural Resources Conservation Service (NRCS) National conservation practice code.

near the reservoir. Creating elevated islands is the most cost effective plan and would be constructed using a fiberglass piling containment system similar to the riprap erosion control methods currently being used around the lake. The recommended estimated reservoir sedimentation/restoration project costs is approximately $2.2 million (Schneider, 2001). The reservoir sedimentation restoration preliminary construction design study and public presentation slides are provided in this report (Appendix H and I).

The sedimentation restoration project is considered a short-term control measure that must be augmented with a comprehensive watershed management program. The adoption and implementation of recommendations in the watershed management plan may require 10 to 20 years of landowner participation to significantly implement best management practices to effectively reduce the total sediment load from entering Lake Lemon (Zogorski et al., 1986).

Sediment removal in the east end of Lake Lemon may enhance the recreational capacity and thereby increase the recreational use and value of the reservoir. As a result, residents and homeowners may desire to invest in their individual properties which would enhance the long-term economic viability of the community. For example, a complementary benefit of this approach is that individual landowners may invest in a community sewer service (Zogorski et al., 1986).

6.4.2 Shoreline Stabilization

A total of 3,779 linear shoreline feet of CBU property were stabilized with funding provided by IDNR's Lake and River Enhancement Program (LARE). Additional shoreline stabilization is necessary for private property surrounding the reservoir. Prioritized as issue number nine, watershed citizens requested that the appropriate authorities seek government funding for private landowners to stabilize the reservoir's remaining shoreline. The total number of shoreline linear feet in need of

stabilization on private property and potential project costs for is not known at this time.

Specific stabilization techniques are dependent on site-specific considerations and should be developed by appropriate authorities. Details of potential shoreline erosion control measures are provided in several previous Lake Lemon research studies (Zogorski et al., 1986; and Jones, 1992).

Examples of shoreline protection measures include:

- Vegetation;
- Bank Sloping;
- Beach sloping;
- Riprap;
- Gabions;
- Concrete;
- Piling; and
- Groins (Zogorski et al., 1986).

6.4.3 Streambank Stabilization

Streambank erosion is caused by the natural flow, cutting action and dispersion of energy contained in stream water. Streambank stabilization controls consist of structural and non-structural techniques that slow water runoff and streamflow velocities. Stream meanders and in-stream obstructions help reduce streamflow velocity and reduce channel erosion.

Examples of structural controls include:

- Deflectors;
- Artificial obstructions;

- Riprap; and
- Gabions.

Examples of non-structural streambank erosion control measures include:

- Vegetative buffers;
- Banksloping to reduce steep streambanks; and
- Remove localized turbulence causing erosion (Zogorski et al., 1986).

A comprehensive stream channel study to survey the morphological features of Beanblossom, Plum and Possum Trot Creeks is needed. The purpose of the streambank survey is to identify and quantify critical areas of the stream corridor in need of stabilization, estimate project costs and develop an implementation timeline. Results of the comprehensive streambank channel assessment will provide the benchmark for evaluating and measuring progress of streambank stabilization implementation.

6.4.4 Sediment Detention Basins

Sediment detention basins can slow the velocity of flowing water and provide a large catchment area for sediment to settle prior to release or discharge into a receiving stream. An estimated 225 acres of wet detention basins were recommended to remove 70 – 90% of suspended sediments from streams of the Lake Lemon watershed (Zogorski et al., 1986). However, sediment detention basins are considered an expensive solution and should be implemented with other runoff control measures such as localized BMPs and streambank stabilization techniques (Barton, 1999).

Prior to installing sediment detention basins, a watershed-wide sediment detention basin assessment is necessary. The purpose of the comprehensive assessment is to:

- Identify optimal locations for the sediment basins;

- Estimate project design and implementation costs; and
- Develop an implementation timeline.

Results of the watershed-wide sediment detention basin assessment will provide the benchmark for evaluating and measuring progress of sediment detention basin implementation.

6.4.5 Land Use Management

A detailed site-specific evaluation of potential BMPs for the Lake Lemon Watershed is beyond the scope of this document. The Monroe and Brown County SWCDs and corresponding NRCS are the most qualified local conservationists who can provide suitable site specific customized recommendations, and in some cases conservation cost-share funding, to individual private landowners.

As part of the site-specific solutions, a strategic and comprehensive conservation implementation plan is a critical need by both the Brown County conservationists to achieve the desired soil erosion reduction goals from land use practices. A part of this plan should inventory existing conservation program participation by landowners, type of conservation cost share projects implemented, geo-spatial distribution of conservation cost-share projects, identification of critical areas in need of soil erosion control practices. Results of the watershed-wide conservation management need assessment will provide the benchmark for evaluating and measuring progress of land use management changes.

6.5 AQUATIC VEGETATION MANAGEMENT

A comprehensive aquatic vegetative management plan has been developed and currently managed by the LLCD. Techniques to control the excessive growth of aquatic vegetation include chemical, manual, and water elevation controls. Costs for

these control measures range from minimal for reservoir elevation management to high for chemical controls estimated at $30,000 annually. Adjusting reservoir elevation for aquatic vegetation control may cause unwanted shoreline erosion and manual harvesting is difficult and time-consuming work. Chemical treatment of aquatic vegetation is most effective and costs about $325 per reservoir acre per year. The Aquatic Management Plan provides details of the use of all vegetative control types and is recommended for further information and details on the control and management of aquatic vegetation (Hoffmann, 2000).

Measuring the effectiveness of chemical treatment applications can be ascertained through the continuation of the annual water quality analyses conducted by Indiana University's School of Public and Environmental Affairs (SPEA).

6.6 FAILING SEPTIC SYSTEMS

Issue addressed in section 6.8, Bacterial Contamination.

6.7 STREAMBANK EROSION

Issue addressed in section 6.4, Reservoir Sedimentation Management.

6.8 BACTERIAL CONTAMINATION

Failing and inadequate on-site septic systems cause bacterial contamination to Lake Lemon. This occurs primarily in the reservoir's east end near the Chitwood Addition and along the lower reaches of Beanblossom Creek (Zogorski et al., 1986). The soils of the watershed, small lot sizes, and a high water table make the area unsuitable for traditional methods of treating human waste. The ideal solution to this problem is the

installation of a sewer system to transport and effectively treat human waste. This solution is extremely costly and would best be undertaken by the Brown County Health Department.

Measuring the effectiveness of bacterial contamination controls can be ascertained through the continuation of annual water quality analyses conducted by the SPEA.

6.9 FLOODING

Identifying and recommending specific measures to prevent flooding near Trevlac along the banks of Beanblossom Creek is beyond the scope of this report. A flood mitigation study and plan is necessary to obtain the engineering information to optimize public health and safety for the lower Beanblossom communities.

7.0 IMPLEMENTATION PLAN

7.1 OVERVIEW

Restoring and protecting water resources of the Lake Lemon watershed requires collaboration, planning, public education and participation, restoration project demonstration, and the implementation of restoration measures. The LLCD will lead restoration activities such as the reservoir's sedimentation/restoration project and shoreline stabilization. Restoration projects, outside LLCD's jurisdiction, such as streambank stabilization and land use management, will require the collaboration of public agency resources and the participation of private landowners.

The Brown County SWCD, NRCS and Hoosier Heartland RC&D should, as part of their established missions, lead restoration initiatives outside of the LLCD jurisdiction. More challenging issues such as flooding and bacterial contamination caused by failing septic systems will require the LLCD to work with the Monroe County Engineering Department and Brown County Department of Health.

A result of this multi-agency collaboration between LLCD and appropriate agencies will enable landowners and public agency stakeholders to become eligible for state and federal restoration funding. An important note to consider is that in all cases representatives of the granting agency should be contacted before the grant application is developed and submitted. A brief list of available conservation funding programs is provided in Table 13.

A proposed general action timeline with lead project agency is provided (Table 12). Recommended priority issues for immediate action include:

- Convene watershed steering committee;
- Obtain permits for the Lake Lemon east end sedimentation/restoration project;

- Apply for Section 319 grant funding for a streambank stabilization and demonstration project; and
- Apply for FEMA Hazard Mitigation Grant Program.

7.2 STEERING COMMITTEE

The Lake Lemon Conservancy District will lead the development of a watershed steering committee. This committee will be responsible to focus the conclusions of the LLWPC an assist in project develop for the implementation of the plan of action recommended in this plan.

The following identifies recommended participants of the watershed steering committee.

- Alvin Balmer, Brown County NRCS District Conservationist;
- Jerod Chew, Resource Conservationist, IDNR;
- Bill Cobb, Chairman, Lake Lemon Conservancy District;
- James Farr, Agricultural Conservation Specialist, IDNR;
- Becky Fletcher, Hoosier Heartland RC&D;
- Steve Glasgow, Water Quality Project Coordinator, CBU; and
- Bob Madden, Manager, LLCD.

7.3 CONSERVATION PRACTICE FUNDING RESOURCES

A summary of fifteen potential funding resources for future planning and implementation of appropriate conservation measures identifies fifteen separate funding programs from state and federal agencies (Table 13). Details and additional information about specific project requirements and application deadlines should be

obtained from the appropriate funding agency. Additional details and contact information for each conservation implementation program is provided in this report (Appendix F).

7.4 SEDIMENTATION MANAGEMENT

Controlling sediment accumulation in Lake Lemon will require the use of in-lake restoration, shoreline and streambank stabilization and land use management measures. This section outlines specific actions to help control erosion at its sources and thereby reduce sedimentation rates in Lake Lemon.

7.4.1 Lake Lemon Sedimentation/Restoration Project

The Lake Lemon Sedimentation/Restoration Project proposed the development of elevated islands using a fiberglass piling containment system similar to that currently being used around the reservoir. This project should be initiated as soon as possible. To restore the reservoir's east end, the study recommends the LLCD complete the following tasks:

- Obtain necessary permits from State and Federal agencies;
- Finalize construction documents;
- Obtain funding for the project; and
- Implementation of the project, either in a single year or multi-year program (Schneider, 2001).

7.4.2 Lake Lemon Shoreline Stabilization

More than 2,892 linear feet of critical shoreline susceptible to erosion have been stabilized. The Indiana Department of Natural Resources (IDNR) Lake and River Enhancement Program (LARE) provided more than $300,000 cost-share funding for this project. Additional shoreline stabilization is needed along private property. The LLCD should continue education and awareness for shoreline stabilization for private

property landowners. Shoreline stabilization is not as immediate as other restoration projects and is recommended for initiation in year two (Table 12). Based on recommendations by the watershed public, the LLCD and the Hoosier Heartland RC&D should pursue private landowner cost-share funding for shoreline stabilization from the IDNR LARE program.

7.4.3 Streambank Stabilization

Since the majority of the Lake Lemon watershed is outside LLCD jurisdiction, a collaborative and incremental streambank restoration and stabilization approach is recommended. Streambank stabilization is recommended for immediate action.

The incremental approach consists of three main phases and include:

1) Streambank stabilization demonstration project;
2) Comprehensive streambank stabilization needs assessment; and
3) Streambank stabilization implementation.

7.4.3.1 Streambank Stabilization Demonstration Project

A streambank stabilization demonstration project to restore a severely eroded streambank along Beanblossom Creek is strongly recommended. The severely eroded streambank site is located along State Route 45 between Trevlac and Helmsburg. The demonstration will provide public education and awareness concerning the need and benefits of restoring stream corridors while stabilizing and restoring a critical site where significant erosion has caused road damage. As members of the watershed steering committee, LLCD, Brown County SWCD and Hoosier Heartland RC&D should collaborate to pursue the development of this demonstration project.

7.4.3.2 *Recommended Streambank Stabilization Demonstration Project Funding Resources*

Funding for streambank restoration, stabilization and public education should be obtained from the US EPA Non-Point Source Pollution Reduction Grant Program (Clean Water Act Section 319). The Indiana Department of Environmental Management (IDEM), Watershed Management Section administers the 319-grant program in Indiana. LLCD, Brown County SWCD and Hoosier Heartland RC&D should lead the 319 grant application development and submit during the next available grant request for proposals (Appendix F).

Applications for Section 319 Nonpoint Source Grants are typically available annually. The total amount of funding available is based on Congress' annual allocation to the State of Indiana. Two separate Section 319 solicitations are available for fiscal year 2002 and are:

- Special Targeted Incremental Solicitation – deadline March 31, 2002; and
- Section 319 Grant Solicitation – deadline October 1, 2002.

The Special Targeted Incremental Solicitation grant is recommended for the LLCD, Brown SWCD and Hoosier Heartland RC&D to apply for funding. This grant will be used for the Beanblossom Creek streambank stabilization demonstration project. Grant Application details can be obtained at the following Internet site, http://www.in.gov/idem/water/planbr/wsm/app_page.html.

7.4.3.3 *Streambank Stabilization Assessment*

The second phase recommended for streambank restoration is comprehensive watershed-wide streambank stabilization needs assessment. The needs assessment survey will characterize, identify,

quantify specific streambank sites that are highly susceptible to erosion and severely eroded areas that require restoration. The Brown County SWCD and Hoosier Heartland RC&D should lead this watershed-wide streambank erosion study. This study should complement a flood study recommended in Section 7.5.

7.4.3.4 Streambank Stabilization Needs Assessment Funding Resources

THE CLEAN WATER ACT SECTION (CWA) 205(J) WATER QUALITY PLANNING GRANT PROGRAM

The Clean Water Act Section (CWA) 205(j) Water Quality Planning Grant Program provides funding for water quality management planning and design (Appendix F). The Indiana Department of Environmental Management (IDEM) administers the program. Funding from the CWA 205(j) can be used to assess the nature, extent and causes of non-point source pollution problems and develop plans that mitigate the identified problems (IDEM, 2001).

The Brown County SWCD and Hoosier Heartland RC&D should lead the Section 205(j) grant application development and submit during the next available grant request for proposals (Appendix F). Details of the 205(j) grant application can be obtained at the Internet site http://www.in.gov/idem/water/planbr/wsm/Section205j_main.html.

INDIANA LAKE AND RIVER ENHANCEMENT PROGRAM

Another source of funding for the watershed streambank stabilization diagnostic study is available from the Indiana Lake and River Enhancement (LARE) program. The Indiana Department of Natural Resources, Division of Soil Conservation manages this conservation planning and implementation grant program. General goals of this

program are to establish a basis for LARE grant applications and identify specific directions for future watershed implementation projects (IDNR, 2001).

Details of IDNR's LARE program and grant application can be obtained from IDNR's Internet site http://www.state.in.us/dnr/soilcons/lare.htm.

7.4.3.5 Implement Streambank Stabilization Measures

The third phase of the streambank stabilization program is the implementation of site-specific stabilization measures as identified in the streambank stabilization needs assessment. The Brown County SWCD and NRCS, and Hoosier Heartland RC&D are the appropriate lead agencies to provide technical and financial assistance for the implementation and management of streambank stabilization measures.

7.4.3.6 Streambank Stabilization Funding Resources

Funding for watershed-wide implementation of streambank stabilization structures, sedimentation basins, and other potential measure to reduce erosion can be obtained from a variety of local, state and federal resources. Usually, this funding is available for site-specific restoration and can be used as a cost-share with individual landowners.

The Brown County SWCD and NRCS, and Hoosier Heartland RC&D should lead the investigation to identify and secure appropriate federal streambank stabilization funding (Appendix F).

7.5 AQUATIC VEGETATION MANAGEMENT

Continue the chemical treatment recommendations that control over abundant nuisance aquatic vegetation based on recommendations of the Lake Lemon Aquatic Plant Management Plan (Hoffmann, 2000). LLCD budgets approximately $30,000 annually for chemical treatment to control the aquatic vegetation.

7.6 BACTERIAL CONTAMINATION MANAGEMENT

7.6.1 On-Site Septic System Management

Bacterial contamination of Lake Lemon is caused by failing and inadequate on-site septic systems surrounding the reservoir. The ideal solution is the installation of a community-wide sewer system to transport and treat waste. Unlike sedimentation, bacterial contamination in Lake Lemon is not severe enough to preclude recreational use of the reservoir. Therefore, it is recommended that this issue follow actions to secure funding for streambank and shoreline stabilization.

7.6.2 Bacterial Contamination Management Funding Resources

The following is a list of potentially available funding resources the watershed steering committee should investigate to help reduce bacterial contamination of Lake Lemon. The LLCD should collaborate with the Brown County Health Department to identify and secure funding for on-site septic system maintenance.

Potential Funding Resources:

- US Department of Agriculture
    - Water and Waste Disposal Systems for Rural Communities
    - Public Works and Development Facilities Program
- US Environmental Protection Agency

- Water Quality Cooperative Agreements
- Sustainable Development Challenge Grants

7.7 FLOOD MANAGEMENT

Recommending specific control measures to prevent further flooding near Trevlac along the banks of Beanblossom Creek is beyond the scope of this report. The LLWPC recognizes that a flood mitigation study is warranted to provide the necessary engineering information to address flooding.

7.7.1 Flood Management Assessment

Because of the concern for public safety and as the leading cause of erosion in the watershed, the Lake Lemon watershed steering committee should immediately seek and secure funding for a watershed flood study (Table 12). Two potential funding resources available are potentially available by the Federal Emergency Management Agency (FEMA) for the communities in the Lake Lemon watershed (Appendix G).

Potential flood protection resources identified include:

- Hazard Mitigation Grant Program; and
- Flood Mitigation Assistance.

7.7.2 Flood Management Funding Resources

The Hazard Mitigation Grant Program assists States and local communities implement long-term hazard mitigation measures following a major disaster declaration. The program's objectives are:

> *"to prevent loss of lives and property due to disasters, implement hazard mitigation plans, enable mitigation measures during immediate recovery form a disaster, and provide funding as necessary" (FEMA 1996).*

The Flood Mitigation Assistance program provides funding for communities to develop flood mitigation plan and implement measures to reduce flood losses. Examples of projects eligible for funding include:

> *"elevation of insured structures, acquisition of insured structures and property, relocation and demolition, dry flood proofing, minor structural projects, and beach nourishment such as planting dune grass" (FEMA, 1997).*

It is recommended that the Lake Lemon Conservancy District continue to work with local, state and federal officials to devise and implement a flood management program for the Lake Lemon watershed.

7.8 MEASURING SUCCESS

The LLCD has contracted with the Indiana University's School of Public Policy and Environmental Affairs (SPEA) to study water quality conditions of Lake Lemon annually since 1996. During the studies water quality samples were collected two-times each year in several regions of the lake. Results of these studies were used by the Lake Lemon Watershed Planning Committee to make critical recommendations for water quality protection programs. It is recommended that LLCD maintain funding for the water quality-monitoring program. The resultant water quality data will help ascertain the long-term value and effectiveness of implemented watershed wide conservation programs.

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