Report

Lake Leota Watershed Study

City of

Evansville, WI

January 2006

Report for

City of Evansville, Wisconsin

Lake Leota Watershed Study

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EXECUTIVE SUMMARY

This report summarizes a watershed study performed by Strand Associates for the Lake Leota watershed in southern Wisconsin near the City of Evansville. The watershed encompasses part of three counties, Rock, Green, and Dane, and is heavily agricultural. Lake Leota, an impoundment of Allen Creek, is a former mill pond that has been severely impaired by sedimentation and other environmental problems. The purpose of this study is to provide recommendations to the City of Evansville and other stakeholders on how to reduce sedimentation of the lake now and in the future to protect future lake dredging and restoration investments.

Specifically, the objectives of the Lake Leota watershed study are as follows:

1. Identify the locations of potential source areas of nonpoint source (NPS) pollutants in the watershed.
2. Estimate the quantity of NPS pollutants that are currently being delivered to the lake from each of the source areas identified in Part 1.
3. Explore best management practices (BMPs) that could be used to improve the conditions in the watershed and their potential benefits.
4. Provide recommendations for BMPs that can be implemented by property owners and local governments and organizations to improve the conditions in the watershed.
5. Research sources of potential funding and technical assistance to individual property owners for implementation of BMPs.
6. Develop the framework for an information and education (I&E) program for residents of the watershed.

A streambank assessment of Allen Creek was performed, and erosion problem areas were photographed, assessed, and logged digitally. A model was developed to estimate the amount of annual sediment reaching Lake Leota from streambank erosion on Allen Creek and its major tributary: approximately 500 tons per year (t/yr). Streambank restoration projects are recommended for the most severe erosion locations in Section 4 of this report. These include vegetated boulder revetments, live staking, vegetated geogrids, and other techniques. Approximately 4,500 feet of streambank is recommended to be restored in several phases.

A model was developed to estimate the amount of soil loss and sediment loading to the lake from sheet and rill erosion on agricultural fields and idle lands in the watershed. Three conditions were modeled: a baseline condition with no BMPs, an existing condition that assumes certain generalized tillage practices in the watershed, and a no-till condition which assumes that all agricultural fields have conservation tillage systems with no-till practices.

The results of the sheet and rill erosion modeling indicated that approximately 35,000 t/yr of soil loss occurs for the baseline condition, 28,000 t/yr for the existing condition, and 20,000 t/yr for the no-till condition. The total amount of sediment reaching Lake Leota for the existing condition is only about 9,700 t/yr for the existing condition, because a large percentage of the sediment gets deposited in transit.

Therefore, it is estimated that a total of approximately 10,200 t/yr of sediment reach the lake each year from sheet and rill erosion and streambank erosion. Approximately 50 percent of the sediment entering the lake is estimated to be captured by the dam in the lake. Dividing by the area of the lake (26.6 acres), this amounts to a sediment accumulation rate of approximately 1.1 inches per year in the lake.

Agricultural BMPs that are recommended for reduction of soil erosion and sediment delivery in the watershed are described and potential cost-sharing programs are listed in Section 4. Examples include conservation tillage practices, buffers, contour farming, water and sediment basins, and grassed waterways. The creation of a Watershed Task Force Committee (WTFC) is recommended to spearhead the implementation of BMPs on landowners' properties and to help landowners obtain funding. An outline of an I&E program for the watershed is recommended in Section 5, and the WTFC would be in charge of implementing it. The WTFC could be a branch of the existing citizen action committee, Save Our Lake Environment (SOLE), in the City of Evansville with a broader outreach to the entire watershed.

A suggested implementation plan and schedule for the first several years of the watershed improvement plan is presented in Section 4. It includes formation of the WTFC, implementation of the I&E program, and construction of the streambank restoration projects, water and sediment control basins, and buffers along the creek and along drainageways. Potential cost-sharing sources are provided for each component of the plan.

SECTION 1
INTRODUCTION

1.01 BACKGROUND

Lake Leota is an impoundment of Allen Creek which originated as a mill pond in 1847 on the northern edge of the City of Evansville. Allen Creek rises in southern Dane County and flows through northwest Rock County and northeast Green County before emptying into the Sugar River. The Lake Leota watershed includes approximately 16,475 acres (approximately 26 square miles) of drainage area in the Allen Creek and Middle Sugar River Watershed (Wisconsin Department of Natural Resources (DNR) Watershed Code SP13). Figure 1.01-1 shows the location of the Allen Creek and Middle Sugar River watershed.

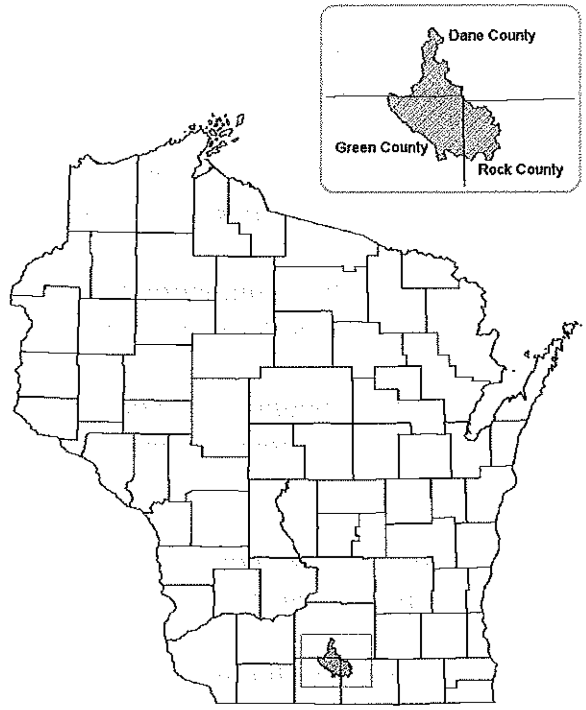


Figure 1.01-1 Location of Allen Creek and Middle Sugar River Watershed

After the mill closed in the late 1800s Lake Leota was drained, but it was dug out again in 1923 as a result of public support for water recreation. Over time, Lake Leota has accumulated sediment, which has been delivered to the lake via Allen Creek and direct stormwater runoff. The lake has experienced severe sediment infilling as well as turbidity, high nutrient input, aquatic weeds, and rough fish. Allen Creek has experienced severe streambank erosion, which has contributed to the lake sediment problem.

Lake Leota is divided by a railroad bridge into an upper and lower section. The upper lake is approximately 11.8 acres, and the lower lake is approximately 26.6 acres.

A citizen action committee called Save Our Lake Environment (SOLE) was formed in the City of Evansville to promote the restoration and preservation of Lake Leota. SOLE has initiated, supported, and sponsored many projects surrounding restoration of the lake, including performing water and sediment sampling, raising funds, holding meetings, and applying for grants. SOLE helped the City of Evansville in 2004 apply for and receive two grants from DNR's Lake Planning Grant Program to fund this study. The two grants are for $10,000 each, and fund Phases I and II of this study, respectively (Grants LPL-986-05 and LPL 987-05). Section 1.03 below describes the scope of each phase of the study.

1.02 OBJECTIVES

The objectives of the Lake Leota watershed study are as follows:

1. Identify the locations of potential source areas of nonpoint source (NPS) pollutants in the watershed.

2. Estimate the quantity of NPS pollutants that are currently being delivered to the lake from each of the source areas identified in Part 1.

3. Explore best management practices (BMPs) that could be used to improve the conditions in the watershed, and their potential benefits.

4. Provide recommendations for BMPs that can be implemented by property owners and local governments and organizations to improve the conditions in the watershed.

5. Research sources of potential funding and technical assistance to individual property owners for implementation of BMPs.

6. Develop the framework for an information and education (I&E) program for residents of the watershed.

1.03 SCOPE OF STUDY

This watershed study has been divided into two phases. The following describes the scope of each phase.

A. Phase I: Identification of Potential Areas of NPS Pollutants in the Watershed

1. Field Survey

A field survey of the main channels of Allen Creek was conducted to identify and document potential areas of NPS pollutants as a result of streambank erosion and runoff from adjacent lands. Limits of field reconnaissance are defined as the main channel of Allen Creek above Lake Leota and the primary unnamed tributary to Allen Creek located west of Lake Leota, excluding minor tributaries.

Potential NPS pollutant areas were documented in a digital photo log, and locations were recorded using a hand-held global positioning system (GPS) data recorder. Photo locations and problem areas were mapped using geographic information system (GIS) software. The field survey results are summarized in Section 3.02 of this report.

2. Screening-Level Computer Modeling

Computer modeling was completed using Revised Universal Soils Loss Equation (RUSLE2) to estimate total suspended solids (TSS) loadings from agricultural and idle lands on an average annual basis. Data required to complete the computer modeling was obtained from county GIS programs, county conservationists, the DNR, United States Geological Survey (USGS), United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), and site visits. This is presented in Section 3.03 of this report.

The original proposal indicated that the computer model PLOAD would be used for pollutant load modeling. However, the lack of available unit loading rates for different agricultural practices led us to use RUSLE2 instead. The RUSLE2 method used in the study is based on a method used by the DNR for agricultural runoff modeling (Kevin Kirsch, DNR Bureau of Watershed Management).

The DNR's Wisconsin Lake Modeling Suite (WiLMS) was used to model phosphorus loading to Lake Leota from different land uses in the watershed. This is presented in Section 3.05 of this report.

B. Phase II: Recommendations and Implementation

1. BMPs

An analysis of BMPs that could be implemented in the Lake Leota watershed was performed, resulting in a BMP implementation plan, which is included in Section 4 of this report.

2. Funding Alternatives

Potential sources of funding were investigated for implementation of the BMPs. Funding options explored included grants and low-interest loans through state and federal programs. These are discussed in Section 4 of this report.

3. Information and Education

A framework for an information and education program for residents and landowners was developed and is included in Section 5. Components of the program include information on the impacts of erosion, potential BMPs, and available funding sources for BMP implementation.

1.04 PREVIOUS RELEVANT STUDIES

Lake Leota has been studied by many different groups over the years. The following reports and studies relating to Lake Leota and Allen Creek were considered in the preparation of this study.

A. Lake Leota, Rock County Management Alternatives, DNR, 1979.

This DNR report analyzes the problems surrounding Lake Leota in the most comprehensive study of the lake and watershed prior to this report. It gives a detailed background of the lake and creek modifications, outlines a feasibility study including sampling and a streambank survey of Allen Creek, discusses water quality problems, and considers five management alternatives for the Lake Leota sedimentation problem including: (1) dredging the lake below the photic zone to an average depth of 10 feet requiring removal of approximately 270,000 cubic yards of sediment, (2) implementing soil conservation practices in uplands to reduce the amount of upstream erosion and sedimentation, (3) removing rough fish to reduce turbidity, (4) removing the dam to allow the creek to return to its natural state, and (5) a do-nothing alternative because of the DNR's perceived view of the very limited recreational potential for Lake Leota.

B. Preliminary Plan Lake Leota Rehabilitation Project, Owen Ayres & Associates, Inc., 1980.

This report presents a dredging plan for Lake Leota that would remove a total of 233,000 cubic yards of sediment. The lake would be dredged at graduated depths from 6 to 10 feet. Sideslopes of 4:1 from a distance of 20 feet from the existing shoreline would be dredged to the desired depth. A 75-foot buffer zone extending into the lake from the south track of the railroad would be left in its natural state. Two properties were investigated for spoils disposal: the Cadman property and the Gildner property. Ayres recommended hydraulic dredging for sediment removal.

C. Proposal for Restoration of Lake Leota and Allen Creek, Gibbs, Sheri, 2000.

This report highlights the history of events surrounding Lake Leota. A notable section spells out past roadblocks to lake rehabilitation including costs of dredging, DNR permits, and an environmental assessment. The report also poses potential solutions such as dredging the upper and lower lake, rerouting the creek to the upper lake, and creating a small holding pond for dredging maintenance.

D. Lake Leota Evaluation Report, University of Wisconsin – Platteville, 2001.

This report was prepared by a group of engineering students under the guidance of faculty advisors at the University of Wisconsin–Platteville (UWP). This report stressed that the success of a lake rehabilitation project depends on the initial study of the lake and continued monitoring following implementation. Removal of 276,000 cubic yards of sediment from the lower lake was recommended. Sediment would be removed to create lake depths from 12 feet in a new sedimentation basin to 6 to 10 feet in the main lake. A 30,000 cubic yard sedimentation basin would be designed for maintenance dredging every ten years. Hydraulic dredging was found to be the most economical method of sediment removal. The report also states that rerouting the creek to the upper lake is not feasible primarily because of the size of the culvert required.

E. Lake Leota–Lake Dredging Planning, Strand Associates, Inc., 2004.

This report summarizes potential dredging alternatives for Lake Leota, their costs, and the associated problems. It identifies potential locations for dredging spoil disposal. It provides recommendations and a schedule for management of the lake as well as a description of the need for a watershed study and potential funding sources. The watershed study was recommended so that sources of sediment could be identified and reduced, resulting in less investment by the City for maintenance dredging.

1.05 APPLICABLE REGULATIONS

The following is a description of the rules and regulations that may apply to relevant Lake Leota watershed activities.

A. Runoff Management Agricultural Performance Standards–NR 151

The agricultural performance standards and prohibitions are outlined in Subchapter II of Wis. Administration Code Chapter NR 151, which sets forth minimum guidance on the control of stormwater runoff pollution from agricultural facilities and operations. Compliance requirements for agricultural performance standards and prohibitions are outlined in Sections NR 151.09-151.097.

Compliance with the performance standards is not required of existing facilities or operations unless cost-sharing is offered by local, state, or other funding sources. At least 70 percent funding for eligible cost-sharing costs must be made available in order to require that a facility correct performance standard violations. Cost-sharing is not required for new facilities or operations or for practices needed for a livestock operation regulated by a Wisconsin Pollutant Discharge Elimination System (WPDES) permit.

1. Sheet, Rill, and Wind Erosion

This performance standard requires croplands to be cropped in such a way to prevent the soil erosion rate from exceeding the "tolerable" rate established for that type of soil.

2. Manure Storage Facilities

This performance standard requires livestock producers who plan to construct, substantially alter, or abandon a manure storage facility to adhere to certain construction standards to prevent manure overflow during a storm. In addition, any existing manure storage facilities that are failing or leaking and pose an imminent threat to public health or fish and aquatic life or violate groundwater standards are required to be upgraded, replaced, or abandoned in an acceptable way.

3. Clean Water Diversions

This performance standard requires livestock producers within a water quality management area to divert runoff from contacting feedlot, manure storage areas, and barnyard areas. A water quality management area (WQMA) is defined in NR 151 as follows: *"WQMA means the area within 1,000 feet from the ordinary high water mark of navigable waters that consist of a lake, pond or flowage, except that, for a navigable water that is a glacial pothole lake, the term means the area within 1,000 feet from the high water mark of the lake; the area within 300 feet from the ordinary high water mark of the lake; the area within 300 feet from the ordinary high water mark of navigable waters that consist of a river or stream; and a site that is susceptible to groundwater contamination, or that has the potential to be a direct conduit for contamination to reach groundwater."*

4. Nutrient Management

This performance standard requires crop or livestock producers to adhere to a nutrient management plan when spreading manure, commercial fertilizer, or other nutrients to agricultural fields.

5. Manure Management Prohibitions

This performance standard prohibits a livestock operation from having an overflow of manure storage, an unconfined manure pile in a water quality management area, direct runoff from a feedlot or stored manure into the waters of the state, and unlimited access by livestock to waters of the state in a location where high concentrations of animals prevent the maintenance of adequate sod or self-sustaining vegetation.

There are basically three ways that existing facilities would need to comply with these performance standards: (1) the farmer would admit noncompliance with a performance standard and would request 70 percent cost-sharing to meet the standard, (2) a town or county would issue a conditional use permit for construction of a new facility that requires that existing facilities meet the performance standards before new construction can commence, and (3) the County or DNR identifies noncompliance with a performance standard (i.e., leaking manure facility) and offers 70 percent cost-sharing.

A new cropping practice or livestock operation is defined as a practice or operation that was not in effect as of the NR 151 ruling or one that has resulted from a significant change and brings the practice out of compliance with the performance standards. In this case, no cost-sharing is required, and the practice must be brought into compliance with the standards described above.

The DNR has delegated the authority to administer and enforce the NR 151 (Agricultural) rules to the counties (Dane, Rock, and Green) since the DNR is focusing their efforts on larger farm operations. Rock County will begin implementing full-scale evaluations of properties and farm operations starting in January 2006 for any landowner requesting cost-sharing for implementation of BMPs. Green County will be updating their land and water conservation plan in 2006 to make it consistent with NR 151 implementation strategies.

B. Nutrient Management–ATCP 50

Wis. Admin. Code Chapter ATCP 50 requires that all farmers who apply manure or commercial fertilizer to cropland adhere to nutrient management plans. The chapter includes rules on what the nutrient management plans must contain and how they are to be implemented. The rule is intended to help protect the state's water resources by preventing excess nutrient applications that can result in NPS pollution of surface water and groundwater.

C. County Ordinances

1. Dane County Manure Management

The Dane County Board of Supervisors recently approved an ordinance amendment regulating manure management and storage facilities. The new ordinance requires farmers to submit plans and apply for a permit prior to spreading liquid manure in the winter. It also puts restrictions on the amount, rates, and locations liquid manure can be spread and prohibits spreading within 1,000 feet of a lake, 300 feet from a stream or drainage ditch, or on steep slopes.

Chapter 14 of the Dane County Code of Ordinances, which regulates manure management and stormwater and erosion control, is in the process of being updated and is tentatively planned to be approved in early 2006. The ordinance requires manure facilities to have facility plans, prohibits unconfined manure storage in water quality management areas, restricts direct runoff from livestock or storage areas, and regulates upgrades, closures, and other alterations to manure storage facilities.

2. Rock County Animal Waste Management

Chapter 30 of the Rock County Code of Ordinances is the Rock County Animal Waste Management Ordinance. The ordinance is similar to the existing Dane County ordinance Chapter 14 described above. It regulates the location, design, construction, installation, and operation of new animal waste facilities and major alterations to existing facilities. It prohibits unconfined animal waste stockpiles in water quality management areas, direct runoff from a feedlot or stored animal waste to waters of the state, overflows of a storage structure, and unlimited access by livestock to waters of the state in a location where high concentrations of animals prevent the maintenance of adequate sod cover.

D. Water Quality Standards for Wisconsin Surface Waters–NR 102

Wis. Admin. Code Chapter NR 102 designates certain surface waters in Wisconsin as outstanding or exceptional resource waters based on their uses and quality. Allen Creek is designated as an exceptional resource water (ERW) south of Evansville as this segment has a very good, diverse warm water sport fishery, according to the DNR.

This classification means that antidegradation rules apply, requiring that the waterbody not be lowered in quality and water quality standards must be enforced.

E. Priority Watersheds and Lakes–NR 120

Wisconsin's Priority Watershed and Priority Lake Program (Chapter NR 120 of Wis. Admin. Code) provides financial assistance to local units of government in selected watersheds to address land management activities that contribute to urban and rural runoff. The DNR issues grants through a cost-share approach that are used to reimburse costs to landowners for the implementation of watershed and lake projects, such as installing voluntary BMPs. Funding for the program is being phased out and will be available to ongoing projects in priority watersheds and lakes until 2009. The program is no longer open to new applicants.

The Allen Creek and Middle Sugar River Watershed is ranked as a medium priority for NPS. About 4.5 miles of the stream above Lake Leota are classified Class II and Class III trout waters (DNR, 1980).

1.06 ABBREVIATIONS AND ACRONYMS

ac-ft	acre-feet
BMP	best management practice
cfs	cubic feet per second
CREP	Conservation Reserve Enhanced Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
cy	cubic yards
DATCP	Wisconsin Department of Agriculture, Trade, and Consumer Protection
DNR	Wisconsin Department of Natural Resources
EQIP	Environmental Quality Incentives Program
ERW	exceptional resource water
FSA	Farm Service Agency
ft	feet
in	inch
GIS	geographic information system
GPS	global positioning system
HSG	hydrologic soils group
LCC	Land Conservation Committee
LCD	Land Conservation Department
LWRM	land and water resource management
NASS	National Agricultural Statistics Survey
NOI	notice of intent

NOT	notice of termination
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
OM	organic matter
pcf	pounds per cubic foot
RCN	runoff curve number
RUSLE	revised universal soil loss equation
SCS	Soil Conservation Service (Now called NRCS)
SDR	soil delivery ratio
SOLE	Save Our Lake Environment
sq ft	square feet
t/ac/yr	tons per acre per year
TMDL	total maximum daily load
TP	total phosphorus
TRM	Targeted Runoff Management
TSS	total suspended solids
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UWEX	University of Wisconsin – Extension
UWP	University of Wisconsin – Platteville
WEI	wind erodibility index
WiLMS	Wisconsin Lake Modeling Suite
WISCLAND	Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data
WLWCA	Wisconsin Land and Water Conservation Association
WPDES	Wisconsin Pollutant Discharge Elimination System

SECTION 2
WATERSHED DESCRIPTION

2.01 LAND USE IN WATERSHED

A USGS map of the Lake Leota watershed is shown in Figure 2.01-1. A large aerial photo map of the watershed is also included in the Appendix. The watershed encompasses parts of three counties: Rock, Green, and Dane. Two small population centers are partially located in the watershed: the Village of Brooklyn to the north and the City of Evansville to the south. According to the U.S. Census Bureau, the population of Brooklyn was 502 at the last census (2000), and the population of Evansville was 4,039. However, most of the City of Evansville is located to the south of Lake Leota and most runoff from the City drains south of the lake. The Village of Brooklyn municipal wastewater treatment plant discharges to Allen Creek upstream of Lake Leota.

The watershed was divided into 20 subbasins by Strand based on topography. The subbasins are numbered according to the county that they primarily occupy (for example D1 and D2 are primarily in Dane County, whereas G1 through G8 are primarily in Green County). The subbasins are smaller land units that are useful for isolating problem areas and recommending improvements.

The predominant land use in the Lake Leota watershed is agriculture, although some low intensity urban development exists in the communities mentioned. The land use information was obtained from the DNR's Wisconsin Initiative for Statewide Cooperation on Landscape Analysis and Data (WISCLAND). The WISCLAND land cover data was derived from satellite imagery acquired from flyovers in August 1991; May, July, September, and October 1992; and May 1993. Local land use records and wetland delineation maps are also incorporated. WISCLAND land use in the watershed is depicted in Figure 2.01-2 and is summarized in Table 2.01-1.

Land Use	Acres	Percent of total
Corn & Other Row Crops	6,642	40
Forage Crops	5,856	36
Grassland, Shrubland, & Barren	2,070	13
Forest	1,307	8
Wetlands	398	2
Urban & Golf Course	158	1
Open Water	43	0.3
Total	16,475	100

Table 2.01-1 Land Use in Watershed (Source: DNR WISCLAND)

According to the WISCLAND land cover data, approximately 76 percent of the land in the watershed is used for agricultural crops. Only about 68 acres (0.4 percent) is developed as residential, commercial, or industrial, and another 92 acres (0.6 percent) is a developed golf course. The rest is divided among forest, wetlands, grassland, shrubland, and idle lands.

An important thing to note regarding the WISCLAND agricultural data is that the agricultural crops are relatively evenly split between row crops (primarily corn and soybeans) and forage crops (alfalfa and other hay). Another land use data source, the National Agricultural Statistics Survey (NASS), was compiled from satellite images from 2004 (see Figure 2.01-3). The NASS data depicts a different breakdown of the land use in the Lake Leota watershed. Primarily, the NASS data shows that 57 percent of the watershed is used for row crops, and only 7 percent is used for forage crops (compared to 40 and 36 percent, respectively, from the WISCLAND data shown in Table 2.01-1).

There are some reasons to suspect the NASS data as erroneous, however, especially in regard to urban versus rural land use. The NASS data shows 1,228 acres, or 7.5 percent, of the watershed as being urban developed. A simple glance at a recent aerial photo or map of the watershed shows that this cannot be correct. The NASS mapping depicts several large urban areas (300 acres or more in size) in locations that are quite clearly agricultural crops on aerial photos. The satellite data must have misidentified certain field covers as urban as there is not that much development in the watershed.

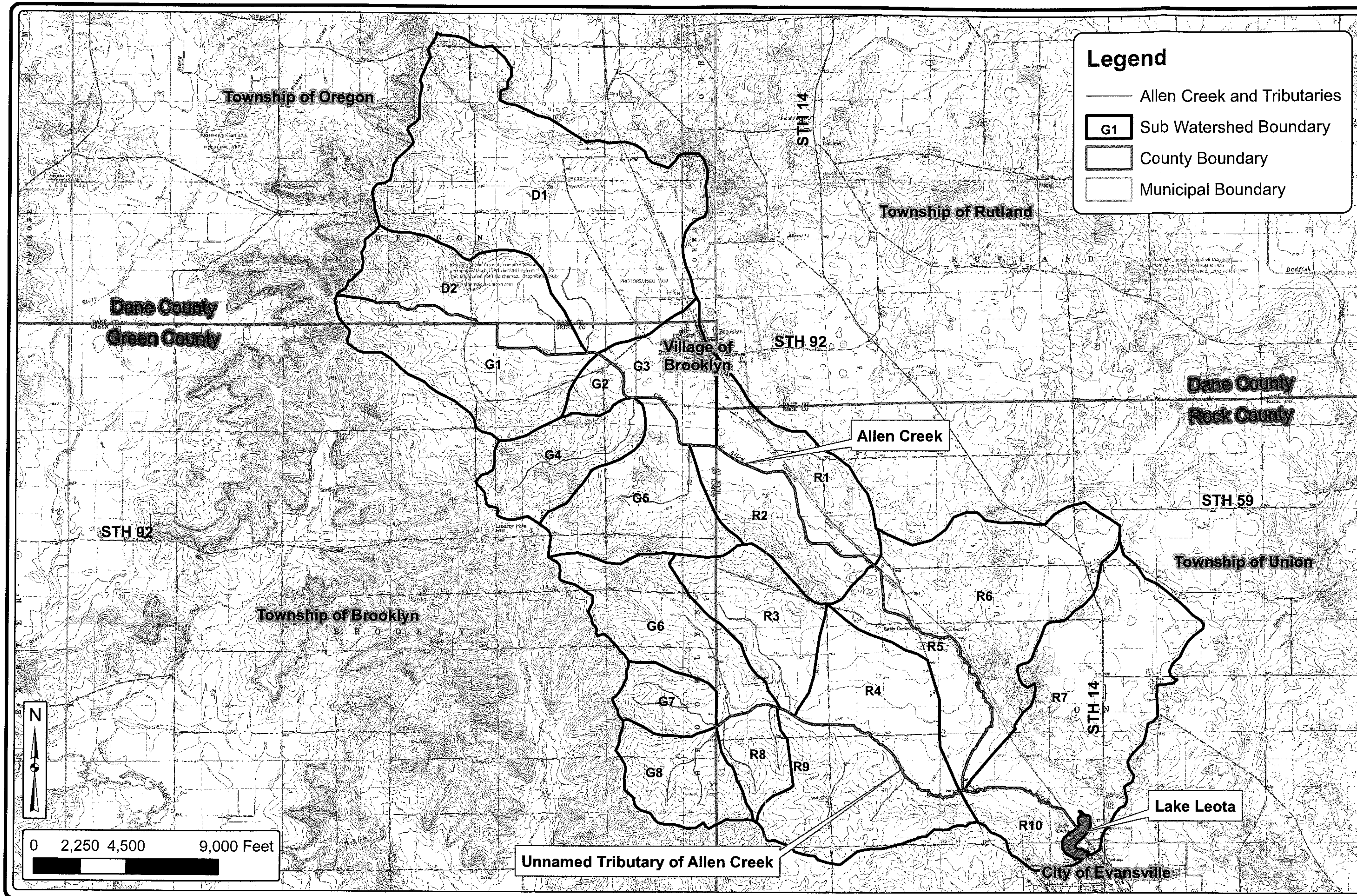
That being said, the NASS data is consistent with the recent change in agricultural land use in the watershed. According to Roger Allan of the USDA NRCS Janesville District, farmers in the watershed have moved away from forage crops over the last several decades in favor of more row crops. This is a result of fewer livestock in the watershed. There are many more farmers operating soybean and corn rotations only and fewer that still include hay in their rotations. In fact, according to Roger Allan, approximately 80 percent of the fields in the watershed are estimated to be planted on a corn-soybean every-other-year rotation, and 20 percent are planted on a corn-soybean-hay rotation.

During the period between 1991 and 2004 when the two land use data sets were compiled, the agricultural land use in the watershed did change substantially, making it difficult to compare the two land use data sets. The WISCLAND data, although more reliable because it incorporates local land use records and wetland delineation maps, is outdated. The NASS data, while very recent and specific as to the types of crops, is less reliable because of the erroneous urban areas. Therefore, a combination of the two data sets was used for the existing condition agricultural modeling, which is described in more detail in Section 3.03.

The WISCLAND data was modified based on the percentages of row crops versus forage crops that are currently in the watershed, according to Roger Allan approximately 80 percent corn/soybean rotation and 20 percent corn/soybean/hay rotation. The resulting modified land use table is shown in Table 2.01-2. For the modified land use data, all the WISCLAND categories remained unchanged except for the row crops and forage crops. The modified agricultural breakdown, 89 percent row crops and 11 percent forage crops, is consistent with the breakdown that Roger Allan described as currently being in the watershed.

Land Use	Acres	Percent of Total	Percent of Total Crops
Corn & Other Row Crops	11,143	68	89
Forage Crops	1,356	8	11
Grassland, Shrubland, & Barren	2,070	13	
Forest	1,307	8	
Wetlands	398	2	
Urban & Golf Course	158	1	
Open Water	43	0.3	
Total	16,475	100	100

Table 2.01-2 Modified Land Use in Watershed (Used for Modeling Existing Condition)



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LAKE LEOTA WATERSHED

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

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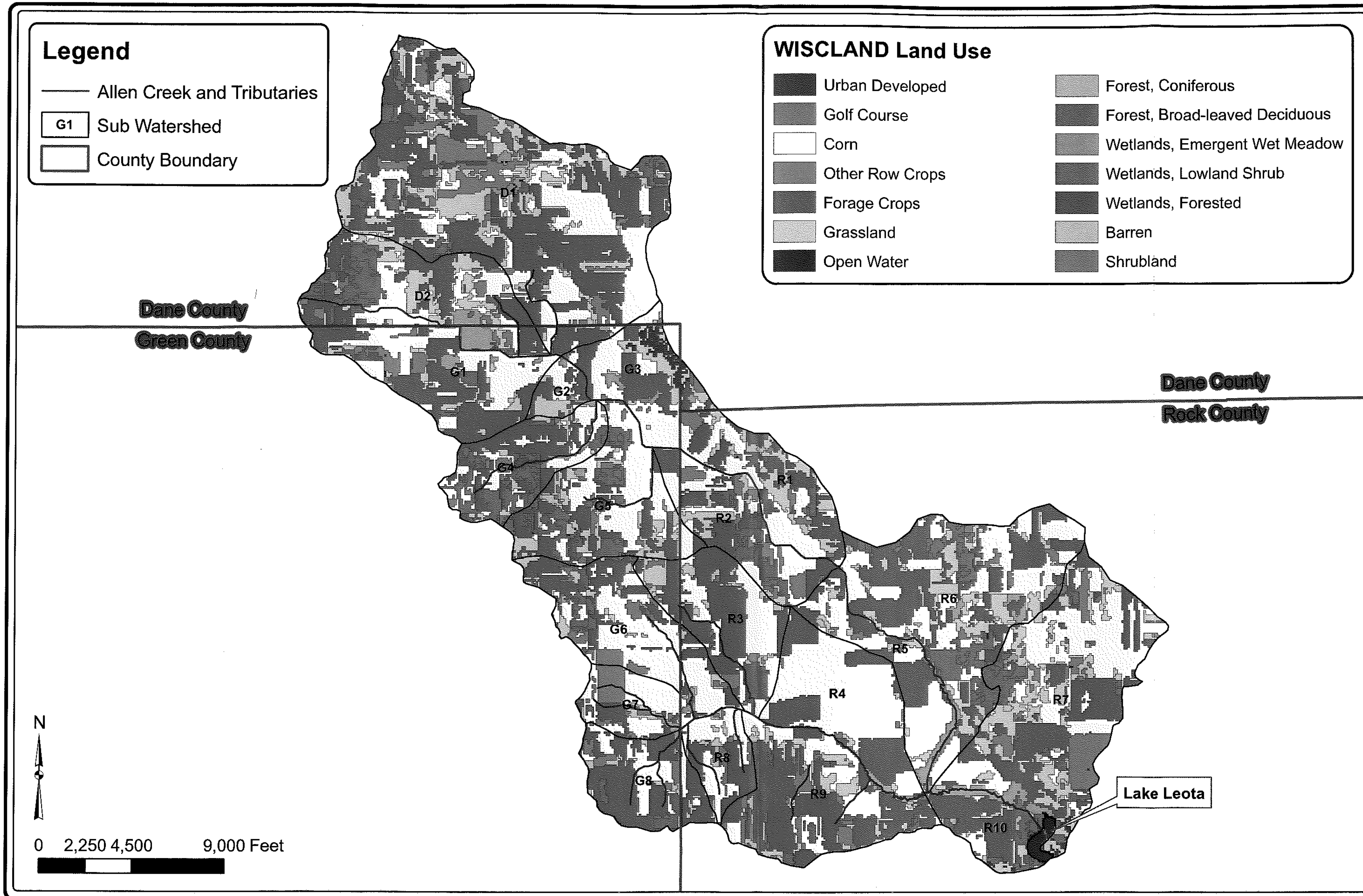
FIGURE 2.01-1
1-354.004



WISCLAND LAND USE IN WATERSHED (1991-1993)

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

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FIGURE 2.01-2
1-354.004

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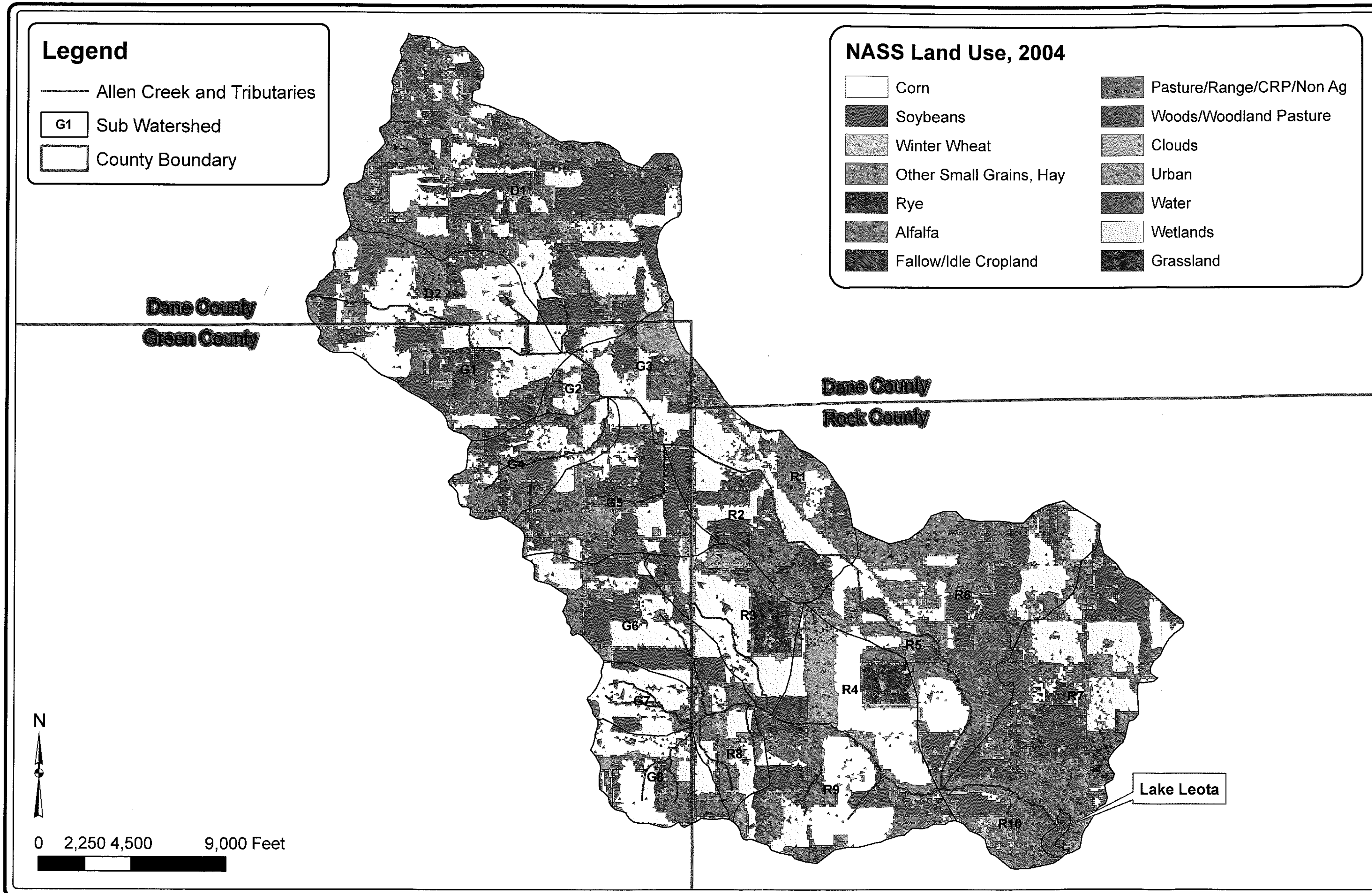

NASS LAND USE IN WATERSHED (2004)

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

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FIGURE 2.01-3
1-354.004

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2.02 PRECIPITATION

The depth and duration of rainfall in a watershed for a given storm event has a major impact on the amount of stormwater runoff produced. Historically, flooding and erosion has occurred in the Lake Leota watershed as a result of stormwater runoff from short-duration, intense storm events. These events most commonly occur in the spring or summer months.

The Lake Leota watershed is located in South Central Wisconsin. Expected rainfall depths for the area for 24-hour storm events of various frequencies are summarized in Table 2.02-1.

Frequency	Annual Exceedance Probability (%)	Rainfall Depths (in.)
1-year	100	2.25
2-year	50	2.78
5-year	20	3.53
10-year	10	4.20
25-year	4	5.18
50-year	2	6.06
100-year	1	7.06

Source: Bulletin 71, Rainfall Atlas of the Midwest

Table 2.02-1 Expected Rainfall for 24-Hour Storm Events

2.03 SOILS

The amount of stormwater runoff produced by a storm event is impacted by the types of soils in the watershed. Soils having a high percentage of sand and gravel will infiltrate a higher percentage of stormwater runoff than will soils having high clay content, meaning that sandy soil generally produces less runoff than clayey soil. The primary soil types in the Lake Leota Watershed are identified in Table 2.03-1. The soils data given in Table 3.04-1 was obtained from the Dane, Green, and Rock County soil surveys. Figures 2.03-1, 2.03-2, and 2.03-3 illustrate properties of the soils in the watershed. The soils data shown in Figures 2.03-1 through 2.04-1 was obtained from the USDA NRCS on-line soils data server (http://soildatamart.nrcs.usda.gov/). Figure 2.03-1 shows the drainage conditions of the soil types, which are grouped by drainage classes.

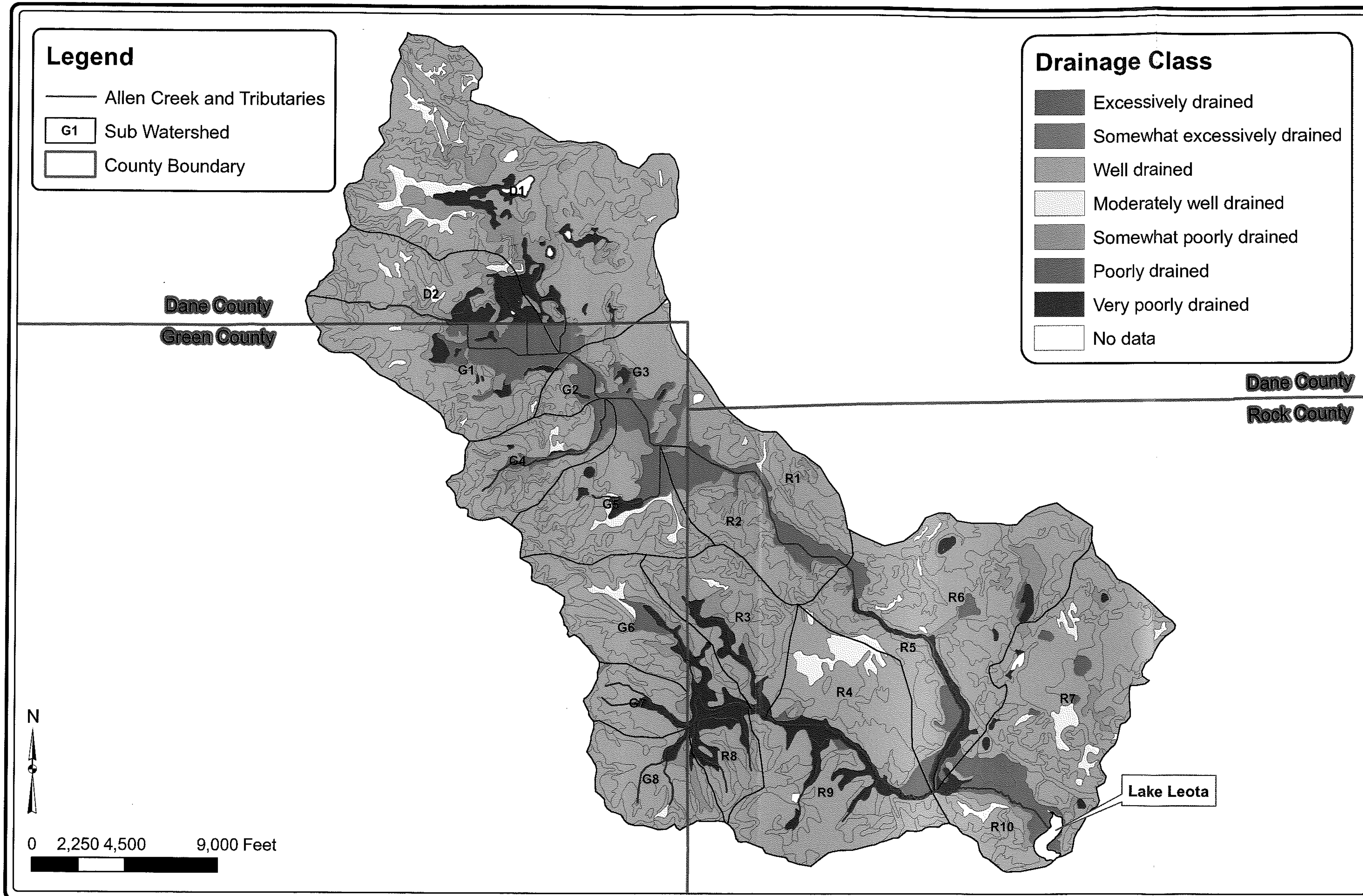
Approximately 83 percent of the soils in the watershed are classified by the NRCS as HSG Group B. Group B soils have a moderate infiltration rate when thoroughly wetted, are chiefly moderately deep to deep, moderately well-drained to well-drained, and have moderately fine to moderately coarse textures. Infiltration rates for the Group B soils range from 0.15 to 0.30 inches per hour, and they have a moderate rate of water transmission (the rate the water moves in the soil).

Soil erosion is a threat not only to farmland but also to downstream water resources. Soil erosion in various forms is a major source of NPS pollution in the Lake Leota watershed. Soil erosion occurs to some extent because of natural causes such as wind, drought, floods, and fires. However, human activities such as construction, logging, off-road vehicle use, and development practices can exacerbate soil erosion beyond natural levels. Some level of soil erosion, termed T, is tolerable in that it does not decrease soil productivity and is determined based on the soil properties. Rates of erosion greater than T are of concern as a threat to agricultural sustainability as well as water quality. Figure 2.03-2 groups the soils in the watershed by T in tons per acre per year (t/ac/yr).

According to the DNR's 1979 Management Alternatives Report, the major ridgetop and valley floor soils (St. Charles, Plano, Westville, and Pecatonica in particular) of the watershed are generally deep and fertile, causing them to have fairly high soil loss T values of 4 to 5 t/ac/yr. The wet lowland soils on nearly level slopes and loamy in nature (Sebewa and Kane in particular) are somewhat less deep and only moderately fertile, so they have lower soil loss tolerance limits of 2 to 3 t/ac/yr. At the time of the DNR's report, it was believed that the intense farming in the watershed was pushing the soils to or above their normal soil loss tolerance limits. The DNR warned that further intensification of farming practices could result in dramatic increases in upland sheet and rill erosion and depletion of the soil's natural fertility and stated that current (1979) levels of farming may not be harming the fertility of the soils but is causing a sediment problem for Lake Leota (DNR, 1979).

Symbol	Soil Name	Description	Acres in Watershed	Percent of Total
Br	Brookston silt loam		285	1.7%
DrA	Dresden silt loam	0 to 2 percent slopes	563	3.4%
DrB	Dresden silt loam	2 to 6 percent slopes	413	2.5%
DrC2	Dresden silt loam	6 to 12 percent slopes, eroded	171	1.0%
DsB	Downs silt loam	2 to 6 percent slopes, heavy substratum	568	3.4%
DuA	Durand silt loam	0 to 2 percent slopes	284	1.7%
DuB2	Durand silt loam	6 to 12 percent slopes, eroded	518	3.1%
DwB2	Durand silt loam	2 to 6 percent slopes, eroded	518	3.1%
FsA	Fox silt loam	0 to 2 percent slopes	239	1.4%
GrB2	Griswold loam	2 to 6 percent slopes, eroded	232	1.4%
HaA	Hayfield loam	0 to 2 percent slopes	273	1.7%
KeA	Kidder silt loam	0 to 2 percent slopes	468	2.8%
KeB2	Kidder silt loam	2 to 6 percent slopes, eroded	501	3.0%
KeC2	Kidder silt loam	6 to 12 percent slopes, eroded	366	2.2%
Mb	Marshan loam		256	1.6%
Mc	Marshan silt loam		304	1.8%
Md	Matherton silt loam		196	1.2%
MmB2	Miami silt loam	2 to 6 percent slopes, eroded	272	1.6%
PeA	Pecatonica silt loam	0 to 2 percent slopes	288	1.7%
PeB	Pecatonica silt loam	2 to 6 percent slopes	254	1.5%
PeB2	Pecatonica silt loam	2 to 6 percent slopes, eroded	288	1.7%
RnB2	Ringwood silt loam	2 to 6 percent slopes, eroded	228	1.4%
RtC2	Rotamer loam	2 to 6 percent slopes, eroded	355	2.2%
SaB	St. Charles silt loam	2 to 6 percent slopes	253	1.5%
SaB2	Saybrook silt loam	2 to 6 percent slopes, eroded	168	1[illegible]
SaC2	Saybrook silt loam	6 to 12 percent slopes, eroded	324	2.0%
SbA	St. Charles silt loam	0 to 2 percent slopes, gravelly substratum	232	1.4%
SbB	St. Charles silt loam	2 to 6 percent slopes, gravelly substratum	214	1.3%
Se	Sebewa silt loam		1145	6.9%
WfB2	Westville loam	2 to 6 percent slopes, eroded	241	1.5%
WnB2	Winnebago silt loam	2 to 6 percent slopes, eroded	223	1.4%
WvB	Westville silt loam	2 to 6 percent slopes	383	2.3%
WvC2	Westville silt loam	6 to 12 percent slopes, eroded	395	2.4%
	All Other Soil Types		5,083	31%
	Total		16,499	100%

Table 2.03-1 Predominant Soil Types in the Lake Leota Watershed



SOIL DRAINAGE CONDITIONS IN WATERSHED

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FIGURE 2.03-1
1-354.004

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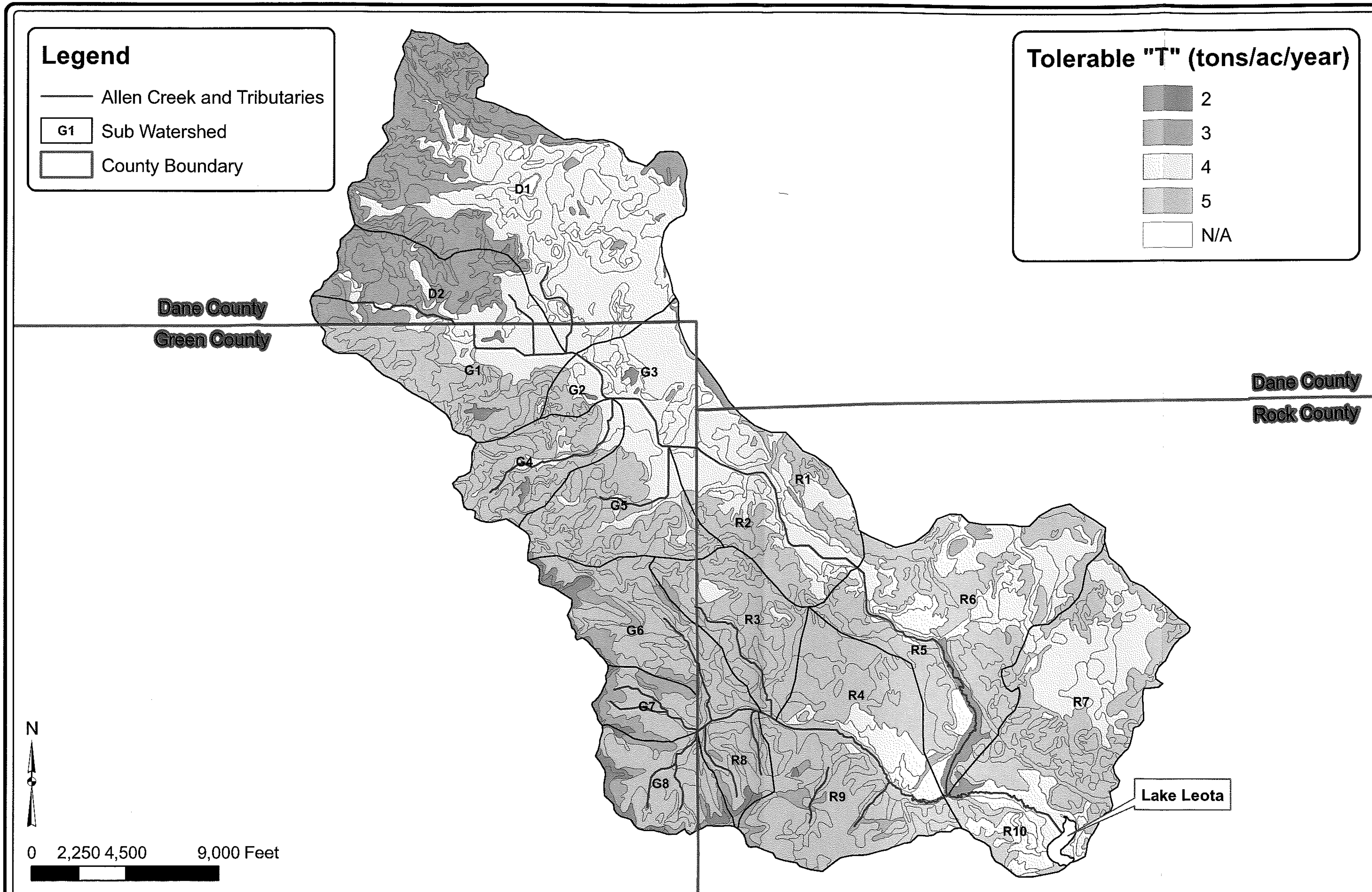

SOIL TOLERABLE "T" VALUES IN WATERSHED

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FIGURE 2.03-2
1-354.004

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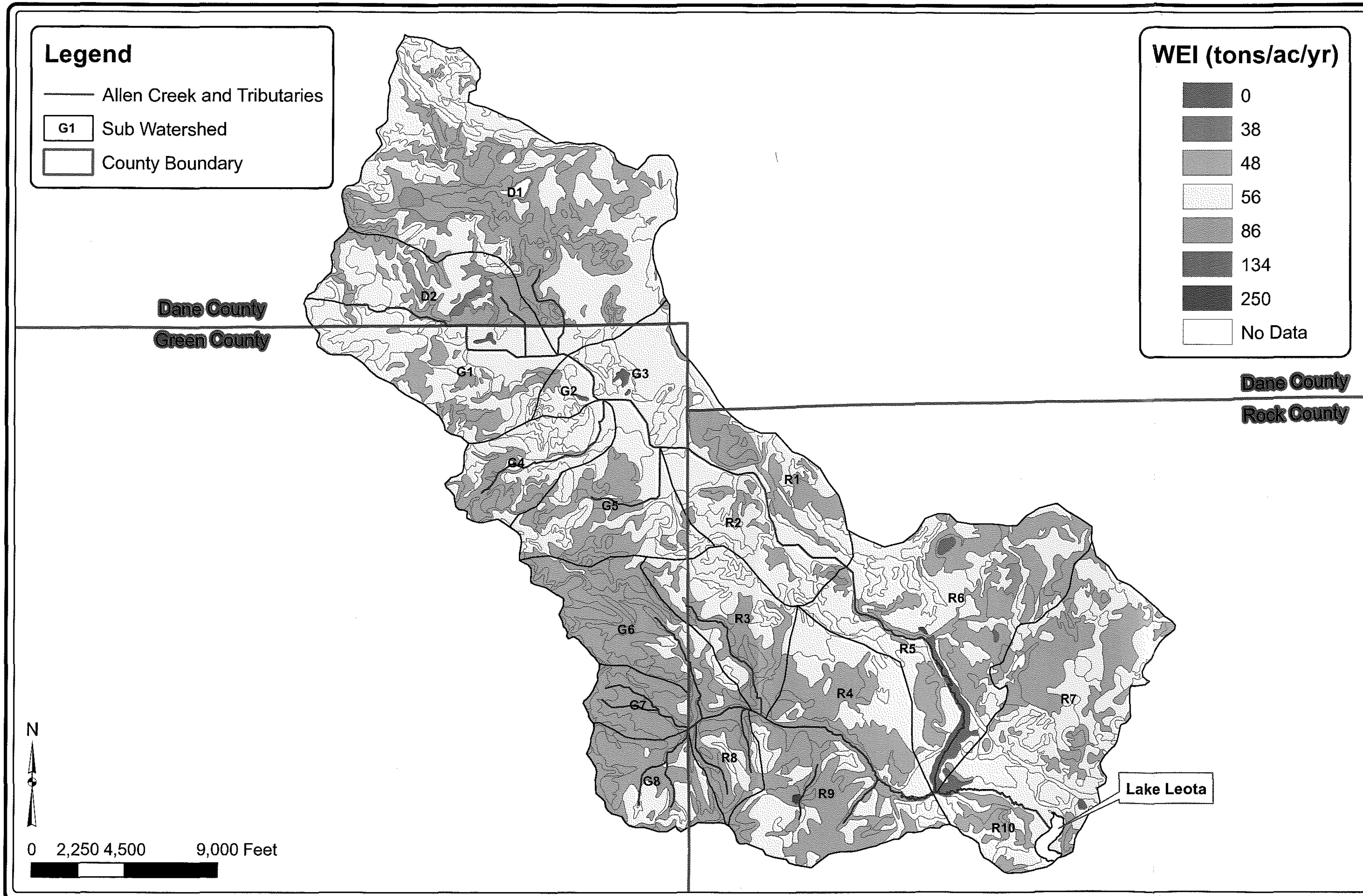

SOIL WIND ERODIBILITY INDEX (WEI) VALUES IN WATERSHED

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FIGURE 2.03-3
1-354.004

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Figure 2.03-3 groups the soils by the wind erodibility index (WEI), also in t/ac/yr units. This is another way of measuring erodibility of soils. However, sheet and rill erosion is more likely to be a problem in the Lake Leota watershed than wind erosion.

2.04 PHYSIOGRAPHY

Another cause of soil erosion is disturbance of land on steep slopes. The Lake Leota watershed is primarily flat, with approximately 38 percent of the slopes in the watershed having a 2 percent grade or less. A very small portion of the watershed has slopes greater than 10 percent (about 5 percent of the watershed). The physiography of the Lake Leota watershed is shown in Figure 2.04-1, which groups the soils by their representative slope gradients.

2.05 WATERSHED CONDITION

A. DNR Designations

According to the DNR, the main problems on Allen Creek are decreased habitat because of NPS pollutants (sedimentation), barnyards, and channelization. The Allen Creek and Middle Sugar River watershed is ranked as a medium priority for NPS pollution.

The lower portion of the creek, south of Evansville, is an ERW, and is meeting its designation. Allen Creek below Evansville has a very good, diverse warm water sport fishery. The dam that forms Lake Leota causes problems with warming water. About 4.5 miles of Allen Creek above Lake Leota are classified Class II and Class III trout waters (DNR, 1980).

B. Creek Condition

In its upper reaches, Allen Creek has been subjected to extensive ditching and channelization. The Union Drainage District began dredging and straightening the creek in 1909 north of Butt's Corners and extending to the Dane County line. Subsequent excavations occurred in 1951 and 1975, which added the four laterals seen on the drainage district figure in Appendix D. In 1976 the DNR restricted additional excavation activity to minimize impacts to trout habitat.

According to the DNR's Lake Leota Management Alternatives Report (1979), the combination of poor land use and the manipulation of the creek has led to increased water temperature, increased fertility, streambank erosion, and siltation in the streambed.

The DNR conducted a streambank erosion survey on both branches of Allen Creek in 1979. A total of 37 erosion sites were identified in the survey, and 17 sites were identified as being severely eroded. The DNR estimated that over half of the sites were a result of natural causes such as undercutting, slumping, and stream meandering. These were primarily small and localized erosion sites. The severe problem areas were all attributed to cattle pasturing areas or crossings, and all but two of them were located within 2.5 miles of the lake.

The DNR 1979 report estimated that only about 100 cubic yards per year of sediment were being delivered to Lake Leota from these streambank erosion sites, a small fraction of the total delivered sediment. The majority of sediment delivery to the lake was estimated to be from sheet and rill erosion.

C. Lake Condition

The average depth of water to the top of the sediment bed for the lower portion of Lake Leota was 1.5 feet in 2001 according to the 2001 UWP Report. In 1979, the average lake depth to the top of the sediment was approximately 3 feet according to the 1979 DNR Report.

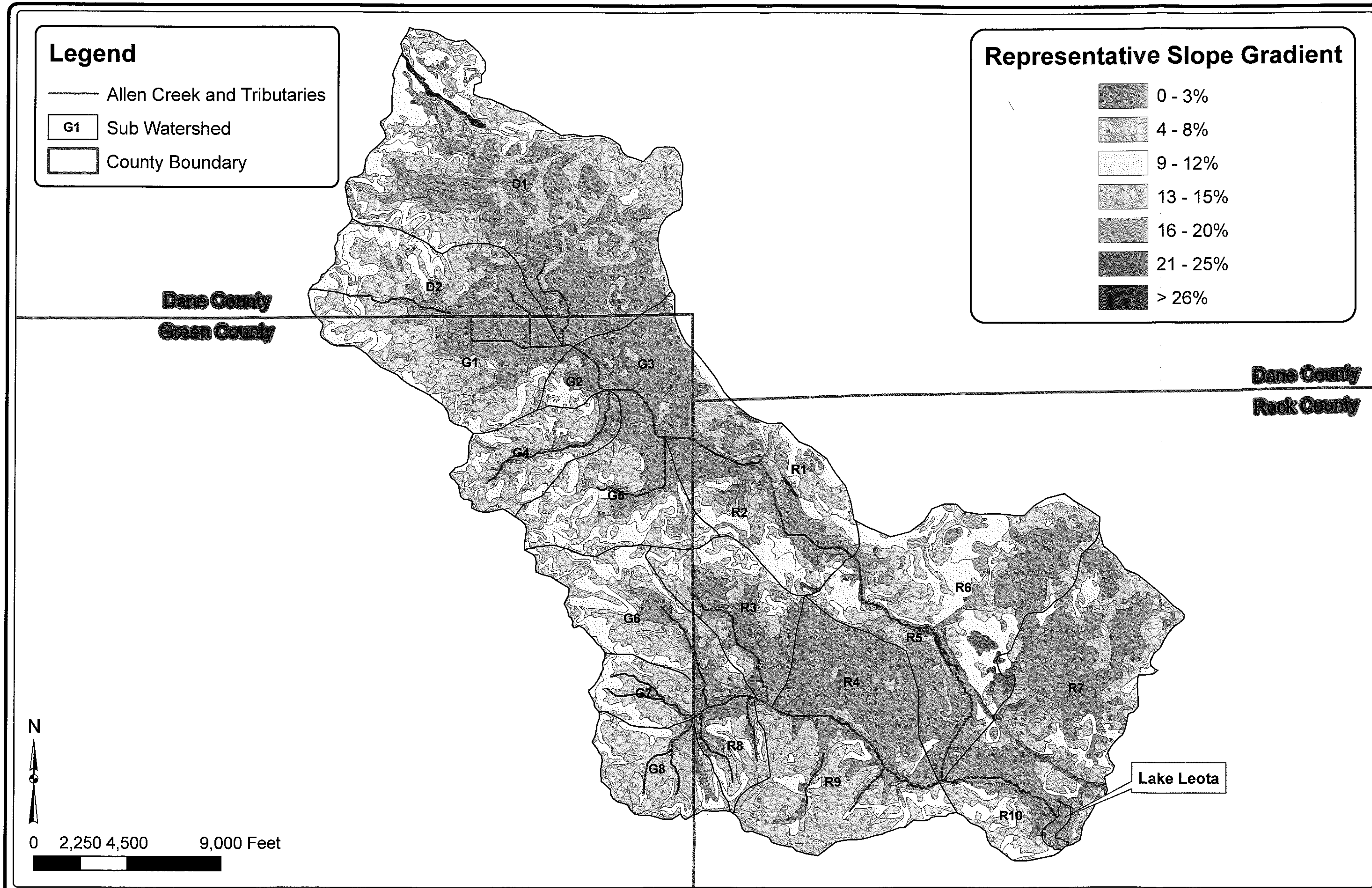
The 1980 report completed by Owen Ayres and Associates stated that the lake sediment samples taken on May 1, 1980, revealed a sediment composition of approximately 75 percent silts and clays. The organic content of the samples was reported to be approximately 10 percent by dry weight.

Five sediment samples were collected by SOLE members and submitted to the Soil and Plant Analysis Lab at the UW-Madison in January 2003. Lake sediments were tested for minerals, heavy metals, percent moisture, percent solids, pH, organic matter, phosphorus, potassium, nitrogen, and texture. The sediments had a moisture content between 51 and 56 percent. Most of the samples, except for one with a high sand content, were between 67 to 73 percent silt and between 23 to 32 percent clay. The results of the analysis were submitted to the DNR in 2003.

The DNR (1979) calculated the average soil loss for the Lake Leota watershed to be 44,000 tons per year, based on an average estimated sheet and rill erosion rate of 3.3 tons/acre/year throughout the watershed. Of this, it was estimated that only 4,000 to 12,000 tons/year reach Lake Leota, with an average rate of roughly 6,500 tons/year. Based on an average of the flowrates and TSS concentrations near the inlet and near the dam from 1964 to 1977 the DNR estimated that an average of approximately 0.9 inches per year accumulates in Lake Leota. This amounted to approximately 2,900 cubic yards per year of sediment accumulation (approximately 50 percent trapping efficiency) based on a 24-acre lake. Owen Ayres' 1980 report adjusted this calculation for a 26.6-acre lake to 3,200 cubic yards per year.

Using data from 1954 to 1964, the USDA Agricultural Research Service in 1977 estimated a sedimentation rate of 0.6 inches per year. The UW-Platteville students calculated a sediment accumulation rate of 0.8 inches per year based on the accumulation of sediment in the lake from 1979 to 2001.

The DNR report concluded that there was a much higher sedimentation rate during the 1964-1977 period than the 1954-1964 period, reflecting an increase in soil erosion resulting from basinwide intensification of farming practices. Specifically it mentions the shift from dairying to hog and cash crops having a negative impact.



SOIL SLOPES - REPRESENTATIVE VALUES IN WATERSHED

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FIGURE 2.04-1
1-354.004

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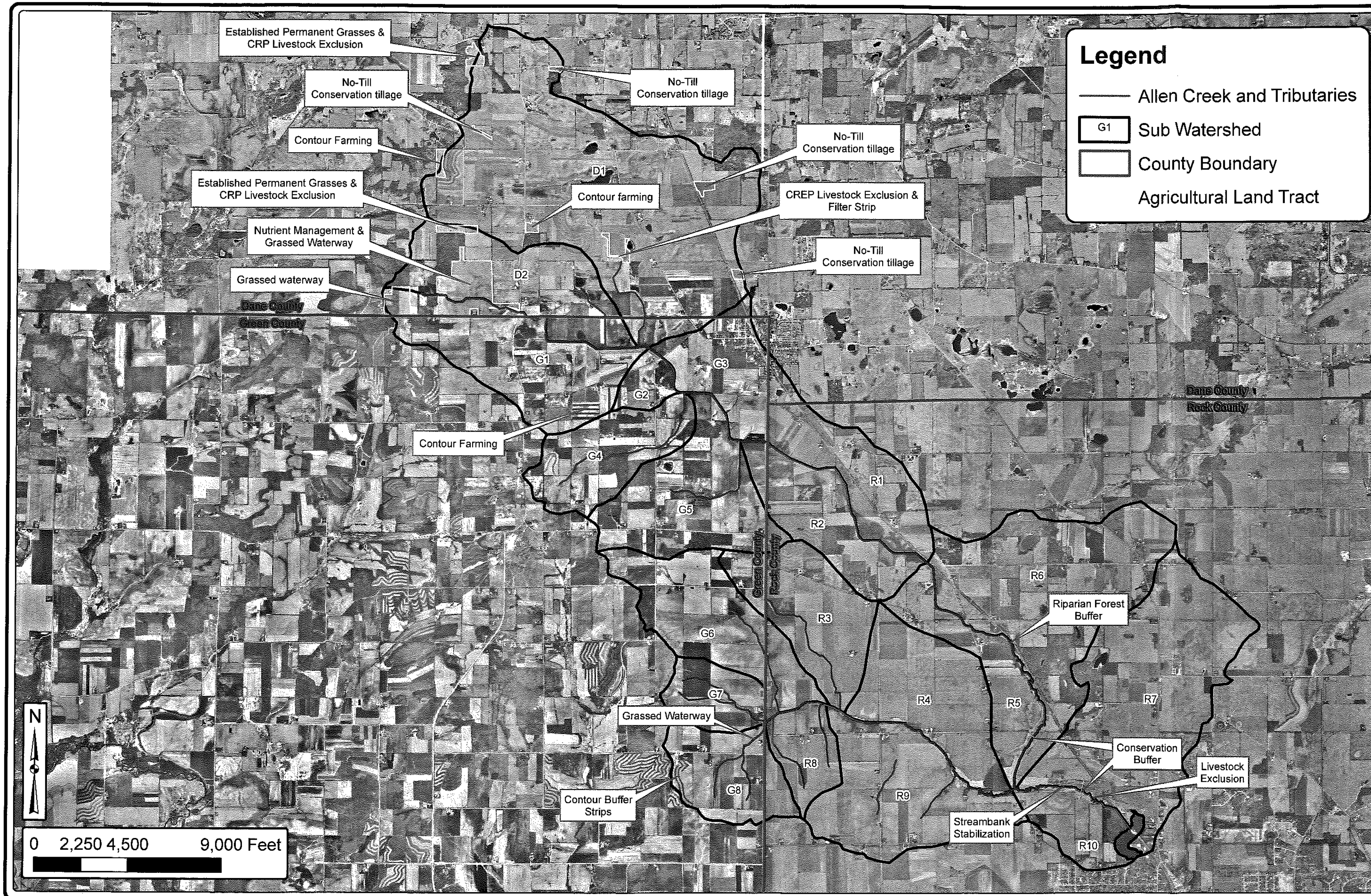
2.06 EXISTING BMPS

According to Roger Allan, the most important BMP in terms of erosion and water quality that has been widely incorporated in the watershed is the no-till operations that approximately 60 percent of the fields now receive. This is a significant change from 30 years ago, when standard farming practices revolved around full tilling of crops. This is discussed further in Section 3.

Additional BMPs include buffer strips near sensitive areas, grassed waterways, manure and nutrient management planning, diversions, riparian forest buffers, and other agricultural conservation practices. Figure 2.06-1 shows some examples of existing BMPs in the watershed that were noted during the streambank assessment.

In Dane County, the Land Conservation Department (LCD) has documented reported BMPs in GIS format. Some of these are shown in Figure 2.06-1, and the associated land tracts for each practice are outlined. Rock and Green Counties have not yet catalogued BMPs digitally, to our knowledge.



EXAMPLES OF EXISTING BMPS IN WATERSHED

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FIGURE 2.06-1
1-354.004

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SECTION 3
NONPOINT SOURCE POLLUTANT LOAD MODELING

3.01 INTRODUCTION TO EROSION AND SEDIMENT DELIVERY

There are many sources that contribute to high sediment and nutrient concentrations to water bodies. In most cases, the largest contributor to high levels of nutrients and sediment in water bodies is NPS pollution. In urban areas, NPS pollutants are primarily leaves, trash, soot, construction sediment, oil, heavy metals, and other debris that accumulate on streets and are washed into storm sewers and streams. In rural areas, erosion of soil from wind and water is the most significant source of NPS pollution.

The Lake Leota watershed is primarily rural, so the sediment and nutrient loading from developed areas and construction is likely insignificant compared to the loading that results from streambank erosion and runoff carrying sediment and nutrients from fields and pastures. Therefore, the primary focus of the NPS pollutant load modeling for this study is streambank and sheet and rill erosion.

Erosion of soil in a watershed can be caused by water (rainfall and runoff) or wind. Wind erosion is most common in the winter when the ground is frozen and the top layer of soil is dry and loose and vegetation is minimal. However, the primary cause of soil erosion in the Midwest is water erosion in the form of sheet, rill, gully, and channel erosion (Ouyang, 1997). Sheet and rill erosion accounts for approximately two-thirds of the gross erosion in the Great Lakes region while gully and channel erosion accounts for the remainder (Ouyang, 1997).

Eroded soil is transported via runoff, gullies, and streams and is deposited in transit, causing sedimentation. A fraction of eroded soil passes through the channel system while some is deposited in water channels. Sediment yield is the term used for the amount of eroded soil that is delivered to the outlet of the watershed or another point of interest. The sediment delivery ratio (SDR) is the amount of eroded soil that contributes to sediment yield divided by the gross soil erosion in the entire watershed. The SDR in a given watershed is influenced by the type of soils, the watershed size, slope, nearness to the main stream, rainfall-runoff factors, and other physical attributes.

Delivery rates are different than soil loss rates. Soil loss occurs at a very localized level, on a field surface or a streambank for example. Delivery rates incorporate the fraction of sediment that settles out in transit, either in sheet runoff or in waterbodies such as Allen Creek. Therefore the loading of sediment to Lake Leota is much less than the soil eroding from farm fields and streambanks.

It is difficult to accurately predict sediment delivery. Many models have been devised that relate SDR to drainage area and/or distance. Watersheds with a large drainage area and fields with long distances to streams have lower sediment delivery ratios. Steep landscapes with short distances to waterways have higher delivery ratios. The model used to predict sediment delivery in this study is Williams' 1977 model that correlates SDR with drainage area, relief-length ratio, and runoff curve number (Ouyang, 1997). The model was developed empirically using data from 15 drainage basins in Texas. The model is expressed as follows:

$$SDR=1.366\times10^{-11}(DA)^{-0.0998}(ZL)^{0.3629}(CN)^{5.444}$$

where DA = drainage area (square kilometers), ZL = relief-length ratio (m/km), and CN = long-term runoff curve number, which is related to the amounts of impervious and pervious ground cover. The relief-length ratio is the difference of the elevations in the watershed divide and outlet divided by the distance between the two points measured parallel to the main stem drainage path.

Table 3.01-1 displays the factors described above and the calculated SDRs for each subbasin in the Lake Leota watershed. SDRs were predicted for each subbasin at two locations: at the outlet of the subbasin, and at the entrance to Lake Leota. The latter takes into account the distance from the outlet of a subbasin to the lake. The average SDR at the outlet of a subbasin is 52 percent, and the average SDR at the entrance to the lake from an individual subbasin is 38 percent.

The Williams model incorporates more factors than most SDR models, which are based solely on the size of the drainage area. However, the model does not take into account the constitution of the soils or the type of ground cover. Soil types matter because soils with course particles settle out faster than soils with finer particles like clay. Also, the model relates SDR to CN, which is a somewhat questionable relationship because an open water body has a CN of 98, which would imply high runoff rates, yet water bodies such as ponds and lakes have probably the highest sediment capture rates. Therefore, the SDRs predicted in Table 3.01-1 are probably higher than actual SDRs.

Another problem with the SDR model is that it is not possible to take into account BMPs that are put in place to trap sediment in the watershed. The controls and practices and land use covers which prevent erosion are usually also the same factors that trap sediment and prevent it from being transported downstream.

Despite these shortcomings, the model can provide an idea of the sediment yield at Allen Creek and at Lake Leota. These SDR values can be applied to the soil loss rates presented in Sections 3.02 and 3.03. The fraction of sediment that actually reaches Lake Leota is much smaller than the overall erosion, as evidenced by the SDRs as low as 25 percent for the subbasins farthest from the lake.

3.02 STREAMBANK EROSION

This section describes the Allen Creek streambank erosion field assessment and modeling performed by Strand.

A. Allen Creek Field Assessment

Streambank erosion can be quantified either by direct field measurement or by visual observations and estimation. Direct field measurement is desired; however, it is not always practical. It is not usually feasible to measure erosion of a streambank over time, as in this case, since the stretch of

TABLE 3.01-1

PREDICTED SEDIMENT DELIVERY RATIOS (SDR) FOR WATERSHED SUBBASINS

Subbasin	Total Acres	High Elev. in Subbasin	Low Elev. (at outlet)	Relief Dif. to Outlet (ft)	Distance from High Point to Outlet (ft)	Subbasin Relief-Length Ratio (to Outlet)	Relief Dif. to Lake (ft)	Distance to Lake along Creek from Outlet (ft)	Total Distance from High Point to Lake (ft)	Overall Relief-Length Ratio (to Lake)	Average RCN	SDR (to outlet) (%)	SDR (to lake) (%)
D1	2,876	1100	960	140	18,200	0.008	190	35,300	53,500	0.004	74	34	25
D2	837	1090	960	130	11,875	0.011	180	35,800	47,675	0.004	74	43	29
G1	945	1100	960	140	12,750	0.011	190	35,800	48,550	0.004	77	53	37
G2	134	1030	960	70	3,625	0.019	120	32,425	36,050	0.003	77	79	42
G3	477	980	960	20	7,000	0.003	70	32,375	39,375	0.002	78	37	32
G4	590	1100	960	140	9,375	0.015	190	37,625	47,000	0.004	72	43	27
G5	891	1090	960	130	10,000	0.013	180	33,625	43,625	0.004	73	43	28
G6	828	1080	950	130	14,125	0.009	170	19,125	33,250	0.005	78	54	44
G7	305	1060	950	110	5,125	0.021	150	22,625	27,750	0.005	78	82	49
G8	525	1040	950	90	5,625	0.016	130	22,625	28,250	0.005	76	60	38
R1	649	1010	940	70	14,250	0.005	100	21,875	36,125	0.003	75	36	29
R2	591	1060	940	120	7,250	0.017	150	21,875	29,125	0.005	75	56	37
R3	713	1060	940	120	8,750	0.014	150	18,125	26,875	0.006	77	59	43
R4	797	980	920	60	13,125	0.005	70	7,400	20,525	0.003	78	42	38
R5	475	980	920	60	14,750	0.004	70	7,375	22,125	0.003	79	46	42
R6	1,556	1010	920	90	14,500	0.006	100	7,375	21,875	0.005	73	31	28
R7	1,689	980	910	70	12,500	0.006	70	0	12,500	0.006	74	32	32
R8	286	1050	940	110	6,125	0.018	140	19,125	25,250	0.006	80	88	58
R9	1,006	1050	920	130	12,125	0.011	140	7,400	19,525	0.007	75	45	39
R10	306	1000	910	90	2,500	0.036	90	0	2,500	0.036	74	74	74
Total/Ave	16,476											52	38

streambank being assessed is very long and since the study time period is very short. Therefore it is usually more practical to observe streambanks for signs of erosion and attempt to estimate the erosion rates that have occurred in the past.

Strand Associates conducted an erosion assessment survey of the streambanks of Allen Creek during April and May of 2005. The survey extended from Lake Leota to the Green/Rock County line along the two main branches of the creek. Locations of lateral erosion and tributaries and gullies were documented, photographed, and recorded using GPS. Any existing BMPs were also documented. The creek was divided into five segments for the survey that were color-coded for reference: blue, purple, pink, green, and orange. Color-coding was used so that there would be no confusion or conflict with any future numeric reach description established by state or local agencies. Figure 3.02-1 shows the extents of the color-coded segments.

Lateral erosion along the streambank was assessed using the visual assessment method. This method is summarized in Table 3.02-1, which was adopted from the USDA NRCS Streambank Erosion Field Office Technical Guide (November 2003). Areas of erosion along the banks of the creek were visually assessed, measured, and documented and then assigned a "severity" rating, as shown in Table 3.02-1. The severity of the erosion is based on visual characteristics, as described in Table 3.02-1. Each rating is associated with an average lateral recession rate, as determined by NRCS.

An additional rating category (Rating 1) was added to identify streambank locations that have been stabilized by a BMP such as riprap. There were four locations on the blue segment that were identified as having been stabilized by riprap. These are shown on Figure 3.02-2.

The results of the streambank survey are depicted graphically in Figures 3.02-2 through 3.02-6. Streambank assessment forms used in the Allen Creek streambank survey are provided in Appendix B. Photo logs and photo maps of the streambank survey are included on a compact disk in Appendix B.

Photographs of some examples of slight, moderate, severe, and very severe erosion locations are shown in Figures 3.02-7 through 3.02-10.

In addition to streambank erosion locations, all vehicle crossings (fords) and minor tributaries to Allen Creek were documented and photographed. There were approximately eight vehicle crossings (not including bridges) identified. An example of a vehicle crossing (on the pink section, Photo 113) is shown in Figure 3.02-11.

Figure 3.02-7 Slight (Rating 2) Streambank Erosion (pu-20, Photo 74)

Figure 3.02-8 Moderate (Rating 3) Streambank Erosion (b-6, Photo 14)

Figure 3.02-9 Severe (Rating 4) Streambank Erosion (or-06, Photo 183)

Figure 3.02-10 Very Severe (Rating 5) Streambank Erosion (or-08, Photo 187)

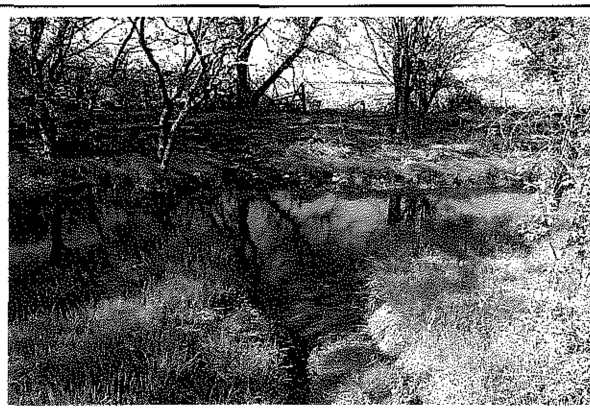
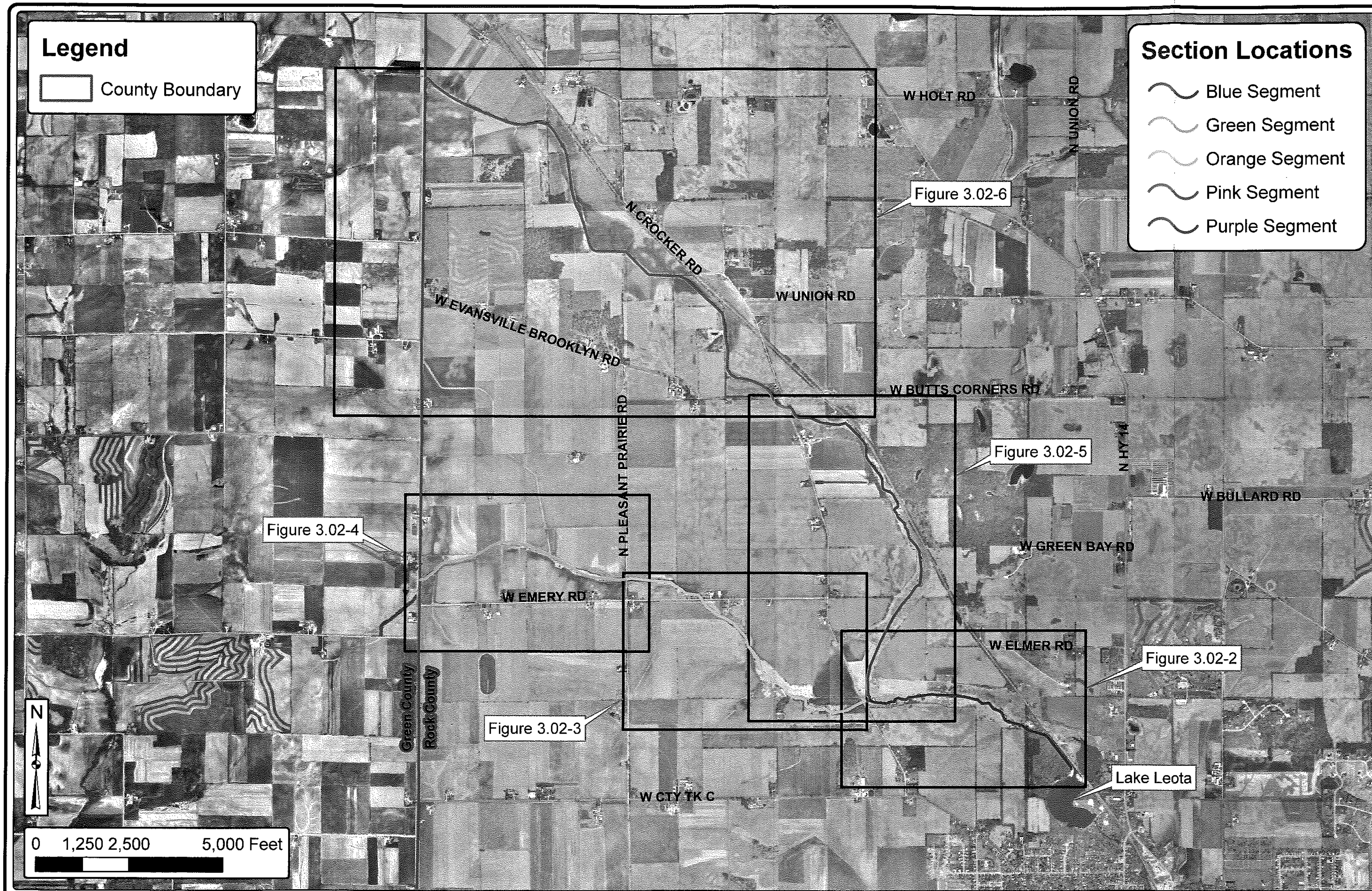


Figure 3.02-11 Vehicle Stream Crossing



ALLEN CREEK STREAM BANK ASSESSMENT - SEGMENT LOCATIONS

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FIGURE 3.02-1
1-354.004

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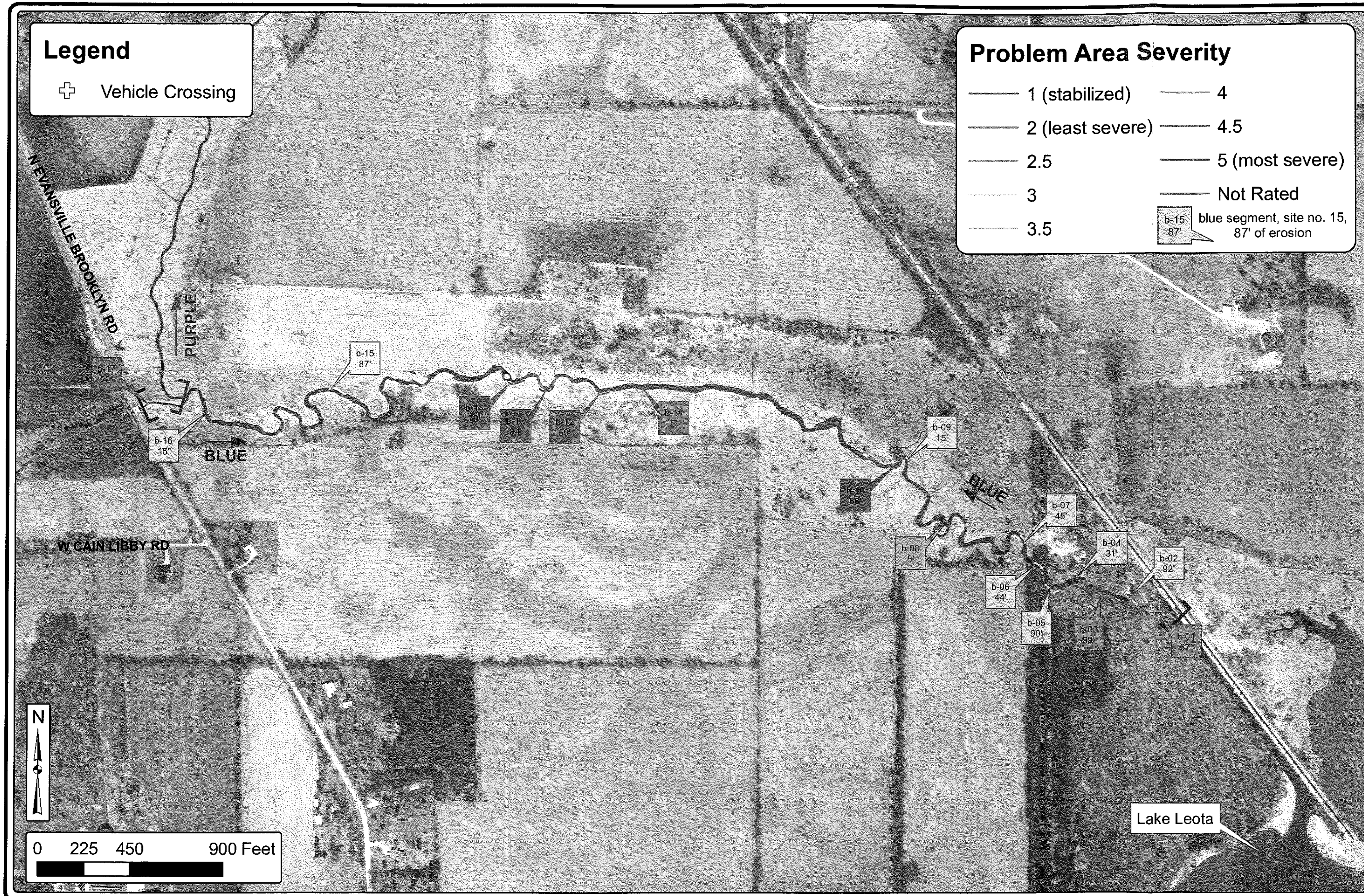

ALLEN CREEK STREAM BANK ASSESSMENT - BLUE SEGMENT

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

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FIGURE 3.02-2
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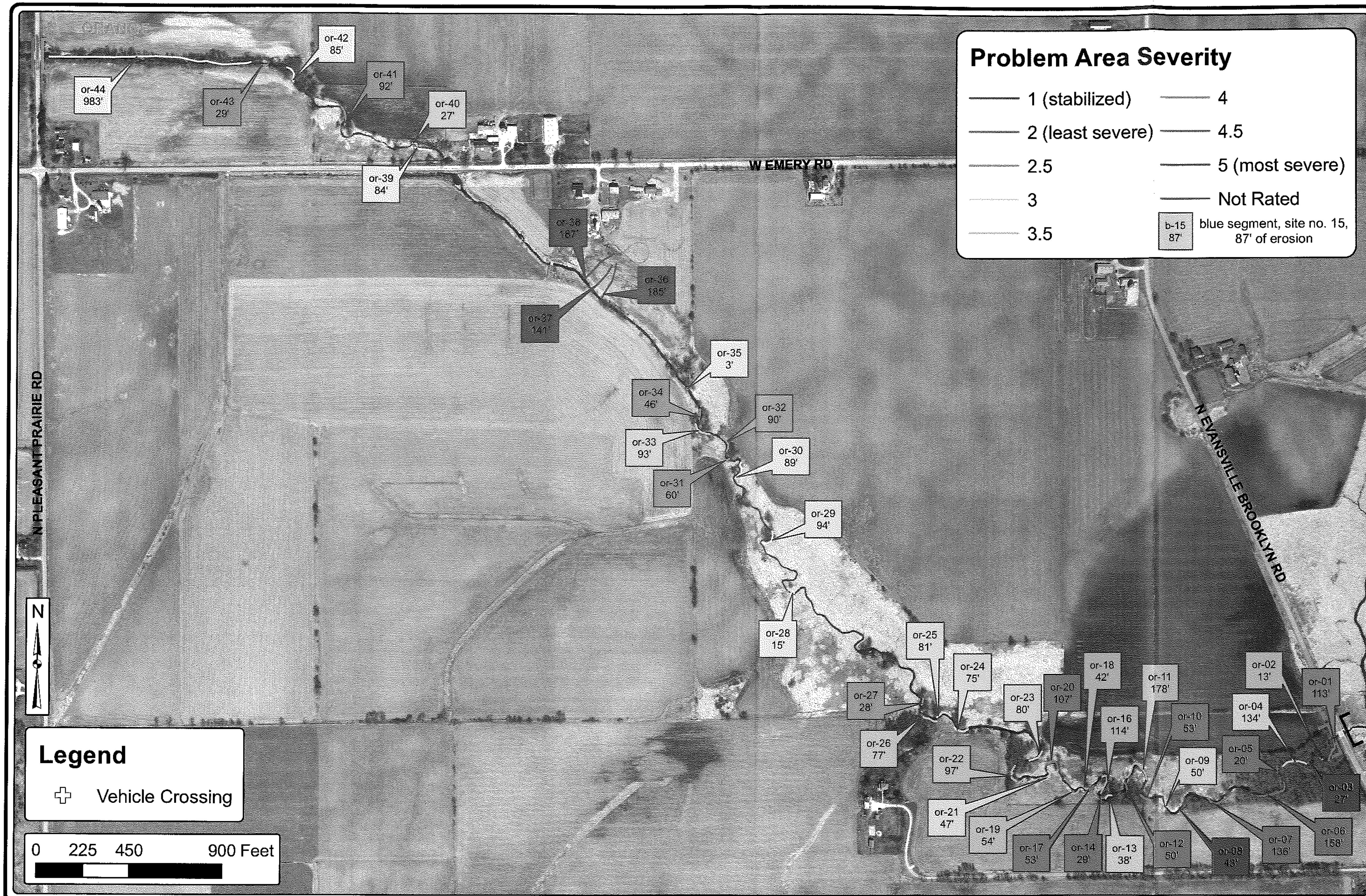

ALLEN CREEK STREAM BANK ASSESSMENT - ORANGE SEGMENT

LAKE LEOTA WATERSHED STUDY
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FIGURE 3.02-3
1-354.004

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ALLEN CREEK STREAM BANK ASSESSMENT - GREEN SEGMENT

LAKE LEOTA WATERSHED STUDY
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FIGURE 3.02-4
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FIGURE 3.02-5
1-354.004

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ALLEN CREEK STREAM BANK ASSESSMENT - PURPLE SEGMENT

LAKE LEOTA WATERSHED STUDY
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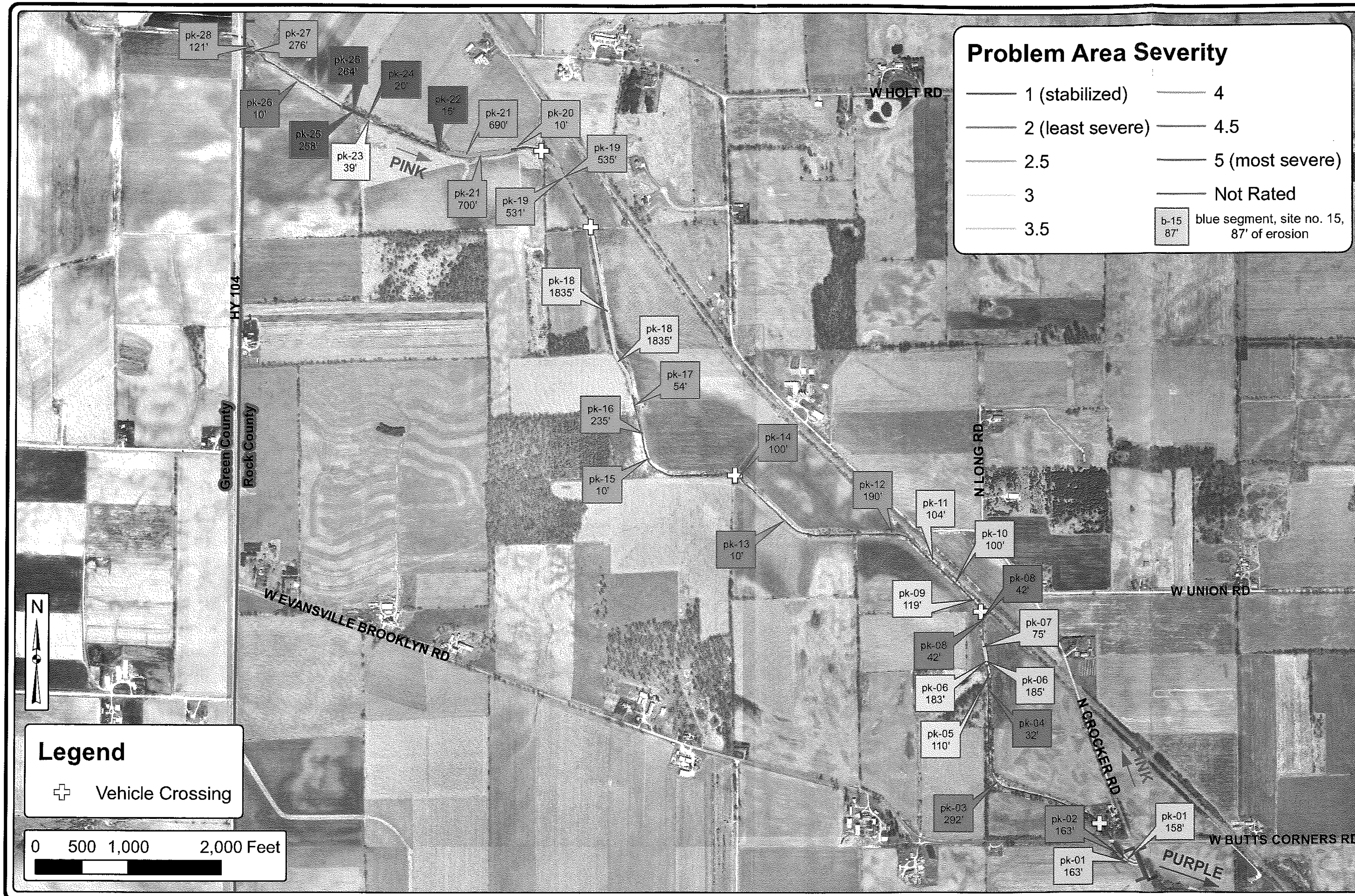

ALLEN CREEK STREAM BANK ASSESSMENT - PINK SEGMENT

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.02-6
1-354.004

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B. Streambank Erosion Quantification

The average annual lateral recession rate of a streambank is the thickness of soil eroded from the bank surface (perpendicular to the face) in an average year. Streambank erosion often occurs in blowouts or chunks because of excessive runoff or a flooding event. For example, a large storm may cause a bank to recede by 10 feet or more in one area. This would result in a very large recession rate for that storm. However, it must be averaged over all the years that no major storms or blowouts occurred to get the annual recession rate. The lateral recession rates shown in Table 3.02-1 are based on experience and a large data set of streambank erosion cases.

Code	Category	Visual Observations/ Features	Lateral Recession Rate (Ft/Yr)
1	Stable	▪ Grass bank or rock bank, noneroding	N/A
2	Slight	▪ Some bare bank but active erosion not readily apparent ▪ Some rills but no vegetative overhang No exposed tree roots	0.01-0.05
3	Moderate	▪ Bank is predominantly bare with some rills and vegetative overhang Some exposed tree roots but no slumps or slips	0.06-0.2
4	Severe	▪ Bank is bare with rills and severe vegetative overhang ▪ Many exposed tree roots and some fallen trees and slumps or slips ▪ Some changes in cultural features such as fence corners missing and realignment of roads or trails Channel cross section becomes U-shaped as opposed to V-shaped	0.3-0.5
5	Very Severe	▪ Bank is bare with gullies and severe vegetative overhang ▪ Many fallen trees, drains, and culverts eroding out and changes in cultural features ▪ Massive slips or washouts common Channel cross section is U-shaped and stream course may be meandering	0.5+

Adapted from USDA NRCS Streambank Erosion Field Office Technical Guide (11/2003)

Table 3.02-1 Streambank Erosion Visual Assessment Table

Once an average annual recession rate is established, the volume and weight of material eroded over time can be calculated using the NRCS Direct Volume Method. The equation is shown below:

$$\frac{(eroding\ area)(lateral\ recession\ rate)(density)}{2{,}000\ lbs/ton} = erosion\ in\ tons/year$$

The eroding area is equal to the length of erosion times the average bank height (perpendicular to bank surface). For each erosion location, a lateral recession rate was assigned, an eroding area was calculated, and the approximate erosion rate was calculated in cubic feet per year. To get the tons per year of eroded material, a density was assumed based on the types of soils in the watershed. NRCS gives approximate density ranges in pounds per cubic foot (pcf) for different types of soils, which are shown in Table 3.02-2.

Soil Texture	Approximate Density (pcf)
Clay	60-70
Silt	75-90
Sand	90-110
Gravel	110-120
Loam	80-100
Sandy Loam	90-110
Gravelly Loam	110-120

Source: NRCS Streambank Erosion Field Office Technical Guide

Table 3.02-2 Soil Densities

The predominant soil texture in the watershed is silt loam. Therefore, an average soil density of 90 pcf was assumed for the erosion calculations.

Based on these calculations, the estimated average annual soil loss from streambank erosion along Allen Creek is approximately 13,650 cubic feet per year (505 cubic yards), or 614 tons per year.

A breakdown of erosion rates by stream segment is shown in Table 3.02-3. The results in Table 3.02-3 show that the most erosion occurs along the pink section (the uppermost reach of Allen Creek), both in terms of length of total streambank and volume or weight. However, the orange segment, the lower reach of the unnamed tributary, has ~~the~~ highest erosion rate per unit length of eroded bank. This indicates that the severity of the erosion along the orange segment is greater, even though there is less annual total soil loss from this segment in terms of volume or weight.

Section	Total Length of Eroded Bank (ft)	Approx. Annual Soil Loss (cf/yr)	Approx. Annual Soil Loss (tons/yr)	Loss per Length of Eroded Bank (lbs/yr/ft)
Blue	611	307	14	46
Purple	3,349	1,097	49	30
Pink	9,507	7,476	336	70
Orange	5,757	4,690	211	74
Green	271	81	4	28
Total	19,494	13,651	614	

Table 3.02-3 Streambank Erosion Summary by Stream Segment

Table 3.02-4 summarizes the loading to Lake Leota from streambank erosion by subbasin. SDRs calculated in Section 3.01 were used to estimate the sediment yield.

Subbasin	Streambank Erosion Soil Loss (tons/yr)	Streambank Erosion Soil Loss (cf/yr)	SDR to Lake (%)	Sediment Loading to Lake from Streambank Erosion (tons/yr)	Sediment Loading to Lake from Streambank Erosion (cf/yr)	Sediment Loading to Lake from Streambank Erosion (in/yr)
G6	1.0	23	81	0.82	18	0.000
R1	165	3,663	81	134	2,973	0.031
R2	146	3,251	65	96	2,126	0.022
R4	136	3,013	90	122	2,708	0.028
R5	32	708	91	29	647	0.007
R6	43	951	89	38	850	0.009
R7	4.9	109	100	4.9	109	0.001
R8	0.4	8	65	0.25	5	0.000
R9	78	1,727	86	67	1,492	0.015
R10	8.9	197	100	8.9	197	0.002
Total	614	13,650		501	11,126	0.12

Table 3.02-4 Sediment Loading to Lake Leota from Streambank Erosion by Subbasin

SDRs for streambank erosion are higher than SDRs for sheet erosion because the erosion location is much closer to the water body, and the sediment does not have the opportunity to settle out in overland flow. The sediment loading rate in inches per year to the lake was calculated by dividing the surface area of the lake (26.6 acres) by the sediment loading in cubic feet per year (cf/yr).

Therefore, according to the modeling, approximately 0.12 inches of sediment is delivered each year to Lake Leota from streambank erosion.

By comparison, the DNR 1979 report estimated that approximately 100 cubic yards (2,700 cubic feet) per year of sediment were being delivered to Lake Leota from the streambank erosion sites identified on Allen Creek. Our estimate of 11,126 cf/yr (412 cy/yr) is about four times greater than the DNR's estimated value. This is likely due to the additional erosion locations and the increased severity of the locations identified in our survey.

3.03 AGRICULTURAL RUNOFF (SHEET AND RILL EROSION)

Solids and phosphorus are two of the most common NPS pollutants resulting from agricultural activity. Delivery of these pollutants to water bodies can be estimated either by monitoring water quality in a watershed or by modeling. It is often not feasible or practical to monitor pollutant loads in a watershed, as reliable data is usually only obtained if the monitoring period is very long (many years) and the sample size is large (frequent and spread across a watershed). Climatic conditions also make it very difficult to achieve accurate sampling, as stormwater runoff is inherently produced during bad weather.

Modeling can be performed using information known about the watershed and basic assumptions and simplifications. This section describes the methodology used and the results of modeling soil loss as a result of erosion from the agricultural lands as well as grasslands, shrublands, and idle/fallow lands in the Lake Leota watershed.

A. Method

Sheet and rill erosion on agricultural and grassed lands in the Lake Leota watershed were modeled using a method that combined erosion rates from the NRCS Revised Universal Soil Loss Equation (RUSLE2) computer program, GIS land use data, NRCS soil data, and generalizations regarding farming practices in the watershed. Using GIS capabilities, the watershed was broken into thousands of land parcels based on soil texture, slope gradient, land use, and subbasin. Land parcels with like properties were grouped, and a matrix was created. RUSLE2 was used to calculate the soil loss rate in tons per acre per year for each land parcel group based on certain assumptions. The soil loss rates were then averaged for each subbasin.

This model was repeated for three conditions: baseline, existing, and no-till. These three conditions are described in more detail in the following three sections. Below are descriptions of the factors used to calculate soil loss rates using the RUSLE2 model.

1. Soils

There are approximately 62 soil types in the Lake Leota watershed. To simplify the model, these soils were lumped together into three categories by soil particle size: silt loam, clay, and sand. The most common type of soil in the watershed is silt loam. This is also the most conservative estimate for TSS loads because silt loam has one of the highest erodibity rates. Clay, on the other hand, is less susceptible to erosion but carries farther in water bodies because the particles are smaller in size. In RUSLE2, the soil types for each category are:

a. Clay, moderate-to-high organic matter (OM), less than 50 percent clay
b. Silt loam, moderate-to-high OM
c. Sand

2. Slope and Row Grade

Another factor that greatly impacts the surface soil erosion on a field is the steepness, or slope. The slope can be defined by two factors, the slope gradient and the slope length. Typically, the steeper the slope gradient, the shorter the slope length. Soils in the county soil surveys are assigned a range of slope gradients, so the representative value (average) slope gradient was used in this study. The representative values of slope gradients in the watershed are shown in Figure 2.04-1. The associated slope lengths for different slope ranges were provided by Roger Allan of NRCS. These values are typical of slope lengths in the watershed. These values are summarized in Table 3.03-1.

Approximate Slope Gradient (%)	Approximate Slope Length (feet)	Approximate Absolute Row Grade (%)
0 - 5	150	1 - 2
6 - 12	100	3 - 4
12 - 20	75	5 - 6
20 - 30	60	7
> 30	25	8

Source: Roger Allan, NRCS Rock County District

Table 3.03-1 Slope Gradients, Slope Lengths, and Absolute Row Grades in Watershed

The absolute row grade is another factor in agricultural runoff and has to do with the ability of the machinery to till along the contour or at an angle to the contour. The grade off the contour at which the tillage occurs is a factor of the steepness of the slope, as the steeper the slope the more difficult it is for the machinery to maintain an even elevation. The approximate assumed absolute row grades for different slopes are shown in Table 3.03-1 and were also provided by Roger Allan.

3. Tillage Practices and Residue

Residues left on fields as a result of tillage practices have a substantial impact on the TSS and total phosphorus (TP) loading rates in runoff from those fields. In fact, Roger Allan of NRCS cited residue as the most important practice for reducing pollutant loads. Three general tillage practices were considered for the watershed: no-till, reduced till, and full till. No-till assumes that the maximum amount of residue remains on the field, greatly reducing the surface erosion. Reduced till leaves slightly less residue: according to Roger Allan, more than 30 percent of total residue remains. Full till is traditional tillage practices, which leaves less than 30 percent of residue on the field.

General Tillage Practice	Cornstalk Residue (%)	Soybean Residue (%)
No-till	70	45
Reduced Till	40	25
Full Till	20	5

Source: Roger Allan, NRCS Rock County

Table 3.03-2 Approximate Crop Residues From Tillage Practices

Table 3.03-2 shows the cornstalk and soybean residues that are assumed to remain on the fields as a result of the three general tillage practices considered. Table 3.03-3 shows that for the existing condition (current practices), it is estimated that approximately 60 percent of the fields in the watershed have no-till, 30 percent have reduced till, and only 10 percent have full till conditions.

B. Baseline Condition

Conversations with NRCS conservationist Roger Allan indicate that many improvements have been made in terms of farming practices and soil erosion in the watershed over the last several decades: primarily, the transition for many farmers from traditional tillage practices to no-till practices. The baseline condition was modeled to simulate conditions in the watershed prior to these changes, representing a worst-case scenario for sheet and rill erosion. For the baseline condition, the following assumptions were made:

1. Traditional mulch tillage practices are assumed for all crops and all fields.
2. Agricultural land use data was taken from WISCLAND (1991-1993 data).
3. No best management practices.

C. Existing Condition

For the existing condition, it is assumed that agricultural practices in the watershed are current practices based on conversations with Roger Allan at NRCS. Tillage practices include no-till and reduced till in addition to full till.

General crop rotation and tillage practices in the watershed were summarized by Rock County and Dane County Land Conservationists. These generalizations were used to make assumptions regarding the land use rotations in the watershed and were extrapolated onto the 2004 land use data mapping. These assumptions are simplified compared to the actual practices in the watershed but are necessary to make the model manageable. The assumptions for this condition are listed as follows:

1. Modified land use data shown in Table 2.01-2 is used (reduced amount of forage crops).

2. Approximately 80 percent of the agricultural land in the watershed is planted on a corn/soybean yearly rotation. On these fields, there is approximately a 50 percent chance from year-to-year that corn will be planted or soybeans will be planted.

3. The remaining 20 percent of the agricultural fields in the watershed practice a corn/soybean/hay rotation. On these fields, it is assumed that the fields have a corn/soybean yearly rotation for 4 years followed by 5 years of alfalfa hay.

4. Approximately 60 percent of the fields in the watershed have no-till operations. Approximately 30 percent have reduced tillage, and the remaining 10 percent have full tillage.

D. No-Till Condition

The no-till condition is exactly what the name indicates: it assumes that all crops have a no-till practice, although the crop rotations are similar to what are in the existing watershed. Land use data is the same as existing conditions. This condition was meant to serve as a hypothetical extreme condition to estimate what erosion reduction could be obtained if all farmers in the watershed practiced no-till on their fields. The following assumptions were used for the no-till condition:

1. Modified land use data shown in Table 2.01-2 is used.

2. Approximately 80 percent of the agricultural land in the watershed is planted on a corn/soybean yearly rotation. On these fields, there is approximately a 50 percent chance from year-to-year that corn will be planted or soybeans will be planted.

3. The remaining 20 percent of the agricultural fields in the watershed practice a corn/soybean/hay rotation. On these fields, it is assumed that the fields have a corn/soybean yearly rotation for 4 years followed by 5 years of alfalfa hay.

4. 100 percent of the fields have no-till operations.

Table 3.03-3 summarizes the assumptions used for the three conditions with regard to tillage practices and crop rotations.

E. Grassland, Shrubland, Pasture, and Idle Lands

To simplify the model, RUSLE2 was used to estimate sheet and rill erosion for noncroplands including grassland, shrubland, pasture, and idle lands. The "idle land" template was used in the RUSLE2 model for baseline, existing, and no-till conditions.

TABLE 3.03-3

AGRICULTURE LAND USE ASSUMPTIONS FOR BASELINE, EXISTING, AND NO-TILL CONDITIONS

	Baseline Condition		Existing Condition		No-Till Condition	
	Acres	%	Acres	%	Acres	%
Total Crops	12,499	100	12,499	100	12,499	100
Total Corn & Row Crops	6,642	53	11,143	89	11,143	89
Total Forage Crops	5,857	47	1,356	11	1,356	11
Total Crops in CB rotation	1,250	10	9,999	80	9,999	80
Total Row Crops in CB rotation	1,250	19	9,999	90	9,999	90
Of the CB Rotation Crops:						
No Till	0	0	6,000	60	9,999	100
Reduced till (>30% residue)	0	0	3,000	30	-	0
Full till (<30% residue)	1,250	100	1,000	10	-	0
Remaining Crops are CB + Hay rotation	11,249	90	2,500	20	2,500	20
Total Row Crops in CB + Hay rotation	5,392	81	1,144	10	1,144	10
Total Forage Crops in CB + Hay rotation	5,857	100	1,356	100	1,356	100
Of the CB + Hay Rotation Crops:						
No Till	0	0	1,500	60	2,500	100
Reduced till (>30% residue)	0	0	750	30	-	0
Full till (<30% residue)	11,249	100	250	10	-	0

Notes:

CB = Corn/Soybean Rotation (every other year)
CB + Hay = Corn/Soybean/Hay rotation (4 years every other year corn and soybean followed by 5 years of alfalfa hay)

F. Results

Soil loss rates in tons per acre per year (t/ac/yr) were estimated using RUSLE2 and entered in the matrix for baseline, existing, and no-till conditions. The RUSLE2 matrix is shown in Table 3.03-4. The table also provides the weighted averages for the various crop rotations and conditions based on the assumptions shown in Table 3.03-3.

Tables 3.03-5 through 3.03-7 summarize the results of the modeling by subbasin for the baseline, existing, and no-till conditions, respectively. Figures 3.03-1 through 3.03-3 illustrate the three conditions in terms of unit loadings. The average tolerable T soil loss values were calculated for each subbasin based on soil types and are shown (in t/ac/yr) in the tables for comparison with the calculated soil losses. The approximate average T value is 4.5 t/ac/yr for the entire watershed; however it is more important that individual fields meet the T for the soil types on the field.

The average subbasin unit load for the baseline condition is 2.4 t/ac/yr. Since the subbasins are different sizes, it makes sense to compare the unit loading from each subbasin rather than the total loading to determine the "hot spots" in the watershed or the areas of highest erosion concentration. The highest unit load for the baseline condition comes from Subbasin G7, with an average unit load of 3.4 t/ac/yr. Therefore, the overall watershed soil loss rate for the baseline condition is still less than the average tolerable T for the watershed.

The average subbasin unit load for the existing condition is 1.9 t/ac/yr. The highest individual subbasin unit load is 2.8 t/ac/yr from Subbasin G4.

The average subbasin unit load for the no-till condition is 1.4 t/ac/yr. Likewise, Subbasin G4 has the highest individual subbasin unit load for the no-till condition of 1.9 t/ac/yr.

The results of this analysis indicate that tillage practices have a dramatic impact on the erosion rates from agricultural fields. It also shows that the practices that have been implemented in the last several decades are predicted to have made a significant contribution to reducing soil loss and NPS pollution in the Lake Leota watershed over the baseline condition.

It is important to remember that only agricultural crop lands and idle lands such as grasslands, shrublands, and fallow lands were included as part of this model. Forests, wetlands, and urban areas were not considered in this model. Therefore, subbasins with higher percentages of farmland probably had higher erosion loads in the model. In general, forested areas will not contribute significantly to sediment loads, and wetlands tend to remove NPS pollutants. Urban areas, while usually an important source of NPS pollution, make up an insignificant percent of the total watershed area, and therefore were not considered. The biggest impact on the sediment loading in the Lake Leota watershed will be accomplished through agricultural practices and streambank restoration/stabilization rather than urban stormwater improvements.

The model also does not consider existing BMPs located throughout the watershed (besides no-till and reduced till practices). Buffer strips, riparian forested buffers, and grassed waterways already established throughout the watershed provide treatment and removal of NPS pollution and prevent sediment movement. Therefore, the results of the modeling are probably higher than actual loadings in the watershed.

Because of the nature of the model assumptions, which applied certain soil loss rates to entire categories within a subbasin, it is difficult to make conclusions concerning specific "hot spots" within the watershed. The results of the model generally showed that fields with silt loam soils, steeper slopes, or traditional tillage practices have the highest soil erosion rates.

3.04 COMBINED MODELING RESULTS

The results of the streambank erosion modeling and the existing condition of the agricultural runoff modeling were combined to estimate annual sediment loading to Lake Leota. SDRs calculated in Section 3.01 were used to estimate the sediment yield at the lake. The area of Lake Leota, 26.6 acres, was used to calculate the loading rate in inches per year.

	Sediment Loading to Lake (tons/yr)			Sediment Loading to Lake (cf/yr)			Sediment Loading Rate to Lake (in/yr)		
Sub-basin	Existing Ag. Runoff	Stream-bank Erosion	Total	Existing Ag. Runoff	Stream-bank Erosion	Total	Existing Ag. Runoff	Stream-bank Erosion	Total
D1	1,278		1,278	28,392		28,392	0.294		0.29
D2	316		316	7,026		7,026	0.073		0.07
G1	658		658	14,628		14,628	0.151		0.15
G2	93		93	2,071		2,071	0.021		0.02
G3	99		99	2,195		2,195	0.023		0.02
G4	310		310	6,885		6,885	0.071		0.07
G5	432		432	9,607		9,607	0.099		0.10
G6	733	0.82	734	16,296	18	16,314	0.169	0.000	0.17
G7	367		367	8,151		8,151	0.084		0.08
G8	415		415	9,223		9,223	0.096		0.10
R1	366	134	499	8,126	2,973	11,098	0.084	0.031	0.11
R2	393	96	488	8,725	2,126	10,852	0.090	0.022	0.11
R3	498		498	11,063		11,063	0.115		0.11
R4	234	122	356	5,203	2,708	7,911	0.054	0.028	0.08
R5	384	29	413	8,536	647	9,182	0.088	0.007	0.10
R6	807	38	846	17,939	850	18,789	0.186	0.009	0.19
R7	841	4.92	845	18,679	109	18,789	0.193	0.001	0.19
R8	327	0.25	328	7,277	5.46	7,282	0.075	0.000	0.08
R9	728	67	795	16,173	1,492	17,665	0.167	0.015	0.18
R10	397	8.86	406	8,815	197	9,012	0.091	0.002	0.09
Total	9,676	500	10,176	215,011	11,108	226,138	2.23	0.12	2.34

Table 3.04-1 Sediment Loading to Lake Leota from Nonpoint Sources (Existing Condition)

TABLE 3.03-4

PREDICTED SOIL LOSS RATES FROM AGRICULTURAL AND IDLE LANDS (RUSLE2)

				RUSLE2 Predicted Soil Loss (t/ac/yr)							Row Crops Weighted Averages (tons/ac/yr)			Forage Crop Weighted Average Existing (t/ac/yr)[6]
				Corn/Soybean (CB)			Corn/Soybean/Hay (CBH)			Grassland/ Pasture/ Shrubland/ Idle				
Soil Type	Slope (%)	Slope Length (ft)	Abs. Row Grade (%)	No-till	Red. Till[1]	Full Till[2]	No-till	Red. Till[1]	Full Till[2]		Exist.[3]	Base[4]	100% No-till[5]	
Clay	4	150	2	1.3	2.8	3.4	1.0	1.5	2.1	0.99	1.9	2.3	1.3	1.3
	9	100	3	1.4	5.4	6.5	2.1	3.0	4.2	2.0	3.1	4.6	1.5	2.6
	13	75	5	1.3	8.5	10	3.3	4.8	6.7	3.0	4.3	7.3	1.5	4.1
Silt Loam	1	150	1	0.48	1.0	1.3	0.38	0.56	0.81	0.34	0.69	0.90	0.47	0.48
	1.5	150	1	0.65	1.4	1.8	0.51	0.76	1.1	0.47	1.0	1.2	0.64	0.64
	2	150	1	0.8	1.7	2.2	0.63	0.94	1.4	0.59	1.2	1.6	0.78	0.80
	4	150	2	1.5	3.3	4.2	1.2	1.8	2.6	1.1	2.2	2.9	1.5	1.5
	4.5	150	2	1.6	3.6	4.7	1.3	1.9	2.9	1.2	2.4	3.2	1.6	1.6
	9	100	3	2.8	6.1	7.6	2.2	3.3	4.8	2.1	4.1	5.3	2.7	2.8
	11	100	4	3.8	8.2	10	3.0	4.5	6.5	2.8	5.5	7.2	3.7	3.8
	13	75	5	4.3	8.9	11	3.4	5.0	7.2	3.1	6.1	7.9	4.2	4.3
	15	75	5	5.0	10	13	4.0	5.8	8.4	3.7	7.1	9.3	4.9	5.0
	16	75	5	5.4	11	14	4.2	6.2	9.1	4.0	7.7	10	5.3	5.3
	19	75	6	6.5	14	18	5.2	7.7	11	4.8	9.6	12	6.4	6.5
	25	60	7	8.4	17	22	6.4	9.6	14	5.9	12	16	8.2	8.1
	28	60	7	9.7	20	26	7.4	11	16	6.6	14	18	9.5	9.3
	38	25	8	12	24	33	9.5	14	21	8.0	17	23	12	12
Sand	1	150	1	0.22	0.49	0.64	0.18	0.27	0.39	0.26	0.33	0.44	0.22	0.23

Notes:

1. Red. Till = Reduced till, residue on fields is more than 30 percent.
2. Full Till = Residue on fields is less than 30 percent.
3. Row crops existing weighted average assumes that existing conditions in watershed are 60% no-till, 30% reduced till, and 10% full till, and 90% of total row crops are on a corn/soybean (CB) rotation and 10% are on a corn/soybean/hay (CBH) rotation, and 90% of row crops are on a CB rotation and 10% are on a CBH rotation.
4. Row crops baseline weighted average assumes that baseline conditions in watershed are 100% full till, and 90% of row crops are on a CB rotation and 10% are on a CBH rotation.
5. Row crops 100% No-till weighted average assumes that conditions in watershed are 100% No-till, and 90% of total row crops are on a CB rotation and 10% are on a CBH rotation.
6. Forage crops existing weighted average assumes that existing conditions in watershed 60% No-till, 30% reduced till, and 10% full till.

TABLE 3.03-5

SUMMARY OF PREDICTED SOIL LOSS TOTALS FROM AGRICULTURAL AND IDLE LANDS FOR BASELINE CONDITION

							Corn and Row Crops		Forage Crops		Grassland/Idle	
Water shed	Total Ag & Grass Acres	Total Loading (tons/yr)	Average t/acre/yr	Average Tolerable Soil Loss (t/ac/yr)	Percent of total area	Percent of total loading	Total Acres	Total Loading (tons/yr)	Total Acres	Percent of total loading	Total Loading (tons/yr)	Total Acres
D1	2,664	6,191	2.3	4.3	18	18	1,034	2,396	1,139	18	3,183	491
D2	616	1,307	2.1	4.4	4.2	3.7	218	448	233	3.7	674	165
G1	869	2,259	2.6	4.8	6.0	6.4	413	993	391	6.4	1,189	64
G2	125	261	2.1	4.5	0.9	0.7	43	69	48	0.7	123	35
G3	415	400	1.0	4.0	2.9	1.1	223	257	132	1.1	119	60
G4	418	1,433	3.4	4.8	2.9	4.1	171	530	208	4.1	832	39
G5	725	1,926	2.7	4.7	5.0	5.5	386	989	220	5.5	758	119
G6	753	2,153	2.9	4.5	5.2	6.1	480	1,399	214	6.1	669	58
G7	291	980	3.4	4.1	2.0	2.8	230	804	47	2.8	162	14
G8	489	1,364	2.8	4.3	3.4	3.9	161	486	298	3.9	838	30
R1	622	1,534	2.5	4.3	4.3	4.4	275	608	213	4.4	681	134
R2	516	1,346	2.6	4.5	3.5	3.8	267	676	189	3.8	591	61
R3	713	1,448	2.0	4.9	4.9	4.1	268	602	379	4.1	756	65
R4	783	803	1.0	4.7	5.4	2.3	518	534	256	2.3	263	10
R5	436	1,177	2.7	4.6	3.0	3.3	253	723	149	3.3	381	34
R6	1,290	3,638	2.8	4.5	8.9	10	545	1,649	523	10	1,631	222
R7	1,417	3,253	2.3	4.5	9.7	9.3	659	1,417	442	9.3	1,304	316
R8	286	733	2.6	4.7	2.0	2.1	164	427	100	2.1	281	22
R9	921	2,298	2.5	4.7	6.3	6.5	304	757	509	6.5	1,420	109
R10	220	651	3.0	4.3	1.5	1.9	32	98	165	1.9	520	23
Total	14,570	35,158	2.4	4.5	100	100	6,642	15,862	5,857	100	16,375	2,071

TABLE 3.03-6

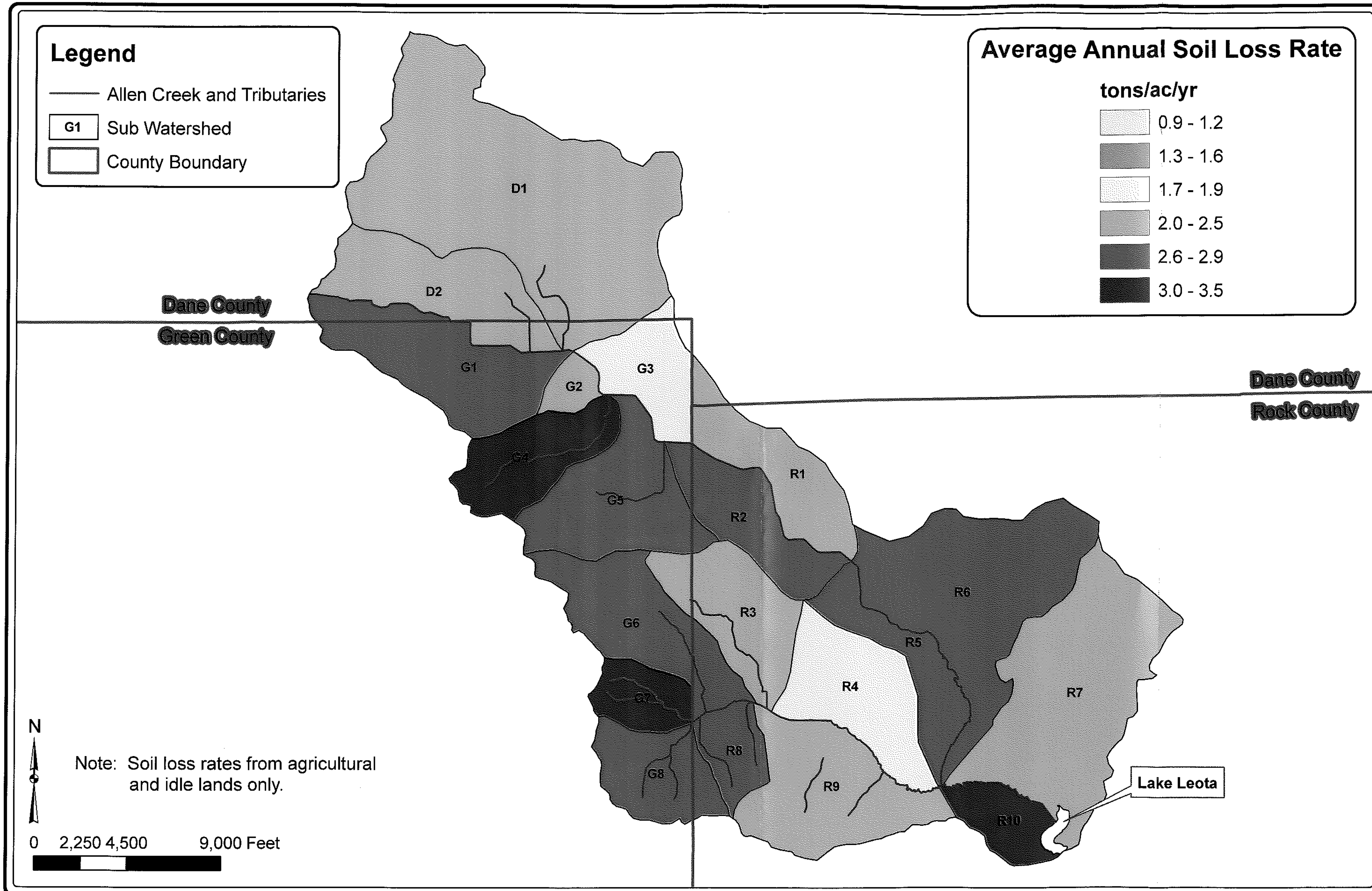
SUMMARY OF PREDICTED SOIL LOSS TOTALS FROM AGRICULTURAL AND IDLE LANDS FOR EXISTING CONDITION

							Corn and Row Crops		Forage Crops		Grassland/Idle	
Water shed	Total Ag & Grass Acres	Total Loading (tons/yr)	Average t/acre/yr	Average Tolerable Soil Loss (t/ac/yr)	Percent of total area	Percent of total loading	Total Acres	Total Loading (tons/yr)	Total Acres	Total Loading (tons/yr)	Total Acres	Total Loading (tons/yr)
D1	2,664	5,023	1.9	4.3	18.3	17.8	1,934	4,068	239	342	491	613
D2	616	1,075	1.7	4.4	4.2	3.8	401	821	50	69	165	185
G1	869	1,800	2.1	4.8	6.0	6.4	716	1,589	88	134	64	78
G2	125	222	1.8	4.5	0.9	0.8	81	141	10	12	35	70
G3	415	313	0.8	4.0	2.9	1.1	316	267	39	23	60	24
G4	418	1,152	2.8	4.8	2.9	4.1	337	996	42	84	39	71
G5	725	1,542	2.1	4.7	5.0	5.5	539	1,257	67	106	119	179
G6	753	1,674	2.2	4.5	5.2	5.9	618	1,466	76	124	58	84
G7	291	743	2.5	4.1	2.0	2.6	247	671	31	57	14	15
G8	489	1,084	2.2	4.3	3.4	3.8	408	962	50	82	30	40
R1	622	1,261	2.0	4.3	4.3	4.5	434	938	54	79	134	244
R2	516	1,070	2.1	4.5	3.	3.8	405	914	50	77	61	79
R3	713	1,164	1.6	4.9	4.9	4.1	576	990	71	83	65	90
R4	783	617	0.8	4.7	5.4	2.2	688	563	85	48	10	6
R5	436	922	2.1	4.6	3.0	3.3	358	782	44	66	34	74
R6	1,290	2,932	2.3	4.5	8.9	10.4	951	2,374	118	200	222	358
R7	1,417	2,655	1.9	4.5	9.7	9.4	980	1,958	121	166	316	532
R8	286	569	2.0	4.7	2.0	2.0	235	502	29	43	22	24
R9	921	1,855	2.0	4.7	6.3	6.6	723	1,599	89	135	109	121
R10	220	537	2.4	4.3	1.5	1.9	175	464	22	39	23	34
Total	14,570	28,209	1.9	4.5	100	100	11,124	23,321	1,375	1,967	2,071	2,921

TABLE 3.03-7

SUMMARY OF PREDICTED SOIL LOSS TOTALS FROM AGRICULTURAL AND IDLE LANDS FOR NO-TILL CONDITION

							Corn and Row Crops		Forage Crops		Grassland/Idle	
Water shed	Total Ag & Grass Acres	Total Loading (tons/yr)	Average t/acre/yr	Average Tolerable Soil Loss (t/ac/yr)	Percent of total area	Percent of total loading	Total Acres	Total Loading (tons/yr)	Total Acres	Total Loading (tons/yr)	Total Acres	Total Loading (tons/yr)
D1	2,664	3,594	1.3	4.3	18	18	1,934	2,711	239	271	491	613
D2	616	786	1.3	4.4	4.2	3.9	401	546	50	55	165	185
G1	869	1,237	1.4	4.8	6.0	6.2	716	1,054	88	106	64	78
G2	125	174	1.4	4.5	0.9	0.9	81	94	10	9	35	70
G3	415	222	0.5	4.0	2.9	1.1	316	179	39	18	60	24
G4	418	803	1.9	4.8	2.9	4.0	337	665	42	67	39	71
G5	725	1,098	1.5	4.7	5.0	5.5	539	836	67	84	119	179
G6	753	1,148	1.5	4.5	5.2	5.7	618	966	76	98	58	84
G7	291	500	1.7	4.1	2.0	2.5	247	440	31	45	14	15
G8	489	727	1.5	4.3	3.4	3.6	408	622	50	65	30	40
R1	622	930	1.5	4.3	4.3	4.7	434	623	54	62	134	244
R2	516	750	1.5	4.5	3.5	3.8	405	610	50	61	61	79
R3	713	814	1.1	4.9	4.9	4.1	576	658	71	66	65	90
R4	783	424	0.5	4.7	5.4	2.1	688	379	85	38	10	6
R5	436	651	1.5	4.6	3.0	3.3	358	525	44	52	34	74
R6	1,290	2,098	1.6	4.5	8.9	11	951	1,582	118	158	222	358
R7	1,417	1,976	1.4	4.5	9.7	9.9	980	1,314	121	131	316	532
R8	286	384	1.3	4.7	2.0	1.9	235	326	29	34	22	24
R9	921	1,282	1.4	4.7	6.3	6.4	723	1,055	89	106	109	121
R10	220	372	1.7	4.3	1.5	1.9	175	307	22	31	23	34
Total	14,570	19,969	1.4	4.5	100	100	11,124	15,493	1,375	1,555	2,071	2,921



AGRICULTURAL SOIL LOSS RATES - BASELINE CONDITION

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.03-1
1-354.004

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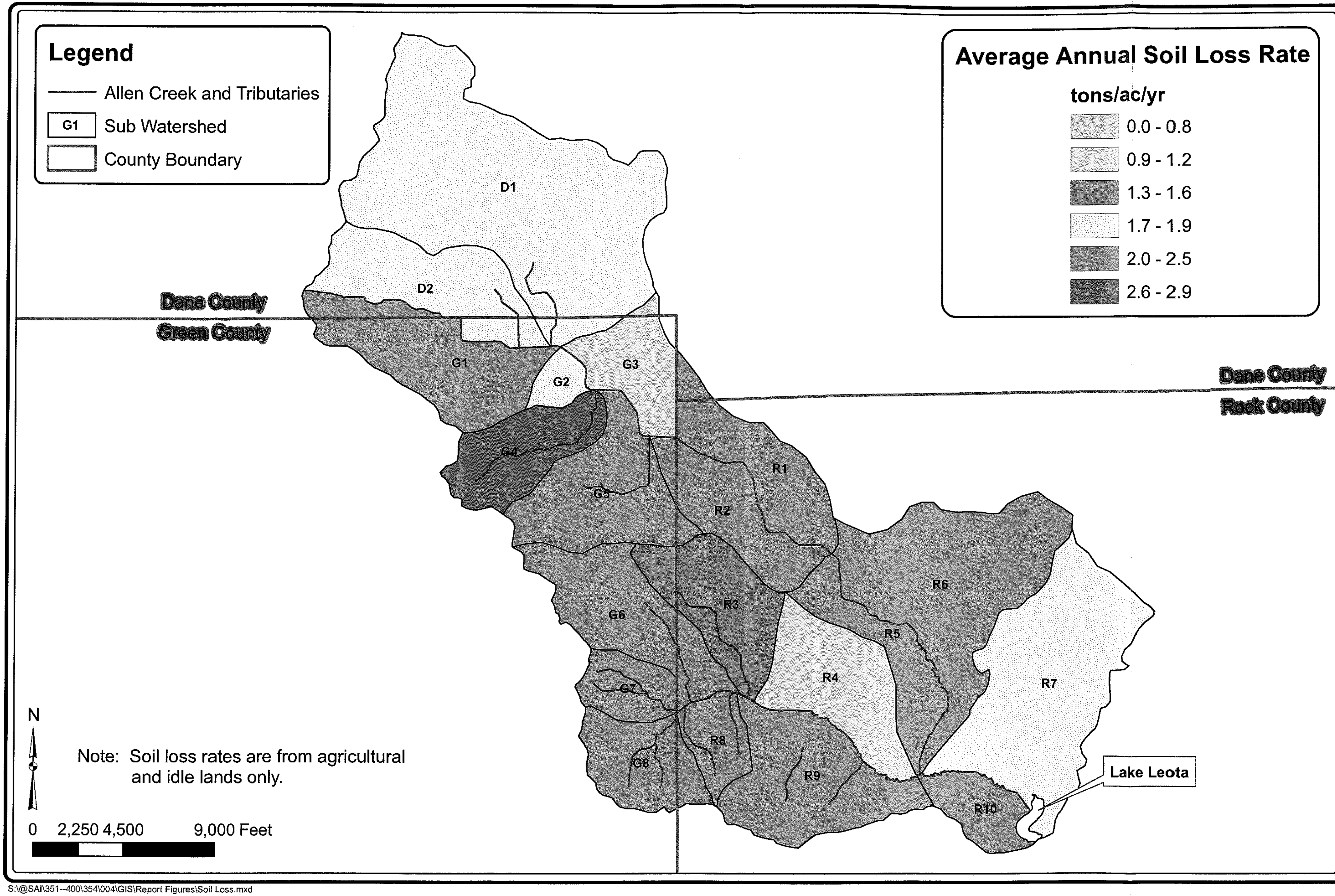
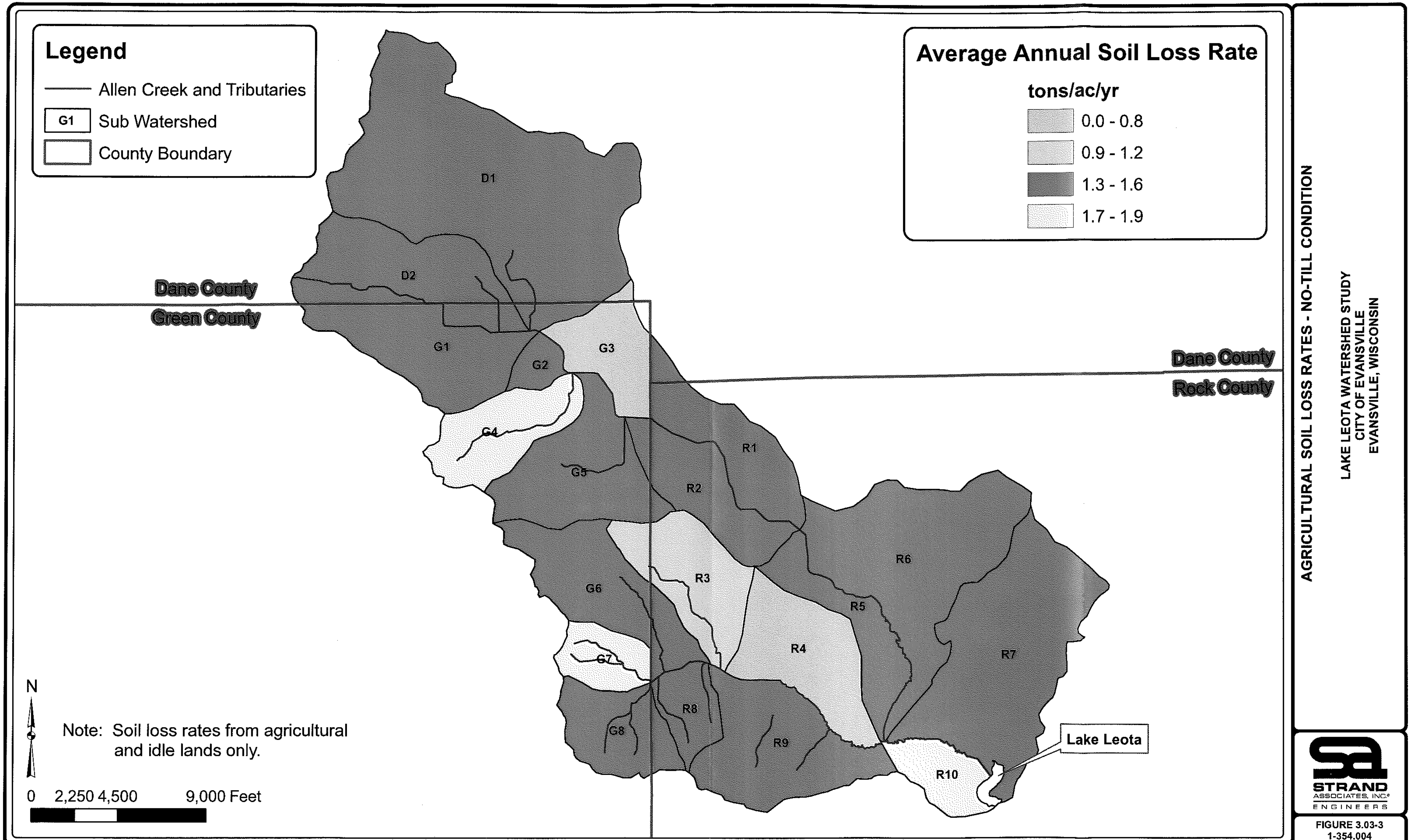


AGRICULTURAL SOIL LOSS RATES - EXISTING CONDITION

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 3.03-2
1-354.004



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Combining the sediment loading results from the streambank erosion modeling and the agricultural runoff modeling shows that the sediment from sheet and rill erosion on fields is significantly higher for most subbasins than the contribution from streambank erosion. This is consistent with the DNR's 1979 observations. Our modeling results indicate that approximately 10,000 t/yr of sediment reach Lake Leota from soil erosion in the watershed, 95 percent of which comes from sheet and rill erosion. By comparison, it was estimated by the DNR in 1979 that 4,000 to 12,000 t/yr reach Lake Leota, with an average rate of 6,500 t/yr.

Based on an average of the flowrates and TSS concentrations near the inlet and near the dam from 1964 to 1977, the DNR estimated that an average of 0.9 inches per year accumulates in Lake Leota. This resulted in an approximate 3,200 cubic yards per year accumulated (based on a 26.6-acre lake). This amounts to a 49 percent retention rate. Our loading estimate into the lake is 2.3 in/yr, and if a 49 percent retention rate is assumed, the accumulation in Lake Leota would be approximately 1.1 in/yr, slightly higher than the 0.9 in/yr rate predicted by the DNR in 1979.

The implementation of BMPs and the switch to no-till practices in the watershed over the last 25 years would seem to indicate that existing loading rates should be lower now than in 1979. However, the move toward row crops away from forage crops in the watershed has more than likely increased sediment loading rates slightly because of the more intensive tillage practices involved with row crops and the higher unit erosion rates.

3.05 PHOSPHORUS MODELING WITH WISCONSIN LAKE MODELING SUITE (WiLMS)

The Wisconsin Lake Modeling Suite (WiLMS) computer program was used to predict phosphorus loading rates to Lake Leota from the land uses in the watershed. Developed by the Lake Management Program of the DNR in October 2003, WiLMS is a lake water quality planning tool which predicts spring overturn phosphorus concentrations, growing season mean phosphorus concentrations, and annual average phosphorus concentrations in lakes based on tributary and lake characteristics. Built in to the model are default phosphorus export values for different types of land uses. These rates, converted from metric units to English units, are shown in Table 3.05-1.

The land use areas for the Lake Leota watershed that were entered into the WiLMS computer model are also shown in Table 3.05-1. The phosphorus loading rates for each land use type were used to predict total phosphorus loadings from each land use type, which are also shown in Table 3.05-1. The land use categories are fairly generalized, so there are many assumptions inherent in the model that make the uncertainty of the results high. Because of this uncertainty, the model gives three ranges of TP concentrations: low, most likely, and high.

The TP loadings predicted by the model for the three ranges are 4,854, 10,888, and 26,430 pounds/yr, respectively. Dividing by the total area of the watershed gives the overall unit loads: 0.29, 0.66, and 1.61 lbs/ac/yr.

Phosphorus delivery to waterbodies is similar to that of sediment. There are many variables that affect the TP loadings to a lake. The fertilizers used in the watershed, the TP concentrations in the soils, the types of crops planted, the BMPs, and many other factors influence the results. Therefore, the WiLMS model should be used as a simplified estimate of TP loads based on generalized assumptions and cannot be used to accurately predict the amount of TP entering Lake Leota.

The Brooklyn Wastewater Treatment Plant (WWTP) is a TP point source in the watershed. As a comparison, assuming the WWTP has a flow of about 0.1 million gallons per day (mgd) and effluent TP around 4 mg/L, this load would be about 1,220 lb TP/year.

3.06 MONITORING DATA FROM SIMILAR WATERSHEDS

As a check, it is always beneficial to compare results of modeling with actual field data obtained from monitoring. Since there is limited data available for the Lake Leota watershed, it can be useful to look at monitoring data from similar watersheds.

The United States Geological Survey (USGS) and the DNR collaborated to summarize suspended sediment and total phosphorus loadings from small watersheds in Wisconsin in the USGS Fact Sheet FS-195-97 (1997). The fact sheet is entitled *Unit-Area Loads of Suspended Sediment, Suspended Solids, and Total Phosphorus From Small Watersheds in Wisconsin.* Monitoring data collected from 1975 to 1996 was assembled for 52 watersheds around the state.

Six of the studied watersheds that are most similar to the Lake Leota watershed in location (located in southern Wisconsin in the till plains area) or in size or composition (percent agricultural) were used to compare the modeling results of this study. Table 3.06-1 presents the six most similar watersheds and the minimum, maximum, and median unit-area TSS and TP loads for the watersheds determined by USGS and DNR. The table also summarizes the extremes and median values for the Southeastern Wisconsin Till Plains rural watersheds studied (14 total) and for the entire state's rural watersheds studied (36 total). For comparison, the Lake Leota watershed has a drainage area of approximately 16,500 acres, or 26 square miles, and is approximately 76 percent agricultural and 1 percent urban developed.

A. Total Suspended Solids (TSS)

From Table 3.04-1, the total sediment loading predicted from agricultural runoff and streambank erosion is 10,176 tons per year. Dividing by a total watershed area of 26 square miles, this gives a unit area loading of 391 tons per square mile per year (t/sq-mi/yr). The results of the modeling studies shown in Table 3.06-1 indicate that this is on the higher range of loading rates for TSS for similar watersheds. The median annual TSS unit area loading for till plains rural watersheds is 32 t/sq-mi/yr, and the maximum is 1,710. However, of the six most similar watersheds, the maximum TSS loading is 350 t/sq-mi/yr, and the median is 19 t/sq-mi/yr.

TABLE 3.05-1

PREDICTED PHOSPHORUS LOADING RATES TO LAKE LEOTA FROM DIFFERENT LAND USE TYPES USING WILMS

		Percent of Total Loading	Nonpoint Source Phosphorus Loading Rate (lb/ac-yr)			Total Nonpoint Source Phosphorus Loading to Lake (lb/yr)		
Land Use	Acres	(%)	Low	Most Likely	High	Low	Most Likely	High
Row Crop Ag	6,654	54.5	0.45	0.89	2.68	2,968	5,937	17,810
Mixed Ag	5,876	38.5	0.27	0.71	1.25	1,573	4,194	7,339
Pasture/grass	2,044	5.0	0.09	0.27	0.45	182	547	912
HD Urban (1/8 ac)	-	0.0	0.89	1.34	1.78	-	-	-
MD Urban (1/4 ac)	68	0.3	0.27	0.45	0.71	18	30	49
Rural Res (>1 ac)	-	0.0	0.04	0.09	0.22	-	-	-
Wetlands	396	0.3	0.09	0.09	0.09	35	35	35
Forest	1,299	1.0	0.04	0.08	0.16	58	104	209
Golf Course	92	0.3	0.18	0.36	0.58	16	33	53
Lake Surface	27	0.1	0.09	0.27	0.89	2	7	24
Total:	16,456	100				4,854	10,888	26,430

This result supports the hypothesis that the sediment loading model described in previous sections is conservatively high due to the fact that BMPs are not accurately accounted for. The SDRs are most likely high, and the erosion rates are also high. It is possible that if a monitoring study were performed on the Lake Leota watershed, the results would be similar to the results for the similar watersheds.

B. Phosphorus

Table 3.06-1 shows the results of the phosphorus monitoring data for the similar watersheds. The minimum, median and maximum TP loads for the similar watersheds are 41, 283 and 1,440 lbs/sq mile/yr, respectively. The Lake Leota phosphorus loading results modeled in WiLMS for the low, most likely, and high values, converted to square miles, are 187, 418, and 1,017 pounds per square mile per year. The WiLMS results are on the same order of magnitude as the monitoring data results for similar watersheds. Therefore, the TP loads from NPS sources to Lake Leota are likely within the modeled range.

The data in Table 3.06-1 indicate that solids loadings and phosphorus loadings vary greatly depending on the watershed location, physical characteristics, and size. According to the study, land use, drainage area, ecoregion, slope, soil type, and climate are all characteristics that affect the magnitude and variability of unit-area loads. The study also concludes that there is no apparent relation between unit-area loads and percent agriculture, percent forest, or drainage area. The primary conclusions drawn are that loads in the Driftless Area of Wisconsin tend to be higher than loads from rural watersheds in the Southeastern Wisconsin Till Plains, primarily because of the steep slopes in the Driftless Area which lead to higher erosion rates. Also, median loads are slightly higher for urban watersheds than for rural watersheds, and urban watershed loads have less variability. The study shows that not only do unit-area loads vary greatly from watershed to watershed, but they also vary greatly from year to year within a single watershed.

Therefore, it appears that the modeling data is a valid method of predicting the range of TSS and TP loads that could be expected in the watershed as a result of its physical characteristics and location. The magnitudes of unit-area loads are similar to those resulting from our modeling study.

3.07 PHOSPHORUS CONCLUSIONS

As noted in Section 3.05, because nonpoint source phosphorus delivery is similar to sediment, it is not possible to use the WiLMS modeling to accurately predict the amount of phosphorus entering and remaining in Lake Leota. Phosphorus also enters Allen Creek and the lake from the Brooklyn WWTP; based on the estimates in Section 3, this may account for about 5 to 20 percent of the total phosphorus load to Allen Creek. The total phosphorus associated with sediment is expected to be delivered to and retained in the lake at about the same rate as the sediment (49 percent as indicated in Section 3.04). However, once in the lake, the fate of phosphorus may be different than that of sediment. As a few examples, phosphorus can be taken up by aquatic plants and algae or absorbed by or released from the lake sediments.

According to the DNR's 1979 study, the average total phosphorus (TP) concentration at the outlet of the lake was 0.18 mg/L in 1977. Wisconsin does not presently have numeric water quality criteria for phosphorus in surface waters. For comparative purposes, Illinois' water quality standard for TP in 20-acre or larger reservoirs is 0.05 mg/L. In 2000, the USEPA developed draft water quality criteria for TP and other nutrient-related parameters. In the southern Wisconsin ecoregion, the USEPA's draft criteria was 0.015 mg/L TP for lakes and reservoirs. However, these criteria were not adopted by Wisconsin. Wisconsin is now in the process of developing water quality criteria for phosphorus, and will begin assessing surface waters for compliance with the criteria after that. The DNR will also begin placing TP limits in WWTP discharge permits after the criteria are developed. The new criteria are anticipated to be in place around 2008.

Since phosphorus readily adsorbs onto soil particles, efforts to reduce erosion and sediment loads will reduce nonpoint source TP loads by approximately the same percentage. The Brooklyn WWTP may have TP limits in its discharge permit after around 2008, which will also reduce TP loadings to Allen Creek and Lake Leota. If the TP loading reductions are significant enough, and if existing phosphorus-laden sediments are removed from the lake, aquatic plant and algae growth should be reduced. This, in turn, should result in more consistent and higher dissolved oxygen levels and better overall water quality.

TABLE 3.06-1

UNIT-AREA ANNUAL TSS AND TP LOADS FROM SIMILAR WATERSHEDS (SOURCE: USGS FACT SHEET FS-195-97)

Watershed and Monitoring Station	Drainage Area (sq mi)	Land Use		Unit-Area Loads of TSS (t/sq-mi/yr)			Unit-Area Loads of TP (pounds/sq-mi/yr)		
		% Ag.	% Urban	Min	Max	Median	Min	Max	Median
Jackson Creek near Elkhorn	16.8	86.3	13.2	15	103	17	141	438	194
Delevan Lake Tributary at Delavan	10	94.7	1.0	4	12	8	41	59	50
Turtle Creek near Clinton	199	88.5	5.0	45	177	111	---	---	722
Silver Creek near Ripon	36.2	85.2	7.9	11	48	19	176	666	283
Pheasant Branch at Middleton	18.3	90.3	8.4	14	350	81	183	1,440	650
Southeastern Wisconsin Till Plains–Rural Watersheds				4.4	1,710	32.4	40.7	1,800	283
State Summary–Rural Watersheds				2.32	1,710	111	23.1	3,960	650

SECTION 4
NONPOINT SOURCE POLLUTANT MANAGEMENT STRATEGY

4.01 GENERAL RECOMMENDATIONS

This section discusses some recommendations for managing NPS pollution in the Lake Leota watershed through streambank restoration techniques (Section 4.02), agricultural BMPs (Section 4.03), and other management solutions. Section 4.04 provides a list of resource partners in NPS protection, and Section 4.05 describes potential cost-sharing opportunities for implementation of practices. A summary of the recommended implementation plan and schedule for the next several years is included in Section 6.

The DNR's 1979 Management Alternatives Report discussed several approaches to land treatment in the Lake Leota watershed to reduce nutrient and sediment loads to the lake. The three broad approaches were described as the following:

1. Improve soil conservation practices on cropland in the watershed to reduce upland sheet and rill erosion. This includes management practices such as contouring, cover crops, grass waterways, longer crop rotations, and minimum tillage.

2. Improve land use practices adjacent to Allen Creek to control streambank erosion. Bank protection and stabilization techniques include fencing, resloping, riprap and cattle crossings.

3. Reduce the nutrient load to Lake Leota by improving surface water runoff and waste management in barnyards and feedlots. This includes runoff management (diversions, terraces, gutters, downspouts, barn-yard grading, and improved site location) and waste management (manure storage facilities, holding ponds, and filter strips).

The DNR report cites the natural fertility of the soil in the watershed and admits that it will require some effort to convince farmers for the need for conservation practices since their soils are still producing. The report states that farm feedlots or barnyards with the highest animal densities and those closest to Lake Leota should receive highest priority in terms of nutrient management efforts. However, it also states that very few feedlots are within 100 yards of the creek or tributaries, and the feedlots are an indirect source of nutrients to the lake.

The DNR approaches listed above are still the primary recommendations for the Lake Leota watershed today. However, this study is intended to expand on those recommendations and provide a plan of action, or implementation, to accomplish those goals. The following is a list of recommendations to be implemented in the watershed to achieve the goal of reducing NPS pollution in the watershed. These are meant to target locations, projects and practices that will have the biggest overall impact.

A. Watershed Task Force Committee (WTFC)

We recommend the formation of a Watershed Task Force Committee (WTFC), either as an entity controlled by SOLE or a branch of SOLE, that would consist of key landowners and stakeholders in the watershed. The WFTC would spear-head projects and implement recommendations, help landowners apply for funding, implement and information and education (I&E) program, track progress and improvements, spread the word about projects and funding opportunities, and generate support among landowners.

4.02 STREAMBANK RESTORATION

Figure 4.02-1 shows some suggested improvements for the most severe erosion problems along Allen Creek. This restoration effort targets streambank erosion areas that are assessed as severe and very severe (Assessment Codes 4, 4.5, and 5) as defined in Section 3.02. The 4.5 and 5-rated sections are lumped into one project (Project 1) and the 4-rated sections are lumped into a second project (Project 2). Project 2 has many locations which need streambank improvements that would likely need to be implemented in several phases.

There is approximately an additional 4,600 feet of streambank rated as 3.5 that is between the moderate and severe rating. If funding becomes available to address the 3.5 ratings, the City or landowners may also want to address these because of the relatively advanced erosive conditions that these locations exhibit. The City may want to consider including some of these sites in the restoration projects if they are near areas identified for improvement in Projects 1 or 2.

Table 4.02-1 summarizes the recommended streambank improvement methods and the opinions of probable cost for Project 1 (most severe). Table 4.02-2 summarizes the improvements recommended for Project 2. Tables 4.02-3 and 4.02-4 summarize the opinions of probable cost for each project. The streambank restoration methods are described and pictured on the following pages. During design of Project 1 and 2, the appropriate streambank restoration technique would be further evaluated possibly requiring modification to the costs presented herein.

The streambank restoration techniques envisioned are vegetated geogrids in the steeper problem areas, vegetated boulder revetments in shady, more gradual bank areas, bank grading/toe protection/revegetation, lunker structures (to provide fish habitat), stone toe protection, tree revetments, live staking, and in-creek tree removal. With most techniques, we envision the use of live stakes to provide soil bioengineering and a more natural appearance. In addition, the live stakes, once established, will provide shade and areas of cooler water that will benefit aquatic species. These various techniques are illustrated in Figures 4.02-2 through 4.02-8.

Implementation of Project 1 would stabilize approximately 637 feet of the most severe erosion locations. This would result in a reduction of approximately 66 tons per year of sediment loss, or about 12 percent of the total estimated existing sediment loss from streambank erosion. Implementation of Project 2 would stabilize approximately 3,896 feet of severely eroding bank. This would result in a reduction of approximately 222 tons per year of sediment loss, or about 40 percent of the total existing streambank erosion.

We also recommend upgrading all vehicle crossings as Project 3 along the main branches of the creek according to the NRCS Technical Standard (Code 578) to stabilize the crossings and protect the creek from bank and bed erosion. The eight locations identified during the streambank assessment survey

RECOMMENDED ALLEN CREEK STREAMBANK IMPROVEMENTS

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.02-1
1-354.004

S:\@SAI\351--400\354\004\GIS\Report Figures\Allen Creek Stream Bank Restoration Locations.mxd

TABLE 4.02-1

RECOMMENDED STREAMBANK IMPROVEMENT LOCATIONS, METHODS, AND ASSOCIATED COSTS–PROJECT 1 (MOST SEVERE)

				Length (ft)					
Problem Area	Side	Rating	Length (ft)	Vegetated Boulder Revetment	Vegetated Geogrid	Grade Steep Slopes, Toe Protection & Revegetate	Live Stakes	Clearing & Grubbing	Erosion Control & Restoration
pk-22		5	15			15		15	15
pk-24		5	20	20				20	20
pk-25	R	5	264	264			30	264	264
pk-25	L	5	258	258			30	258	258
or-03		4.5	27		27		10	27	27
or-08		4.5	43		43		10	43	43
pk-26		4.5	10	10				10	10
Subtotal			637	552	70	15	80	637	637
Cost per ft				$150	$130	$85	$35	$5	$7
Cost Each									
Total Cost				$82,800	$9,100	$1,275	$2,800	$3,185	$4,459

Overall Subtotal:	$103,619
35% Engineering & Contingency:	$36,267
Total:	$139,886
Cost per linear foot:	$220/ft

Note: Costs do not include construction easement acquisition.

TABLE 4.02-2

RECOMMENDED STREAMBANK IMPROVEMENT LOCATIONS, METHODS, AND ASSOCIATED COSTS–PROJECT 2 (SEVERE RATINGS)

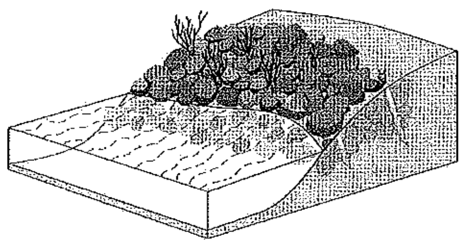
			Length (ft)									
Problem Area	Side	Length (ft)	Vegetated Boulder Revetment	Vegetated Geogrid	Grade Steep Slopes, Toe Protection, & Revegetate	Lunker Structures	Stone Toe Protection	Tree Revetments	Live Stakes	In-Creek Tree Removal	Clearing & Grubbing	Erosion Control & Restoration
b-01		67				67				67	67	67
b-03		99	99						15	99	99	99
or-05		20	20						5		20	20
or-06		158	158						25	158	158	158
or-07	L	136	136						20		136	136
or-07	R	136	136						20		136	136
or-10		53	53						10		53	53
or-12		50		50					10		50	50
or-14		29			29						29	29
or-17		53						53	53		53	53
or-20		107		107					20		107	107
or-31		60	60						15		60	60
or-34		46	46						5		46	46
or-41		92	92						15		92	92
or-43		29				29			0		29	29
pk-02		163					163		163		163	163
pk-12		190							190	190	190	190
pk-15		10						10	10		10	10
pk-16		235		235					40		235	235
pk-17		54	54						5		54	54
pk-21	L	700		700					50		700	700
pk-21	R	690					690		50		690	690
pk-27		276					276		40		276	276
pk-28		121					121		20		121	121
pu-25		72			72						72	72

			Length (ft)									
Problem Area	Side	Length (ft)	Vegetated Boulder Revetment	Vegetated Geogrid	Grade Steep Slopes, Toe Protection, & Revegetate	Lunker Structures	Stone Toe Protection	Tree Revetments	Live Stakes	In-Creek Tree Removal	Clearing & Grubbing	Erosion Control & Restoration
pu-30		70			70						70	70
pu-32		97			97						97	97
pu-33		83			83						83	83
Subtotal		3,896	854	1,092	351	96	1,250	63	781	514	3,896	3,896
Cost/LF			$150	$130	$85	$150	$75	$15	$35	$10	$5	$7
Cost/EA												
Total			$128,100	$141,960	$29,835	$14,400	$93,750	$945	$27,335	$5,140	$19,480	$27,272

Subtotal:	$488,217
35% Engineering & Contingency:	$170,876
Total:	$659,093
Cost per linear foot:	$169/LF

Note: Costs do not include construction easement acquisition.

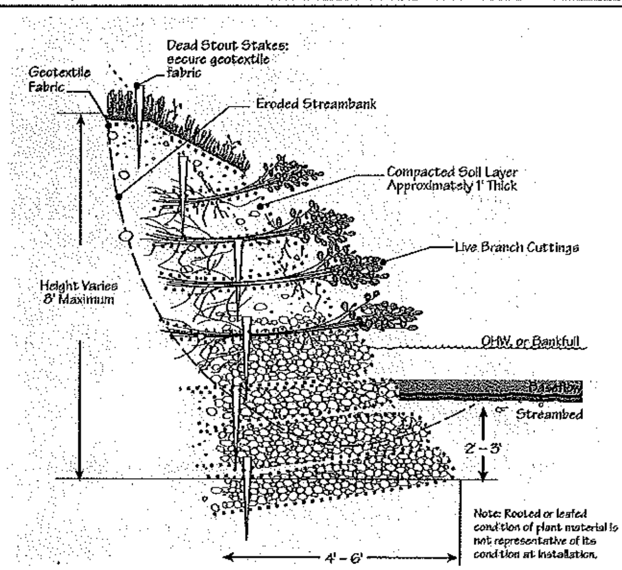
are shown on Figure 4.02-1. Upgrading the vehicle crossings would include adding stone to the creek bed and banks and vegetating side slopes to stabilize crossings in accordance with the NRCS Technical Standard.



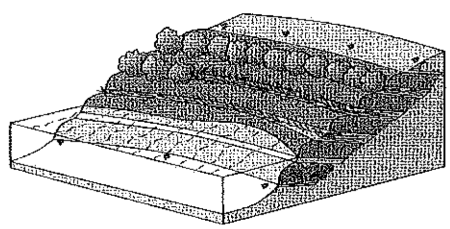
(a) *Federal Interagency Stream Corridor Restoration Handbook (NRCS)*

(b) *City of Madison*

Figure 4.02-2 Vegetated Boulder Revetment with Live Staking



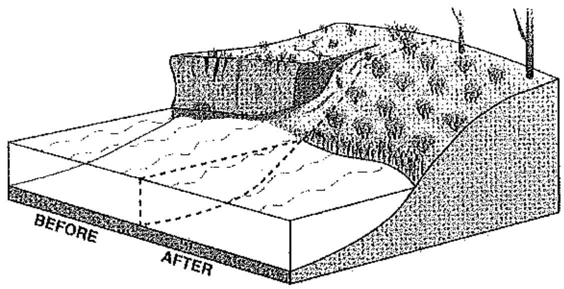
Vegetated Geogrids



(a) & (b) Federal Interagency Stream Corridor Restoration Handbook (NRCS)

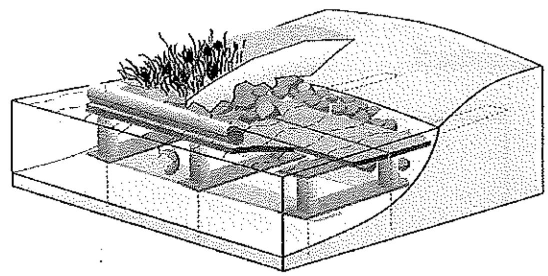
(c) Strand photo

Figure 4.02-3 Examples of Vegetated Geogrids



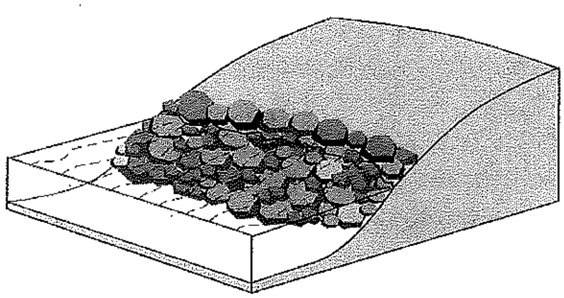
Source: Federal Interagency Stream Corridor Restoration Handbook (NRCS)

Figure 4.02-4 Bank Shaping and Planting



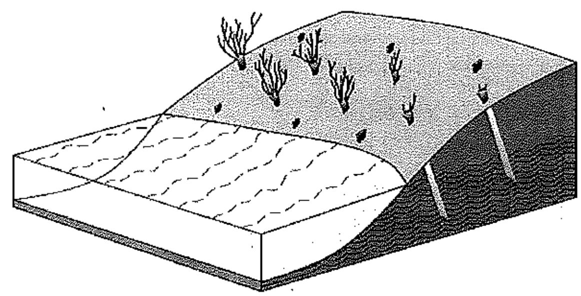
Source: Federal Interagency Stream Corridor Restoration Handbook (NRCS)

Figure 4.02-5 Lunker Structure



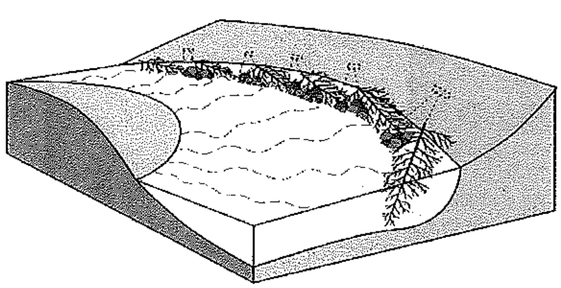
Source: Federal Interagency Stream Corridor Restoration Handbook (NRCS)

Figure 4.02-6 Stone Toe Protection



Source: Federal Interagency Stream Corridor Restoration Handbook (NRCS)

Figure 4.02-7 Live Staking



Source: Federal Interagency Stream Corridor Restoration Handbook (NRCS)

Figure 4.02-8 Tree Revetments

Item	Capital Cost
Clearing and Grubbing	$3,200
Streambank Restoration w/Vegetated Geogrid	$9,100
Streambank Restoration w/Vegetated Boulder Revetment	$82,800
Streambank Restoration with Slope Grading/Toe Protection, and Revegetation	$1,300
Live Staking (80 LF as part of above techniques)	2,800
Erosion Control/Restoration	$4,500
Subtotal	$103,700
Engineering and Contingencies (35 percent)	36,300
Total	$140,000
Cost per linear foot	$220/LF

Note: Costs do not include construction easement acquisition.

Table 4.02-3 Opinion of Probable Cost – Allen Creek Improvements – Project 1 – Streambank Problem Areas Rated 4.5 and 5 (Very Severe)

Item	Capital Cost
Clearing and Grubbing	$19,500
Streambank Restoration w/Vegetated Geogrid and Toe Protection	$142,000
Streambank Restoration w/Vegetated Boulder Revetment	$128,000
Streambank Restoration with Slope Grading/Toe Protection, and Revegetation	$29,800
Streambank Restoration with Stone Toe Protection	$93,800
Streambank Restoration with Tree Revetments	$1,000
Streambank Restoration with Lunker Structures	$14,400
Live Staking (781 LF as part of above techniques)	$27,300
In-Creek Tree Removal (514 LF as part of above techniques)	$5,100
Erosion Control/Restoration	$27,300
Subtotal	$488,200
Engineering and Contingencies (35 percent)	170,900
Total	$659,100
Cost per linear foot	$170/LF

Note: Costs do not include construction easement acquisition.

Table 4.02-4 Opinion of Probable Cost – Allen Creek Improvements – Project 2 – Streambank Problem Areas Rated 4 (Severe)

Item	Capital Cost
Vehicle Stream Crossing Stabilization (8 x $2,000 each)	$16,000
Subtotal	$16,000
Engineering and Contingencies (35 percent)	5,600
Total	$21,600

Note: Costs do not include construction easement acquisition.

Table 4.02-5 Opinion of Probable Cost – Allen Creek Improvements – Project 3 – Vehicle Stream Crossing Upgrades

4.03 AGRICULTURAL BMPS

This section describes BMPs that could be implemented on agricultural lands in the Lake Leota watershed to reduce NPS pollution.

Many BMPs are not only environmentally and ecologically beneficial, they also make good economic sense for landowners. Soil erosion impacts natural resources by delivering excess sediment and other harmful pollutants, but it also reduces the productivity of agricultural lands by stripping away nutrients and fertile topsoil. Good conservation is also good business.

Many agricultural practices currently being implemented in the Lake Leota watershed can be considered BMPs. For example, the residue management provided by no-tillage practices has a substantial impact on the amount of sediment delivered to waterbodies, as described in the modeling in Section 3. Some BMPs are management practices such as tillage, nutrient management, and crop rotation, and some BMPs are physical characteristics such as riparian buffers and grassed waterways.

While many of the BMPs listed in this section have been implemented to some extent throughout the watershed, there is still potential for improvement to reduce NPS pollution to Lake Leota, Allen Creek, and other water resources. We recommend further implementation of BMPs throughout the watershed, with an emphasis on targeting BMP projects in the "hot-spot" subbasins (the ones with the highest loadings in Figure 3.03-2) and on properties that have the highest impact to waterbodies such as those adjacent to Allen Creek.

The following agricultural conservation practices, listed in alphabetical order, are a selection from the many practices recommended by NRCS. The descriptions come from NRCS Conservation Practice Standards, and NRCS practice code numbers are given for each. A complete listing of NRCS Conservation Practice Standards can be found at the following web-site: www.nrcs.usda.gov/technical/standards/nhcp.html.

1. Conservation Crop Rotation (Code 328)

Conservation crop rotation is the practice of growing crops in a recurring sequence on the same field to reduce sheet and rill erosion, reduce wind erosion, maintain soil organic matter content, manage the balance of plant nutrients, manage plant pests, provide food for livestock, and provide food and cover for wildlife. Figure 4.03-1 shows an example of this.

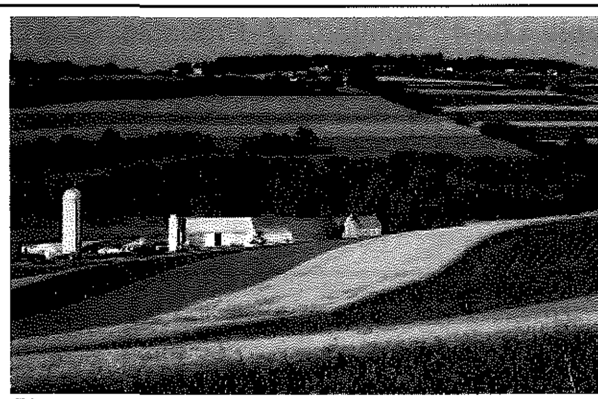


Photo source: NRCS, Practice Code 328

Figure 4.03-1 Conservation Crop Rotation

2. Contour Buffer Strips (Code 332)

Contour buffer strips are narrow strips of permanent, herbaceous vegetative cover established across the slope and alternated down the slope with parallel, wider cropped strips. This is done to reduce sheet and rill erosion, reduce transport of sediment off-site, and enhance wildlife habitat.

3. Contour Farming (Code 330)

Contour farming is tillage, planting, and other farming operations performed on or near the contour of the field slope. This is done to help reduce sheet and rill erosion and reduce transport of sediment and other water-borne contaminants. Figure 4.03-2 shows an example of contour farming.

Photo source: NRCS, Practice Code 330

Figure 4.03-2 Contour Farming

4. Cover Crop (Code 340)

Cover crop is grasses, legumes, forbs, or other herbaceous plants established for seasonal cover and conservation purposes. This practice reduces erosion from wind and water, increases soil organic matter, manages excess nutrients in the soil profile, promotes biological nitrogen fixation, increase biodiversity, suppresses weeds, provides supplemental forage, and manages soil moisture.

5. Fence (Code 382)

A fence is a barrier constructed to prevent access to animals or people where natural barriers are not effective. This is especially important for protecting water quality areas from livestock access.

6. Field Border (Code 386)

A field border is a strip of permanent vegetation established at the edge or around the perimeter of a field to reduce erosion from wind and water, protect soil and water quality, manage harmful insect populations, provide wildlife food and cover, increase carbon storage in biomass and soils, and improve air quality. Figure 4.03-3 shows an example of a field border.

Photo source: NRCS, Practice Code 412

Figure 4.03-3 Field Border

7. Filter Strip (Code 393)

A filter strip is a strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forest land) and environmentally sensitive areas. The purposes of this practice are the following: (a) protect water quality by filtering and removing sediment, organic matter, pesticides, sediment-borne phosphorus, and other pollutants from sheet flow runoff and subsurface flow through deposition, adsorption, plant uptake, denitrification or other processes; (b) eliminate row crop production and associated pollutants adjacent to environmentally sensitive areas; and (c) protect and stabilize the riparian zone and reduce flood water velocity.

8. Grassed Waterway (Code 412)

A grassed waterway is a natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation to convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding; to reduce gully erosion; and to protect and/or improve water quality by filtering sediment and other water-borne pollutants. Figure 4.03-4 shows an example of a grassed waterway.

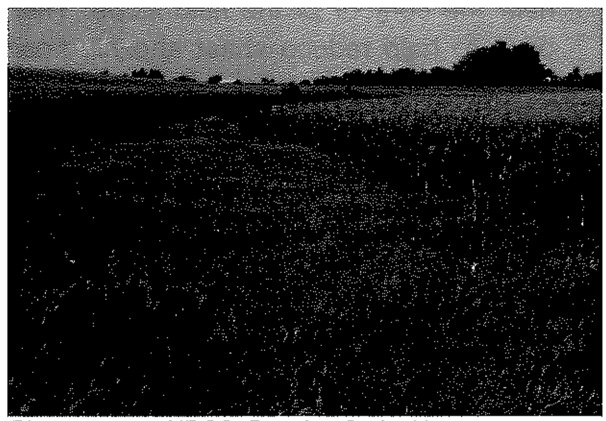


Photo source: NRCS, Practice Code 412

Figure 4.03-4 Grassed Waterway

9. Nutrient Management (Code 590)

Nutrient management is managing the amount, source, placement, form, and timing of the application of nutrients and soil amendments. This is intended to minimize nutrient entry into surface water, groundwater, and atmospheric resources while maintaining and improving the physical, chemical, and biological condition of the soil.

10. Residue Management

a. Mulch Till (Code 329B)

Residue management using mulch till is the practice of managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round while growing crops where the entire surface is tilled prior to planting. This practice includes mulch tillage methods commonly referred to as chiseling, subsoiling, and disking. It applies to tillage for annually planted crops and to tillage for planting perennial crops. This practice helps reduce inter-rill, rill, and wind erosion.

b. No-Till and Strip Till (Code 329A)

Residue management using no-till or strip till is the practice of managing the amount, orientation, and distribution of crop and other plant residues on the soil surface year-round while growing crops in narrow slots or tilled strips in previously untilled soil and residue. This practice includes tillage and planting methods commonly referred to as no-till, row till, slot plant, strip till, zero till, or zone till. This reduces inter-rill, rill, and wind erosion. Figure 4.03-5 shows an example of crop residue.

Photo source: NRCS, Practice Code 329

Figure 4.03-5 Residue Management

11. Riparian Forest Buffer (Code 391)

Riparian forest buffer is an area of trees, shrubs, and herbaceous plants that functions as a vegetated ecotone and is located adjacent to water bodies and water courses. An ecotone is the boundary between adjacent ecosystem types. It can include environmental conditions that are common to both neighboring ecosystems and can have higher species diversity. This practice is meant to provide shade to lower water temperatures and facilitate higher stream dissolved oxygen concentrations to improve habitat for aquatic organisms; provide a source of detritus and large woody cover for aquatic organisms; improve water quality by establishing permanent tree and herbaceous cover in floodplain areas subject to out-of-bank flow and/or scour erosion; provide habitat and corridors for aquatic and terrestrial flora and fauna; increase transpiration and infiltration, resulting in slower groundwater discharge to streams and reduced flood flows and to mitigate flood damage; increase the biodiversity of plant and animal species in riparian areas; and improve water quality by reducing amounts of sediment, organic matter, nutrients, pesticides, and other pollutants in surface runoff and reducing the amounts of nutrients and other chemicals in shallow groundwater. Figure 4.03-6 shows a riparian forest buffer.

Photo source: NRCS, Practice Code 391

Figure 4.03-6 Riparian Forest Buffer

12. Riparian Herbaceous Cover (Code 390)

Riparian herbaceous cover is grasses, grass-like plants, and forbs that are tolerant of intermittent flooding or saturated soils and that are established or managed in the transitional zone between terrestrial and aquatic habitats. The practice provides food, shelter, shading substrate, access to adjacent habitats, nursery habitat and pathways for movement by resident and nonresident aquatic, semiaquatic and terrestrial organisms; improves and protects water quality by reducing the amount of sediment and other pollutants, such as pesticides, organic materials, and nutrients in surface runoff as well as nutrients and chemicals in shallow ground water flow; helps stabilize streambank and shorelines; and increases net carbon storage in the biomass and soil.

13. Row Arrangement (Code 557)

Row arrangement is establishing a system of crop rows on planned grades and lengths primarily for erosion control and/or water management. Figure 4.03-7 shows an example of row arrangement.

Photo source: NRCS, Practice Code 557

Figure 4.03-7 Row Arrangement

14. Stream Crossing (Code 578)

A stream crossing is a stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles. An adequately constructed stream crossing will improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream and reduce streambank and streambed erosion while providing a crossing for access to another land unit. Measures should be installed to minimize erosion of the roadside ditch, road surface, and/or cut slopes.

15. Streambank and Shoreline Protection (Code 580)

This is a treatment used to stabilize and protect banks of streams or constructed channels, lakes, reservoirs, or estuaries. This practice may prevent the loss of or damage to land, utilities, roads, buildings, or other facilities adjacent to the banks; maintain the capacity of the channel and floodplain; maintain or restore channel meander and velocity that would not adversely affect downstream facilities; reduce sediment loads that cause degradation of habitat and water quality; and improve or protect recreation, fish and wildlife habitat, and biodiversity.

16. Stripcropping (Code 585)

Stripcropping is growing row crops, forages, small grains, or fallow in a systematic arrangement of equal width strips across a field. This practice may reduce soil erosion from water and transport of sediment and other water-borne contaminants, reduce soil erosion from wind, and protect growing crops from damage by wind-borne soil particles.

17. Water and Sediment Control Basin (Code 638)

A water and sediment control basin is an earth embankment or a combination ridge and channel generally constructed across the slope and minor watercourses to form a sediment trap and water detention basin. This practice may be established to improve farmability of sloping land; reduce watercourse and gully erosion; trap sediment; reduce and manage onsite and downstream runoff; and improve downstream water quality. This is usually applied where the terrain is irregular or hilly, such as unglaciated zones, and can be combined with grassed drainage ditches/waterways.

A local example of an implementation project involving water and sediment control basins is the Stewart Lake watershed project near Mount Horeb, Dane County. The Dane County LCD has undertaken around 13 water and sediment control basins at the heads of draws leading to Stewart Lake, a 7-acre lake created by a small dam. The DCLCD is implementing these basins prior to a planned dredging of the lake to protect the investment of dredging. Figure 4.03-8 shows two examples of basins constructed in the Stewart Lake watershed.

Photos source: Dane County LCD, Stewart Lake Watershed

Figure 4.03-8 Water and Sediment Control Basin

County LCDs, with the help of the WFTC, should identify several projects per year and work to implement them with the landowners' permission and help the landowners obtain cost-sharing funds from the sources described in Section 4.05 below.

An example of a practice that has been successfully implemented in parts of the Lake Leota watershed along the creek and in the uplands is buffers. Buffer types range from grassed waterways and field windbreaks to relatively new configurations such as alley cropping, vegetative barriers, and herbaceous wind barriers. Other buffer types include riparian forest buffers, riparian herbaceous buffers, filter strips, contour buffer strips, field borders, cross-wind trap strips, and living snow fences. If properly designed, installed, and maintained, conservation buffers offer an array of environmental benefits including soil erosion control, air and water quality improvements, fish and wildlife habitat, conservation of biodiversity, and carbon sequestration.

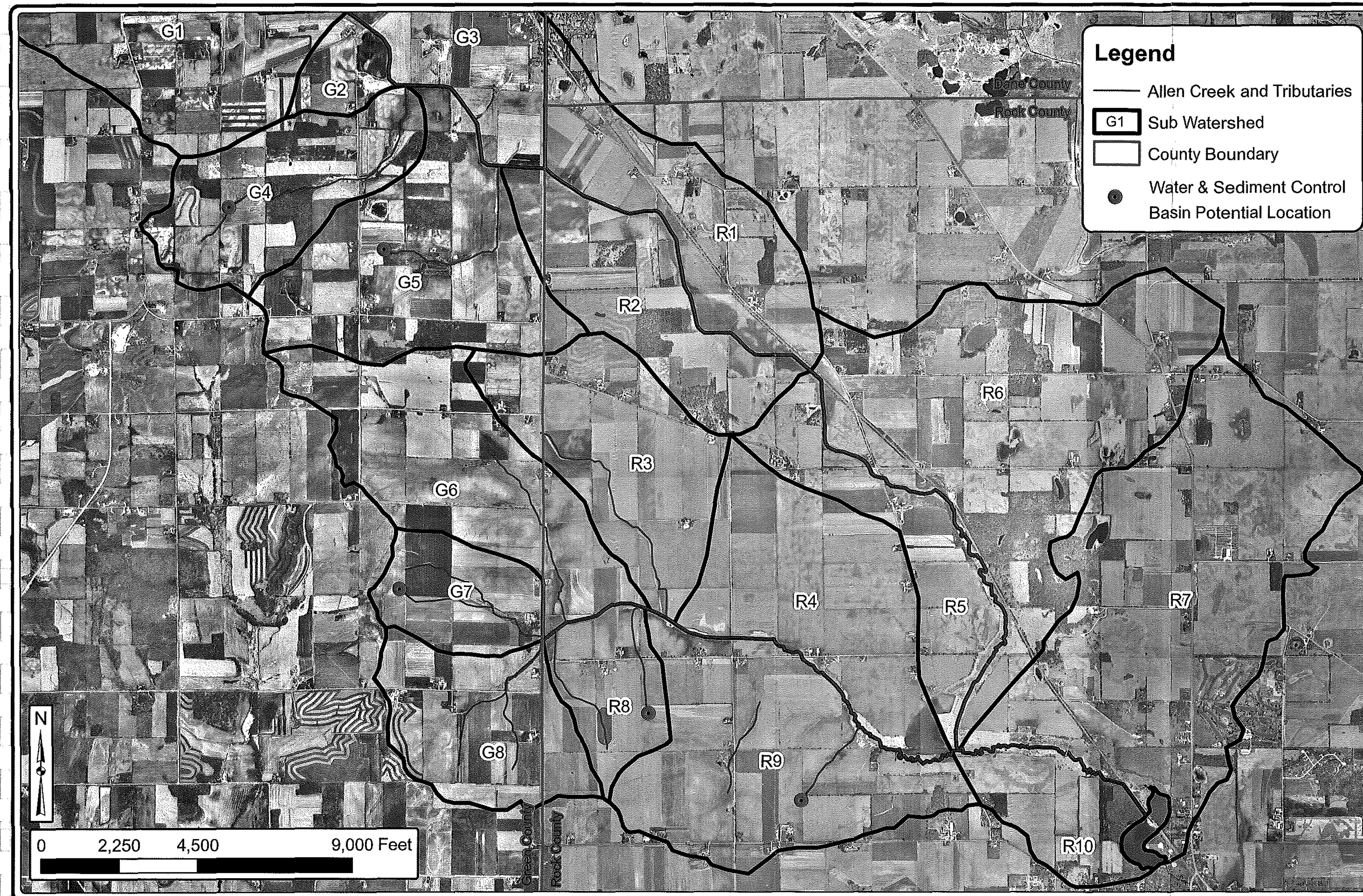
Conservation practices such as buffers have a two-pronged effect on NPS pollution because practices that result in less soil erosion usually also filter and trap eroded soil from upstream areas, preventing sediment movement and delivery. We recommend the installation of 50-foot buffers (or as recommended by the County LCDs) on both sides along Allen Creek and its main tributary in the areas identified as having the highest sediment loading rates in the models (see Figures 3.03-2 and 3.03-3). These buffers should be implemented by landowners with the help of the WTFC and the County LCDs. Potential cost-sharing sources for these buffers are described in Section 4.05 below.

Efforts should be focused on riparian landowners as well as landowners with steep fields or other fields at high risk of erosion. Larger producers in the watershed may be more eligible for cost-sharing and may have a potential for a higher impact because more land could be devoted to conservation.

In addition, we recommend installing 25-foot buffers (or as recommended by the County LCDs) on all drainageways leading to Allen Creek that don't already have buffers. This is a lower priority than the buffers along the creek, but would still be an important BMP for reducing sediment loading to the creek and to Lake Leota.

We recommend constructing five water and sediment control basins in the watershed, focusing on priority subbasins identified in the modeling (see Figures 3.03-2 and 3.03-3). These should be constructed in the uplands, on steeper terrain, at the head of existing drainage ditches. The downstream drainageways should be vegetated and made to comply with NRCS technical standards for grassed waterways. Figure 4.03-9 shows five recommended locations for water and sediment control basins in the watershed.

Because of federal privacy laws, we were unable to obtain a complete list of locations of existing BMPs in the watershed. Figure 2.06-1 shows some examples of existing agricultural BMPs that we noticed during our assessment survey as well as BMPs documented by Dane County in GIS format, but it is not meant to be comprehensive. We recommend a full-watershed Landowner Inventory Survey (LIS) to better document the locations of all BMPs implemented in the watershed as well as problem areas. The information obtained from the LIS could be mapped digitally, similar to Dane County's GIS mapping of BMPs. This would allow better identification of areas where more focus needs to be given for BMP implementation. County LCDs may be able to provide some of this information if landowner permission for release of this information is granted. Working with a consultant, the information could be digitally mapped in a GIS format if the Rock and Green County LCDs don't have this capability.



POTENTIAL LOCATIONS FOR WATER AND SEDIMENT CONTROL BASINS

LAKE LEOTA WATERSHED STUDY
CITY OF EVANSVILLE
EVANSVILLE, WISCONSIN

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.03-9
1-354.004

S:\@SAI\351--400\354\004\GIS\Report Figures\Control Basins.mxd

The LIS could be modeled after the Farm Practices Inventory performed for the Lake Mendota Priority Watershed Project (Betz, 2000). The survey consists of questions involving farming practices such as nutrient management, pesticide management, livestock quantities and proximities to water resources, cost-sharing programs, crop rotations and tillage practices, and other conservation and management topics. This would allow the WTFC to prioritize improvement projects, and to establish a baseline for future assessments in the watershed.

In Section 3, we analyzed a full no-till alternative. While we realize that it is unlikely the watershed will ever be 100 percent no-till, we think it is a good goal. Based on our predictions, just this practice alone has the potential to reduce the existing sediment loading rate to Lake Leota by approximately 30 percent over existing loadings. Additional BMPs in conjunction with the no-till practice would make a substantial impact and reduce the frequency of dredging of Lake Leota.

The I&E program outlined in Section 5 outlines many specific recommendations on ways to encourage landowners and other groups to implement good conservation practices and BMPs.

4.04 RESOURCES

The following is a list of NPS Protection Partners in Wisconsin. These agencies and organizations are a good source of technical information and assistance as well as cost-sharing opportunities for implementation of agricultural BMPs (see Section 4.05 for information on cost-sharing programs).

1. County Land Conservation Departments (LCDs)

   a. Rock County

   Tom Sweeney, Rock County Conservationist, 608-754-6617
   440 N. US Hwy. 14, Janesville, 53546-9708

   b. Dane County

   - Web site: http://www.countyofdane.com/landconservation/programpg.htm
   - Contact: Duane Wagner, Conservationist, 608-224-3742, or Curt Diehl, Conservation Specialist, 608-224-3741
     1 Fen Oak Ct., Room 208, Madison, 53718-8812

   c. Green County

   Todd Jenson, Green County Conservationist, 608-328-9527
   2841 6th St, P.O. Box 497, Monroe, 53566-0497

2. USDA Natural Resources Conservation Service (NRCS)

   a. Web site: http://www.nrcs.usda.gov/

b. Contact: Roger Allan, NRCS District Conservationist, 608-754-6617
440 N. US Hwy. 14, Janesville, 53546-9708

3. USDA Farm Service Agency (FSA)

a. Rock County: Judy Schambow, 608-754-6617
b. Dane County: Roger Johnson, 608-224-3767
c. Green County: Teresa Zimmer, 608-325-4195 ext. 104

4. University of Wisconsin Extension (UWEX)

a. Web site: http://www.uwex.edu/topics/agriculture/
b. Contacts:
   - Rock County: Jim Stute, jim.stute@ces.uwex.edu, 608-757-5696
   - Dane County: Nolan Anderson, nolan.anderson@ces.uwex.edu, 608-224-3717
   - Green County: Mark Mayer, mark.mayer@uwex.edu, 608-328-9440

5. Wisconsin Department of Natural Resources (DNR)

a. Web site: http://www.dnr.state.wi.us/org/water/wm/nps/animal.htm
b. Contact: Mike Vollrath, Ag. Runoff Management Specialist, 608-935-1940
michael.vollrath@dnr.state.wi.us
Dodgeville Area Office, 3448 State Hwy 23, Dodgeville, WI 53522

6. Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP)

a. Web site: http://datcp.state.wi.us/core/agriculture/agriculture.jsp
b. Contact: Agricultural Resource Management Division, 608-224-4500

7. Wisconsin Land and Water Conservation Association (WLWCA)

a. Web site: http://www.wlwca.org/
b. Contact: Rebecca Baumann, Executive Director, 608-833-1833
rebeccabaumann@wlwca.org

4.05 POTENTIAL COST-SHARING OPPORTUNITIES

Phase II of this assessment included an analysis of programs that can provide funding and technical assistance to individual property owners. We anticipate that the City, SOLE, and the counties can work with the targeted property owners to obtain funding and help implement recommended BMPs.

Adequate funding is crucial to the success of rehabilitating the Lake Leota watershed. Funding, in the form of both grants and loans, may be available from several governmental agencies including the following:

- Wisconsin Department of Natural Resources (DNR)
- Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Army Corps of Engineers (USACE)
- U.S. Department of Agriculture (USDA)

Eligible recipients typically include local governments (counties, villages, towns, cities), nongovernmental organizations, and individual landowners. Stakeholder groups such as SOLE can help show local support for projects, increasing the likelihood of funding from governmental agencies. In addition, partners such as Trout Unlimited could be brought in as sponsors to donate labor and materials to help build such improvements as lunker structures for streambank restoration.

Cost-share funds for installing pollutant control measures target sites that contribute the greatest pollutant load. In the Lake Leota watershed, these primarily include upland fields, streambank erosion, streambank habitat degradation sites, manure spreading, and barnyards. Sources that generate the greatest NPS pollutant loads and can be feasibly controlled are the most likely to be eligible for financial and technical assistance. More information regarding some of the grant programs can be found in the Strand Stormwater Funding Brochure in Appendix C and below.

A. Targeted Runoff Management (TRM)

DNR Targeted Runoff Management (TRM) grants are awarded to control polluted runoff from both urban and rural sites. The grants are targeted at high-priority resource problems, and projects are site-specific and generally smaller in size than a subwatershed. Some examples of eligible BMPs include some cropland protection, detention ponds, livestock waste management practices, stream bank protection projects and wetland construction. Other practices eligible for funding are listed in NR 153 and NR 154.04. The TRM Web site is http://www.dnr.state.wi.us/org/water/wm/nps/grants/TRM.htm.

TRM grants can fund the construction of rural and urban BMPs, including design of BMPs as part of a construction project. Most work is only reimbursable when done during the grant period, with the exception of land acquisition and design completed prior to the grant. A maximum cost-share rate of 70 percent of eligible costs is available to TRM grant recipients, with a maximum state funding share of $150,000. The deadline for applying for the TRM grant program each year is April 15.

TRM grants may not be used to fund the following:

1. Projects to control pollution regulated under Wisconsin law as a point source. This includes activities to meet permit requirements for large livestock feeding operations and municipal or industrial activities to meet permit requirements under NR 216.

2. Construction site erosion control and postconstruction structural BMPs for new development.

3. Projects that are not water-quality based (such as projects to solve drainage or flooding problems) or dredging projects.

4. Rural projects within priority watershed project areas, unless a showing is made that the priority watershed funding is inadequate to cover the entire TRM project.

B. Lake Protection Grants

Some Lake Leota watershed projects may be eligible for the DNR's Lake Protection Grant program. Eligible projects include the following:

1. Purchase of land or conservation easements that will significantly contribute to the protection or improvement of the natural ecosystem and water quality of a lake.

2. Restoration of wetlands and shorelands that will protect a lake's water quality or its natural ecosystem (these grants are limited to $100,000). Special wetland incentive grants of up to $10,000 are eligible for 100 percent state funding if the project is identified in the sponsor's comprehensive land use plan.

3. Development of local regulations or ordinances to protect lakes and the education activities necessary for them to be implemented (these grants are limited to $50,000)

4. Lake management plan implementation projects recommended in a plan and approved by the DNR. These projects may include watershed management projects, lake restoration, diagnostic feasibility studies, or any other projects that will protect or improve lakes.

Awards may fund up to 75 percent of project costs (maximum grant amount $200,000 unless otherwise specified above). The application deadline is May 1 of each year. The following projects are not eligible for funding through Lake Protection and Classification grants:

1. Dam repair, operation, or removal.
2. Purchase of property on which a dam is located.
3. Water safety patrols.
4. Dredging.
5. Design, installation, operation or maintenance of sanitary sewers or septic systems.
6. Most chemical treatments or mechanical harvesting of aquatic plants.
7. Maintenance and operation of equipment and facilities.

The DNR recommends a preapplication meeting because of the size, complexity, and technical nature of these projects, especially if the project requires plan or permit approvals. This will ensure the application will be complete and can be evaluated and considered for funding.

New AIS grant program)

This study is funded by a similar grant program, the DNR Lake Planning Grant Program.

C. River Protection Grants

Similar to the lake protection grants described above, the DNR also awards grants for protecting and restoring rivers and their ecosystems. Eligible grantees can be reimbursed for up to 75 percent of eligible project costs, not to exceed $50,000. The deadline for applying is May 1 of each year. Eligible projects include:

1. Purchase of land or conservation easements.
2. Development of local regulations or ordinances to protect or improve water quality.
3. Installation of practices to control NPS pollution.
4. Restoration projects including instream or shoreland habitat and protection.
5. DNR-approved activities needed to implement planning recommendations.
6. Education, planning, and design activities necessary for the implementation of a management project.

The following projects are not eligible for funding under the river protection grants program:

1. Dam repair and operation.
2. Purchase of property on which a dam is located (unless for the purpose of facilitating dam removal).
3. Dredging.
4. Design, installation, operation, or maintenance of sanitary sewers, treatment plants, or on-site sewerage systems.

D. Conservation Reserve Program (CRP) and Conservation Reserve Enhanced Program (CREP)

The Conservation Reserve Program (CRP) and the Wisconsin Conservation Reserve Enchanced Program (CREP) is an opportunity for individual landowners to voluntarily enroll agricultural lands into conservation practices such as riparian buffers, filter strips, wetland restorations, and waterways. The Lake Leota watershed is entirely located within the CREP eligibility region for riparian projects. The program is a federal-state-local partnership that includes the USDA, the Farm Service Agency (FSA), DATCP, NRCS, DNR, and participating county LCDs. Through the program, USDA provides $200 million, the state provides another $40 million in bond funds to landowners, and counties contribute by utilizing LCD staff to implement the program.

Since 1982, significant decreases in cropland erosion have been noted as a result of the implementation of a variety of soil conservation practices that include the conversion of highly erodible cropland to vegetative cover through the CRP (USDA-NRCS, 2001).

The following practices are eligible for cost-share funds through CREP within the riparian project regions:

1. Filter strips.

2. Riparian buffers.

3. Grassed waterways (up to 1,000 feet into cropland from the enrolled riparian buffer or filter strip).

4. Wetland restorations (in conjunction with an enrolled riparian buffer, filter strip, or established upland grassland habitat).

5. Marginal pastureland wildlife habitat buffer.

CREP is set up as a way of increasing the benefits to individual landowners by incorporating state funds into the federal CRP. The annual and up-front incentives from the federal government (USDA) and the State of Wisconsin (DATCP and DNR) are described below:

1. Federal Incentives

   a. Annual payments for up to 15 years based on the soil types on the lands and the installed practices (rental rates typically range from $35 to $120 per acre).

   b. Annual incentive payment between 35 and 60 percent of the annual rental rate.

   c. Annual maintenance payment of $5 to $10 per acre, depending on soils and practice.

   d. Signing incentive payment (SIP): up-front one-time payment of $140 to $150 per acre for signing up the land.

   e. Cost-sharing of 50 percent of eligible costs for installing practices.

   f. An additional 25 percent cost-sharing incentive for wetland restoration projects to restore land hydrology.

   g. Practice incentive payment (PIP): an additional 40 percent cost-sharing for practices eligible for a SIP.

2. State of Wisconsin Incentives

   a. Up-front incentive of 1.5 times the annual rental rate for a 15-year agreement, or 12 times the annual rental rate for a perpetual conservation easement.

   b. Twenty percent cost-sharing for implementation of eligible practices.

For more information regarding the CREP program, visit http://www.fsa.usda.gov/dafp/cepd/crep.htm or contact the USDA FSA representative for the region of interest (listed above).

E. NRCS Environmental Quality Incentives Program (EQIP)

The NRCS Environmental Quality Incentives Program (EQIP) is a program that provides assistance to farmers for natural resources conservation on their lands. Funded through the 2002 Farm Bill (Farm Security and Rural Investment Act), EQIP provides cost-sharing for livestock or agricultural producers. A maximum of $450,000 aggregate for fiscal years 2002 though 2007 may be distributed to an individual or entity. Cost-sharing can be provided up to 75 percent (up to 90 percent for limited resource producers) of the costs of certain conservation practices such as the following:

1. Grassed waterways
2. Filter strips
3. Manure management facilities
4. Capping abandoned wells
5. Other practices important to improving and maintaining the health of natural resources

In Rock County, the Local Work Group sets local EQIP priorities and has set streambank stabilization as a priority for cost-sharing. The Local Work Group has encouraged landowners receiving EQIP funds to also receive funds from the Wisconsin CREP program for establishing buffers. According to Roger Allan, this has already been accomplished to some extent in the Lake Leota watershed, especially just upstream of the lake. However, there is potential for more landowners in the watershed to take advantage of the dual funding opportunity.

The fiscal year 2006 allocations for EQIP are $994,705,524 nationwide.

F. USEPA Nonpoint Source Implementation Grants (319 Program)

USEPA provides grants to states to implement NPS projects in accordance with Section 319 of the Clean Water Act (CWA). NPS pollutant reduction projects can be used to protect source water areas and the general water quality of water resources of a watershed. Examples of previously funded projects include installation of BMPs for animal waste; design and implementation of BMP systems for stream and lake watersheds; basinwide landowner education programs; and lake projects previously funded under the CWA Section 314 Clean Lakes Program. This program is administered by the DNR (contact: Greg Sevener, gregory.sevener@dnr.state.wi.us, 715-582-5013). States provide 40 percent non-Federal match for the grant, and recipients typically provide 40 percent match for each project, but it varies from state to state.

A success story in Wisconsin using funds from the 319 program is Bass Lake in Marinette County where BMPs were implemented to reduce nutrient loading from animal waste sources in the watershed.

G. Soil and Water Resource Management Grants

DATCP awards annual grants to eligible county Land Conservation Committees (LCCs) and other cooperators to pay for county conservation staff and to finance landowner cost sharing. To be eligible for grant funds, a county must have a DATCP-approved land and water resource management (LWRM) plan.

DATCP awards grant funds as part of an allocation process working with the DNR. The allocation process involves several steps: (1) counties and others apply for grant funds, (2) DATCP evaluates applications based on grant criteria, (3) DATCP prepares a preliminary and final plan to allocate grant funds. Grant funds must be spent in the year allocated, except DATCP may extend cost-share funds for an additional year for specific projects.

DATCP administers grant funds by signing contracts with grant recipients. Grant recipients must use cost-share and other approved forms. DATCP reimburses counties and other grant recipients for expenditures up to the limit of their grant awards. For more information on the Soil and Water Resource Management Grant Program, visit the following Web site: http://datcp.state.wi.us/arm/agriculture/land-water/conservation/soil_water_rm.jsp.

H. NRCS: Conservation on Private Lands Grant Program

The National Fish and Wildlife Foundation is working to expand and strengthen its partnership with the NRCS to support innovative and effective conservation and stewardship of private lands through the Conservation on Private Lands Grant Program. The goal of the partnership is to support high quality projects that engage private landowners, primarily farmers and ranchers, in the conservation and enhancement of wildlife and natural resources on their lands. Successful projects will address conservation practices in ongoing agriculture, ranching, and forestry operations (at the watershed or landscape scale); offer value for fish and wildlife; include partnerships; and have a strong on-the-ground component.

Funding is provided to winning projects at a maximum of 50 percent cost-sharing. Typical awards range from $10,000 to $150,000. The program has an annual funding level of $3 million.

SECTION 5
INFORMATION AND EDUCATION PROGRAM

5.01 INFORMATION AND EDUCATION GOALS

We recommend initiating a program to inform and educate landowners and other residents and businesses in the watershed of measures that can be taken to reduce negative impacts on surrounding natural resources. The Lake Leota I&E program is intended to raise awareness among individuals and organizations concerning NPS pollution and conservation and is intended to be carried out by the proposed WTFC in conjunction with the City of Evansville, the County LCDs, nearby municipalities, and other citizen action groups such as SOLE.

The primary goal of the I&E program for the Lake Leota watershed is for residents and other shareholders of the watershed to have a full understanding of the impacts their actions have on the health of Allen Creek and Lake Leota and to make beneficial decisions and take action to protect the natural resources of the watershed. This section describes more specific I&E goals and audiences, and Section 5.02 suggests actions or tasks that can be implemented to achieve the goals.

The framework for this plan is modeled after the Nonpoint Source Control Plan for the Lake Mendota Priority Watershed Project (2000).

A. Audiences

The primary targeted audiences for I&E in the Lake Leota watershed are rural audiences, which are approximately categorized as follows:

1. Those involved directly with land management (land owner/operator).

2. Those involved directly with livestock animals and manure management (livestock operators).

3. Those who work with landowners/operators and livestock operators (agricultural businesses, crop consultants, farm suppliers, seed companies, and co-ops).

4. Those involved in conservation activities (high school, vocational/technical and university instructors, FFA, and 4-H leaders and youth).

Secondary, other audiences that could be targeted in the watershed are categorized as follows:

5. Those involved in planning and developing (developers and engineers).

6. Those involved during implementation of site plans (contractors, builders, and inspectors).

7. Those who influence policy and decision-making (elected officials, municipal regulatory bodies, zoning officials, boards).

8. Those who support change (conservation groups, media, civic organizations, and concerned citizens) .

9. Those who are future actors and supporters (teachers and youth groups).

B. Objectives

The general goal of an I&E program is to increase the public's awareness and appreciation of how their actions influence the land, water, and air around them, and their bottom line. This goal supports the overall goal of the watershed, which is to cost-effectively reduce the NPS pollutant loads to Allen Creek, Lake Leota and other natural resources in the watershed. The following specific objectives for the target audiences described above are intended to meet these goals. These objectives are not intended to be all-encompassing but provide a framework.

1. Agricultural Issues

   a. All landowners involved in agricultural practices will be aware of how tillage practices influence soil erosion. to help their bottom line → fuel, & econ. benefits time

   b. All landowners involved in livestock will adhere to nutrient management plans to reduce the risk to the environment from excessive application of natural and commercial fertilizers.

   c. Eligible landowners will understand the economic benefits of installing conservation practices and would know how to obtain cost-sharing funds.

2. Urban and Development Issues

   a. All urban audiences will understand the environmental, social, and economic impacts of stormwater runoff.

   b. During the development and plat approval process, those involved with developing and implementing the plan will design and implement an effective stormwater runoff control plan.

   c. Those involved in developing and implementing site plans will adhere to the best methods available for reducing sediment loadings from construction sites.

   d. Homeowners, government officials, and business owners will know how to decrease pollutants coming from their property.

5.02 PROGRAM COMPONENTS

Suggested components of the Lake Leota Watershed I&E Program are described below:

1. Send an informational direct-mail piece on a specific conservation topic to targeted landowners such as farmers with agricultural crops, farmers with livestock, and riparian owners (landowners with land adjacent to the creek or lake).

2. Work with local organizations such as SOLE to promote public participation and awareness of water quality issues.

3. Identify key landowners in the watershed and contact them directly to see if they would be willing to serve on the WTFC or implement a specific agricultural conservation practice or topic. This can lead to more activity among other landowners in the watershed because word spreads if a program is successful with a few key individuals or groups.

4. Hold workshops about funding opportunities and help landowners get application materials, or help calculate the economic advantages for them if they were to apply for funding. Advertise workshops in local papers, newsletters, and through direct-mailings or phone calls.

5. Develop demonstration sites for wetlands restoration, buffers, streambank restoration, grassed waterways, water and sediment control basins, and other BMPs that have been implemented or are in the process of being implemented in the watershed. Create a watershed map identifying these locations.

6. Organize local 4-H and other student groups to implement a conservation project such as a buffer or streambank restoration planting, a creek cleanup, or a manure diversion. Teach the students why conservation is important and how the project will contribute to the health of the watershed. Have the local papers cover the project.

7. Provide educational displays/booths on conservation practices at various public events and gatherings such as county fairs and the Evansville Fourth of July event.

8. Raise awareness of other similar projects in nearby watersheds, such as Stewart Lake watershed in Dane County. This could involve a field trip or presentation by Dane County LCD staff on the progress of the watershed improvements.

9. Work with the county LCDs to provide I&E in a joint effort, where feasible.

10. Enlist other interest groups such as Trout Unlimited to provide coordination and volunteers.

11. Develop and promote nutrient and pest management demonstration sites in the watershed.

12. Distribute leaflets and pamphlets to homeowners regarding such topics as proper usage of lawn care products, disposal of oil and other car care products, proper approaches to vehicle washing, pet waste collection, water conservation practices for homeowners, and proper disposal of household hazardous wastes. Preprinted materials may be available from sources such as the UW-Extension, DNR, and County LCDs to minimize development costs. These may be distributed at such locations as local libraries, community events and meetings, or other public buildings. The City of Evansville's Eager Free Public Library may be a good repository of the pamphlets and leaflets. This recommendation is aimed more at urban areas, but would be beneficial throughout the community.

13. Stencil storm drains to discourage dumping of oil and other pollutants in villages and towns. A cost-effective approach may be to work with Boy Scouts or other groups and school organizations to promote this activity as an educational program.

14. Write newsletter articles for publication in organization newsletters and local newspapers. The periodic articles written by SOLE and published in the Evansville Review are a good example.

15. Create a page on the City of Evansville's Web site detailing Lake Leota watershed issues, including stormwater and conservation information. This should include the framework for the I&E program, upcoming activities, and documentation of past activities.

16. Join Citizen Lake Monitoring Network & Water Action Volunteers & stream monitoring

SECTION 6
IMPLEMENTATION PLAN AND SCHEDULE

6.01 IMPLEMENTATION PLAN AND SCHEDULE

The Lake Leota WTFC should be formed during the first year (2006). SOLE, the City, and County LCDs should collaborate on this task and gather volunteers, and set goals and milestones. Funding may be available through the 319 Program, the River Protection Grant Program, or the Conservation on Private Lands Grant Program for operating expenses or for certain activities. related to the WFTC

Table 6.01-1 shows a suggested timeline and funding sources for an implementation plan for the first four years of watershed improvements.

TABLE 6.01-1

SUGGESTED INITIAL IMPLEMENTATION PLAN

Step	Description	Potential Responsible Part(ies)	Potential Cost-Sharing Source(s)	Implementation Schedule
1	Form a Watershed Task Force Committee (WTFC) ▪ Identify key landowners and/or other volunteers to serve on committee	SOLE	River Protection Grant, Conservation on Private Lands Grant	Early 2006
2	Perform a Landowner Inventory Survey (LIS) to locate existing BMPs and other practices in the watershed ▪ Create map of existing BMPs, identify areas of need	WTFC with assistance from LCDs and/or consultant	Lake Planning Grant, Apply by April 15, 2006 for 2007 funding	Fall 2006/Spring 2007
3	Begin implementation of I&E Program ▪ BMP Installation Demonstration Projects ▪ Hold a Conservation Funding Workshop for Landowners ▪ Create Web-site page outlining goals and activities of WTFC	WTFC	River Protection Grant, Apply by February 1, 2007 for 2007 activities	Fall 2007
4	Implement Streambank Restoration Project 1 (See Figure 4.02-1)	WTFC, Landowners, Rock County LCD, with consultant assistance	TRM Grant	Apply by April 15, 2006 for 2007 funding
5	Construct 5 water and sediment control basins in uplands of subbasins with highest TSS loading rates (See Figure 4.03-9)	WTFC, Landowners, County LCDs, with consultant assistance	TRM, EQIP, CRP/CREP	Apply by April 15, 2006 for 2007 funding
6	Implement Streambank Restoration Project 2 (See Figure 4.02-1)	WTFC, Landowners, Rock County LCD, with consultant assistance	TRM Grant	Apply by April 15, 2008 for 2009 funding (do in 2 or 3 phases possibly)
7	Implement vehicle stream crossings upgrades – Project 3 (See Figure 4.02-1)	WTFC, Landowners, Rock County LCD	River Protection, TRM Grants	2009
8	Install 50-foot buffers on each side of Allen Creek in areas identified as priorities by LIS and WTFC	WTFC, Landowners, County LCDs	CRP/CREP, TRM, EQIP, Lake & River Protection	As funding becomes available
9	Install 25-foot buffers on each side of all drainageways leading to Allen Creek	WTFC, Landowners, County LCDs	(See above)	As funding becomes available
10	Continue with Implementation of I&E Program	WFTC	River Protection Grant	2007, 2008, 2009, and beyond, apply for funding periodically

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Allen Creek Streambank Erosion Field Notes

Date: 4/26/2005 Observer: CCG Section: blue Weather: clear in AM to overcast and rainy in PM

GPS Point	Photo(s)	Side (L or R)	Avg. Bank Height	Length	Erosion Assessment (see below)	Comments/Notes/Observations
b-1	1,2,3,4	L	5'	GPS	4	last curve before channel, water moving fast, fallen trees, exposed roots
b-2	5	R	2'	GPS	3	upstream of beaver dam (photo 6)
b-3	7,8,9,10	L	2'	GPS	4	beaver dam remnants causes fast water on L side, many fallen trees on upstream end
b-4	11	R	4'	30'	3	upstream of fallen trees area
b-5	12,13	L	3'	GPS	3	photo 12 is fallen tree that blocks creek flow, water moving fast
b-6	14-16	R	4'	GPS	3	at end of property (barbed wire)
b-7	17	R	3'	GPS	3	good grass buffer (> 50') upstream good vegetation on creek
b-8	18	R	4'	5'	2.5	fallen tree, island formed, some erosion around outer bend
b-9	19	R	4'-5'	20'	3	steep, bare soil, grass roots exposed, water moving fast, deep
b-10	21	L	3'-4'	GPS	1	possibly BMP, stones along steep bank, good vegetation, no erosion
b-11	28,29,30	L	2'-3'	GPS	?	gully-deposited sand/sediment bar in creek; gully long, grassy
b-12	31	L	3'	GPS	1	looks like rip rap placed here; stable, good BMP, water moving fast
b-13	33	L	3'	GPS	1	rip-rapped
b-14	33.5	L	2'	GPS	1	rip-rapped
b-15	34	R	2'-3'	GPS	3	some vegetation, some exposed soil with root overhang
b-16	35, 36	R	4'	15'	3	across from low-lying swale which may get a lot of concentrated flow
b-17	38	R	1'	20'	2	lots of hanging roots

1	**Stable**	• Grass bank or rock bank, non-eroding.
2	**Slight**	• Some bare bank but active erosion not readily apparent. • Some rills but no vegetative overhang. • No exposed tree roots.
3	**Moderate**	• Bank is predominantly bare with some rills and vegetative overhang. • Some exposed tree roots but no slumps or slips.
4	**Severe**	• Bank is bare with rills and severe vegetative overhang. • Many exposed tree roots and some fallen trees and slumps or slips. • Some changes in cultural features such as fence corners missing and realignment of roads or trails. • Channel cross section becomes U-shaped as opposed to V-shaped.
5	**Very Severe**	• Bank is bare with gullies and severe vegetative overhang. • Many fallen trees, drains, and culverts eroding out and changes in cultural features. • Massive slips or washouts common. • Channel cross section is U-shaped and stream course may be meandering.

Allen Creek Streambank Erosion Field Notes

Date: 4/26/2005 Observer: CCG Section: purple Weather: drizzly, overcast, windy

GPS Point	Photo(s)	Side (L or R)	Avg. Bank Height	Length	Erosion Assessment (see below)	Comments/Notes/Observations
pu-01	46,47	L	2'	GPS	2	downstream of bridge
pu-02	49	L	2'	GPS	2	
pu-03	50	R	2'-3'	GPS	3	
pu-04	51	L	3'-4'	GPS	3	
pu-05	54	R	3'	10'	3	
pu-06	55	R	1'	10'	2	
pu-07	56	L	1'-2'	GPS	3	
pu-08	57, 58	L	4'	GPS	3	
pu-09	59, 60	R	4'	GPS	3	
pu-10	61	L	2'-3'	GPS	3	
pu-11	62	R	3'-4'	GPS	3	
pu-12	63	L	2'-3'	GPS	3	
pu-13	64	R	3'	6'	3	
pu-14	65	R	2'-3'	GPS	2	
pu-15	66	L	1'	GPS	3	
pu-16	70	L	3'	GPS	3	dead grass overhang -- roots hanging
pu-17	71	R	2'	GPS	3	
pu-18	72	both	1'-2'	GPS	3	
pu-19	73	L	3'	GPS	3	
pu-20	74	L	1'	GPS	2	
pu-21	75	L	2'	GPS	3	
pu-22	77	R	4'	10'	3	
pu-23	78	L	3'	GPS	2	
pu-24	84	both	2'	GPS	2	
pu-25	85	R	2'-3'	GPS	4	
pu-26	86-87	R	2'-3'	GPS	3	
pu-27	88	R	4'	10'	3	
pu-28	89	R	3'	GPS	3	
pu-29	90	L	3'-4'	GPS	3	
pu-30	91-93	R	3'-4'	GPS	4	
pu-31	94,95	R	4'-5'	?	3	ran out of GPS batteries at 2:40 pm, drew on map
pu-32	97,98	R	4'	?	4	
pu-33	99	R	4'-5'	100'	4	rocks, lots of fallen trees, bare bank, some dead grasses

Allen Creek Streambank Erosion Field Notes

Date: 4/26/2005 Observer: CCG Section: purple Weather: drizzly, overcast, windy

GPS Point	Photo(s)	Side (L or R)	Avg. Bank Height	Length	Erosion Assessment (see below)	Comments/Notes/Observations
pu-34	100	L	3'	25'	3	
pu-35	101, 102	R	2'	?	3	very long, see map
pu-36	103	L	2'-3'	?	3	see map
pu-37	104, 105	both	2'-3'	?	3	just downstream of bridge, wooded area

1	**Stable**	• Grass bank or rock bank, non-eroding.
2	**Slight**	• Some bare bank but active erosion not readily apparent. • Some rills but no vegetative overhang. • No exposed tree roots.
3	**Moderate**	• Bank is predominantly bare with some rills and vegetative overhang. • Some exposed tree roots but no slumps or slips.
4	**Severe**	• Bank is bare with rills and severe vegetative overhang. • Many exposed tree roots and some fallen trees and slumps or slips. • Some changes in cultural features such as fence corners missing and realignment of roads or trails. • Channel cross section becomes U-shaped as opposed to V-shaped.
5	**Very Severe**	• Bank is bare with gullies and severe vegetative overhang. • Many fallen trees, drains, and culverts eroding out and changes in cultural features. • Massive slips or washouts common. • Channel cross section is U-shaped and stream course may be meandering.

Allen Creek Streambank Erosion Field Notes

Date: 4/28/2005 Observer: CCG Section: pink Weather: sunny, mild

GPS Point	Photo(s)	Side (L or R)	Avg. Bank Height	Length	Erosion Assessment (see below)	Comments/Notes/Observations
pk-01	106-108	both	2'-3'	GPS	3	some downed trees, shady, rocky bed
pk-02	109	L	3'-4'	GPS	4	lots of exposed roots, outside bend DS of bridge
pk-03	114	L	2'	GPS	2	somewhat shady, water slow, deep, mucky bed
pk-04	115	R	1'	GPS	2	shaded, steep slope up to farm field
pk-05	116	R	2'	GPS	3	shaded, steep, fallen tree blocking water
pk-06	119	both	3'-4'	GPS	3	sloping bank, shaded, sandy bed
pk-07	120	L	2'-3'	GPS	3	vertical bank, some overhang, creek shallow, wide
pk-08	121, 122	both	2'	GPS	2	shady, creek wide, shallow, sandy & clayey DS of bridge
pk-09	126	R	4'	GPS	3	wooded, steep, hanging roots
pk-10	128, 129	R	3'-4'	GPS	3	wooded, steep, hanging roots, some fallen branches
pk-11	130	R	3'-4'	GPS	3	overhanging roots, steep slope from RR bed
pk-12	131-133	R	2'-3'	GPS	4	trees across creek, lots of exposed roots, steep
pk-13	134	L	NA	NA	2	tree used to grow on bank, water scoured out around it
pk-14	136	R	3'-4'	NA	2	steep bank, dead grass overhang, DS of crossing
pk-15	137	L	4'	10'	4	tree overhang, exposed roots, bed mucky
pk-16	140	R	4'-5'	GPS	4	exposed roots, sediment bank, major overhang
pk-17	141, 142	R	3'	GPS	4	across from field gully, overhanging roots
pk-18	143-150	both	3'-4'	GPS	3.5	roots overhang, steep, trees down, rocky banks, shady, whole section bad both sides, goes very long
pk-19	151, 152	both	2'	GPS	2.5	shady, some exposed roots, downed branches
pk-20	154	R	2'	GPS	2.5	across from field gully
pk-21	155	both	4'-5'	GPS	4	severe overhang, bare soil, exposed roots, across from gullies on farm
pk-22	160-162	L	6'-8'	15'	5	bank eroded out around dead tree, no vegetation on gully
pk-23	163,164	L	3'	GPS	3	water routed by fallen trees, across from big gully; exposed roots, rocky bank
pk-24	165, 166	R	6'-7'	20'	5	huge gully, big sediment bar, trees exposed
pk-25	167	both	3'-4'	GPS	5	severe erosion, downed trees, roots, shady
pk-26	168-170	L	6'	NA	4.5	pipe outlet broken in two pieces, huge gully, manure smell
pk-27	171-173	L	3'	GPS	4	shady, DS of bridge, overhanging roots, dead trees
pk-28	174	R	3'-4'	GPS	4	exposed roots, bare soil, rocks, shady, DS of bridge

1	Stable	• Grass bank or rock bank, non-eroding.
2	Slight	• Some bare bank but active erosion not readily apparent. • Some rills but no vegetative overhang. • No exposed tree roots.
3	Moderate	• Bank is predominantly bare with some rills and vegetative overhang. • Some exposed tree roots but no slumps or slips.
4	Severe	• Bank is bare with rills and severe vegetative overhang. • Many exposed tree roots and some fallen trees and slumps or slips. • Some changes in cultural features such as fence corners missing and realignment of roads or trails. • Channel cross section becomes U-shaped as opposed to V-shaped.
5	Very Severe	• Bank is bare with gullies and severe vegetative overhang. • Many fallen trees, drains, and culverts eroding out and changes in cultural features. • Massive slips or washouts common. • Channel cross section is U-shaped and stream course may be meandering.

Allen Creek Streambank Erosion Field Notes

Date: 5/5/2005 Observer: CCG Section: orange Weather: sunny, warm

GPS Point	Photo(s)	Side (L or R)	Avg. Bank Height	Length	Erosion Assessment (see below)	Comments/Notes/Observations
or-01	178	both	2'-3'	GPS	2.5	upstream of bridge, bare soil, roots, shaded
or-02	179	both	5'	GPS	3.5	tree roots exposed, outside bend, wooded
or-03	180	L	5'	GPS	4.5	lots of hanging roots, severely cut away, downed trees
or-04	181	both	3'	GPS	3	bare bank
or-05	182	R	4'	GPS	4	roots, trees down, bare soil
or-06	183,184	L	4'	GPS	4	roots, trees down, bare soil
or-07	185	both	3'	GPS	4	roots, bare bank, vertical bank
or-08	186-188	L	5'-6'	GPS	4.5	places where soil actually fallen off in piles
or-09	189	R	3'-4'	GPS	3	grass overhang (dead, tree roots exposed) creek deep
or-10	190	L	4'-5'	GPS	4	tree roots, vertical slope, outer bend
or-11	191	both	4'-5'	GPS	3.5	dead grass overhang
or-12	192	L	5'	GPS	4	roots, bare soil, vertical bank
or-13	193	R	2'-3'	GPS	3	bare soil, roots, active erosion
or-14	194	L	8'-10'	GPS	4	slump/gully from field, bare soil, vertical drop
or-16	195	R	5'-6'	GPS	3.5	vertical, bare, roots
or-17	196	L	6'-7'	GPS	4	active erosion, hanging roots, grass overhang, shallow, rocky
or-18	197	R	6'-7'	GPS	3.5	grass overhang, very scoured out
or-19	198	L	7'-9'	GPS	3.5	scoured out, grass shelf, hanging roots
or-20	199,200	R	6'-7'	GPS	4	trees hanging on by roots, severe overhang
or-21	201	L	6'-7'	GPS	3	trees hanging on by roots, severe overhang
or-22	202	L	3'-4'	GPS	3.5	wooded, tree roots exposed, bare soil, creek deep
or-23	203,204	R	3'	GPS	3	roots, vegetation overhang
or-24	205,206	L	3'-4'	GPS	3	root overhang, dead grass, DS of farm
or-25	207	R	3'-4'	GPS	3	root overhang, dead grass, DS of farm
or-26	208	L	4'	GPS	3.5	tree roots, exposed soil
or-27	210	R	2'-3'	GPS	2.5	vegetative overhang, vertical bank, large tree down
or-28	214	L	3'-4'	15'	3	vegetative overhang, vertical bank, large tree down
or-29	215	R	3'-4'	GPS	3	large tree shades bank, vertical bank, exposed roots
or-30	216	R	4'-5'	GPS	3	steep, bare bank, outer bend
or-31	217	L	5'-6'	GPS	4	large tree w/roots half out, bare soil, loose, sharp bend
or-32	218	R	4'	GPS	2.5	some vegetation, some overhang, steep bank
or-33	219	L	5'	GPS	3.5	tree roots, loose soil, little vegetation
or-34	220	R	4'	GPS	4	soil mostly gone, just large tree w/roots exposed

or-35	221	R	5'	NA	3	pipe discharge from farm, water coming out, bare soil
or-36	222	R	4'	GPS?	NA	deep narrow trench from farm, recently dug, water flowing, expose
or-37	223	R	4'-5'	GPS?	NA	deep narrow trench from farm, recently dug, water flowing, expose
or-38	224	R	4'-5'	GPS?	NA	deep narrow trench from farm, recently dug, water flowing, expose
or-39	228	L	3'	GPS	3	overhang roots, shaded, rocky
or-40	229, 230	R	3'	GPS	3.5	tree roots sticking out, slump from field
or-41	231, 232	R	3'-4'	GPS	4	trees exposed, fence overhang, large rocks, wooded
or-42	233	R	3'	GPS	3	dead grass overhang, fallen trees, roots, branches
or-43	234	L	2'-3'	GPS	4	exposed roots, bare soil, fallen tree
or-44	235-238	both	2'-3'	GPS	3	roots, wooded, soil, branches in water, whole stretch is eroded

1	**Stable**	• Grass bank or rock bank, non-eroding.
2	**Slight**	• Some bare bank but active erosion not readily apparent. • Some rills but no vegetative overhang. • No exposed tree roots.
3	**Moderate**	• Bank is predominantly bare with some rills and vegetative overhang. • Some exposed tree roots but no slumps or slips.
4	**Severe**	• Bank is bare with rills and severe vegetative overhang. • Many exposed tree roots and some fallen trees and slumps or slips. • Some changes in cultural features such as fence corners missing and realignment of roads or trails. • Channel cross section becomes U-shaped as opposed to V-shaped.
5	**Very Severe**	• Bank is bare with gullies and severe vegetative overhang. • Many fallen trees, drains, and culverts eroding out and changes in cultural features. • Massive slips or washouts common. • Channel cross section is U-shaped and stream course may be meandering.

Allen Creek Streambank Erosion Field Notes

Date: 5/5/2005 Observei CCG Section: green sunny, warm

GPS Point	Photo(s)	Side (L or R)	Avg. Bank Height	Length	Erosion Assessment (see below)	Comments/Notes/Observations
gr-01	239, 240	L	3'	GPS	3	overhanging roots, bare soil, downed trees, shady
gr-02	241	L	3'-4'	GPS	3	tree roots, bare bank
gr-03	247	R	2'	10'	2	bare soil, uneven ground, sloughing from field
gr-04	248	L	1'-2'	GPS	2.5	vegetative overhang, sharp angle
gr-05	249	L	3'	5'	3	very close to field edge, sharp bank, soil exposed
gr-06	250	both	2'-3'	GPS	3	eroded bank, veg. overhang
						Lateral I

1	**Stable**	• Grass bank or rock bank, non-eroding.
2	**Slight**	• Some bare bank but active erosion not readily apparent. • Some rills but no vegetative overhang. • No exposed tree roots.
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STRAND ASSOCIATES, INC.® ENGINEERS

☐	Information Only
☒	Project Specific 1-354.004
☐	Policy Memo - File With

MEMORANDUM

TO: File
FROM: Cassie Goodwin
DATE: May 6, 2005
RE: Allen Creek Streambank Erosion Picture Descriptions

Pictures 1-105 were taken April 26, 2005, Pictures 106-176 were taken April 28, 2005, and Pictures 177-256 were taken May 5, 2005.

Picture	ID	Description
1	7723	Fallen trees and eroded bank near beginning of channel in woods; looking west.
2	7724	Same area as 1, looking south towards eroded bank.
3	7725	Same as 1.
4	7726	Looking downstream (east) from bank towards last bend in creek before meeting channel.
5	7727	Looking downstream (east) at eroded banks and sediment bar in woods.
6	7728	Looking south towards bank eroded by water diverted by fallen trees – possibly beaver dam.
7	7729	Looking southwest at eroded bank with vegetative overhang.
8	7730	Looking south at bank near 7, tree hanging over water.
9	7731	Looking downstream (east) at bare bank and fallen tree.
10	7732	Looking north at fallen tree and erosion on far bank.
11	7733	Looking north at outside bend with bare soil and many fallen branches/trees.
12	7734	Looking upstream (west) at bank with overhanging dead grasses and tree, rocks exposed.
13	7735	Looking downstream (southeast) at eroded bank and more fallen trees.
14	7736	Looking east at moderately eroded bank.
15	7737	Looking north at eroded bank.
16	7738	Looking east at same eroded bank as 15, with sediment bar on left.
17	7739	Looking northeast at erosion on outside bend, no longer in woods.
18	7740	Looking southwest at "island", creek mostly goes around to north, lower part is pretty dry.
19	7741	Looking northeast at eroded bank at sharp outside bend.
20	7742	Looking north at finger coming into creek from north.
21	7743	Looking downstream towards bend near entrance of finger, some erosion apparent.
22	7744	Looking north at small finger coming in.
23	7745	Looking north at small finger coming in.
24	7746	Looking north at small finger coming in, some erosion apparent.

Picture	ID	Description
25	7747	Looking north at old fencing falling over towards creek.
26	7748	Looking upstream (northwest) at fencing.
27	7749	Looking southwest at sunken area draining field.
28	7750	Looking northeast at sediment "peninsula" created by runoff from sunken area in picture 29.
29	7751	Looking southwest at sunken gully near sediment peninsula.
30	7752	Looking downstream (east) at sediment peninsula in picture 28.
31	7753	Looking downstream (east) at old metal canister and rock bank – potentially an old BMP.
32	7754	Looking north at finger coming in.
33	7755	Looking downstream at rip-rap area on outside bend. Seems pretty stable.
33.5	7756	Looking downstream at another outside bend with rip-rap.
34	7757	Looking upstream (northwest) at eroded bank on outside bend.
35	7758	Looking east at eroded bank across from field gully/low area.
36	7759	Looking southwest back at field low area and eroded bank.
37	7760	Looking upstream (west) at split-off of north branch of creek.
38	7761	Looking downstream (east) at vegetative overhang on outside bend downstream of bridge.
39	7762	Looking upstream (southwest) at bridge on Evansville Brooklyn Road.
40	7763	Looking north at sunken area near entrance of small finger/gully.
41	7764	Looking west at small finger/gully.
42	7765	First of many "orangish" gullies coming into creek from farm field.
43	7766	Looking west at farm ditch/sunken area – very soft saturated ground.
44	7767	Looking upstream (north) at location where ditch comes into creek (from left).
45	7768	Looking upstream (north) towards small stone bridge.
46	7769	Looking downstream (south) at eroded outside bank downstream of bridge.
47	7770	Looking downstream (south) at scoured-out area and eroded bank downstream of bridge.
48	7771	Looking northwest at finger coming in to creek.
49	7772	Looking downstream (southwest) at eroded bank with new vegetation at water surface.
50	7773	Looking downstream (southeast) at eroded outside bend with new vegetation at surface.
51	7774	Looking upstream (north) at eroded outside bend.
52	7775	Looking west at finger coming in.
54	7776	Looking east at eroded bank with overhanging dead grasses.
55	7777	Looking east at bank erosion and sunken area.
56	7778	Looking downstream (southwest) at bank erosion.
57	7779	Looking upstream (north) at outside bend erosion.
58	7780	Looking downstream (southwest) at undercut bank on outside bend.
59	7781	Looking upstream (northeast) at outside bend erosion.
60	7782	Looking downstream (southeast) at same portion of bend as 59.

Picture	ID	Description
61	7783	Looking downstream at eroded bank on outside bend just upstream of 60.
62	7784	Looking southeast at outside bend with some erosion and new growth.
63	7785	Looking downstream (south) at eroded bank and vegetation in creek on sediment bars.
64	7786	Erosion on sharp outer bend (looking south).
65	7787	Erosion on outer bend (looking east).
66	7788	Erosion on outer bend (looking west).
67	7789	Finger coming in to creek from farm field just north of bridge (looking northwest).
68	7790	Looking south (downstream) at small stone bridge.
69	7791	Finger coming in creek from east just north of bridge.
70	7792	Looking downstream (south) at eroded bank with dead grass overhang.
71	7793	Looking downstream (south) at scoured out bank with vegetated overhang.
72	7794	Looking downstream (south) at eroded banks on both sides of creek.
73	7795	Looking southwest at undercut bank.
74	7796	Looking upstream (northwest) at eroded outside bend and sediment bar.
74.5	7797	Looking downstream (south) at same bend as 74.
75	7798	Looking downstream (south) at slight erosion on outer bank.
76	7799	Looking northwest at finger coming in with eroded channel/gully.
77	7800	Looking northeast at erosion on sharp outer bend.
78	7801	Looking downstream (southeast) at bend with slightly undercut bank.
79	7802	Looking northeast at vehicle crossing.
80	7803	Looking southeast at same vehicle crossing as 79.
81	7804	Looking at culvert under railroad tracks (east).
82	7805	Looking upstream (northeast) at brownish-colored finger coming in to creek.
83	7806	Looking west at finger coming in to creek.
84	7807	Looking upstream (southwest) at eroded bank on both sides of bend.
85	7808	Looking upstream (northeast) at severely eroded bank and fallen trees.
86	7809	Looking downstream (southeast) at severely eroded bank with dead grass overhang.
87	7810	Looking downstream (southeast) at eroded bank caused be fallen tree diversion.
88	7811	Outer bank of sharp bend, looking north.
89	7812	Looking downstream (east) at outer bank erosion and sediment bar.
90	7813	Looking downstream (south) at undercut bank with fallen trees.
91	7814	Looking downstream (southeast) at bare bank and fallen tree branches.
92	7815	Looking upstream (northeast) at bank from same spot as 91.
93	7816	Looking upstream (north) at bend from same spot as 91, 92.
94	7817	Looking upstream (northeast) at eroded inside bend with bare bank.
95	7818	Looking downstream (east) at same eroded bend as 94.

Picture	ID	Description
97	7819	Small meander forming island, looking downstream (southeast) towards main creek (left).
98	7820	Looking downstream (southeast) inside bank of main creek where meander splits off.
99	7821	Looking northeast at bank erosion, large rocks, and fallen tree branch.
100	7822	Looking downstream (southeast) at eroded outer bend.
101	7823	Looking east at eroded bank with vegetated overhang.
102	7824	Looking downstream (south) at bank erosion on both sides and riffles.
103	7825	Looking upstream (northwest) at eroded bank in wooded area. Many fallen trees.
104	7826	Looking downstream (south) at bare bank in wooded area downstream of bridge.
105	7827	Looking upstream (north) at bank in wooded area same as 104.
106	7828	Looking south at slight bank erosion just upstream of bridge on N. Evansville Brooklyn Rd.
107	7829	Looking downstream (south) at streambank just upstream of bridge.
108	7830	Looking upstream (north) at stream towards bridge on W. Evansville Brooklyn Rd.
109	7831	Looking upstream (north) at bank erosion with exposed tree roots.
110	7832	Looking upstream at bridge on W. Evansville Brooklyn Rd.
111	7833	Looking north at vehicle crossing.
112	7834	Looking south at same vehicle crossing as 112.
113	7835	Looking south at another vehicle crossing.
114	7836	Looking upstream (northwest) at slightly eroded bank with new vegetation at surface.
115	7837	Looking upstream (northeast) at bank with slight erosion.
116	7838	Looking upstream (northeast) at eroded bank across from swale which drains pond.
117	7839	Looking southeast at pond and grassy area that drains it.
118	7840	Looking southeast at bank where pond drains into creek.
119	7841	Looking upstream (north) at wooded portion of creek with some bare banks.
120	7842	Looking upstream (north) at eroded bank on left side.
121	7843	Looking downstream (south) at erosion on right side.
122	7844	Looking upstream (north) from same location as 121.
123	7845	Looking upstream (north) at small wood bridge.
124	7846	Looking west at vehicle crossing just upstream of bridge.
125	7847	Looking northeast at gully from railroad tracks just upstream of vehicle crossing and bridge.
126	7848	Looking upstream (northwest) at bank erosion with exposed roots.
127	7849	Looking upstream (northwest) at large piece of sheet metal in creek.
128	7850	Looking upstream (north) at bank erosion in woods just north of sheet metal.
129	7851	Looking northeast at large piece of sheet metal and bank erosion around it.
130	7852	Looking upstream (north) at bank erosion with exposed roots.
131	7853	Looking upstream (north) at logs crossing stream.
132	7854	Looking downstream (east) at same logs crossing stream (some telephone poles).

Picture	ID	Description
133	7855	Looking upstream (west) of log dam at bare bank on left side.
134	7856	Looking downstream (east) at tree jutting out and shore eroded away around it.
135	7857	Vehicle crossing (looking north).
136	7858	Looking downstream (southeast) from road crossing at eroded bank with overhanging grass.
137	7859	Looking downstream (south) at tree with exposed roots and eroded bank.
138	7860	Looking upstream (north) from same point as 137 at erosion on far bank and sediment bar.
139	7861	Looking further upstream (north) from same point as 138.
140	7862	Looking upstream (northeast) at eroded bank and sediment bar.
141	7863	Looking east at bank with vegetative overhang across from deep gully.
142	7864	Looking southwest at bank with deep gully from same point as 141.
143	7865	Looking downstream (south) at eroded bank with exposed roots and overhang.
144	7866	Looking upstream (north) at bank erosion and downed limbs.
145	7867	Looking downstream (south) at same point as 144 at eroded banks.
146	7868	Looking upstream (northwest) at exposed bank with exposed roots and rocks.
147	7869	Looking east at bank with severely exposed roots and downed limbs and trees.
148	7870	Looking east at eroded bank with fallen limbs.
149	7871	Vehicle crossing, looking east.
150	7872	Looking downstream (south) from road crossing.
151	7873	Looking upstream (north) at slight bank erosion on right side.
152	7874	Looking downstream (southeast) at bank erosion and fallen limbs.
153	7875	Vehicle crossing, looking north.
154	7876	Looking north at bank erosion on outside bend.
155	7877	Looking north at bank erosion.
156	7878	Looking southwest at huge junkpile in gully from field.
157	7879	Looking north at huge junk pile in gully from field towards creek.
158	7880	Looking downstream from rickety old bridge at bank erosion.
159	7881	Looking south at rickety old bridge.
160	7882	Looking north towards creek at burnt tree and branches in gully.
161	7883	Looking down at creek from top of bank towards burnt tree at bare gully.
162	7884	Looking northeast towards downstream at burnt tree and burnt out gully.
163	7885	Looking downstream (southeast) at trees across creek.
164	7886	Looking upstream (northwest) at eroded bank on left (from same point as 163).
165	7887	Looking north at eroded gully in bank.
166	7888	Looking south towards downstream where gully comes in to creek, sediment bank.
167	7889	Looking upstream (northwest) at vegetative overhang with exposed roots, fallen tree.
168	7890	Looking west at sunken bank with pipe coming from field.

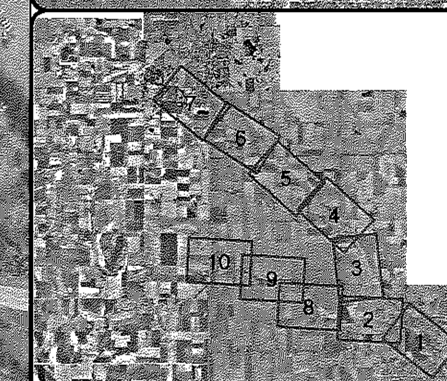
Picture	ID	Description
169	7891	Looking towards creek, another section of pipe, full of sediment, same place as 168.
170	7892	Same place as 168 and 169, different angle.
171	7893	Looking downstream (south) at bank erosion and fallen trees.
172	7894	Looking upstream (west) from same point as 171, at eroded bank and exposed roots.
173	7895	Looking upstream (northwest) towards bridge on Hwy 104 near Brooklyn.
174	7896	Looking north at eroded bank and exposed tree roots just downstream of Hwy 104 bridge.
175	7897	Looking upstream (northwest) at Hwy 104 bridge.
176	7898	Looking north at water pouring out of WWTP sewer discharge just upstream of bridge.
177	0149	Looking downstream under bridge at Evansville Brooklyn Rd.
178	0150	Looking upstream (southwest) at stream just upstream of bridge at Evansville Brooklyn Rd.
179	0151	Looking upstream (south) at eroded outer bend in wooded area upstream of bridge.
180	0152	Looking upstream (southwest) at eroded bank and fallen tree across creek.
181	0153	Looking upstream at bare banks on both sides.
182	0154	Looking upstream (west) at bank with roots, erosion, in woods.
183	0155	Looking upstream (south) at cut-away bank with long roots hanging, rocky bed.
184	0156	Looking upstream (west) at downed trees, high eroded outer bank with bare soil.
185	0157	Looking upstream (north) at eroded bank and rocky bed.
186	0158	Looking upstream (south) at bank erosion with soil fallen off in chunks.
187	0159	Looking southeast at sharp eroded bank with dangling roots.
188	0160	Looking downstream (south) at bank with soil fallen off in chunks.
189	0161	Looking upstream (north) at streambank erosion and grass overhang.
190	0162	Looking upstream (west) at streambank erosion on outer bend, vertical slope.
191	0163	Looking upstream (northwest) at streambank erosion on outer bend.
192	0164	Looking downstream (northeast) at streambank erosion.
193	0165	Looking upstream (southwest) at eroded bank with dead grass overhang.
194	0166	Looking southwest at sloughing on bank from farm field runoff.
195	0167	Looking upstream (northeast) at sharp bank erosion on outer bend.
196	0168	Looking southwest at eroded outer streambank with vegetative overhang.
197	0169	Looking downstream (east) at two sharp curves, outer banks severely eroded, overhang.
198	0170	Looking downstream (east) at scoured out bank and overhang, sediment sloughed off.
199	0171	Looking upstream (north) at trees overhanging bank, outer bend.
200	0172	Looking downstream (northeast) at same outer bend, very high bare bank, overhang.
201	0173	Looking downstream (east) at outer bend erosion.
202	0174	Looking downstream (south) at wooded eroded bank with branches down.
203	0175	Looking southeast at bank and exposed soil, grass overhang.
204	0176	Looking upstream (east) at same bank and outer bend.

Picture	ID	Description
205	0177	Looking south at bank with vegetation falling over , cut away, DS of farm.
206	0178	Looking southeast at same bank with tree roots exposed.
207	0179	Looking north at bank with trees down, DS of farm.
208	0180	Looking upstream (southwest) at creek with small tributary coming in from farm (on left).
209	0181	Looking south at small tributary from farm.
210	0182	Looking north at eroded outer bank under tree cover.
211	N/A	No picture
212	0183	Unknown location
213	N/A	No picture
214	0184	Looking south at sloughed bank.
215	0185	Looking upstream (northeast) at eroded steep bank on outer bend.
216	0186	Looking upstream (northeast) at eroded steep bank on outer bend.
217	0187	Looking upstream (west) at high steep eroded bank with dead grass overhang.
218	0188	Looking upstream (north) at scoured out bank.
219	0189	Looking upstream (west) at bank erosion on outer bend.
220	0190	Looking downstream (southeast) towards bank erosion.
221	0191	Looking north at pipe discharging into creek and scoured out bank.
222	0192	Looking north towards deep narrow ravine connecting farm to creek and piles of displaced soil.
223	0193	Looking north towards second deep narrow ravine parallel to first one.
224	0194	Looking north towards third deep narrow ravine, which seems to connect to first two.
225	0195	Looking south toward pipe discharging water from field.
227	0196	Looking downstream (southeast) at culvert under Emery Rd and fallen trees blocking creek.
228	0197	Looking upstream (west) at eroded bank and fallen tree.
229	0198	Looking north at bank with fence falling over due to scoured out bank (same pt as 199).
230	0199	Looking north at bank with fence falling over and gully from field, exposed tree roots.
231	0200	Looking northeast at eroded bank with vegetative overhang.
232	0201	Looking northeast at bank with exposed tree root and fence hanging over scoured out bank.
233	0202	Looking upstream (north) at creek with scoured bank, fallen trees.
234	0203	Looking downstream (east) at wooded creek with exposed roots, bare bank.
236	0204	Looking south at eroded bank with vegetative overhang.
237	0205	Looking downstream (east) downstream of culvert at eroded bank.
238	0206	Looking upstream (west) at large culvert under Pleasant Prairie Rd.
239	0207	Looking downstream (east) at bank erosion and fallen tree.
240	0208	Looking upstream (west) at bank erosion and fallen trees from same spot as 240.
241	0209	Looking south at bank erosion.
242	0210	Looking downstream (southeast) towards partially buried culvert/pipe and tree branches.

Picture	ID	Description
243	0211	Looking south at grassy swale (left) and small gully (right) coming from farm field.
244	0212	Looking upstream (west) at creek bed and vegetative buffer on either side.
245	0213	Looking south at bare gully/swale from farm field.
246	0214	Looking south at vehicle crossing.
247	0215	Looking upstream (west) at sunken bank due to runoff from field.
248	0216	Looking upstream (southwest) at bank scouring.
249	0217	Looking south at scoured out spot on creek bank.
250	0218	Looking southeast at eroded spot on bank near 251.
251	0219	Looking south at bare spot/scour in vegetative barrier between crop field and creek.
252	0220	Looking south at vehicle crossing along property line.
253	0221	Looking north at confluence of small northern branch in to creek.
254	0222	Looking upstream (west) at bridge under Hwy 104, concrete slab completely dry.
255	0223	Looking north from road in to ditch upstream of bridge on Hwy 104, some water in ditch.
256	0224	Looking southwest at swale coming in to ditch on Hwy 104 across from creek.

APPENDIX B
ALLEN CREEK STREAMBANK ASSESSMENT AND PHOTO LOGS

Legend
- Grid
- Picture Location
- Problem Area



STREAMBANK EROSION ASSESSMENT

MAP PAGE 1

0 100 200 400
Feet

STRAND ASSOCIATES, INC. ENGINEERS

1-354.004

Legend

Grid

Picture Location

Problem Area

STREAMBANK EROSION ASSESSMENT

MAP PAGE 2

0 100 200 400

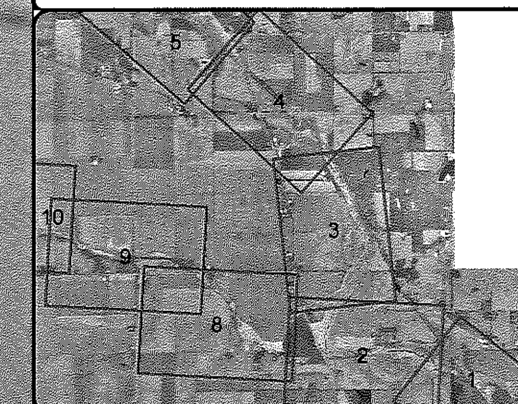
Feet

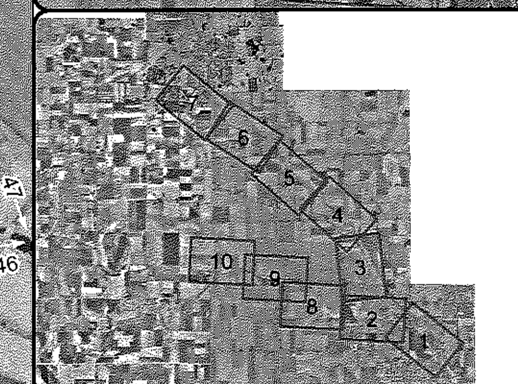
STRAND ASSOCIATES, INC. ENGINEERS

1-354.004

Legend

- Grid
- Picture Location
- Problem Area





STREAMBANK
EROSION ASSESSMENT

MAP PAGE 3

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STRAND ASSOCIATES, INC.
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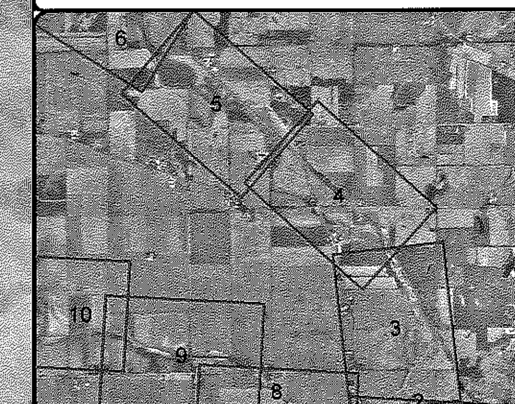
1-354.004

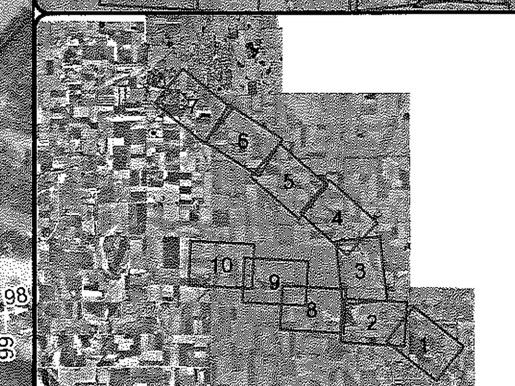
Legend

Grid

Picture Location

Problem Area





STREAMBANK
EROSION ASSESSMENT

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STRAND ASSOCIATES, INC. ENGINEERS

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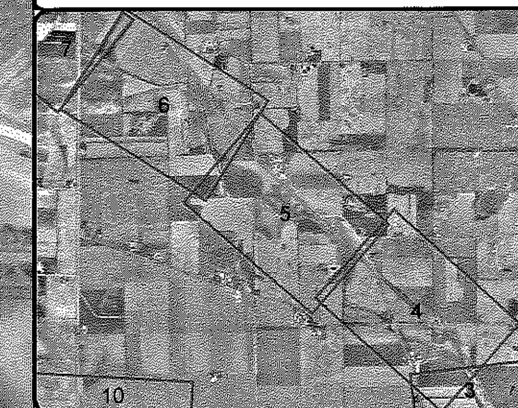
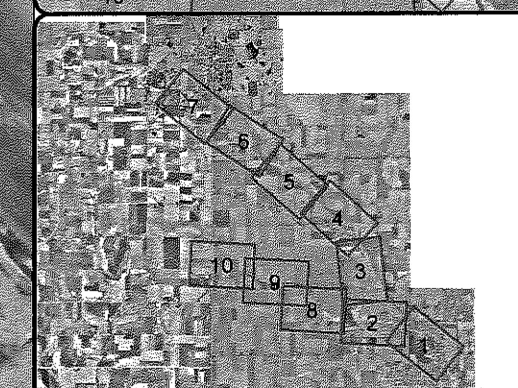
Legend

Grid

Picture Location

Problem Area





STREAMBANK EROSION ASSESSMENT

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STRAND ASSOCIATES, INC. ENGINEERS

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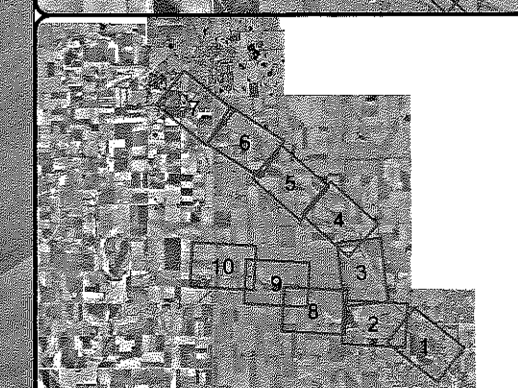

STREAMBANK EROSION ASSESSMENT

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STRAND ASSOCIATES, INC. ENGINEERS

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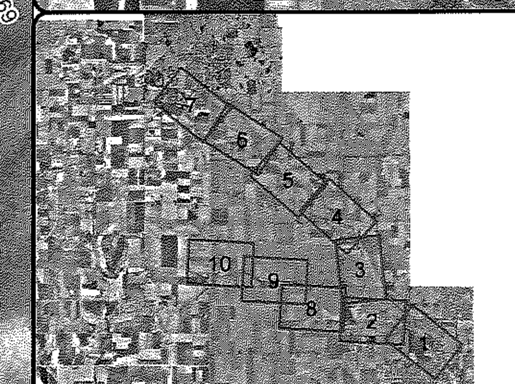
Legend

Grid

Picture Location

Problem Area



STREAMBANK
EROSION ASSESSMENT

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STRAND ASSOCIATES, INC. ENGINEERS

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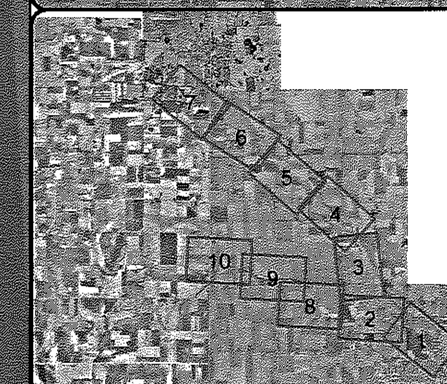
Legend

Grid

Picture Location

Problem Area



STREAMBANK EROSION ASSESSMENT

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STRAND ASSOCIATES, INC. ENGINEERS

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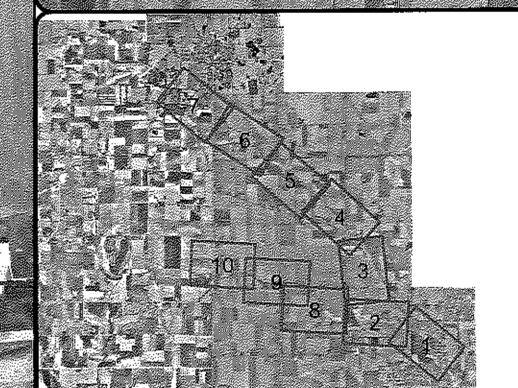
Legend

Grid
Picture Location
Problem Area



STREAMBANK EROSION ASSESSMENT

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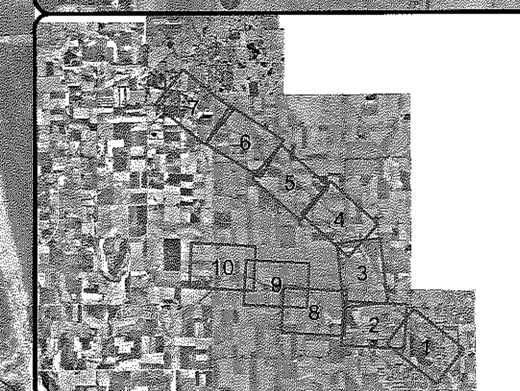
Legend

Grid

Picture Location

Problem Area



STREAMBANK EROSION ASSESSMENT

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APPENDIX C
STORMWATER FUNDING BROCHURE

Stormwater Management Funding

The Wisconsin Department of Natural Resources (WDNR) and the Federal Emergency Management Association (FEMA) have a long history of providing funding for stormwater management planning, design, and construction. Some of the WDNR and FEMA programs include Urban Nonpoint Source and Stormwater Grants (UNPS & SW), Municipal Flood Control Grants, Lake and River Planning and Management Grants, Targeted Runoff Management Grants, Clean Water Fund – Urban Runoff Loans, and FEMA – Hazard Mitigation Grants. In the last three years, we have been successful in helping a number of our clients procure stormwater and lake grants. A representative list is shown in the table below.

Community	Project	Grant Type	Grant Amount
Algoma, WI	Regional Detention Basin Plan *	U	$10,976
Bonduel, WI	Stormwater Management Plan	U	$16,450
Bristol, WI	North Lake George Flood Reduction Project	M	$333,603
Bristol, WI	Detention Pond A Restoration and Enhancement *	U	$121,000
Bristol, WI	Stormwater Quality Management Plan – Phase II	U	$19,950
Dodgeville, WI	Stormwater Utility	U	$28,840
Dodgeville, WI	Stromwater Plan	U	$21,600
Hartland, WI	Stormwater Management Plan *	U	$35,700
Hartland, WI	Stormwater Utility	U	$42,000
Hartland, WI	Detention Basin Construction	U	$150,000
Janesville, WI	Ordinances and Regional Detention Basin Plan	U	$84,000
Lake Mills, WI	Owen Street Regional Detention Basin	U	$45,750
Lake Mills, WI	Stormwater Plan and Utility	U	$55,860
Lancaster, WI	Stormwater Utility	U	$28,000
Lancaster, WI	Kolar Property Regional Detention Facility	U	$55,920
Maple Bluff, WI	Stormwater Quality Management Plan	U	$12,600
Marshfield, WI	Stormwater Utility and Ordinances	U	$73,010
Marshfield, WI	Stormwater Management Plan	U	$36,800
Monona, WI	Stormwater Utility Feasibility Study	U	$28,000
Monona, WI	Stormwater Management Plan and Mapping	U	$24,220
New Glarus, WI	Stormwater Management Plan	U	$23,100
New Glarus, WI	Streambank Restoration at WWTP	U	$18,900
Omro, WI	Stormwater Quality Management Plan	U	$12,250
Omro, WI	Northeast Stormwater Management Plan	U	$4,270
Oshkosh, WI	Murdock Detention Basin Property Acquisition	M	$330,000
Oshkosh, WI	Anchorage Basin Relief Channel Construction *	M	$698,500
Oshkosh, WI	Sawyer Creek Floodway Land Acquisition	M	$101,500
Prairie du Sac, WI	Stormwater Utility	U	$30,000
Whitewater, WI	Cravath & Tripp Lakes Stormwater & Erosion Ordinances*	L	$7,500
Whitewater, WI	Stormwater Plan and Utility	U	$57,500
Evansville, WI	Lake Leota Management Plan - Phase I and II	L	$20,000
Madison, WI	Wingra Creek Streambank Restoration	U	$101,050
		Total:	**$2,628,849**

M = Municipal Flood Control Grants
U = Urban Nonpoint Source and Stormwater Grants
L = Lake Planning and Management Grants

** Project Description Inside*

Grant-Funded Stormwater Projects

Oshkosh - Anchorage Basin Flood Relief Channel

The Anchorage Basin is a 428-acre residential/commercial area in east Oshkosh currently experiencing frequent flooding. This project, which is slated to begin design in 2004, will convert an abandoned railroad line into a flood relief channel to alleviate this flooding. The proposed flood relief channel will provide a positive outlet to Lake Winnebago to augment the currently undersized storm sewer system serving the area. Construction and replacement of culverts are an integral component of the proposed project. An associated project in this basin, as shown in the table on the front of this brochure, is the Murdock Detention Basin. This detention basin is a component of the overall flooding relief plan for the Anchorage Basin and received funding for property acquisition.

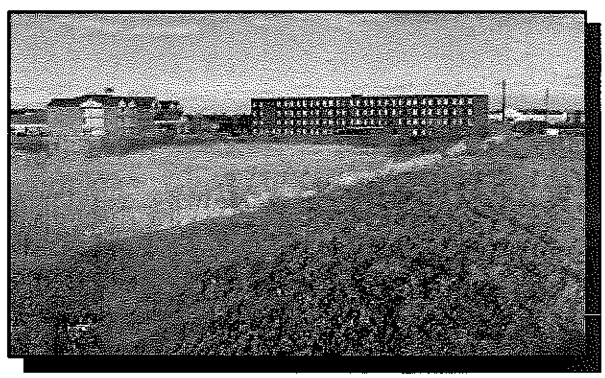
Estimated Construction Cost: $2 million

Whitewater - Cravath and Tripp Lakes Stormwater and Erosion Control Ordinances

This project was prompted by a study showing that Year 2000 pollutant loadings were expected to result in total phosphorus concentrations in Cravath and Tripp Lakes that exceed the recommended levels for recreational use and for the maintenance of a warm-water fishery. To begin to address these findings, the City of Whitewater sought to establish administrative authority to control stormwater discharge from construction and post-construction sites. The stormwater and erosion control ordinances will minimize impacts of future development and prevent lake degradation. In addition, watershed divide and land use mapping was completed to facilitate future analysis of pollution sources and resultant water quality problems in the lake.

Technical Assistance Cost: $10,000

Bristol - Pond A Restoration and Enhancement



Before

Pond A was originally built as a flood control pond but provided minimal water quality benefits. This project rehabilitated the existing pond that had filled in with sediment and was becoming a nuisance and potential hazard because of stagnant water and steep slopes. The project design included 4:1 side slopes, a 10' safety shelf, sediment forebay, outlet control structure, 100-year emergency overflow, and shoreline/wet edge seed mix around the perimeter of the pond. The restoration brought the pond into compliance with WDNR Wet Detention Basin Standard and will remove 80% of the total suspended solids reaching the pond from the 73-acre commercial land use watershed. In addition, the pond will control up to a 100-year storm.

Pond Construction Cost: $148,000

After

Algoma - Regional Detention Basin Plan

The Town of Algoma is served almost exclusively by ditches along street systems that ultimately discharge to Lake Winnebago. The topography in the area is flat and much of the development occurred prior to the implementation of strong guidelines for stormwater management. Therefore, the Town has many areas that are prone to flooding and water quality degradation. This plan focuses on solutions to flooding and water quality issues with a system of regional detention basins. The plan addresses location and sizing of the regional basins, coordination and consistency with the Town Comprehensive Land Use Plan, projected costs for implementation of the regional detention basin plan including land acquisition, funding of construction, and maintenance of the basins, and a public information and education program relating to the plan.

Technical Assistance Cost: $18,000

Hartland - Phase II Stormwater Quality Management Plan

The Village of Hartland was designated by the USEPA and the DNR as a permitted municipality under Phase 2 Stormwater Rules. In response to this designation and in an effort to protect the Bark River and other local resources, the Village budgeted funds to develop a Stormwater Management Plan. The primary objective of the plan was to reduce the adverse impacts of nonpoint source stormwater runoff discharging from the Village to adjacent water resources including the Bark River, nearby wetlands, and groundwater resources. The project mapped the urban discharge points and drainage basins within the Village, evaluated current Village practices and programs, developed SLAMM computer models to estimate pollutant loadings to each identified outfall, identified and evaluated potential types and locations of Best Management Practices (BMPs) to address impacts on stormwater runoff, developed a Capital Improvements Plan on prioritization of stormwater management practices, including stormwater management report, and assistance with grant administration.

Technical Assistance Cost: $53,000

Fitchburg-Nine Springs Creek Streambank Restoration

Nine Springs Creek is a major watercourse in the Lake Monona watershed, draining approximately 6 square miles upstream from Fish Hatchery Road in Fitchburg. The Nine Springs Creek watershed has experienced rapid urbanization over the past decade. Increased peak discharges resulting from this development have contributed to significant erosion of the streambanks through a City-owned golf course. Streambank erosion has created an aesthetic concern and has contributed to a degradation in water quality downstream from the golf course.

Before

We were hired to develop a streambank restoration plan for critical stream reaches in the golf course. The final design stabilized stream banks, improved aesthetics of the watercourse, and reduced sediment loss to downstream areas. The design featured toe of slope stabilization using buried gabion rolls, erosion control mats on 2:1 banks, and native seeding. Implementation of the plan included measures to minimize impacts on the existing golf course. Funding for this project was procured by the City of Fitchburg.

Construction Cost: $110,000

After

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Summarized below are a number of the more popular WDNR grant programs.

Strand Associates, Inc.
Madison, WI
608-251-4843
Joliet, IL
815-744-4200
Louisville, KY
502-583-7020
Lexington, KY
859-225-8500
Mobile, AL
251-479-0394
Columbus, IN
812-372-9911
Lancaster, OH
740-687-4779
Indianapolis, IN
317-423-0935
Milwaukee, WI
414-271-0771

Funding Type	Application Date	State/Local % Cost Share	Eligible Projects	Non-Eligible Projects	Restrictions/ Details
Urban Nonpoint Source & Stormwater Grant – WDNR *Priority: Urban Area Water Quality-Based Projects. Planning, Design, and Construction.* *Wisconsin administers the USEPA Section 319 monies through this program.*	April 15 of each year	Planning: 70/30 Design: 50/50 Construction: 50/50 Acquisition: 50/50 • Max of $85,000 for Planning Project • Max of $150,000 for Construction Project • Projects Involving Land Acquisition and/or Permanent Easements can request an additional $50,000.	• Streambank/ Shoreline Restoration • Wet Detention Ponds • Stormwater Utilities • Stormwater Mapping • Stormwater Management Plans • Stormwater/ Erosion Control Ordinances • Public Information/ Education • Street Sweepers*	• Best Management Practice (BMP) construction for new development • Projects that are not water quality based, such as projects to solely solve drainage flooding problems • Dredging Projects	• *Urban Area Definition*: Population Density of 1,000/sq miles or Commercial Land Use or for Planning Projects projected to be urban in 20 years. • Check NPS Ranking on *Watersheds and Lakes* List for basin priorities.
Targeted Runoff Managment Grant (TRM) - WDNR *Priority: Control Polluted Runoff from both Urban and Rural Sites . . . Design and Construction of BMPs.*	April 15 of each year	70/30 up to a maximum of $150,000 50/50 for property acquisition (included in the $150,000 maximum)	• Streambank Restoration • Wetland Construction • Detention Ponds • Cropland Protection • Livestock Waste Management Practices • Property Aqcuisition	• BMP construction for new development • Projects that are not water quality based, such as projects to solely solve drainage/flooding problems • Dredging projects • Rural projects in priority watershed areas. • Projects to control pollution regulated under WI law as a point source (i.e., NR 216 permittted communities). • Planning projects.	• Design and construction of BMPs (previously construction only). • No Phase I or Phase II NR 216 Permitted Communities
Municipal Flood Control Grant – WDNR *Priority: See eligible projects column . . . Planning, Design, Construction, and Administrative Activities.*	April 15, 2005 Every two years.	70/30 Maximum allowed per applicant: 20% of funding available in that grant cycle.	• Acquisition & Removal of Structures • Floodproofing and elevation of structures • Streambank Restoration • Dam Removal • Fish & Native Plant Habitat • Restoration • Acquisition of Vacant Land for Flood Storage and Conveyance • Flood collection, retention, detention, storage facilities. • Flood Insurance Studies and Flood Mapping Projects		• Eligible projects are in order of DNR priority. (Projects near bottom have less chance of being funded.). • Must have appraisal done prior to grant application for acquisitions (must include copy with application).
Lake Planning Grant - WDNR (Large Scale) *Note: wetland restoration grants also available.*	February 1 and August 1 of each year	75/25 Maximum of $10,000 per grant. Maximum of two grants per grant cycle.	• Physical, chemical, biological, and sociological data collection • Water quality assessment • Watershed Evaluation • Wetland Restoration • Ordinance Development • Management/ Implementation plans for lake protection rehabilitation		• Each lake eligible for more than one planning grant with a lifetime maximum of $100,000
River Protection Grant - WDNR • Planning • Management	May 1 of each year	75/25 • Plan: Maximum of $10,000 per grant. • Mgmnt: Maximum $50,000 per grant.	• Plan: River organization development, information and education, water quality/fish/aquatic life assessment, non-point source assessments. • Mgmt: In-stream/ shoreland habitat restoration, land/ easement purchase, local ordinance development.	• Dam repair/operation • Dredging	

To learn how Strand can secure funding for your project or for additional information regarding stormwater or water resources funding, please contact
Jon Lindert at our Madison office, 608-251-4843 or e-mail at jon.lindert@strand.com
You may also visit us at www.strand.com

*DNR will fund the incremental cost to go from a conventional brush streetsweeper to a high-efficiency sweeper when buying a high efficiency sweeper.