



**AMERY LAKES
PROTECTION & REHABILITATION
DISTRICT
LAKE MANAGEMENT PLAN
2004**

**AMERY LAKES PROTECTION AND
REHABILITATION DISTRICT**

LAKE MANAGEMENT PLAN

Prepared For:

Amery Lakes Protection and Rehabilitation District

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2004

Amery Lakes Protection and Rehabilitation District
LAKE MANAGEMENT PLAN

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Amery Lakes Protection and Rehabilitation District
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EXECUTIVE SUMMARY

The Amery Lakes Protection and Rehabilitation District has expended many years of effort and expense to address the potential problem of a degrading water quality in Pike Lake, North Twin, and South Twin Lakes. (Hundreds of volunteer hours, consulting with and studies by the Department of Natural Resources, Polk County, and others have been evaluated and compiled in this Lake Management Plan.) The purpose of the project is to establish existing lake water quality conditions, identify potential water quality concerns, and develop a plan that will protect, maintain, and enhance the Amery Lakes' water quality. 2

With a surface area of 368 acres, the three lakes are an impoundment of a 1,522 acre watershed. The north basin of Pike Lake has a water residence time of 8.65 years as compared to North Twin Lake (3.43 years) and South Twin Lake (0.55 years). Thus, water entering the north end of Pike Lake will take almost 13 years before discharging through the impoundment to the Apple River.

Located in the city waters of Amery, the Amery Lakes and surrounding area has been long prized for its beauty and water quality. The uplands forests of mixed deciduous (maple, hemlock, and yellow birch) and conifers (pines, spruce) grow on glacially derived soils that tend to be sandy loams to silt loams with very little exposure or outcropping of the underlying bedrock. These soils are naturally high in phosphorous.

The Amery Lakes Community Survey identified peace and tranquility, and recreational usage (i.e., boating, fishing, etc.) of the waters as the most important aspects of these lakes. The Amery Lakes and surrounding area are valued for providing peace and quiet, have natural beauty, and offer good fishing. These factors indicate that the Lakes and surrounding City of Amery will continue to be a focal area for use and population growth, thus forecasting increased development and recreational use of the area. ✓

Nutrient levels and Secchi disk measurements indicate water quality to have a TSI (trophic status index) of mesotrophic to eutrophic. The Lakes are still considered to have a high water quality, but it is important that regional and specific ^{local} protection measures be instituted to protect the water quality from the continuing pressure of land development.

Watershed water quality modeling has demonstrated the fragile nature of this lake system. Control of nutrient and sediment laden storm water runoff is considered the primary factor that will aid in preserving water quality in these lakes. Nutrients will continue to be introduced from ale sediments, but the principal control is storm water runoff, both from surface runoff and the City's storm water drainage system. The relatively high retention time in this lake system (over 13 years) does not allow for a rapid flushing of this lake system, thus efforts to control the incoming water quality are important to the overall health of the Amery Lakes. ✓

These protection measures include ongoing and greater educational and outreach efforts; island and shoreline restoration projects; watershed and subwatershed erosion control best management practices and ordinances; ordinance enforcement of erosion control; limitation of phosphorous content of fertilizers; special shoreline practices in sensitive areas; fishery development – both stocking and habitat; and ongoing lake water quality monitoring.

CHAPTER 1: INTRODUCTION

1.1. Introduction

“Visit Amery...the City of Lakes” is the welcome phrase seen throughout the City of Amery and represents the recreational and tourist culture of Amery. The Amery Lakes include Pike, North Twin, and South Twin Lakes and are invaluable resources to the City of Amery, surrounding townships, and Polk County. The Amery Lakes and those lakes in the surrounding area have become a recreational focus area for residents of Minneapolis/St. Paul, as well as residents of the area. The lakes underscore the setting of the region and are the focus of local community events.

The ALPRD (Amery Lakes Protection and Rehabilitation District) planning area (Figure 1) is part of the Upper Apple River Watershed (SC06; Figure 2) of the St. Croix Basin (Figure 3). Downtown Amery is situated between the Apple River and the Amery Lakes. Wisconsin State Highway 46 (Keller Avenue) bisects the City of Amery from north to south. The Amery Lakes are located west of Highway 46 and are aligned north to south as Pike Lake, North Twin Lake, and South Twin Lake. The Apple River is the natural outlet for these lakes and it is located east of Highway 46. An impoundment on the Apple River creates a flowage which extends northward on the City's east side. The Amery Lakes drain from north to south and outlet below the Apple River dam.

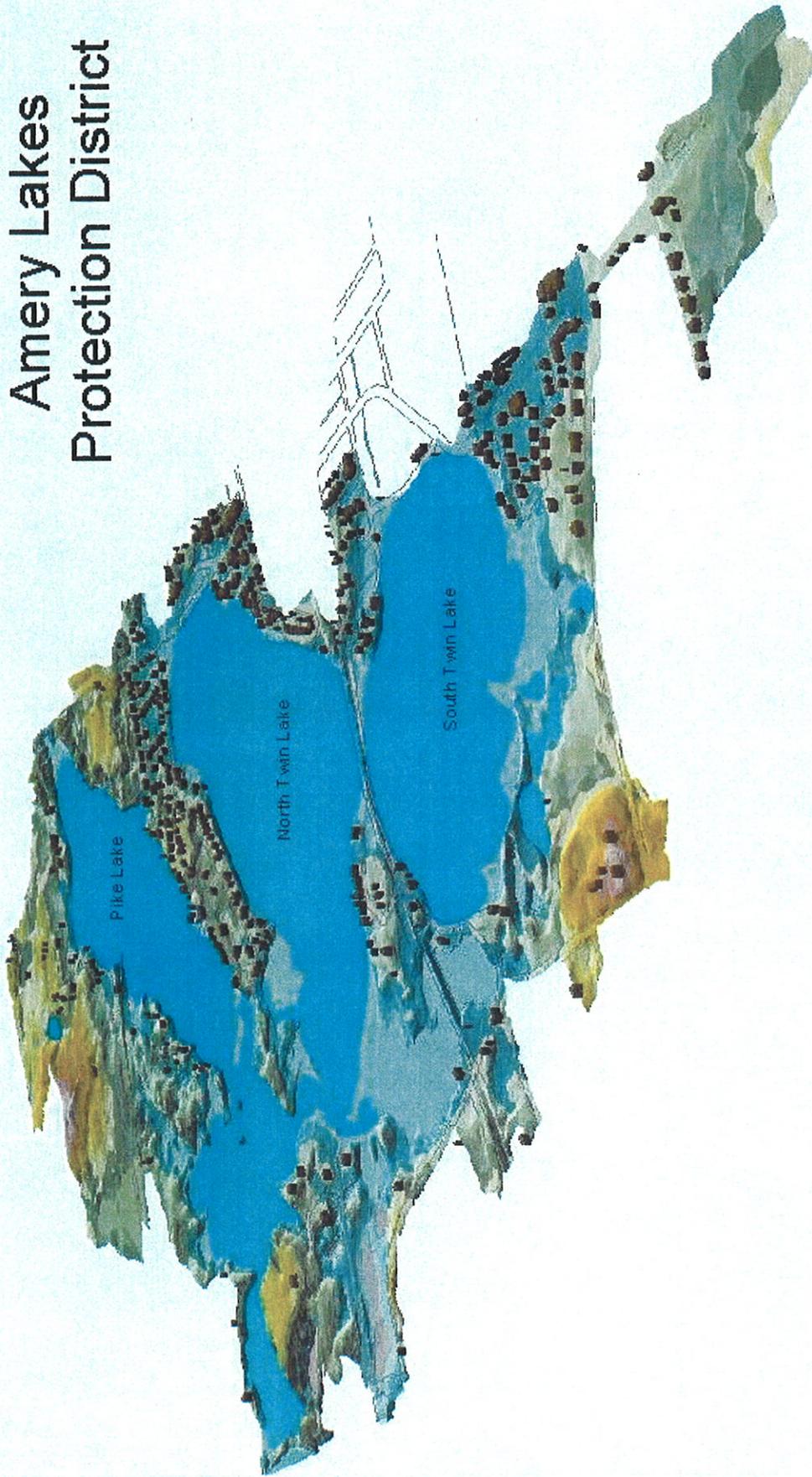
Pike Lake and North Twin Lake are connected by a navigable channel at the southwest corner of Pike Lake and enters at the northwest corner of North Twin Lake. A connection between the North Twin Lake to the Apple River was closed on May 5, 1989, by the Wisconsin Department of Natural Resources. North Twin Lake flows south through a 12-inch culvert pipe and into South Twin Lake. Flow out of South Twin Lake is controlled by a weir on the east edge of the lake. An open swale connects the weir with the Amery city storm sewer system, which provides drainage to the Apple River. *drains to*

The Amery Lakes are subjected to increased recreational usage and development pressures, as the area attracts more residents and other land use changes occur in the vicinity of the lakes. These pressures are perceived by many as negatively impacting the lakes in various ways, including: diminishing water quality, encouraging overuse of water-based recreational opportunities, and generally reducing the quality of life in the riparian community.

The Amery Lakes' unique waters are a way of life in Amery. The aesthetic, recreational, and environmental qualities of the lakes have, to date, withstood the pressures of modern life and are the focus of this Lake Management Plan. The ALPRD has taken the necessary steps to prepare this Plan with the assistance of its partners.

Figure 1: Amery Lakes Planning Area

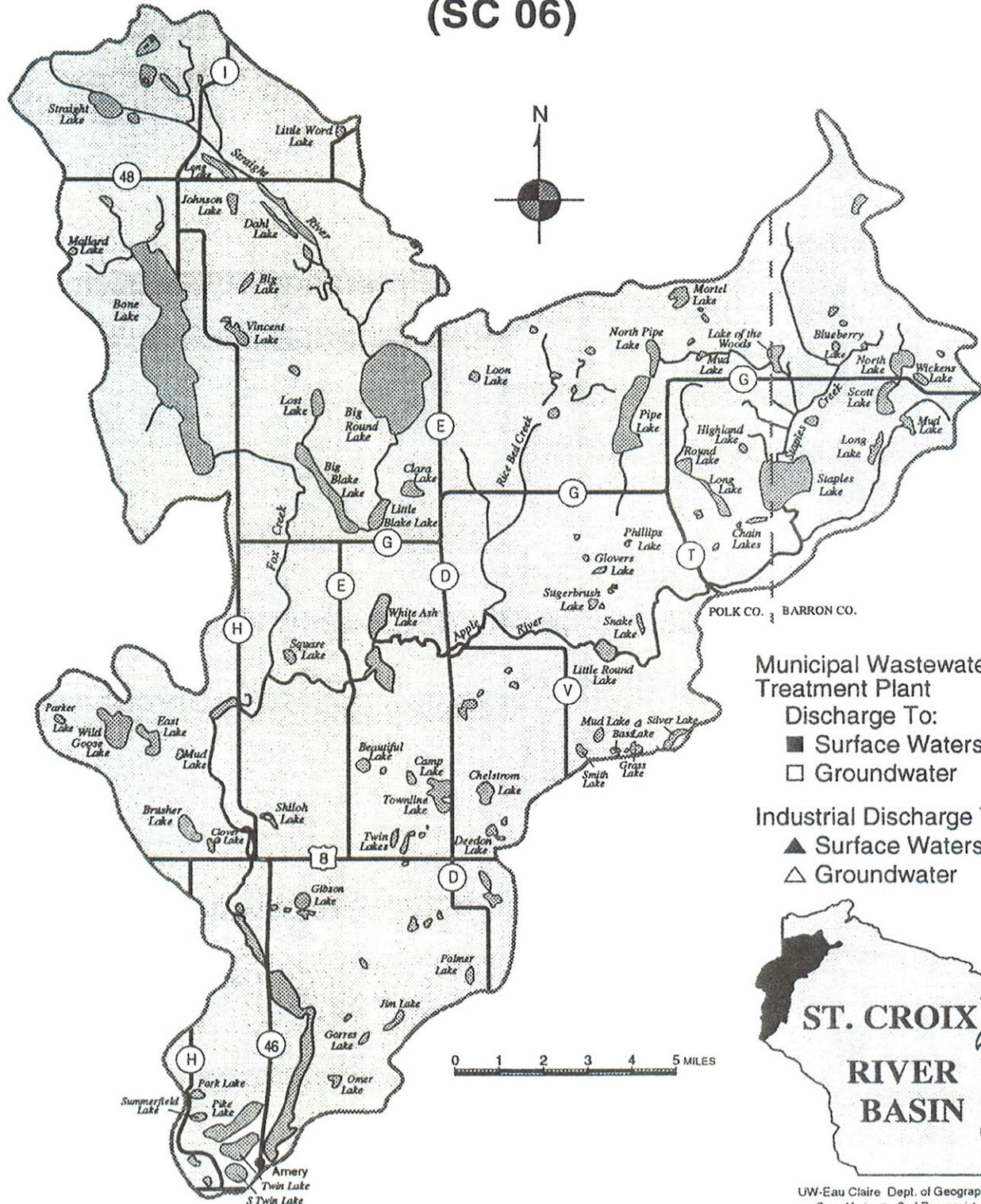
Amery Lakes Protection District



Map is not to scale.

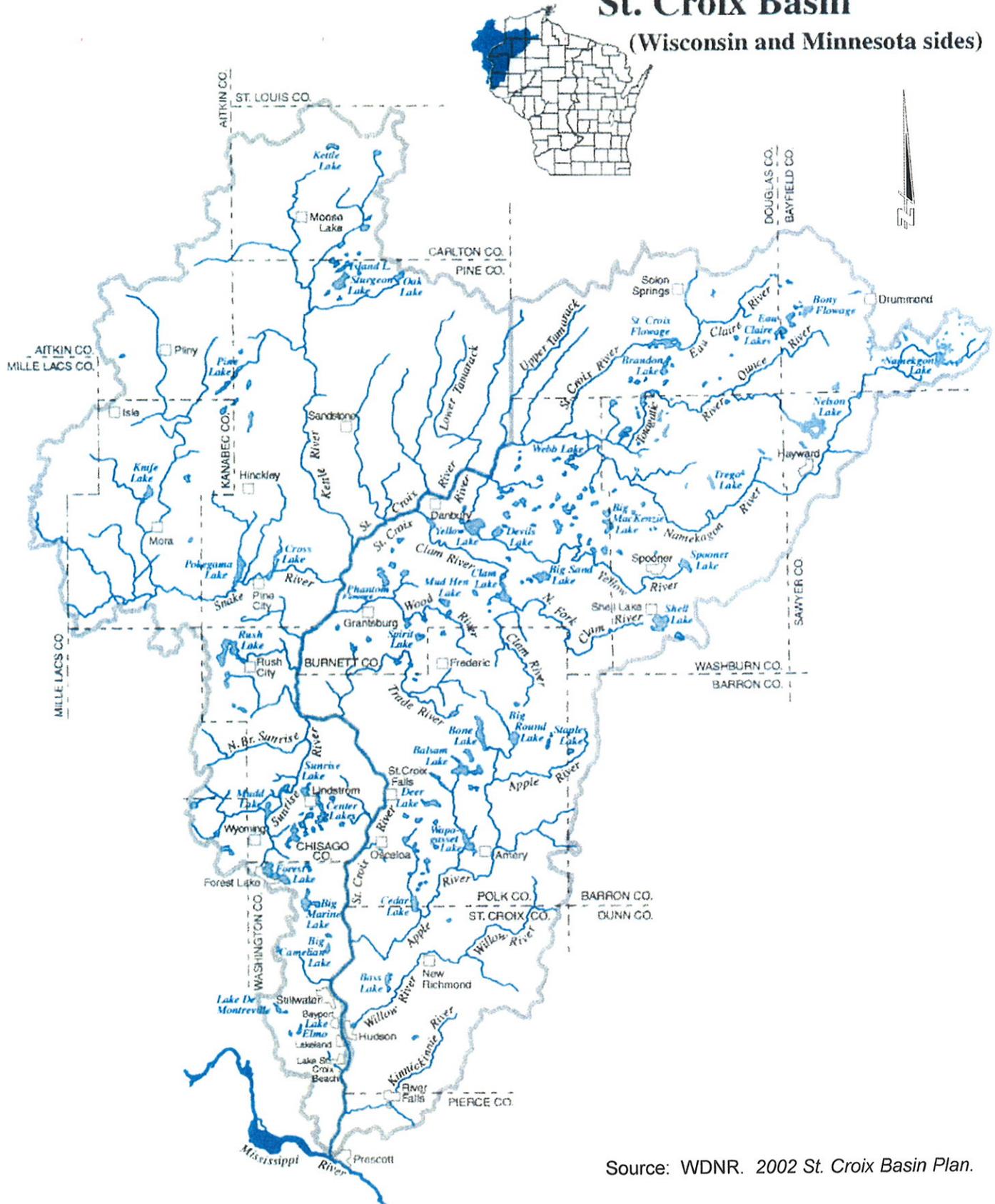
UPPER APPLE RIVER WATERSHED

(SC 06)



Source: WDNR. 1994 St. Croix Basin Water Quality Management Plan.

St. Croix Basin
(Wisconsin and Minnesota sides)

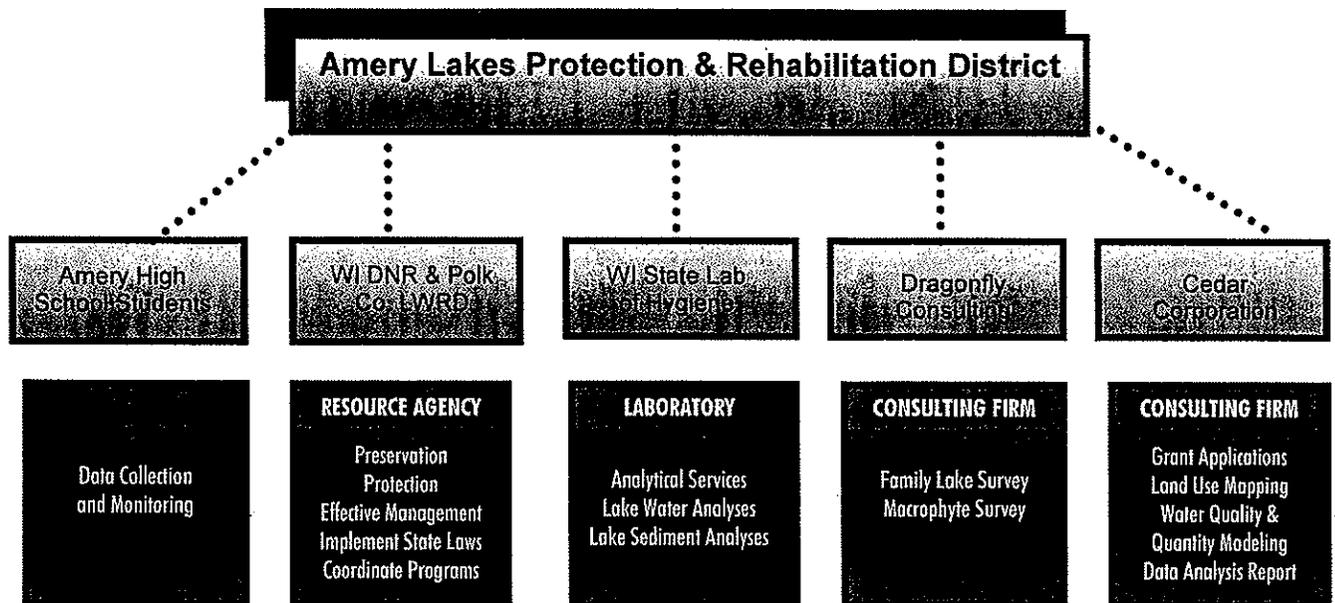


Source: WDNR. 2002 St. Croix Basin Plan.

1.2. Partners

Lake Management projects require a significant investment of time, and involve the efforts and cooperation of many individuals and agencies to develop an understanding of the lake system. To assist in this project, ALPRD involved the Wisconsin DNR, Polk County Land & Water Resources Department, Wisconsin State Lab of Hygiene, interested Amery High School students, Dragonfly Consulting of Amery, WI, and Cedar Corporation of Menomonie, WI. ALPRD collaborated with this team (Figure 4) to complete the various projects in preparation of the Amery Lakes Management Plan.

Figure 4: AMERY LAKES MANAGEMENT PLAN ORGANIZATION CHART



1.2.a Amery Lakes Protection and Rehabilitation District

The Amery Lakes Protection and Rehabilitation District (*hereafter referred to as ALPRD*) was established in 1978 through public hearings and resolutions from the City of Amery and Polk County (Appendix A). The first *Amery Lakes District—Lake Management Feasibility Study* was completed from 1980-82 (Appendix B). In cooperation with the City of Amery, ALPRD applied for grant monies in 1991 to undertake a second lakes study to compare the new 1991 data collection to the 1980 study (Appendix B). The City of Amery Council soon passed new construction requirements along the Amery Lakes that include a set-back of 65 feet; they also passed an ordinance controlling phosphorus containing fertilizers, reducing phosphate content to 1% by January 1, 1993 (Appendix C). The Wisconsin DNR summarized prior studies and created recommendations in the *1994 St. Croix Basin Water Quality Management Plan*. By 1995, two educational brochures were sent out by the ALPRD in efforts to educate the community about lake management and protection (Appendix D). The Amery High School began involving biology students in a Freshwater Ecology field course in and around Amery (Appendix E).

As mentioned, the Wisconsin Department of Natural Resources (WDNR) created a resource document called the *1994 St. Croix Basin Water Quality Management Plan*, which is intended to be used as a guide for water resource priorities and activities. Of the many lake and watershed recommendations, the WDNR recommended that the “Water Resource Management (WRM) should assist the ALPRD in completing its lake planning grants project (page 174).”

In 2002, the ALPRD lake management planning efforts took another step forward with the application and successful award of three large-scale Wisconsin DNR Lake Planning grants. Both the Pike Lake and North Twin Lake Planning Grants were awarded in May 2002, with a total of \$20,000 awarded to the ALPRD (Appendix F). Another \$10,000 was granted to the ALPRD in November 2002 for award of the South Twin Lake Planning Grant (Appendix G).

With successful completion of initial steps in collecting funds, the ALPRD was ready to complete documentation of a Lake Management Plan. The ALPRD Lake Management Plan will refine the *St. Croix Basin Water Quality Management Plan* and will guide site specific implementation projects within the proposed study area. The Plan will utilize the best available methodology and management practices to: encourage infiltration of storm water; improve shoreline and shoreland buffers; reduce water runoff, volume and velocities; reduce pollutant loading; and, minimize impacts on wetlands, springs, the Amery Lakes, and other ecological and natural features.

1.2.b. Wisconsin Department of Natural Resources (WDNR)

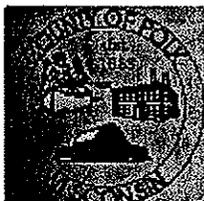


Throughout Wisconsin, the WDNR is the agency in charge and has full responsibility for coordinating many disciplines and programs to maintain Wisconsin’s environment and coordinate many outdoor recreational activities. The WDNR are dedicated to preserve, protect, maintain, and manage Wisconsin’s natural resources. For more information on the WDNR, go to www.dnr.state.wi.us.

The main Northern Region WDNR contacts that are working on this project are:

1. Danny Ryan, WNDNR Lake Specialist, 810 West Maple Street, Spooner, WI, 54801; ryand@dnr.state.wi.us; 715-635-4072.
2. Jane Malischke, WDNR Financial Assistant Specialist, 810 West Maple Street, Spooner, WI, 54901; malish@dnr.state.wi.us; 715-635-4062.

1.2.c. Polk County Land & Water Resources Department



Polk County recognizes that water resources are one of its most important assets. These assets provide citizens safe drinking water, recreation, wildlife habitat, and scenic beauty. Their mission statement is “to preserve, protect, and enhance our natural resources.”

The Polk County Land & Water Resources Department has worked with the City of Amery on a 20,000 sq. ft. restoration project on six sites surrounding the north and east sides of South Twin Lake. They also were subcontracted to collect storm water samples and flow data with automatic samplers for the ALPRD project. To learn more about this department go to: <http://www.co.polk.wi.us/landwater/index.htm>.

1. Jeremy Williamson, Water Quality Specialist, Polk Co. LWRD, 100 Polk County Plaza, Suite 120, Balsam Lake, WI 54810; Jeremyw@co.polk.wi.us; (715) 485-8699.

1.2.d. Wisconsin State Lab of Hygiene (WSLH)

The Wisconsin DNR Lakes Planning Grants require that all analytical work be completed by a Wisconsin DNR certified analytical laboratory. Generally, this is the Wisconsin State Laboratory of Hygiene (WSLH). This arrangement allows for ease in administration as well as data consistency and quality control.



Since 1903, Wisconsin citizens have depended on the WSLH to help maintain the high quality of life in our state. As the state's public health and environmental laboratory, the WSLH helps:

- maintain the public health of all Wisconsin's citizens;
- safeguard the state's environment;
- educate state residents on public health issues.

Mission Statement: The Wisconsin State Laboratory of Hygiene (WSLH) shall develop and provide essential public health laboratory support to communities, agencies and private health providers consistent with the public health goals of the State.

The WSLH provides clinical, environmental, and industrial analytical services, specialized public health procedures, reference testing, training, technical assistance and consultation for private and public health agencies. The Environmental Health Division is located in Madison at 2601 Agriculture Drive. To learn more about the WSLH go to: <http://www.slh.wisc.edu/>. You can reach the Environmental Health Division at 1-800-442-4618.

1.2.e. Dragonfly Consulting



Located one mile south of Amery on Highway 46, Dragonfly Gardens' greenhouse provides plant materials for their habitat restoration portions of Dragonfly Consulting. Dragonfly Consulting completed the ALPRD's Macrophyte Survey and Family Lake Survey.

Dragonfly Consulting provides a variety of environmental services including shoreline restoration design, water resource planning, conservation project management, and grant writing.

Experts in habitat restoration, Dragonfly provides free assistance with plant selection to local gardeners and restorers of native habitat. Their products, services, plant selections, order forms, and pricing can be found on their website at: <http://www.dragonflygardens.net/>.

1. Cheryl ^{Clemens} Bursik, Plant Specialist, P.O. Box 192, Amery, Wisconsin 54001; dragnfly@spacestar.net; 715-268-~~7660~~ 46666.
2. Robert Bursik, Plant Specialist, P.O. Box 192, Amery, Wisconsin 54001; dragnfly@spacestar.net; 715-268-7660.

1.2.f. Cedar Corporation

An engineering/environmental consulting firm from Menomonie, Wisconsin, Cedar Corporation was hired by the ALPRD to provide project assistance in grant application preparation, to be their Plan facilitator, provide technical assistance with some project aspects, and prepare the Lake Management Plan. Cedar Corporation provides professional engineering, building design, planning, landscape architecture, interior design, environmental, and water resource services to public and private clients primarily in western Wisconsin.



Cedar Corporation was involved with land use mapping, watershed and sub-watershed delineations, 3D mapping, water quantity and in-lake quality modeling, data analysis, and report preparation. To learn more about special areas of expertise and project examples, go to www.cedarcorp.com. The main Cedar Corporation contacts are:

1. Scott McCurdy, Professional Geologist and Environmental Group Leader, Cedar Corporation, 604 Wilson Avenue, Menomonie, WI, 54751; scott.mccurdy@cedarcorp.com; 715-235-9081.
2. Russ Kiviniemi, Professional Engineer and Civil Group Leader, Cedar Corporation, 604 Wilson Avenue, Menomonie, WI, 54751; russ.kiviniemi@cedarcorp.com; 715-235-9081.

1.3. What Is a Lake Management Plan?

Until now, there has been no specific ALPRD Comprehensive Plan created to document the latest lake activities, data and background information for the Amery Lakes. The purpose of a Lake Management Plan is to provide a reference for that information and to set a strategy to manage, maintain, and protect the aesthetics, recreational values, and environmental and water quality of the Amery Lakes. This Management Plan represents a community and statewide effort to assure that appropriate investments are made to protect the value of the Amery Lakes today and into the future.

More specifically, a Lake Management Plan provides:

- A guide for resource protection.
- A discussion of general lake processes.
- An assessment of current conditions in the lakes.
- Provides recommendations to protect, manage, and improve *current* lake conditions.
- Uses best available information to assist in setting realistic goals, objectives, and actions in order to achieve *desired* lake conditions.
- A reference tool to be used and updated as lake conditions change.

1.4. Why the ALPRD Needs a Management Plan

✓ Despite today's remarkable condition of these lakes, there is concern that the water quality of Pike, North Twin, and South Twin Lakes cannot continue without intervention. Currently, there are not many obvious problems related to lake user conflicts and/or exotic species. However, with Amery continuing to be a highly desirable destination for residents and visitors, the riparian community is concerned with the probable decline in water quality as development pressures and non-point source runoff from new construction and agricultural land uses increase within the watershed.

ALPRD is a Lake District, thus, this body has the authority to regulate activities around the Amery Lakes and levy taxes to preserve water quality. Once ALPRD adopts this Plan, the Plan will be presented to local, county, and state agencies with the purpose that these entities adopt this Lake Management Plan. *for adoption.*

ordinance must be passed by the city

This document provides the framework for future actions and can be adopted by the ALPRD board and its members, and others (such as the City of Amery and the Town of Lincoln) thereby making a commitment to implement future actions. This Plan provides baseline data on which future improvement projects can be evaluated to see if improvements to the aesthetics, recreational use, environmental and water qualities of the Amery Lakes have been realized. The ALPRD recognizes that the Plan is dynamic and modifications and improvements to the Plan are intended. The ALPRD will seek input to ensure the Amery Lakes remain assets to their community. The ALPRD further recognizes the need for this Plan and that the effectiveness of the Plan is solely dependent on its application. Coordination of future water quality protection and improvement implementation projects and updates to the Plan are necessary to keep the Plan current.

The ALPRD needs a Lake Management Plan because:

- ♦ Amery Lakes need protection – lakes are recognized as ecosystems sensitive to human development and as thermometers ^{gauges} of watershed environmental quality.
- ♦ The community and District members expect healthy and diverse lakes.
- ♦ The community and District members expect clean and plentiful water for recreation and relaxation.
- ♦ A healthy Amery Lakes system supports increased tourism, property value, community morale, and a diverse ecology for the local community. ✓

CHAPTER 2: PROJECT DESCRIPTION

2.1 Project Scope

Managing the water quality of the Amery Lakes first requires a survey of existing factors that contribute to the Lakes' condition. A lake is influenced by everything that occurs in its watershed. Visible and invisible compounds and materials entering the Amery Lakes usually adhere to the sediments, which accumulate on the lake bottom over time. The materials bound to lake-bottom sediments tend to rob oxygen from the lake ecosystem, which stresses some aquatic animals, including fish, etc. By controlling the sources of pollution in the Amery Lakes' watershed drainage area, lake water quality and the associated fish and wildlife habitat surrounding the Lakes will be better protected.

✓
many things
may
specify

The ALPRD Lake Management Plan goals are to identify areas of water quality concerns and identify management objectives for the water resources of the Amery Lakes. Since Wisconsin adopted its version of the Federal Clean Water Act in 1974, surface water quality protection and pollution control are not just individual objectives to be completed on one occasion, but require an on-going commitment to improve and protect clean water.

2.2 Goals

The proposed Plan is comprised of a multi-phased program of data acquisition, analysis and planning, covering both in-lake and watershed areas of concern, as set forth in the recommendations contained within the WDNR Basin Plan. These data, together with a comprehensive program of public information and education, will ultimately form the basic plan preparation and the determination of appropriate lake and watershed management practices. This Plan addresses the Amery Lakes system as defined by Pike, North Twin, and South Twin Lakes and surrounding watersheds. Thus, the goals of the ALPRD Lake Management Plan are:

1. Conduct an in-lake water quality monitoring program during the period of May 2002 through May 2004, in order to develop an understanding of the seasonal water quality conditions in the lake and provide a basis for developing the Lake Management Plan elements related to in-lake water quality conditions.
2. Contribute to and complement those studies being conducted by the U.S. Geological Survey, U. S. Army Corps of Engineers, Wisconsin DNR, and other governmental agencies within the St. Croix Basin.

3. Evaluate the effectiveness of current lake management measures in moderating the phosphorus loadings to the Amery Lakes system.
4. Quantify and assess changes in the quality of the Amery Lakes system, and to formulate appropriate management and remedial strategies necessary to preserve a high quality of recreational opportunity for the residents of, and visitors to, the Amery Lakes system. Specifically, such strategies will consider the effects of increases or decreases in the phosphorus loading to the Lakes.
5. Promote public information campaigns by identifying: 1) those issues of greatest concern to the riparian community of the Amery Lakes area, and 2) those areas where public information is most critical for the scientifically sound and sustainable management of the Amery Lakes system;
6. Minimize negative impacts to wetlands, environmental corridors, and other ecological habitat.
7. Identify water quality problems in the lake/tributary watershed area for management activities for specific lakes and streams.
8. Anticipate future management activities necessary for water quality protection.
9. Incorporate the communities' concerns, activities, and public awareness of everyone's responsibilities to water quality protection and involvement.

Accomplishment of these goals will result in the creation of a Lake Management Plan that will identify complex measures necessary to manage and protect the Amery Lakes system in a manner capable of providing the desired long-term water quality benefits to the Amery Lakes system, consistent with the objectives of Chapter NR 190: Lakes Management Planning Grants, *Wisconsin Administrative Code* (Appendix H). Such benefits are consistent with ongoing lake management actions being undertaken by the ALPRD, in cooperation with Federal, State, County, City, and other local agencies.

2.3 Objectives

The ALPRD Lake Management Planning project is a multi-phased program including data collection, analysis, and future planning, covering both in-lake and watershed areas of concern. The WDNR Lake Planning Grants provided funding for completion of these elements:

1. Delineation of the Tributary Watersheds and Sub-watersheds to the Amery Lakes: The Amery Lakes' watersheds were reviewed and refined using U. S. Geological Survey topographic mapping, aerial photography, 2-foot contour information, and other appropriate mapping resources. The delineation identified the boundaries of the study area and the area in which in-lake water quality, sediment, and runoff sample stations are located.

2. Evaluation of Current Land and Watershed Management Measures: Prepare a digital map and associated spreadsheet that includes current land uses within the Amery Lakes' watershed area. These results are used to develop storm water runoff patterns.
3. Design, Installation, and Operation of Automatic Storm Water Sampling Gauges: Based upon the area delineated in task 1, two stream gauge locations will be identified and appropriate gauging structures designed to provide an estimate of surface inflows at two locations to the Amery Lakes system. Precipitation data will be recorded. This work is to be completed by the Polk County Land & Water Resources Department.
4. Collection and Review of Water Quantity Data: Using the gathered data and the HydroCAD water quantity model, the characteristics of the surface water hydrology of the Amery Lakes system will be compiled, analyzed, and reported. These data will be used to develop information for the In-Lake Water Quality Modeling for task 10.
5. Global Positioning (GPS) Unit Purchase: The ALPRD will purchase a GPS Unit for the Amery High School Freshwater Ecology Class. Students will learn about the importance of sample identification. This instrument will be used in identifying sample locations for tasks 6 through 9 below.
6. In-Lake Water Quality Monitoring: In-lake water quality data gathering and analysis was conducted on Pike, North Twin, and South Twin Lakes. The ALPRD collected the samples in each lake with possible assistance from the Amery High School Freshwater Ecology Class. Using the GPS Unit from task 5 above, sampling locations will be identified and recorded. Sampling procedures will be conducted pursuant to Wisconsin DNR protocols and analysis completed by the State Lab of Hygiene. Data acquired under this task will be used to assess the impact of the nutrient on the Amery Lakes system as reflected in in-lake water quality and by lake trophic status.
7. In-Lake Sediment Sampling and Analysis: In parallel with task 6, in-lake sediment sampling and analysis will be conducted on Pike, North Twin, and South Twin Lakes. The ALPRD will collect the samples in each lake with possible assistance from the Amery High School Freshwater Ecology Class. Using the GPS Unit from task 5 above, sampling locations will be identified and recorded. Sampling procedures will be conducted pursuant to Wisconsin DNR protocols and analysis completed by the State Lab of Hygiene. Data acquired under this task will be used to assess the impact of the nutrients on the Amery Lakes system as reflected in in-lake water quality and by lake trophic status.
8. Storm Water Runoff Monitoring: Four outfalls around Pike and North Twin Lakes were sampled during storm water runoff. Using the GPS Unit from task 5 above, sampling locations will be identified and recorded. Grab samples will be collected by the ALPRD volunteers and analysis completed by the State Lab of Hygiene. Data acquired under this task will be used to assess the impact of the nutrients on the Amery Lakes' system as reflected in in-lake water quality and by lake trophic status.

*Change
here*

9. Macrophyte Survey: During the summer of 2003, a macrophyte survey was completed on Pike and North Twin Lakes by Dragonfly Consulting. This survey method was comprised of a grid point intercept method of sampling the lakes for macrophytes. Using the GPS Unit from task 5 above, sampling locations will be identified and recorded. Analysis will involve Dr. Stanley Nichol's method to calculate floristic quality assessment of the lakes. Plant coverage, exotic identification, species diversity, and nuisance stands warranting management actions will be identified and discussed.
10. In-Lake Water Quality Modeling: Cedar Corporation used the BATHTUB model to identify the trophic status of the lake and to model the nutrient and sediment impacts on lake water quality given land use and storm water quality within the Amery Lakes' Watershed. These calculations form the basis for modeling the response of the lake system to various external and internal contaminant management measures. Estimated contaminant loadings to the Amery Lakes system will be determined and extrapolated to forecast future watershed land use conditions using the Wisconsin Lake Model Spreadsheet or equivalent modeling method. These verified and validated results will be used to determine recommended lake management measures necessary to protect and rehabilitate the Amery Lakes system over an approximate 20-year planning period.
11. Publication of Water Quality Data: Water quality data for the Amery Lakes system, collected during the tasks above will be compiled by the State Lab of Hygiene and entered into the Wisconsin DNR STORET Database. The data will be provided to the ALPRD for use in developing a Lake Management Plan for the Lakes. The data will then be used as a basis for evaluating modeling results and the foundation for proposing management actions.
12. Community Survey: Dragonfly Consulting prepared a Family Lake Survey. An Amery Lakes assessment of recreational use, water quality and clarity perceptions, and feedback to the ALPRD was completed. The survey was tabulated and recorded by Dragonfly Consulting.
13. Identification of Recommended Land and Watershed Management Measures: Based upon the results obtained during the investigations set forth above, a water quality management plan has been developed, providing a technically sound basis for establishing lake management measures designed to achieve the water quality goals and water use objectives for the Amery Lakes system:
 - Identify a range of possible management options that could be applied to the Amery Lakes system, with varying levels and degrees of intervention. The management options include consideration of potential development, present and potential water quality and water pollution, desired water uses, public concerns, and varying degrees of the maintenance of plant and animal communities within the Amery Lakes' Watershed.
 - Determine the technical feasibility of the options once a comprehensive list of possible management options has been identified.

- Evaluate feasible options to determine the cost effectiveness and impact period following implementation, but preceding any anticipated beneficial result.
 - Select options that have the best chance of being successful in meeting the desired use goals set by the community for further consideration by the ALPRD and community.
 - Formulate the most effective and acceptable options into a strategy for the management of the Amery Lakes system that is agreeable to community members, local decision-makers, and other interested parties. This information will ultimately allow selection of those measures for inclusion in the refined Lake Management Plan that has proven success in mitigating the effects of nutrient enrichment in the Amery Lakes system.
14. Prepare Recommendations Within a Lake Management Plan: The results of these analyses have been incorporated into a comprehensive Lake Management Plan. This document recommends lake protection measures necessary to protect and maintain the water quality and quantity of the Amery Lakes system.
15. Dissemination of Information to the Public: Data on water quality gathered during this planning program has been compiled in the Wisconsin DNR STORET Database. A summary of these data has been prepared for the ALPRD. A presentation of the results will be completed at a regularly scheduled Amery City Council meeting. Copies of these data are available to those agencies and organizations interested in such data.

CHAPTER 3: ENVIRONMENTAL INFLUENCES

Before developing a plan that protects, maintains, and enhances the Amery Lakes, it is important to document those existing conditions and influences within the watershed boundaries. Understanding the physical, biological, human environments, and the history of the Amery Lakes Area Watershed is critical in determining the standards that best protect the Watershed and meet the member communities' needs.

3.1. Physical Environment

Geologic processes (plate tectonics, glaciation and erosion) have defined the physical environment of the Amery Lakes Area Watershed over the course of millions of years. The distribution of bedrock, unconsolidated (loose) sediments, landforms, and structural features in the Watershed are the geologic backbone on which the biological and human environments exist. The characteristics of the physical environment ultimately determine the availability of natural resources, the susceptibility of resources to pollution, and success of living organisms in the Watershed.

3.2. Geomorphology and Surficial Geology

Geomorphology is the study of the shape of the Earth's surface and the processes that sculpt it. The relief (variation in height and slope) of the landscape establishes the drainage pattern within the Watershed and drives the hydrologic (water) cycle (Figure 5). Surficial geology is a description of the distribution and physical properties of earth materials that are exposed at the surface. In the Amery area, these deposits are derived from the geologically recent glacial periods.

In the Amery Lakes Area Watershed, a thin blanket of windblown silt, or loess, covers the land and is the parent material for topsoil in most soil profiles. Glacially derived pitted outwash, a layer of stratified sand and gravel overlies the bedrock.



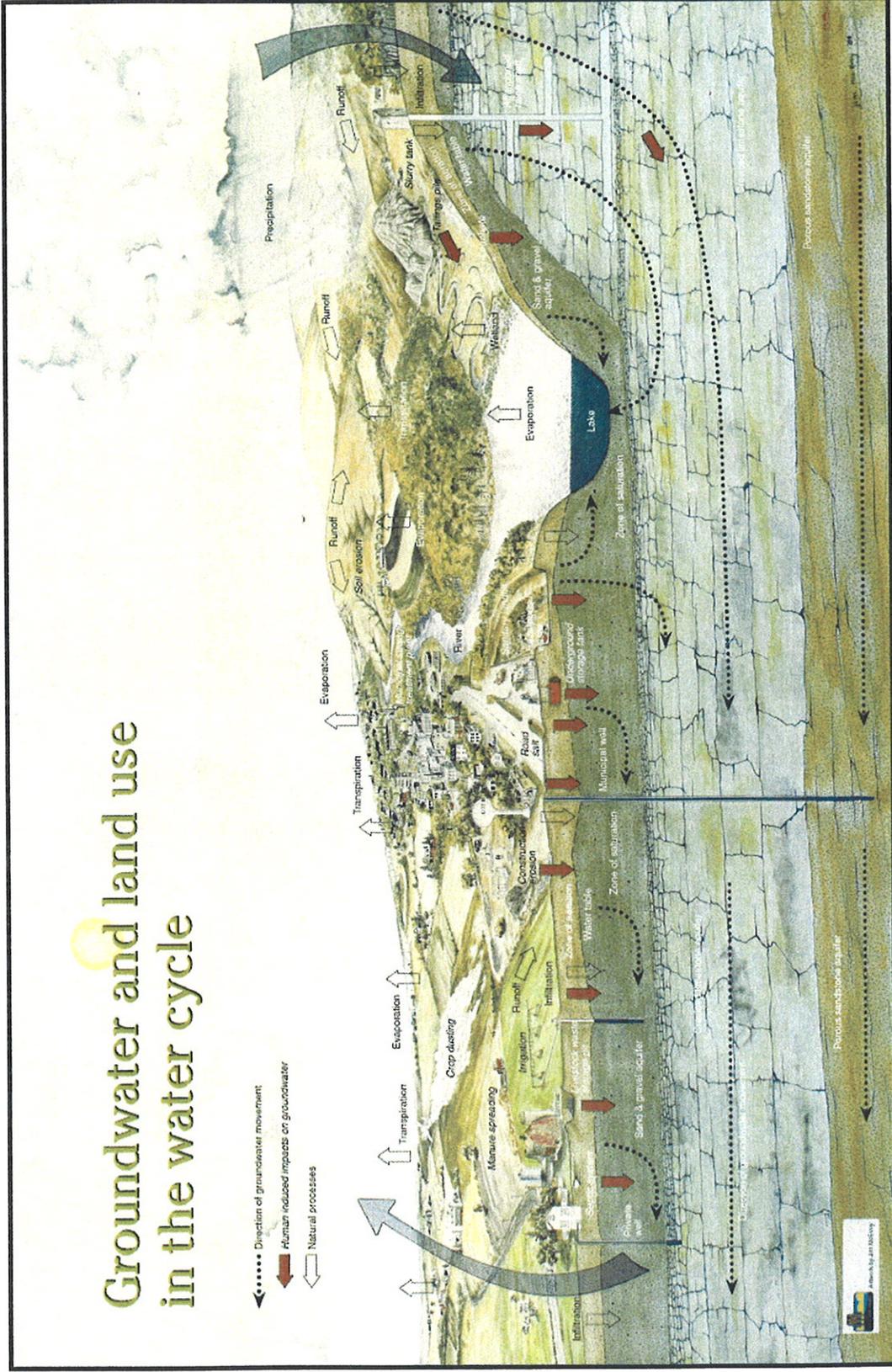
DID YOU KNOW?



Glaciers are rivers of ice. They form as snow and ice accumulate year after year after year. When they reach a certain thickness, they begin to slowly move under their own weight. The ice that covered Wisconsin was thousands of feet thick.

Throughout time, the forces of wind, water, and ice have modified the landscape of the Amery Lakes Area Watershed. The most recent influential process to shape the topography of the Watershed was the movement of continental ice sheets. During the Pleistocene Epoch (between 2 million and 10,000 years before present), glaciers repeatedly covered most of northern Wisconsin. The last glaciation, or Great Ice Age, occurred approximately 20,000 years before present (called the Wisconsinan glaciation). Many different ice

Groundwater and land use in the water cycle



Source: <http://www.dnr.state.wi.us/org/water/dwg/gw/GW-Poster.gif>

sheets (glacial lobes) traversed Wisconsin (Figure 6). The Superior Lobe traversed the Amery Lakes Area Watershed during the last part of the Wisconsinan Glaciation.

About 10,000 years ago, a general global warming trend occurred that was periodically interrupted by relatively short, cool periods. Following a period of stabilization, glaciers may advance or retreat. As the ice front receded, it stopped at various points and built up the land (as the ice melted away) and formed a land feature known as an end moraine. End moraines are irregular ridges of land that form along the edge or margin of the ice sheet. These ridges may vary in height and composition depending on the materials (also called glacial drift), the ice sheet eroded and the amount of time the ice remained melting in one location.

The different glacial deposits deposited in Wisconsin 10,000 years ago are illustrated on Figure 7. Typically in Polk County, there is dark colored glacial sediment called an "end moraine" that continues in a broad belt from the west to northeast part of Wisconsin. The Amery Lakes are located north of the end moraines and in an area of "pitted outwash." These outwash deposits are formed from stratified melt water-deposits, or horizontal layers of sand and gravel that were carried by running water from the melting ice of a glacier. These deposits formed in depressions or "pits" that often have steep slopes and may be filled with water. The Wisconsin Ice Age Trail (Figure 8) marks the glacial margin throughout Wisconsin. The trail is available to visitors for hiking or biking.

While the ice melted, eroding winds deposited a second material around Wisconsin and the Amery Lakes Area Watershed. This wind blown silt, or loess, formed a thin blanket of soil covering most of the Watershed. Loess is the parent material for local topsoil and is found in most soil profiles. It is fine grained and has a tendency to easily erode.

3.3. Bedrock Geology

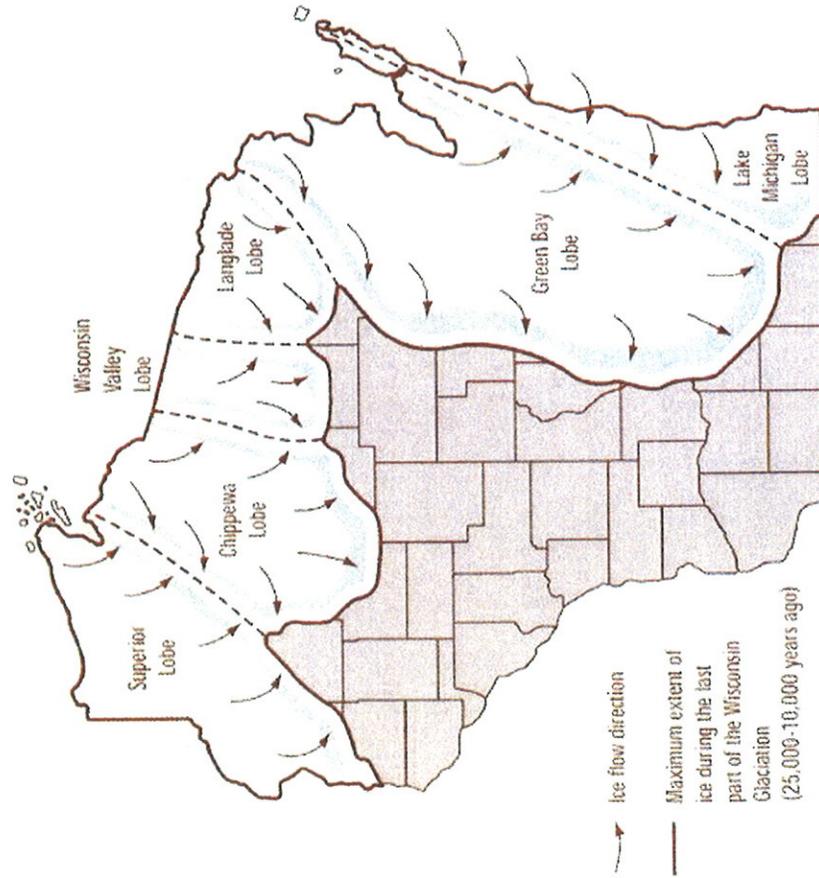
Underlying the surficial sediment and landforms is bedrock (Figures 9-10), which is that solid rock underlying the unconsolidated surface materials or overburden. In this region, overburden deposits consist of unstratified clay, silt, sand, gravel, and boulders. As described above, these unconsolidated sediments in the Amery Lakes area are of glacial origin.

The bedrock of the Amery Lakes Area Watershed is Cambrian age sandstone underlying Ordovician age dolomite and shale (deposited some 555 million to about 520 million years ago). This bedrock geology is characteristic of a marine dominated sedimentary sequence and is present throughout the region, covering one-third of the state.

3.4. Aquifers

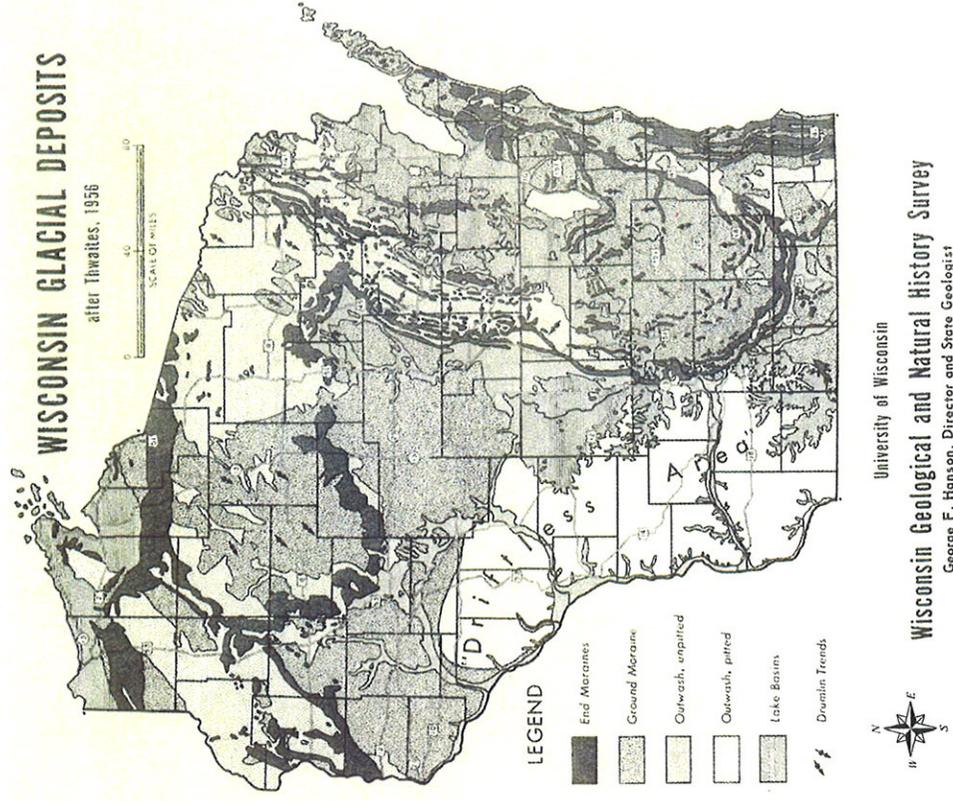
Geologic units serve as a storage place for water and are often tapped by humans as a source of drinking water. From Wisconsin's land surface to the deeper porous bedrock, surface waters infiltrate the ground due to the force of gravity.

Figure 6: Glacial Lobes of the Wisconsin Glaciation



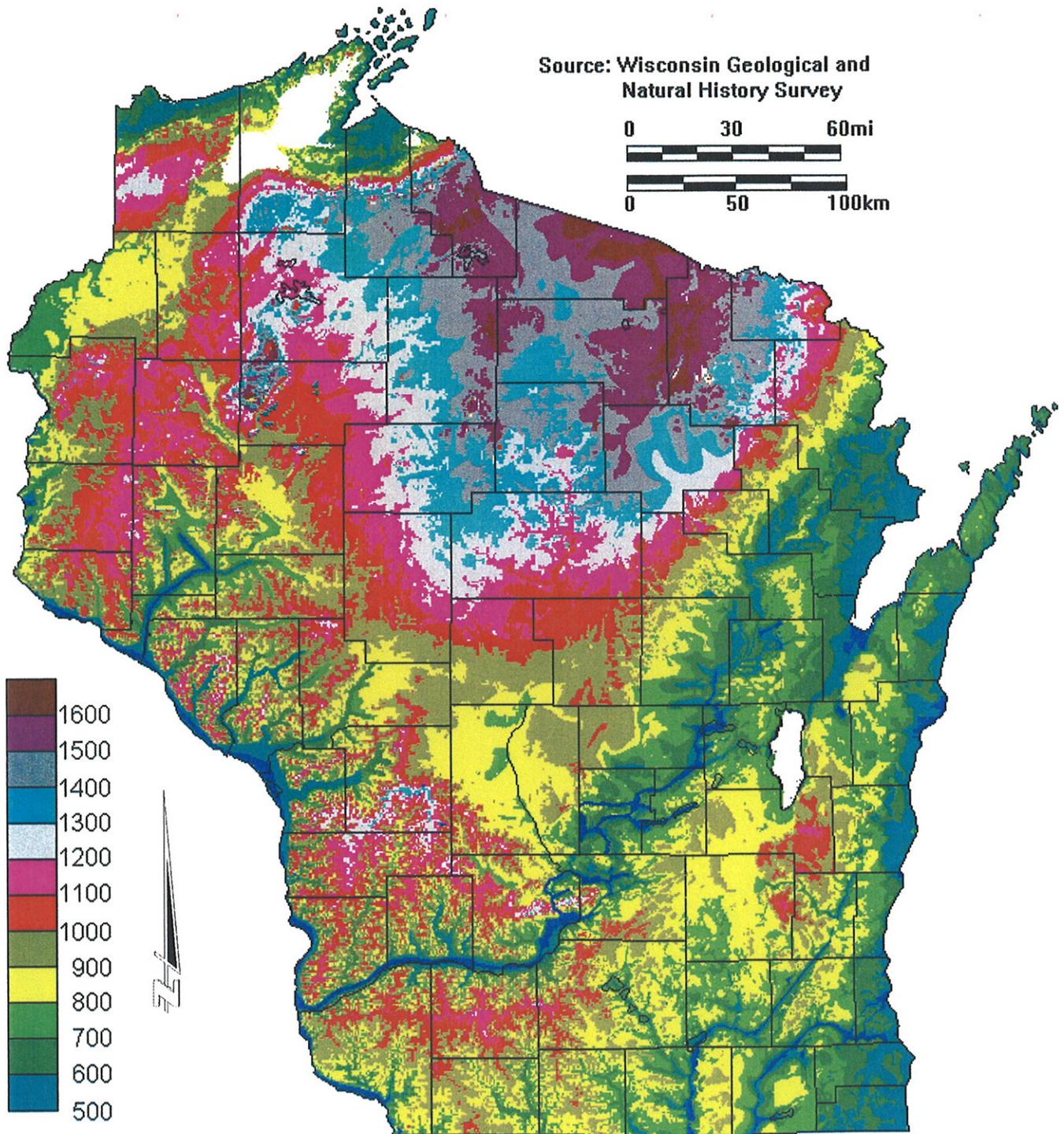
Source: WDNR. PUB-FR-182 2001. Forest Legacy Program.
Figure 1—Glacial Lobes of the Wisconsin Glaciation.

Figure 7: Glacial Deposits of Wisconsin



University of Wisconsin
Wisconsin Geological and Natural History Survey
George F. Hanson, Director and State Geologist

Figure 10: Wisconsin Bedrock Elevation Map with County Overlay



Source: <http://www.uwgb.edu/dutchs/geolwisc/WisBrkElevLgCty.htm>

Amery has an excellent quality, high volume groundwater that is used to serve the community. Currently, Amery uses two municipal wells to tap the sandstone aquifer some 200 to 400 feet below the surface. Protection of this water supply from possible groundwater contamination is a concern. Contaminants from abandoned landfills, chemicals, failing septic systems, leaking underground storage tanks, and improperly handled animal waste could lead to a contaminated groundwater supply. The Amery City Council and community are helping to protect their groundwater supply through the development of a wellhead protection plan and ordinance.

The information regarding Wisconsin's aquifers is referenced from the U.S. Geological Survey (USGS) Information Circular 39 of 1981, "*Ground-Water-Quality Atlas of Wisconsin*" by Phil Krammerer, Jr. Krammerer identifies two aquifers in the Amery area through the interpretation of the geology and hydrologic water quality data; these are the sand and gravel, and sandstone aquifers. The USGS report studied approximately 2,800 wells which reported water quality data available on the USGS computer system (WATSTORE) and 85 percent (or 2,443) were found to pump water from a single major aquifer (the sand and gravel unit). These are interpreted to be single family residences.

The USGS Circular 39 of 1981 describes the aquifers (as noted in Figure 11) as:

1. The sand and gravel aquifer is...
 - a. ...the largest in terms of surface area as it underlies approximately 70% of the State.
 - b. ...present in every county in the State except is limited in the 12 counties of the "Driftless Area." The "Driftless Area" is in central Wisconsin.
 - c. ...the youngest, or most recent deposited, aquifer that was deposited after the end of the Ice Age some 10,000 years ago.
 - d. ...a formation of unconsolidated sand and gravel deposits of glacial drift.

2. The sandstone aquifer is...
 - a. ...the second largest in terms of surface area that underlies approximately 60% of the State.
 - b. ...the largest, most extensive in terms of volume of water within more layers of land.
 - c. ...present under all or part of the State's 59 counties.
 - d. ...the oldest or earliest deposited of the three major Wisconsin aquifers.
 - e. ...formed of Cambrian (505-570 million years ago; shelled animals present) and Ordovician (438-505 million years ago; earliest fish were formed) sandstones and dolomites.

3.5. Soils

When geologic materials are exposed on the earth's surface, the rocks and minerals of which they are composed disintegrate and decompose (weather). An important product of this weathering process is the soil, or **veneer**.

Figure 11: Generalized Geological Section of Wisconsin Aquifers

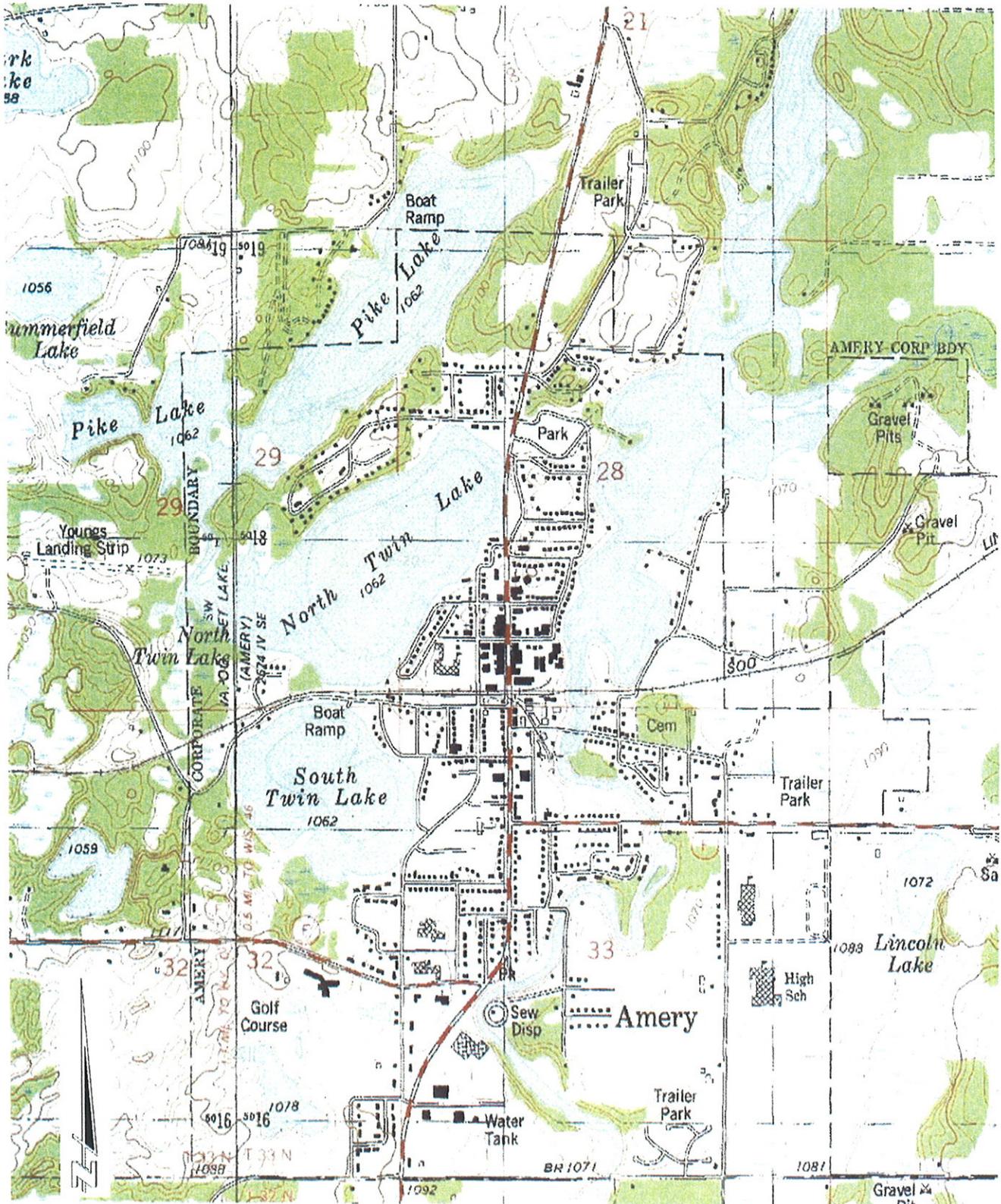
SYSTEM	GEOLOGIC UNIT	DOMINANT LITHOLOGY	AQUIFER
QUATERNARY	HOLOCENE ALLUVIAL AND PLEISTOCENE GLACIAL DEPOSITS	UNCONSOLIDATED SAND AND GRAVEL; VARIABLE AMOUNTS OF SILT, CLAY AND ORGANIC MATERIAL	SAND AND GRAVEL 1
DEVONIAN	UNDIFFERENTIATED	DOLOMITE AND SHALE	SILURIAN DOLOMITE
SILURIAN	UNDIFFERENTIATED	DOLOMITE	
ORDOVICIAN	MAQUOKETA SHALE	SHALE	MAQUOKETA SHALE
	GALENA DOLOMITE, AND DECORAH AND PLATTEVILLE FORMATIONS; UNDIFFERENTIATED	DOLOMITE	GALENA- PLATTEVILLE
	ST. PETER SANDSTONE	SANDSTONE	SANDSTONE 2
	PRAIRIE du CHIEN GROUP	DOLOMITE	
CAMBRIAN	CAMBRIAN SANDSTONES, UNDIFFERENTIATED	SANDSTONE	
PRECAMBRIAN	LAKE SUPERIOR SANDSTONE AND LAVA FLOWS	SANDSTONE AND SHALE, BASALT	PRECAMBRIAN AQUIFER LAKE SUPERIOR SANDSTONE AND LAVA FLOWS
	IGNEOUS AND METAMORPHIC ROCKS	GRANITIC AND METAMORPHIC ROCKS	PRECAMBRIAN AQUIFER BASEMENT COMPLEX

Source: Modified from...U.S. Geological Survey. Ground-water-quality Atlas of Wisconsin. Information Circular 39. 1981.

The formation of soil is dependent on five factors:

- **Parent Material** – Refers to the great variety of unconsolidated organic and mineral mater in which soil is formed. The differing chemical and physical properties of parent materials results in varying types of soils. Most of the soils in the Amery Lakes Area Watershed are formed from pitted outwash. The second topsoil parent material is wind blown silt, or loess.
- **Time** – Is the length of exposure on the earth's surface a parent material has experienced. Soils mature or age, meaning they develop horizons, increase in depth, and change chemically. Since glaciers remove older soils and deposit new parent materials, the majority of the Watershed's soils can be considered to be as old as the last ice age or approximately 10,000 to 20,000 years old.
- **Climate** – Refers to the established temperature and moisture conditions at and near the earth's surface. Climate is one of the most important factors in solid development as it affects mechanical (i.e. freeze-thaw) and chemical weathering (i.e. leaching) of parent materials. It is important to note that climate may change on the time scale over which soils are formed. Polk County is characterized with a continental climate. This climate is considered to have seasonal changes of long and snowy winters with several days being severely cold, to warm summers with several excessively hot and humid days. Spring and fall are often of short duration with increased precipitation.
- **Vegetation** – Refers to the plant community that is established in a soil. Plants mechanically (through root growth) and chemically (by enrichment in organics and removal of nutrients) alter the soil and aide its formation. The dominant vegetation in an area varies and changes with the climate.
- **Topography** – Refers to the shape of the land surface. The most important factor of topography for soil formation is slope (Figures 1 and 12). The slope of a surface will determine if soil erosion or deposition is likely to occur. Soils vary from hilltop to hillside to valley or depression. The Amery Lakes area averages about 1,200 feet mean sea level. The area consists of flat to gently rolling hills and numerous wetlands. The surface water drainage from the Amery Lakes topography is primarily from the overland flow and groundwater supporting the three Amery Lakes.

Over time, soils develop horizons (a vertical differentiation based on observable physical and chemical properties). The O Horizon is an accumulation of organic material on the soil surface characterized by decomposing plant material with little mineral content. The A Horizon (commonly called topsoil) has an accumulation of organic material, a loose or open texture, and is leached of dissolved chemicals and fine particles. The E Horizon is a light-colored layer characterized by leaching of iron and aluminum with a lower organic content. The B Horizon is the horizon where the material leached from the A and E Horizons tends to accumulate. The C Horizon is made up of slightly weathered parent material that has not undergone leaching or accumulation. Depending on the soil forming factors acting on a surface, some of the horizons may be poorly developed or missing; removing, compacting, and/or mixing soil horizons can dramatically alter the soil's ability to sustain vegetation, or varieties of vegetation.



Source: Amery 7.5 Minute USGS Quadrangle, 1978.

Soils are described based on their physical and chemical properties. Soil classification systems are used to group soils of similar properties and to provide a systematic means of mapping. For the purposes of this Management Plan, the soils of the Watershed are classified into their hydrologic soil group (HSG). This classification system is based on infiltration (water movement into soil) and transmission (water movement through soil) rates. A soil's HSG classification describes its potential to produce runoff.

In 1955, the USDA characterized four hydrologic soil groups. The groups range from low runoff potential (Group A) to high runoff potential (Group D).

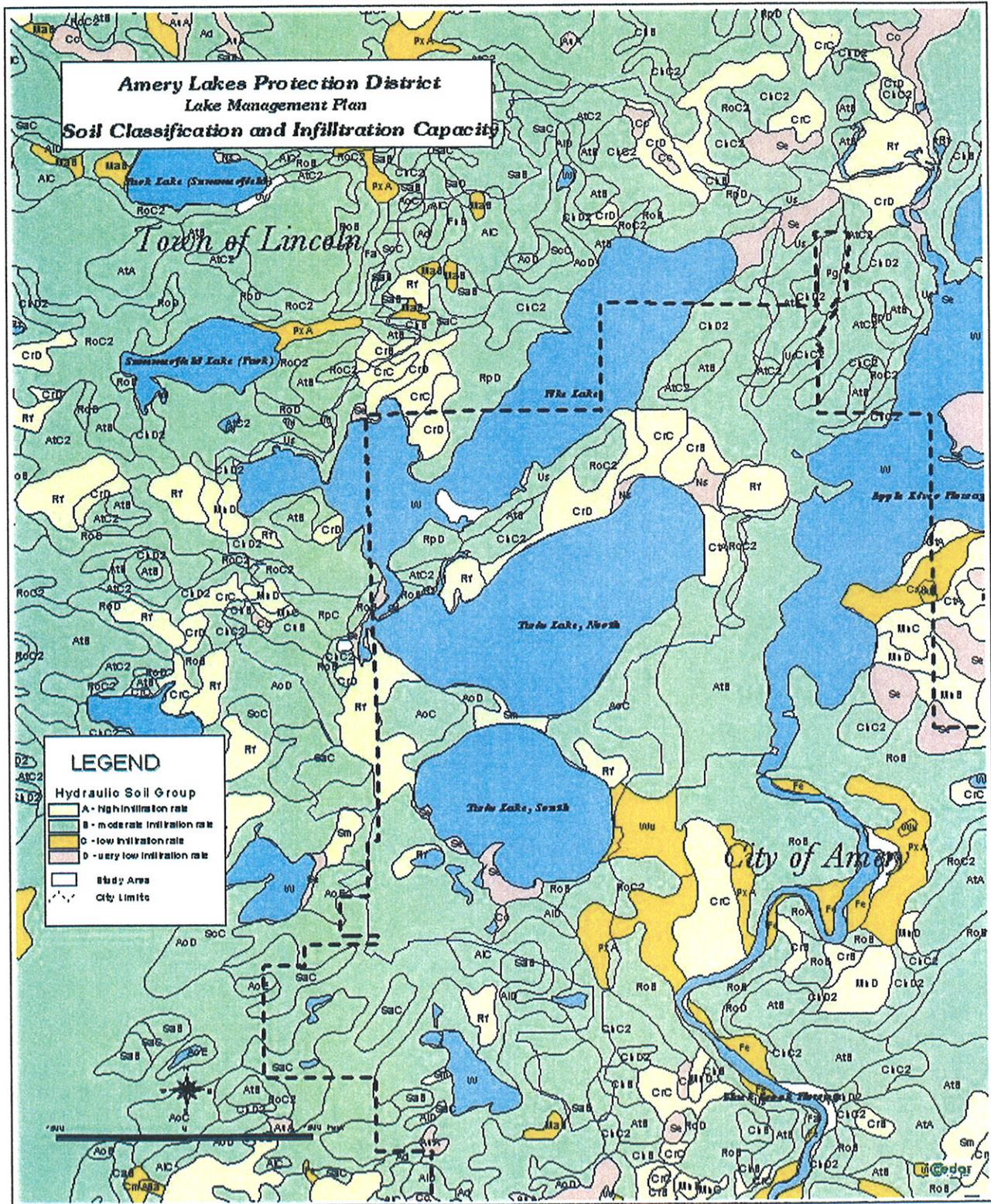
- **Group A:** Well to excessively drained soils. High infiltration rate even when thoroughly wetted. Transmission greater than 0.30 inches per hour.
- **Group B:** Moderately well- to well-drained soils. Moderate infiltration rates when thoroughly wetted. Transmission between 0.15 and 0.30 inches per hour.
- **Group C:** Soils with an impeding layer to downward water movement. Low infiltration rates when thoroughly wetted. Transmission between 0.05 and 0.15 inches per hour.
- **Group D:** Soils with almost impervious material at or near the surface. Very low infiltration rates when thoroughly wetted. Transmission between 0 and 0.05 inches per hour.
- **None:** Soils that do not meet the criteria of Group A, B, C, or D. The soil may be saturated but there is no ability for precipitation to infiltrate the soil.

The soils in the Amery Lakes Area Watershed are very diverse. Figure 13 represents the Amery Lakes Area Watershed soil types with identified hydrologic soil groups. Appendix I includes a soil mapping legend for the county. More detailed information is available in the Soil Survey of Polk County.

The relationship of a soil group to its landscape position is important in delineating wetlands and determining the susceptibility of the soil type to erosion.

1. Wetland or former wetland areas are characterized by hydric soils. Hydric soils are defined in the *1987 Army Corp of Engineers Wetland Delineation Manual (ACEWDM)* as "soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation." Hydric soils are considered to be an indicator of a wetland.

Areas with low infiltration rates (Group C and D) and flatter topography are prone to being wetlands, but wetlands may also form where the water table is at or near the surface regardless of soil texture. Wetland hydrology is defined in the 1987 ACEWDM as "the sum total of wetland characteristics in areas that are inundated or have saturated soils for a sufficient duration to support hydrophytic vegetation." In order for wetland hydrology to be present the area must be inundated or saturated to the surface for at least 5% of the growing season (consecutive days) in most years (greater than 50%). As the average growing season for Polk County is 127 days, (Soil Survey of Polk County,



Modified from: Soil Survey of Polk County

WI, p. 1), areas inundated or saturated for 6 or more consecutive days during the growing season for greater than 50% of the years on average meet the definition of a wetland.

2. The erosion potential of an area is a combination of a soil's infiltration rate, texture, drainage, and slope. Areas with low infiltration rates and steep slopes have soils that are more likely to erode, but even soils with high infiltration rates are likely to erode on steep slopes.

Over a relatively short time, the lands in the Amery Lakes area have been logged, farmed, grazed, or built upon, and some of the original topsoil has been lost through water and wind erosion. By volume, sediments resulting from erosion are the nation's largest water pollutant. The sediment that is carried in runoff from the land is seen as reduced water depths in lakes or streams, sediment laden water, and means of transport for nutrients. *Measures should be taken to stabilize sediments and prevent them from running off the land.*

With the many lakes and wetlands within the Amery Lakes Watershed, the area still supports prime agricultural land. *Preserving and protecting farmland is vital in protection of the Amery Lakes as they have a greater potential for infiltration.* However, agricultural practices that preserve topsoil and minimize erosional losses (by wind or water) need to be implemented and maintained where necessary. *non developed areas*

Wetlands have many natural values and serve as wildlife habitats and flood control devices. As precipitation reaches the ground, some water runs off and some infiltrates. The natural functions of wetlands is to serve as filters for sediment, nutrients, and other pollution. With increased development, comes increased water running off into wetlands. *Wetlands in the Amery Lakes Watershed should be protected, managed, and maintained per the U.S. Army Corps of Engineers and Wisconsin DNR standards.* Wetlands help improve water quality. *maybe not adequate protection*

Urban activities increase sediment runoff and typically concentrate them at the outlet of storm water drainage pipes and swales. These areas must be considered as having a high potential to degrade the water quality of receiving waters. Storm water runoff management is an important consideration in the improvement and the protection of lake water quality.

3.6. Population Characteristics

Population is an important factor that measures settlement and development. Increases or decreases in the population of an area may show where the Amery Lakes Area Watershed is stressed or where it may be undisturbed. The economics of the Amery area can help identify pollutant trends and an economic profile of Polk County can be found in Appendix J. Also, examining historical trends and present population changes provides information that can predict a better understanding of the future for the Amery Lakes.

3.8.a. Historic Population

Polk County, the City of Amery, and the Towns of Lincoln and Black Brook have increased in population over the past five decades. In 2003, the total population in Polk County is listed at 43,204, in the City of Amery is 2,874, and in the Town of Lincoln is 2,390. Table 1 illustrates historic population information from 1950 through 2003. Figure 14 represents the City of Amery and the Town of Lincoln's historic population and Figure 15 represents Polk County's historic population.

	1950	1960	1970	1980	1990	2000	2003
Lincoln Township	852	886	1,198	1,683	1,835	2,304	2,390
Black Brook Township	778	726	775	949	964	1,208	1,304
City of Amery	1,625	1,769	2,126	2,404	2,657	2,845	2,874
Polk County	24,944	24,968	26,666	32,351	34,773	41,319	43,204
Wisconsin	3,434,575	3,951,777	4,417,731	4,705,767	4,891,769	5,363,675	5,490,718
United States	151,325,798	179,323,175	203,211,926	226,545,805	248,709,873	281,421,906	290,809,777

Source: 2003 data is from July 1, 2003; other 2003 data is the final population for that year.

U.S. Census Bureau, Wisconsin Department of Administration, West Central Wisconsin Regional Planning Commission



Figure 14: MUNICIPALITY Historic Population

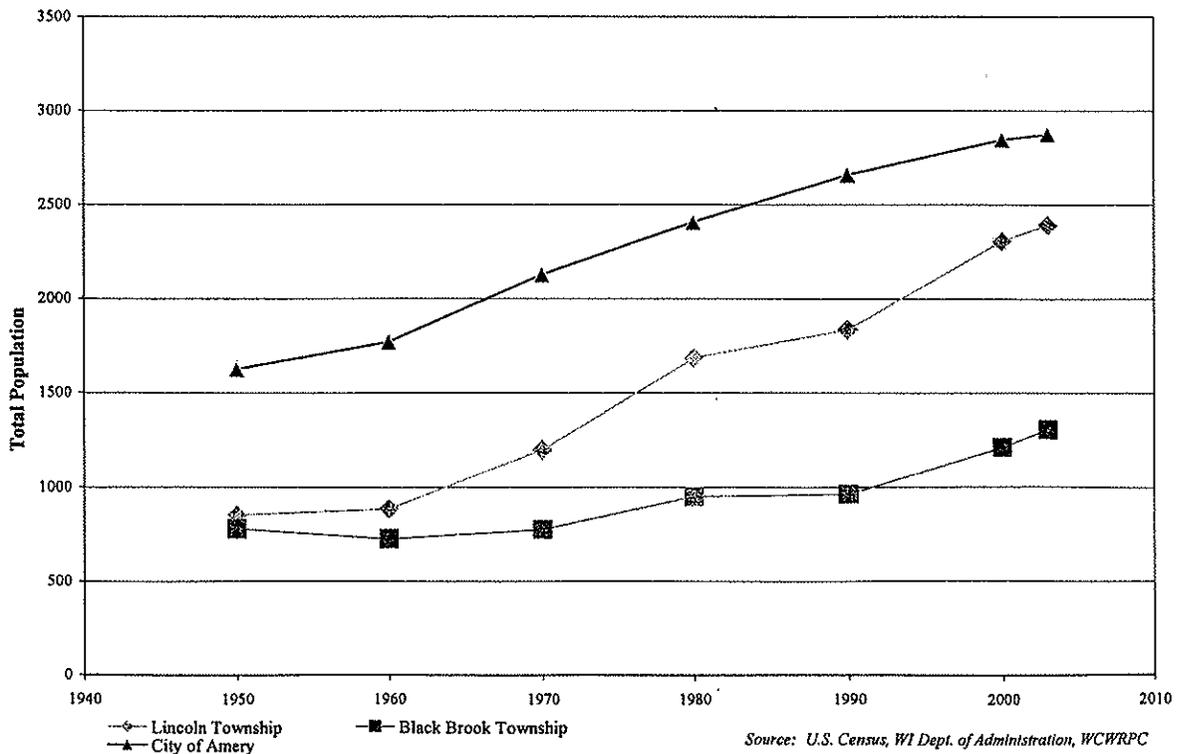
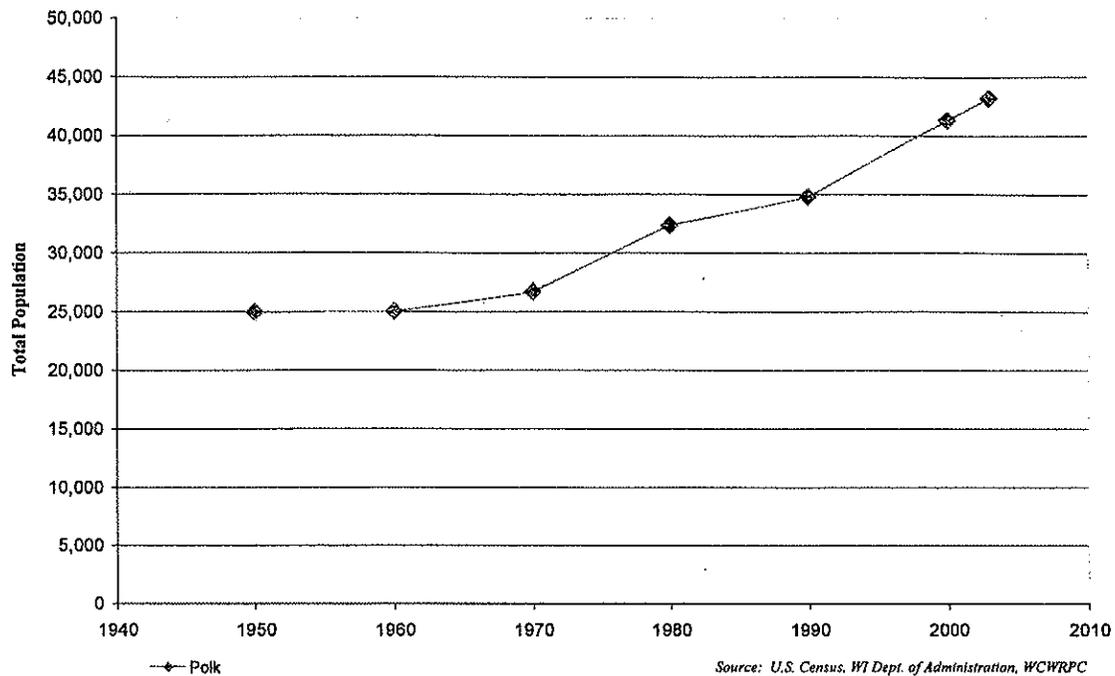


Figure 15: POLK COUNTY Historic Population



3.8.b. Projected Population

Table 2 shows population projections from through 2025 for Polk County, the City of Amery, Black Brook and Lincoln Townships. Figures 16 and 17 present population progressions in these localities. This information was generated by the Wisconsin Department of Administration and the method is described in Appendix K.

	Census Data			Projected Data				
	1980	1990	2000	2005	2010	2015	2020	2025
Lincoln Township	1,683	1,835	2,304	2,456	2,607	2,737	2,856	2,963
Black Brook Township	949	964	1,208	1,318	1,426	1,522	1,611	1,692
City of Amery	2,404	2,657	2,845	2,875	2,906	2,919	2,931	2,928
Polk County	32,351	34,773	41,319	43,621	45,901	47,842	49,592	51,152
Wisconsin	4,705,767	4,891,769	5,363,675	5,563,896	5,751,470	5,931,386	6,110,878	6,274,867

Source: Wisconsin Department of Administration, "Final Population Projections for Wisconsin Municipalities: 2000 - 2025," January 2004.



Figure 16: MUNICIPALITY Projected Population

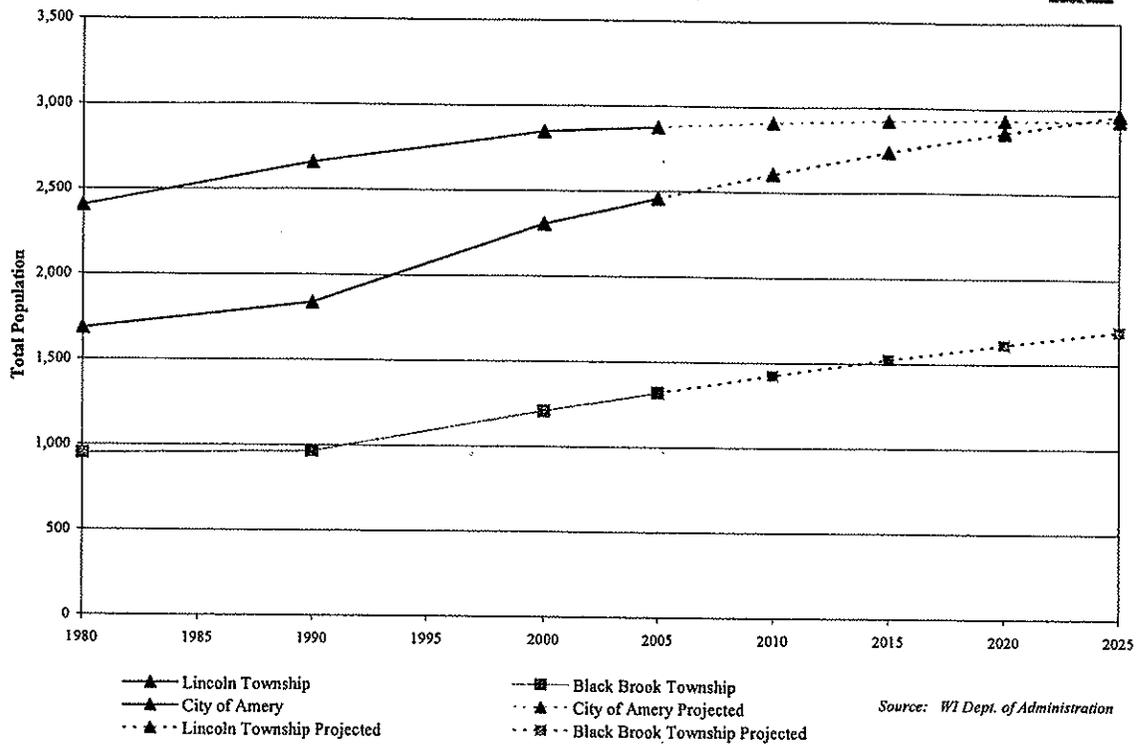
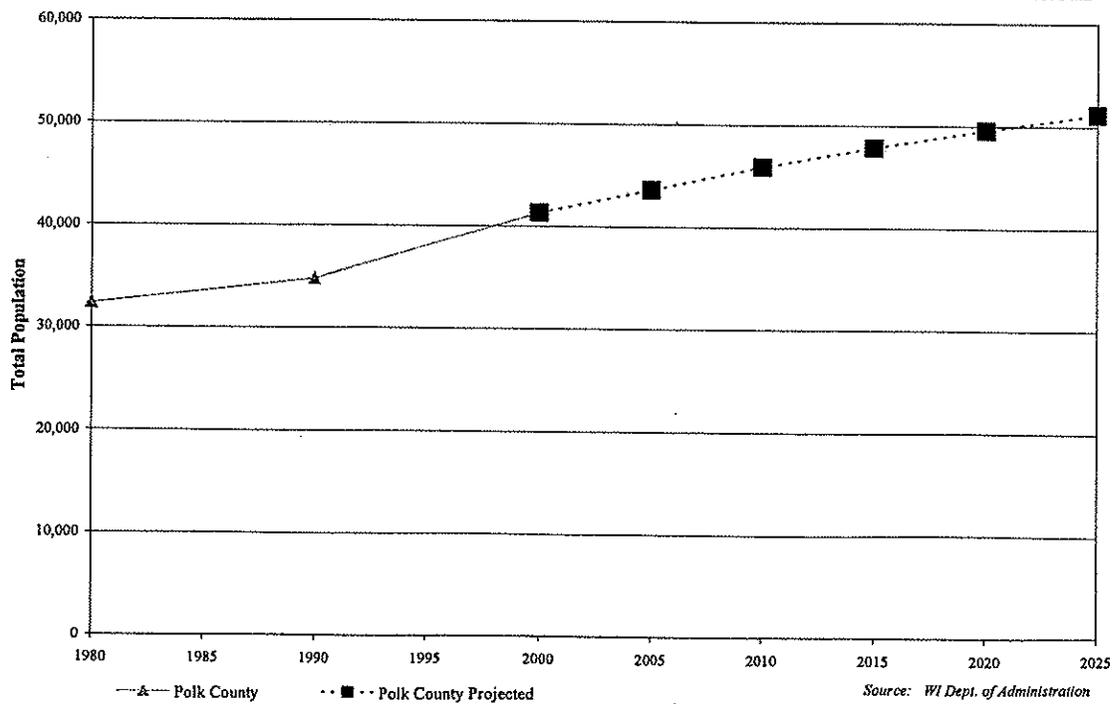


Figure 17: POLK COUNTY Projected Population



CHAPTER 4: COMMUNITY SURVEY AND PLANNING ACTIVITIES

4.1. Community Survey

Past chapters of this Plan covered regional background information. This section discusses community involvement through responses from community surveys and the proactive educational activities of the Amery Lakes Protection and Rehabilitation District (ALPRD).

4.2. ALPRD Family Lake Survey

This phase of the grant project surveyed the Amery Lakes community in order to assess those characteristics, practices, and perceptions of the Lakes and Watershed Area. This survey provides a current assessment of the present and future recreational use of the Lakes and the concerns and attitudes of current lake residents and users.

Dragonfly Consulting provided the ALPRD with design of the community survey titled: *ALPRD Family Lake Survey*. The survey was conducted in 2003 with 1,085 anonymous surveys sent to Watershed residents. A total of 335 surveys (30.9%) were returned and tabulated.

The ALPRD Family Lake Survey form and report are presented in Appendix L. The information gained from the survey is to be given to the WDNR and ALPRD Board as feedback from the community on their progress and offers continued support for future plans.

Based on survey results, the comments suggest:

1. The top three activities regularly performed on the Amery Lakes are appreciating peace and tranquility, observing wildlife, and fishing and motorized boating.
2. The top three activities sometimes performed on Amery Lakes are fishing, entertaining friends and relatives, observing wildlife and non-motorized boating.
3. The top three activities rarely performed on Amery Lakes are ice fishing, jet skiing, and snowmobiling.