WATERSHED

Fox River / Chain O' Lakes

CHAIN O' LAKES WATERSHED-BASED PLAN

February 2024

Chain O'Lakes

Watershed – Based Plan

February 2024

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ACRONYMS/ABBREVIATIONS USED IN CHAPTER 1

BMP – Best Management Practices

CWA – Clean Water Act

FWA – Fox Waterway Agency

HUC – Hydrologic Unit Code

ISWS – Illinois State Water Survey

Illinois EPA – Illinois Environmental Protection Agency

LCHD – Lake County Health Department

NPS – Nonpoint Source

SMC – Lake County Stormwater Management Commission

SEWRPC – Southeast Wisconsin Regional Planning Commission

SEWFRC – Southeast Wisconsin Fox River Commission

TMDL – Total Maximum Daily Load

USEPA – United States Environmental Protection Agency

WDNR – Wisconsin Department of Natural Resources

1 INTRODUCTION

1.1 WHAT IS A WATERSHED?

A **watershed** is the area of land drained by a river, stream, or other body of water (see Figure 1-1 for a diagram of a watershed system). Other common names given to watersheds include **drainage basins and catchments**.

As simple as the definition sounds, a watershed is actually a complex interaction between ground, climate, water, vegetation, and animals. In today's developed watersheds, other elements, such as sewage, agricultural drainage, **impervious surfaces**, stormwater, and erosion can all be detrimental to the health of the watershed.

Figure 1-1: Diagram of a Watershed

The health of a waterbody is a direct reflection of how the land in the watershed is used and managed. Some of the benefits of a healthy watershed are: improved water quality, fewer flooding problems, enhanced wildlife habitat, recreational opportunities, and better quality of life.

1.1.1 WHY A WATERSHED-BASED PLAN?

WATERSHED: Land area that drains water to a given point, usually a river, stream or lake. The land area above a given point on a waterbody (river, stream, lake, wetland) that contributes runoff to that point is considered the watershed.

DRAINAGE BASIN: Synonymous with "watershed," though often used to describe the watersheds of larger rivers or hydrologic systems (e.g., the "Mississippi River drainage basin" or "Great Lakes drainage basin").

SUBWATERSHED: A smaller basin within a larger watershed that drains to a common point in the larger watershed. The 4 subwatersheds in the Chain O' Lakes planning area have an average size of 12.8 square miles, with a range of 4.5 – 25 square miles. See Chapter 3, Section 3.1.4 for more information about the planning area's 4 subwatersheds.

IMPERVIOUS SURFACES: A surface that does not allow water to infiltrate to the soil layer, including pavement, rooftops, and roads.

Water is elemental to our lives. Plants and animals, including humans, are largely composed of water, and generally require clean water to survive. Our communities, food systems, energy sources, and countless products that we consume every day are dependent upon water. Despite this dependence, water is often taken for granted until it negatively affects us, usually due to short supply, inundation, or pollution.

This watershed-based plan is important because it specifically addresses water-related issues in communities within the Chain O' Lakes planning area. Clean and abundant water, healthy lakes and streams, and recreational access are important to residents and business and, therefore, play a significant role in the quality of life, health and economic vitality of our communities. Clean and healthy watersheds are assets that make communities more desirable for residents and businesses. The many lakes in the Chain are a popular recreational destination for residents, as well as visitors, and are a highly visible indicator of watershed health. These waters support a diverse variety of water-dependent plants and animals and are critical to local ecosystems, as well as supporting important economic and population centers.

Water does not generally flow according to political boundaries. Consequently, it is recognized that the watershed is an appropriate scale to address most water resource issues, which often involves multiple political jurisdictions. The Chain O' Lakes watershed planning process brought together numerous stakeholders to provide input towards the management and enhancement of water resources. This watershed-based plan utilizes sources of up-to-date information, such as historical data, to provide a summary of existing conditions and trends. It recommends actions stakeholders can take to protect resources that are in good condition and restore those that have been degraded.

1.2 CHAIN O' LAKES WATERSHED PLANNING AREA

1.2.1 Chain O' Lakes Watershed

The Chain O' Lakes watershed is comprised of 15 lakes interconnected with the Fox River, and is part of the larger Upper Fox River basin that originates in Wisconsin. The drainage area of the Fox River, including upstream of the Chain, is approximately 1,200 square miles. The surface area of the lake system itself is more than 7,000 acres.

The lands surrounding the Chain O' Lakes were being cleared of forests by 1840. The cleared land was converted to row-crop agriculture. From that original agricultural base, the shores of the Chain were steadily converted to residential and recreational uses. The interconnected bodies of water, natural shoreline, picturesque beauty, and proximity to Chicago have combined to make the Chain a popular area for swimming, boating, water skiing, fishing, and resort development (Kothandaraman et al., 1977). Today, the Chain is the busiest inland recreational waterway per acre in the United States.

1.2.2 Planning Area

The Chain O' Lakes watershed-based plan covers 51 square miles (32,922 acres), less than 2% of the Fox River watershed. Hereinafter referred to as the "Chain" or "planning area," this area encompasses portions of western Lake County and eastern McHenry County, Illinois, and portions of 8 municipalities and 7 townships (see Figure 1-2). It includes 13 of the 15 interconnected lakes that make up the entire Chain O' Lakes.

The planning area contains 18 miles of stream and over 4,400 acres of open water wetlands. Figure 1-3 depicts the size and location of the planning area relative to the larger upstream Fox River Basin.

The United States Geological Survey (USGS) has developed a coding system for hydrologic systems that is used throughout the United States by numerous federal, state, and local agencies and organizations. Each watershed unit is assigned a Hydrologic Unit Code (HUC), with the number of digits in each code dependent upon watershed size and its relationship to larger watersheds to which it belongs (if any). Table 1-1 includes the four applicable 12-digit HUC subwatersheds. The planning area is located within the larger HUC 8 Upper Fox River basin (code – 07120006). See Chapter 3, Section 3.1.3 for more detailed information on HUCs.

This is an "umbrella" watershed-based plan because the 51 square-mile planning area includes four subwatersheds. This umbrella plan also guides local stakeholders to implement Best Management Practices (BMPs) that provide cost and pollution effective solutions to surface water quality impairments.

Table 1-1: Chain O' Lakes Subwatersheds and 12-Digit HUCs

SUBWATERSHED	12-DIGIT HUC	HUC NAME	Area (acres)
Channel Lake	071200061005	Channel Lake	2,886
Bassett Creek	071200061006	Bassett Creek – Fox River	4,324
Nippersink Lake	071200061009	Nippersink Lake – Fox River	15,879
Pistakee Lake	071200061010	Pistakee Lake – Fox River	9,833

Channel in the Chain O' Lakes

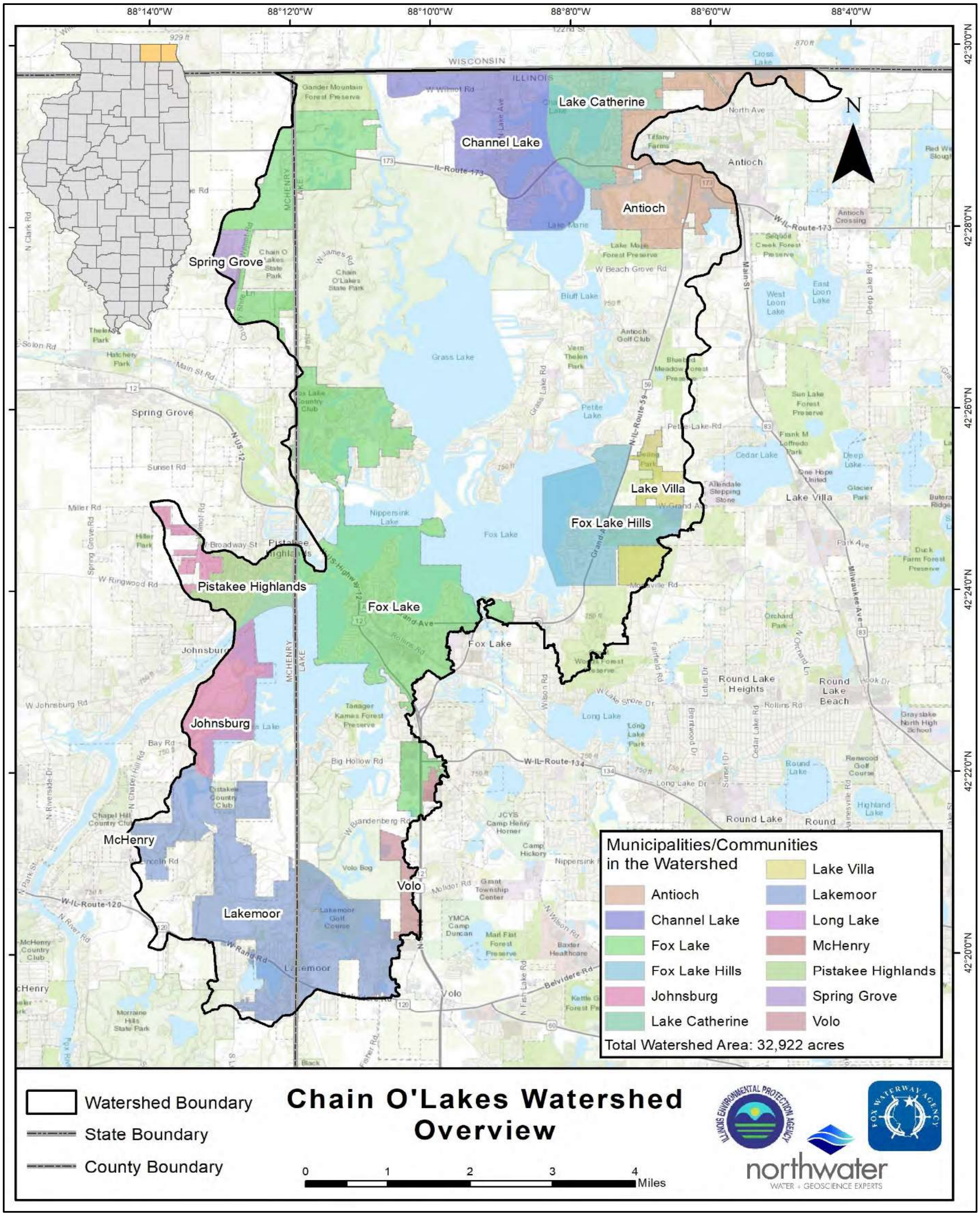

Figure 1-2: Chain O' Lakes Watershed and Planning Area

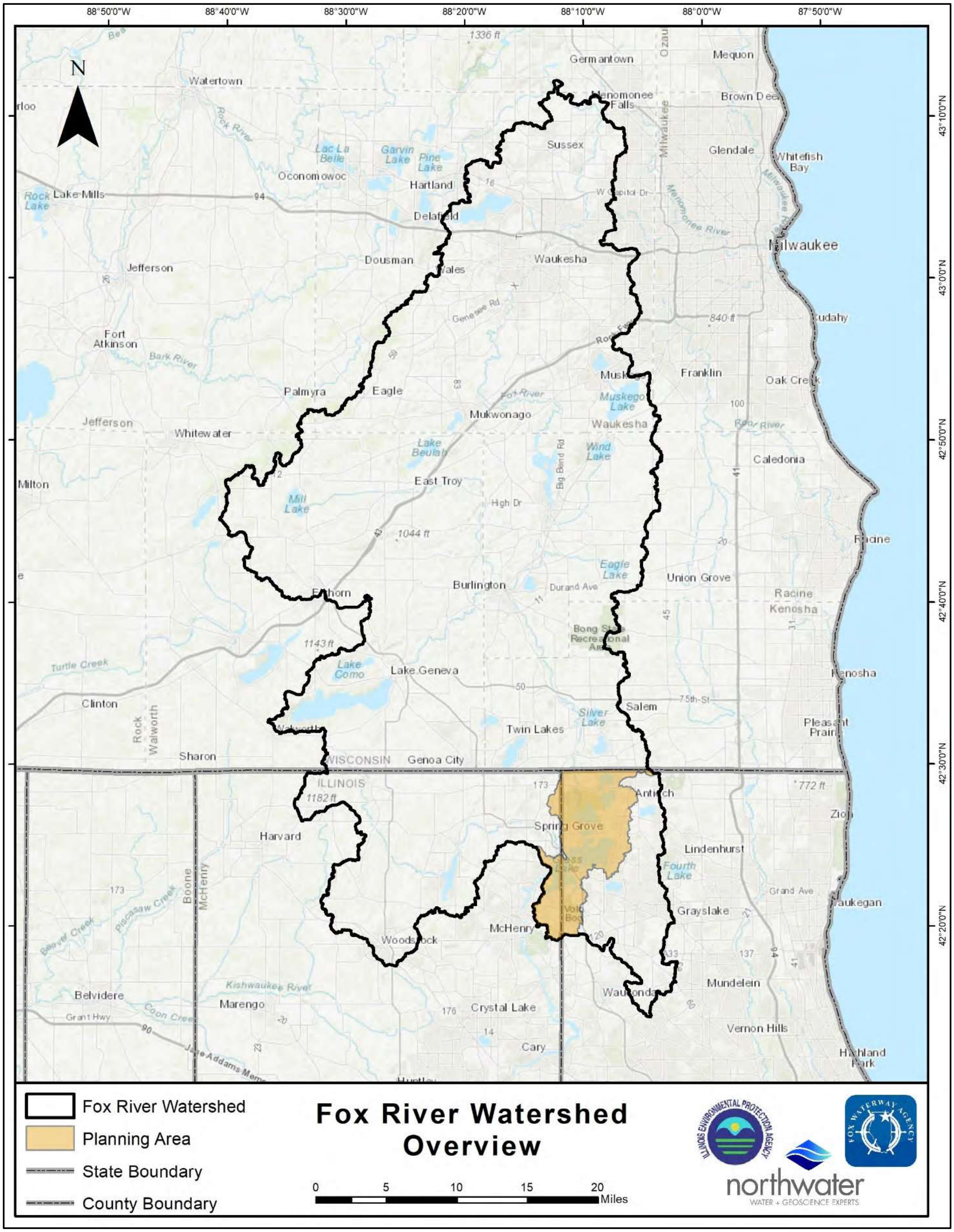

Figure 1-3: Chain Planning Area in Relation to Fox River Watershed

1.3 WATERSHED PLAN PURPOSE

Given that no formal watershed-based plan exists, the Fox Waterway Agency (FWA) took the lead to develop one. The purpose of this effort was to develop a plan to reduce the impacts of water pollution, especially sediment and nutrients, restore lake health to a healthy condition, and provide opportunities for stakeholders to have a significant role in the process.

A broad representation of watershed stakeholders participated in the process and developed and supported this plan. A significant objective of the effort and the implementation of the plan going forward is to return the numerous waterbodies in the planning area that are listed as **impaired** on the 2020/2022 Illinois 303(d) list of impaired waters to conditions that fully support their designated uses (Illinois EPA, 2022). Figure 1-4 depicts the waterbodies that are impaired in the planning area. This plan identifies BMPs to remedy or mitigate water quality impairments and the loss or degradation of natural resources. The plan also recommends watershed stakeholders implement actions to preserve, manage, and restore natural resources, as well as prevent actions that will cause or exacerbate unintended water quality and stormwater problems. Watersheds do not generally coincide with political boundaries, so watershed planning improves coordination and cooperation among communities and the land and water resources they share and impact.

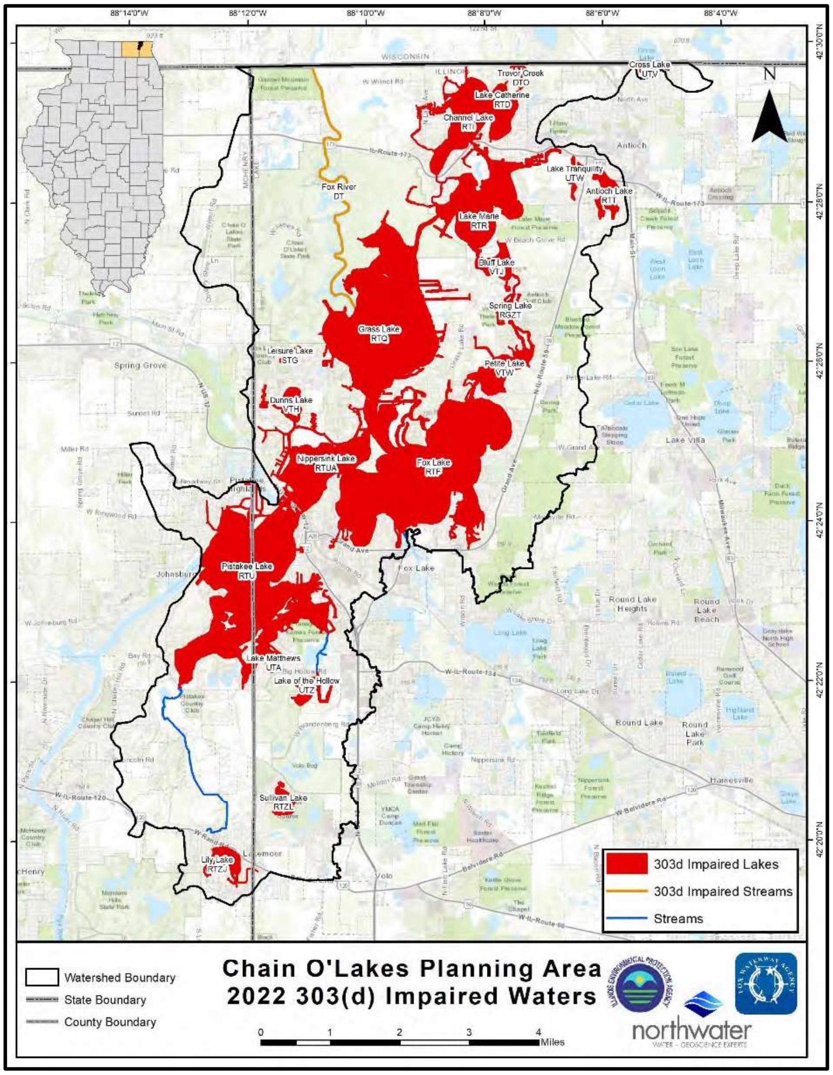

Figure 1-4: Chain O' Lakes 2020/2022 303(d) Impaired Waters

> **IMPAIRED WATERS:**
> The Clean Water Act requires states to identify waters that do not or are not expected to meet applicable water quality standards with current pollution control technologies alone.

1.4 WATERSHED PLAN REQUIREMENTS, PROCESS, AND ORGANIZATION

The primary scope of this project is the development of a comprehensive watershed-based plan that identifies actions to improve water quality and reduce the impact of nutrients and sedimentation. The planning approach was designed to help stakeholders from multiple jurisdictions and with various interests to better understand and become engaged in the watershed. The desired outcome is to spur implementation of water quality improvement projects and programs that will accomplish the goals and objectives established in this plan. The FWA worked with numerous stakeholders, including public agencies, local units of government, landowners, and private sector professionals with interests in the watershed.

This plan relied heavily on a 2020 Total Maximum Daily Load (TMDL) report of the Upper Fox River/Chain O'Lakes, as well as other relevant studies, reports, and adjoining watershed plans completed by the Lake County Stormwater Management Commission (SMC) and others.

Development of this plan was funded, in part, by the Illinois EPA through Section 319 of the Clean Water Act (CWA). Section 319 grants are also awarded to projects to protect water quality in Illinois. Projects must address water quality issues relating directly to nonpoint source (NPS) pollution. Funds can also be used for the implementation of watershed management plans, including the development of information/education programs and for the installation of BMPs. Section 319 funds give higher priority to applications that are implementing a site-specific action plan recommendation (project) in an approved watershed-based plan or TMDL that meets the watershed-based plan requirements. A portion of the Section 319 funds is allocated to projects that are not recommendations in an approved plan, but projects within them may be prioritized. The Chain plan follows Illinois Environmental Protection Agency (EPA) guidance and is designed to meet the nine elements required by the United States Environmental Protection Agency (USEPA) for a watershed-based plan.

NOTEWORTHY – USEPA'S NINE ELEMENTS OF A WATERSHED –BASED PLAN

1. Identification of the causes and sources, or groups of similar sources, of pollution that will need to be controlled to achieve the pollutant load reductions estimated in the watershed-based plan;
2. Estimate of the pollutant load reductions expected following implementation of the management measures described under number 3 below;
3. Description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under number 2 above, and an identification of the critical areas in which those measures will be needed to implement the plan;
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the plan;
5. Public information/education component that is designed to change social behavior;
6. Plan implementation schedule;
7. Description of interim, measurable milestones;
8. Set of criteria that can be used to determine whether pollutant loading reductions are being achieved over time;
9. Monitoring component to evaluate the effectiveness of the implementation efforts over time.

1.5 PREVIOUS AND RELATED STUDIES PLANS AND INITIATIVES

Biological, habitat, water quality, and demographic/geographic data for this plan were compiled from several previous and concurrent studies of the Chain. This information was collected, analyzed, summarized, and supplemented with newly collected field data, and was then used to reach conclusions regarding the condition of the resources in the planning area. Field studies completed in association with this effort include stream and lake inventories which are described in Chapter 3 of this plan. References for previous and related reports and studies compiled are listed in Table 1-2.

In addition to studies or plans, there are related or complementary initiatives being spearheaded by other groups and entities in the larger Fox River watershed. These include:

1. **Friends of the Fox River** - Friends of the Fox River is a 501(c)(3) nonprofit organization made up of citizens and organizations taking action to protect and maintain the quality of the Fox River and its tributaries. They conduct education, advocacy, and monitoring and work with the Fox River Study Group. A primary focus of the organization is dam removal downstream of the planning area.
2. **Fox River Study Group** - The Study Group was formed as a collaborative approach to creating a healthier Fox River. They developed an effective water monitoring program for the Fox River and is using that data to guide communities toward the best solutions to improve water quality. The Study Group has developed a model that makes it possible to evaluate priorities for watershed management, assess the effects of development options in the region, ensure efficient use of taxpayer dollars on watershed projects and educate stakeholders on the best ways to achieve cleaner water and sustainable development. The Study Group released its Fox River Implementation Plan (FRIP) in 2015 which was updated in 2022 covering an area from the Stratton Dam (immediately downstream of the planning area) to the Illinois River. The plan recommended municipal wastewater treatment facilities reduce their phosphorus discharges to the Fox River together with efforts towards reducing pollution from NPS runoff.
3. **Southeast Wisconsin Regional Planning Commission (SEWRPC) and Southeastern Wisconsin Fox River Commission (SEWFRC) –** responsible for an inventory of streambank erosion along 27 miles of the Fox River in Wisconsin, development of erosion prioritization ranking criteria, characterization of pollutant sources, prioritization of projects to reduce loading, programmatic approaches to reduce cost related to pollutant load reductions, and education and outreach programs. Work also includes a future Fox River hazard mitigation study that will propose strategies to reduce the risk and vulnerability due to flooding, dam failure, and drought in Wisconsin and an ongoing regional study of chloride in surface and groundwater that encompasses the Fox River watershed.
4. **Fox Illinois River Basin TMDL** – an effort is currently underway by the Wisconsin Department of Natural Resources (WDNR) to address phosphorus and sediment impairments along the Fox. The project is in the monitoring phase (Phase 1). Once completed, it will provide reductions needed to meet Wisconsin water quality standards, as well as implementation recommendations. This effort will be a major step forward in addressing external loading to the Chain O' Lakes.

Table 1-2: Related Studies and Plans

PREVIOUS & RELATED STUDIES/PLANS	YEAR COMPLETED	AUTHOR/OWNER
Fox Illinois River Basin TMDL	TMDL currently underway	WDNR
Illinois Integrated Water Quality Report and Section 303 (d) List, 2020/2022	2022	Illinois EPA
Upper Fox River/Chain O' Lakes Watershed TMDL Report	2020	CDM Smith
Lake Catherine/Channel Lake Management Plan	2017	Integrated Lakes Management
Fox River Implementation Plan	2015, updated in 2022	Fox River Study Group and Geosyntec Consultants
Lake County Wetland Restoration and Preservation Plan	2020	Lake County Stormwater Management Commission (SMC)
Southeastern Wisconsin Fox River Commission Implementation Plan: 2011 - 2020	2011	Southeastern Wisconsin Regional Planning Commission
Village of Fox Lake, Antioch Stormwater Management Program Plan	2016, 2017	SMC, Bleck Engineering Company, Inc., Baxter & Woodman, Inc.
2014 Summary Report of the Fox Chain O' Lakes	2014	Lake County Health Department (LCHD)
Lake Reports – 12 individual lakes	2014-2015	Lake County Health Department (LCHD)
Nippersink Creek Watershed Plan	2008 (expired)	Watershed Resource Consultants, Inc., Fluid Clarity, Ltd., Nippersink Creek Watershed Planning Committee
Sequoit Creek Watershed Plan	2004 (expired)	Tetra Tech EM Inc.
Manitou Creek Watershed Plan	2004 (expired)	Hey and Associates, Inc.
Sediment Management Alternatives for the Fox Chain of Lakes along the Fox River in Illinois	2002	Illinois State Water Survey (ISWS)
Phase 1 Diagnostic / Feasibility Study of Channel Lake and Lake Catherine	2000	Cochran & Wilken, Inc.
Fox Chain of Lakes Investigation and Water Quality Management Plan	1977	ISWS and State Geological Survey

1.6 USING THE PLAN

1.6.1 WHO SHOULD USE THIS PLAN?

This plan will be of limited use without the commitment of stakeholders to improve, restore, manage, and steward watershed resources. The FWA, municipal and county agencies and elected officials, as the primary land use, management, development, and infrastructure authorities in the watershed, will have a significant amount of influence and responsibility for implementing this plan. These public agencies represent the interests of their constituents and are strongly influenced by every community resident or landowner. Therefore, each community member has the potential to influence the actions that occur in the Chain through active participation.

State and federal agencies, elected officials, and private organizations, such as homeowner associations and conservation organizations, will also play an important role. State and federal agencies can support the implementation of this plan by approving projects in a timely fashion, supporting them with funding, and providing technical information, tools, and resources to assist local authorities and watershed organizations in their efforts. Private associations and organizations have the ear and influence of their members and can provide significant contributions to land and water protection. Individual watershed residents and landowners must also accept responsibility for managing their own land and water resources responsibly.

All jurisdictions, organizations, businesses and institutions, private landowners, and residents will have to work together to successfully protect and restore the lakes. The flow of water also does not respect property lines or jurisdictional boundaries; therefore, everyone needs to share the long-term stewardship responsibility and the costs and benefits of improvements.

The success of plan implementation will also be determined by the ability of stakeholders to organize to coordinate, communicate, and manage activities. Watershed organizations are generally formed from the organizations and/or individuals who participated in the watershed planning process and often become the drivers of plan implementation and provide educational outreach to the community. A watershed organization will be the primary mechanism to engage the general public, to support plan implementation, and to voice their concerns and celebrate their successes in restoring resources.

1.6.2 How To Use This Plan

For those unfamiliar with watershed planning, this document may appear overwhelming. There are pages of information to navigate, numerous tables and maps and many recommendations that will require the work and cooperation of numerous stakeholders. These recommendations are for agencies, institutions and organizations to consider. There are also several straightforward actions that individuals can take to improve the watershed. Every action, no matter how small, when undertaken by many or key landowners, can have a positive impact. For a general understanding of what this plan is about, please read the Executive Summary, which also includes a list of top priority actions for the next ten years. For additional details, browse the table of contents and advance to the section you are interested in.

To find out…

- What this plan is intended to accomplish, read about the watershed issues, opportunities, goals, and objectives for improving watershed health and improving water quality in **Chapter 2**.
- Detailed information about watershed resources and conditions, read the section(s) of interest in **Chapter 3**.
- What the problems are facing the watershed, **Chapter 4** includes a summary and analysis of watershed problems that need to be addressed by the action plan.
- What kind of actions can be taken to improve the watershed, the action plan in **Chapter 5** includes a watershed-wide programmatic action plan that includes general recommendations and policy options, as well as a site-specific action plan directed to critical areas of the Chain that identifies actions that can improve water quality in specific areas. A web application has been created that allows watershed stakeholders to access the site-specific action plan recommendations through a mapping tool.

- What kind of funding may be available to provide cost share for implementing watershed improvement projects, refer to the funding sources in **Chapter 6 and Appendix B**.
- What sort of outreach and education is needed so that watershed stakeholders understand the watershed problems, their role, and have the capability to implement the Action Plan, refer to **Chapter 7**.

1.7 REFERENCES

Illinois Environmental Protection Agency, 2022. "Illinois Integrated Water Quality Report and Section 303(d) List, 2020/2022." Illinois Environmental Protection Agency, Bureau of Water: Springfield.

Lake County Health Department, 2014. 2014 Summary Report of the Fox Chain O' Lakes.

V. Kothandaraman, Ralph L. Evans, Nani G. Bhowmik, John B. Stall, David L. Gross, Jerry A. Lineback, and Gary B. Dreher, 1977. Fox Chain of Lakes Investigation and Water Quality Management Plan. Cooperative Resources Report 5.

CHAPTER TWO: WATERSHED ISSUES, OPPORTUNITIES, GOALS, AND OBJECTIVES

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LIST OF TABLES

ACRONYMS/ABBREVIATIONS USED IN CHAPTER 2

BMP – Best Management Practices

Illinois EPA – Illinois Environmental Protection Agency

FWA – Fox Waterway Agency

2 WATERSHED ISSUES, OPPORTUNITIES, GOALS, AND OBJECTIVES

2.1 ISSUES AND OPPORTUNITIES

WATERSHED PLANNING COMMITTEE: A committee comprised of Fox Waterway Agency staff and watershed stakeholders with a goal of creating an umbrella watershed-based plan for the Chain O' Lakes planning area and reducing sediment, nutrient and bacteria pollution.

One of the first tasks the Chain O' Lakes watershed committee (watershed planning committee) undertook was to identify issues that a watershed-based plan should address and opportunities or strategies to address those issues. Participants (watershed stakeholders) over the course of regular planning meetings identified issues and opportunities they felt were important to the watershed planning process. In addition, stakeholders submitted concerns through a website developed by the Fox Waterway Agency (FWA).

Stakeholders identified key issues and concerns during the meetings including:

- Lake clarity.
- Algae.
- Shoreline erosion.
- Excessive runoff from impervious surfaces and agricultural areas.
- A lack of education on impacts to the Chain and lake management.
- External nutrient and sediment loading.
- Sedimentation and recreational access (need for dredging).
- Nuisance wildlife (geese).
- Inadequate monitoring.
- Septic systems.

Issues and opportunities were most related to water quality and sedimentation, the need for education, and runoff. Several of these issue categories translate directly to watershed planning goals identified in Section 2.2. The remaining categories and individual issues and opportunities are addressed by objectives or action recommendations elsewhere in the plan.

To establish goals, a group from the planning committee, the general public, and the FWA generated a list of water quality concerns. Each individual generated multiple concerns they had with water quality. These were then grouped. For each group, the question was then asked - In the future, if these concerns were addressed, how would you describe the water quality? This resulted in 3 water quality goals. Recognizing the need to engage the community and community leaders in watershed efforts, a fourth goal was established related to education, information and engagement. A fifth and final goal was set to address opportunities for access to the waterway for maintenance and monitoring.

Table 2-1 summarizes the primary issues and opportunities identified by stakeholders. Columns in the table indicate how issues and opportunities relate to the goals established for the watershed plan.

Table 2-1: Issues and Opportunities Identified by Stakeholders

The asterisk (*) indicates the issue/opportunity applies to multiple categories or does not neatly fit in a single category. The "X" symbol indicates the issue/opportunity is directly addressed by the Goal Category; the carat (^) indicates goals that secondarily address the issue.

WATERSHED ISSUES AND OPPORTUNITIES	GOAL CATEGORIES				
	WATER QUALITY - CLARITY	WATER QUALITY – NUTRIENTS, VEGETATION & ALGAE	WATER QUALITY – BACTERIA, POLLUTION & RECREATIONAL USE	COMMUNITY AND STAKEHOLDER EDUCATION & COMMUNICATION	ACCESS FOR MONITORING & MAINTENANCE
ISSUE/OPPORTUNITY CATEGORY: SEDIMENTATION	X	*	*	^	*
Shoreline stabilization in high-impact areas	X	X	^	^	^
Conversion to natural habitat and vegetative buffers in low-impact areas	X	^	^	^	^
Bioswales and rain gardens for filtering	X	X	X	^	^
Field borders, cover crops, and other practices on agricultural fields	X	X	^	^	*
Replace hard surfaces (i.e., roofs, pavement, compacted soil, etc.) to filter runoff	X	X	^	^	*
Streambank erosion control	X	^	*	^	*
Daylight and replace concrete or PVC drainpipes with naturalized practices	X	X	^	^	^
Maintain existing sediment basins	X	^	^	^	^
Dredging	X	^	X	^	^
External sources of sediment from Fox River in Wisconsin and other areas outside the planning area	X	*	*	^	*
ISSUE/OPPORTUNITY CATEGORY: ALGAE BLOOMS	X	X	X	^	*

WATERSHED ISSUES AND OPPORTUNITIES	GOAL CATEGORIES				
	WATER QUALITY - CLARITY	WATER QUALITY – NUTRIENTS, VEGETATION & ALGAE	WATER QUALITY – BACTERIA, POLLUTION & RECREATIONAL USE	COMMUNITY AND STAKEHOLDER EDUCATION & COMMUNICATION	ACCESS FOR MONITORING & MAINTENANCE
Stormwater runoff reductions	X	X	^	^	*
Septic and sewer system maintenance	*	X	X	^	*
Reduce agricultural runoff	X	X	X	^	*
Reduce impervious surfaces to filter water naturally	X	X	^	^	*
External nutrient loading from outside planning area	X	X	*	^	*
Enhance wetland habitat to promote filtering	X	X	X	^	*
Inform property owners on best practices	X	X	^	^	X
Reduce pesticide and salt use	*	X	X	^	*
Reduce waterfowl and pet waste from entering waterway	*	X	X	^	*
ISSUE/OPPORTUNITY CATEGORY: SHORELINE STABILIZATION	X	^	*	^	*
Shoreline stabilization with riprap in high-impact areas	X	^	^	^	^
Replace weak rooted vegetation with native vegetation along shorelines	X	X	*	^	*
Remove invasive species from shorelines to encourage native vegetation	X	X	X	^	*

WATERSHED ISSUES AND OPPORTUNITIES	GOAL CATEGORIES				
	WATER QUALITY - CLARITY	WATER QUALITY – NUTRIENTS, VEGETATION & ALGAE	WATER QUALITY – BACTERIA, POLLUTION & RECREATIONAL USE	COMMUNITY AND STAKEHOLDER EDUCATION & COMMUNICATION	ACCESS FOR MONITORING & MAINTENANCE
ISSUE/OPPORTUNITY CATEGORY: EDUCATION AND OUTREACH	^	^	^	X	^
Create watershed working group	*	*	*	X	^
Support increased and ongoing volunteer data collection and monitoring	^	^	^	X	X
Building stronger partnerships	*	*	^	X	^
Interjurisdictional support	*	*	^	X	X
Some level of municipal coordination across watershed	*	*	^	X	^
Education of homeowners/municipal officials/contractors and landscape professionals (particularly related to shoreline erosion and vegetation dumped into waterway)	*	X	^	X	^
Adoption and implementation of the Fox Chain O' Lakes watershed-based plan	X	^	^	X	^
Increase informational signage in waterway	*	*	^	X	*
Coordinate across state lines	^	^	^	X	*
Watershed plan updates needed for Manitou and Sequoit Creek	X	^	^	X	^

2.2 WATERSHED GOALS AND OBJECTIVES

The watershed planning committee generated 5 goals to address watershed stakeholder issues/concerns. Establishing these watershed goals allowed the committee to develop objectives and outcomes for each. The goals are central to the development of the watershed action plan (**Chapter 6**).

Goals and objectives reflect watershed conditions, address stakeholder priority issues, consider expected changes, and meet current and possible future funders' expectations. Measurable indicators were assigned to each goal to help measure future progress toward meeting each as the action plan is implemented. The action plan contains recommended:

- Programmatic actions that address lakes and streams, runoff management, water quality and sedimentation, education and information, monitoring, and watershed coordination and partnerships.
- Site-specific actions that recommend Best Management Practices (BMPs) for specific problem locations identified during inventories and assessments.

NOTEWORTHY: WHAT ARE GOALS VERSUS OBJECTIVES?

GOALS:

- Targets for the watershed plan.
- The desired change or outcome to achieve.
- Driven by stakeholder issues and problems identified by the watershed assessment.
- Ideally are clear, concise, and measurable.

OBJECTIVES:

- Specific, more precise steps needed to attain goals.
- Position reached or purpose achieved by an activity by a specific time.
- Objective outcomes should be measurable, attainable, relevant, and time-based.
- There may be multiple objectives to achieve a goal(s).

Chapter 6 (Plan Implementation and Evaluation) examines goals by looking at their performance and progress. The section also evaluates milestones related to measurable indicators for the watershed goals and objectives.

"Our Vision is that our water quality contributes to the Chain of Lakes being an appealing destination and that the water leaving our system does not negatively impact our neighbors both near and far."

2.2.1 WATERSHED GOAL #1

GOAL: Our water is clear enough that you can see the bottom in shallow water.

OUTCOME: *Increased water clarity is indicated by reduced turbidity and suspended solids.*

OBJECTIVES:

a) Stabilize eroding shoreline segments.

Indicator: Feet of stabilization projects implemented.

b) Reduce suspended solids pollutant loads consistent with plan recommendations.

Indicator: Number of structural BMP projects implemented.

c) Implement an aggressive lake dredging program for areas impaired by sediment.

Indicator: Cubic yards of sediment removed.

d) Maintain water clarity for aesthetics and to support balanced aquatic macrophyte and fish communities.

Indicator: Acreage of riparian area management and restoration including practices such as buffers and conversion to native prairie.

Indicator: number of waters from which Illinois EPA removes the aquatic life use impairment.

e) Practice sensible salting to minimize chlorides in runoff.

Indicator: Number of public agencies with winter maintenance responsibilities that use alternative de-icing products.

f) Align watershed planning area with local, county, and regional green infrastructure vision.

Indicator: Number of green infrastructure projects.

2.2.2 WATERSHED GOAL #2

GOAL: Our water is free of excessive nutrients, so algae growth does not turn our water green.

OUTCOME: *Eliminate harmful algae blooms from the Chain O' Lakes.*

OBJECTIVES:

a) Reduce phosphorus pollutant loads consistent with plan recommendations.

Indicator: Number of structural BMP projects implemented.

b) Slow and retain/detain stormwater runoff and flows to improve nutrient uptake.

Indicator: Number of urban retention/detention BMPs implemented.

c) Restore and manage riparian areas (including wetlands, vegetation and buffers) to enhance beneficial functions and improve lake water quality.

Indicator: Acreage of riparian area management and restoration including practices such as buffers and conversion to native prairie.

2.2.3 Watershed Goal #3

GOAL: Our water is clean enough that there are no recreational restrictions for boating, swimming and fishing.

OUTCOME: *Eliminate beach closures from the Chain O' Lakes.*

OBJECTIVES:

a) Implement an aggressive lake dredging program for heavily silted areas.

Indicator: Cubic yards of sediment removed.

b) Reduce fecal coliform pollutant loads consistent with plan recommendations.

Indicator: Number of waters from which Illinois EPA removes bacteria impairment.

c) Promote long-term maintenance of balanced, native aquatic plant communities in the Chain.

Indicator: Increase in native plant diversity.

d) Promote long-term maintenance of balanced fish communities in the Chain.

Indicator: Increase in native fish species and health.

Indicator: Number of waters from which Illinois EPA removes fish consumption impairment.

2.2.4 Watershed Goal #4

GOAL: Our community and stakeholders are knowledgeable and engaged in the preservation of our watershed.

OUTCOME: *There is an active watershed group driving education and clean up and advocating for policies and projects in the watershed.*

OBJECTIVES:

a) Support sustainability and effectiveness of local watershed groups.

Indicator: Number of people reached by watershed outreach campaign.

Indicator: Number of workshops, educational events, and meetings held.

Indicator: Number of volunteers and volunteer organizations active in the Chain.

b) Provide information and educational resources to elected officials, schools, and the general public on Chain O' Lakes water quality and possible solutions (e.g., BMPs).

Indicator: Number of entities reached by watershed outreach campaign.

Indicator: Number of workshops, educational events, and meetings held.

c) Involve private landowners in resource protection efforts.

Indicator: Number of private landowners reached.

Indicator: Number of recommended BMPs installed on private ground.

d) Reduce the impacts of potentially failing septic systems.

Indicator: Number of educational events and workshops specific to septic system maintenance.

Indicator: Number of septic systems eliminated and connected to sewer.

2.2.5 Watershed Goal #5

GOAL: Our communities have land within the watershed so activities to monitor, maintain and improve water quality can be implemented.

OUTCOME: *There is sufficient monitoring that there is an accurate picture for the Illinois EPA to determine if the watershed is impaired, and there is access and supporting land that major maintenance within the Chain can be completed on a regular basis.*

OBJECTIVES:

a) Watershed streams and lakes meet applicable water quality standards.
Indicator: Number of water bodies meeting applicable standards.

b) Develop and implement a lake and watershed monitoring program to collect, assess and report physical, chemical, and biological water quality data on a regular basis.

Indicator: Implementation and support of watershed monitoring program.

Indicator: Regular reports on water quality monitoring to community and stakeholders.

Indicator: Number of volunteers involved in monitoring program.

CHAPTER 3: WATERSHED CHARACTERISTICS ASSESSMENT

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LIST OF FIGURES

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ACRONYMS/ABBREVIATIONS USED IN CHAPTER 3

ADID – Advance Identification
BMP – Best Management Practices
CFU- Colony Forming Units
CY – Cubic Yards
CMAP – Chicago Metropolitan Agency for Planning
CWA – Clean Water Act
CWS - Community Water Supply
DEM – Digital Elevation Models
DFIRM - Digital Flood Insurance Rate Maps
DO – Dissolved Oxygen
E. coli- Escherichia coli
FLU – Future Land Use
FWA – Fox Waterway Agency
FEMA - Federal Emergency Management Agency
fasl – Feet Above Sea Level
GIS – Geological Information System
GPS – Global Positioning System
HSG – Hydrologic Soil Groups
HUC - Hydrologic Unit Code
Highly Erodible - HEL
IDNR – Illinois Department of Natural Resources
IDOT – Illinois Department of Transportation
Illinois EPA – Illinois Environmental Protection Agency
ISGS – Illinois State Geologic Survey
ISWS – Illinois State Water Survey
INSAC - Illinois Nutrient Science Advisory Committee
INAI – Illinois Natural Areas Inventory
INPC - Illinois Nature Preserves Commission
LCFPD – Lake County Forest Preserve District
LCHD – Lake County Health Department
LCWI- Lake County Wetland Inventory
LiDAR - Light Detection and Ranging
LRR- Lateral Recession Rate
LRS – Load Reduction Strategy
MCCD – McHenry County Conservation District
MGD – Millions of Gallons Per Day
MS4 - Municipal Separate Storm Sewer System
NCWS - Non-Community Water Supply
NVSS – Nonvolatile Suspended Solids
NO_{2-} - Nitrite
NO_{3-} - Nitrate
NPDES - National Pollutant Discharge Elimination System
NPS – Nonpoint Source
NRCS – Natural Resources Conservation Service
NWI- National Wetlands Inventory
PCB - Polychlorinated biphenyl
PRW- Potentially Restorable Wetlands
SCS- United States Department of Agriculture Soil Conservation Service
SEWRPC - Southeastern Wisconsin Regional Planning Commission
SFHA - Special Flood Hazard Areas
SMC – Lake County Stormwater Management Commission
STEPL - Spreadsheet Tool for the Estimation of Pollutant Load
SWPP - Stormwater Pollution Prevention Plan
TMDL – Total Maximum Daily Load
TN – Total Nitrogen
TP – Total Phosphorus
TSS - Total Suspended Solids
USDA – United States Department of Agriculture
USEPA – United States Environmental Protection Agency
USFWS- U.S. Fish and Wildlife Service
USGS – United States Geological Survey
VLMP – Volunteer Lake Monitoring Program
VSS – Volatile Suspended Solids
WDO – Lake County Watershed Development Ordinance
WRAPP- Lake County Wetland Restoration and Preservation Plan
WRTDS - Weighted Regression on Time Discharge and Season
WWTP- Wastewater Treatment Plant

3 WATERSHED CHARACTERISTICS ASSESSMENT

3.1 WATERSHED LOCATION AND BOUNDARIES

The focus of this report and plan is the Chain O' Lakes watershed within Lake County and northeastern McHenry County in Illinois. The Chain O' Lakes lies within the larger Fox River drainage basin (Figure 3-1). All report elements focus only on this planning area within Illinois, hereinafter referred to as the "Chain" or the "planning area.". The planning area is approximately 51 mi^2 (32,922 acres). About 41 mi^2 (26,438 acres) are in Lake County and 10 mi^2 (6,484 acres) are in McHenry County, Illinois.

3.1.1 Watershed Size

The Fox River Watershed, measured in its entirety from where it enters the Illinois River is 2,658 mi^2. At the outlet of the Chain O' Lakes near Johnsburg, which is the downstream extent of the planning area, the watershed is 1,200 mi^2. The planning area encompasses only 51.4 mi^{2}of this.

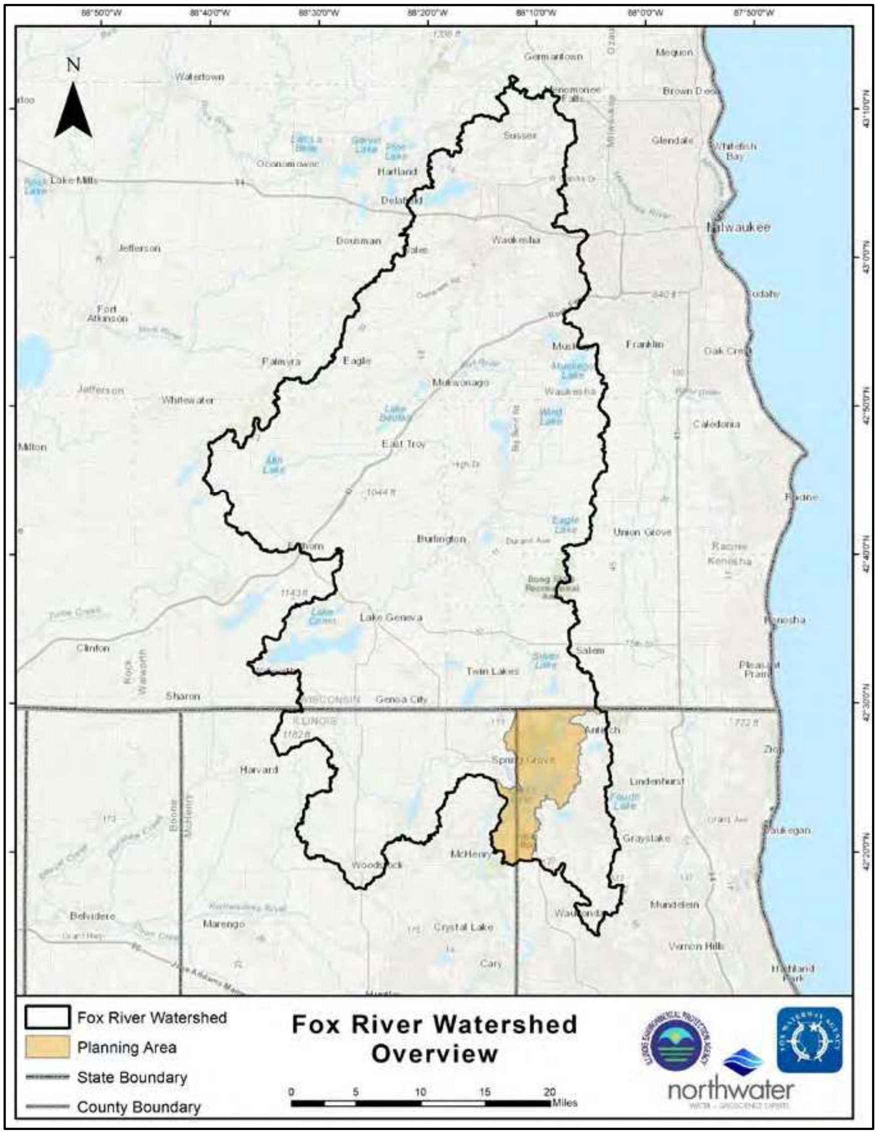

Figure 3-1: Fox River Watershed and Planning Area

3.1.2 Watershed Location

The Chain O' Lakes planning area generally drains from north to south from the Illinois state line south to the Village of Johnsburg in McHenry County and includes 4 subwatersheds in northwestern Lake County and northeastern McHenry County. It extends southward to the end of the drainage near Illinois Route 120 in Lakemoor.

3.1.3 Watershed Boundaries

The boundaries of the Chain area are primarily defined by topographic features formed by the retreat of the continental ice sheet during the Wisconsin glaciation and subsequent geologic processes. Constructed physical features, as well as political boundaries, also affect its delineation. The Chain represents a portion of the larger Fox River watershed that originates in Waukesha County, Wisconsin, and continues beyond the planning area to the Illinois River at Ottawa, Illinois. However, because the remainder of the Fox River basin, as well as other major tributaries such as Nippersink Creek and Sequoit Creek are located outside, they are not discussed in detail.

The subwatershed boundaries used in this report are similar to established hydrologic boundaries. They have been modified in the northern portion along the Illinois/Wisconsin state line. This modification is the result of the jurisdictional extent of the Fox Waterway Agency (FWA) that does not extend into Wisconsin.

There are four subwatersheds in the planning area that have been used as the basis for previous studies and local project work. From north to south, they are Channel Lake, Bassett Creek – Fox River, Nippersink Lake – Fox River, and Pistakee Lake – Fox River. Stream and lake networks have been aggregated into these 4 subwatersheds and, therefore, will continue to be used for general discussion. Figure 3-2 depicts the planning area landscape features and subwatershed boundaries.

The United States Geological Survey (USGS) has developed a coding system for hydrologic systems that is used throughout the United States by numerous federal, state, and local agencies and organizations. Each watershed unit is assigned a **Hydrologic Unit Code (HUC)** with the number of digits in each code relating to watershed size and its relationship to larger watersheds to which it belongs (if any). Table 3-1 includes the applicable HUCs for the planning area.

Noteworthy: Hydrologic unit code (HUC)

A hydrologic unit can accept surface water directly from upstream drainage areas, and indirectly from associated surface areas such as remnant, noncontributing, and diversions to form a drainage area with single or multiple outlet points. Hydrologic units are only synonymous with classic watersheds when their boundaries include all the source area contributing surface water to a single defined outlet point. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to twelve digits based on the six levels of classification:

- 2-digit HUC first-level (region)
- 4-digit HUC second-level (subregion)
- 6-digit HUC third-level (accounting unit)
- 8-digit HUC fourth-level (cataloguing unit)
- 10-digit HUC fifth-level (watershed)
- 12-digit HUC sixth-level (subwatershed)

Table 3-1: Hydrologic Units and HUC Designations for the Planning Area

HUC	HUC NAME	HUC LEVEL (NUMBER OF DIGITS)
07	Upper Mississippi River	HUC 2
0712	Upper Illinois	HUC 4
07120006	Upper Fox	HUC 8
0712000610	Squaw Creek – Fox River	HUC 10
071200061005	Channel Lake	HUC 12
071200061006	Basset Creek – Fox River	HUC 12
071200061009	Nippersink Lake – Fox River	HUC 12
071200061010	Pistakee Lake – Fox River	HUC 12

3.1.4 SUBWATERSHEDS

Table 3-2 and Figure 3-2 display the major **subwatersheds** in the planning area. There are 4 ranging in size from approximately 5 mi^2 (Channel Lake) to 25 mi^2 (Nippersink Lake) with an average of 13 mi^2. The Channel Lake and Bassett Creek subwatersheds are not entirely within, as they extend north into Wisconsin, and the planning area terminates at the state line.

SUBWATERSHED: The area within a larger watershed that drains to a single point, such as a tributary stream or lake. Large watersheds are comprised of smaller subwatersheds.

Table 3-2: Planning Area Subwatersheds

SUBWATERSHEDS	SQUARE MILES	ACRES	% OF PLANNING AREA
Bassett Creek	6.7	4,324	13.1%
Channel Lake	4.5	2,886	8.8%
Nippersink Lake	24.8	15,879	48%
Pistakee Lake	15.4	9,833	30%
TOTAL:	**51**	**32,922**	**100%**
TOTAL FOX RIVER WATERSHED AT CHAIN O' LAKES / PLANNING AREA OUTLET	**1,200**	**768,000**	**-**

Area in the Nippersink Lake Subwatershed

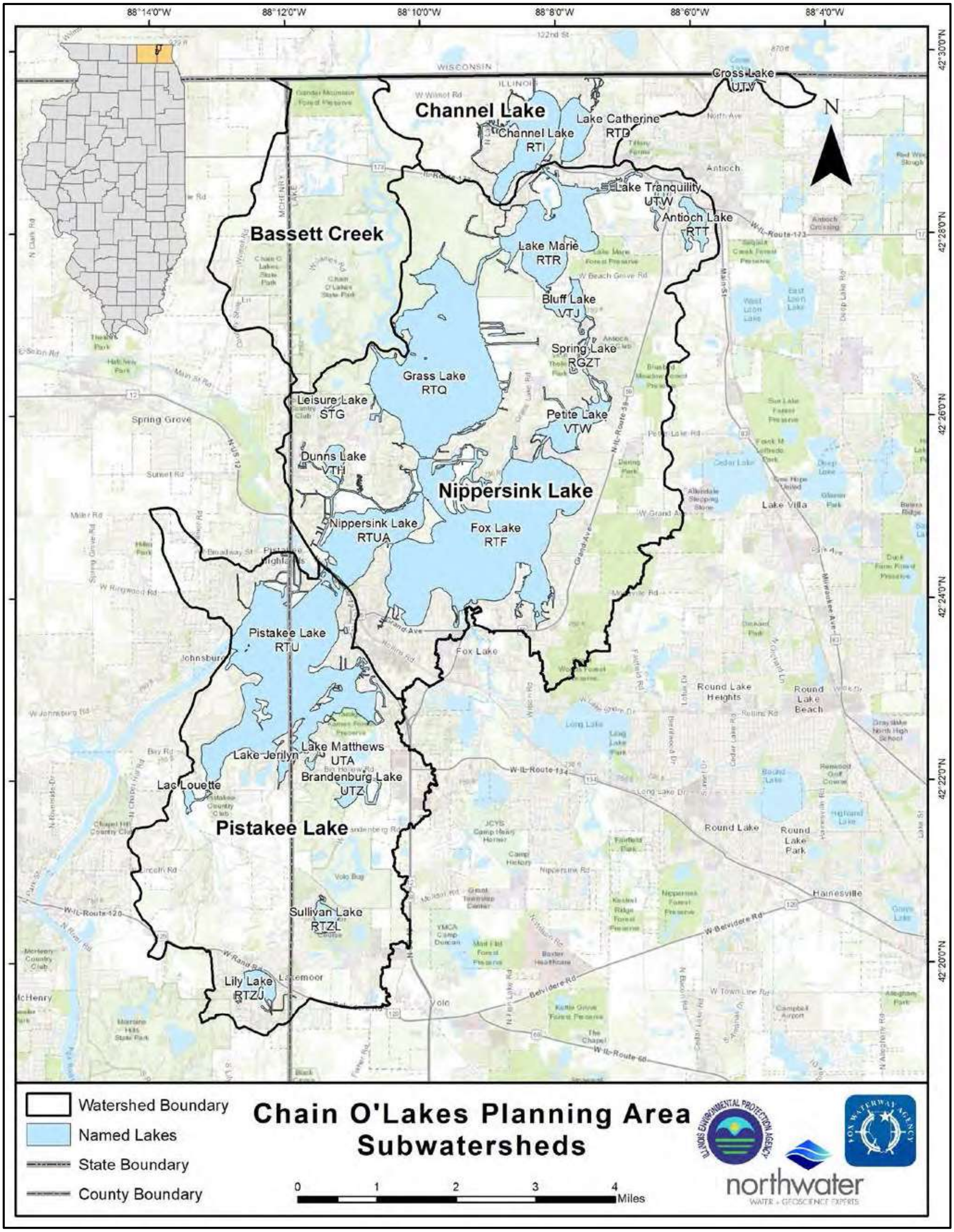

Figure 3-2: Subwatershed Map

3.2 WATERSHED HYDROLOGY

Hydrology is the study of the occurrence, circulation, distribution, and properties (e.g., quality) of water. Earth's water is constantly being cycled between oceans, the atmosphere, and land through different pathways at different rates. The movement of the earth's water through these various pathways is called the **hydrologic cycle**. Although inherently complex, one can gain a general understanding of how it works by envisioning the following process. Clouds form over the ocean due to the evaporation of water. Wind carries the clouds ashore where they produce rain. Excess rainfall (i.e., stormwater runoff) flows into lakes, rivers, wetlands, and groundwater. Over time, water stored in the lakes, rivers, and wetlands, either evaporates back into the atmosphere or flows back into the ocean, beginning the cycle anew.

Primarily, hydrology involves studying the flow of water through the various pathways that can be found within a geographical area. These pathways connect every component of the landscape and can generally be divided into surface and groundwater hydrology. Surface water includes all hydrologic pathways at or above the earth's surface, including precipitation, evapotranspiration and surface water flow. Groundwater includes all hydrologic pathways below the surface including infiltration, interflow, and groundwater flow. When applied to a watershed, hydrology typically involves studying the flow of water between the surface pathways that connect the air, land, lakes, rivers, and wetlands found within a watershed.

Hydrology and hydraulics are terms used to describe the effects of precipitation, including infiltration, runoff, and evaporation on land surfaces that drain to streams and lakes. Hydrologic studies of watersheds typically determine how topography and human modifications affect water volumes in watersheds, subwatersheds and smaller catchments. Hydraulics is the branch of science that deals with practical application of liquid in motion.

NOTEWORTHY: HYDROLOGIC CYCLE

The hydrologic cycle describes the continuous movement of water on, above, and below the surface of the earth. The total mass of water on earth remains relatively constant over time, but the amount of water in each of its three primary states, solid (ice), liquid (water), and gas (water vapor), is variable depending on a wide range of climate-related variables. Water moves from one state to another through various hydrologic pathways, such as evaporation, transpiration, condensation, precipitation, infiltration, surface water flow, and interflow (shallow groundwater flow). As water moves between states, energy is exchanged, which affects temperatures on the surface of the earth. For example, when water evaporates, energy is absorbed, and the surface of the earth is cooled through the process of evaporative cooling. When water condenses, energy is released, and the surface of the earth is warmed. These energy exchanges occur on a global scale, are powered by solar energy and have a significant influence on the earth's climate, as does water in its three primary states. For example, water vapor absorbs and emits energy back toward the surface of the earth; however, when water vapor forms into clouds, it reflects a significant amount of solar radiation back into space. Water and the hydrologic cycle are responsible for earth's mild climate and makes life possible on earth.

The defining feature of the Chain planning area is a group of interconnected glacial and human-modified lakes with the Fox River as the primary inflow from the north and outflow to the south. While most of the lakes are natural in origin, water has been artificially regulated for the purposes of improving navigation since the construction of a wooden dam in 1907 at McHenry, Illinois. Today, the modern Stratton Lock and Dam is operated by the State of Illinois Department of Natural Resources (IDNR). While the planning area is only 51 mi^2, the entire watershed at the outlet of the Chain O' Lakes (the outlet of the planning area) is 1,200 mi^2 and includes a large portion of the Fox River in Wisconsin, as well as smaller direct tributaries to the lakes such as Sequiot Creek, Manitou Creek and Nippersink Creek. Many issues identified in this plan that are manifest in the planning area are related to the cumulative impact of the entire Upper Fox River basin.

3.2.1 Major Lakes in the Planning Area

There are 13 major interconnected lakes in the planning area plus numerous others encompassed by or disconnected from the Chain. Two lakes commonly referred to as being part of the Chain O' Lakes, Duck Lake and Long Lake, fall outside the planning area. All major lakes, plus several others are referenced in this report and include Bluff Lake, Lake Catherine, Channel Lake, Dunns Lake, Fox Lake, Grass Lake, Lake Marie, Nippersink Lake, Petite Lake, Pistakee Lake, Redhead Lake, Spring Lake, Lake Matthews, Brandenburg Lake, Lake Jerilyn, and Lac Louette. Each but Lac Louette and Lake Jerilyn have been assigned an Illinois EPA assessment code or ID which are referenced in this section and others. A detailed analysis of water quality in most of the major lakes is provided in Section 3.3.5.

While water flows generally from north to south through the Chain, fed largely by the Fox River and smaller tributaries, there is a complex pattern of inter-lake circulation that varies with inflows and outflows. In a foundational study, the Illinois State Water Survey (ISWS) and Illinois State Geological Survey (ISGS) (Kothandaraman, et al., 1977) undertook comprehensive examination of these flow conditions and detailed them in a 1977 cooperative report. The summary of water movement, residence time, or the average period that water spends in a particular waterbody, and depths are adapted from this report and generalized. The authors noted the erratic nature of flows within the system made estimates of residency time difficult. Overall, the study calculated a residency time of around 11 to 29 days during average flow conditions, and significantly longer, up to 229 days, during very low inflow periods.

3.2.1.1 Bluff Lake

Bluff Lake (Assessment ID – VTJ) is a glacially formed lake with a surface area of 100 acres, and a maximum depth of 28 ft (Figure 3-3). The average depth is 10.5 ft, and there are 3 miles of shoreline. Estimated residency time is approximately 4.5 days. During periods of average flow to the Chain from the Fox River and other tributaries, water flows north from Lake Marie into Bluff Lake and then south on to Petite Lake.

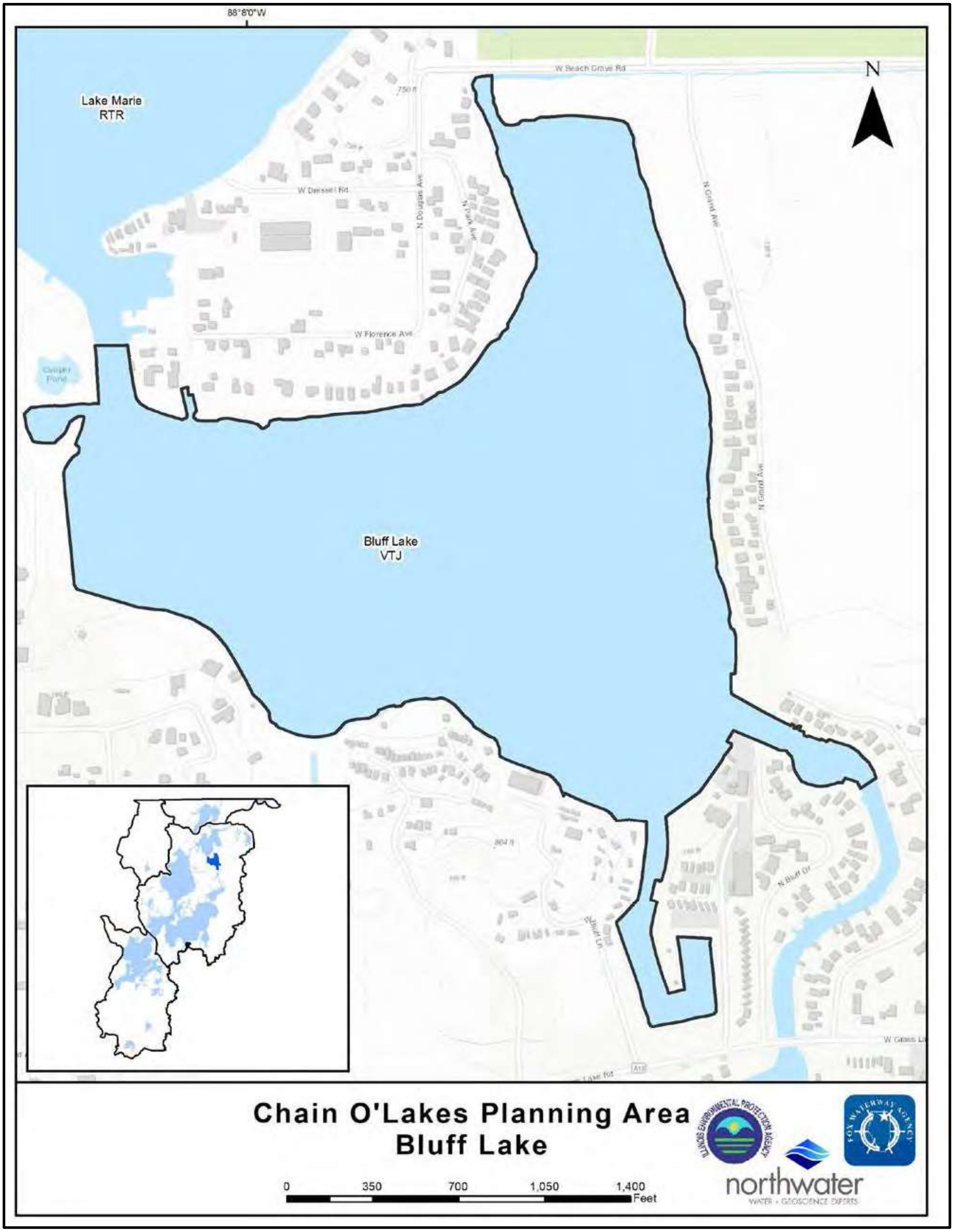

Figure 3-3: Bluff Lake

3.2.1.2 Lake Catherine

Lake Catherine (Assessment ID - RTD) is a glacially formed lake 165 acres in size, with a maximum depth of 39 ft and average depth of 16.7 ft. The lake does stratify seasonally. The shoreline length is approximately 2 miles, and it is hydraulically connected to Channel Lake (Figure 3-4) though a now-eroded gravel bar that separated them in the past. The watershed area of Lake Catherine and Channel Lake is about 17 mi^2, the majority of which is outside the planning area, in Wisconsin. Trevor Creek is the primary named stream feeding Lake Catherine.

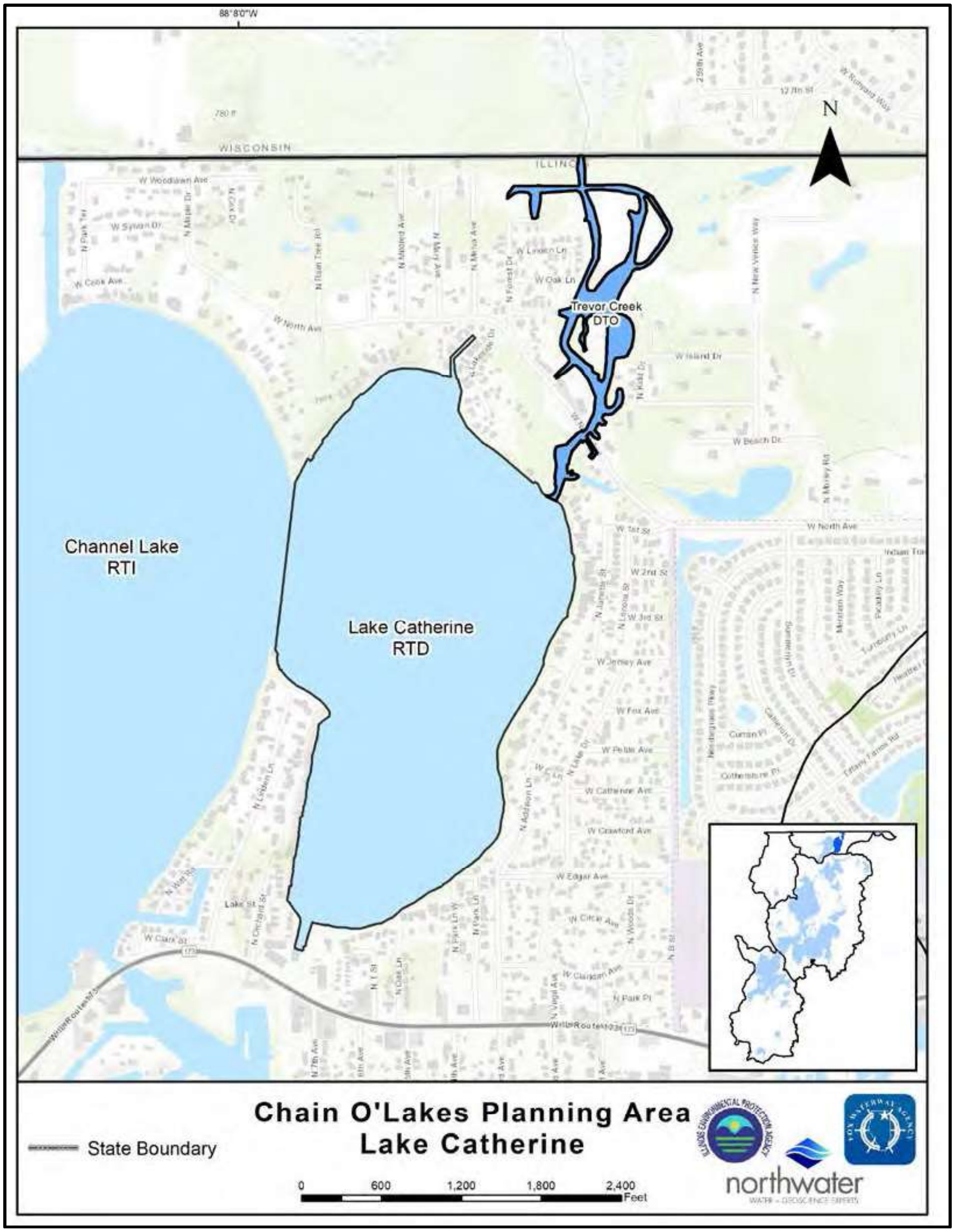

Figure 3-4: Lake Catherine

3.2.1.3 Channel Lake

Channel Lake (Assessment ID - RTI) is glacially formed, approximately 371 acres in size (Figure 3-5) with a maximum depth of 36 ft and 9.6 miles of shoreline. Lake Catherine and Channel Lake are highly connected. The two lakes have a sizeable watershed of approximately 17 mi^2, with approximately 75% of it in Wisconsin and, thus, outside the Chain planning area. The two streams that convey water to Lake Catherine and Channel Lake are Trevor Creek and an unnamed tributary. In addition to flows from the watershed, there are inter-lake circulations between Lake Marie and Channel Lake which appear to be largely wind driven and erratic. At times, the wind was found to push sizable flows northwest from Lake Marie. When the wind subsides, flows reverse. The authors of the 1977 report note that while the water velocity was low, these flows carry fine sediments and may be an important source of sedimentation. Residence time was estimated to be around 28 days.

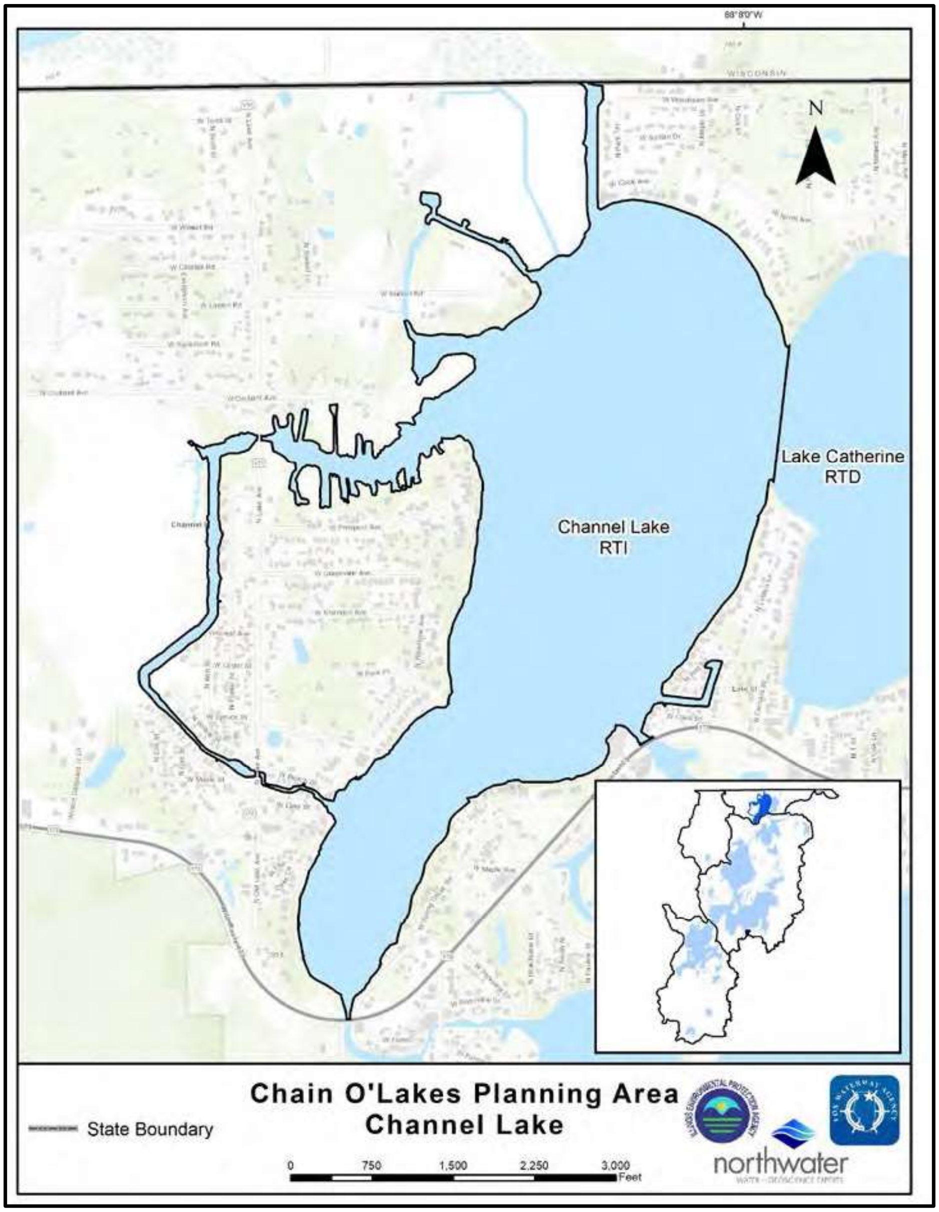

Figure 3-5: Channel Lake

3.2.1.4 Dunns Lake

Dunns Lake (Assessment ID - VTH) is a glacial lake with an approximate surface area of 68 acres, 4 miles of shoreline, an average water depth of 3.8 ft and a maximum depth of 7.5 ft (Figure 3-6). Due to its shallow depth, Dunns does not undergo seasonal stratification. It is connected by a channel to Nippersink Lake and is in the Nippersink Lake subwatershed. Dunns receives runoff from surrounding land and has a watershed area of approximately 450 acres. There is no data available for residence time. It is assumed that water generally flows from Dunns through the channel to Nippersink Lake.

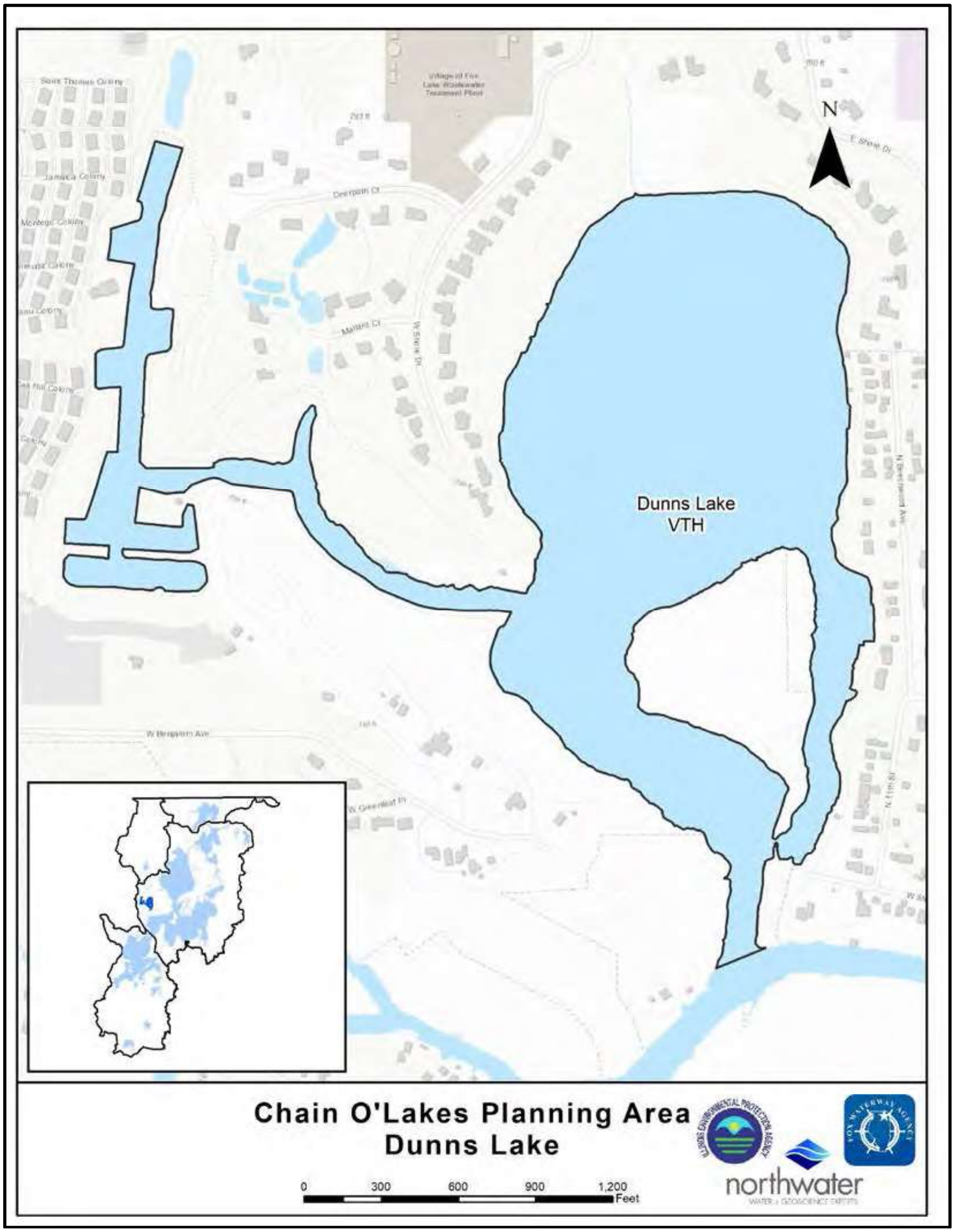

Figure 3-6: Dunns Lake

3.2.1.5 Fox Lake

Fox Lake (Assessment ID – RTF) is a glacial lake with a surface area of 1,881 acres, an average depth of 5.6 ft and a maximum depth of 12 ft (Figure 3-7). Due to this shallow depth, it does not thermally stratify. The lake has 23 miles of shoreline. Prevailing water movement is from north to south, receiving generally high flow from Grass Lake and a smaller volume from Petite Lake. There are, however, complex intra-lake currents, driven mostly by wind. Water moves south, downstream to Nippersink Lake. Reasonable residence time estimates are unavailable. The lake receives water not only from inter-lake flows, but from its watershed, much of which is outside the planning area. For instance, Manitou Creek (formerly known as Squaw Creek) enters Fox Lake and has a watershed area of approximately 48 mi^2, none of which is in the planning area.

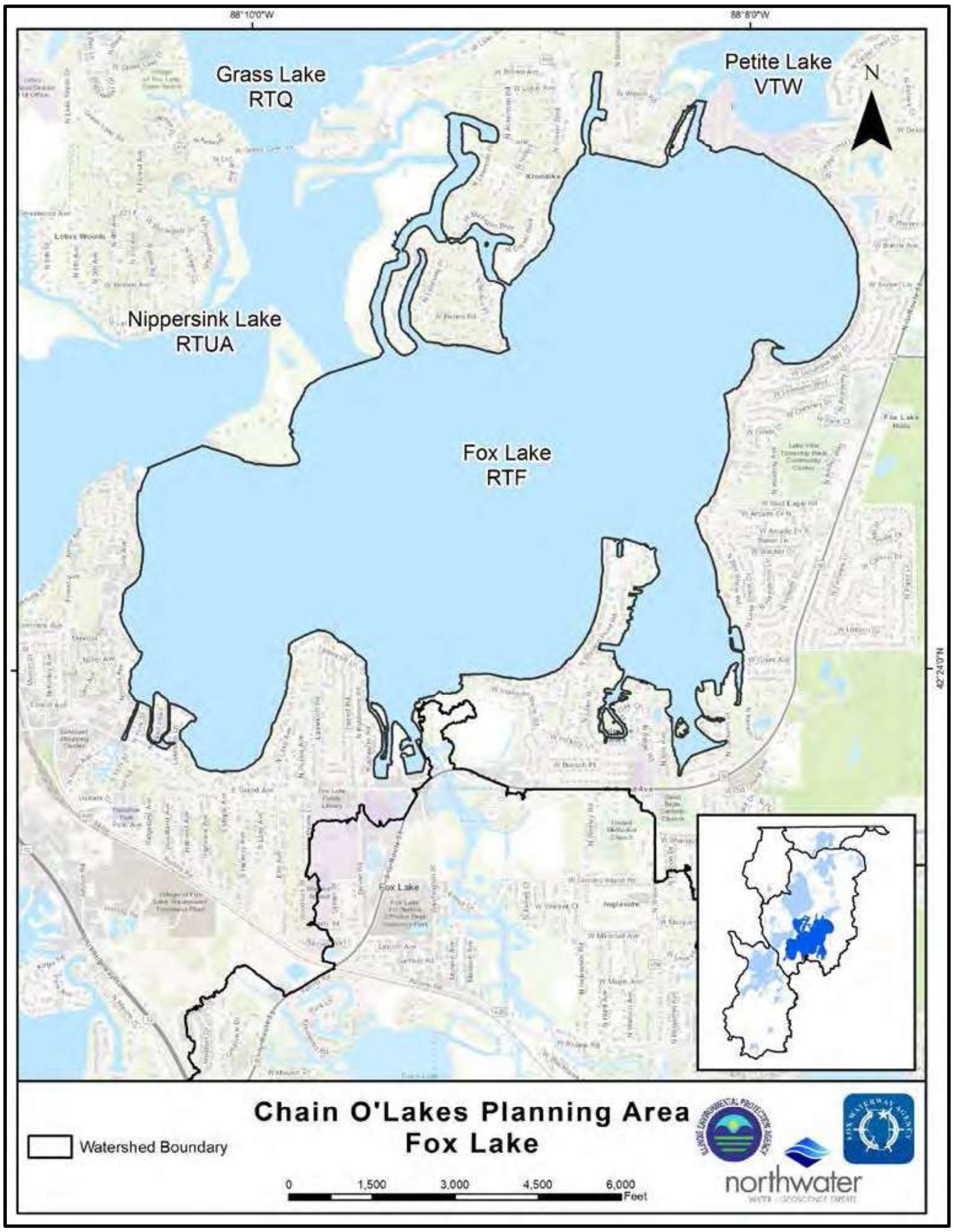

Figure 3-7: Fox Lake

3.2.1.6 Grass Lake

Grass lake (Assessment ID – RTQ) is a shallow glacial lake of 1,623 acres, an average depth of 2.3 ft and a maximum depth of 6 ft. The shoreline length is approximately 21 miles (Figure 3-8). The lake does not thermally stratify. Grass Lake receives its water primarily from the Fox River's roughly 614,000-acre watershed. Approximately 4,300 of those acres are in the planning area. The water then flows from Grass Lake south to Nippersink Lake, though some is north to Lake Marie. Estimated water retention time is short, at around 4 days.

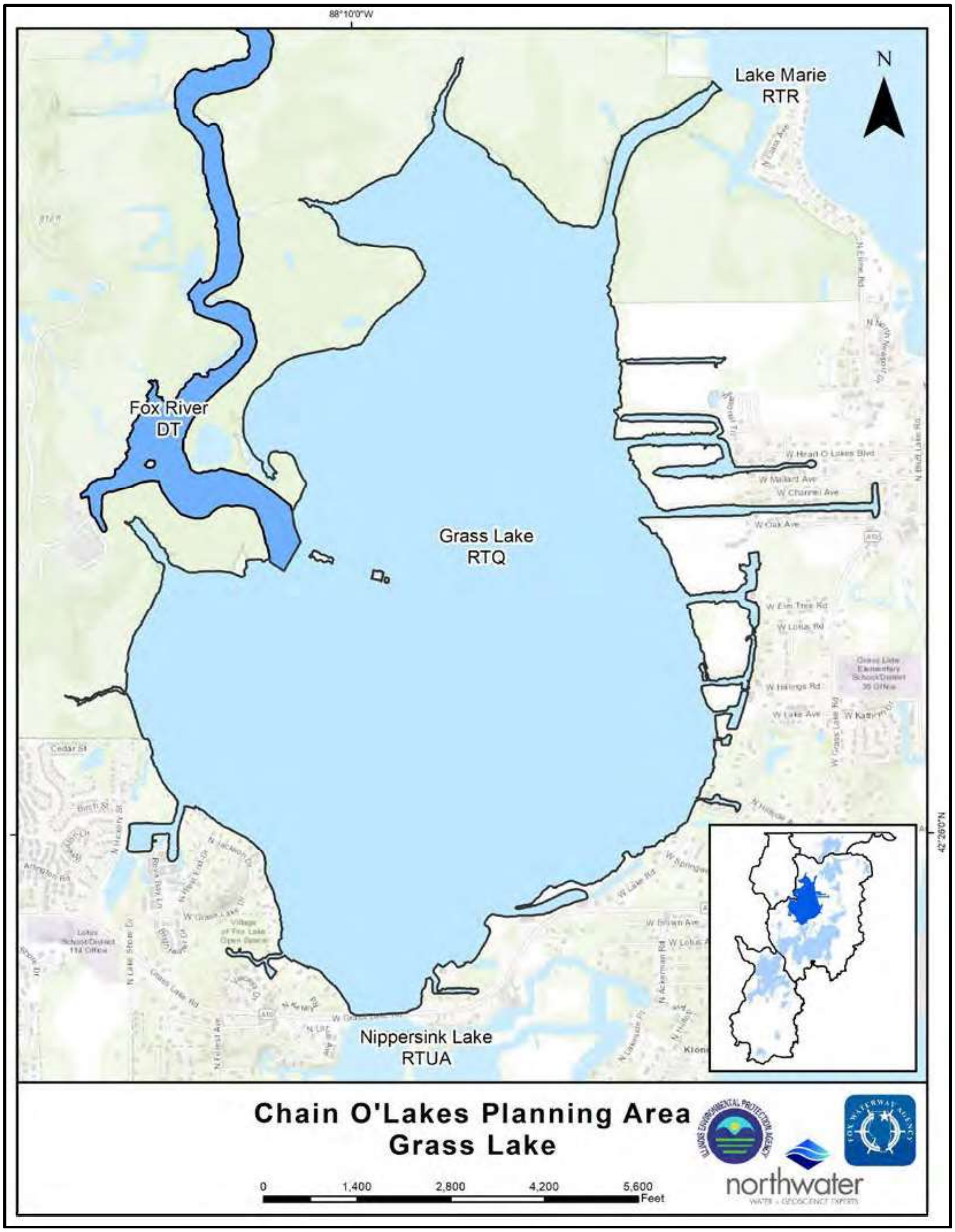

Figure 3-8: Grass Lake

3.2.1.7 Lake Marie

Lake Marie (Assessment ID – RTR) is a glacially formed lake with a surface area of 596 acres, a maximum depth of 30 ft and an average depth of 16.7 ft (Figure 3-9). The lake undergoes thermal stratification seasonally and has 15 miles of shoreline. During normal conditions, the prevailing flow is from Grass Lake, and then out to Bluff Lake. Circulation exchanges water with Channel and Lake Catherine but is largely dependent on wind conditions. The estimated residence time is around 21 days. Additional flow to Lake Marie is from Sequoit Creek, a 14.8 mi^2 watershed that is outside the planning area.

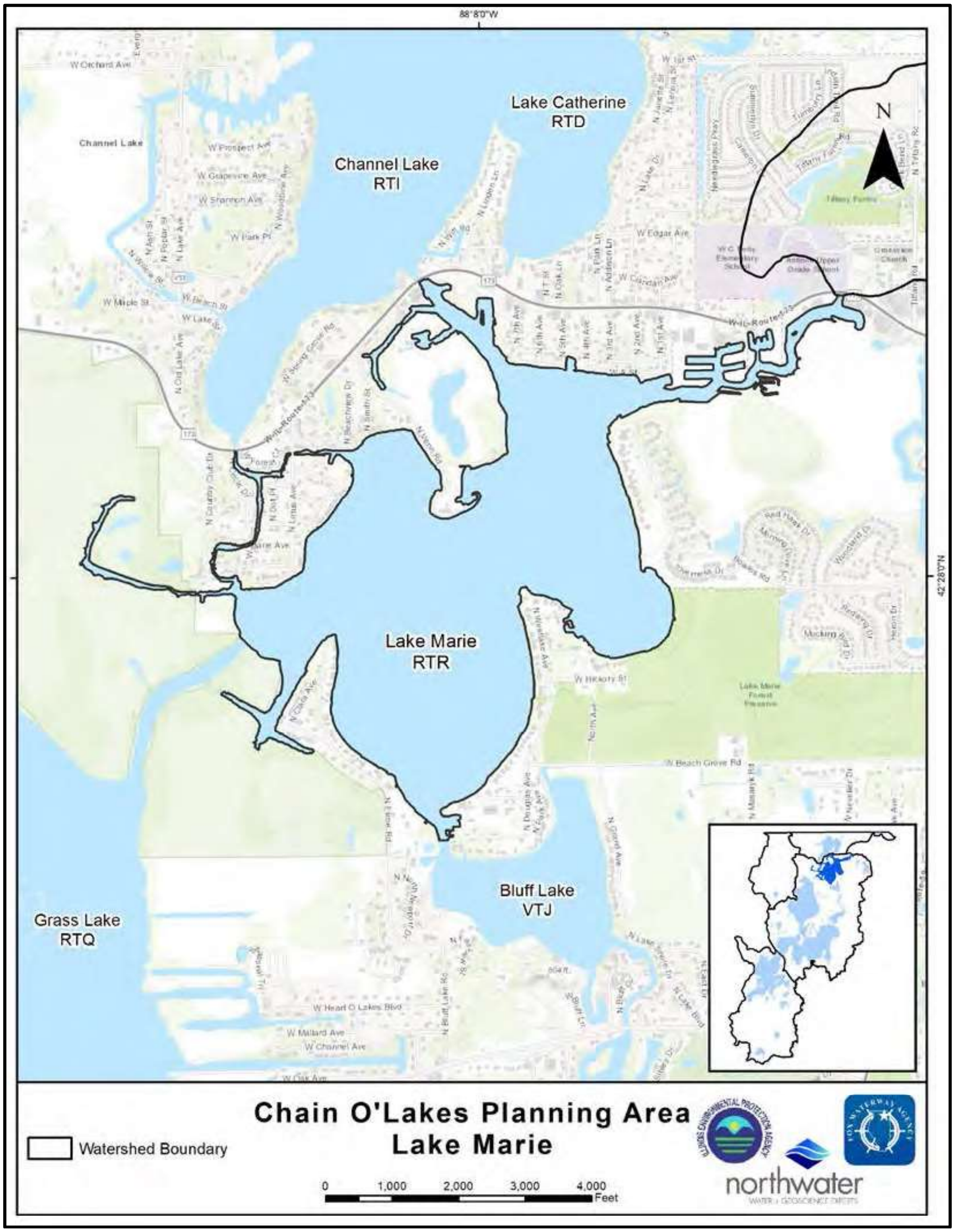

Figure 3-9: Lake Marie

3.2.1.8 Nippersink Lake

Nippersink Lake (Assessment ID - RTUA) is a glacial lake with a surface area of 718 acres, a maximum depth of 5 ft, and an average depth of 2.5 ft (Figure 3-10). Due to the shallow water, it does not undergo seasonal thermal stratification. The length of shoreline is 18.5 miles. Prevailing downstream flow conditions from north to south means Nippersink receives water from Grass and Fox Lakes with some exchange with Dunns depending mostly on wind and water levels. During periods of low flow from the Fox River, water circulates in a less predictable fashion and may even flow in an upstream direction at times. Estimated water residence time is short at just 1.5 days. In addition to upstream lake flows, Nippersink receives local runoff from its watershed, but does not have additional large tributaries contributing from outside the planning area.

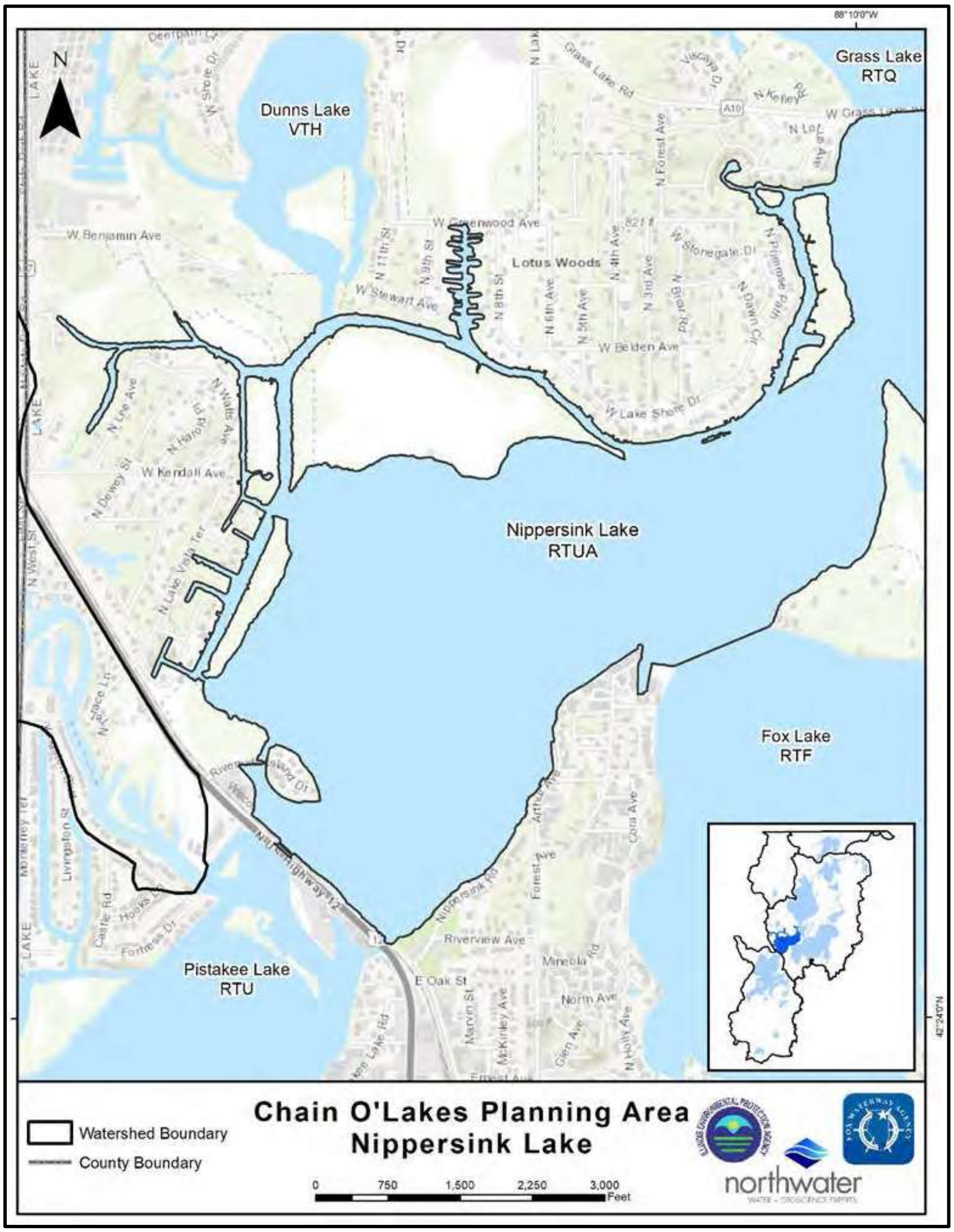

Figure 3-10: Nippersink Lake

3.2.1.9 Petite Lake

Petite Lake (Assessment ID – VTW) is 195 acres in size with a maximum depth of 19 ft and an average depth of 5.2 ft (Figure 3-11). The lake undergoes seasonal thermal stratification and has a shoreline of 7.3 miles. There is a general north to south flow from Bluff Lake, through Spring Lake to Petite. This flow then continues south to Fox Lake though, at times, wind conditions may reverse this. Estimated hydraulic residence time in Petite is about 6.4 days. It does not have significant inflows from large tributary watersheds outside of the planning area.

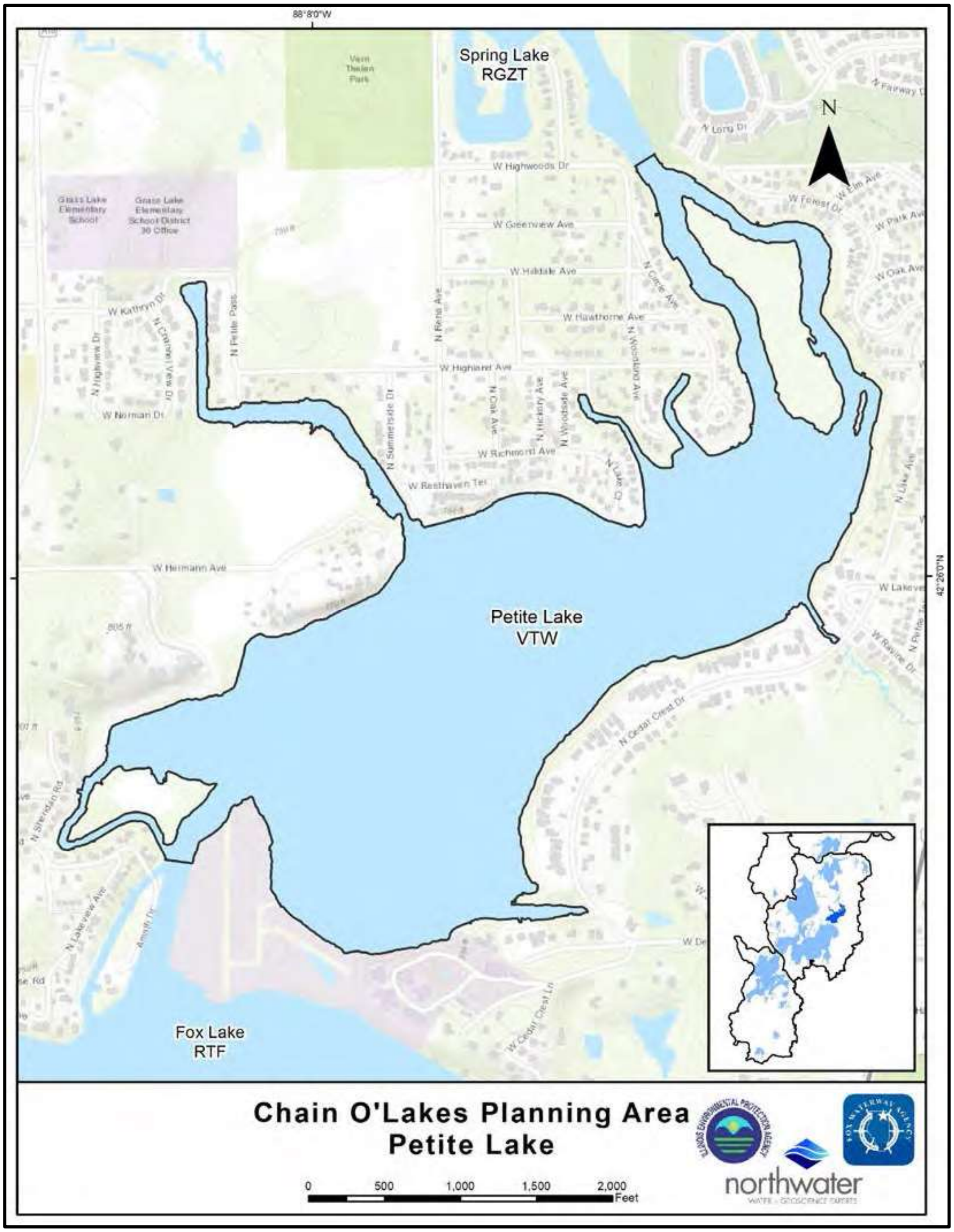

Figure 3-11: Petite Lake

3.2.1.10 Pistakee Lake

Pistakee Lake (Assessment ID – RTU) is a glacial lake, and the furthest downstream in the Chain. Water from Pistakee flows out and continues down the Fox River. The lake is approximately 1,730 acres, with a maximum depth of 30 ft and an average depth of 5.2 ft (Figure 3-12). Thermal stratification does occur seasonally. The shoreline length of Pistakee Lake is 30 miles. The lake receives flow primarily from Nippersink Lake to the north, with additional flow from Redhead Lake and Lac Louette and their respective watersheds. Pistakee also receives water from Nippersink Creek and its sizable watershed of 208 mi^2, all of which is outside the planning area. Estimated residence time of water in the northwest part of the lake is around 3.7 days, though the average for the entire lake was estimated to be about 10 days.

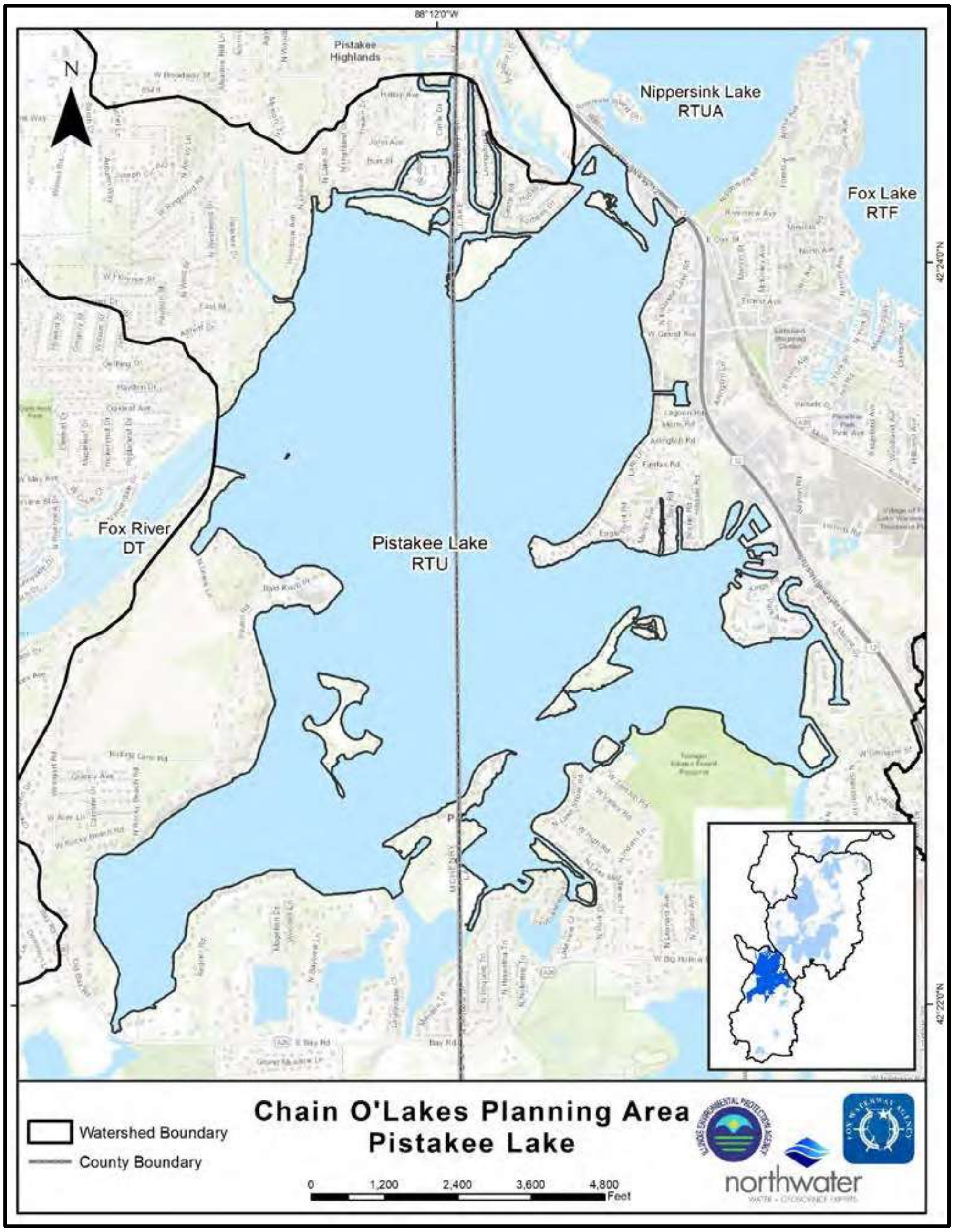

Figure 3-12: Pistakee Lake

3.2.1.11 Redhead Lake

Redhead Lake (Assessment ID – RTV) is small and glacially formed. Its surface area is 51 acres and has a shoreline length of 2.1 miles (Figure 3-13). The lake is quite shallow with a maximum depth of 4.5 ft and an average depth of 1.8 ft. Redhead flows to Pistakee Lake and receives water from its watershed, all of which is within the planning area. There are no estimates available of residence time.

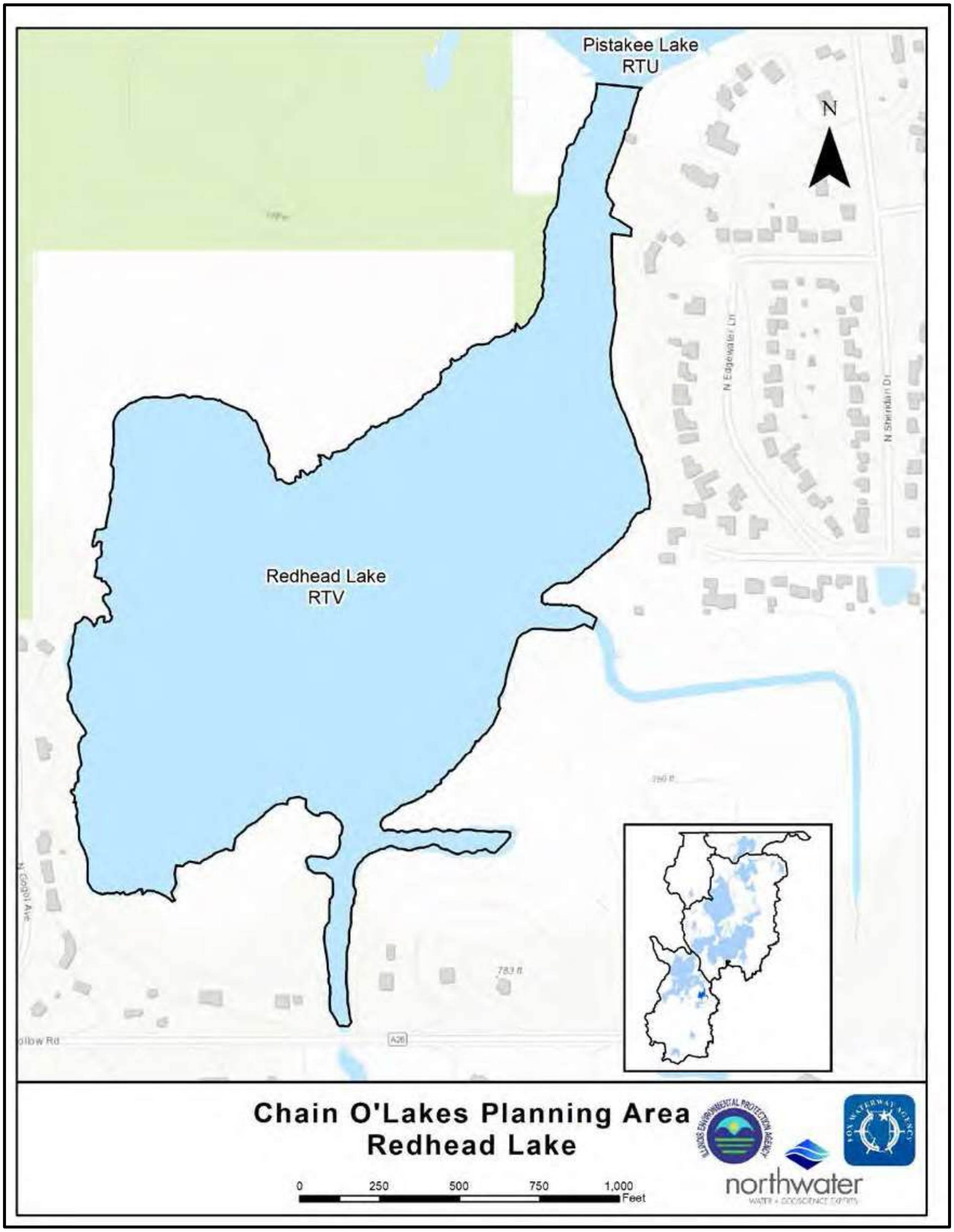

Figure 3-13: Redhead Lake

3.2.1.12 Spring Lake - (Illinois EPA Assessment ID RGZT)

Spring Lake (Assessment ID – RGZT) is a small lake of 43 acres, with a maximum depth of 10 ft (Figure 3-14). There are 4.6 miles of shoreline. Flow is predominantly from north to south, receiving water from Bluff Lake, and providing water to Petite Lake to the south. There is no estimate of water residence time available. Spring Lake has a small watershed that receives local runoff.

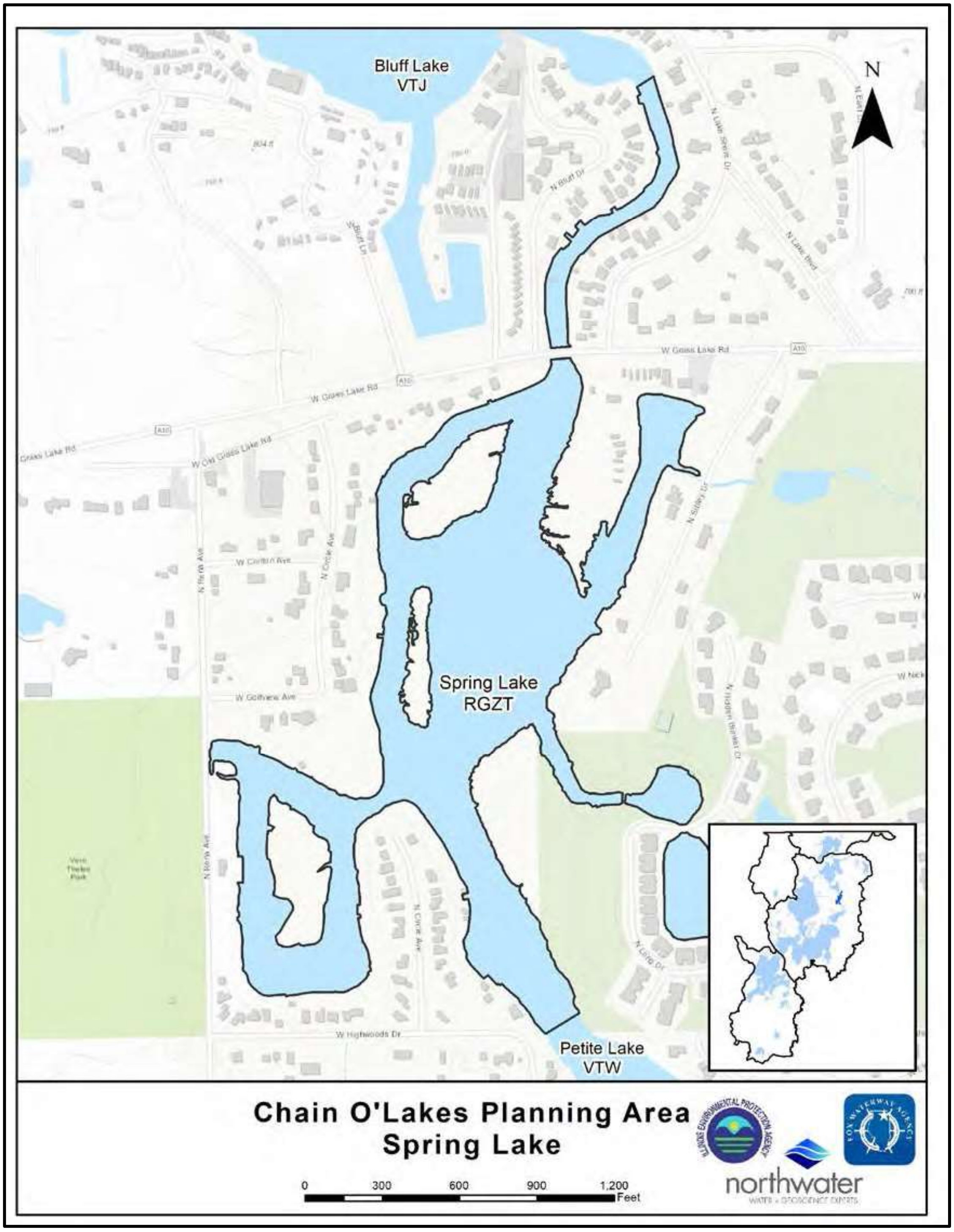

Figure 3-14: Spring Lake

3.2.1.13 Lake Matthews, Lac Louette and Lake Jerilyn

Lake Matthews (Assessment ID – UTA), Lac Louette (also called Mud Lake), and Lake Jerilyn make up the remaining major lakes in the Chain planning area (Figure 3-15). Very little information is available on Lac Louette and Lake Jerilyn which is commonly associated with Pistakee Lake. Lake Matthews was constructed by dredging in 1922 and is only 9 acres in size. It has a maximum water depth of 5 ft and an average of 2.5 ft. It has just 0.7 miles of shoreline and receives some direct runoff from its small watershed. Lake Jerilyn is 25 acres in size and has 1.4 miles of shoreline. Lac Louette has a surface area of 23 acres and 1.6 miles of shoreline.

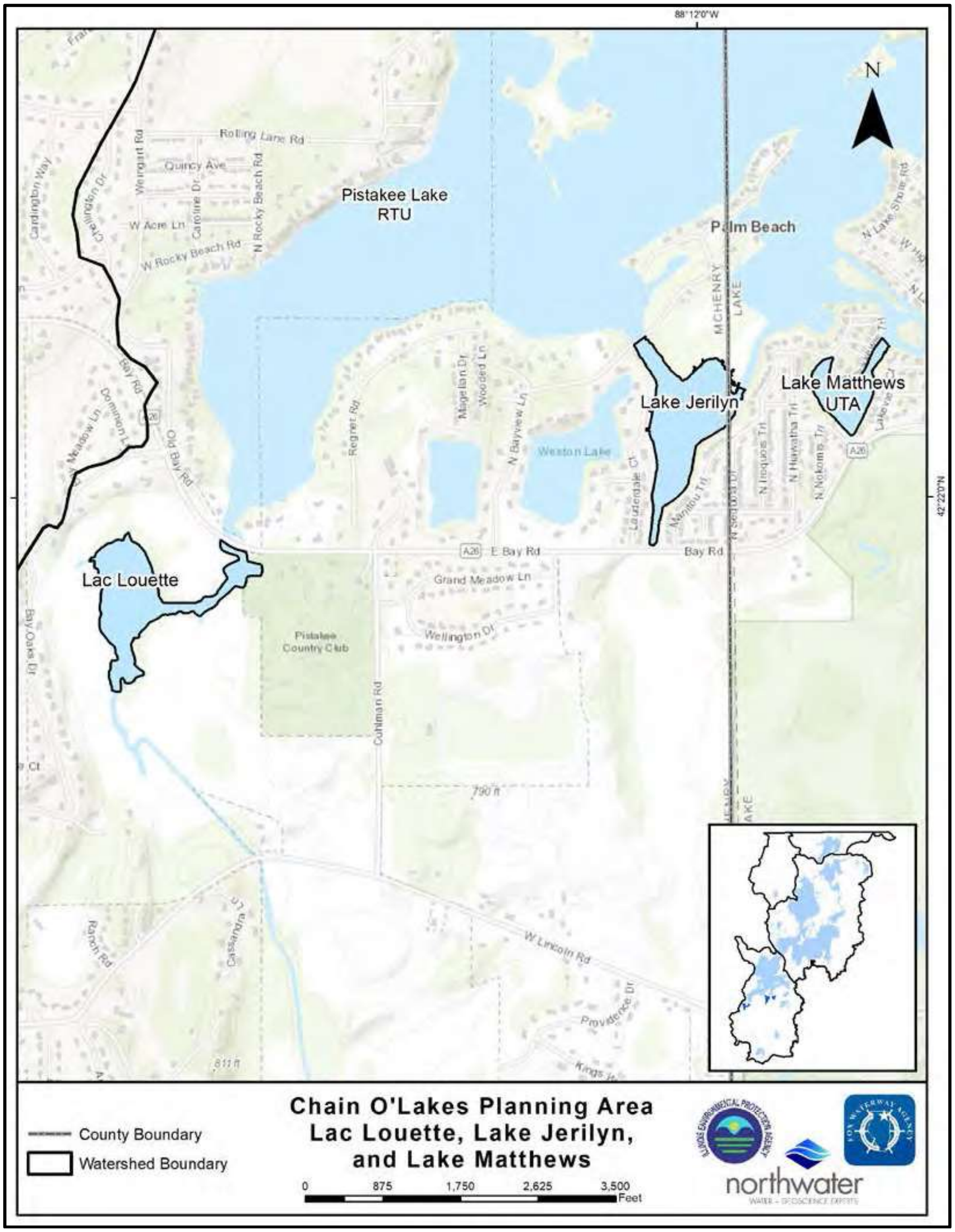

Figure 3-15: Lake Matthews, Lac Louette and Lake Jerilyn

3.2.2 Streams in the Planning Area

Due to limitations with the accuracy of the National Hydrography Dataset (NHD), the wetted extent of streams was digitized using aerial imagery, Digital Elevation Models (DEMs), and verified through field surveys. The NHD is a publicly available map layer representing the water drainage network of the United States. The planning area stream network is comprised of 17.7 miles across its four subwatersheds (Figure 3-16). The network consists of major named and unnamed streams that generally flow year-round. Intermittent channels, or ditches, are referred to as "gullies" and are described in Section 3.4.2. Stream extent is listed in Table 3-3. Streams in each subwatershed are summarized below:

1. **Bassett Creek – Fox River Subwatershed:** contains 39,170 ft or 7.4 miles of open water streams. This is made up of primarily the Fox River from the Illinois/Wisconsin State line to Grass Lake. The Fox is 5.7 miles in length. All remaining streams are unnamed tributaries and cover an additional 1.7 miles or 9,125 ft.
2. **Channel Lake Subwatershed:** has 12,513 ft of stream or 2.4 miles. The only named stream is Trevor Creek at 1.4 miles (7,242 ft) and another 5,270 ft of unnamed tributaries or 1 mile.
3. **Nippersink Lake – Fox River Subwatershed:** no named streams exist in this subwatershed. There are 3.6 miles or 19,228 feet of unnamed tributaries.
4. **Pistakee Lake – Fox River Subwatershed:** contains 22,407 ft or 4.3 miles of stream. This includes Lily Lake Drain that is 2.2 miles in length or 11,423 ft. Unnamed tributaries make up another 10,984 ft or 2.1 miles.

Table 3-3: Stream Length by Subwatershed

SUBWATERSHED	12-DIGIT HUC(s)	STREAM LENGTH (FT)	STREAM LENGTH (MI)
Bassett Creek - Fox River	071200061006	39,170	7.4
Channel Lake	071200061005	12,513	2.4
Nippersink Lake - Fox River	071200061009	19,228	3.6
Pistakee Lake - Fox River	071200061010	22,407	4.3
	TOTAL:	93,318	17.7

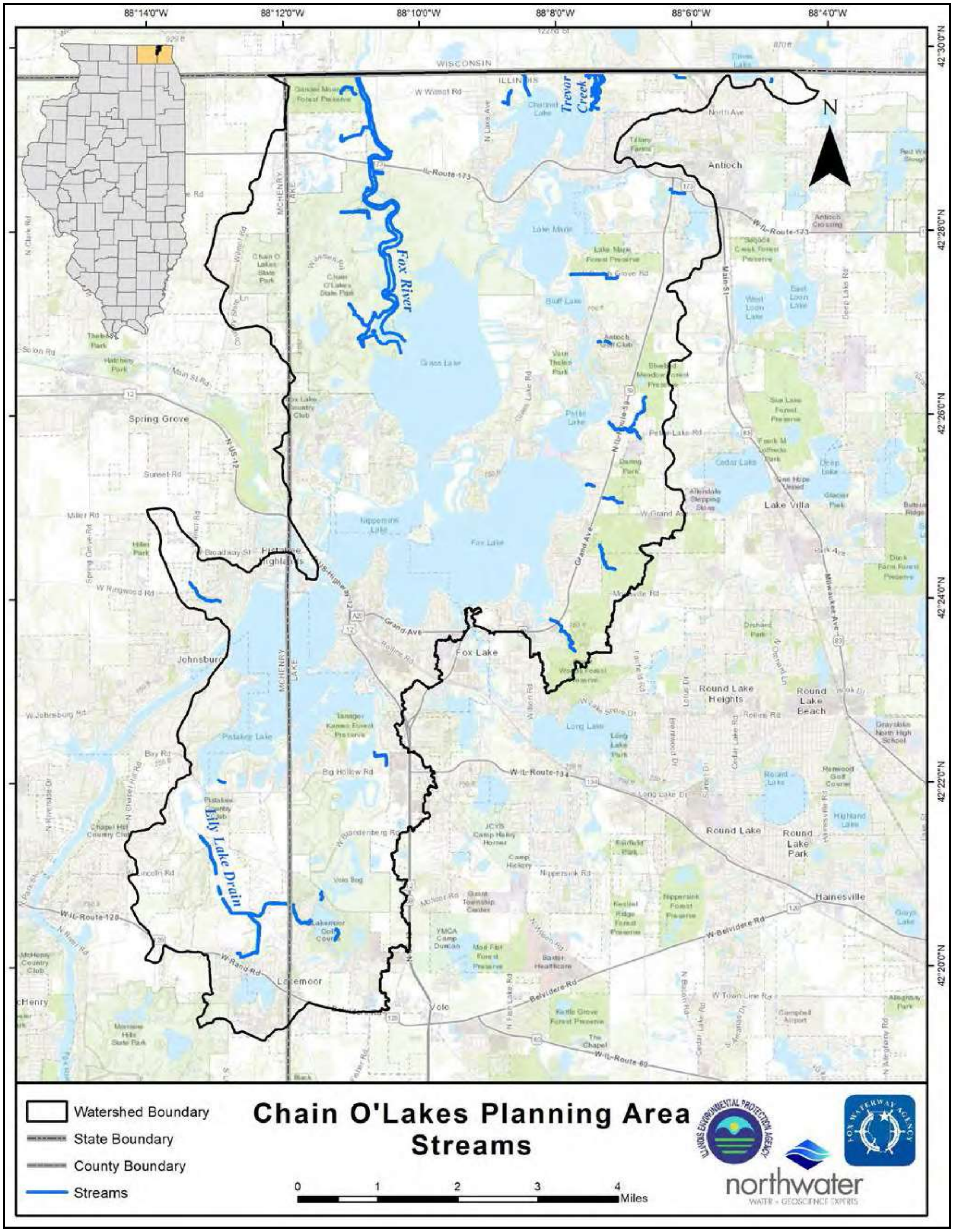

Figure 3-16: Streams

3.2.3 Wetlands in the Planning Area

European settlers to the region altered much of the watershed planning area's natural hydrology and wetland processes. They drained wet areas, channelized streams, plowed prairie land, and cleared forests to farm the rich soils. Even after these alterations, the underlying soil retains clues to its prior condition. Hydric soils (soils that remain wet for an extended period) can help identify the locations of pre-settlement wetlands.

WETLANDS: Areas with a high potential for exhibiting hydric soil, hydrophytic vegetation, and required hydrologic conditions.

Wetlands filter sediments and nutrients from runoff, provide wildlife habitat, reduce flooding, and help maintain water levels in streams. They also provide areas where groundwater is recharged by surface water. By performing these functions, wetlands improve the water quality and biological health of streams and lakes located downstream and protect public safety.

Several wetland types exist in the Chain. These wetlands are characterized based on the location in the landscape, soil, vegetation, and hydrology. Freshwater emergent and forested wetlands are the most recognizable type and form in many different landscapes, including in isolated depressions and along stream corridors.

The first comprehensive effort to inventory and map wetland resources in the planning area was the National Wetlands Inventory (NWI), undertaken by the U.S. Fish and Wildlife Service (USFWS) in the mid-1980s. The NWI maps initially were developed by interpreting high-altitude aerial photographs using stereoscope, pen, and ink. Image interpretation for the NWI has evolved to now use geospatial software. There are 13,205 acres of NWI wetlands in the planning area with 11,525 acres in Lake County and 1,681 acres in McHenry. This acreage includes streams, lakes, and ponds. Counting only freshwater emergent and forested wetlands, there is a total of 5,103 NWI acres, with 4,542 acres in Lake County and 561 acres in McHenry.

3.2.3.1 Lake County Wetlands

In 1990, a countywide wetland mapping effort was undertaken. The **Lake County Wetland Inventory** (LCWI) was initially published in 1993, comprehensively updated in 2002, and the current version has a publication date of 2016. By way of comparison, the LCWI reflects nearly twice the acreage of wetland resources for Lake County as the NWI and approximately 30% more acreage for the planning area in Lake County.

NOTEWORTHY: LAKE COUNTY WETLAND INVENTORY

The *Lake County Wetland Inventory (LCWI)* was originally developed in 1993 by a multi-agency team using a combination of information sources, including wetland inventory maps and the 1970 Soil Survey of Lake County by the USDA-Soil Conservation Service (SCS), National Wetland Inventory (NWI) maps by the USFWS, and various years of aerial photography. The LCWI was updated in 2002 using high resolution aerial photography and enhanced with Lake County GIS topographic information (elevation contours). The updated 2002 LCWI maps identify five different wetland types: *wetlands, farmed wetlands*, *artificial wetlands*, *converted wetlands*, and *Advance Identification wetlands (ADID)*. The LCWI is intended to improve the understanding and management of the County's wetland resources.

While the NWI offers a classification of wetland areas based on vegetation and hydrology, in 1992, the U.S. Environmental Protection Agency (USEPA) completed an **Advanced Identification (ADID)** study of high-function wetlands in Lake County using the LCWI as a base. The ADID study identified about 200 wetland complexes in the county that were predicted to have high ecological, stormwater management, and water quality enhancement functionality. Thirty-seven wetland complexes totaling 5,807 acres in the Lake County portion of the planning area have been identified as high-quality wetlands through the ADID process. The three primary functions evaluated were ecological value based on wildlife habitat quality and plant species diversity; hydrologic functions such as stormwater storage value and/or shoreline/bank stabilization value; and water quality values such as sediment/toxicant retention and nutrient removal/transformation function.

NOTEWORTHY: HIGH FUNCTIONALITY (ADID) WETLANDS

In 1992, Lake County implemented the *Advanced Identification (ADID)* process to identify high functionality wetlands that should be protected. The ADID program is a USEPA program developed to shorten permit processing time and provide information to local governments to aid in zoning, permitting and land acquisition decisions. Three primary functions were used by the USEPA and U.S. Army Corps of Engineers (USACE) to evaluate wetlands during the ADID process: biological functions (i.e., threatened or endangered species, wildlife habitat, and plant species diversity), hydrologic functions (i.e., stormwater storage), and water quality mitigation functions (i.e., sediment and toxicant retention, shoreline/bank stabilization).

The Lake County Wetland Restoration and Preservation Plan (WRAPP), which builds on these previous studies, provides the most current iteration of wetland resources and their functionality. According to the WRAPP, approximately 5,133 acres of wetlands remain in the Chain planning area, plus an additional 7,359 acres of streams, lakes and ponds.

3.2.3.2 McHenry County Wetlands

Excluding streams, ponds, and lakes, the NWI indicates there is a total of 561 acres of wetlands within the McHenry County portion of the Chain. These are categorized as freshwater emergent and forested shrub wetlands. A 2005 ADID survey of McHenry County indicated 1,899 acres of high-quality wetlands including lakes and ponds.

3.2.3.3 Wetland Loss

To determine the extent of wetland loss, a comparison was performed between the NWI and current or existing wetland extent. Current wetlands were delineated by comparing the mapped wetlands from the LCWI, ADID and WRAPP, combined with an interpretation of existing aerial imagery. Results indicate there are currently 4,929 acres of wetlands in the planning area

NOTEWORTHY: WETLAND RESTORATION AND PRESERVATION PLAN

The Wetland Restoration and Preservation Plan (WRAPP) was adopted by SMC and the Lake County Board in 2020. Its dataset reflects enhancements of the 2002 LCWI maps using high resolution aerial photography and LiDAR collected since 2002, as well as existing information from the Lake County ADID study, soil surveys, and other available mapping products. Each WRAPP polygon was enhanced with descriptors associated with the NWI classification system and *hydrogeomorphology*. Using this combined information, the WRAPP estimates the functions (services) of mapped wetland and water resources for both existing and pre-settlement conditions within Lake County. The WRAPP supports watershed-based assessments of wetland function, identifies locations of *potentially restorable wetlands (PRWs),* and identifies opportunities for *wetland enhancement* and *preservation*. The WRAPP includes an on-line decision support tool (DST) to help users prioritize restoration and preservation opportunities based on acreage, wetland function or functional loss, allowing the user to make informed decisions on wetland restoration and preservation options targeted to user-specific goals and objectives.

excluding lakes, ponds, and streams (Figure 3-17). Compared to the NWI (Table 3-4), up to 173 acres of previously delineated wetlands may have been drained or modified; therefore, opportunities exist to restore those areas.

Table 3-4: Estimated Wetland Loss

CURRENT WETLANDS		NWI WETLANDS		
AREA (ACRES)	DIFFERENCE FROM NWI	EMERGENT (ACRES)	FORESTED/SHRUB (ACRES)	TOTAL (ACRES)
4,929	-3.4%	4,156	947	5,103

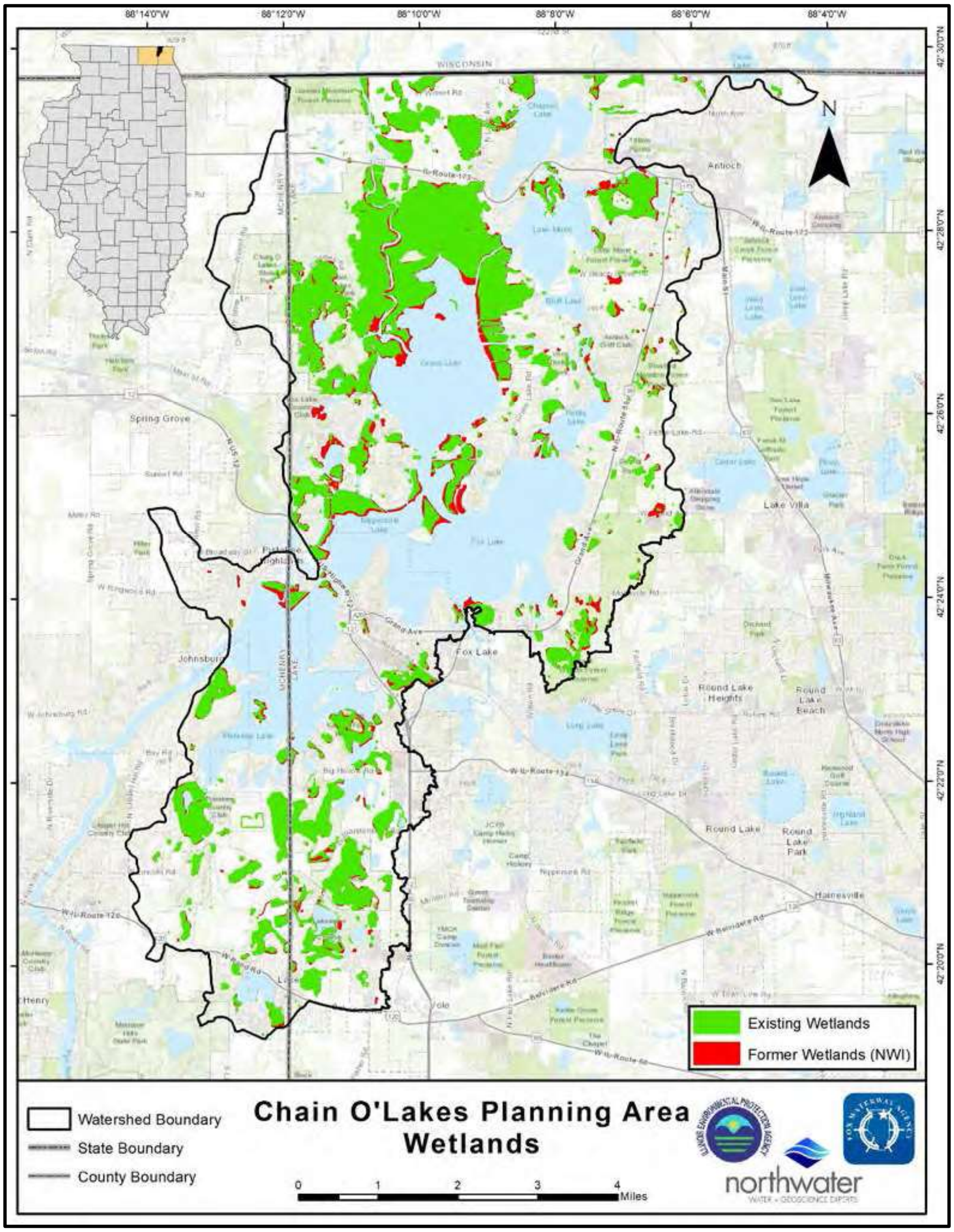

Figure 3-17: Existing and Former Wetlands

3.2.4 Approaches to and Tools for Wetland Management

Within a watershed, wetlands are managed using multiple approaches and various tools, including planning efforts, regulations, and voluntary activities. Advanced planning efforts can help identify wetland needs and potential locations.

Regulation of wetland impacts by agencies and municipalities is arguably the most visible approach for wetland management. This typically involves permits and may require mitigation which can occur at the national, state, county, and local (municipal) level. In Lake County for example, the Lake County Watershed Development Ordinance (WDO) establishes a no-net-loss policy for wetland impact, with a goal of net gain in function. The WDO sets the minimum requirements for the county, including the need for a permit to approve wetland impacts and requirement for mitigation if impacts exceed the minimum threshold. Wetland impacts within Lake County are to be mitigated within the county on a watershed basis. Wetland mitigation can take the form of mitigation banking, or a site-specific mitigation project involving wetland restoration, enhancement or, in rare cases, preservation.

Voluntary wetland restoration and management efforts are performed not as a required activity adjunct to a regulatory action but in response to a desire to restore or manage a target wetland for a specific purpose (e.g., duck habitat, flood water storage, etc.). Typical approaches include wetland preservation and wetland restoration or enhancement through on-the-ground activities that may include, but are not limited to, tile disablement, selective herbicide application, prescribed burning, on-line flow restriction, and water level control.

Wetland Restoration: The re-establishment of wetlands in areas where they previously existed and were altered by drainage activities or landscape modifications.

Wetland Enhancement: Augmenting wetland functions beyond the current conditions; enhancement of one function sometimes can occur at the expense of other functions.

Mitigation Banking: A system of credits and debits to offset environmental impacts associated with site development and achieve no net loss, typically accomplished via restoration, creation, enhancement, or preservation of similar wetland, stream, or natural habitats near the area of impact with the specific goal of compensating for unavoidable impacts to aquatic resources.

Wetland Preservation: Actions taken to maintain the size and functions of an existing wetland or water body.

3.3 LAKE AND STREAM WATER QUALITY

Water quality refers to a waterbody's ability to support a variety of aquatic life, recreational and aesthetic uses. Water pollution reduces the health of aquatic ecosystems and may be harmful to human health. Water quality is impacted by pollutants from multiple point and nonpoint sources (NPS). During storms, pollutants on the landscape are washed from the ground into storm sewers, roadside drainage ditches, natural drainageways and ultimately into the watershed's receiving streams and lakes.

Physical changes in the watershed, such as stream channelization and the loss of riparian vegetation and wetlands, reduce the ability of the natural drainage system to filter pollutants and infiltrate water into the ground, and contribute sediment and other pollutants to the streams and lakes, thereby reducing the quality of aquatic habitat. Water quality degradation is also caused by an increase in watershed impervious cover that has led to an increase in the volume and rate of runoff.

3.3.1 Relevant Water Quality Parameters

Water quality parameters most relevant to the Chain planning area and their importance are described in this section. An analysis of current and historical data is presented in Section 3.3.6**.**

Phosphorus - chemical phosphorus can be found in dissolved and sediment-bound forms but, as it is a nutrient necessary for life, it is often sequestered as a component of aquatic biota, primarily algae. In freshwater systems, phosphorus naturally occurs in smaller concentrations than nitrogen, making it the nutrient that limits the growth of algae and plants. Increased nutrient concentrations (especially phosphorus) in a waterbody stimulates plant, algae, and cyanobacteria growth, which can lead to large populations. Blooms, especially those formed by cyanobacteria, can produce harmful water quality conditions and toxins. Of particular concern in lakes, phosphorus can accumulate over time in sediments and then continue to be released even if inputs are reduced. The two common water quality measures of phosphorus are:

1. **Total phosphorus (TP)** – includes dissolved and particulate forms. Inorganic particulate phosphorus is mostly chemically bound to sediment particles, and organic particulate phosphorus is associated with plant or animal matter.
2. **Orthophosphate** – Also called soluble reactive phosphorus (SRP) or dissolved phosphorus, this component of TP is readily taken up and used by algae. Orthophosphate is often found in very low concentrations in phosphorus-limited systems where the nutrient is rapidly taken up by algae and plants.

Phosphorus samples in the Chain are typically taken at the surface of the water and near the bottom, as many of the lakes undergo seasonal stratification, and chemical and biological processes affecting concentrations can differ markedly between the layers.

Nitrogen - is a nutrient necessary for life and is typically abundant in freshwater systems. Nitrogen occurs in several forms in water, with the inorganic forms such as nitrate being readily available for plant and algae use. Ammonia (NH_3) and its companion ion, ammonium, (NH_4^+) are also forms quickly used by plants and algae, but depending on acidity of the water and concentration, it can become toxic.

Dissolved Oxygen (DO) - is a measure of how much oxygen is in the water of a lake or stream. Adequate concentrations are necessary for fish and other animals to breathe and, thus, is an indicator of ecosystem health. Dissolved Oxygen fluctuates due to many factors, including temperature, photosynthesis and respiration of plants and algae, wind and wave action, and organic matter decomposition. High levels of plants and algae can often cause very low levels of DO, especially overnight, as these organisms continue to use up oxygen even when they are not photosynthesizing during the day.

Dissolved Oxygen has typically been collected as a depth profile in the Chain. This is an important aspect of lake sampling, as seasonal stratification occurs. During this stratification, usually starting in late spring or early summer, two distinct layers of water form a warmer upper layer called the epilimnion, and a cooler lower layer called the hypolimnion, divided by a distinct transitional layer called the thermocline. Mixing of water across the barrier is limited, until fall when the lake "turns over" and destratifies. Different chemical and biological processes occur in the layers and can drive nutrient cycling. For instance, low oxygen conditions naturally occur in the hypolimnion. In these conditions, nitrogen and phosphorus in the form of ammonia and orthophosphate respectively, can be released from sediment. This release can be a significant portion of nutrient loading to the body of water, referred to as internal loading.

Total Suspended Solids (TSS) - refers to all the particulate matter in a given volume of water retained by a filter. It varies temporally in both rivers and lakes, typically increasing from erosion during runoff events, lake turnover, biological processes, and human disturbances, and is a measure helpful for understanding sources of sedimentation. There is no regulatory numeric criteria for TSS in Illinois, however, Illinois EPA identified a target of under 18.2 mg/L which is discussed further in Section 3.3.3. Total Suspended Solids can be differentiated between Volatile Suspended Solids (VSS), organic materials such as algae and decomposing organic matter, and Nonvolatile Suspended Solids (NVSS), which include non-organic "mineral" substances, including dirt or soil particles.

Secchi Disk Depth - is a simple measure of water clarity. A black and white disk is lowered into the water, and the depth recorded when the black and white parts cannot be differentiated. This parameter has been collected by many watershed and lake groups, and provides an important long-term data set on water clarity and can be used as indicators of algal growth and TSS.

Fecal Coliform, E. Coli - is a measure of a group of bacteria that are used as indicators of possible sewage contamination in water. These bacteria are not generally harmful themselves, but they indicate the possible presence of harmful bacteria, viruses and protozoans that live in human and animal digestive systems. Sampling for fecal coliforms frequently takes place near public recreational waters such as swimming beaches. The units for fecal coliform are Colony Forming Units (CFU) per 100/mL of sample water. Common sources of fecal coliform and E. coli are sewer overflows, leaking or otherwise failing septic systems, wildlife, and animal feedlots.

3.3.2 Water Quality Standards and Status of Designated Use Support

Water quality standards are laws or regulations established to enhance water quality and protect public health and welfare. Standards consist of criteria necessary to support and protect a specific "designated use" of a waterbody and an antidegradation policy. Examples of designated uses are: Primary Contact, Aesthetic Quality, Aquatic Life, Fish Consumption, and Public Food / Water Supply.

Criteria are expressed numerically for standards with a numeric limit (e.g., 10% of samples over a time period cannot exceed a certain concentration), or as narrative description for standards without a numeric limit (e.g., increased algae growth causes a segment not to meet aesthetic standards). These uses are determined to be fully supported, not supported, not assessed, or to have insufficient information to make a determination. Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected. Waterbodies are considered impaired for a particular designated use when they exceed these numeric or narrative standards, with a potential cause then assigned to the impairment. As required by the Clean Water Act (CWA), Illinois biennially reports if the waters of the state meet each of their designated uses in the "Integrated Water Quality Report and Section 303(d) List" ("Integrated Report").

Illinois EPA evaluates physical, biological, and chemical monitoring data to make assessments of designated use support. For some uses, monitoring data may indicate non-support or impairment. For example, depauperate fish or invertebrate taxa may indicate impairment of the aquatic life designated use. In these cases, physical and/or chemical monitoring data are compared to numeric water quality standards to determine if pollutants are present in sufficient quantities to cause an impairment of one or more designated uses. In other cases, exceedance or violation of the water quality standard is enough to list the use as not supported and the water as "impaired." For example, exceedance of the fecal coliform standard results in non-support of primary contact. Waters with one or more pollutants identified as the cause of impairment are added to the "303(d) list" of impaired waters and put onto a schedule for development of a Total Maximum Daily Load (TMDL) study for the pollutant(s) of concern. In some cases, "non-pollutants" are identified as the cause of non-support. Non-pollutants are typically non-chemical causes of impairment such as modification of flows in a stream by dams, alteration of habitat, or the presence of non-native invasive species. Once a surface water assessment is made, it typically remains unchanged in subsequent editions of the Integrated Report unless new data is obtained by Illinois EPA that indicates a change is warranted. Changes from previous editions are reported in an appendix to the Integrated Report. Illinois numeric water quality standards are found in Title 35 Illinois Administrative Code, Subtitle C, Section 206. Standards relevant to the focus of this watershed plan and additional context are summarized below:

1. **Offensive Condition Standard** - is frequently related to the aesthetic quality or aquatic life designated uses and violations can be caused by the presence of many unnatural conditions including excessive algal growth, plant growth, sedimentation, and turbidity. In the Chain, TSS is frequently the listed cause of the aesthetic quality impairment as it is a measure of light-blocking particles within water and includes both inorganic and organic matter (i.e., sediment and algae, respectively). While there is no numeric criterion, Illinois EPA has recommended a non-regulatory TSS target of below 18.2 mg/L for the lakes in the planning area to meet the narrative standard. Prior to the 2020/2022 Integrated report, Illinois EPA used an index to assess aesthetic quality. Non-Volatile Suspended Solids, a measure of only the inorganic particles such as sediment, was part of that index. While there is currently no NVSS numeric criterion in Illinois, the agency has established a target of 13.6 mg/L in the Chain.
2. **Dissolved Oxygen Standard** - is frequently related to the aquatic life designated use. Numeric criteria have been established for DO, and the most relevant parts of the regulation are:
    a) March – July: DO must not be below 5 mg/L at any time or 6 mg/L daily mean averaged over 7 days in streams and in water above the thermocline of stratified lakes.
    b) August – February: DO must not be below 3.5 mg/L at any time, 4 mg/L daily minimum averaged over 7 days, or 5.5 mg/L daily mean averaged over 30 days in streams and in water above the thermocline of stratified lakes.
3. **Total Phosphorus Standard** - applies only to lakes and is frequently related to the aesthetic value and aquatic life designated uses. In lakes greater than 20 acres, TP may not exceed 0.05 mg/L. In streams, there is no numeric phosphorus criteria, but the Illinois Nutrient Science Advisory Committee (INSAC) has put forth a recommended concentration of 0.113 mg/L for wadable streams in the northern ecoregion of Illinois. This recommendation will be used as a reference in streams. However, it should be noted that it has not been accepted as a regulatory criteria, and other studies have proposed different standards.

4. **Fecal Coliform Standard** - is relevant to the primary contact recreation designated use. The numeric standard has two parts. Fecal coliform cannot exceed:
    a) A mean of 200 CFU/100 ml with at least 5 samples in a 30-day period
    b) No more than 10% of the samples in a 30-day period above 400 CFU/100ml
        - There is rarely enough data for Illinois EPA to fully assess the fecal coliform sample using the above criteria, and instead they apply the thresholds across 5 years. Refer to the 2020/2022 integrated report for a full explanation.

3.3.2.1 Streams

Only one stream segment in the planning area is assessed by Illinois EPA for support of designated uses. Segment IL_DT-35, the 5.4-mile section of Fox River that begins at the Wisconsin state line and empties into Grass Lake, has impairments related to Aquatic Life, Primary Contact and Aesthetic Value.

There are 8 causes of fish consumption impairment, mainly legacy pesticide residues. Aquatic Life impairment is caused by unknown sources and by sedimentation/siltation. Primary Contact use is impaired with cause of fecal coliform (Table 3-5).

Table 3-5: Causes of Stream Impairments – Fox River segment IL_DT-35

IMPAIRED DESIGNATED USE	CAUSE
Fish Consumption	Aldrin
	Dieldrin
	Endrin
	Heptachlor
	Mercury
	Mirex
	Polychlorinated Biphenyls (PCB)
	Toxaphene
Aquatic Life	Cause Unknown
	Sedimentation/Siltation
Primary Contact	Fecal Coliform

Source: Illinois EPA 303d list 2020/2022

3.3.2.2 Inland Lakes

Illinois EPA has assessed 7,748 acres of lakes in the planning area, representing 19 assessment units, including those that are not part of the Chain. Every assessed lake is impaired for at least one of its designated uses. A summary of inland lake causes of designated use impairments is provided in Table 3-6.

Table 3-6: 2020/2022 Causes of Impairment by Lake

LAKE NAME	ASSESSMENT UNIT ID	DESIGNATED USE	CAUSE
Antioch	IL_RTT	Aesthetic Quality	Total Suspended Solids
Bluff	IL_VTJ	Fish Consumption	Mercury, Polychlorinated Biphenyls
Catherine	IL_RTD	Fish Consumption	Mercury, Polychlorinated Biphenyls
Channel	IL_RTI	Fish Consumption	Mercury, Polychlorinated Biphenyls

LAKE NAME	ASSESSMENT UNIT ID	DESIGNATED USE	CAUSE
Cross	IL_UTV	Aesthetic Quality	Phosphorus, Total
Dunns	IL_VTH	Aesthetic Quality	Total Suspended Solids
Fox	IL_RTF	Aesthetic Quality	Total Suspended Solids
		Fish Consumption	Aldrin, Dieldrin, Endrin, Heptachlor, Mercury, Mirex, Polychlorinated Biphenyls, Toxaphene
Grass	IL_RTQ	Aesthetic Quality	Total Suspended Solids
		Fish Consumption	Aldrin, Dieldrin, Endrin, Heptachlor, Mercury, Mirex, Polychlorinated Biphenyls, Toxaphene
Brandenburg Lake	IL_UTZ	Aesthetic Quality	Phosphorus, Total
Lake Matthews	IL_UTA	Aesthetic Quality	Total Suspended Solids
Lake Tranquility	IL_UTW	Aesthetic Quality	Total Suspended Solids
Leisure	IL_STG	Aesthetic Quality	Phosphorus, Total, Total Suspended Solids
Lily	IL_RTZJ	Aesthetic Quality	Phosphorus, Total
Marie (Lake)	IL_RTR	Fish Consumption	Mercury, Polychlorinated Biphenyls
Nippersink	IL_RTUA	Aesthetic Quality	Total Suspended Solids
		Fish Consumption	Mercury, Polychlorinated Biphenyls
Petite	IL_VTW	Fish Consumption	Mercury, Polychlorinated Biphenyls
Pistakee	IL_RTU	Aesthetic Quality	Total Suspended Solids
		Fish Consumption	Mercury, Polychlorinated Biphenyls
Spring (Lake)	IL_RGZT	Aesthetic Quality	Total Suspended Solids
Sullivan Lake	IL_RTZL	Aesthetic Quality	Cause Unknown

Source: Illinois EPA

3.3.3 Total Maximum Daily Loads (TMDL)

Total Maximum Daily Load (TMDL): An estimation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. It assesses contributing point and nonpoint sources and identifies pollution reductions necessary for designated use attainment.

Section 303(d) of the Clean Water Act requires Illinois EPA to identify all waters that do not meet water quality standards. For those impaired by pollutants, Section 303(d) requires the development of a TMDL. The Illinois EPA developed TMDL reports for TP and fecal coliform for each of the impaired water bodies in the planning area. The TMDL includes several waterbodies outside the planning area, included in this section, as they all drain to the Chain. Additional parameters addressed include DO, pH and sediment/silt. Total Suspended Solids does not have numeric criteria in Illinois, and development of TMDLs was deferred for this cause of impairment. Instead, Illinois created "Load Reduction Strategies (LRS)" to meet a lake target of 18.2 mg/L TSS (Table 3-7). A total of 26 TP and 1 fecal coliform TMDLs were approved. Where applicable, actions identified in the reports were included in the programmatic and site-specific action plans (see Chapter 5). As noted in Table 3-7, substantial phosphorus reductions are needed to meet water quality standards in the planning area, ranging from 7% in Lake Catherine to 82% for Nippersink Lake. Significant reductions in TSS are also needed in most lakes and range from 15% in Spring Lake and up to 68% for Grass Lake. Outside the planning area, some reductions needed are even higher with Deep Lake needing a 91% reduction in TP to meet water quality standards.

Table 3-7: TMDLs in the Planning Area

LAKE NAME	ASSESSMENT UNIT ID	PARAMETER ADDRESSED	TMDL STATUS	LOAD CAPACITY (LBS/DAY – TP, TSS; CFU/DAY FC)	REDUCTION NEEDED
Spring	IL_RGZT	Total Phosphorus	Approved	1.72	81%
		Total Suspended Solids	Addressed (LRS)	180	15%
Catherine	IL_RTD	Total Phosphorus	Approved	4.83	7%
Fox	IL_RTF	Total Phosphorus	Approved	54.4	70%
		Total Suspended Solids	Addressed (LRS)	34,675	50%
Channel	IL_RTI	Total Phosphorus	Approved	6.8	49%
Long*	IL_RTJ	Total Phosphorus	Approved	13.4	66%
Grass	IL_RTQ	Total Phosphorus	Approved	101	76%
		Total Suspended Solids	Addressed (LRS)	1,877	68%
Marie	IL_RTR	Total Phosphorus	Approved	11.3	66%
Antioch	IL_RTT	Total Phosphorus	Approved	0.6	65%
		Total Suspended Solids	Addressed (LRS)	60	0%
Pistakee	IL_RTU	Ammonia	Impairment Removed	-	-
		Total Phosphorus	Approved	156.4	79%
		Total Suspended Solids	Addressed (LRS)	23,195	45%
Nippersink	IL_RTUA	Total Phosphorus	Approved	49.1	82%
		Total Suspended Solids	Addressed (LRS)	3,177	62%
Redhead	IL_RTV	Total Phosphorus	Approved	0.54	61%
Duck*	IL_RTZG	Total Phosphorus	Approved	2.98	14%
		Total Suspended Solids	Addressed (LRS)	743	30%
Wooster*	IL_RTZH	Total Phosphorus	Approved	3.69	40%
Davis*	IL_STQ	Total Phosphorus	Approved	0.3	85%
N. Churchill*	IL_STR	Total Phosphorus	Approved	0.51	59%
		Total Suspended Solids	Addressed (LRS)	87	85%

LAKE NAME	ASSESSMENT UNIT ID	PARAMETER ADDRESSED	TMDL STATUS	LOAD CAPACITY (LBS/DAY – TP, TSS; CFU/DAY FC)	REDUCTION NEEDED
S. Churchill*	IL_STS	Total Phosphorus	Approved	0.39	52%
		Total Suspended Solids	Addressed (LRS)	68	67%
Hidden L.*	IL_UTM	Dissolved Oxygen	Addressed in TP TMDL		
		pH	Addressed in TP TMDL		
		Total Phosphorus	Approved	0.104	79%
		Total Suspended Solids	Addressed (LRS)	19	81%
L. Tranquility	IL_UTW	Total Phosphorus	Approved	0.41	43%
		Total Suspended Solids	Addressed (LRS)	34	0%
Mcgreal L.	IL_UTX	Total Phosphorus	Approved	0.193	78%
Deep*	IL_VTD	Fecal Coliform	Approved	1968	91%
Dunns	IL_VTH	Total Phosphorus	Approved	0.79	41%
		Total Suspended Solids	Addressed (LRS)	76	65%
Bluff	IL_VTJ	Total Phosphorus	Approved	2.88	65%
Fish (Duncan)*	IL_VTK	Total Phosphorus	Approved	1.77	75%
		Total Suspended Solids	Addressed (LRS)	437	0%
Fischer*	IL_VTT	Total Phosphorus	Approved	1.22	77%
		Total Suspended Solids	Addressed (LRS)	582	50%
Petite	IL_VTW	Total Phosphorus	Approved	4.73	70%
Turner	IL_VTZA	Total Phosphorus	Approved	0.6	21%
		Total Suspended Solids	Addressed (LRS)	94	21%
Summerhill Estate*	IL_WTA	Total Phosphorus	Approved	0.2	80%
		Total Suspended Solids	Addressed (LRS)	54	0%
Fox River above Grass Lake	IL_DT-35	Sediment/Siltation	Addressed (LRS)	Varies, based on flow conditions	0-62%

**denotes lake is outside of planning area*

Chain O’ Lakes TMDLs for TP and the LRS for TSS address impaired aesthetic quality for the waterbodies in the planning area. The fecal coliform TMDL for Deep Lake addresses the primary contact designated use. Associated modeling indicates that loads of TP originate from both internal and external sources. External sources include point sources such as Wastewater Treatment Plant (WWTP) discharges, and NPS such as runoff from residential developed areas, agriculture and open space. Internal sources include resuspension of nutrient-containing sediments from hydraulic action such wind or recreation induced waves. Fecal coliform sources include point sources such as Municipal Separate Storm Sewer Systems (MS4s) and NPS including septic systems, wildlife waste, pet waste and stormwater. Suspended sediments are primarily from NPS and internal resuspension, as data suggests point sources are minor TSS contributors.

3.3.4 Summary of Existing Monitoring in the Planning Area

Lake chemical, physical, and biological monitoring has been conducted by multiple agencies within the planning area. Monitoring frequency and intensity varies considerably between waterbodies and over time. Organizations that have been collecting data consistently include the Illinois EPA and the Lake County Health Department (LCHD). Illinois EPA collects samples on an approximately 5-year rotation as part of its Ambient Lakes Water Quality Monitoring Network. Lake County assesses lakes every 8-10 years. Additionally, there are several volunteer groups in the Chain that collect data on their waterbody of interest. Much of the volunteer data was originally collected as part of the Illinois Volunteer Lake Monitoring Program (VLMP), which was suspended in 2019. However, some groups continue to collect data using the program's protocols. There are several licensed swimming beaches among the lakes that are routinely monitored in the summer for fecal coliform bacteria by the LCHD.

In the following sections, water quality of each major lake is summarized. Some were excluded due to a lack of available data needed to perform an adequate analysis. To simplify, intra-lake sites were aggregated into a lake-wide total. The number of samples reported for some parameters reflects multiple individual measurements along the lake depth profile at a site. This profile is important in lakes that are seasonally stratified, as conditions and chemical and biological processes differ significantly above and below the thermocline. For example, the hypolimnion, or water below the thermocline, often has low oxygen levels in the summer, whereas the epilimnion, or water above the thermocline, is well oxygenated.

Little stream monitoring has occurred in the planning area. One notable exception is Illinois EPA station DT-35 on the Fox River between its mouth at Grass Lake and the Wisconsin state line. There are also several tributary streams that drain into the planning area. These streams are summarized as they are important external sources of nutrient and sediment loads to the main body of the lakes. Included are Nippersink Creek, Sequoit Creek and Manitou Creek.

Lake Catherine

3.3.5 Lake Water Quality

Water quality summaries for each of the major, assessed lakes in the planning area are presented in this section. Those without adequate data are excluded, including Lake Jerilyn and Lac Louette. Lake Matthews has very limited monitoring data and are included in the Pistakee Lake summary.

3.3.5.1 Bluff Lake – VTJ

Water quality has been monitored by Illinois EPA (2012, 2017, 2022), LCHD (2014) and through the Illinois VLMP (annually). In addition, the LCHD monitors waters around swimming beaches for harmful algal blooms and unsafe levels of bacteria annually. Table 3-8 shows the parameters and number of samples of each collected since January 2010. Bluff Lake has a maximum depth of 28 ft and typically undergoes seasonal stratification, and many of the parameters were collected as depth profiles, so a simple mean or median of each parameter is not necessarily illustrative of actual conditions. To provide insight into the difference in parameters above and below the thermocline, data was organized into shallow (≤4 ft) and deep (≥12 ft) groups. However, this grouping is imperfect, as stratification only occurs seasonally, some early spring and late fall data from unstratified water may be comingled with data from stratified water. Note that the deep and shallow sample means of TP are above the 0.05 mg/L water quality standard indicating that phosphorus is a consistent issue.

Table 3-8: Bluff Lake Water Quality Data Summary

PARAMETER	TOTAL SAMPLES	MEAN SHALLOW SAMPLES	UNITS	NUMBER SHALLOW SAMPLES	MEAN DEEP SAMPLES	UNITS	NUMBER DEEP SAMPLES
Alkalinity	32	210	mg/L	16	237	mg/L	16
Ammonia	30	0.17	mg/L	14	2.4	mg/L	16
Chloride	24	118	mg/L	12	123	mg/L	12
Chlorophyll α	17	72.4	µg/L	6	9.9	µg/L	3
Secchi Disk Depth	14	-					
Secchi Disk Depth (VLMP)	198	-					
Dissolved Oxygen	139	8.6	mg/L	32	3.8	mg/L	71
Dissolved Oxygen Saturation	129	100	%	27	30.1	%	66
Kjeldahl Nitrogen	32	1.5	mg/L	16	3.9	mg/L	16
Microcystin	14	2.7	µg/L	14	-	µg/L	0
Nitrate + Nitrite	25	0.21	mg/L	13	0.19	mg/L	12
pH	139	8.2	SU	32	7.5	SU	71
Phosphorus, Total	16	0.08	mg/L	27	0.42	mg/L	16
Orthophosphate	13	0.02	mg/L	15	0.38	mg/L	15
Specific Conductance	139	648	S/cm	32	743	mS/cm	71
Temperature, Water	129	21.9	C	27	17.6	C	66
Total Suspended Solids	30	9.1	mg/L	15	6.6	mg/L	15
Turbidity	18	8.6	NTU	9	30.6	NTU	9
Volatile Suspended Solids	30	125	mg/L	5	5.3	mg/L	10

Dissolved Oxygen is collected as a depth profile, with samples collected on an interval from surface to lake bottom. Example depth profiles of DO before and during stratification are presented in Figure 3-18 and Figure 3-19, respectively, with the thermocline around 10 ft in depth during stratification.

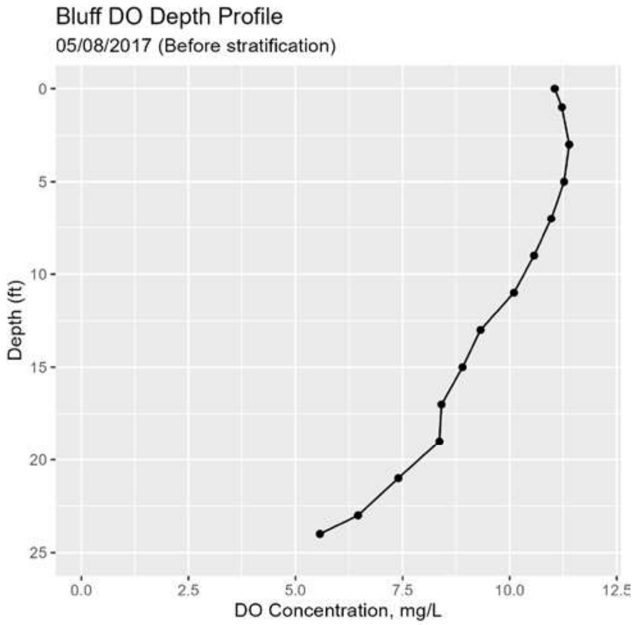

Figure 3-18: Bluff Lake Unstratified DO Profile

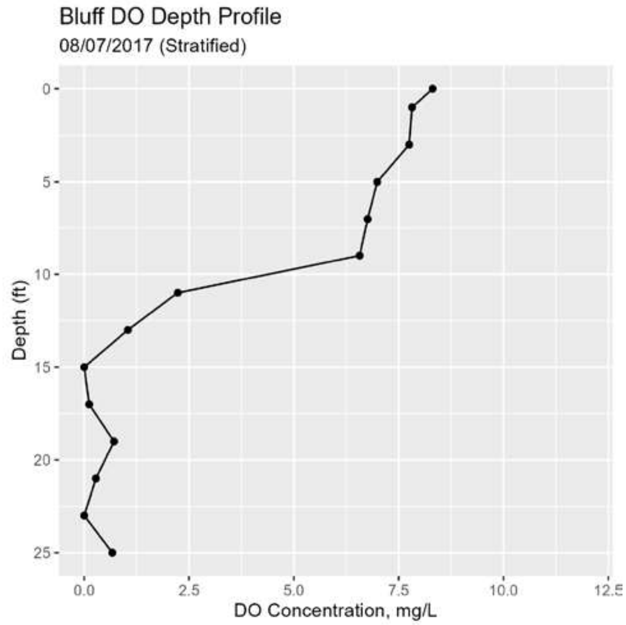

Figure 3-19: Bluff Lake Stratified DO

Figure 3-20 is a plot of all DO data collected on Bluff Lake since 2010. There are 3 years of sampling (2012, 2014, 2017). Seasonal stratification is clearly indicated by the data, as deep DO samples during the summer months cluster near zero.

This condition has implications for nutrient cycling, as phosphorus is released from sediments during times of low oxygen (anoxic). This can be an important source of phosphorus in the lake, known as internal loading.

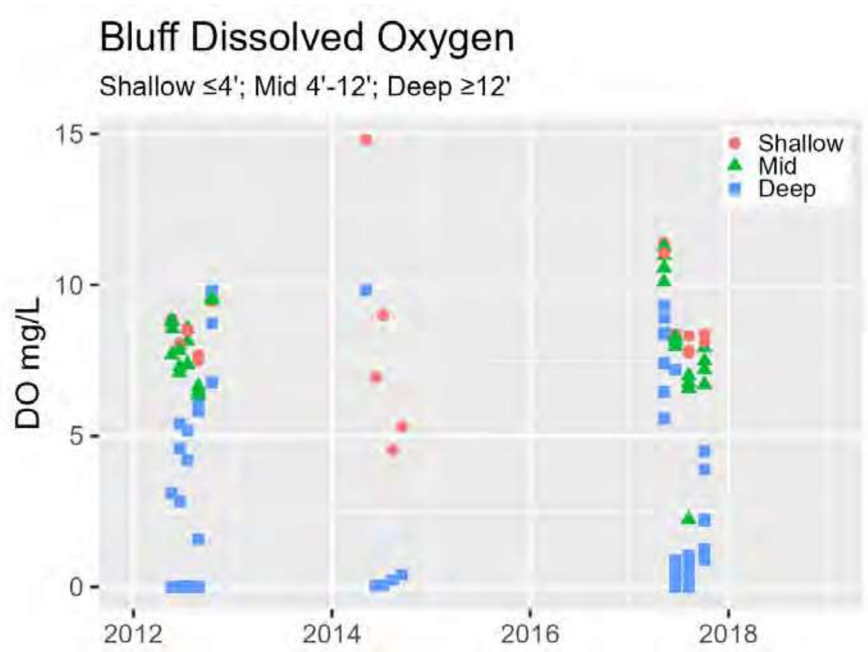

Figure 3-20: Bluff Lake DO

The 2018 TMDL calculated the TP load to Bluff Lake at 8.25 lbs/day with internal loading of 1.36 lbs/day, or 16% of the total daily load. Of the total, overland runoff from the watershed was calculated to be 313 lbs/year, with flows from Lake Marie providing an annual load of 2,201 lbs/year to Bluff Lake.

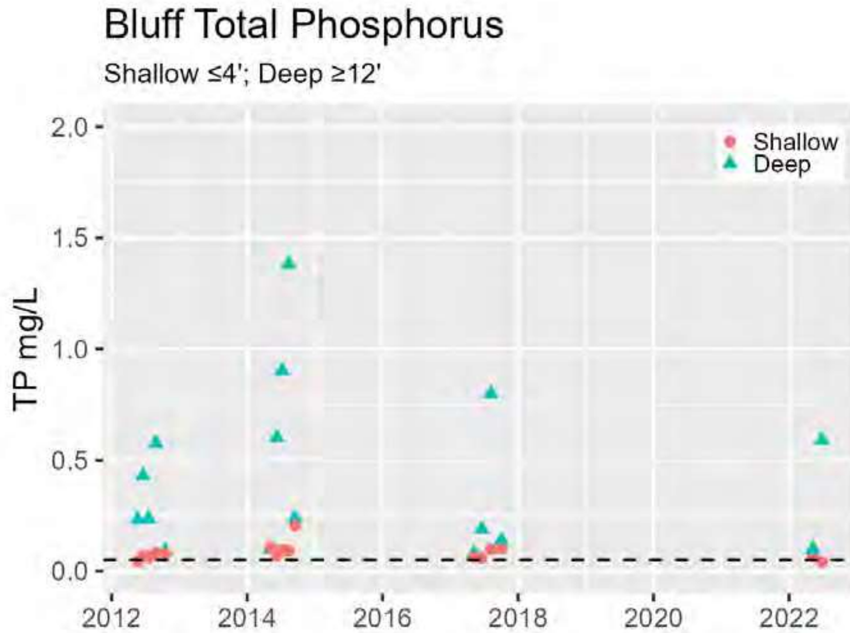

Figure 3-21: Bluff TP

Figure 3-21 illustrates the increased TP levels in the deep part of the lake during periods of stratification, which then becomes available as internal loading to algae and plants as it diffuses across the thermocline and mixes with the upper layers of water during fall turnover. As illustrated, 14 of 16 shallow TP samples are above the 0.05 mg/L water quality standard visualized as a dotted line.

Orthophosphate or dissolved phosphorus (Figure 3-22) makes up a low proportion of TP in shallow samples. This is an indication that during the summer, most phosphorus above the thermocline is of particulate form and associated with suspended sediments or algae. The opposite is true below the thermocline, as most is dissolved, indicating it has been released by bottom sediments in low oxygen conditions.

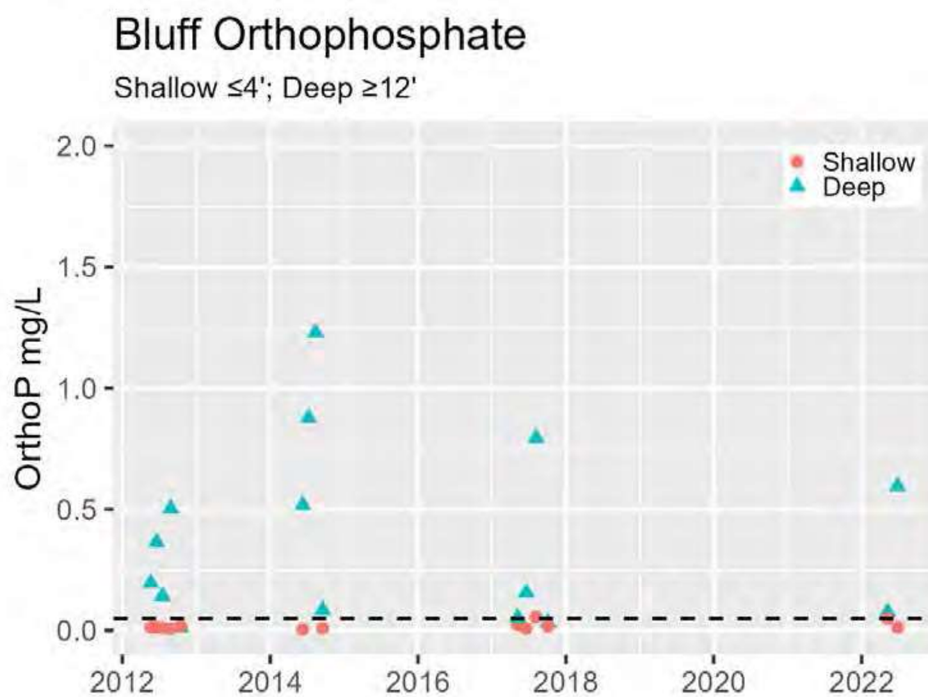

Figure 3-22: Bluff Lake Orthophosphate

Samples of TSS are below the 18.2 mg/L Illinois EPA target value and appear to have been declining since 2012 (Figure 3-23). This also is reflected in annual mean Secchi depth measurements collected by local volunteers through the Illinois VLMP (Figure 3-24). As this data is collected annually, it provides important insight into trends that occur between more comprehensive sampling.

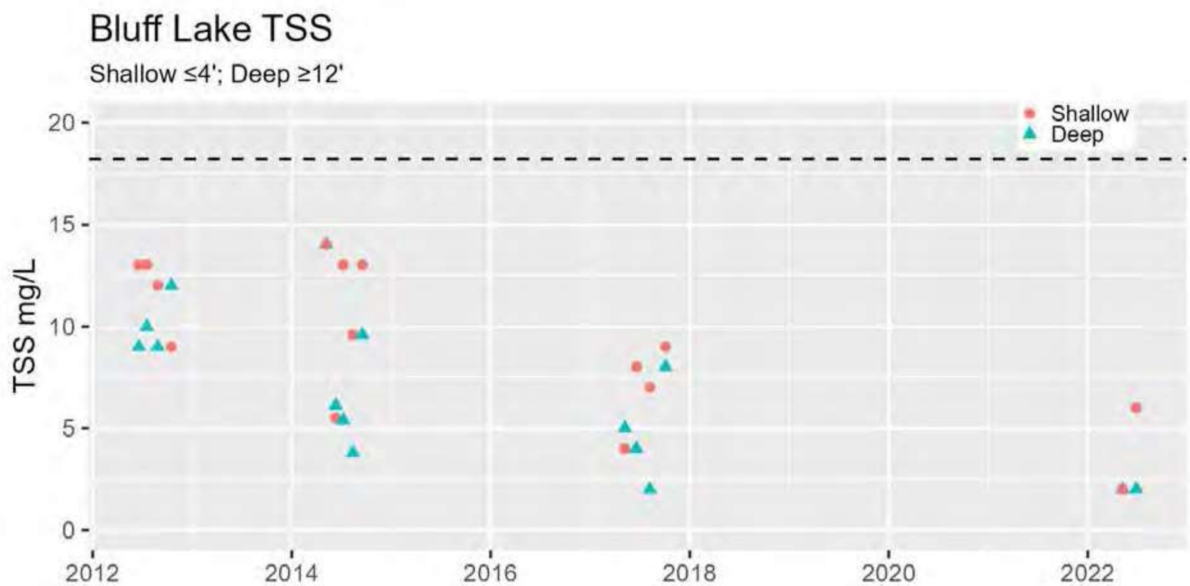

Figure 3-23: Bluff Lake TSS

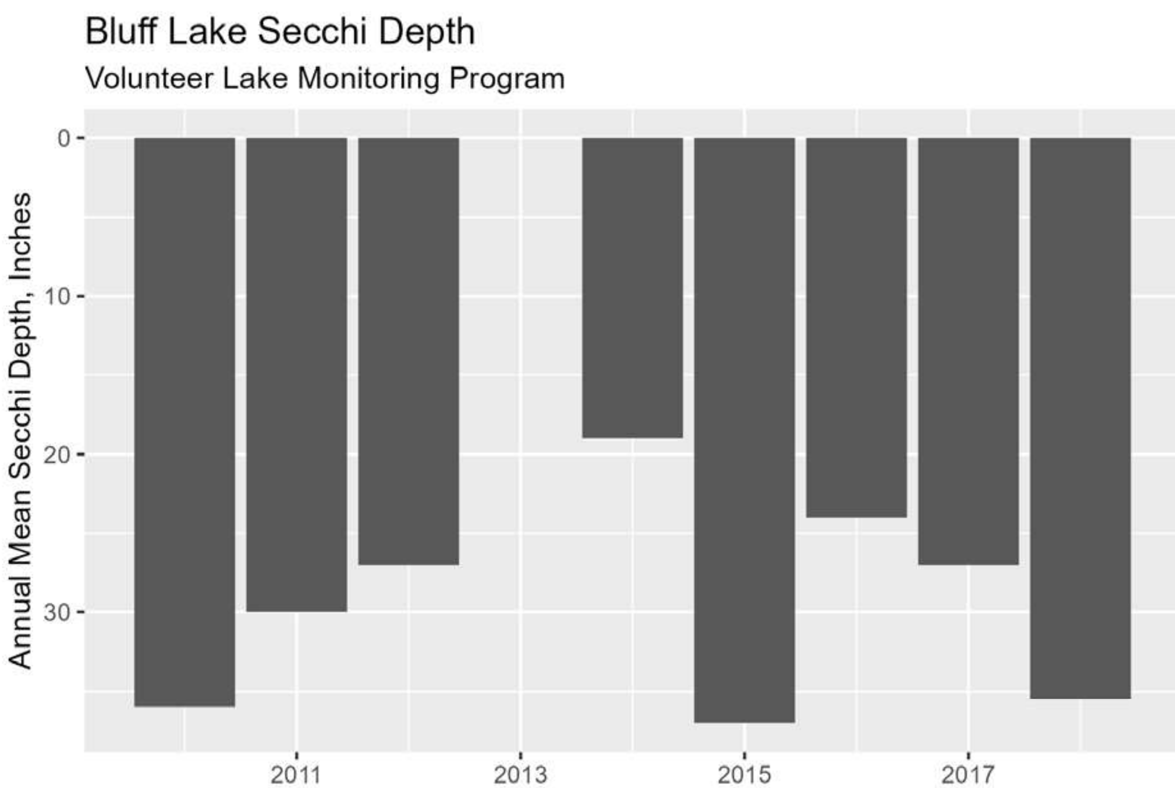

Figure 3-24: Bluff Secchi Depth

Bacteria levels are monitored at inland lake beaches by the LCHD twice monthly from May to September. If samples are above 235 CFU/100 mL, the health department informs the beach manager, and a closure is issued. Two beaches on Bluff Lake are monitored routinely, with a total of 5 closures between 2012 and 2021, 4 at Chain O' Lakes Beach and 1 at Lodges Beach (Table 3-9).

Table 3-9: Bluff Lake Beaches E. coli

YEAR	MEDIAN CFU/100 mL	HIGHEST CFU/100 mL	NUMBER OF SAMPLES	NUMBER OF CLOSURES
Chain O' Lakes				
2010	5.2	34.5	18	0
2011	2.6	105	16	0
2012	5.2	31.4	14	0
2013	4.1	34.5	14	0
2014	2.5	41.6	12	0
2015	3.6	248	14	0
2016	2	21.6	14	0
2017	**4.7**	**517**	**16**	**1**
2018	16.9	579	16	0
2019	15.3	88.4	14	0
2020	8.5	77.6	12	0
2021	**9.1**	**866**	**22**	**3**
2022	4.7	86	16	0
Lodges Beach				
2010	3.1	8.5	8	0
2011	3.6	98.7	16	0
2012	5.2	30.9	14	0
2013	8.6	81.3	16	0
2014	6.3	8.6	12	0
2015	2.6	137	12	0
2016	4.1	16.1	14	0
2017	**32.3**	**866**	**18**	**1**
2018	34.6	185	14	0
2019	16	48	14	0
2020	9.2	22.6	10	0
2021	2.6	11	14	0
2022	20.7	85.7	16	0

3.3.5.2 Channel Lake – RTI

Channel Lake water quality was monitored by Illinois EPA in 2012, 2017 and 2022 (only partial data), the LCHD (2014) and through the Illinois VLMP (annually). In addition, the health department monitors waters around swimming beaches for harmful algal blooms and unsafe levels of E. coli. Table 3-10 shows the parameters and number of samples collected. Channel Lake typically undergoes seasonal stratification. To provide insight into the difference in parameters above and below the thermocline, data was organized into shallow (≤4 ft) and deep (≥10 ft) groups. However, this grouping is imperfect, as stratification only occurs seasonally and thus some early spring and late fall data from unstratified water may be comingled with data from stratified water. Sediment data show that Channel Lake is relatively clear throughout the entire water column, but chlorophyll α, a measure of suspended algae can be elevated at times, raising TSS. Channel and Catherine Lakes are the most hydraulically isolated from the Fox River which is the likely driver of low TSS.

Table 3-10: Channel Lake Water Quality Data Summary

PARAMETER	UNITS	TOTAL SAMPLES	OVERALL MEAN	NUMBER OF DEEP SAMPLES	MEAN OF DEEP SAMPLES	NUMBER OF SHALLOW SAMPLES	MEAN OF SHALLOW SAMPLES
Alkalinity	mg/L	43	205	16	225	27	192.7
Ammonia as N	mg/L	38	1.3	15	3.1	23	0.09
Chloride	mg/L	19	92.3	8	94.2	11	91
Chlorophyll α	µg/L	27	28.4	11	11.7	3	80
Secchi Disk Depth (VLMP)	in	149	59.2	-	-	-	-
Secchi Disk Depth	in	23	50.2	-	-	-	-
Dissolved Oxygen	mg/L	289	6.1	159	4.2	59	8.8
Dissolved Oxygen Saturation	%	279	67.8	154	44.4	54	99.7
Kjeldahl Nitrogen	mg/L	43	2	16	3.5	27	1
Microcystin	µg/L	48	9.4	-	-	48	9.4
Nitrate + Nitrite	mg/L	33	0.07	11	0.07	22	0.07
Orthophosphate	mg/L	38	0.19	15	0.43	23	0.03
pH	SU	289	7.9	159	7.6	59	8.2
Specific Conductance	µS/cm	288	613	159	622	58	573
Temperature, Water	C	279	19.3	154	17.5	54	21.5
Total Phosphorus	mg/L	43	0.2	16	0.44	27	0.06
Total Suspended Solids	mg/L	41	6	15	4.8	26	6.7
Turbidity	NTU	27	13.3	9	26.3	18	6.8
Volatile Suspended Solids	mg/L	31	4.6	10	3.5	21	5.1

Dissolved Oxygen is collected as a depth profile in Channel Lake. Example depth profiles are in Figure 3-25 and Figure 3-26 and show typical conditions before seasonal thermal stratification and while stratified. The thermocline is estimated to be around 10 ft. Figure 3-27 shows all DO samples collected since 2010.

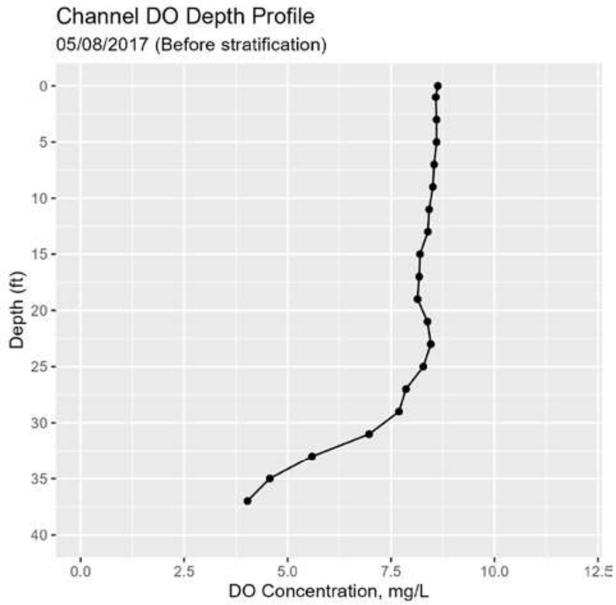

Figure 3-25: Channel Lake Unstratified DO Profile

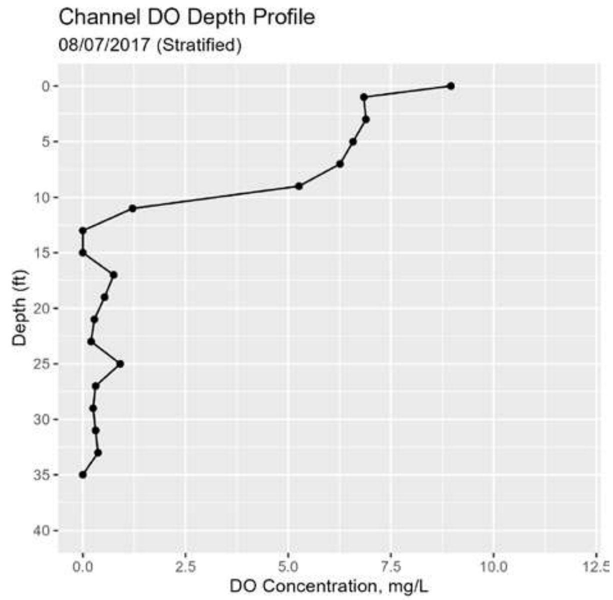

Figure 3-26: Channel Lake Stratified DO Profile

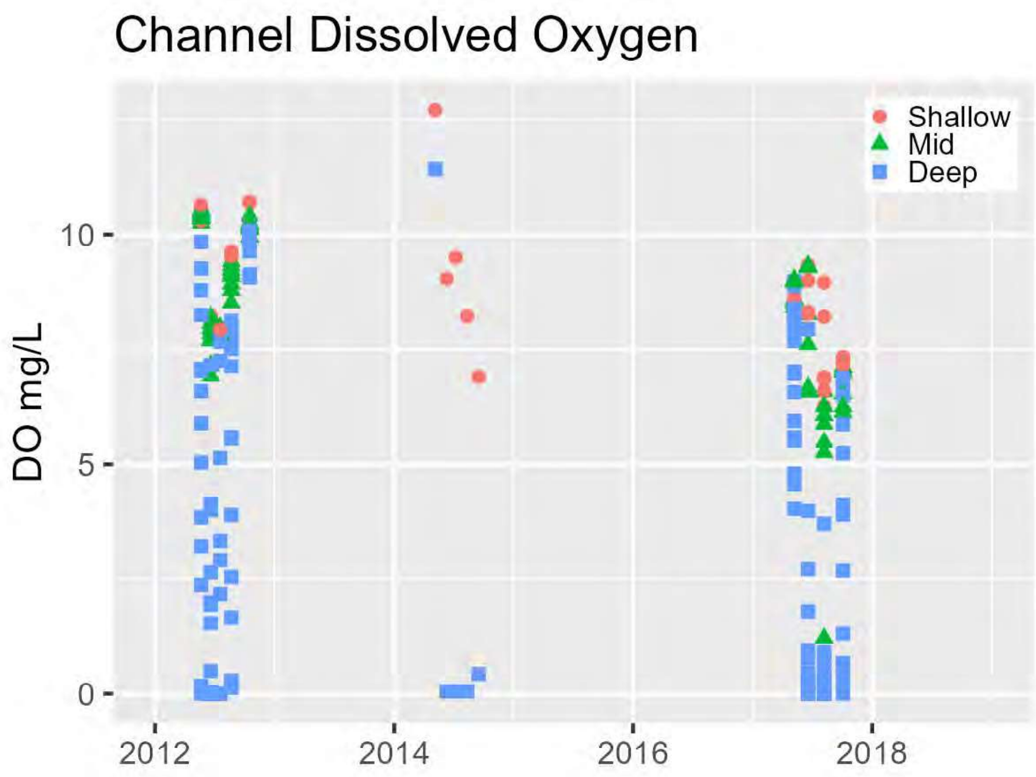

Figure 3-27: Channel DO

The Upper Fox River-Chain O' Lakes TMDL identified a TP load of 13.4 lbs/day for Channel Lake by grouping Lake Catherine and Channel together as one body of water, and with negligible flow from Lake Marie. The report indicated external phosphorus load originates from the lakes' watershed, much of which drains into Channel and Catherine from Trevor Creek and, therefore, the internal load is only 2.8 lbs/day.

Data presented in Figure 3-28 illustrates the increased phosphorus levels in the deep part of the lake during periods of stratification, which then becomes available to algae and plants as it diffuses across the thermocline and mixes with the upper layers of water during fall turnover and through limited summer diffusion across the thermocline. This phosphorus is released from the sediment in dissolved form and is an important component of internal loading. As illustrated in Figure 3-28, 13 of 27 shallow TP samples in Channel Lake are above the 0.05 mg/L water quality standard. The TMDL calculated a 49% reduction in TP load is needed to meet the water quality standard.

Orthophosphate (dissolved phosphorus) makes up a low proportion of TP in shallow samples (Figure 3-29). This is an indication that during the summer, most phosphorus above the thermocline is of particulate form and associated with suspended sediments or algae. The reverse is true below the thermocline, as most phosphorus is dissolved, indicating it has been released by bottom sediments in low oxygen conditions.

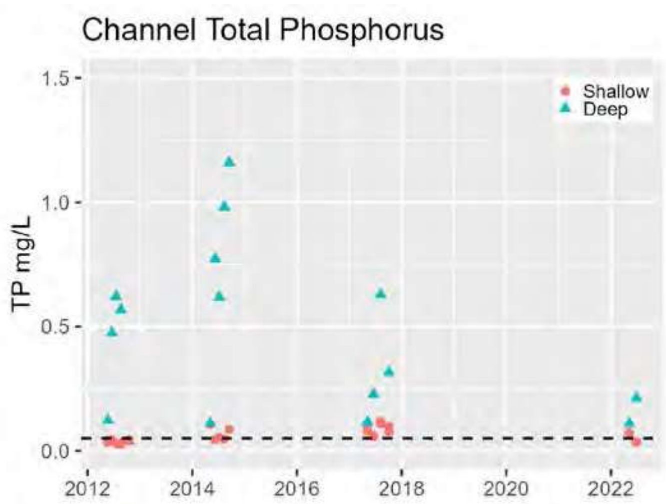

Figure 3-28: Channel Lake TP

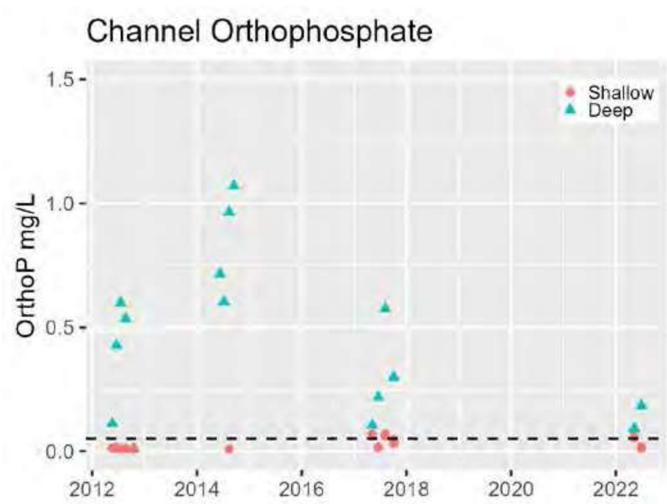

Figure 3-29: Channel Lake Orthophosphate

Samples of TSS are below the 18.2 mg/L target value and appear to have been declining since 2012 (Figure 3-30). This trend also is reflected in annual mean Secchi measurements collected by local volunteers through the Illinois VLMP and by the Friends of Lake Catherine and Channel Lake in 2022 (Figure 3-31). As VLMP data is collected annually, it provides important insight into trends that occur between more comprehensive sampling by agencies such as Illinois EPA and the LCHD.

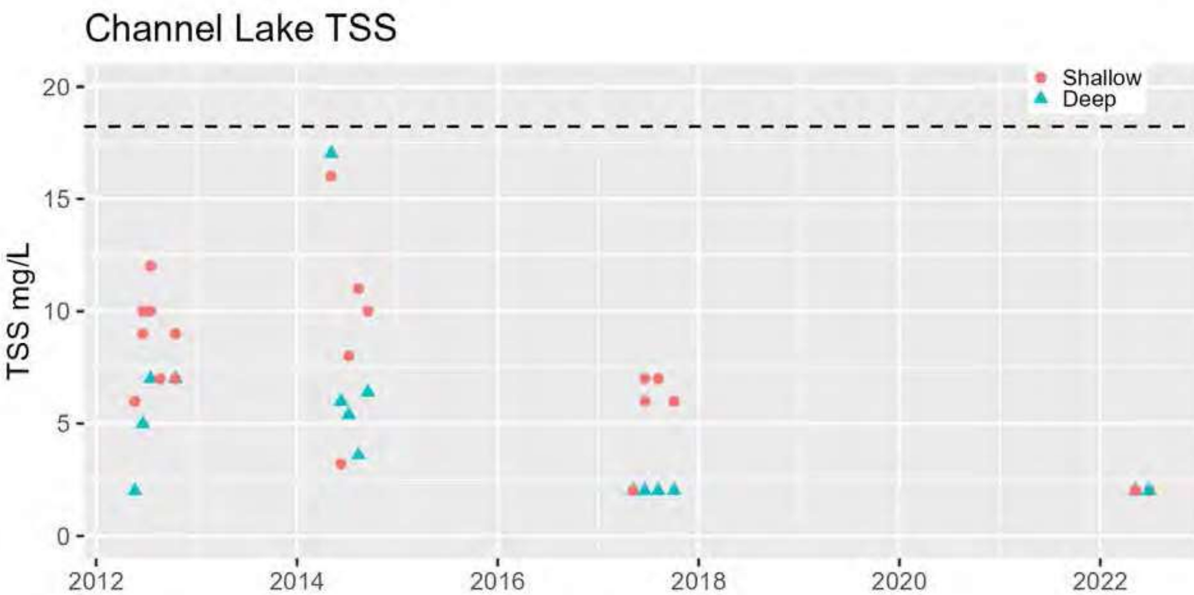

Figure 3-30: Channel Lake TSS

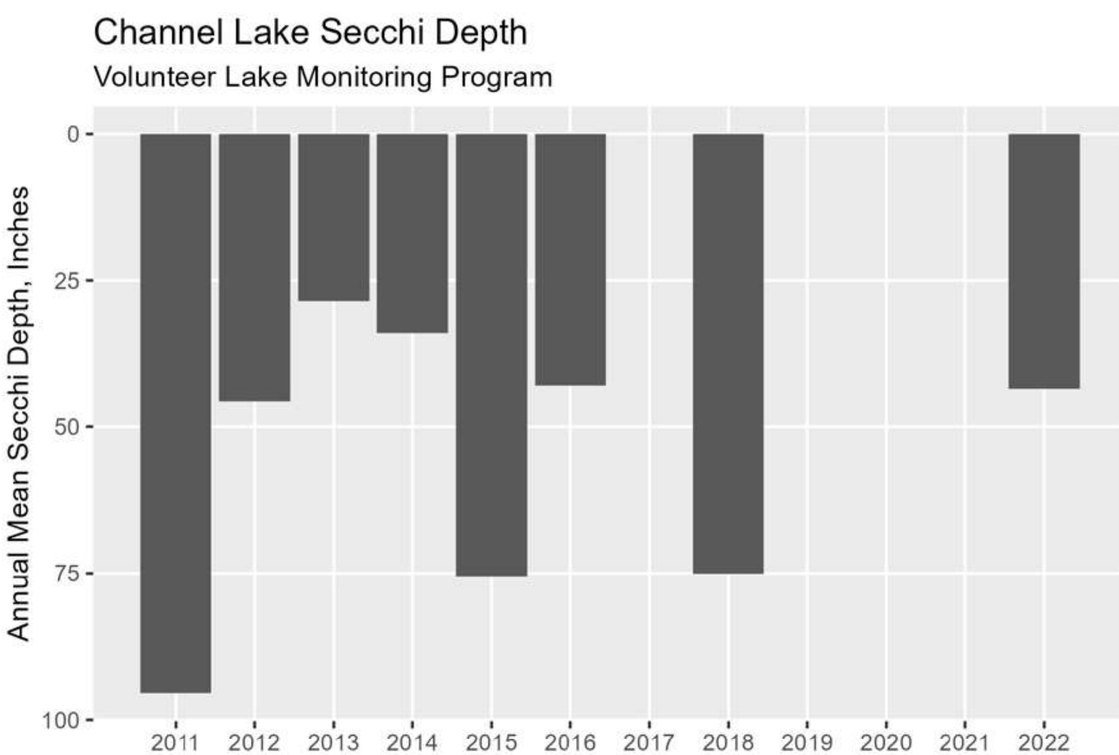

Figure 3-31: Channel Lake Secchi Depth

Bacteria levels are monitored at inland lake beaches by the LCHD twice monthly from May to September. If samples are above 235 CFU/100 mL, the health department informs the beach manager, and a beach closure is issued. Three beaches on Channel Lake are monitored routinely, with a total of 18 closures between 2010 and 2022 (Table 3-11). Turtle Beach Marina experienced the highest number of closures, or 12. Bluff's Subdivision was closed only once in 2017.

Table 3-11: Channel Lake Beaches E. coli

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER OF CLOSURES
Bluff's Subdivision				
2010	2	19.7	8	0
2011	3.6	24.9	16	0
2012	1.5	10.8	14	0
2013	7.9	75.9	14	0
2014	3.6	62.7	12	0
2015	1.5	47.1	12	0
2016	1	88.4	14	0
2017	**9.7**	**115**	**16**	**1**
2018	3.1	649	16	0
2019	8.5	93.3	14	0
2020	9.7	20.1	12	0
2021	2	146	14	0
2022	3.1	25.9	16	0
Turtle Beach Marina				
2010	7.4	2,419	22	0
2011	54.7	291	18	0
2012	10.4	770	16	0
2013	31.4	83.6	16	0
2014	7.9	19.9	12	0
2015	35.6	228	12	0
2016	16.65	57.6	14	0
2017	**23.3**	**1,733**	**22**	**3**
2018	**50.65**	**2,419**	**18**	**2**
2019	157	2,419	16	0
2020	34.6	249	12	0
2021	**172**	**2,419**	**32**	**7**
2022	57.6	387.3	20	0
Lake Shore Park Beach				
2010	4.7	148	8	0
2011	7.4	123	16	0
2012	10.9	35	14	0
2013	**4.7**	**2,419**	**18**	**2**
2014	2	51.2	12	0
2015	8.3	27.5	12	0
2016	8.6	59.4	14	0

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER OF CLOSURES
2017	5.8	27.2	12	0
2018	**14.4**	**2,419**	**16**	**1**
2019	**93.9**	**1,986**	**18**	**1**
2020	**99.9**	**1,553**	**8**	**1**
2021	17.9	60.9	14	0
2022	18.4	59.4	16	0

3.3.5.3 Dunns Lake – VTH

Dunns Lake water quality has been monitored by Illinois EPA (full sampling in 2018, limited parameters related to harmful algal bloom monitoring annually), the LCHD (2014) and through the Illinois VLMP. In addition, the LCHD monitors waters around swimming beaches for harmful algal blooms and unsafe levels of E. coli annually. Table 3-12 shows the parameters and number of samples of each collected in Dunns Lake since January 2010. Note the elevated average chlorophyll α, a measure of suspended algae, and microcystin, a type of blue-green algae. The high levels are likely noticeable to the human eye as green tinted water which indicate a nutrient-rich lake environment. Additionally, ammonia is somewhat elevated, which likely is attributable to a WWTP discharge into Dunns Lake prior to its 2022 closure.

Table 3-12: Dunns Lake Water Quality Data Summary

PARAMETER	UNITS	NUMBER OF SAMPLES	OVERALL MEAN
Alkalinity	mg/L	13	211
Ammonia as N	mg/L	9	0.42
Chloride	mg/L	11	125
Chlorophyll α	µg/L	13	47
Secchi Disk Depth	in	13	20
Secchi Disk Depth (VLMP)	in	99	12.5
Dissolved Oxygen	mg/L	37	10.6
Dissolved Oxygen Saturation	%	32	124
Kjeldahl Nitrogen	mg/L	13	8
Microcystin	µg/L	53	6.11
Nitrate + Nitrite	mg/L	10	0.22
Orthophosphate	mg/L	8	0.02
pH	SU	37	8.1
Specific Conductance	µS/cm	37	755
Temperature, water	C	32	22.3
Total Phosphorus	mg/L	13	0.08
Total Suspended Solids	mg/L	13	22.2
Volatile Suspended Solids	mg/L	8	10.9

Dissolved Oxygen is collected as a depth profile in Dunns Lake, however, the lake is shallow and does not thermally stratify. A typical depth profile is shown in Figure 3-32, and a plot of all DO results is shown in Figure 3-33. Dissolved Oxygen during the growing season is elevated and indicates a high algal or aquatic plant population.

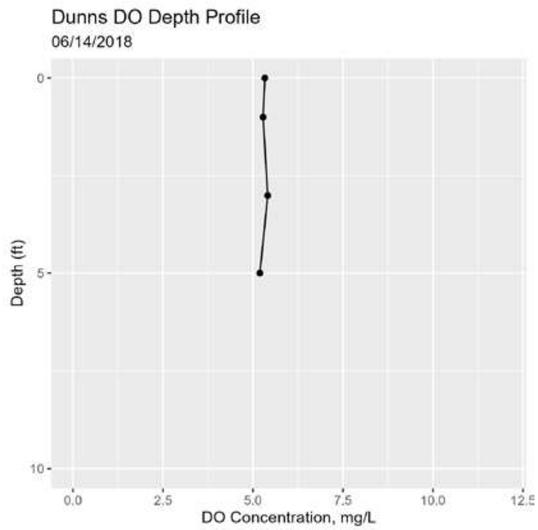

Figure 3-32: Dunns Lake DO Profile

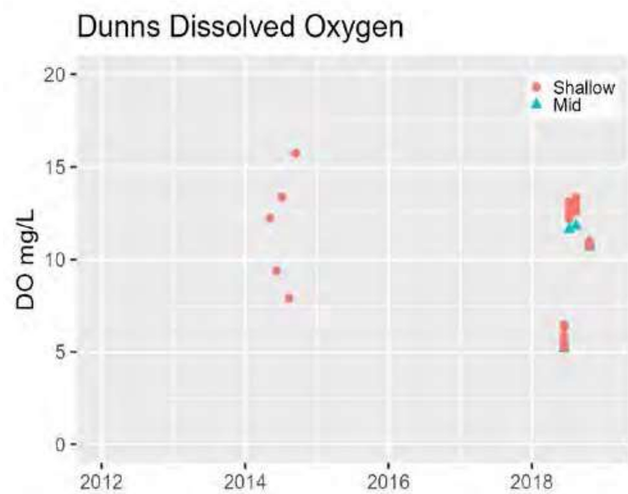

Figure 3-33: Dunns Lake DO

Total Phosphorus samples were collected in 2014 and 2018 by the LCHD and Illinois EPA, respectively (Figure 3-34). Twelve of the 13 total samples were above the 0.05 mg/L TP standard. The TMDL calculated the TP load for Dunns Lake to be 1.34 lbs/day, with a 41% reduction needed. Nearly half the annual load (229.8 lbs/yr) was estimated to be from the Fox Lake Tall Oaks WWTP. This plant was decommissioned in 2022 with wastewater now being sent to the Fox Lake Northwest Regional Sewer Treatment Plant, and there is no longer a point source load to Dunns Lake. Future data collection should show the impact of this reduction in load.

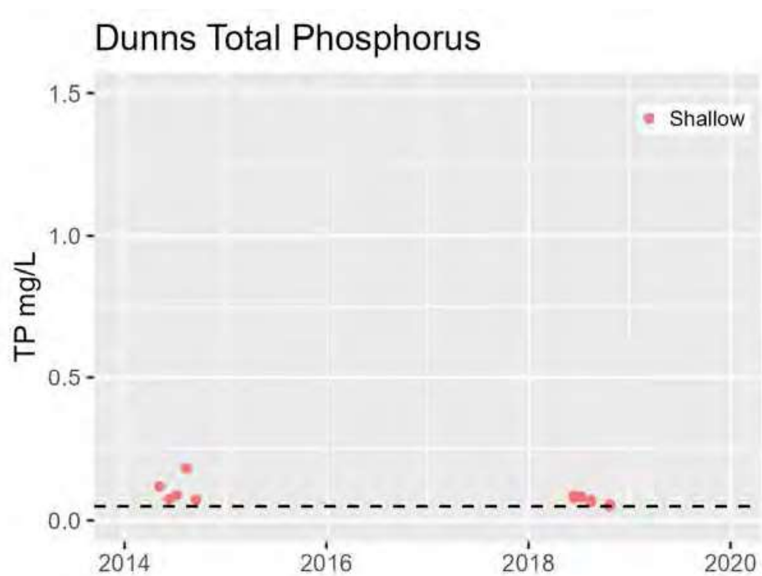

Figure 3-34: Dunns Lake TP

Total Suspended Solids were measured in 2014 and 2018. Levels were well above the Illinois EPA recommended target of 18.2 mg/L for most samples (Figure 3-35). Secchi disk depth was measured by volunteers from 2014 to 2017. The average Secchi depth is quite shallow, (Figure 3-36) and indicates high levels of TSS, which includes both sediments and algae.

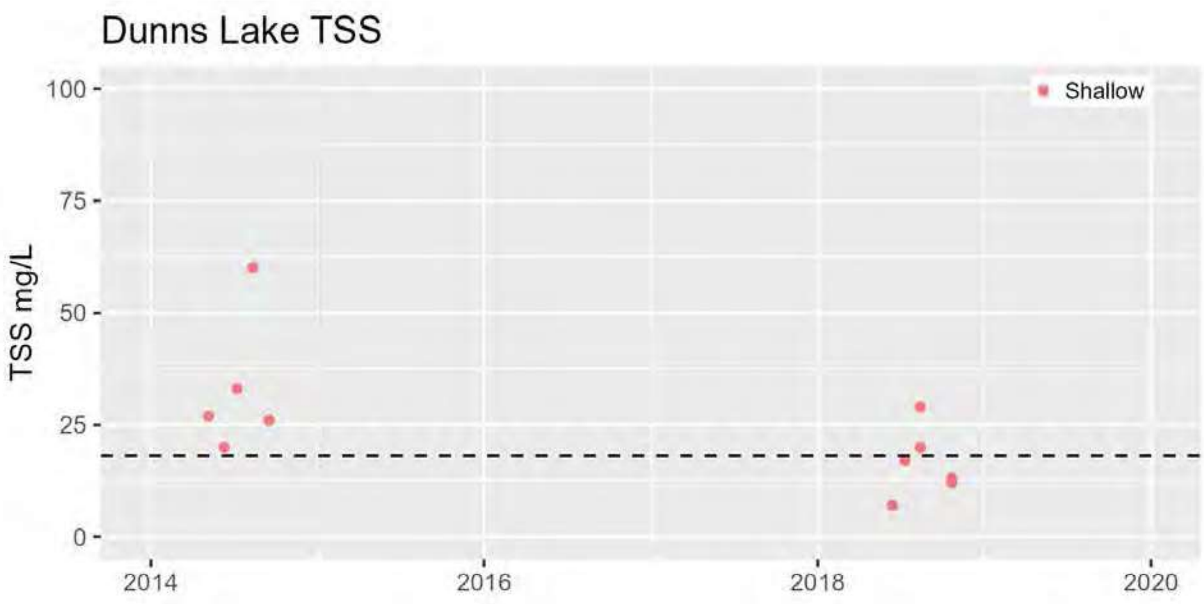

Figure 3-35: Dunns Lake TSS

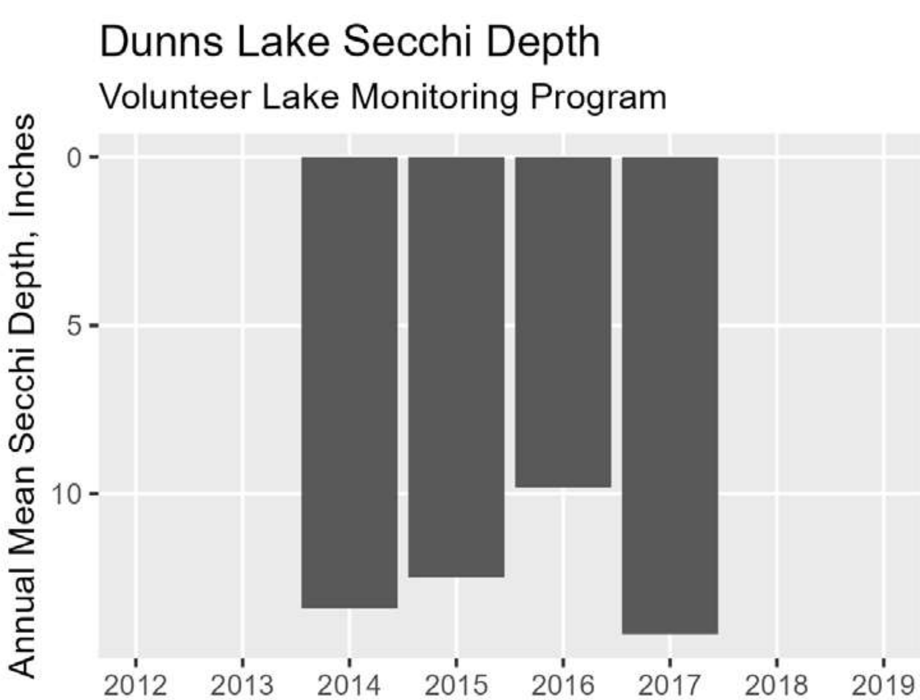

Figure 3-36: Dunns Lake Secchi Depth

Illinois EPA monitors microcystin annually, a toxic compound produced by blue green algae. In Dunns Lake, 5 of 53 samples collected since 2014 were above the 8 µg/L public health advisory level (Figure 3-37), indicating a frequent issue with harmful algal blooms on Dunns Lake.

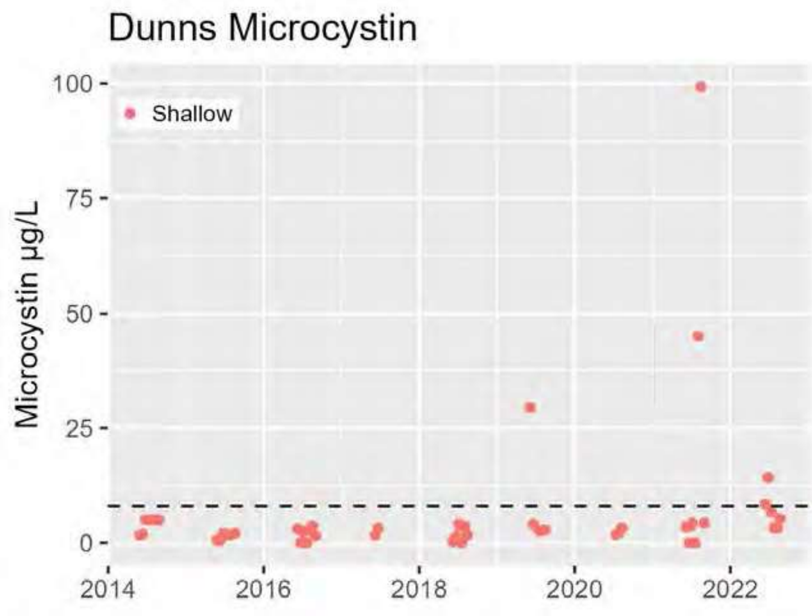

Figure 3-37: Dunns Lake Microcystin

E. coli levels are measured near the Dunns Lake Beach swimming area (Table 3-13). Beach closure data was not available for Dunns Lake Beach, but typically, if samples are above 235 CFU/100 mL, the health department informs the beach manager, and a swim ban is issued.

Table 3-13: Dunns Lake Beach E. coli

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER OF CLOSURES
2010	34.1	2,419	22	0
2011	51.1	199	16	0
2012	39	2,419	16	0
2013	13.5	55.6	14	0
2014	16.3	435	16	0
2015	18.3	45.5	14	0
2016	20.8	108	14	0
2017	31.5	148	12	0
2018	16.7	157	12	0
2019	37.9	816	14	0
2020	13.3	2,419	12	0
2021	57.1	410	21	0
2022	28.5	172	16	0

3.3.5.4 Fox Lake – RTF

Fox Lake was monitored in 2012, 2014, 2017, and 2022. General water quality parameters were collected, as noted in Table 3-14. Fox Lake is shallow and does not thermally stratify. It receives runoff from its own local watershed and from Manitou Creek, which is outside the planning area. Water quality data is consistent with a nutrient rich environment having elevated phosphorus, TSS and DO.

Table 3-14: Fox Lake Water Quality Data Summary

PARAMETER	UNITS	TOTAL SAMPLES	OVERALL MEAN
Alkalinity	mg/L	42	222
Ammonia as N	mg/L	39	0.09
Chloride	mg/L	33	126
Chlorophyll α	µg/L	27	58.9
Secchi Disk Depth	in	23	18
Secchi Disk Depth (VLMP)	in	141	21
Dissolved Oxygen	mg/L	113	9
Dissolved Oxygen Saturation	%	103	100
Kjeldahl Nitrogen	mg/L	43	1.56
Microcystin	µg/L	13	0.53
Nitrate + Nitrite	mg/L	37	0.26
Orthophosphate	mg/L	32	0.02
pH	SU	113	8.2
Specific Conductance	µS/cm	113	741.8
Temperature, Water	C	103	20.5
Total Phosphorus	mg/L	43	0.1
Total Suspended Solids	mg/L	42	21.1
Turbidity	NTU	27	23.7
Volatile Suspended Solids	mg/L	32	11.4

Dissolved Oxygen is generally in an appropriate range above 5 mg/L. Illinois EPA collected DO data as a depth profile, and the LCHD as a surface and near-bottom sample pair. The lake is generally well mixed and aerated, as illustrated in Figure 3-38. In 2012, several samples showed low DO, under 5.0 mg/L, however, these samples appear to be outliers and possibly were taken in or directly on the surface of the sediment. Figure 3-39 shows a typical depth profile with a bottom sample that appears to be of poor data quality.

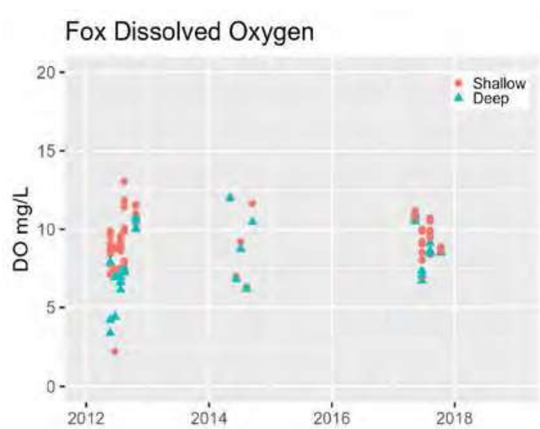

Figure 3-38: Fox DO

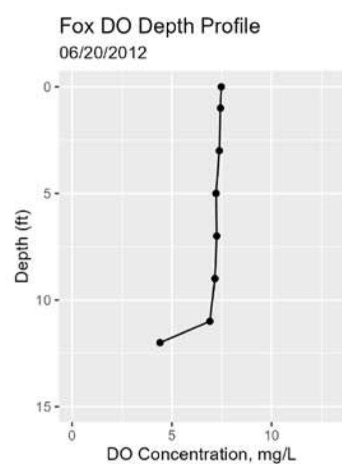

Figure 3-39: Fox DO Profile

The TMDL estimated that the TP load to Fox Lake is 183 lbs/day. This includes outflows from Grass, Petite, Duck and Long Lakes, as well as runoff from the watershed and internal loading. The internal load was calculated to be 19.4 lbs/day versus 4.3 lbs/day from the watershed for a total of 66,795 lbs annually. A 70% reduction is needed to meet the water quality standard. Total Phosphorus and orthophosphate samples were collected in 2012, 2014, 2017, and 2022. Twenty-three of 27 TP samples exceeded the 0.05 mg/L standard (Figure 3-40). Orthophosphate makes up a small percentage of TP samples (Figure 3-41) and is an indication that much of the phosphorus is in particulate form or in algae, which is confirmed by elevated TSS numbers discussed below.

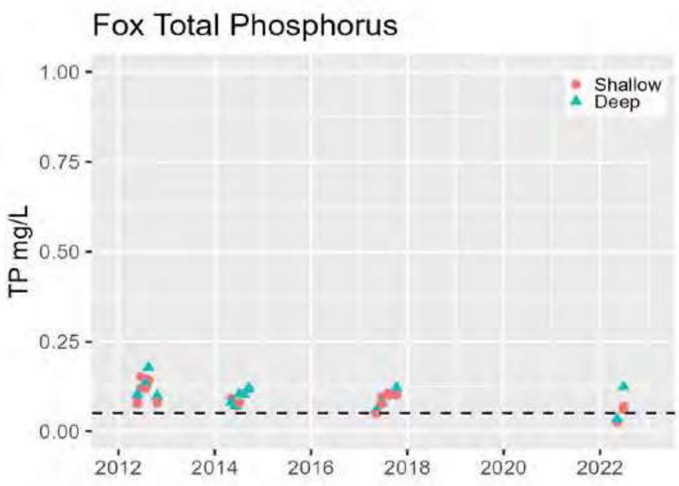

Figure 3-40: Fox Lake TP

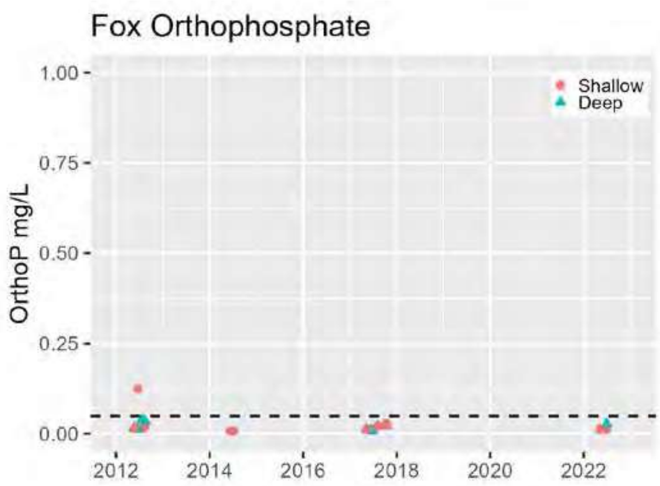

Figure 3-41: Fox Lake Orthophosphate

Total Suspended Solids are frequently above the 18.2 mg/L target, though they appear to be decreasing (Figure 3-42). Secchi disk depth was collected most years from 2011-2016 by volunteers (Figure 3-43).

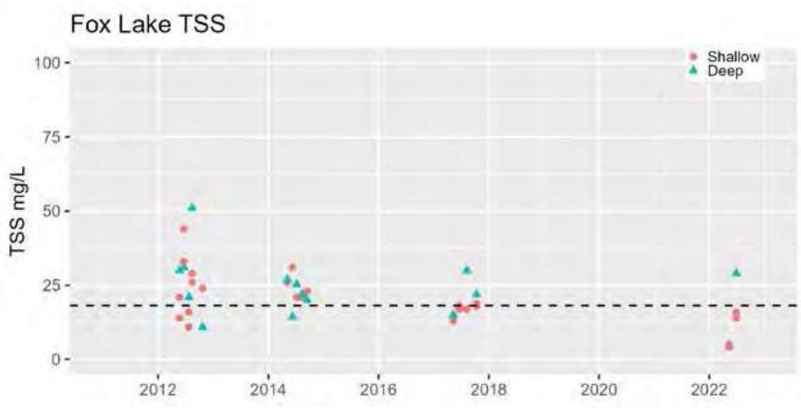

Figure 3-42: Fox Lake TSS

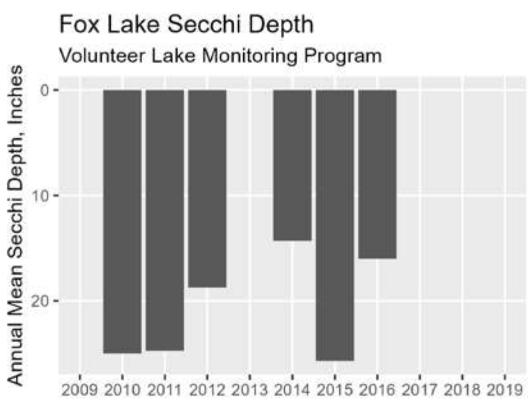

Figure 3-43: Fox Lake Secchi Depth

E. coli samples are taken at Fox Lake beaches and those collected since 2010 have resulted in 8 swim bans through 2021 (Table 3-15). If samples are above 235 CFU/100 mL, the health department informs the beach manager, and a beach closure is issued. Stanton Bay Park had 1 closure in 2014 and 2019, and 2 in 2020.

Table 3-15: Fox Lake Beaches E. coli

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER OF CLOSURES
Buena Park				
2010	19.8	275	8	0
2011	27.7	579	14	0
2012	**30.6**	**727**	**14**	**1**
2013	13.3	178	14	0
2014	46.6	2,419	14	0
2015	7.95	37.3	14	0
2016	20.5	47.9	14	0
2017	18.2	198	12	0
2018	20.6	83.3	12	0
2019	**128**	**2,419**	**18**	**3**
2020	40.9	162	12	0
2021	15.3	248	18	0
2022	32.4	2,419	18	0
Stanton Bay Park				
2010	59.8	387	11	0
2011	129	261	16	0
2012	14.6	110	14	0
2013	7.4	28.5	14	0
2014	**32.8**	**214**	**12**	**1**
2015	14.8	62	14	0
2016	27.4	222	14	0
2017	18.3	173	12	0
2018	25.9	172	12	0
2019	**34.6**	**2,419**	**16**	**1**
2020	**34.2**	**416**	**12**	**2**
2021	5.2	148	17	0
2022	282	2,419	36	0

3.3.5.5 Grass Lake – RTQ

Grass Lake is the most upstream lake on the Chain and receives most of its flow from the Fox River and its watershed of over 600,000 acres in Wisconsin. Grass is shallow and does not thermally stratify. Water quality data is available for 2012, 2014, 2017, and 2022 (Table 3-16). Data indicates that Grass Lake is a nutrient-rich environment. The TSS data indicates a high sediment load in the lake, from both resuspension of lake sediments and the Fox River.

Table 3-16: Grass Lake Water Quality Data Summary

PARAMETER	UNITS	TOTAL SAMPLES	OVERALL MEAN
Alkalinity	mg/L	27	242
Ammonia as N	mg/L	22	0.06
Chloride	mg/L	23	131
Chlorophyll α	µg/L	27	80.4
Secchi Disk Depth	in	23	14.4
Secchi Disk Depth (VLMP)	in	88	14.5
Dissolved Oxygen	mg/L	56	11.4
Dissolved Oxygen Saturation	%	51	130
Kjeldahl Nitrogen	mg/L	27	1.5
Microcystin	µg/L	10	0.09
Nitrate + nitrite	mg/L	26	0.49
Orthophosphate	mg/L	22	0.02
pH	SU	56	8.3
Specific Conductance	µS/cm	56	809
Temperature, Water	C	51	20.7
Total Phosphorus	mg/L	27	0.12
Total Suspended Solids	mg/L	27	33.9
Turbidity	NTU	18	32
Volatile Suspended Solids	mg/L	22	14.4

Dissolved Oxygen is typically collected as a depth profile, though the lake is too shallow to thermally stratify.

Samples have been in an appropriate range above the DO standard, however, there were very high values measured in 2012, which indicates high levels of algae or aquatic plants, a symptom of nutrient enrichment (Figure 3-44).

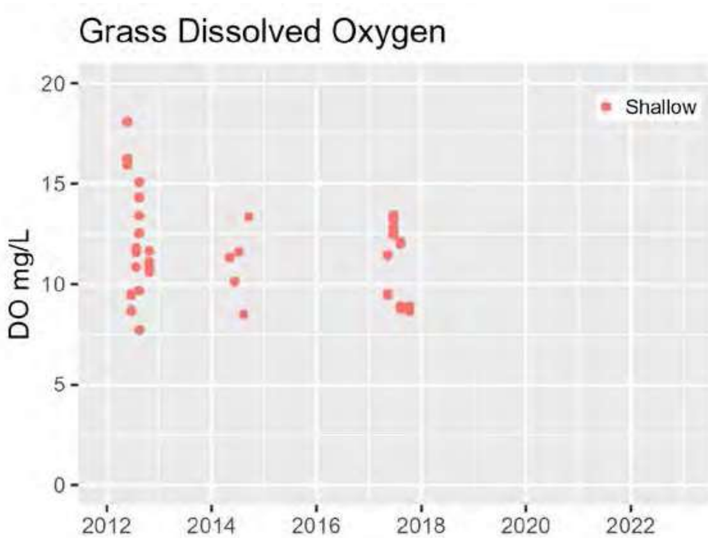

Figure 3-44: Grass Lake DO

The TMDL calculated a TP load of 424 lbs/day. Internal loading is a minor contribution at only 29.4 lbs/day. External inputs from the Fox River are estimated to be 385 lbs/day. Overland runoff directly to Grass Lake and flows from Lake Marie contribute about 10 lbs/day. To meet the TP standard of 0.05 mg/L, a 76% reduction is needed. In the 4 years of monitoring, 26 of 27 samples were above 0.05 mg/L (Figure 3-45). In Grass Lake, orthophosphate makes up a small proportion of TP (Figure 3-46), indicating that most phosphorus is in particulate form, bound to sediments and in algae.

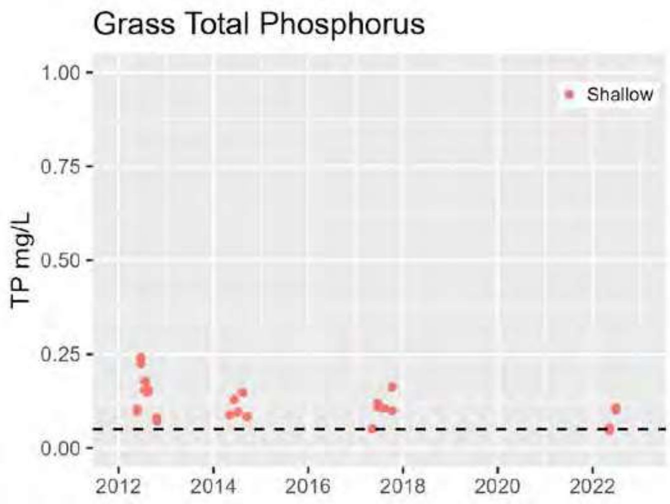

Figure 3-45: Grass Lake TP

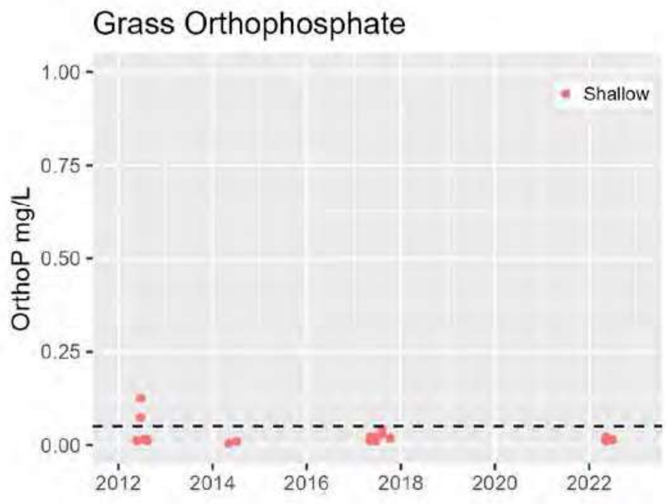

Figure 3-46: Grass Lake Orthophosphate

Total Suspended Solids are consistently above the 18.2 mg/L target (Figure 3-47). Grass Lake is shallow, and wind and boat traffic cause wave action that leads to resuspension of sediments, combined with the sediment load from the Fox River and sources such as shoreline erosion. Volunteers collected Secchi Depth from 2013-2018, as shown in Figure 3-48.

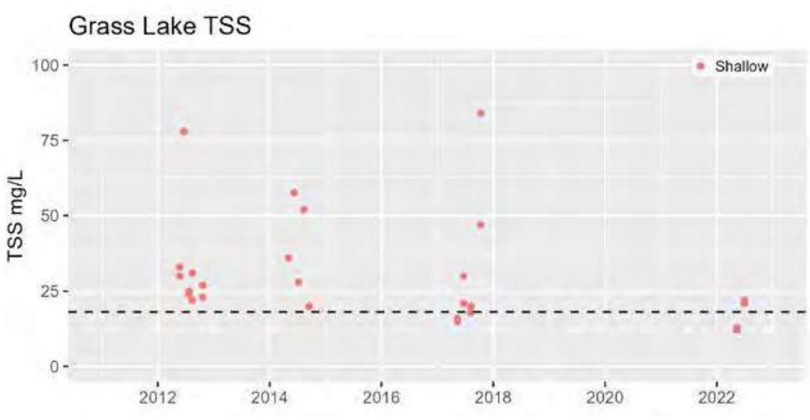

Figure 3-47: Grass Lake TSS

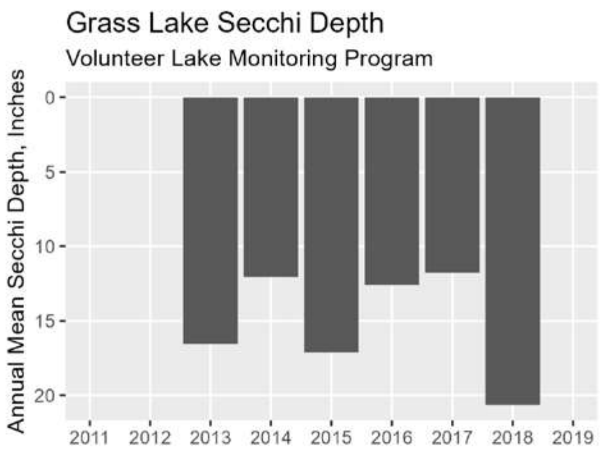

Figure 3-48: Grass Lake Secchi Depth

E. coli sampling at the Grass Lake Marina beach has identified high bacterial levels in most years. These high numbers have led to 17 beach closures since 2012 (Table 3-17).

Table 3-17: Grass Lake Marina E. coli

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER OF SWIM BANS
2010	21.8	770	21	0
2011	35.1	1,986	16	0
2012	**13.4**	**1,553**	**16**	**3**
2013	**16**	**2,419**	**14**	**1**
2014	**15.8**	**980**	**17**	**4**
2015	**126**	**1,120**	**16**	**4**
2016	81.6	185	10	0
2017	5.8	70.3	10	0
2018	**15.5**	**770**	**14**	**1**
2019	8	63.1	12	0
2020	**30.5**	**770**	**16**	**1**
2021	**52.4**	**1,046**	**22**	**3**
2022	42.2	123	14	0

3.3.5.6 Lake Catherine – RTD

Water quality data was collected in 2012, 2014, 2017, and 2022 and is summarized in Table 3-18, with selected parameters further explored thereafter. Data indicates the lake is eutrophic with high algae and plant populations, but also with high water clarity due to its relatively isolated location in the Chain, away from the influence of sediment-rich water from the Fox River. Lake Catherine has a large interface with Channel Lake, though it was previously separated by a now-eroded sand and gravel bar. The lake thermally stratifies seasonally.

Table 3-18: Lake Catherine Water Quality Data Summary

PARAMETER	TOTAL SAMPLES	UNITS	OVERALL MEAN	NUMBER OF DEEP SAMPLES	MEAN OF DEEP SAMPLES	NUMBER OF SHALLOW SAMPLES	MEAN OF SHALLOW SAMPLES
Alkalinity	43	mg/L	204.4	16	226	27	191
Ammonia as N	38	mg/L	1.2	16	2.7	22	0.11
Chloride	19	mg/L	94.4	8	96.9	11	92.6
Chlorophyll α	27	µg/L	23.1	23	16.4	4	61.5
Secchi Disk Depth	24	in	62.6	-	-	-	-
Dissolved Oxygen	318	mg/L	5.6	241	4.6	77	8.8
Dissolved Oxygen Saturation	308	%	62.5	236	51.1	72	99.9
Kjeldahl Nitrogen	42	mg/L	-	16	3.5	26	-
Microcystin	50	µg/L	14	-	-	50	14
Nitrate + Nitrite	33	mg/L	0.08	11	0.07	22	0.08

PARAMETER	TOTAL SAMPLES	UNITS	OVERALL MEAN	NUMBER OF DEEP SAMPLES	MEAN OF DEEP SAMPLES	NUMBER OF SHALLOW SAMPLES	MEAN OF SHALLOW SAMPLES
Orthophosphate	38	mg/L	0.19	16	0.43	22	0.02
pH	318	SU	7.8	241	7.6	77	8.2
Specific Conductance	317	µS/cm	614	241	625	76	577
Temperature, Water	308	C	18.4	236	17.4	72	21.4
Total Phosphorus	43	mg/L	0.21	16	0.47	27	0.05
Total Suspended Solids	40	mg/L	5.4	14	4.3	26	6
Turbidity	27	NTU	13.1	9	27.7	18	5.8
Volatile Suspended Solids	30	mg/L	3.9	9	3	21	4.2

Dissolved Oxygen is collected as a depth profile in Lake Catherine. The lake undergoes seasonal stratification, and a typical profile is presented in Figure 3-49. A profile with unstratified conditions was unavailable. The low DO measured below the thermocline is typical of stratified lakes, and this very low DO creates the conditions that release available phosphorus from sediments into the water column, which is an important source of nutrients that can lead to algal blooms and further eutrophication (Figure 3-50).

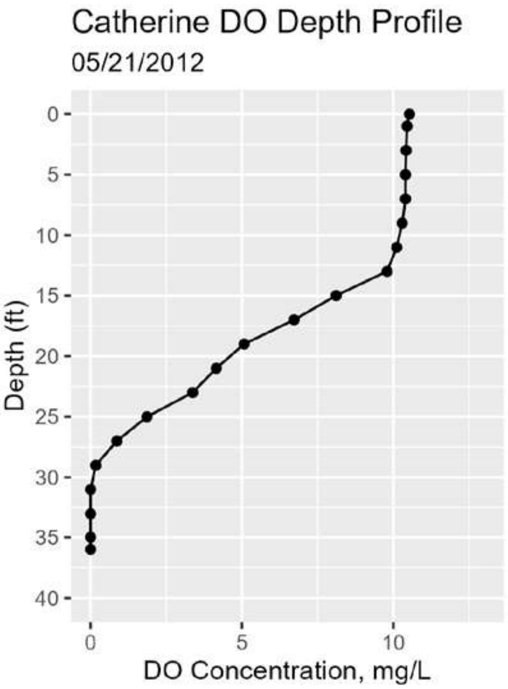

Figure 3-49: Lake Catherine Stratified DO Profile

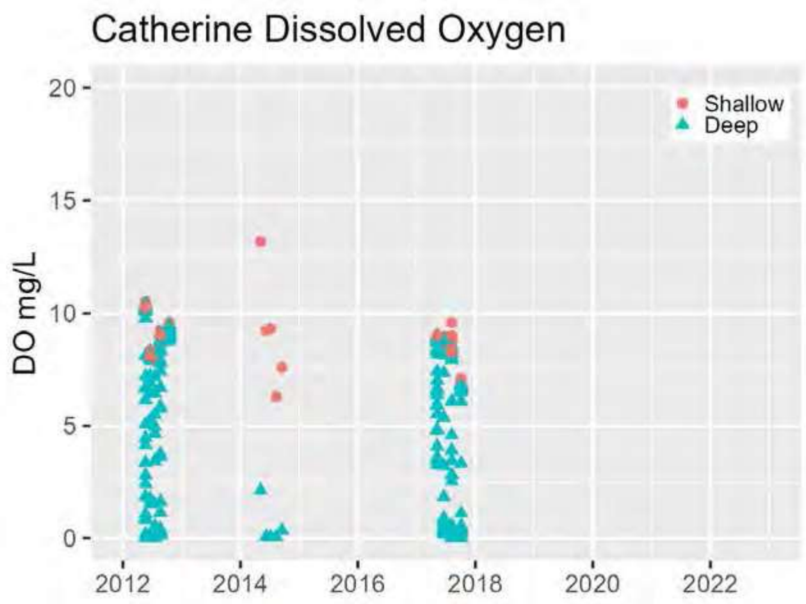

Figure 3-50: Lake Catherine DO Data

The TMDL calculated a TP load to Lake Catherine of 5.2 lbs/day, 1.32 lbs/day of this generated internally, and 3.9 lbs/day from the watershed. The TP from Lake Marie was assumed to be negligible based on the limited flows observed from Lake Marie into Channel Lake and Lake Catherine. Most of the watershed feeding Lake Catherine is in Wisconsin, outside the planning area. The TMDL calculated a 7% reduction in TP is needed to meet the water quality standard of 0.05 mg/L. Eleven of 27 samples (41%) taken near the surface were above the standard (Figure 3-51). In Lake Catherine, orthophosphate is a small percentage of TP above the thermocline (Figure 3-52), indicating that it is generally in particulate form or is quickly used up by algae and plants. In deep samples, below the thermocline, orthophosphate generally makes up a very high proportion of TP. This indicates dissolved phosphorus is being released from bottom sediments in low oxygen conditions.

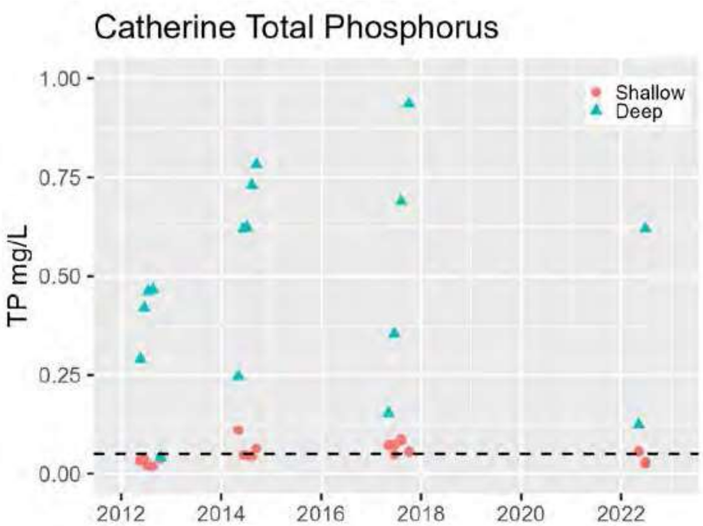

Figure 3-51: Lake Catherine TP

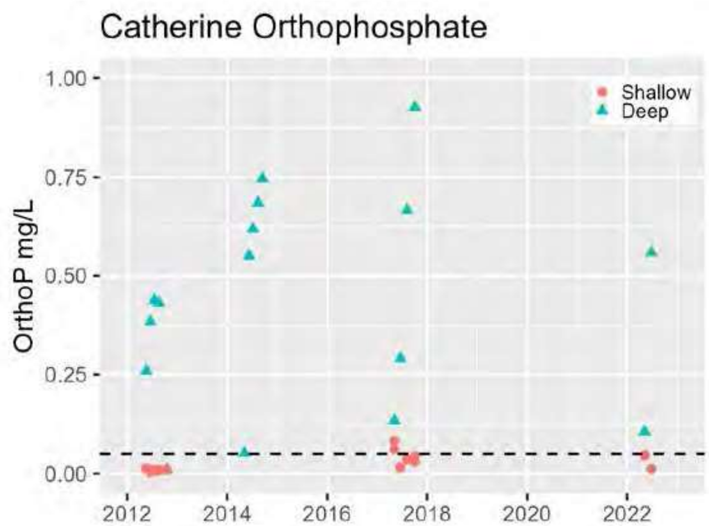

Figure 3-52: Lake Catherine Orthophosphate

Total Suspended Solids have been below the 18.2 mg/L target in each of the sampling events since 2012 (Figure 3-52). Secchi depth was monitored by volunteers annually from 2012 through 2018, and again in 2022 (Figure 3-53).

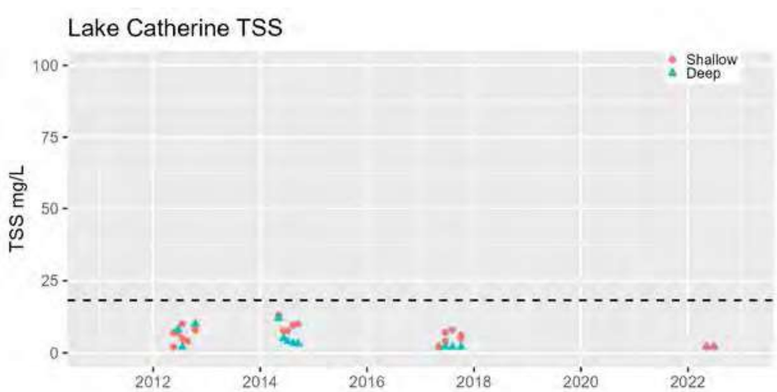

Figure 3-53: Lake Catherine TSS

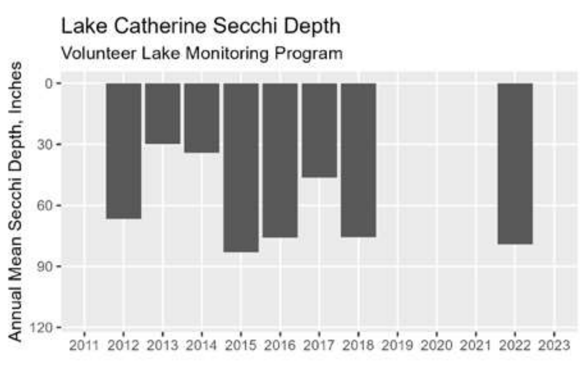

Figure 3-54: Lake Catherine Secchi Depth

The LCHD collects E. coli data annually from three beaches on Lake Catherine. Bacteria levels are generally low at Club Zobak and Warriner's Subdivision II, with a few instances that have resulted in swim bans. At Felters Subdivision, higher levels have resulted in 17 closures, most notably 8 in 2019 alone (Table 3-19).

Table 3-19: Lake Catherine Beaches E. coli

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER OF CLOSURES
Club Zobak				
2010	5.3	64.4	8	0
2011	17	69.7	16	0
2012	5.2	34.1	14	0
2013	14.7	53.8	14	0
2014	4.7	11	12	0
2015	15.5	44.1	12	0
2016	12.2	159	14	0
2017	10.4	83.3	14	0
2018	6.9	47.1	14	0
2019	**60.5**	**1,299**	**18**	**1**
2020	12.1	25.6	10	0
2021	9.2	114	14	0
2022	15.6	62.4	16	0
Warriner's Subdivision II				
2010	5.2	76.2	8	0
2011	4.1	71.2	17	0
2012	**14.3**	**325**	**16**	**1**
2013	24	77.1	16	0
2014	4.1	16	12	0
2015	4.2	150	12	0
2016	21.7	113	14	0
2017	**9.7**	**866**	**16**	**1**
2018	5.2	141	14	0
2019	16.7	260	16	0
2020	19.2	36.4	12	0
2021	12.2	28.5	14	0
2022	56.1	548	22	0
Felters Subdivision				
2010	2.5	13.4	8	0
2011	9.7	158	16	0
2012	8	62.4	14	0
2013	16.5	107	16	0
2014	6.3	14.5	12	0
2015	11.5	50.4	12	0
2016	18	155	14	0
2017	**64.4**	**1,733**	**16**	**1**
2018	27.4	90.9	14	0
2019	**242**	**2,419**	**32**	**8**
2020	**39.5**	**816**	**12**	**1**
2021	**199**	**2,419**	**28**	**7**
2022	55.4	2,419	24	0

3.3.5.7 Lake Marie – RTR

Lake Marie was sampled in 2012, 2014, 2017, and 2022. Results are summarized in Table 3-20. Data indicates the lake is nutrient-rich with average water clarity. It thermally stratifies in the summer months with a thermocline around 12 ft deep as shown in Figure 3-56 versus unstratified conditions shown in Figure 3-55 . This layering of water prevents mixing, and water below the thermocline becomes anoxic, or very low in DO. The low DO measured below the thermocline is typical of stratified lakes (Figure 3-57), and this creates internal loading conditions that release phosphorus from sediments into the water column and can lead to algal blooms and further eutrophication.

Table 3-20: Lake Marie Water Quality Data Summary

PARAMETER	TOTAL SAMPLES	UNITS	OVERALL MEAN	NUMBER OF DEEP SAMPLES	MEAN OF DEEP SAMPLES	NUMBER OF SHALLOW SAMPLES	MEAN OF SHALLOW SAMPLES
Alkalinity	45	mg/L	216	17	227	28	210
Ammonia as N	33	mg/L	0.6	11	1.64	22	0.13
Chloride	23	mg/L	123	8	119	15	124
Chlorophyll α	27	µg/L	49.4	15	35.8	12	66.3
Secchi Disk Depth	23	in	32.7	-	-	-	-
Secchi Disk Depth (VLMP)	86	in	38.6	-	-	-	-
Dissolved Oxygen	194	mg/L	6.5	118	5.2	76	8.4
Dissolved Oxygen Saturation	184	%	72.2	113	57.7	71	95.4
Kjeldahl Nitrogen	35	mg/L	1.73	12	2.57	23	1.29
Microcystin	12	µg/L	0.84	-	-	-	-
Nitrate + Nitrite	38	mg/L	0.19	13	0.18	25	0.2
Orthophosphate	33	mg/L	0.08	11	0.2	22	0.02
pH	194	SU	7.8	118	7.8	76	8.2
Specific Conductance	194	µS/cm	757	118	772	76	735
Temperature, Water	184	C	20.6	113	20	71	21.6
Total Phosphorus	35	mg/L	0.15	12	0.3	23	0.08
Total Suspended Solids	35	mg/L	9.7	17	8.5	23	10.5
Turbidity	27	NTU	13.4	9	17.6	18	11.4
Volatile Suspended Solids	35	mg/L	7.2	12	6.2	23	7.7

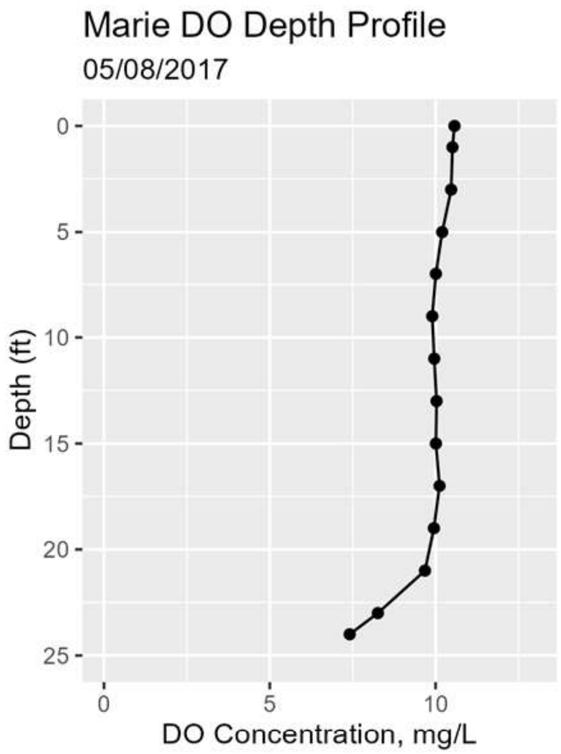

Figure 3-55: Lake Marie Unstratified DO Profile

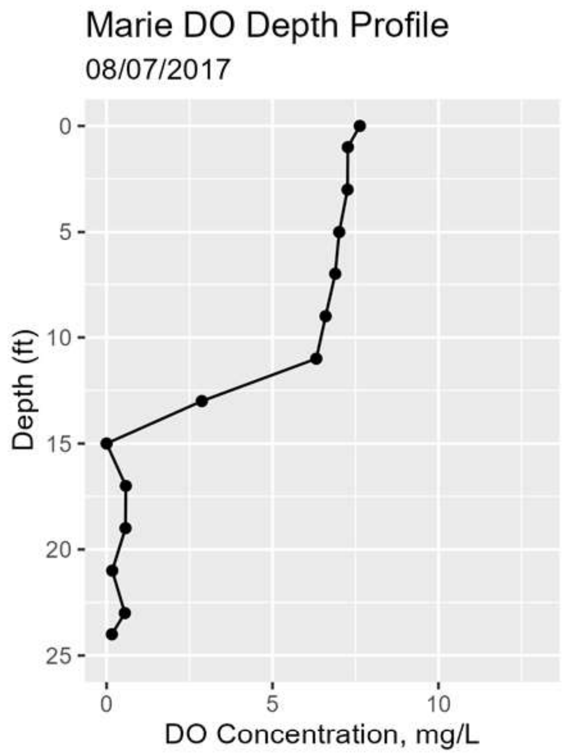

Figure 3-56: Lake Marie Stratified DO Profile

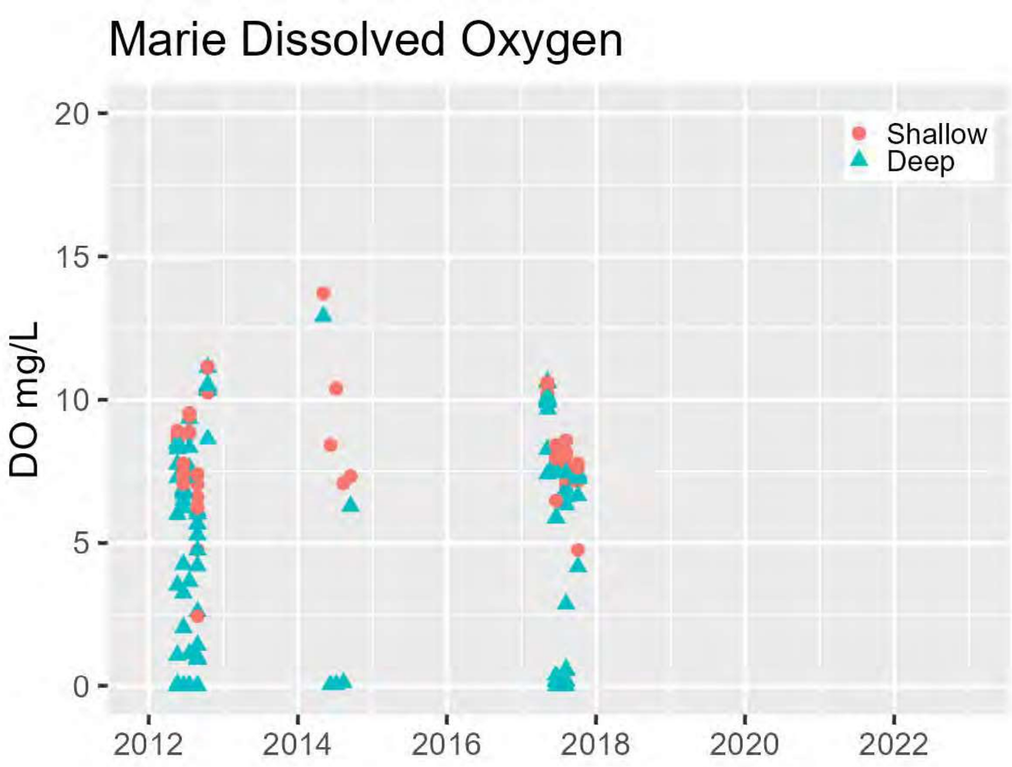

Figure 3-57: Lake Marie DO

Total Phosphorus above the thermocline is typically above 0.05 mg/L or 26 of 28 samples (93%) collected since 2012 (Figure 3-58). Similar frequency of exceedances is also seen in dissolved phosphorus samples (Figure 3-59). The TMDL calculated that a 66% reduction in the annual TP load is needed to meet the water quality standard. Total load is 32.7 lbs/day, with 6.5 lbs/day estimated to come from upstream lake flows (Lake Catherine and Channel Lake), internal loading of 6.57 lbs/day, and 11.1 lbs/day from Lake Marie's watershed, including direct drainage and flows from Sequoit Creek outside the planning area. It should be noted that these daily values exclude the Village of Antioch WWTP which discharges to Sequoit Creek and is responsible for an estimated 8.25 lbs/day.

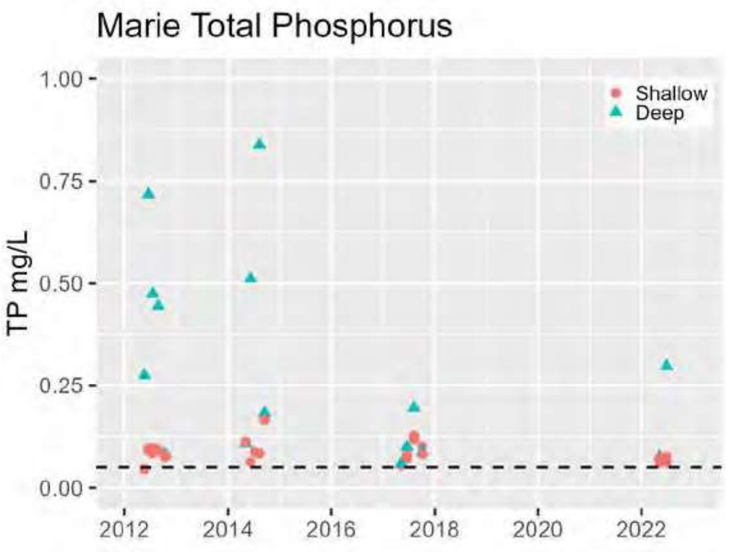

Figure 3-58: Lake Marie TP

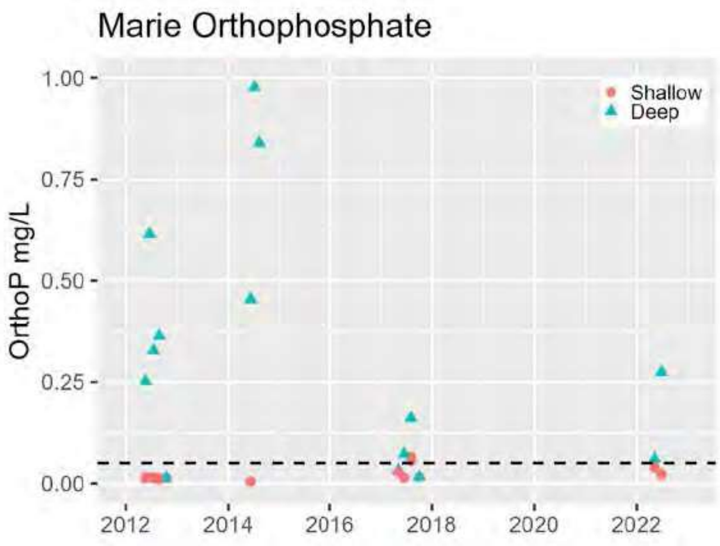

Figure 3-59: Lake Marie Orthophosphate

Total Suspended Solids are typically below the 18.2 mg/L Illinois EPA target, with a small number of samples exceeding the threshold (Figure 3-60). Volunteers collected Secchi readings in 2010, 2014 and 2015 (Figure 3-61). There is no E. coli monitoring data for Lake Marie.

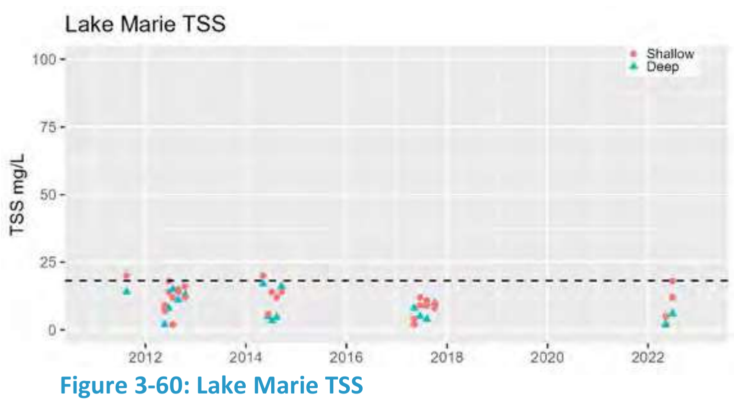

Figure 3-60: Lake Marie TSS

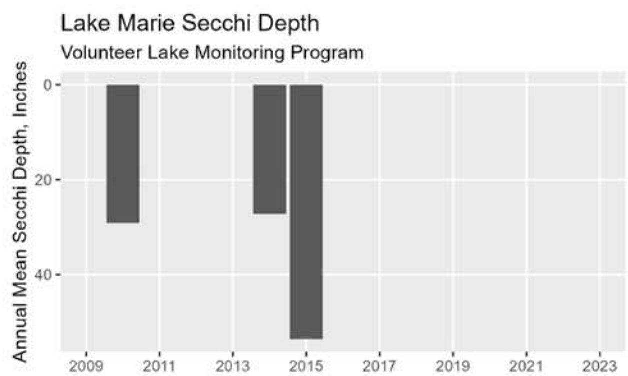

Figure 3-61: Lake Marie Secchi Depth

3.3.5.8 Nippersink Lake -RTUA

Water quality data was collected from Nippersink Lake in 2012, 2014, 2017, and 2022. The lake does not thermally stratify. Table 3-21 gives the average of the samples taken across all years. Chlorophyll α results are elevated, and DO profile data shows that the lake is typically well-mixed (Figure 3-63) with adequate to elevated DO (Figure 3-62) indicating a nutrient-rich environment that supports aquatic plants and algae.

Table 3-21: Nippersink Lake Water Quality Data Summary

PARAMETER	TOTAL SAMPLES	OVERALL MEAN	UNITS
Alkalinity	27	241	mg/L
Ammonia as N	22	0.06	mg/L
Chloride	23	127	mg/L
Chlorophyll α	27	75	µg/L
Secchi Disk Depth	23	15	in
Secchi Disk Depth (VLMP)	79	14	in
Dissolved Oxygen	66	10	mg/L
Dissolved Oxygen Saturation	61	117	%
Kjeldahl Nitrogen	27	1	mg/L
Nitrate + Nitrite	26	0.39	mg/L
Orthophosphate	23	0.02	mg/L
pH	66	8.24	SU
Specific Conductance	66	793	µS/cm
Temperature, Water	61	20.4	C
Total Phosphorus	27	0.11	mg/L
Total Suspended Solids	27	31.6	mg/L
Turbidity	18	31.9	NTU
Volatile Suspended Solids	22	14.2	mg/L

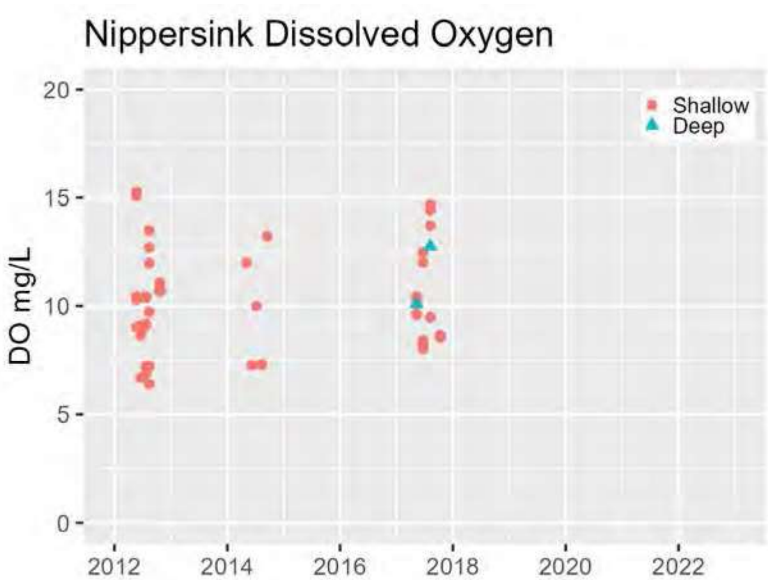

Figure 3-62: Nippersink Lake DO

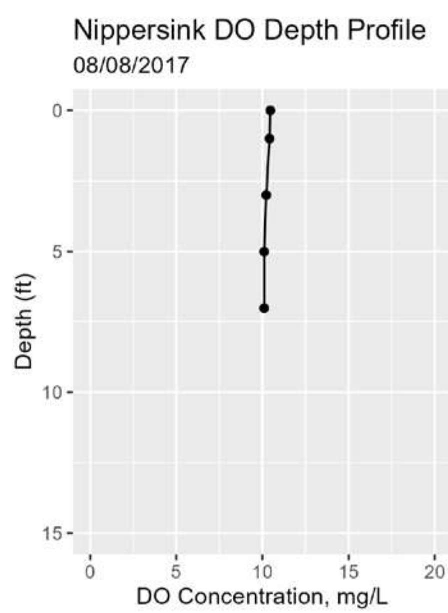

Figure 3-63: Nippersink Lake DO Profile

Total Phosphorus is elevated with 25 of 27 or 93% of samples exceeding the 0.05 mg/L water quality standard (Figure 3-64). Orthophosphate is a small proportion of TP, indicating that most phosphorus is in particulate form, and attached to sediments or incorporated into algal biomass (Figure 3-65). The shallow depth of Nippersink and the amount of boat traffic likely exacerbates the phosphorus issue through resuspension of nutrient-rich sediments into the water column.

The TMDL estimated a daily TP load of 269 lbs/day with an 82% reduction needed to meet the standard. Flows from Grass Lake and Dunns Lake were estimated to contribute 243 lbs/day of TP to Nippersink, with an estimated 0.5 lbs/day coming from Nippersink Lake's watershed, and roughly 25 lbs/day attributed to internal loading.

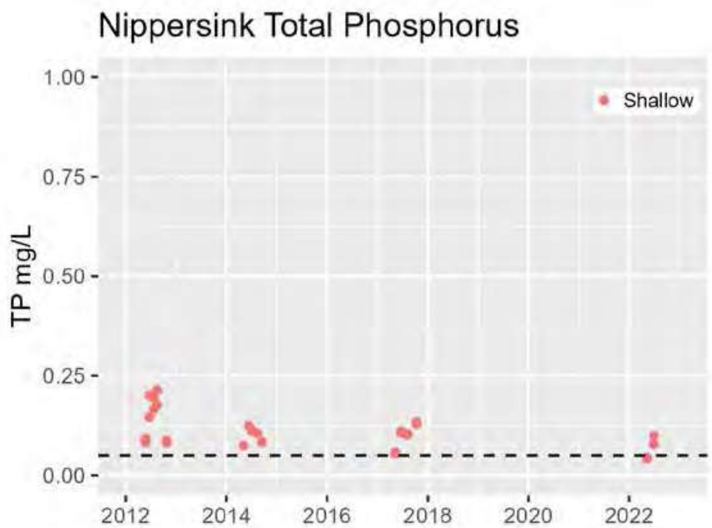

Figure 3-64: Nippersink Lake TP

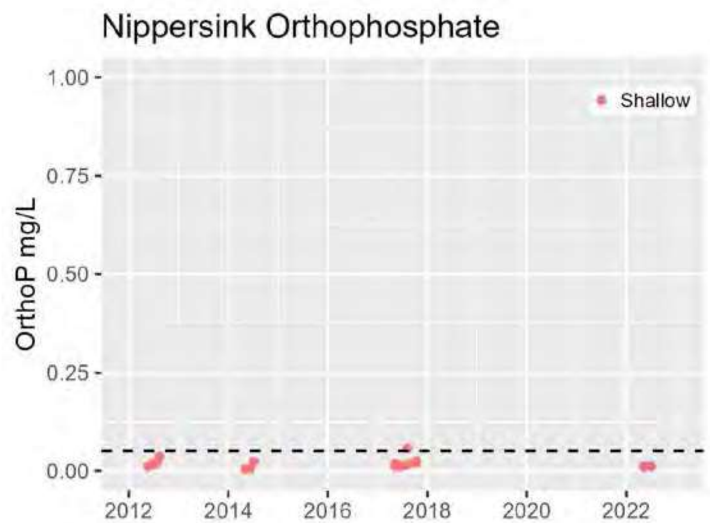

Figure 3-65: Nippersink Lake Orthophosphate

Total Suspended Solids are routinely above 18.2 mg/L (Figure 3-66). The shallow depth of Nippersink combined with boat traffic and wind likely contribute to the TSS level through resuspension of sediments. Secchi Disk Depth was collected for several years and is presented in Figure 3-67.

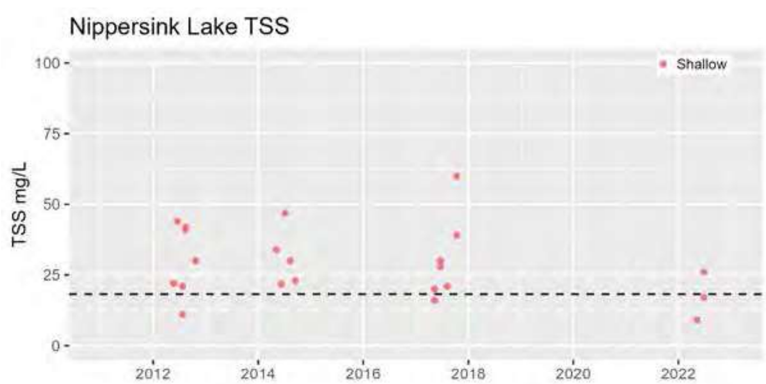

Figure 3-66: Nippersink Lake TSS

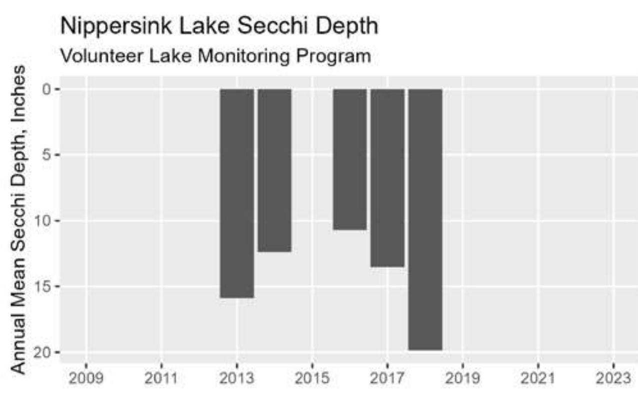

Figure 3-67: Nippersink Lake Secchi Depth

3.3.5.9 Petite Lake – VTW

Water quality samples were collected from Petite Lake in 2012, 2014, 2017, and 2022 (Table 3-22). Data indicates Petite typically does not fully stratify as shown in Figure 3-68 and in Figure 3-69, but it may occasionally stratify weakly. Water clarity is typically good as evidenced by Secchi disk data and TSS, however, algae blooms likely lower clarity occasionally, and are an indicator of a eutrophic system.

Table 3-22: Petite Lake Water Quality Data Summary

PARAMETER	TOTAL SAMPLES	UNITS	OVERALL MEAN	NUMBER OF DEEP SAMPLES	MEAN OF DEEP SAMPLES	NUMBER OF SHALLOW SAMPLES	MEAN OF SHALLOW SAMPLES
Alkalinity	32	mg/L	207	16	208	16	206
Ammonia as N	27	mg/L	0.12	14	0.13	13	0.11
Chloride	26	mg/L	122	13	122	13	122
Chlorophyll α	16	µg/L	61.1	5	14.3	11	82.3
Secchi Disk Depth	14	in	22.4	-	-	-	-
Secchi Disk Depth	136	in	29.8	-	-	-	-
Dissolved Oxygen	90	mg/L	8.4	49	7.7	41	9.2
Dissolved Oxygen Saturation	80	%	95.2	44	87.7	36	104
Kjeldahl Nitrogen	32	mg/L	1.6	16	1.6	16	1.6
Microcystin	14	µg/L	2.1	-	-	-	-
Nitrate + Nitrite	24	mg/L	0.18	12	0.18	12	0.18
Orthophosphate	22	mg/L	0.02	11	0.02	11	0.02
pH	90	SU	8.1	49	8.1	41	8.2
Specific Conductance	90	µS/cm	682	49	691	41	673
Temperature, Water	80	C	21.2	44	20.9	36	21.5
Total Phosphorus	32	mg/L	0.09	16	0.09	16	0.09
Total Suspended Solids	31	mg/L	12.8	16	12.8	15	12.8
Turbidity	18	NTU	13.1	9	13.9	9	12.2
Volatile Suspended Solids	21	mg/L	9.1	11	9	10	9.3

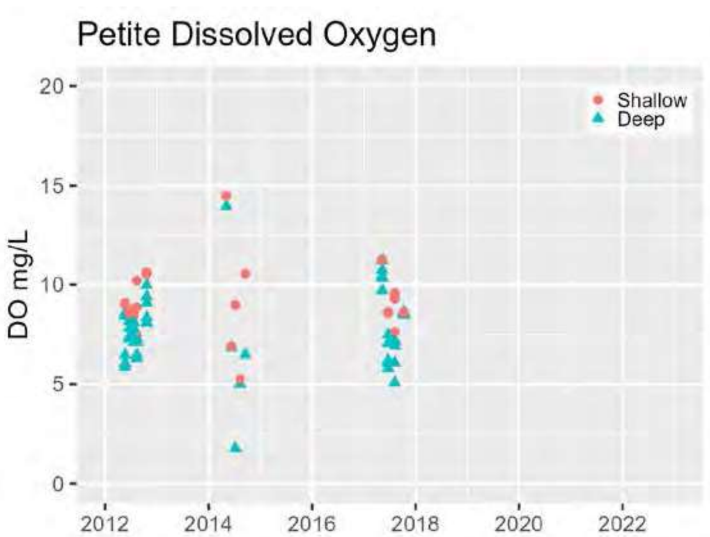

Figure 3-68: Petite Lake DO

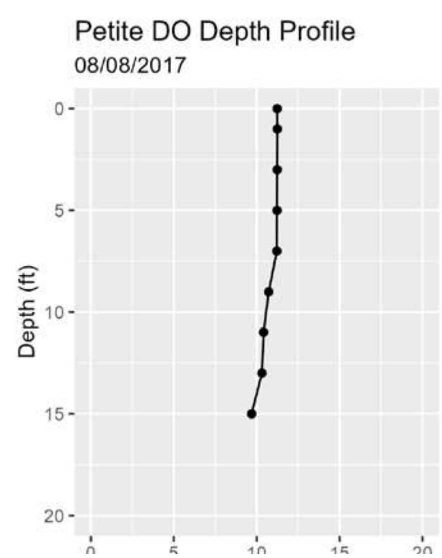

Figure 3-69: Petite Lake DO Profile

Total Phosphorus levels are high, with 15 of 16 samples since 2012 exceeding the 0.05 mg/L water quality standard (Figure 3-70). Orthophosphate makes up a small proportion of TP, indicating a eutrophic system in which phosphorus is mostly in particulate form, attached to sediments or incorporated into algae and plants (Figure 3-71). The TP load to Petite estimated by the TMDL is 15.6 lbs/day, with an internal load of 4.82 lbs/day, 9.6 lbs/day from upstream lakes, and 1.2 lbs/day from the lake's watershed. A 70% reduction is needed to meet the water quality standard.

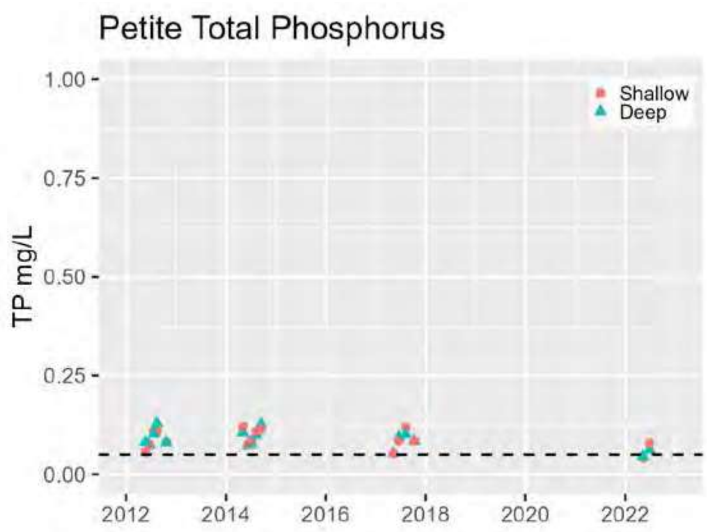

Figure 3-70: Petite Lake TP

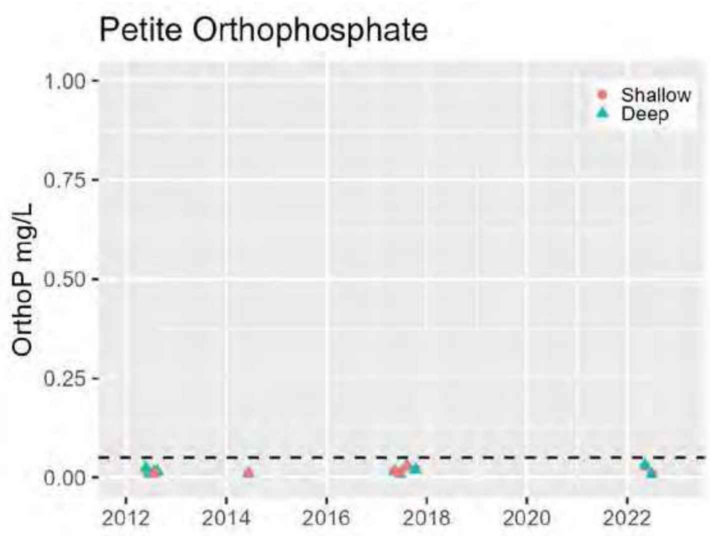

Figure 3-71: Petite Lake Orthophosphate

Total Suspended Solids are occasionally above the 18.2 mg/L Illinois EPA recommended threshold (Figure 3-72). Volunteers collected Secchi depth measurements 7 of 9 years from 2010-2018 until the program was discontinued. It appears that there is a trend of decreasing Secchi depth, however, the dataset may reflect annual variability (Figure 3-73).

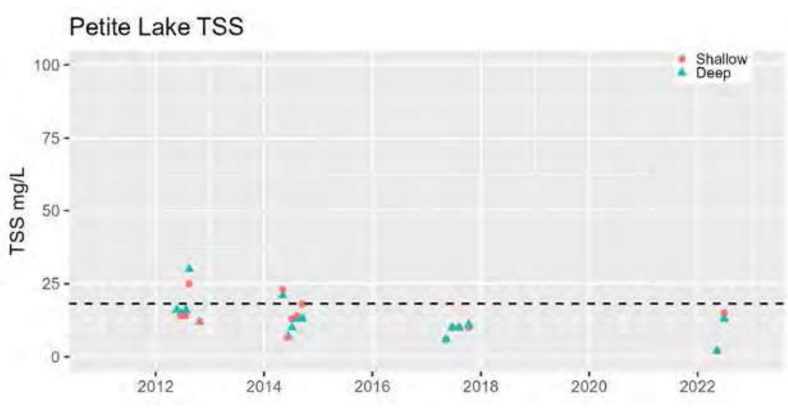

Figure 3-72: Petite Lake TSS

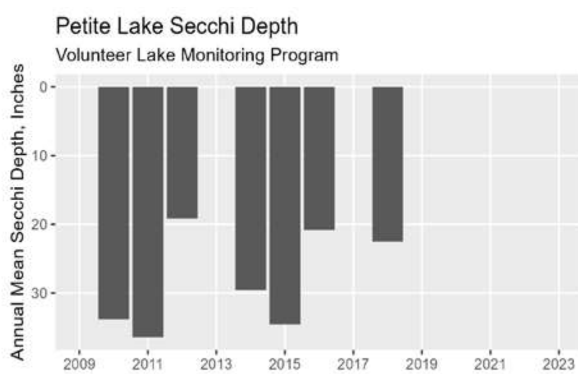

Figure 3-73: Petite Lake Secchi Depth

E. coli data is collected by the LCHD each summer at two swimming beaches in Petite Lake. Samples greater than 235 CFU/100mL are reported to the beach manager triggering a closure. From 2012-2021, the Highwood Subdivision beach had 38 beach closures issued (Table 3-23). Closure data was not available for Summerside beach.

Table 3-23: Petite Lake Beaches E. coli

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER CLOSURES
Highwood Subdivision				
2010	31.7	435.2	12	0
2011	131	344.8	20	0
2012	**112**	**2419.2**	**20**	**4**
2013	**54**	**727**	**16**	**1**
2014	**329**	**2,419**	**42**	**16**
2015	**262**	**2,419**	**40**	**11**
2016	**101**	**326**	**18**	**3**
2017	53.9	186	10	0
2018	46.3	122	12	0
2019	69.1	225	12	0
2020	**76.9**	**365**	**14**	**1**
2021	**87.5**	**2,419**	**20**	**2**
2022	255	1,414	30	0
Summerside				
2010	32.3	517	9	0
2011	21	276	16	0
2012	18.5	93.3	12	0
2013	30.6	127	8	0
2014	20	59.5	10	0
2015	8.6	48	14	0
2016	14.1	37.3	14	0
2017	25.6	44.3	7	0
2018	28	140	6	0
2019	26.5	26.5	3	0
2020	15.7	1,733	16	0

3.3.5.10 Pistakee Lake – RTU

Water quality data was collected in 2012, 2014, 2017, and 2022. Table 3-24 shows a summary of the primary parameters collected. Data indicates the lake is eutrophic, with frequently high DO indicating abundant aquatic plants and algae.

Table 3-24: Pistakee Lake Water Quality Summary

PARAMETER	TOTAL SAMPLES	UNITS	OVERALL MEAN	NUMBER OF DEEP SAMPLES	MEAN OF DEEP SAMPLES	NUMBER OF SHALLOW SAMPLES	MEAN OF SHALLOW SAMPLES
Alkalinity	43	mg/L	229	16	230	27	229
Ammonia as N	40	mg/L	0.46	15	1.1	25	0.09
Chloride	34	mg/L	114	13	113	21	115
Chlorophyll α	27	µg/L	74.4	12	49.6	15	94.2
Secchi disk Depth	24	in	20.8	-	-	-	-
Secchi Disk Depth (VLMP)	108	in	26.8	-	-	-	-
Dissolved Oxygen	163	mg/L	7.6	104	6.5	59	9.7
Dissolved Oxygen Saturation	153	%	84.5	99	70.6	54	110
Kjeldahl Nitrogen	43	mg/L	1.8	16	2.3	27	1.5
Microcystin	2	µg/L	0.84	-	-	-	-
Nitrate + Nitrite	39	mg/L	0.35	13	0.25	26	0.4
Orthophosphate	30	mg/L	0.04	10	0.08	20	0.02
pH	163	SU	8.04	104	7.9	59	8.2
Specific Conductance	163	µS/cm	751	104	762	59	732
Temperature, Water	153	C	20.2	99	19.8	54	20.9
Total Phosphorus	42	mg/L	0.12	15	0.14	27	0.11
Total Suspended Solids	43	mg/L	15.2	16	11.9	27	17.1
Turbidity	27	NTU	21.4	9	25.7	18	19.3
Volatile Suspended Solids	33	mg/L	10.1	11	7.9	22	11.2

Dissolved Oxygen is typically in a range above the standard. The lake weakly stratifies during the summer months, with a poorly defined thermocline. During this stratification, low DO occurs below the thermocline, as is typical. Example depth profiles are in Figure 3-74 and Figure 3-75, and a chart of all samples is in Figure 3-76.

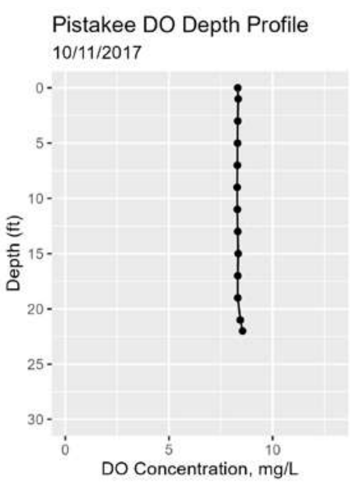

Figure 3-74: Pistakee Unstratified

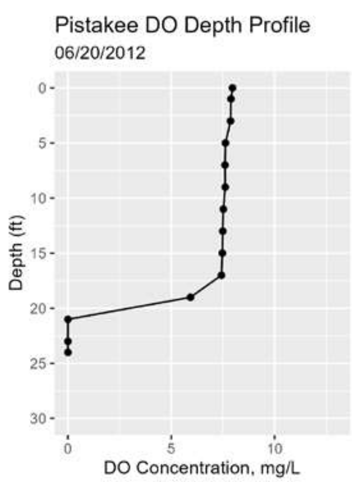

Figure 3-75: Pistakee Stratified DO Profile

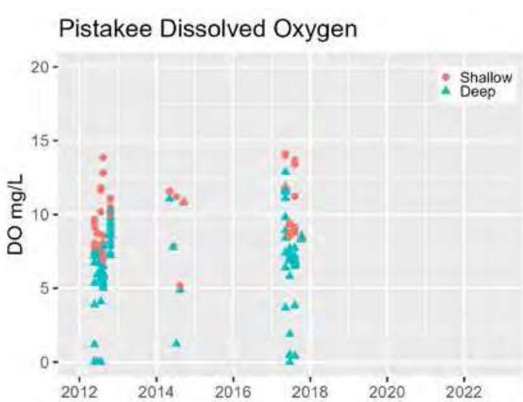

Figure 3-76: Pistakee Lake DO

Pistakee Lake has high levels of phosphorus, with 25 of 27 samples taken at less than 4 ft depth exceeding the standard of 0.05 mg/L (Figure 3-77). Orthophosphate makes up a low proportion of TP (Figure 3-78). Most phosphorus is in particulate form, either attached to sediments or incorporated into plants and algae, indicating a eutrophic system. The TP load was estimated by the TMDL to be 747.6 lbs/day. Of this, 394 lbs/day was estimated to come from Nippersink Lake, 0.5 lbs/day from Redhead Lake, 241 lbs/day from overland and watershed runoff (mainly Nippersink Creek), 15 lbs/day from point sources discharging to the lake and its tributaries, and 5.52 lbs/day from internal loading. The TMDL estimated that a 79% reduction is needed to meet the 0.05 mg/L water quality standard.

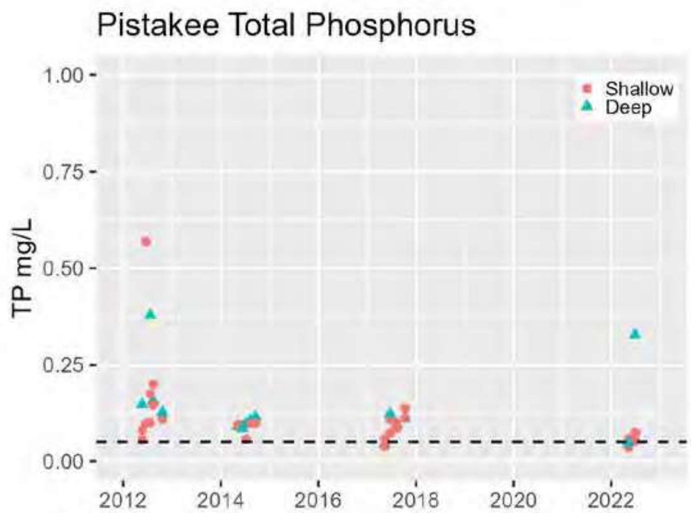

Figure 3-77: Pistakee Lake TP

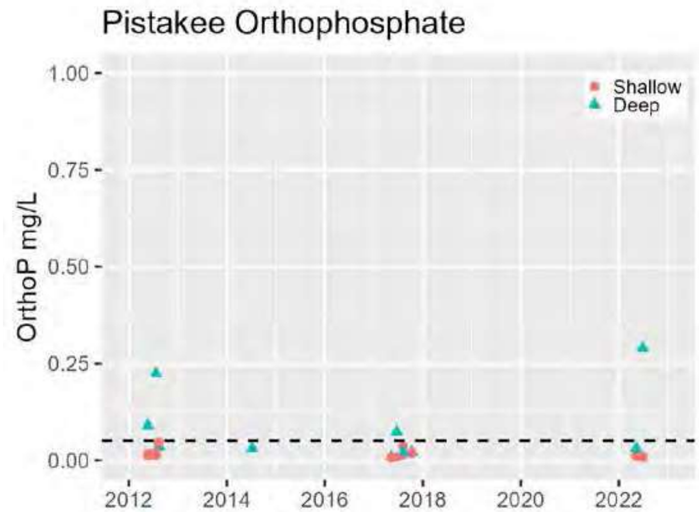

Figure 3-78: Pistakee Lake Orthophosphate

Total Suspended Solids are frequently above the 18.2 mg/L Illinois EPA target (Figure 3-79). Secchi Depth was measured in 5 years since 2010 by volunteers as part of the VLMP. No trend in water clarity was apparent in the limited data (Figure 3-80). There is no E. coli or fecal coliform bacteria monitoring data available.

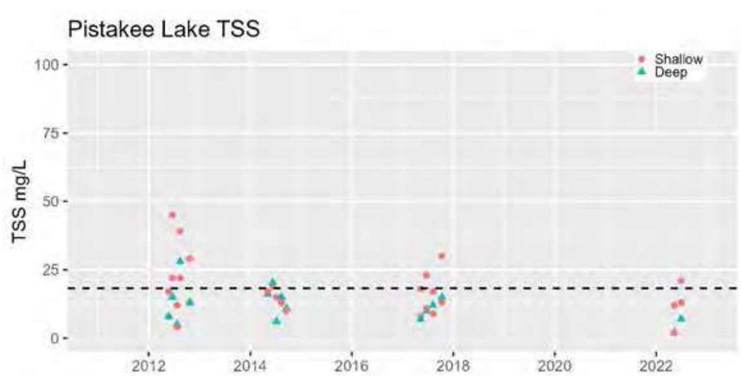

Figure 3-79: Pistakee Lake TSS

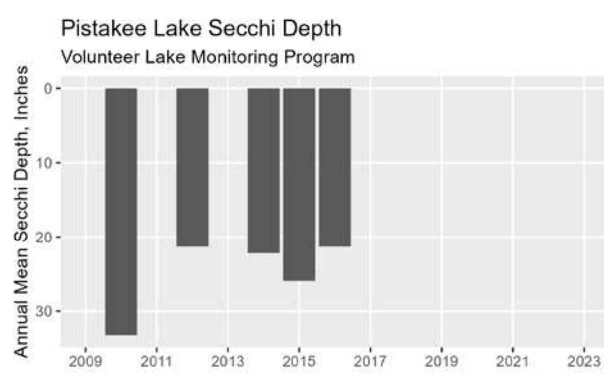

Figure 3-80: Pistakee Lake Secchi Depth

3.3.5.11 Lake Matthews – UTA

Lake Matthews is very shallow and is connected to Pistakee Lake via a navigable canal. Although data is limited, The LCHD evaluated water quality in 2014 for a lake report. As described in the report, all sampling was at shallow depth as the lake does not stratify. Water clarity is poor, with an average 2.85 ft Secchi depth and average TSS of 25 mg/L. Toal Phosphorus concentrations averaged 0.118 mg/L, well above the water quality standard of 0.05 mg/L. Dissolved Oxygen was in a normal range above 5 mg/L. Blue-green algae samples were collected in 2013 and of the 6 taken, all had detectable levels of cyanobacteria below the health advisory level of 20 µg/L. Although additional monitoring is needed, data indicates a potential risk of harmful algal blooms in Lake Matthews.

3.3.5.12 Redhead Lake – RTV

Redhead Lake was monitored in 2014 by the LCHD, and in 2018 by the Illinois EPA. The lake does not stratify. A summary of available water quality data is in Table 3-25. Data indicate a eutrophic system with a high abundance of aquatic plants present. Nutrient data shows low levels, as nitrogen and phosphorus are quickly taken up by plants.

Table 3-25: Redhead Lake Water Quality Data Summary

PARAMETER	TOTAL SAMPLES	UNITS	MEAN OF SAMPLES
Alkalinity	9	mg/L	217
Ammonia as N	4	mg/L	0.05
Chloride	6	mg/L	91.5
Chlorophyll α	9	µg/L	17.5
Secchi Disk Depth	9	in	17.8
Secchi Disk Depth (VLMP)	42	in	26
Dissolved Oxygen	19	mg/L	9.5
Dissolved Oxygen Saturation	14	%	109
Kjeldahl Nitrogen	9	mg/L	1.2
Microcystin	17	µg/L	0.16
Nitrate + Nitrite	4	mg/L	0.04
Orthophosphate	4	mg/L	0.02
pH	19	SU	8
Specific Conductance	19	µS/cm	476
Temperature, Water	14	C	20.5
Total Phosphorus	9	mg/L	0.05
Total Suspended Solids	9	mg/L	9.4
Volatile Suspended Solids	4	mg/L	3

Redhead Lake DO is typically in an appropriate range, though sometimes elevated (Figure 3-81). There are abundant aquatic plants in Redhead that contribute to the high DO during the growing season.

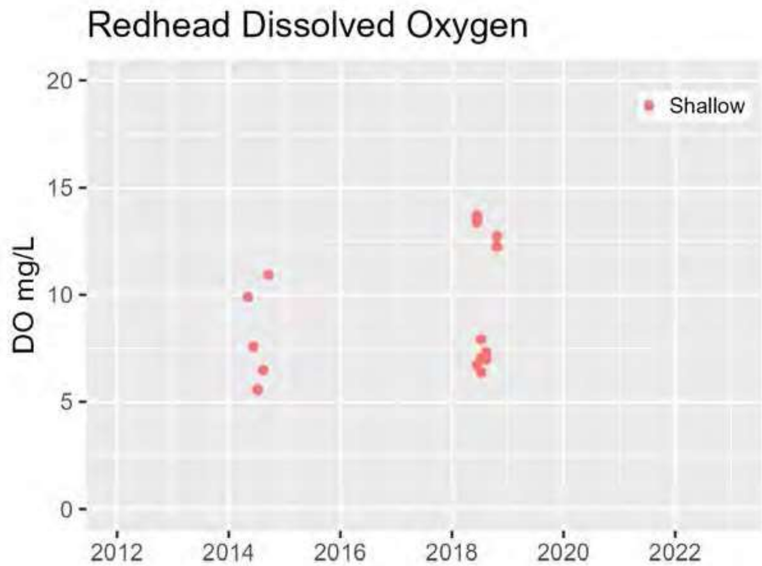

Figure 3-81: Redhead Lake DO

The TMDL calculated a TP load of 1.39 lbs/day, with 1.05 lbs/day being contributed from the lake's drainage area, and 0.34 lbs/day from internal loading. A 61% reduction is needed to meet the 0.05 mg/L standard. Of the 9 samples collected in 2014 and 2018, 5 exceeded the water quality standard (Figure 3-82). Limited orthophosphate data is available (Figure 3-83).

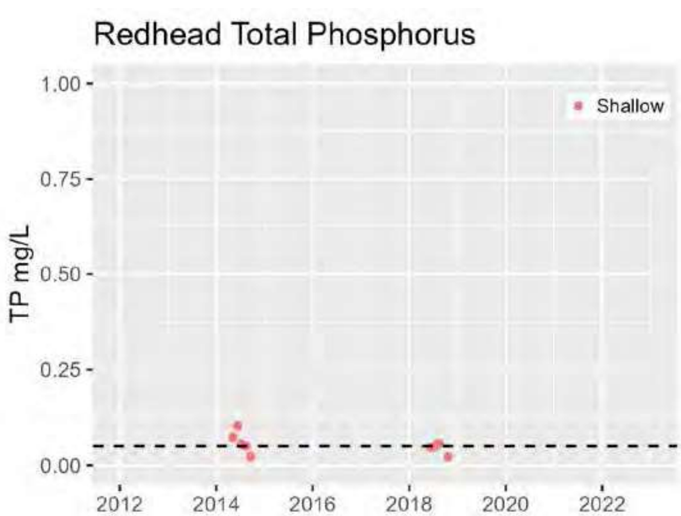

Figure 3-82: Redhead Lake TP

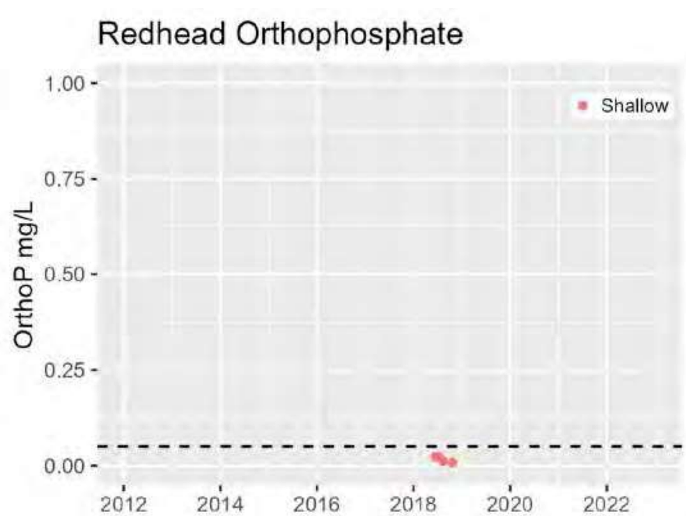

Figure 3-83: Redhead Lake Orthophosphate

In Redhead, 2 of 5 TSS samples in 2014 were above the 18.2 mg/L target, and 0 of 4 above the target in 2018 (Figure 3-84). Secchi depth collected as part of the VLMP is limited to 3 years since 2009 (Figure 3-85).

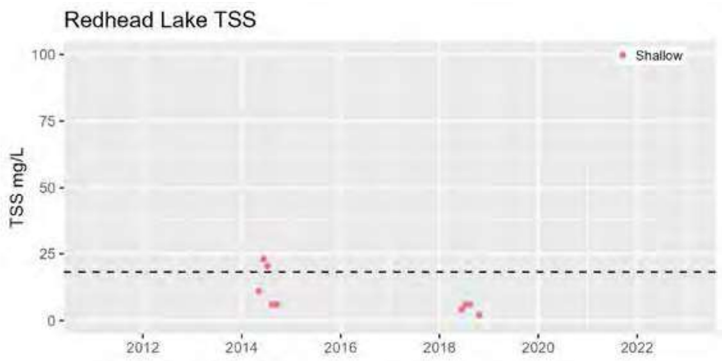

Figure 3-84: Redhead Lake TSS

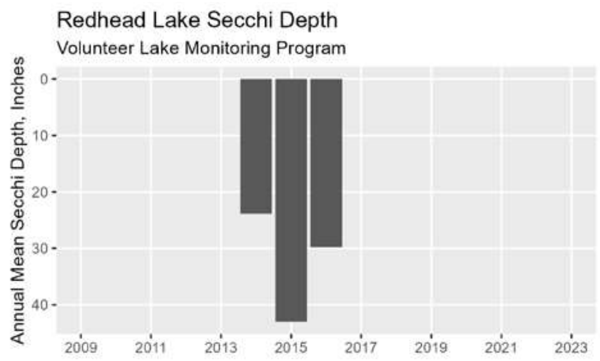

Figure 3-85: Redhead Lake Secchi Depth

The LCHD collects E. coli data annually near swimming beaches. Typically, samples are collected every 2 weeks, and beach closures are issued if levels are above 235 CFU/100 mL (Table 3-26). Closures occurred at Hilldale Manor beach in 6 of the last 10 years, with 7 in 2018 and 11 in 2019.

Table 3-26: Redhead Lake Beach E. coli – Hilldale Manor

YEAR	MEDIAN CFU/100 ML	HIGHEST CFU/100 ML	NUMBER OF SAMPLES	NUMBER CLOSURES
2010	404	980	6	0
2011	32.3	435	14	0
2012	**94.2**	**1,986**	**16**	**1**
2013	9.8	27.8	14	0
2014	17.7	109	12	0
2015	10.9	53	14	0
2016	**40.1**	**613**	**18**	**2**
2017	26.2	60.5	12	0
2018	**190**	**1,203**	**26**	**7**
2019	**1,013**	**2,419**	**32**	**11**
2020	**122**	**411**	**16**	**2**
2021	**12.8**	**517**	**18**	**1**
2022	54.3	272	16	0

3.3.5.13 Spring Lake – RGZT

Water quality data was collected on Spring Lake in 2014 by the LCHD and by Illinois EPA in 2018 (Table 3-27). Overall, data is limited. The lake has a maximum depth of 10 ft and does not thermally stratify.

Table 3-27: Spring Lake Water Quality Data Summary

PARAMETER	TOTAL SAMPLES	OVERALL MEAN	UNITS
Alkalinity	9	204	mg/L
Ammonia as N	6	0.22	mg/L
Chloride	6	112	mg/L
Chlorophyll α	9	51.3	µg/L
Secchi Disk Depth	9	19.1	in
Secchi Disk Depth (VLMP)	62	27.8	in
Dissolved Oxygen	21	8.1	mg/L
Dissolved Oxygen Saturation	16	90	%
Kjeldahl Nitrogen	9	1.6	mg/L
Nitrate + Nitrite	6	0.15	mg/L
Orthophosphate	6	0.02	mg/L
pH	21	8.1	SU
Specific Conductance	21	533	µS/cm
Temperature, Water	16	22	C
Total Phosphorus	9	0.09	mg/L
Total Suspended Solids	9	12.1	mg/L
Volatile Suspended Solids	4	5	mg/L

Dissolved Oxygen has been measured at an appropriate range above the water quality standard in the limited sampling that was done in 2014 and 2018 (Figure 3-86).

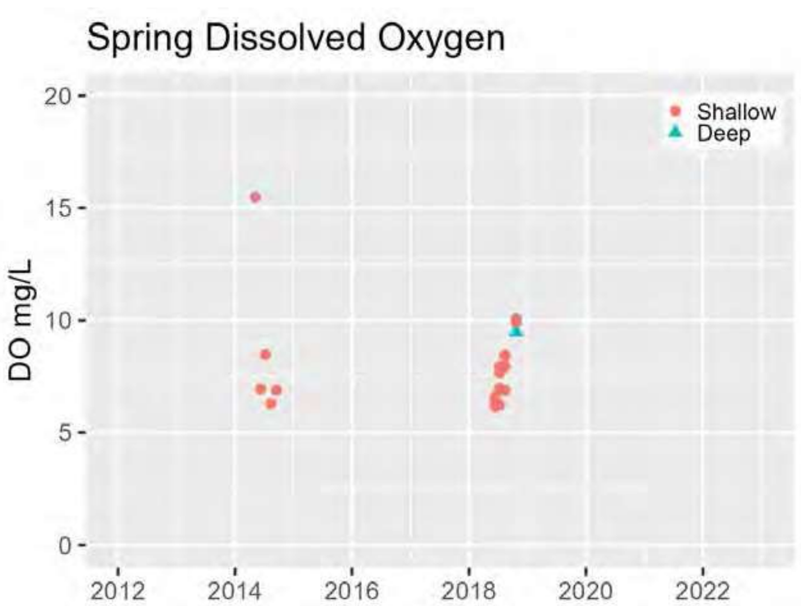

Figure 3-86: Spring Lake DO

Spring Lake exhibits high TP evidenced by 8 of 9 samples in 2014 and 2018 above the 0.05 mg/L standard (Figure 3-87) with generally low orthophosphate (Figure 3-88). The TMDL estimated a TP load of 9.27 lbs/day. This is made up of 7.58 lbs/day from Bluff Lake flows, 0.84 lbs/day from overland runoff from the lake's watershed, and 0.84 lbs/day from internal loading, which typically consists of resuspended sediments and phosphorus being released from sediment. A 70% reduction is necessary to meet the water quality standard of 0.05 mg/L.

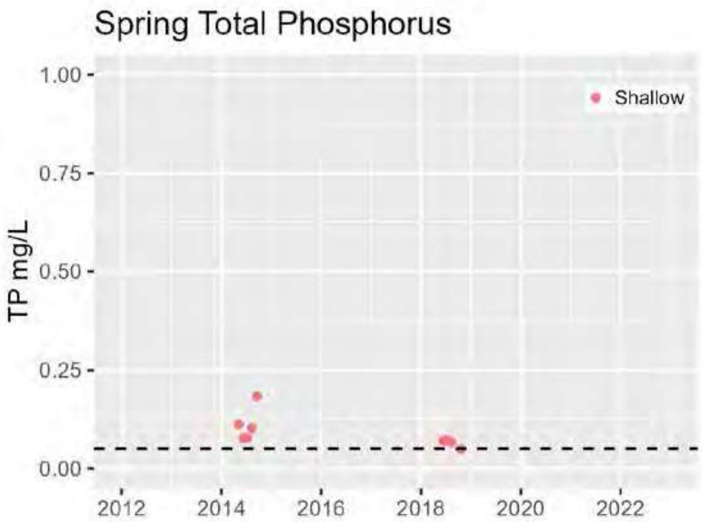

Figure 3-87: Spring Lake TP

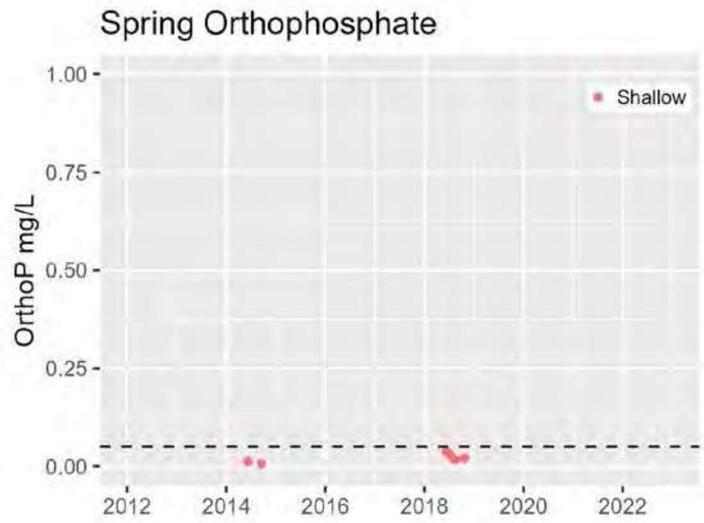

Figure 3-88: Spring Lake Orthophosphate

Total Suspended Solids data is limited, with only 9 samples from 2014 and 2018. All but 1 were below the 18.2 mg/L TSS target recommended by Illinois EPA (Figure 3-89). Secchi depth measurements from the Illinois VLMP were collected in most years from 2010-2018, however, near the end of the record, the number of measurements per year decreased, increasing uncertainty (Figure 3-90). For instance, there was only 1 measurement in 2015, making it appear that Secchi depth was unusually deep.

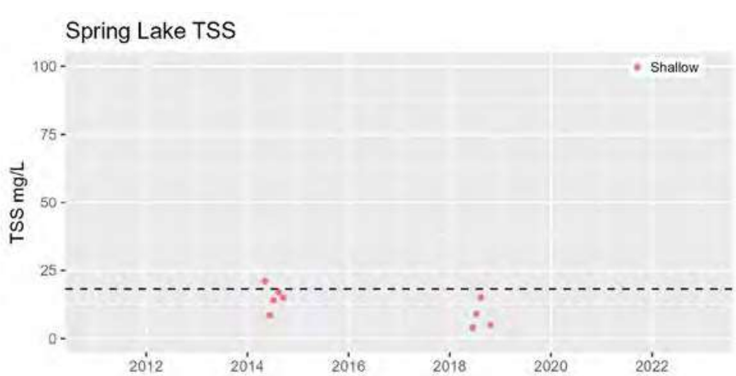

Figure 3-89: Spring Lake TSS

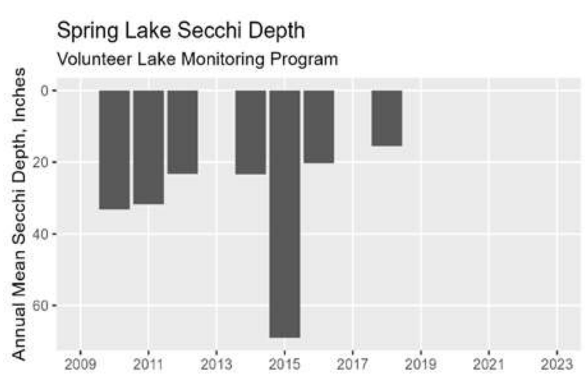

Figure 3-90: Spring Lake Secchi Depth

3.3.6 Stream Water Quality

One monitored stream site is within the planning area and located on the Fox River between its outlet to Grass Lake and the Wisconsin State Line. Illinois EPA has collected data annually at this station, DT-35 (Table 3-28). This station is important, as it captures conditions in the Fox River, the biggest tributary to the Chain O' Lakes. Major water quality parameters are collected about 8 times per year. In addition, Illinois EPA has collected metals and other contaminant data on a limited basis. These are not included in the summary below.

Table 3-28: Fox River at DT-35 Water Quality Summary

PARAMETER	TOTAL SAMPLES	MEAN OF SAMPLES	UNITS
Alkalinity	99	254	mg/L
Ammonia as N	97	0.08	mg/L
Chloride	101	121	mg/L
Chlorophyll α	98	34.4	µg/L
Dissolved Oxygen	87	10.4	mg/L
Dissolved Oxygen Saturation	85	97.2	%
Fecal Coliform	34	264	CFU/100mL
Kjeldahl Nitrogen	99	0.91	mg/L
Microcystin	16	0.07	µg/L
Nitrate + Nitrite	100	1.6	mg/L
Organic Carbon	101	6.6	mg/L
Orthophosphate	100	0.03	mg/L
pH	86	8	SU
Specific Conductance	85	904	µS/cm
Temperature, Water	87	13.2	C
Total Phosphorus	101	7.8	mg/L
Total Suspended Solids	100	24.2	mg/L
Turbidity	78	19.1	NTU
Volatile Suspended Solids	99	8.7	mg/L

Dissolved Oxygen in the Fox River is typically within a normal range with occasional high and low values that indicate a eutrophic system with high levels of algal and plant photosynthesis and respiration (Figure 3-91).

Total Phosphorus is elevated in the Fox River before it enters Grass Lake. While there is no water quality standard in streams, the 0.05 mg/L TP standard for lakes is shown in Figure 3-92 for reference. Seventy-nine of 100 TP samples since 2010 were above the 0.05 mg/L level, indicating the Fox River is a significant contributor to the phosphorus issue in the Chain O' Lakes. The drinking water standard for nitrate is 10 mg/L, however, this standard is only based on the allowable limit in finished drinking water and is not directly related to ecosystem health. While the maximum nitrate levels seen in the Fox River above Grass Lake are under 4 mg/L, nitrate is still contributing to eutrophication in the Chain.

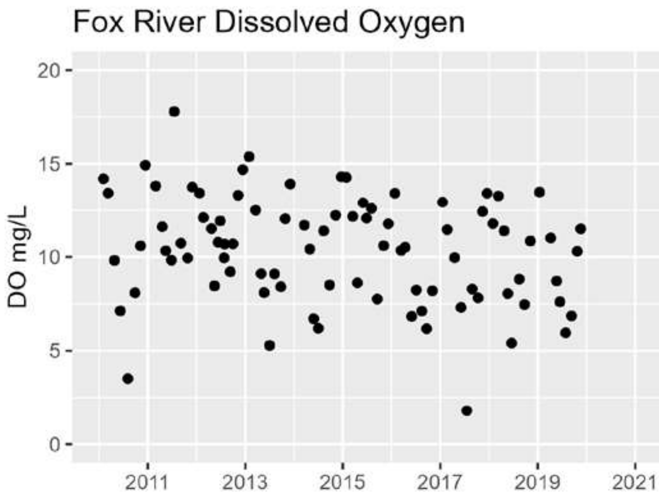

Figure 3-91: Fox River DO at DT-35

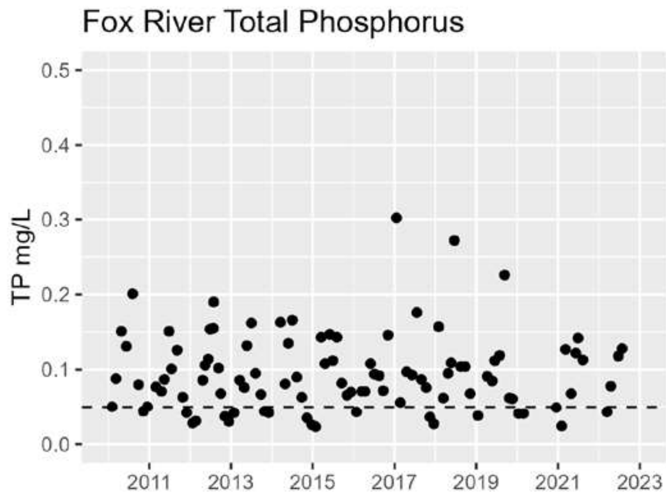

Figure 3-92: Fox River TP at DT-35

There is no numeric standard in Illinois for sediment in rivers. However, Illinois EPA provided a numeric target for NVSS of 13.6 mg/L as part of the TMDL. In the Fox, 51 of 99 NVSS samples exceeded the 13.6 mg/L target since 2010 (Figure 3-93). Non-volatile Suspended Solids is the portion of TSS made up of inorganic particulate matter and, therefore, TSS values are typically higher (Figure 3-94).

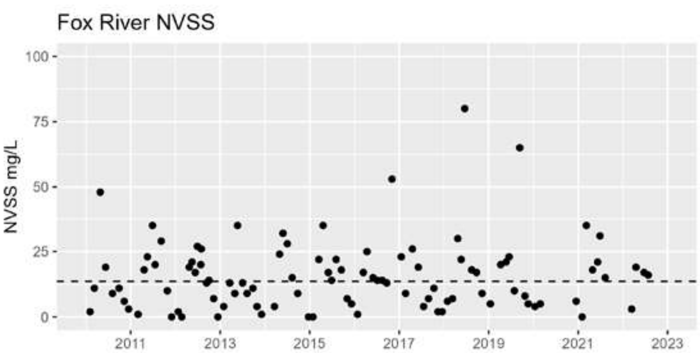

Figure 3-93: Fox River NVSS at DT-35

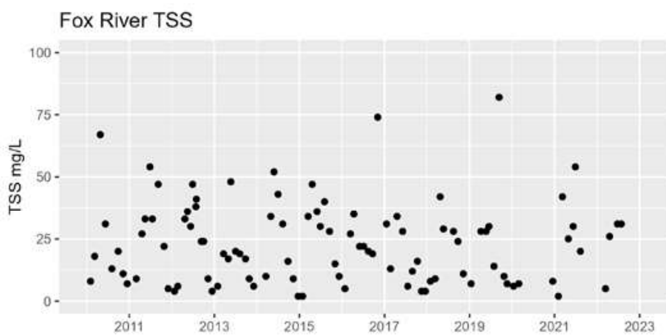

Figure 3-94: Fox River TSS at DT-35

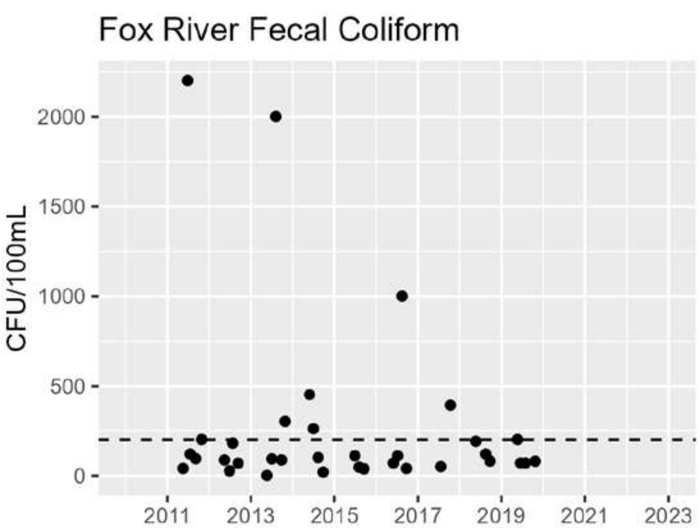

Figure 3-95: Fox River at DT-35 Fecal Coliform

The Illinois EPA collects fecal coliform samples as part of its routine monitoring program. Determining if a stream section is not supporting its designated uses due to fecal coliform is a multi-part test and is detailed fully in Illinois' Integrated Water Quality Report. However, for reference, the 200 CFU/100mL threshold is noted on the chart in Figure 3-95. Fecal coliform exists in low background levels with occasional very high samples.

3.3.7 Loading and Yield

Understanding the loading of chemical constituents is important to understanding watershed dynamics. While concentrations give an indication of the conditions at a single point in time, the load is the total mass of a chemical constituent that is contributed to a given body of water over a specified period and may be reported in various units, such as pounds per year. To accurately calculate loads from streams, concentration and flow data across time are needed. For example, a small stream with a low flow may have a high concentration of phosphorus, but because the volume of water at that high concentration is small, the load is also small. Conversely, a very large stream may have low phosphorus concentrations, but the volume of water is very high and, therefore, the load is also high. This section provides load estimates from each of the main tributaries, and the area that drains directly into each lake in the planning area, which together comprise the entire load to the Chain. To understand the cumulative loading, tributaries that fall outside the planning area are included in this analysis. Loads are presented for TP and nitrate or the nutrients most associated with eutrophication, and for NVSS that makes up a portion of TSS and a parameter directly relevant to sedimentation. Values presented in this section were used to calibrate a NPS loading model discussed in Chapter 4.

3.3.7.1 Loading Estimation Method

Loading was estimated by integrating USGS and Illinois EPA water quality and discharge data into the Weighted Regression on Time Discharge and Season (WRTDS) tool. This USGS tool is widely used for estimating loads and trends in loading. It provides both annual estimates and annual estimates normalized for flow. Flow is generally the biggest driver, thus, annual loads can be highly erratic based on precipitation. The flow normalized load output of the WRTDS removes the influence of year-to-year variation in flow, which means that any changes observed are being driven by watershed dynamics.

To calculate loading and trends at a particular location using WRTDS, a complete daily discharge dataset and a temporally dense water quality dataset of 10 years or more is needed. The water quality dataset used should include, at a minimum, samples taken quarterly with few gaps and ideally collected at the same location, in combination with discharge measurements. However, water quality and discharge are often collected at separate sites. In such cases, loads are calculated at the nearest appropriate discharge location with the assumption that water yield and concentrations are generally uniform between sample sites. This allows for extrapolation of loads from ungauged areas (i.e., the watershed area downstream of the discharge site, and where the tributary enters the lake). The following equation was used:

$$Load_{gauged}\left(1+\frac{Area_{ungauged}}{Area_{gauged}}\right)=Load_{Total}$$

Several of the subwatersheds in the planning area do not have a suitable water quality and discharge dataset available. Thus, a nearby site or pair of sites with similar land use characteristics were chosen as a surrogate. The WRTDS tool was then run to estimate loading in the ungauged or unmonitored subwatersheds. Results based on surrogate data are considered a rough approximation, suitable for illustrative and planning purposes. For more accurate estimates, significant additional data collection, model verification, and data quality control is necessary.

3.3.7.2 Fox River Load Estimate

Loads from the Fox River to Grass Lake were estimated (Table 3-29) using Illinois EPA water quality data from station DT-35 on the Fox River at Rt. 173 and discharge from the station USGS-05545750 Fox River at New Munster. The USGS station has a drainage area of 811 mi^2 and is upstream of the Illinois EPA site. The watershed size measured at the mouth of the Fox River at Grass Lake is 871 mi^2. To extrapolate for the ungauged area between the USGS site and Grass Lake, a ratio of 1.07 was applied. Model results indicate that nitrate and TP are trending slightly down, while NVSS or sediment is trending slightly up over the last 10 years.

Table 3-29: Upper Fox River Sediment and Nutrient Loads to Chain O' Lakes

UPPER FOX RIVER ESTIMATED LOADS DELIVERED TO THE CHAIN O' LAKES – WRTDS WQ STATION: IL_DT-35 FOX RIVER AT IL 173 DISCHARGE STATION: USGS-05545750 FOX RIVER AT NEW MUNSTER, WI WATERSHED SIZE: 871 MI^2			
CONSTITUENT	AVERAGE ANNUAL LOAD (FLOW NORMALIZED) 2012-2021	AVERAGE ANNUAL YIELD (FLOW NORMALIZED)	TREND DIRECTION 2012-2021
Nitrate	2,784,000 lbs/year	5 lbs/ac/yr	Slightly decreasing
Total Phosphorus	133,000 lbs/year	0.25 lbs/ac/yr	Slightly decreasing
NVSS (sediment)	21,372 tons/yr	0.04 tons/ac/yr (76 lbs/ac/yr)	Slightly increasing

3.3.7.3 Nippersink Creek Load Estimate

Loads from the Nippersink Creek watershed, which falls outside the planning area, were estimated using Illinois EPA water quality data from station DTK-04 on Nippersink Creek at Winn Road and discharge data from the USGS station 05548280 on Nippersink Creek at Spring Grove. The drainage area of the discharge station is 192 mi^2 and the total watershed area is approximately 208 mi^2. Thus, a watershed area ratio of 1.08 was applied to the ungauged area. Trends over the past 10 years indicate that nitrate is slightly decreasing while TP and NVSS or sediment are increasing during the same period (Table 3-30).

Table 3-30: Nippersink Creek Sediment and Nutrient Loads to the Chain O' Lakes

NIPPERSINK CREEK ESTIMATED LOADS DELIVERED TO CHAIN O' LAKES FROM - WRTDS WQ STATION: IL-DTK-04 NIPPERSINK CREEK DISCHARGE STATION: USGS-05545750 NIPPERSINK CREEK AT SPRING GROVE WATERSHED SIZE: 208 MI^2			
CONSTITUENT	AVERAGE ANNUAL FLOW NORMALIZED LOAD 2012-2021	AVERAGE ANNUAL YIELD (FLOW NORMALIZED)	TREND DIRECTION 2012-2021
Nitrate	839,000 lbs/year	6.9 lbs/ac/yr	Slightly decreasing
Total Phosphorus	36,000 lbs/year	0.29 lbs/ac/yr	Slightly increasing
NVSS (sediment)	5,377 tons/yr	0.04 tons/ac/yr (80.8 lbs/ac/yr)	Increasing

3.3.7.4 Manitou Creek Load Estimate

Average annual normalized loads from the Manitou Creek watershed, which falls outside the planning area, were estimated using surrogate sites in the nearby Des Plaines River watershed. The drainage area of the Des Plaines River at Russel Rd. is 123 mi^2, while the Manitou Creek watershed is 48 mi^2. Flow normalized loads and yields from the Des Plaines were proportioned to calculate estimates for Manitou (Table 3-31).

Table 3-31: Manitou Creek Sediment and Nutrient Loads to the Chain O' Lakes

ESTIMATED LOADS DELIVERED TO CHAIN O' LAKES FROM MANITOU CREEK WQ STATION (SURROGATE): IL-G-08 DES PLAINES RIVER AT RUSSEL RD. DISCHARGE STATION: USGS-05527800 DES PLAINES RIVER AT RUSSEL RD. WATERSHED SIZE: 123 MI^2		
CONSTITUENT	AVERAGE ANNUAL FLOW NORMALIZED LOAD 2011-2020	AVERAGE ANNUAL YIELD (FLOW NORMALIZED)
Nitrate	202,800 lbs/year	6.6 lbs/ac/yr
Total Phosphorus	15,400 lbs/year	0.5 lbs/ac/yr
NVSS (sediment)	584 tons/yr	0.02 tons/ac/yr (38.1 lb/ac/yr)

3.3.7.5 Sequoit Creek Load Estimate

Flow normalized loads from Sequoit Creek, which falls outside the planning area, were also calculated using surrogate sites in the nearby Des Plaines where watershed characteristics are similar. The drainage area of the Des Plaines River at Russel Rd. is 123 mi^2, while the Sequoit Creek watershed is 13 mi^2. Flow normalized loads and yields from the Des Plaines were proportioned to calculate estimates for Sequoit. As the load estimate is made using a surrogate watershed, it does not explicitly consider the Village of Antioch WWTP. However, the Des Plaines River surrogate does have point source discharges which are included in the estimates. The results indicate Sequoit Creek is an important source of nutrients and sediment from outside the planning area (Table 3-32).

Table 3-32: Sequoit Creek Sediment and Nutrient Loads to the Chain O' Lakes

ESTIMATED LOADS DELIVERED TO CHAIN O' LAKES FROM SEQUOIT CREEK WQ STATION (SURROGATE): IL-G-08 DES PLAINES RIVER AT RUSSEL RD. DISCHARGE STATION: USGS-05527800 DES PLAINES RIVER AT RUSSEL RD.		
CONSTITUENT	AVERAGE ANNUAL FLOW NORMALIZED LOAD 2011-2020	AVERAGE ANNUAL YIELD (FLOW NORMALIZED)
Nitrate	55,000 lbs/year	6.6 lbs/ac/yr
Total Phosphorus	4,200 tons/year	0.5 lbs/ac/yr
NVSS (sediment)	159 tons/yr	0.02 tons/ac/yr (38.1 lbs/ac/yr)

3.3.7.6 Camp Creek / Trevor Creek Load Estimate

Flow normalized loads from Trevor Creek and Camp Creek, which drain into Channel Lake and Lake Catherine, were estimated using surrogate sites in the nearby Nippersink Creek, as very limited data is available on Camp and Trevor. The drainage area of Nippersink Creek at Spring Grove is 192 mi^2, while the Camp Creek/Trevor Creek watershed is 15.3 mi^2. Flow normalized loads and yields were proportioned to calculate these estimates (Table 3-33). While relatively minor contributors to nutrient and sediment based on a small watershed area, there is opportunity to reduce the load to the Chain using practices listed in this watershed plan.

Table 3-33: Loads Delivered to Chain from Camp and Trevor Creeks

ESTIMATED LOADS DELIVERED TO CHAIN O' LAKES FROM CAMP AND TREVOR CREEKS WQ STATION (SURROGATE): IL_DTK-04 NIPPERSINK CREEK AT WINN RD DISCHARGE STATION: USGS-05545750 NIPPERSINK CREEK AT SPRING GROVE		
CONSTITUENT	AVERAGE ANNUAL FLOW NORMALIZED LOAD 2011-2020	AVERAGE ANNUAL YIELD (FLOW NORMALIZED)
Nitrate	67,563 lbs/year	6.9 lbs/ac/yr
Total Phosphorus	2,840 lbs/year	0.29 lbs/ac/yr
NVSS (sediment)	392 tons/yr	0.04 tons/ac/yr (80.8 lbs/ac/yr)

3.3.7.7 Planning Area Direct Drainage Load Estimates

To calculate the entire average annual load to the Chain O' Lakes, runoff that flows directly to them must be considered in addition to loads estimated from tributaries. Nutrient and sediment from lands within the planning area that drain directly to Chain were estimated using yields calculated from nearby watersheds (Table 3-34). The Bassett Creek subwatershed is not included in the table or results as all its land drains to the Fox River. Fox River loading is presented in the previous Section 3.3.7.2. In addition, these estimates do not include contributions from internal loading or lake shoreline erosion which is a significant source of sediment and nutrients as detailed in Section 3.4.3.

Table 3-34: Estimated Loads by Subwatershed in Planning Area from Direct Runoff

SUBWATERSHED	CONSTITUENT	AVERAGE ANNUAL FLOW NORMALIZED LOAD 2011-2020	AVERAGE ANNUAL YIELD (FLOW NORMALIZED)	SURROGATE
Nippersink Lake (15,879 ac)	Nitrate	104,801 lbs/year	6.6 lbs/ac/yr	Des Plaines River
	Total Phosphorus	7,940 lbs/year	0.5 lbs/ac/yr	
	NVSS (sediment)	302 tons/yr	0.019 tons/ac/yr	
Channel Lake (2,886 ac)	Nitrate	17,940 lbs/year	6.9 lbs/ac/yr	Nippersink Creek
	Total Phosphorus	754 lbs/year	0.29 lbs/ac/yr	
	NVSS (sediment)	104 tons/yr	0.04 tons/ac/yr	
Pistakee Lake (9,833 ac)	Nitrate	64,899 lbs/year	6.6 lbs/ac/yr	Des Plaines River
	Total Phosphorus	4,917 lbs/year	0.5 lbs/ac/yr	
	NVSS (sediment)	187 tons/yr	0.019 tons/ac/yr	

3.3.7.8 Average Annual Flow Normalized Loads to the Chain O' Lakes

The estimated annual flow normalized load of TP, nitrate and NVSS from all external sources is presented in Table 3-35. This table represents the sum of all the above WRTDS and surrogate estimates and is based on 2011-2020 data. A total of 4,136,003 lbs of nitrogen, 205,051 lbs of phosphorus and 28,477 tons of sediment is delivered to Chain annually. Using an external watershed drainage area of 767,870 acres, this translates to an annual nitrogen yield of 5.4 lbs/ac, and annual phosphorus yield of 0.27 lbs/ac, and an annual sediment yield of 0.04 tons/ac.

Table 3-35: Annual Flow Normalized Load - All Sources

CONSTITUENT	ESTIMATED ANNUAL FLOW NORMALIZED LOAD FROM ALL SOURCES
Nitrate	4,136,003 lbs / 5.4 lbs/ac
Total Phosphorus	205,051 lbs / 0.27 lbs/ac
NVSS (sediment)	28,477 tons / 0.04 tons/ac

3.3.7.9 Chain O' Lakes as a Sediment and Nutrient Trap

A 1-year estimate of sediment and nutrient loads delivered to and from the system illustrates the challenges facing the Chain (Table 3-36). Although not normalized to flow, results from 2020 indicate the Chain is a major sink of both sediment and nutrients. The gross load estimates for each tributary plus direct runoff were summed for a "total load in." Since no data is available from the Fox River at Johnsburg to calculate "total load out," an estimation was performed using the USGS station on the Fox River at Algonquin, and the Illinois EPA water quality station DT-22 on the Fox near Crystal Lake. To account for the area between the outlet and the analysis site, it was necessary to subtract the estimated contribution from the watershed between the outlet of the Chain and the Fox River at Algonquin. Loads from this area were estimated by applying yields derived from the Upper Fox River to the land area as a surrogate and then subtracting the result from the total calculated load. Not accounted for are the additional issues of sediment and nutrients that originate within the lakes from shoreline erosion and from internal loading of nutrients released from legacy sediments. Shoreline erosion is detailed in Section 3.4.3. It is estimated that up to 216,132 lbs of phosphorus, 1,582,034 lbs of nitrate and 9,792 tons of sediment is trapped in the Chain each year.

Table 3-36: Year 2020 Estimated Loads to Fox Chain O' Lakes

TRIBUTARY	TP (LBS)	NITRATE (LBS)	NVSS (TONS)	ACRES	ESTIMATION METHOD
Fox River At Grass Lake	244,720	4,487,400	28,151	557,440	WRTDS + Watershed Area Ratio
Sequoit Creek	7,840	70,740	273	8,332.8	Yield from Surrogate Des Plaines
Manitou Creek	28,940	260,820	1,005	30,720	Yield from Surrogate Des Plaines
Camp/Trevor Creeks	5,630	129,334	904	9,798	Yield From Surrogate Nippersink Creek
Nippersink Creek	76,568	1,759,120	12,302	133,267	WRTDS + Watershed Area Ratio
Nippersink Lake Direct Drainage	14,959	134,820	519	15,879	Yield from Surrogate Des Plaines
Pistakee Lake Direct Drainage	9,263	83,480	322	9,833	Yield from Surrogate Des Plaines
Channel Lake Direct Drainage	1,492	34,320	240	2,600	Yield From Surrogate Nippersink
TOTAL LOAD FROM WATERSHED:	**389,412**	**6,960,034**	**43,716**	**767,870**	**-**
TOTAL LOAD OUT:	***173,280***	***5,378,000***	***33,924***	***-***	***WRTDS + Watershed Area Ratio + Yield Surrogate of Fox River at Grass Lake***
LOAD TRAPPED IN CHAIN:	**216,132**	**1,582,034**	**9,792**	**-**	**-**

3.4 STREAM AND LAKE PHYSICAL CONDITIONS

This section describes the current physical conditions of lakes and streams in the planning area, including "gullies" or channels with intermittent flow. Data presented were generated from a series of field assessments combined with an analysis of digital map layers.

3.4.1 STREAMS

Stream assessments were completed in 2022 through direct observations at all road crossings during a watershed "windshield" survey and supplemented with Geographic Information System (GIS) analysis. These assessments recorded qualitative information on several easily observed and measured parameters that provide information on the "baseline" conditions of stream channel and riparian area. The results provide a framework for watershed characterization and for prioritizing and implementing management strategies in the plan.

The stream assessment included erosion rates, relative adequacy of buffer zones, and stream channelization. This allows for a general assessment of the stream conditions and quantification of sediment and nutrient loads from bank erosion.

3.4.1.1 Stream Channelization

Stream channelization describes any activity that moves, straightens, shortens, cuts off, diverts, or fills in a stream channel. These activities, which include widening, narrowing, or lining a stream channel, alter the discharge and increase the velocity of water flowing through the streams. In natural meandering streams, channelization decreases the length of the stream and increases the gradient of the channel. Because it is the nature of concentrated, flowing water to create meandering channels with overbank floodplains that dissipate the energy of the flowing water, channelized streams may be susceptible to bank instability and erosion. Modifications in one area of the watershed or stream channel affect other areas upstream, downstream or within the immediate area. Table 3-37 and Figure 3-96 illustrate the degree of channelization in each subwatershed within the planning area. Table 3-38 lists total length channelized by individual stream. The Channel Lake subwatershed contains the greatest percentage of channelized stream length, or 83%, followed by Pistakee Lake at 65%. Basset Creek contains the least, or only 6.9% of all stream miles.

Table 3-37: Streambank Channelization by Subwatershed

SUBWATERSHED	TOTAL (FT)	TOTAL (MI)	CHANNELIZED (FT)	CHANNELIZED (MI)	PERCENT CHANNELIZED
Bassett Creek-Fox River	39,170	7.4	2,710	0.5	6.9%
Channel Lake	12,513	2.4	10,407	2.0	83%
Nippersink Lake-Fox River	19,228	3.6	3,645	0.7	19%
Pistakee Lake-Fox River	22,408	4.2	14,585	2.8	65%
TOTAL:	**93,319**	**18**	**31,346**	**5.9**	**34%**

By stream, Trevor Creek and Lily Lake Drain are channelized along their entire lengths in the planning area followed by 20% of all Unnamed Tributary length. The Fox River has not been channelized.

Table 3-38: Streambank Channelization by Stream

STREAM NAME	TOTAL (FT)	TOTAL (MI)	CHANNELIZED (FT)	CHANNELIZED (MI)	PERCENT CHANNELIZED
Fox River	30,045	5.7	0	0	0%
Lily Lake Drain	11,423	2.2	11,423	2.2	100%
Trevor Creek	7,242	1.4	7,242	1.4	100%
Unnamed Tributary	44,608	8.4	12,681	2.4	28%
TOTAL:	**93,319**	**18**	**31,346**	**5.9**	**34%**

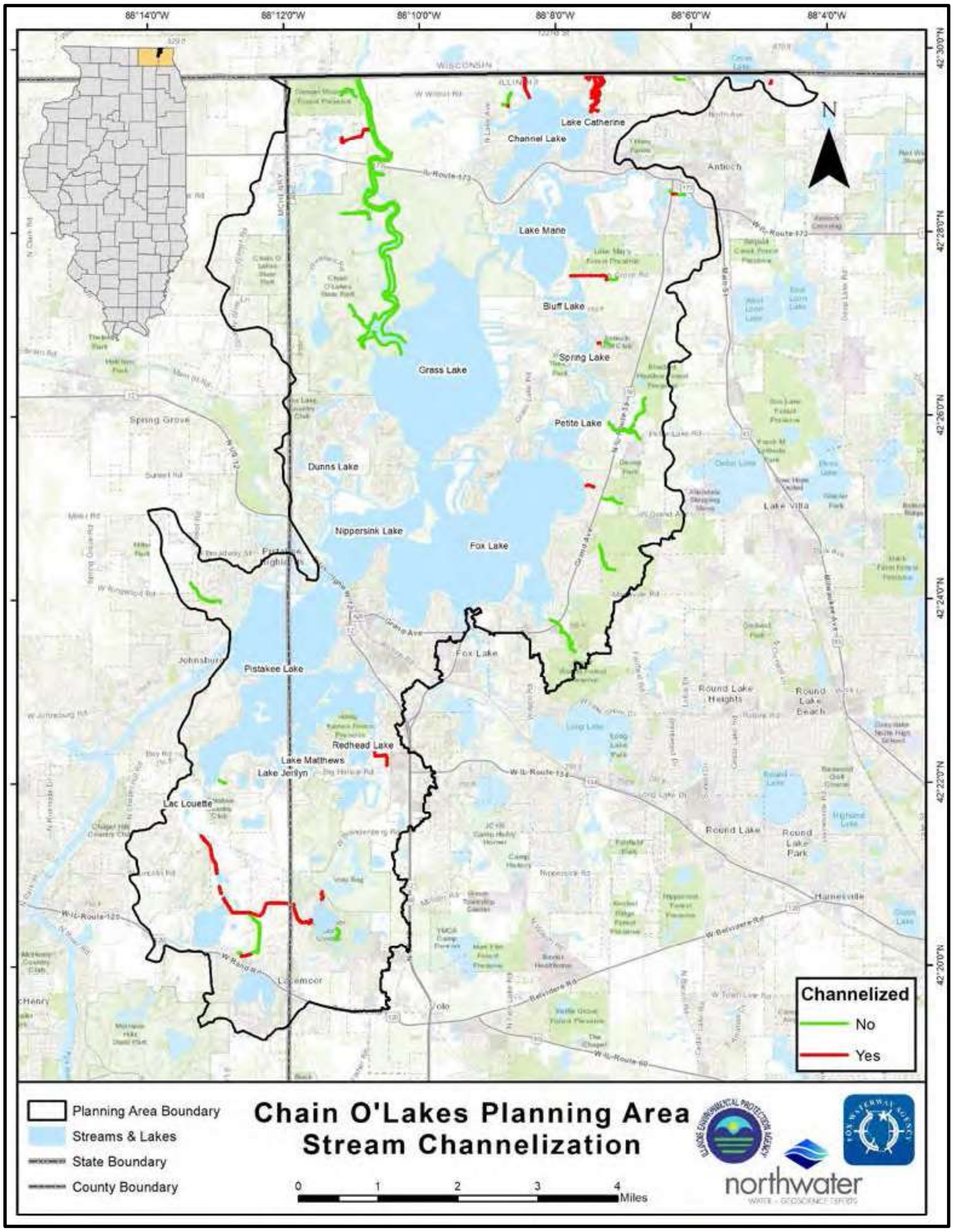

Figure 3-96: Stream Channelization

3.4.1.2 Streambank and Bed Erosion

Streambank erosion was quantified using eroding bank height, bank length and lateral recession rates (LRR). Values were estimated during field observations and transferred to GIS. Soil nutrient concentrations for streambanks were derived from measured values from within the chain and from similar watersheds. The following equations were used to estimate total annual loads:

$$\boldsymbol{Sy = L \times LRR \times H \times yd \times SDR \times STF}$$

Sy – sediment yield in tons/yr
L – eroding bank length in feet
LRR – estimated lateral recession rate in feet per year
H – eroding bank height in feet
γd – Soil dry weight density (tons/ft^3)
SDR – Sediment Delivery Rate (1)
STF – Sediment Transport Factor (0.23 - 0.85)

$$\boldsymbol{TN = \left[Sy \times \frac{2000\ lbs}{1.0\ ton}\right] \times\ Nc\ x\ Cf}$$

TN – Total nitrogen load from streambanks in lbs/yr
Sy – Sediment yield in tons/yr
Nc – Nitrogen concentration in soil (0.002 - 0.013 lbs/lb)
Cf – Correction factor, 1.0

$$\boldsymbol{TP = \left[Sy \times \frac{2000\ lbs}{1.0\ ton}\right] \times\ Pc\ x\ Cf}$$

TP – Total phosphorus load from streambanks in lbs/yr
Sy – Sediment yield in tons/yr
Pc – Phosphorus concentration in soil (0.0002 - 0.0004 lbs/lb)
Cf – Correction factor, 1.0

Streams are dynamic systems, in a perpetual state of flux, therefore, all banks exhibit some form of erosion. Surface runoff to streams contributes to streambank erosion and is dependent upon key factors such as the duration, timing, and amount of precipitation; the type and condition of soil; and land use and vegetative buffers.

Streambed erosion, degradation or lowering, is a process by which the bed of the stream is eroded to a new lower level at a much faster rate than occurs naturally. No instances were noted during field surveys. As the stream assessment was limited to observations at road crossings, it is possible that localized bed erosion could be occurring. Given the low gradient nature of planning area streams and generally stable banks, bed erosion is believed to be negligible or nonexistent.

Field observations indicate that the severity of streambank erosion is variable but, overall, very low. Results indicate bank erosion is responsible for delivering 294 tons of sediment, 6,192 lbs of nitrogen, and 209 lbs of phosphorus annually to the Chain (Table 3-39 and Table 3-40). Streams in the planning area yield an average of 3.1 lbs of sediment per foot per year.

By subwatershed, Bassett Creek is responsible for the majority of the sediment and nutrient loading, due almost entirely to the Fox River. This subwatershed is responsible for 78% of the sediment, 84% of the nitrogen, and 81% of the phosphorus from streambank erosion. Channel Lake is responsible for the least. By stream, the Fox River contributes 219 of the 294 tons/yr sediment, followed by all other Unnamed Tributaries at a combined 70 tons/yr. Lilly Lake Drain and Trevor Creek contribute very little in terms of bank erosion and associated nutrient loading.

Table 3-39: Streambank Erosion by Subwatershed

SUBWATERSHED	STREAMBANK MILES	SEDIMENT LOAD (TONS/YEAR)	SEDIMENT LOAD (LBS/FT OF STREAM)	NITROGEN LOAD (LBS/YEAR)	PHOSPHORUS LOAD (LBS/YEAR)
Bassett Creek-Fox River	15	229	5.8	5,224	170
Channel Lake	4.7	5.7	0.5	86	3.4
Nippersink Lake-Fox River	7.3	37	1.9	552	22
Pistakee Lake-Fox River	8.5	22	1.0	330	13
TOTAL:	**35**	**294**	**3.1**	**6,192**	**209**

Table 3-40: Streambank Erosion by Stream

STREAM NAME	STREAMBANK MILES	SEDIMENT LOAD (TONS/YEAR)	SEDIMENT LOAD (LBS/FT OF STREAM)	NITROGEN LOAD (LBS/YEAR)	PHOSPHORUS LOAD (LBS/YEAR)
Fox River	11	219	7	5,071	164
Lily Lake Drain	4.3	1.8	0.2	27	1.1
Trevor Creek	2.7	3.1	0.4	47	1.9
Unnamed Tributary	17	70	1.6	1,047	42
TOTAL:	**35**	**294**	**3.1**	**6,192**	**209**

Bank Erosion on the Fox River

3.4.1.3 Stream Riparian Buffers

For the purposes of this report, the riparian zone is the area extending 50 ft from the left and right side of a stream channel. Vegetated riparian buffers are of interest because they can make streambanks more resistant to erosion, buffers act as filters for runoff and pollutants, and riparian areas offer habitat for wildlife and can be important green infrastructure corridors. The width and quality of vegetated riparian buffers were visually evaluated in the field and checked against aerial photography, including those locations that were not otherwise assessed in the field.

Example of a Riparian Buffer

Table 3-41 and Table 3-42 summarize the results of a stream buffer adequacy analysis. A properly vegetated buffer of greater than 50 ft width was categorized as adequate, and anything less, inadequate. Native grass, wetlands, forbs, and trees were considered appropriate buffer vegetation, while lawn, bare dirt and cropland, pasture, structures, and hardscape were considered poor. Throughout the planning area, buffer width and adequacy were related to riparian land use, with wide, high quality riparian buffers located along streams flowing through large natural wetland, grass, or forested land, and in protected areas. Generally, more urbanized areas had much less adequate buffer widths.

Streams are generally well buffered or approximately 79% of all banks considered adequate (Table 3-41). Although most are well buffered, areas exist where improvements can be made. Buffers can be expanded on nearly 7 miles or 21% of all banks in the planning area (Figure 3-97).

Buffer type varies with forest, accounting for 37% of all bank miles. Wetlands make up 36%, general open space (lawns) and golf courses 11%, grasslands/scrublands 6.5%, and residential 4.4%. The other categories combined make up roughly another 6% (Table 3-42). It should be noted that buffer length does not match exactly with streambank lengths due to the method of analysis and a 50 ft setback, reducing overall buffer length compared to length of stream.

Table 3-41: Streambank Buffer Adequacy

TOTAL BANK LENGTH (FT)	TOTAL BANK LENGTH (MI)	INADEQUATE (MI)	ADEQUATE (MI)	INADEQUATE %	ADEQUATE %
174,919	33	6.8	21%	26	79%

Table 3-42: Streambank Buffer Land Use Categories

BUFFER TYPE	TOTAL BANK MILES	% STREAMBANK LENGTH
Forest	12	37%
Wetlands	12	36%
Open Space/ Golf Course	3.8	11%
Grasslands/Scrublands	2.1	6.5%
Residential	1.4	4.4%
Agriculture	0.91	2.7%
Industrial/Commercial	0.51	1.2%

BUFFER TYPE	TOTAL BANK MILES	% STREAMBANK LENGTH
Roads/Driveway/Parking Lot	0.3	0.8%
Parks and Recreation	0.2	0.71%
Open Water	0.15	0.5%
TOTAL:	33	100%

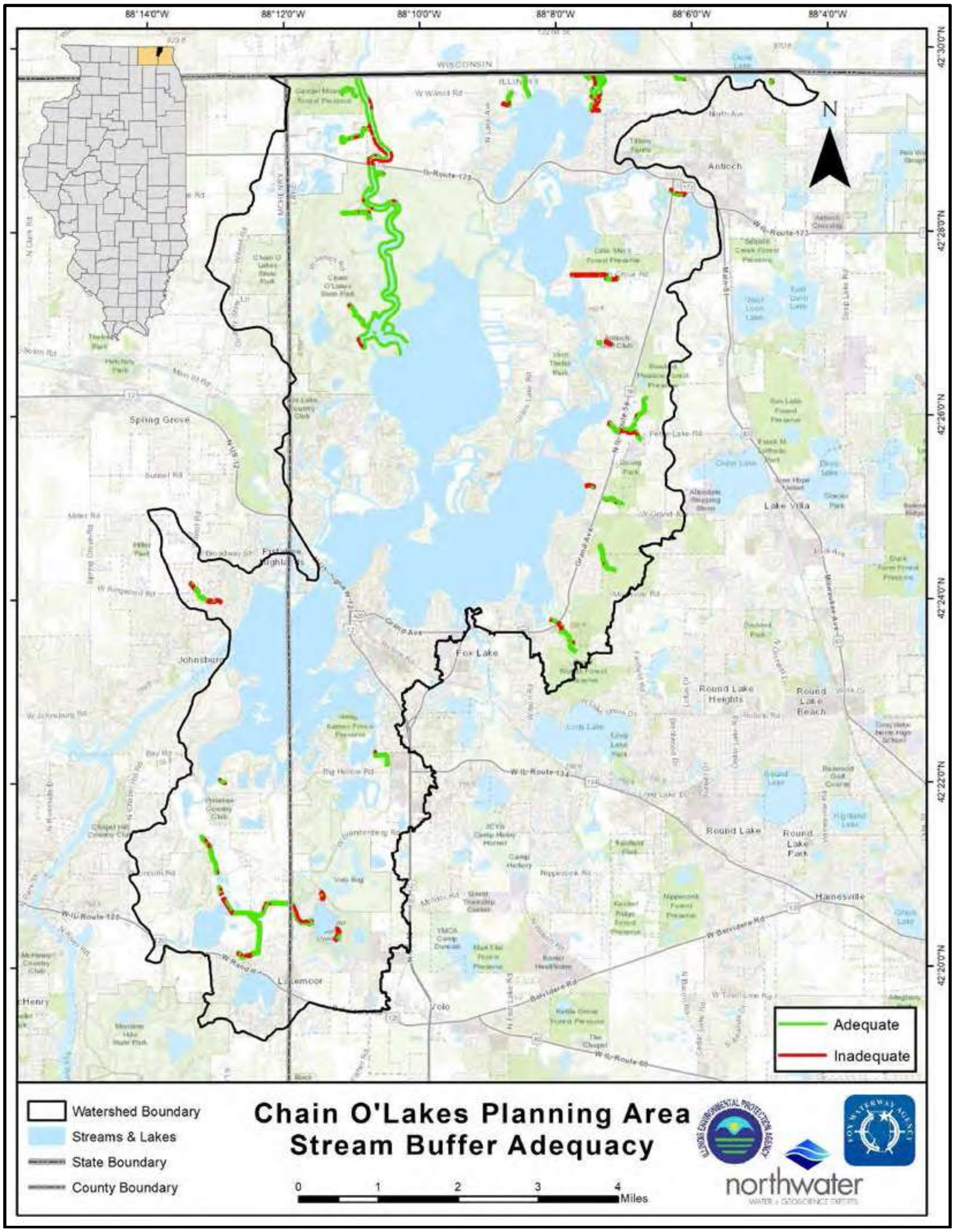

Figure 3-97: Stream Buffer Adequacy

3.4.2 GULLY EROSION

Gully erosion is the removal of soil along drainage lines by surface water runoff. Once started, gullies will continue to move unless steps are taken to stabilize the disturbance. Gully erosion occurs when water is channeled across unprotected land and washes away the soil along the drainage lines. Under natural conditions, run-off is moderated by vegetation which generally holds the soil together, protecting it from excessive run-off and direct rainfall. To repair gullies, the objective is to divert and modify the flow of water moving into and through the gully so that scouring is reduced, sediment accumulates, and vegetation can establish. Stabilizing the gully head is important to prevent damaging water flow and headward erosion. In most cases, gullies can be prevented by good land management practices.

Gully erosion was evaluated during a watershed windshield survey and estimated using GIS. Results presented in this section represent both ephemeral (those that form each year) and permanent (those that receive intermittent streamflow and expand over time such as a forested ditch or channel). For those ephemeral gullies not visible from a road or observed during the windshield survey, GIS was used to estimate their location and extent. Gullies were delineated in GIS using aerial imagery and high-resolution elevation data, and a conservative average estimated width, depth, and years eroding were applied. For gullies observed in the field, dimensions were directly measured and transferred to GIS for analysis.

Total net erosion in tons/year and estimates of nitrogen and phosphorus loading were calculated using the equations below. A distance-based delivery ratio was applied to account for proximity to a receiving waterbody. Sediment trapping efficiency was accounted for if the gully drained to a detention structure. Soil nutrient concentrations were obtained from measured data in similar watersheds and from literature. The following equations were applied to estimate gully erosion and nutrient yields:

$$\boldsymbol{Sy} = \left\{\frac{\boldsymbol{L} \times \boldsymbol{W} \times \boldsymbol{H}}{\boldsymbol{Y}} \times \boldsymbol{\gamma d}\right\} \boldsymbol{DPS^{0.2069}}$$

Sy – sediment yield in tons/yr
L – gully length in feet
W – gully width in feet
D -gully depth in feet
Y – years eroding
γd – Soil dry weight density (tons/ft^3)
DPS$^{0.2069}$- Distance to lake or perennial stream or waterbody in feet, delivery ratio
STF – Sediment Transport Factor (0.75)

$$\boldsymbol{TN} = \left[\boldsymbol{Sy} \times \frac{\mathbf{2000\ lbs}}{\mathbf{1.0\ ton}}\right] \times \ \boldsymbol{Nc\ x\ Cf}$$

TN – Total nitrogen load from gully in lbs/yr
Sy – Sediment yield in tons/yr
Nc – Nitrogen concentration in soil (lbs/lb)
Cf – Correction factor, 1.0

$$\boldsymbol{TP} = \left[\boldsymbol{Sy} \times \frac{\mathbf{2000\ lbs}}{\mathbf{1.0\ ton}}\right] \times \ \boldsymbol{Pc\ x\ Cf}$$

TP – Total phosphorus load from gully in lbs/yr
Sy – Sediment yield in tons/yr
Pc – Phosphorus concentration in soil (lbs/lb)
Cf – Correction factor, 1.0

Gully erosion is originating from 5 different land use categories and is responsible for delivering 27 tons/yr of sediment, 15 lbs/yr of phosphorus, and 43 lbs/yr of nitrogen (Table 3-43). Of the 19,645 ft (3.7 mi) in the planning area, 37% is from forested areas and 31% is from cropland. Most of the sediment and nutrient loading is from cropland, or 59% of the sediment, 74% of the nitrogen, and 65% of the phosphorus. Average gully depth ranges from 0.5 – 1.5 ft and width from 0.98 – 2.1 ft.

Table 3-43: Gully Erosion and Loading

LAND USE	LENGTH (FEET)	SEDIMENT LOAD (TONS/YR)	NITROGEN LOAD (LBS/YR)	PHOSPHORUS LOAD (LBS/YR)	AVERAGE GULLY WIDTH (FEET)	AVERAGE GULLY DEPTH (FEET)
Row Crops	6,089	16	32	9.7	0.62	0.47
Open Space	888	2.4	4.8	2.4	2.1	1.5
Forest	7,197	7.2	3.6	2.7	1.2	1.1
Grasslands	3,744	1.1	2.2	0.4	0.98	0.98
Forest/Scrub	1,727	0.4	0.5	0.16	1	1
TOTAL:	**19,645**	**27**	**43**	**15**	**1.2**	**1**

3.4.3 Lakes

All accessible named major lakes in the Chain were directly assessed by boat in the spring of 2022. All other remining lakes or ponds were evaluated using aerial photo interpretation and during a watershed windshield survey. This resulted in over 200 miles of shoreline being observed (Figure 3-98).

The inventory assessed the health of lakes and provided information on natural and anthropogenic impacts. Shoreline erosion was quantified, sediment deposition, outfall structures, existing stabilization practices (e.g., seawall versus riprap) and buffers were evaluated. Collectively, this data provides essential information for watershed planning and management.

3.4.3.1 Shoreline Erosion

Shoreline erosion is a natural process which results in the loss of sediment from a shoreline. It occurs gradually, however, anthropogenic influences such as clearing of vegetation or rocks and increased stormwater runoff can substantially accelerate this process. Sediments eroded from shorelines are transferred to the lake's water column, which increases turbidity and introduces nutrients and contaminates which are attached to the sediment. This sediment is mostly deposited on the lakebed, which can result in degraded habitat for fish and aquatic life.

Shoreline assessments were conducted by boating the perimeter of the waterbody and assigning erosion values for each segment of shoreline. All other lakes and ponds were evaluated using aerial photo interpretation and during the watershed windshield survey. Values were recorded using GPS. Varying levels of erosion were observed. Based on these results, lake shoreline stabilization is a priority in this plan.

Annual sediment, nitrogen and phosphorus loads were calculated using equations below. Eroding bank height, bank length and lateral recession rates (LRR) estimated in the field were transferred to GIS. An interpretation of historical imagery was utilized to confirm recession rates for natural banks. Lake bank soil nutrient concentrations were estimated from soil cores obtained from representative areas within the Chain. The following equations were used to estimate total annual loads:

$$\boldsymbol{Sy = L \times LRR \times H \times yd \times SDR \times STF}$$

Sy – sediment yield in tons/yr
L – eroding bank length in feet
LRR – estimated lateral recession rate in feet per year
H – eroding bank height in feet
γd – Soil dry weight density (tons/ft^3)

$$\boldsymbol{TN = \left[Sy \times \frac{2000\ lbs}{1.0\ ton}\right] \times\ Nc\ x\ Cf}$$

TN – Total nitrogen load from lake banks and streambanks in lbs/yr
Sy – Sediment yield in tons/yr
Nc – Nitrogen concentration in soil (0.013 – 0.002 lbs/lb)
Cf – Correction factor, 1.0

$$\boldsymbol{TP = \left[Sy \times \frac{2000\ lbs}{1.0\ ton}\right] \times\ Pc\ x\ Cf}$$

TP – Total phosphorus load from lake banks and streambanks in lbs/yr
Sy – Sediment yield in tons/yr
Pc – Phosphorus concentration in soil (0.0002 – 0.0004 lbs/lb)
Cf – Correction factor, 1.0

Of the 208 miles of shoreline evaluated, 147 miles, or 71%, were directly assessed by boat and, therefore, a more complete dataset is presented for these banks and the lakes themselves. Total annual sediment loading is 5,867 tons with 5,742 tons or 98% estimated to be originating from those lakes directly assessed by boat (Table 3-44). Total annual nutrient loading is 143,947 lbs of nitrogen and 4,537 lbs of phosphorus. The vast majority of the sediment and nutrients originating from bank erosion can be attributed to Grass, Fox, Pistakee, and Nippersink Lakes. Grass Lake alone is responsible for 45%. Furthermore, banks that contribute 100 lbs of sediment per foot or more are responsible for 90% of the total sediment, 95% of the total nitrogen and 93% of the total annual phosphorus load. These highly eroding banks represent only 3.4% of the 147 miles assessed by boat and just 2.4% of all shorelines.

Shoreline length, annual sediment load, percent of annual sediment load from all shorelines, annual nitrogen and annual phosphorus loading is listed in Table 3-44 by major named lake and for those waterbodies indirectly assessed. Grass, Fox, Pistakee, and Nippersink Lakes together contribute 95% of the entire sediment load. Lake Catherine contributes the least.

Figure 3-98 shows erosion rates for all assessed lakes, as well as those estimated but not directly assessed. A detailed map book representing 10 individual maps depicting shoreline erosion rates can be found in Appendix A.

Table 3-44: Nutrient and Sediment Loading from Shoreline Erosion

LAKE NAME	BANK LENGTH (MI)	SEDIMENT LOAD (TONS/YR)	PERCENT OF TOTAL SEDIMENT LOAD FROM SHORELINE	NITROGEN LOAD (LBS/YR)	PHOSPHORUS LOAD (LBS/YR)
Grass Lake	21.2	2,644	45.1%	67,786	2,098
Nippersink Lake*	18.5	1,673	28.5%	43,063	1,331
Fox Lake	22.9	745	12.7%	18,539	581
Pistakee Lake*	29.8	521	8.9%	12,528	398
Dunns Lake	4	59	1%	235	24
Lake Marie	14.8	37	0.63%	689	25
Petite Lake	7.3	33	0.56%	358	17
Spring Lake	4.6	8.5	0.14%	61	3.9
Channel Lake	9.6	8.3	0.14%	96	4.4
Bluff Lake	3	4.9	0.08%	20	2
Redhead Lake	2.1	1.1	0.02%	12	0.6
Lake Catherine	2.1	0.3	0.01%	1.3	0.1
All Other Directly Assessed	6.6	8.1	0.14%	41	3.4
All Other Non-Directly Assessed	61.9	124	2.12%	518	50
TOTAL:	**208**	**5,867**	**-**	**143,947**	**4,537**

**Includes 4.8 miles of remotely assessed shoreline in Nippersink Lake and 0.64 miles in Pistakee Lake*

Stabilized Shoreline

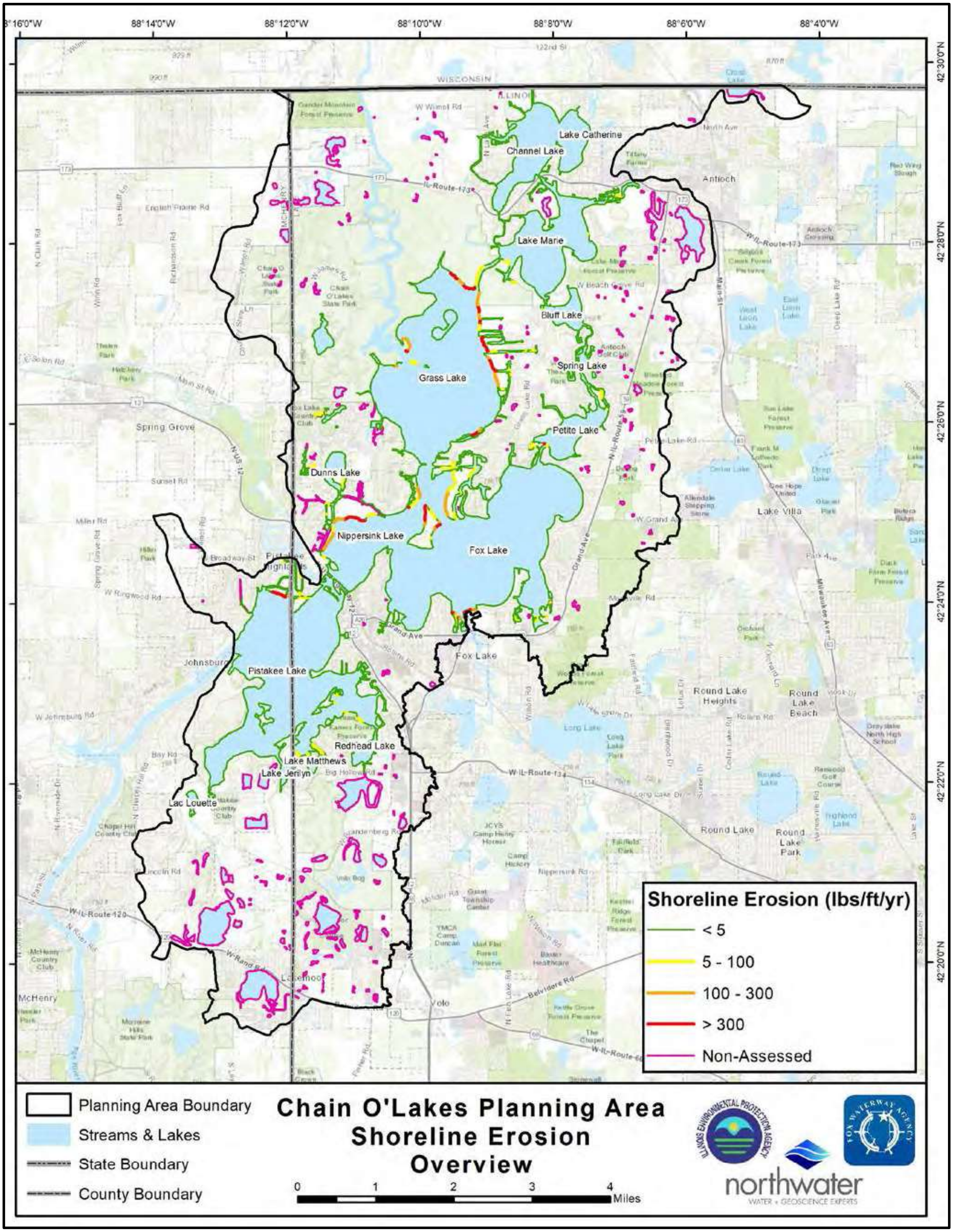

Figure 3-98: Shoreline Erosion

3.4.3.2 Existing Shoreline Stabilization Practices and Condition

In the Chain, shoreline can be categorized as natural, rip-rap or rocked, concrete, seawall (wooden and with rip rap) and, in one instance, tires. Each category was then grouped into "failing" or "stable." Data shown in Table 3-45 indicates that the majority of banks are natural (64 miles) followed by seawalls (38 miles) and rip-rap or rock (33 miles). Concrete banks cover 6.2 miles. Grass Lake contains the most miles of natural banks, followed by Nippersink. Pistakee Lake has the most rip-rap, concrete and seawall. Lake Marie contains the greatest number of failing rock banks and Pistakee the most failing seawalls at almost a mile. In total, 2.1 miles have some type of failing structure, or 1.5%.

Table 3-45: Shoreline Stabilization Practices and Condition

LAKE NAME	NATURAL (MI)	RIP-RAP (MI)	FAILING (MI)	SEAWALL (MI)	FAILING (MI)	CONCRETE (MI)	FAILING (MI)	TIRES
Bluff Lake	0.58	0.63	0	1.56	0	0.17	0	0
Channel Lake	5.69	1.46	0	1.65	0.23	0.62	0	0
Dunns Lake	1.79	1.20	0	1.03	0	0	0	0
Fox Lake	6.47	5.16	0.03	9.96	0.24	0.98	0	0.02
Grass Lake	13.1	5.98	0.007	1.82	0.23	0	0	0
Lac Louette	1.47	0.1	0	0	0	0	0	0
Lake Catherine	0.18	0.46	0	0.71	0	0.73	0	0
Lake Jerilyn	0.48	0.42	0	0.47	0	0	0	0
Lake Marie	6.48	3.65	0.12	3.89	0.22	0.43	0.02	0
Lake Matthews	0.02	0.61	0	0	0	0.04	0	0
Leisure Lake	0.09	0.79	0	0	0	0	0	0
Nippersink Lake*	8.71	1.64	0	3.16	0.02	0.13	0	0
Petite Lake	3.19	1.86	0	2.17	0.02	0.11	0	0
Pistakee Lake*	7.47	7.57	0.03	10.54	0.86	2.66	0.02	0
Redhead Lake	1.69	0.38	0	0	0	0.05	0	0
Spring Lake	2.68	0.56	0	1.04	0.02	0.26	0	0
Turner Lake	1.53	0	0	0	0	0	0	0
Unnamed Lake/Pond	0.42	0.09	0	0	0	0	0	0
TOTAL:	**62**	**32.5**	**0.18**	**38**	**1.8**	**6.18**	**0.046**	**0.02**

**Excludes 4.88 miles of non-assessed shoreline in Nippersink Lake and 0.64 miles in Pistakee Lake*

3.4.3.3 Lake Sediment Accumulation

Sediment erosion, transport and deposition are naturally occurring processes. Land use changes and anthropogenic modifications within the watershed can amplify the magnitude of these processes. A 2002 ISWS report prepared by Nani G Bhowmik and Misganaw Demissie indicated a significant loss of capacity in the Chain due to sedimentation. This is especially true in Grass Lake, the first lake the Fox River enters, which has undergone maximum sediment deposition. This and other studies present a range of values for sediment inflow, outflow, deposition, and trapping efficiency of the Chain. All indicate some level of management is needed to address both internal and external sources of sediment.

To address this issue and their responsibility to maintain the lakes for improved navigation and boat access, the FWA leads an active, permitted program that includes both hydraulic and mechanical dredging, sediment dewatering and storage, and beneficial re-use. The FWA receives nearly $2,000,000 annually from boat sticker sales, which is the primary source of funding for this work. Since 2019, the Agency has removed over 400,000 cubic yards (CY) from channels, lakes and the Fox River to tackle an estimated 100,000 CY entering the system annually.

Every year, sites are prioritized based on need and the availability of resources. Despite a lack of adequate financing to tackle the entirety of the problem, the FWA is making progress. This watershed plan is one more tool that can be used to secure future funding for in-lake and watershed projects aimed at addressing sedimentation.

In addition to the challenges it presents for the FWA, sediment deposition is also a primary concern of planning area stakeholders. A total of 49 locations were identified during the lake assessment where significant sedimentation warrants action. These areas include and expand upon those already prioritized by the FWA. In addition to limiting sedimentation from external sources and within, such as from eroding shorelines, sediment removal is proposed as a key strategy to maintain lake depth for navigation and recreation and reduce the potential for internal nutrient release from nutrient-rich soil. The 49 areas identified for sediment removal total 1,739 acres and approximately 23,852,600 CY using an average dredged depth of 3 ft.

3.4.3.4 Lake Buffers

The riparian zone is the land area immediately adjacent to the bank of a river or lake. Vegetated lake buffers are of interest because they can make lake banks more resistant to erosion, buffers act as filters for runoff and pollutants, and riparian areas offer habitat for wildlife. In addition, riparian buffers, such as native grasses and forbs, can discourage grazing by nuisance geese. Width and quality were visually evaluated while assessing lake banks and checked against aerial photography, including those locations that were not otherwise observed in the field. Buffer adequacy is only presented for major lakes in the planning area. A properly vegetated buffer of greater than 50 ft width was categorized as adequate, and anything less, inadequate. Native grass, wetlands, forbs, and trees were considered appropriate buffer vegetation, while lawn, bare dirt, pasture, structures, and hardscape were considered poor.

Lakes are generally not well buffered or approximately 51% of all shorelines considered inadequate (Table 3-46). Substantial areas exist where improvements can be made. Buffers can be expanded on nearly 62 miles (51%) in the planning area, although some inadequately buffered land use types, such as boat houses, marinas, and beaches, are unlikely candidates for buffer expansion (Figure 3-99). Buffer type varies with open space (primarily lawns), accounting for 27% of all bank miles. Wetlands make up 33%, forests 23%, residential 11%, and roads, driveways, and parking lots 4.6%. The 37 other categories combined make up roughly another 16% (Table 3-48).

Table 3-46: Lake Buffer Adequacy

TOTAL SHORELINE (FT)	TOTAL SHORELINE (MI)	INADEQUATE (MI)	ADEQUATE (MI)	INADEQUATE %	ADEQUATE %
635,746	120	62	59	51%	49%

Table 3-47: Lake Buffer Adequacy by Lake

LAKE NAME	TOTAL SHORELINE (FT)	TOTAL SHORELINE (MI)	INADEQUATE (MI)	ADEQUATE (MI)	INADEQUATE %	ADEQUATE %
April Pond	239	0.05	0.05	0	100%	0%
Bluff Lake	14,684	2.8	2.1	0.7	74%	26%
Brandenburg Lake	92	0.0	0.02	0	100%	0%
Channel Lake	43,126	8.2	3.8	4.3	47%	53%
Dunns Lake	18,648	3.5	1.5	2.0	43%	57%
Fox Lake	102,168	19	13	5.9	69%	31%
Grass Lake	90,543	17	5.1	12	30%	70%
Jackson Estate Pond	429	0.08	0.1	0.01	85%	15%
Lac Louette	157	0.03	0.03	0	100%	0%
Lake Catherine	10,638	2.0	1.5	0.5	74%	26%
Lake Jerilyn	6,381	1.2	0.7	0.5	59%	41%
Lake Marie	63,797	12	6.7	5.4	55%	45%
Lake Matthews	262	0.05	0.0	0.01	87%	13%
Nippersink Lake	82,235	16	4.8	11	31%	69%
Petite Lake	34,789	6.6	3.6	3.0	55%	45%
Pistakee Lake	129,163	24	16	8.7	65%	35%
Redhead Lake	10,291	1.9	0.6	1.4	29%	71%
Riva Bay Pond	327	0.06	0.1	0.0	84%	16%
Spring Lake	16,989	3.2	1.6	1.6	49%	51%
Unnamed Lakes & Ponds	623	0.1	0.1	0.03	76%	24%
Vacation Pond	136	0.03	0.0	0.02	21%	79%

Table 3-48: Lake Buffer Types

BUFFER TYPE	TOTAL SHORELINE (MI)	% SHORELINE
Open Space	33	27%
Wetlands	29	24%
Forest	28	23%
Residential	15	13%
Roads/Driveway/Parking Lot	5.5	4.6%
Mobile Home Park	1.4	1.1%
Grasslands	1.4	1.1%
Marina	1.1	0.9%
Other buffer types less than 1 mile	6.4	5.1%
TOTAL:	**127**	**100%**

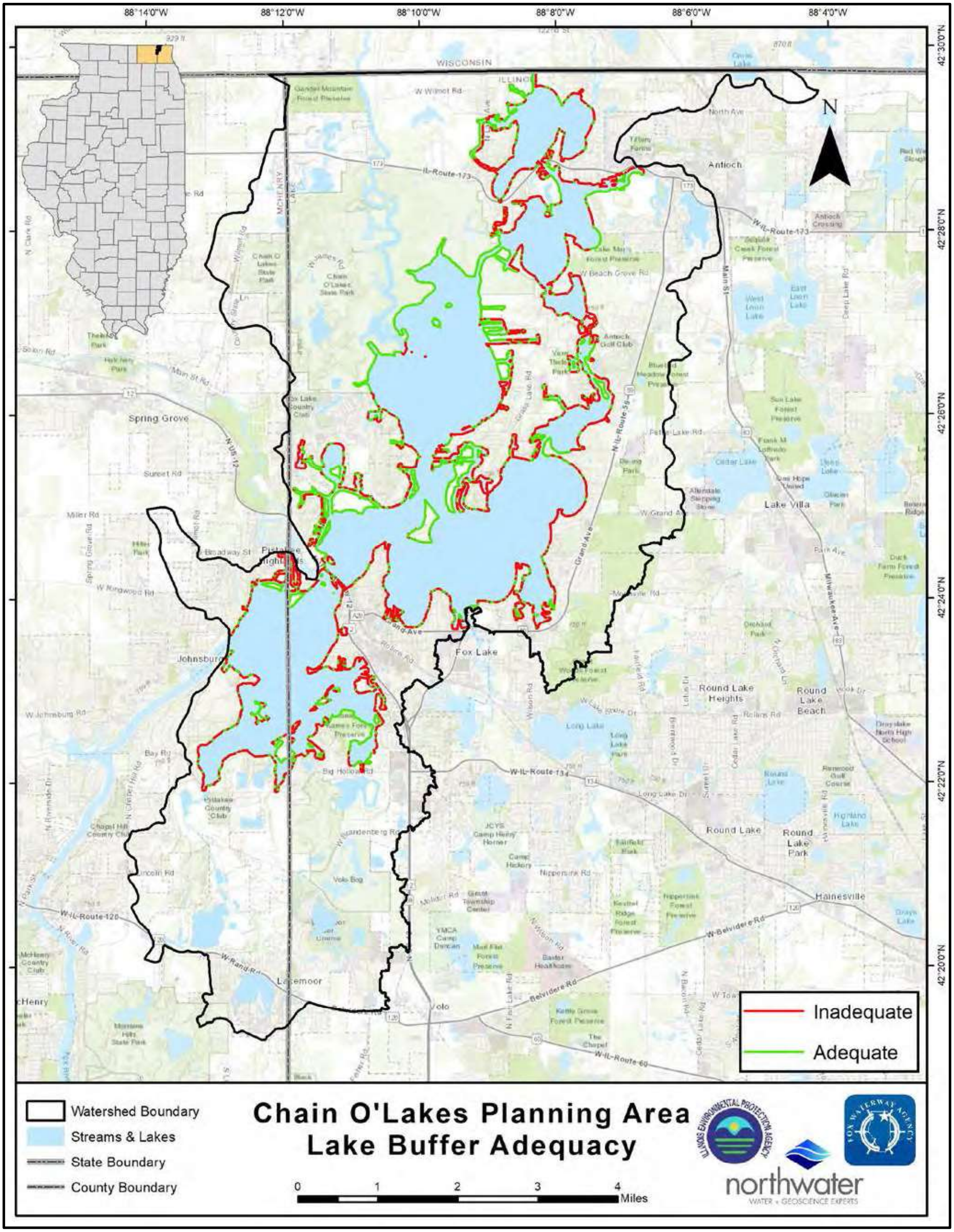

Figure 3-99: Lake Buffer Adequacy

3.4.3.5 Discharge Points

Discharge points include outfalls that discharge into waterbodies including "pipes" such as drain tile outlets, sump pump discharges, and storm sewers. The lake inventory documented 162 visible discharge points, although many more are believed to exist. A total of 150 stormwater outfalls were identified, or 93% of all inventoried. The remaining points include residential drainage pipes and other or "unknown."

Example Discharge Pipe

Discharge points can contribute to erosion and the transport of excess sediment and associated nutrients to the lake chain. Project recommendations in Chapter 5 address many of the discharge pipes identified. Outfalls may cause localized erosion, resulting in a positive feedback loop of erosion near the outfall, which may result in pipe, end section, apron, or headwall failure.

3.5 FLOODPLAIN

A review and analysis of the most recent Federal Emergency Management Agency (FEMA) Digital Flood Insurance Rate Maps (DFIRM) indicates there are 14,607 acres of 100-year floodplain within the planning area, or 44% of total area (Table 3-49). Flood hazard areas on the Flood Insurance Rate Map are identified as Special Flood Hazard Areas (SFHA). The SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year but are broken up into different zones based on severity of flood hazard risk. The 1-percent annual chance flood is also referred to as the base flood, or 100-year flood (FEMA, 2018).

Table 3-49: Floodplain Area by Subwatershed

SUBWATERSHED	AREA (AC)	FLOODPLAIN AREA (AC)	FLOODPLAIN AREA (%)
Bassett Creek-Fox River	4,324	1,088	25%
Channel Lake	2,886	1,099	38%
Nippersink Lake-Fox River	15,879	8,359	53%
Pistakee Lake-Fox River	9,833	4,061	41%
TOTAL:	**32,922**	**14,607**	**44%**

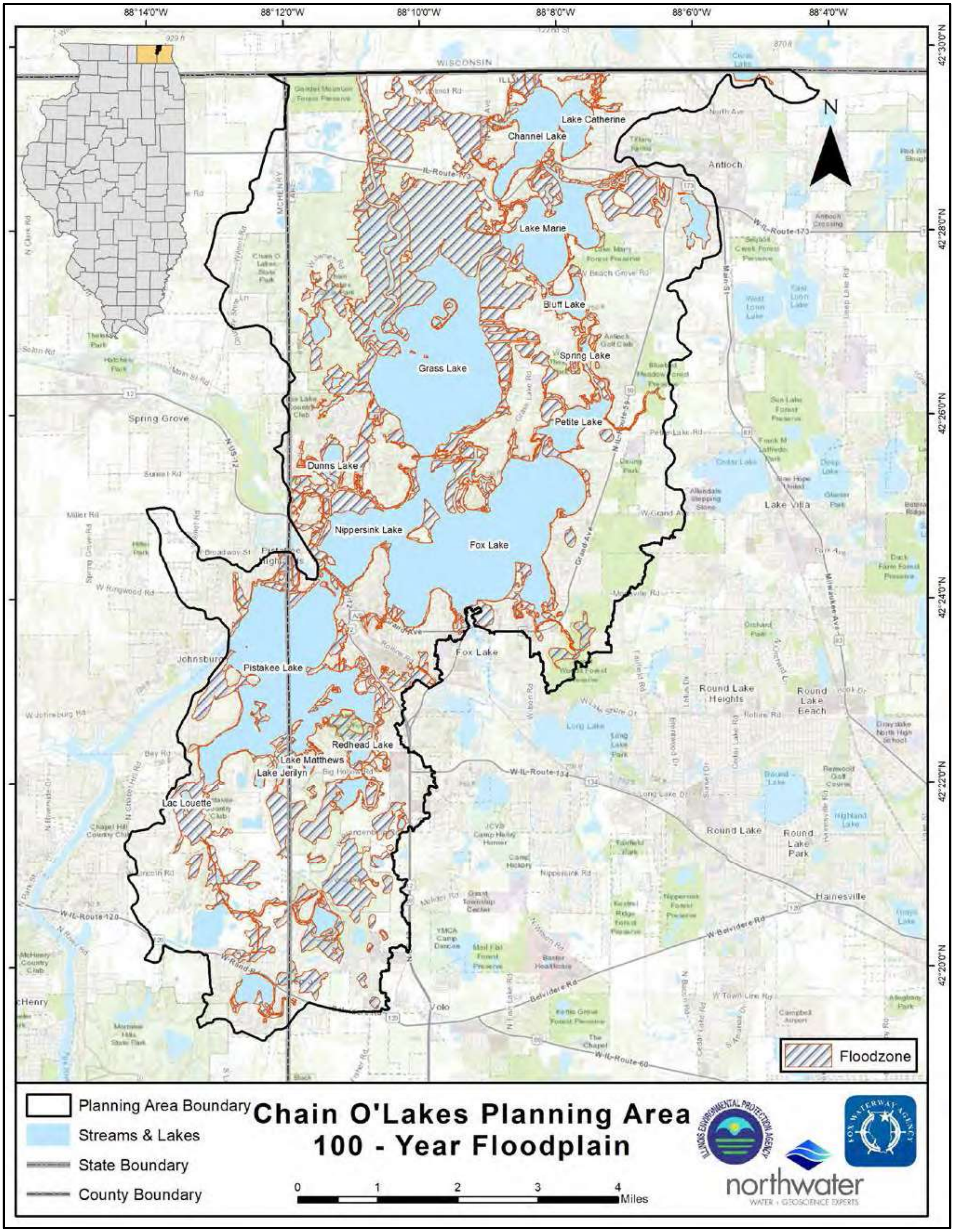

Figure 3-100: 100-Year Floodplain

3.6 GEOLOGY & HYDROGEOLOGY

The geology and hydrogeology of the planning area has been comprehensively studied and characterized in the literature. The Surficial Geology of Fox Lake Quadrangle at 1:24,000 scale was completed as part of the Central Great Lakes Geologic Mapping Coalition program in 2008 (Thomason and Barnhardt, 2008). The USGS and ISWS have published dozens of publications on the shallow and deep groundwater resources in the study area. There is also historical and ongoing groundwater monitoring between the ISWS, county governments and USGS. This section includes a broad summary of surficial geology and hydrogeology in the context of informing watershed planning and management.

3.6.1 GEOLOGY

The Chain O'Lakes planning area is located along the northwest portion of the Wheaton morainal region in the Great Lakes Section of Illinois. Surficial materials and hydrology have been fundamentally shaped by glacial processes of deposition and erosion. Table 3-50 and Figure 3-101 differentiate the surficial geology of the planning area which is blanketed with 100 to ~400 ft of unconsolidated glacial till and outwash formations, referred to as "drift," which range in composition from clay matrix tills to sands and gravels. The study area also includes some regionally significant areas of peat development.

The drift thickness above bedrock ranges from ~100 ft in the central portion beneath many of the lakes to nearly 400 ft along the northwest and eastern portion of the planning area. This drift supports sand and gravel aquifers at different layers. The drift is underlain by carbonate and dolomite bedrock of Silurian age; this bedrock houses a shallow bedrock aquifer often referred to as the Silurian Dolomite aquifer. In the west-central and southern portion of the planning area, the drift is underlain by Maquoketa shale group of Ordovician age and the Silurian dolomite is not present (Maquoketa shale is older than the Silurian dolomite).

Table 3-50: Surficial Geology of Chain O'Lakes

SURFICIAL GEOLOGY	DESCRIPTION[1]	AREA (ACRES)	PERCENT OF PLANNING AREA
Peat	Thin Grayslake Peat underlain by Henry outwash or silty to clayey Wedron tills	6,366	23%
Lake Deposits	Silt and clay of Carmi Member of Equality Formation underlain by silty and clayey Wedron tills	2,158	7.9%
Alluvium	Thin Cahokia alluvium underlain by sandy to gravelly Wedron tills	11	0.0%
Glacial Outwash	Henry outwash underlain by silty to clayey Wedron tills	5,497	20%
Glacial Till	Thick silty and clayey Wedron tills	6,766	25%
	Thin sandy to loamy Wedron till underlain by sandy to gravelly till and silty to clayey till	365	1.3%
	Thick sandy to gravelly Wedron till underlain in some areas by silty to clayey tills	6,245	23%

[1] *Adapted from Illinois State Geological Survey Stack-Unit Mapping of Geologic Materials in Illinois to a Depth of 15 meters*

3.6.2 Hydrogeology

Groundwater is a critical resource in the Chain. The groundwater systems strongly interact with the surface water hydrology and lake chain (Mills, 2014), and the aquifers serve as the primary potable water supply for the area and have notable vulnerabilities to drought, contamination and depletion.

There are four major aquifer systems which include (i) unconsolidated sand and gravel aquifers (ii) Silurian dolomite aquifer, (iii) the Cambrian-Ordovician sandstone aquifer (St. Peter sandstone), and (iv) the Elmhurst-Mount Simon sandstone aquifer. All the aquifer systems are used for public and private water supply except for the latter, which is very deep and produces brackish water. In general, the shallower sand and gravel aquifers receive abundant recharge due to their proximity to the surface and engagement with surface water systems. This, however, also makes them more vulnerable to contamination, occurrences of which have been reported in the planning area and documented in the literature and government records. The shallower aquifers are also more susceptible and responsive to drought impacts and seasonal issues versus the deeper bedrock counterparts. The deeper bedrock aquifers have different considerations as the recharge occurs over hundreds to thousands of years, with recharge areas extending into Wisconsin. Depletion and over-exploitation of the bedrock aquifers are the primary concern, whereas contamination from anthropogenic sources is a lesser concern.

The unconsolidated sand and gravel aquifers consist of several different systems. The deepest consists of fine sand and silts, which were deposited in a shallow proglacial lake environment and present throughout most of the planning area. Mid-level coarse sand and gravel aquifers are more discontinuous and present in the eastern part of the Chain, whereas the shallow aquifers (< 100 ft depth) blankets most of the southern part and the north-western portion underlying the lakes (see Henry Formation and Cahokia alluvium in Figure 3-100).

As previously mentioned, groundwater resources are the primary water supply for the Chain. There are 28 active Community Water Supply (CWS) and 104 Non-Community Water Supply (NCWS) wells recorded in the state database. In addition to public wells, there are estimated to be at least 6,200 private water wells based on the Illinois State Geologic Survey (ISGS) wells and borings database. Average depth of the CWS wells is 286 ft, ranging from 86 to 1,400 ft. For private wells, the average depth is 103 ft, ranging from 22 to 1,350 ft. The shallower wells are completed within the sand and gravel aquifers and the deeper ones extend into the Silurian and Cambrian-Ordovician aquifers. Well yield or pumping rate data was available for 4,488 wells, with 29 yielding in excess of 100 gallons per minute and six yielding in excess of 1,000 gallons per minute. Private wells are primarily completed in the unconsolidated sand and gravel aquifers; only 5.5% reported production from bedrock units. The ISGS mapping indicates that both major sand and gravel and bedrock aquifers underlay a majority of the watershed.

In the context of watershed planning and management, shallow groundwater is a critical resource for the health and function of ecosystems, the lake Chain and water supply. Moreso than many watersheds in the Midwest United States, the prevalence and importance of groundwater may warrant consideration of an integrated water management approach in the future.

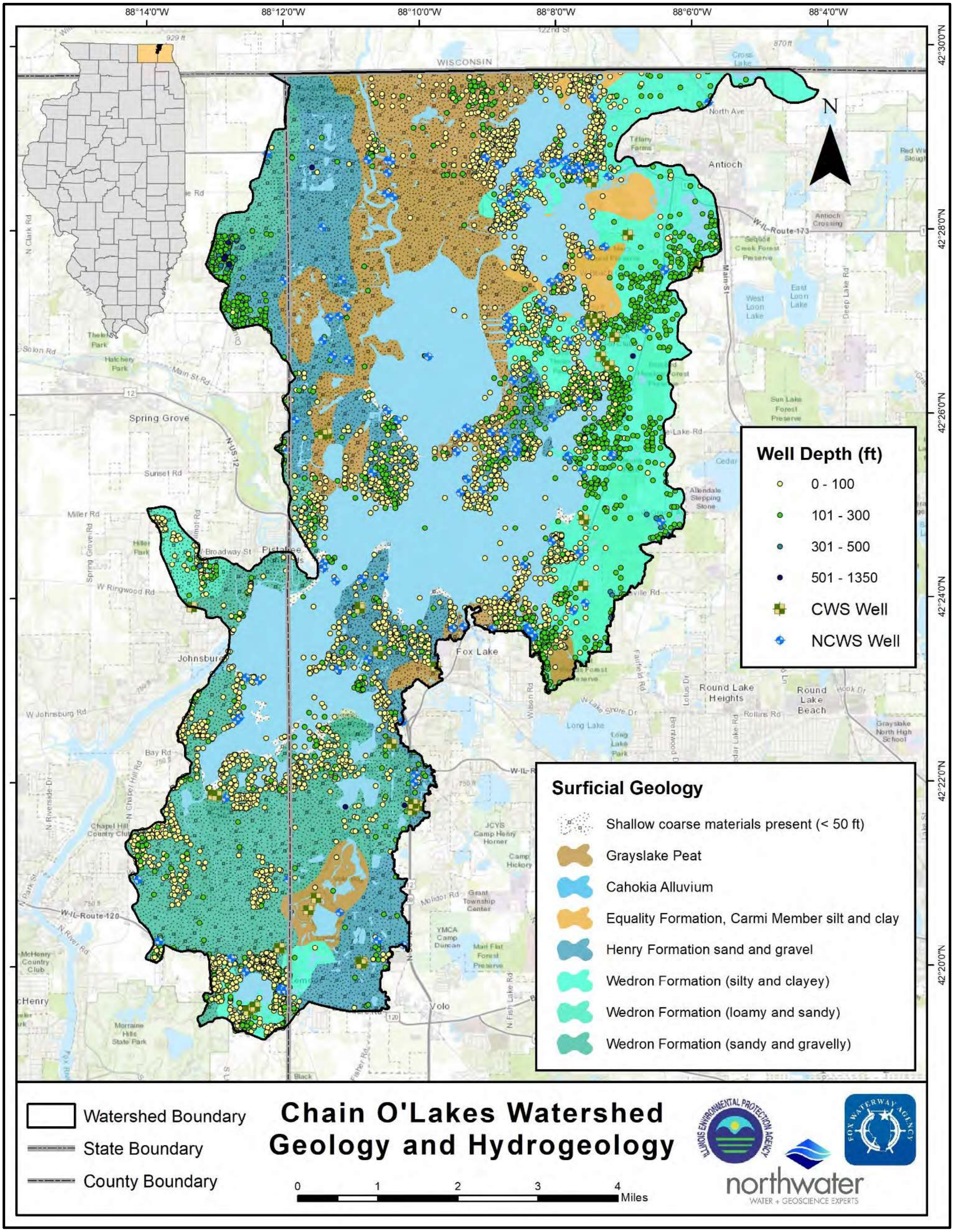

Figure 3-101: Geology and Wells

3.7 THE WATERSHED OVER TIME

The landscape of the Chain planning area prior to European settlement included numerous natural communities (e.g., swamp, woodlands and prairies). Illinois pre-settlement vegetation maps of the planning area at the time of European settlement indicate there were natural communities such as forest/woodlands, prairie and wet prairie, wetlands, marsh, and swamp, as shown in Figure 3-101.

Most of the planning area at that time was a landscape of upland and bottomland forest, water, and prairie. Upland forest dominated 55% followed by 33% water, 5% prairie and 7% of bottomland forest, marsh, swamp, wet prairie, and slough combined. Prairie was found along the west and south end of the planning area while upland forest surrounded water and wetlands where the major lakes in the Chain exist today. These natural communities likely worked in unison to infiltrate and treat precipitation, which minimized surface runoff. The natural drainage system was largely composed of marshes, wet prairie, swamp, sloughs, and large areas of open water.

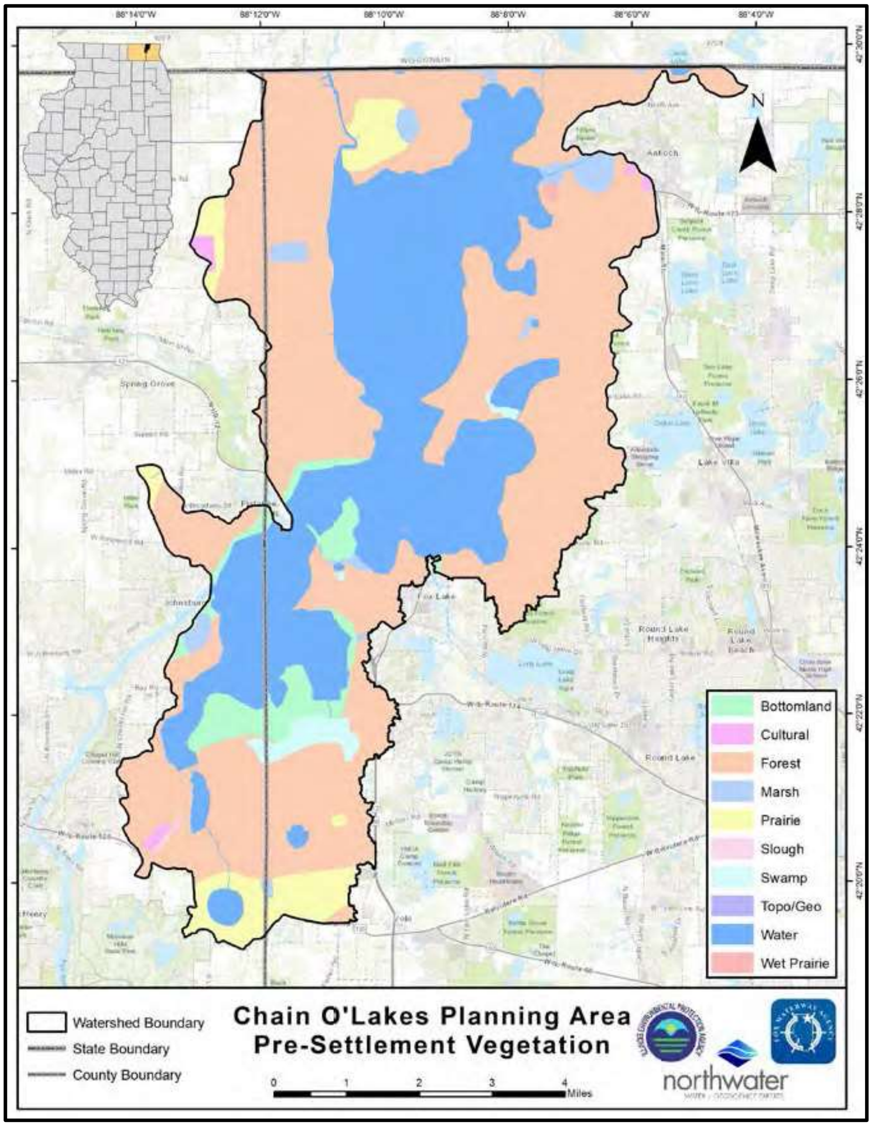

Figure 3-102: Pre-European Settlement Plant Communities

Discharge (volume of flowing water) in the planning area is derived from three general sources of flow:

- baseflow and interflow, the discharge of groundwater and shallow subsurface flow to streams, wetlands and waterbodies;
- overland flow and surface runoff, discharge of water flowing over the ground surface as a result of direct precipitation, snowmelt, ground saturation, or other sources of water. Flow in streams, surface waters and wetlands is included in this category; and
- treated effluent and return flow, discharge of water that has been used for some human activity such as treated wastewater from public water supplies or industrial uses, cooling and process water, and irrigation. Treated effluent and return flow from industrial processes and irrigation are not significant sources of overall streamflow in the planning area.

Under pre-settlement landscape conditions, discharge during much of the year in all streams was driven by baseflow, interflow, and tributary flow (runoff) from smaller streams and wetlands. Runoff from precipitation had a less pronounced effect on stream discharge compared to present conditions. As the planning area has developed, baseflow and interflow has likely been reduced with surface runoff contributing a greater proportion of the volume of annual discharge. Development with impervious cover, tiling, channelization of streams, and ditching of wetlands and low-lying areas likely lowered shallow groundwater levels in some areas. Consequently, stream hydrology in the area has likely been extensively altered since European settlement.

3.8 CLIMATE AND PRECIPITATION

The National Centers for Environmental Information provides data from weather stations found across the state. Thirty-year normals for the watershed were acquired from a weather station in Lake Villa. The data consists of averages summarized from 1991-2020 and are shown in Table 3-51. Temperatures are measured in degrees Fahrenheit and precipitation in inches.

CLIMATE NORMALS: 30-year averages of climatological variables including temperature and precipitation.

The average annual temperature is 48.6° F. July and August experience monthly averages greater than 70° F; the lowest are in January (22.2° F). The highest average maximum is 82.3° F in July and the lowest average minimum is in January (14.6° F). In general, minimum and maximums follow the same monthly trends as average temperatures. Average annual precipitation for the 30-year time span is 37.8 in. The highest level of precipitation is in May with a mean of 4.4 in. The lowest average monthly rainfall occurs in February (1.9 in). Average precipitation levels of this time frame follow an identical trend to the averages in recent years past.

Table 3-51: Climate Normals (1991 – 2020)

MONTH	MAXIMUM TEMP (°F)	MINIMUM TEMP (°F)	MEAN TEMP (°F)	MEAN PRECIPITATION (IN)
January	29.9	14.6	22.2	2.1
February	34	17.5	25.7	1.9
March	44.8	26.6	35.7	2.6
April	56.8	37.1	46.9	4.1
May	68.8	47.8	58.3	4.4
June	78.4	57.9	68.1	4.2
July	82.3	63.1	72.7	3.9
August	80.6	61.8	71.2	3.3
September	73.4	54.4	63.9	3.4
October	60.4	43.1	51.7	3
November	47.1	30.9	39	2.5
December	35	20.8	27.9	2.3
AVERAGE:	**57.6**	**39.6**	**48.6**	**3.1 (37.8 YEARLY)**

Data were also acquired from the PRISM climate group from the last 15 years (April 2008-March 2023). The PRISM climate group is a part of the Northwest Alliance for Computational Science and Engineering based at Oregon State University and supported by the United States Department of Agriculture (USDA) Risk Management Agency. Temperatures are presented in degrees Fahrenheit and the precipitation in inches (Table 3-52).

The average annual temperature is 47.5° F. July experiences monthly averages greater than 70° F; the lowest average temperatures are in January (20.7° F). The highest average maximum is 82.2° F in July and the average minimum is in January (13.1° F).

Average levels of this time frame follow an identical trend to those from the period of 1991-2020. In general, minimum, average, and mean temperatures follow the same monthly trends as average values from the same period.

The average annual precipitation for the most recent 15 years is 39.6 in. The month with the highest level is June with an average of 5 in. The lowest average monthly rainfall occurs in January (1.8 in). The wettest months of the year are April through July, where the average annual precipitation exceeds 4 in.

Table 3-52: Monthly Climate (2008 – 2023)

MONTH	MAXIMUM TEMP (°F)	MINIMUM TEMP (°F)	MEAN TEMP (°F)	MEAN PRECIPITATION (IN)
January	28.3	13.1	20.7	1.8
February	31.5	14.2	22.8	2
March	44.1	25.8	35	2.5
April	55.8	35.5	45.7	4.2
May	68.2	46.6	57.4	4.4
June	78.3	57	67.7	5
July	82.2	61	71.6	4.2
August	80.7	58.9	69.8	3.6
September	74.2	52.2	63.2	3.9
October	60.8	40.4	50.6	3.6
November	46.7	29.1	37.9	2
December	35	20.4	27.7	2.5
AVERAGE:	**57.2**	**37.9**	**47.5**	**3.3 (39.6 YEARLY)**

3.9 TOPOGRAPHY AND RELIEF

Topographic data is used in the planning process to aid in the development of Digital Elevation Models, or DEMs, and to delineate drainage areas. Figure 3-103 represents the Chain O'Lakes planning area boundary and topography using 2017 DEMs for Lake and McHenry Counties. Average elevation is 759 ft above sea level (fasl), with the lowest elevation at 722 ft at the shoreline of Channel Lake. The highest elevation is 958 fasl within the Gander Mountain Forest Preserve in the northwestern corner of the planning boundary.

Area slopes are shown in Figure 3-104. Average slope is 5.9% (3.4°) and the maximum is 739% (82°). Areas around the outer boundary of the planning area, primarily on the western edge, contain the greatest slopes. Overall, slopes are low and the watershed is generally flat.

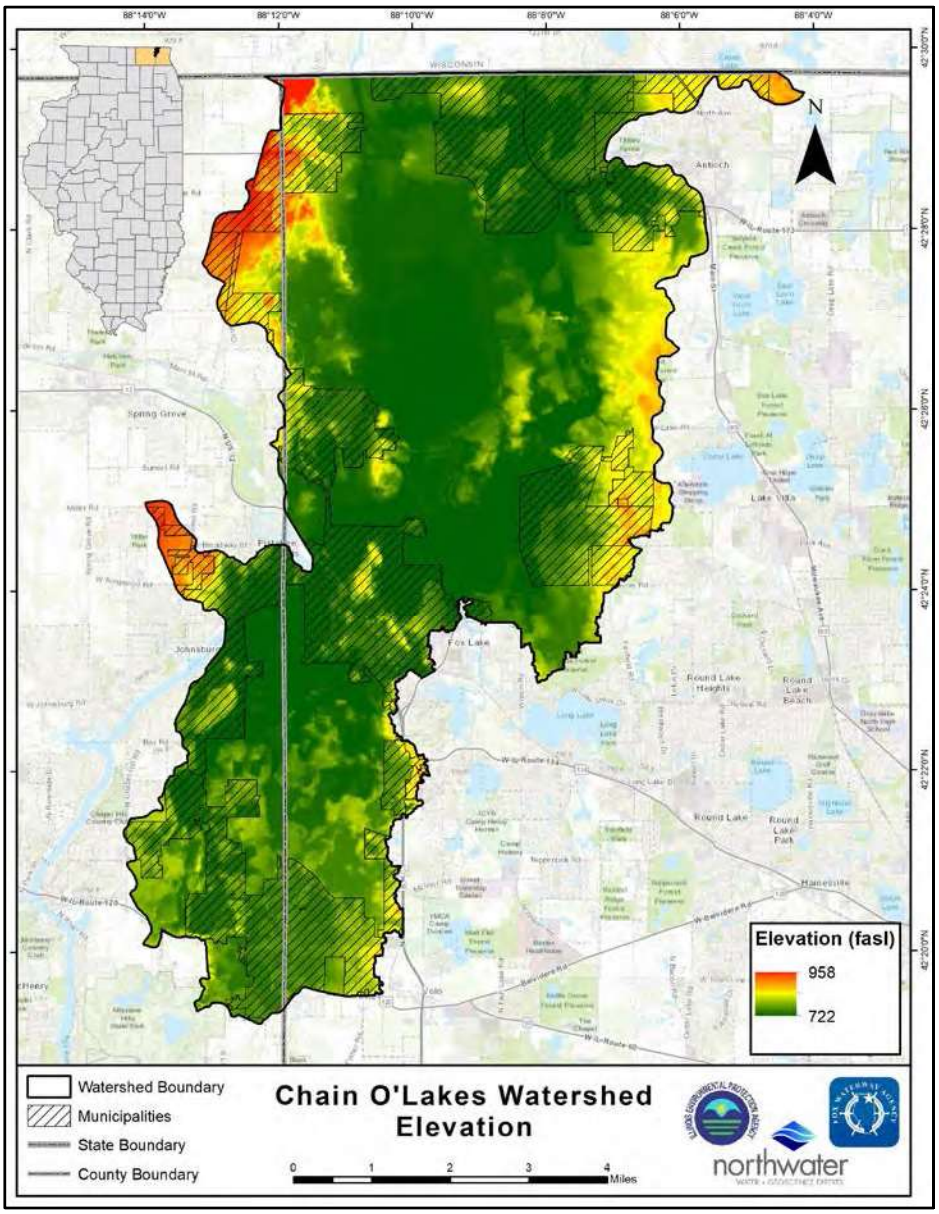

Figure 3-103: Elevation Above Sea Level

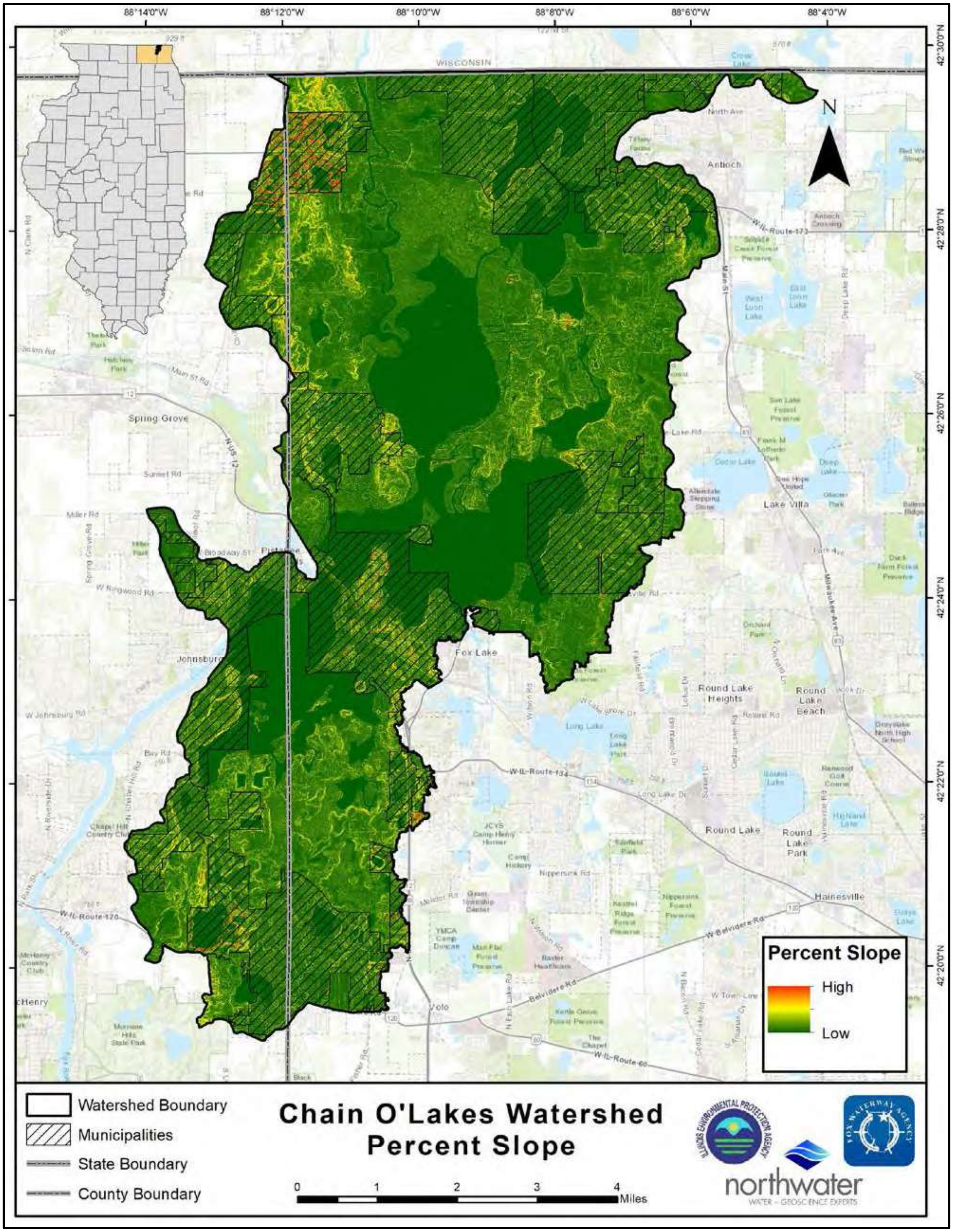

Figure 3-104: Surface Slope Percent

3.10 PLANNING AREA SOILS

Deposits left during and after the last glacial period are the raw materials of present soil types. A combination of physical, biological and chemical variables, such as topography, drainage patterns, climate, erosion and vegetation, have interacted over centuries to form the variety of soils found in the planning area. These soils were formed under wetland, forest and prairie plant communities, and they are identified by a name associated with each series or class with similar characteristics. A series name generally is derived from a town or landmark in or near the area where it was first recognized, although naming conventions vary by county.

Soils affect water-holding capacity, erosion potential and **infiltration** capabilities of the land. Soil characteristics indicate the way they will interact with water in the environment, and therefore are useful in watershed planning. These characteristics can help guide where restoration or certain practices may be successful and where there may be constraints to project implementation.

INFILTRATION: That portion of rainfall or surface runoff that moves downward into the subsurface soil.

SOIL PHASE: A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

The USDA Natural Resource Conservation Service (NRCS) has produced detailed (current) soil surveys for Lake and McHenry Counties. These contain information regarding the physical and chemical properties, as well as information regarding human use for each soil series and **soil phase**. The soil surveys were utilized to extract detailed data for the planning area. Table 3-53 includes the major soil series (more than 2% of the planning area) present and the area occupied by each. Figure 3-105 shows their distribution in the planning area. At 17%, the Houghton series is the most prevalent type. These soils consist of very deep, very poorly drained soils formed in organic materials in depressions and drainageways on lake plains, outwash plains, ground moraines, end moraines, till plains, and floodplains. Slopes range from 0 to 2 percent.

Table 3-53: Major Soil Types in the Planning Area

SOIL SERIES NAME	ACRES	% OF PLANNING AREA
Water	8,316	25%
Houghton	5,674	17%
Ozaukee	3,025	9.2%
Casco	2,894	8.8%
Fox	2,719	8.3%
Zurich	1,438	4.4%
Orthents	916	2.8%
Wauconda	878	2.7%
Total, Major Soil Types	25,860	*79%*
All Other Soil Types	7,062	*21%*
TOTAL:	**32,922**	**100%**

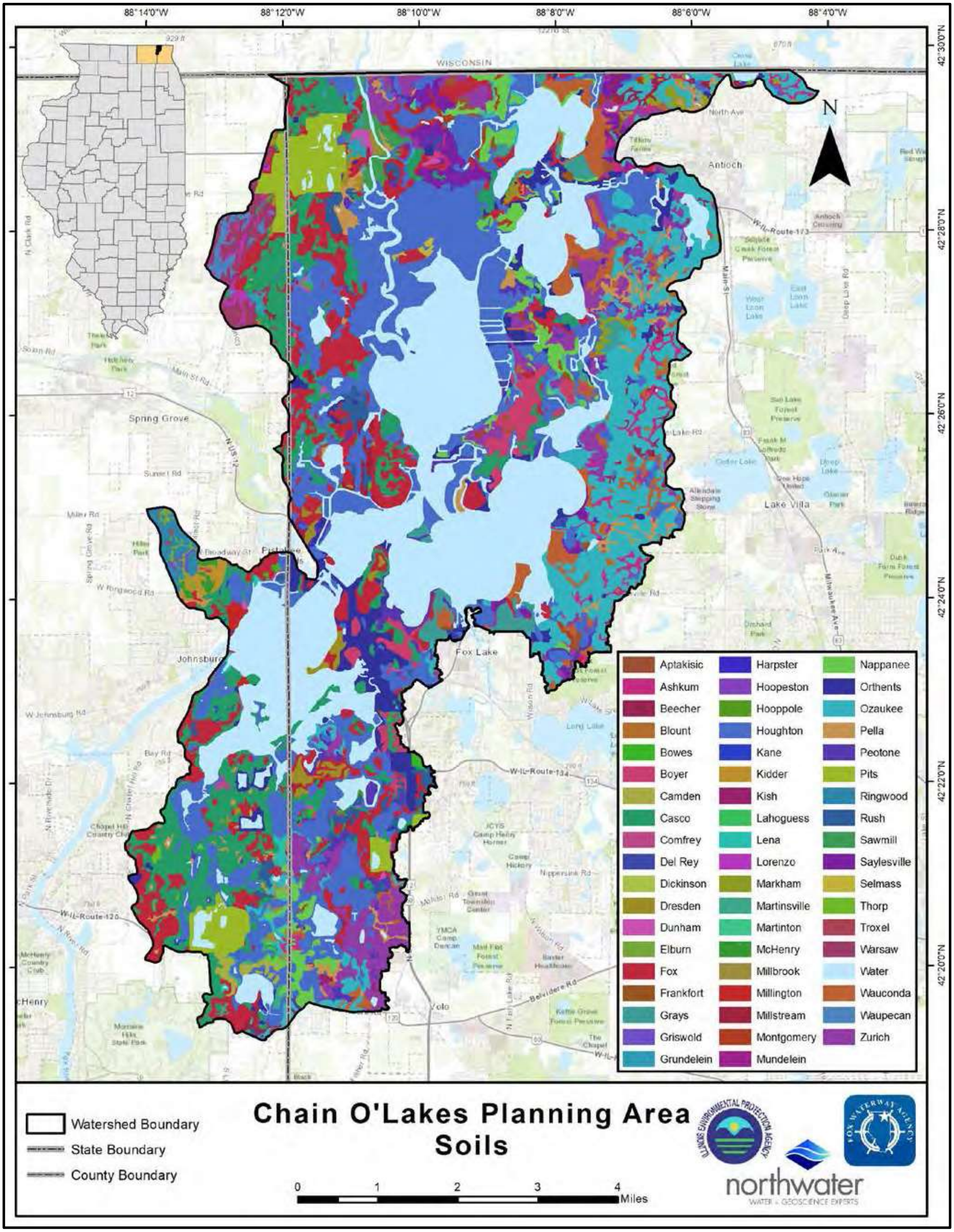

Figure 3-105: Soils

3.10.1 Hydric Soils

Hydric soils form in areas of the landscape that are seasonally or permanently saturated with water. These conditions are conducive to the growth of **hydrophytic vegetation**; therefore, the presence of hydric soils is indicative of present or historical wetland conditions or may indicate areas of depression. Areas with hydric soils and drained hydric soils that do not presently contain wetlands may be utilized for wetland restoration.

Hydric Soils: A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part. These conditions alter the physical, biological and chemical characteristics of the soil, thereby influencing the species composition or growth, or both, of plants on those soils.

Hydrophytic Vegetation: Plants that tolerate or require saturated soil or standing water.

Figure 3-106 maps hydric soils in the Chain which cover approximately 7,481 acres (23%), while non-hydric soils cover about 16,687 acres (51%). The remaining 8,754 acres (27%) is water. Hydric soils are concentrated around bodies of water but well-distributed over the entire planning area. Unmapped pockets likely occur in ravines, particularly where groundwater flow creates saturated soil conditions ("seeps").

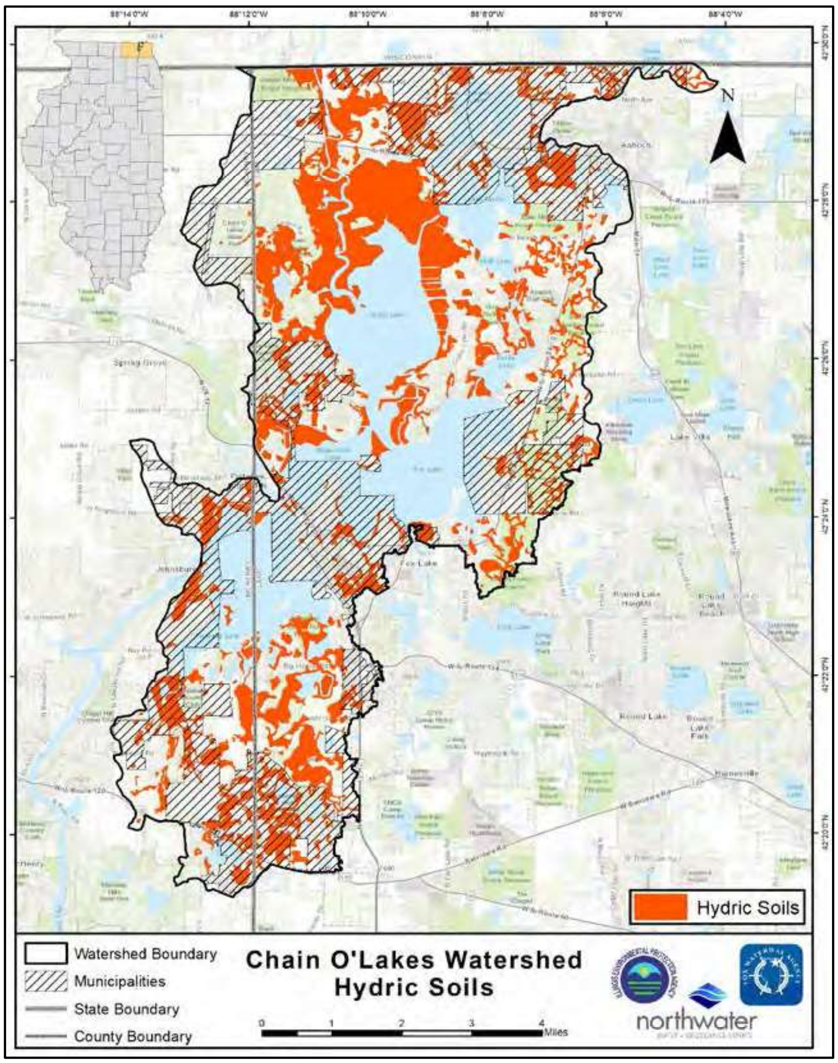

Figure 3-106: Hydric Soils

3.10.2 Soil Erodibility

Soil erodibility is largely determined by the tendency of soil particles to become detached and mobilized by water and the ground slope. Highly erodible (HEL) soils in the Chain are highly susceptible to erosion by water due to a combination of slope, particle size, and cohesion, but they are not prone to erosion by wind.

Highly erodible soils are considered in this plan because erosion from these soils can potentially end up in surface waters, contributing to high amounts of sediment accumulation in streams and lakes.

The movement or loss of soil resulting from erosion may also cause damage to property as buildings and infrastructure are undermined. The removal and disposal of sediment accumulated in lakes, ponds, detention ponds and the storm drainage system can be an expensive maintenance activity.

NOTEWORTHY: Soil Erodibility and Pollution

Soil characteristics, especially the tendency of soil particles to become detached and mobilized by water runoff, have considerable impact on water quality. For instance, sandy soils are more prone to erosion than clayey soils, although pollutants are more likely to be attached to clay particles.

It is important to map highly erodible soils because they represent areas that may contribute large amounts of total suspended solids (TSS) to streams and lakes. High TSS levels can result in stream degradation as a result of silt deposition and pollution. Some pollutants frequently attach to TSS particles and wash into lakes and streams, polluting the water and sediments and decreasing water clarity.

In the planning area, 5,220 acres (16%) are classified by the NRCS as HEL. These soils are largely associated with upland areas and steeper slopes adjacent to some major water bodies. Although HEL soils do not cover a significant proportion of the area, they do have the potential to negatively impact water quality.

Erodible soils along lakeshores, stream channels, and disturbed land surfaces (e.g., active croplands and construction sites) are most susceptible to erosion (Figure 3-107). Stabilization practices on croplands could substantially reduce erosion. Additionally, land developers are required to follow the federal, state and county regulations regarding soil erosion and sediment control measures during construction.

Soil Erosion

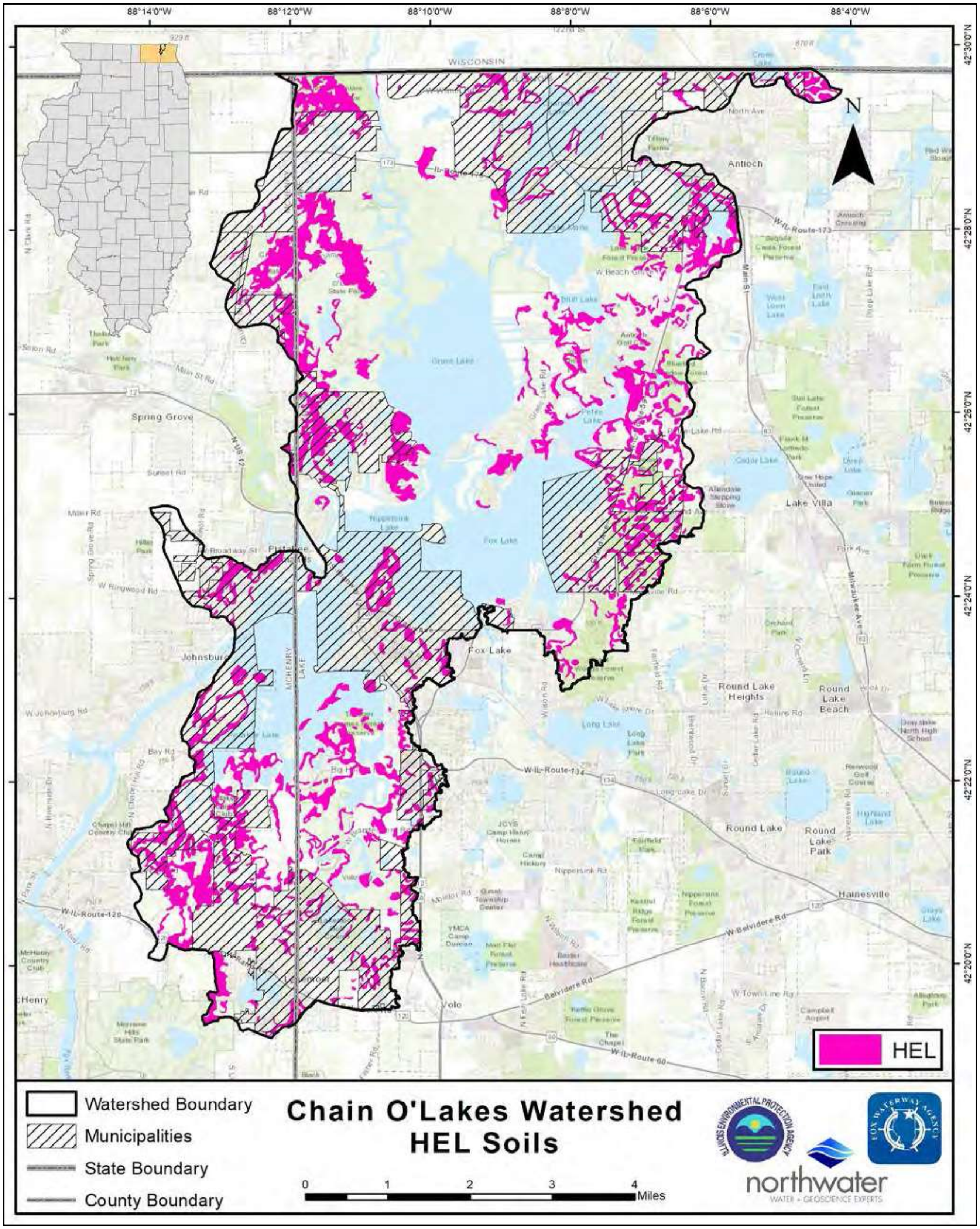

Figure 3-107: Highly Erodible Soils

3.10.3 Hydrologic Soil Groups

The NRCS broadly classifies soils based on their drainage characteristics into four different hydrologic soil groups. The classification considers soil texture, drainage description, runoff potential, infiltration rate and transmission rate (permeability). Group A is comprised of the most permeable soil types (i.e., sandy soils) and has the least runoff potential while group D includes the most impermeable (i.e., clay) and has the greatest runoff potential. The main groups are separated into four categories: A, B, C, and D. See Table 3-54 for permeability and surface runoff characteristics and Figure 3-108 for distribution in the planning area.

Table 3-54: Hydrologic Soil Groups and Corresponding Attributes

GROUP	SOIL TEXTURE	DRAINAGE DESCRIPTION	RUNOFF POTENTIAL	INFILTRATION RATE	TRANSMISSION RATE	ACRES (% PLANNING AREA)
A	Sands (and Gravels), Loamy Sand, or Sandy Loam	Well to Excessively Drained	Low	High	High (greater than 0.30 in/hour)	6,169 (19%)
B	Silt Loam or Loam	Moderately Well to Well Drained	Moderate	Moderate	Moderate	9,330 (28%)
C	Sandy Clay Loam	Somewhat Poorly Drained	High	Low	Low	7,394 (22%)
D	Clay Loam, Silty Clay Loam, Sandy Clay Loam, Silty Clay, or Clay	Poorly Drained	High	Very Low	Very Low	917 (3%)
					TOTAL:	**23,810**

There are also areas of the planning area with combined soil groups such as: A/D, B/D and C/D and N/A – water, landfills, urban areas, etc. (totaling 2%). These groups are a combination of soil types and exhibit a combination of permeability and surface runoff characteristics. The soil characteristics can change depending on saturation, slope and time of year. If these soils can be adequately drained (with underground drain tiles or other techniques), then they are assigned to dual hydrologic soil groups based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition.

Runoff curve numbers classify the runoff potential of different soil types with different types of land cover. The curve numbers are a function of group, land cover or usage and antecedent soil moisture conditions. The curve number value ranges from 0 - 100. Lower runoff curve numbers indicate low runoff potential, while larger runoff curve numbers indicate increased runoff potential. Overall, soils in the planning area are somewhat poorly to well-drained.

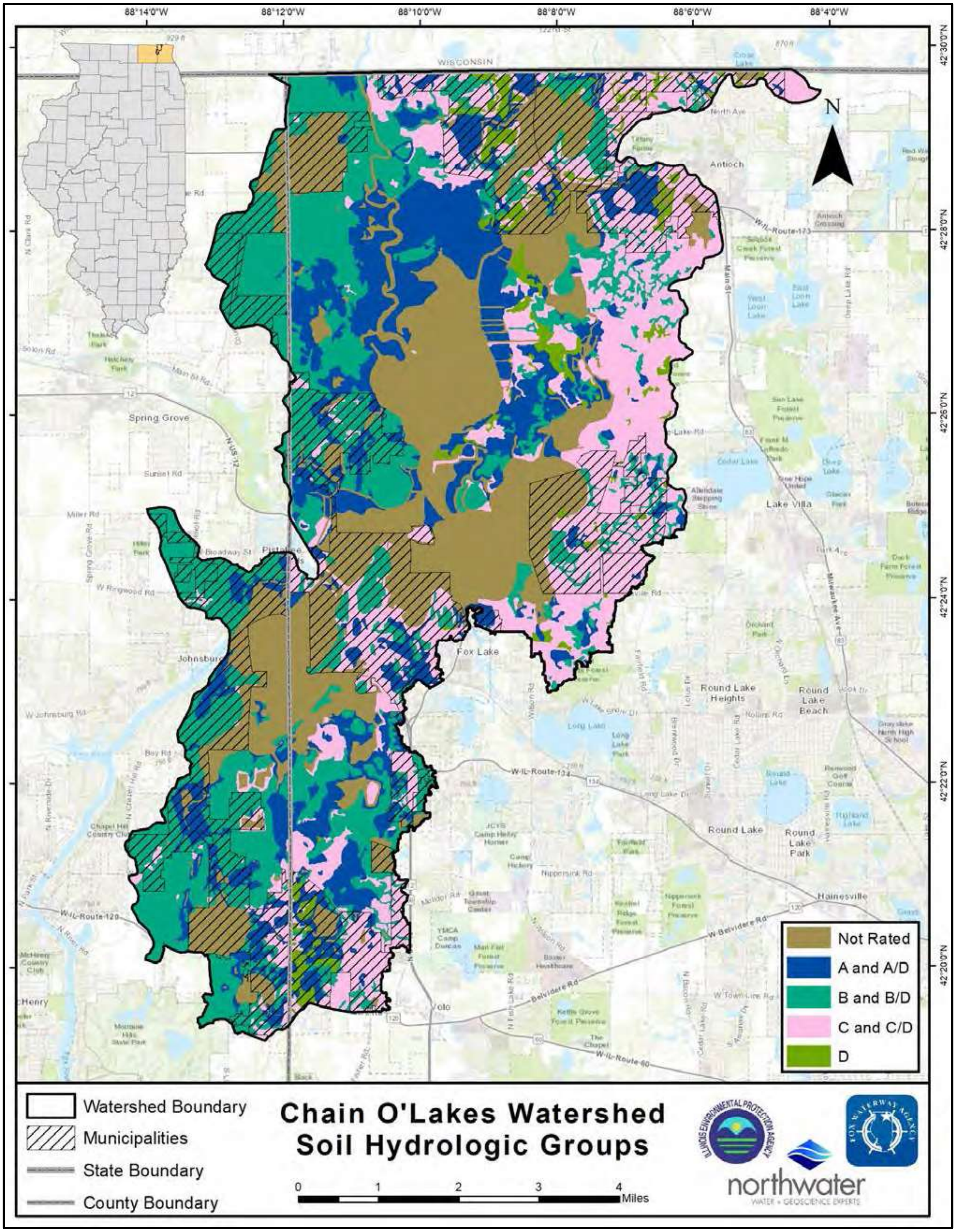

Figure 3-108: Hydrologic Soil Groups

3.11 WATERSHED JURISDICTIONS AND DEMOGRAPHICS

3.11.1 Units of Government

The planning area has numerous political jurisdictions, including municipal, township, and other local, state, and federal elective and agency jurisdictions. The boundaries of these are seldom drawn to coincide with watershed boundaries. Thirty percent of the Chain is incorporated, within 8 municipalities or villages (totaling 9,943 acres). The Village of Fox Lake is the largest by area with 4,287 acres, or about 13% coverage. The next largest municipality is the Village of Lakemoor which occupies 2,814 acres, or about 8.5%. There are an additional 9 unincorporated census designated places, with 14% (4,720 acres). The planning area is made up of 7 townships (totaling 32,922 acres). Antioch Township is the largest by area with 16,093 acres inside, or about 49%. The next largest is Grant Township with 6,549 acres, or about 20% of the planning area. Municipalities and are shown in Figure 3-109 and Table 3-55 and Table 3-56. Other major units of government include the State of Illinois - IDNR, the Lake County Forest Preserve District (LCFPD), the McHenry County Conservation District (MCCD), and the FWA. No federal government-owned land exists.

The FWA is the lead unit of government responsible for this plan and was created to improve and maintain the Fox River and Chain O'Lakes public waterway for recreational uses, restore environmental quality, minimize flooding, promote tourism, and enhance the quality of life along the waterway for residents and users alike. Their jurisdiction includes the 15 interconnected lakes, which make up the Chain O'Lakes and 30 miles of the Fox River stretching from the Wisconsin State line to the Algonquin Dam, as well as their tributaries and over 40 miles of navigable channels. Although their physical jurisdiction is limited to the waterway itself, their partnerships with local landowners and organizations, and governmental agencies allow them to cooperate in many land-based projects that affect the waterway. The FWA operates on a limited budget, primarily through revenue generated from user fees or boat stickers. This limited budget goes to maintaining safety, management of sediment (dredging), debris and shoreline as well as collaborative projects outside of the lakes.

Table 3-55: Municipalities

MUNICIPALITY/VILLAGE NAME	ACRES	% OF THE PLANNING AREA
Fox Lake	4,287	13%
Lakemoor	2,814	8.5%
Antioch	1,242	3.8%
Johnsburg	855	2.6%
Lake Villa	375	1.1%
Volo	214	0.7%
Spring Grove	153	0.5%
McHenry	2.9	0.01%
TOTAL:	**9,943**	**30%**

Table 3-56: Townships

NAME	ACRES	% OF THE WATERSHED
Antioch	16,093	49%
Grant	6,549	20%
McHenry	5,587	17%
Lake Villa	2,711	8.2%
Burton	1,525	4.6%

NAME	ACRES	% OF THE WATERSHED
Nunda	341	1.0%
Wauconda	116	0.4%
TOTAL:	32,922	100%

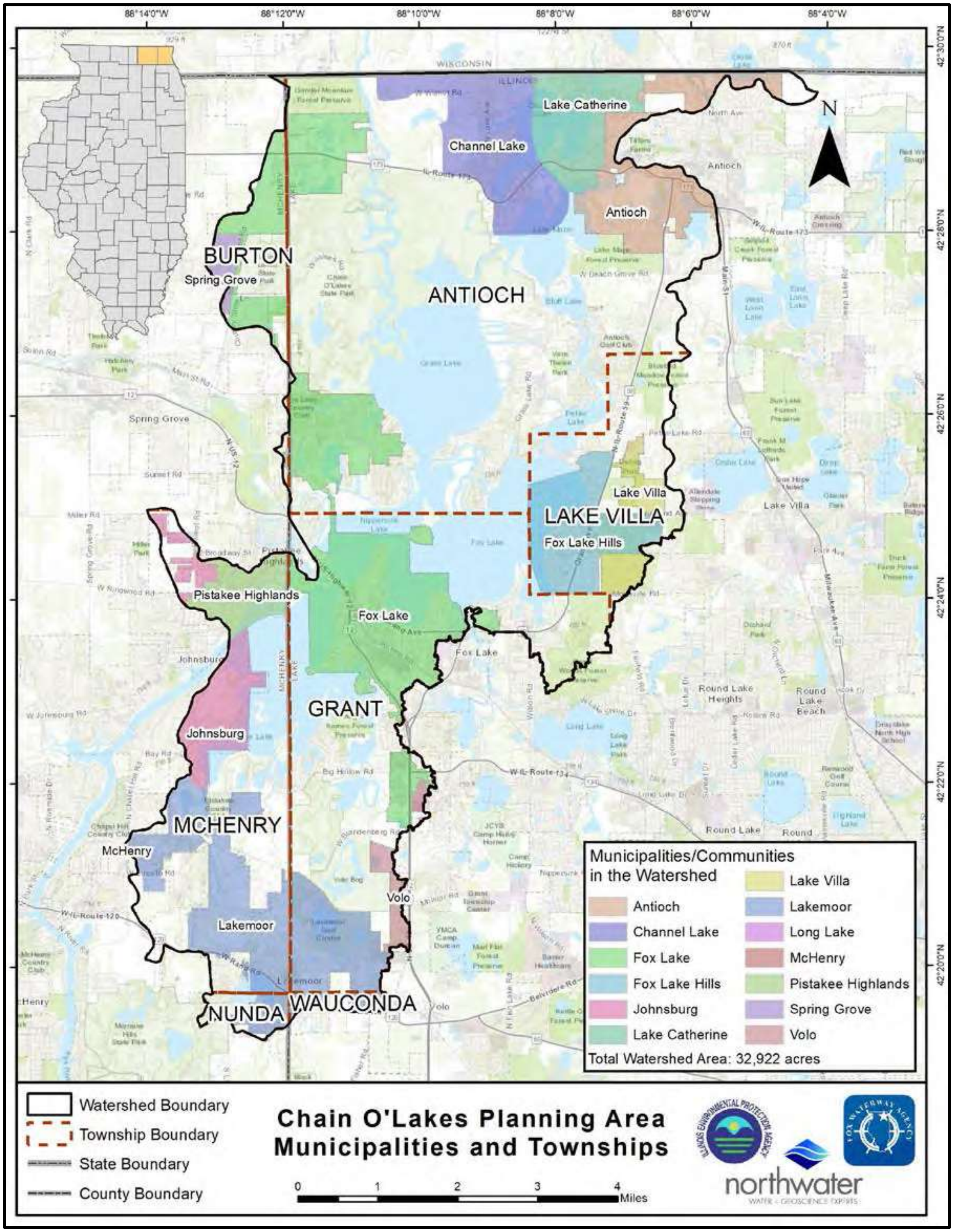

Figure 3-109: Municipalities, Communities and Townships

3.11.2 Roles and Responsibilities of Each Unit of Government

One of the challenges of creating and implementing watershed-based plans is that a watershed usually includes multiple jurisdictions that have varying interests, resources, and responsibilities. This variability can be beneficial if the jurisdictions actively work together to collaborate on policies, projects, and practices, but frequently it presents coordination challenges for efficiently implementing projects and for providing program, policy, and regulatory consistency. In some cases, independent actions by one community or jurisdiction can have a detrimental impact on watershed neighbors, or a good project may not be as effective as it could have been if resources had been pooled to expand the scope of the project to cover a broader area, thereby providing economies of scale.

Watershed planning brings communities together to protect and improve the land and water resources that they share and impact. Watershed activities and projects offer many opportunities for communities and other government agencies to operate outside of their traditional "silos." When communities meet regularly as a group, it provides opportunities to share information and coordinate activities. For instance, when a community or agency develops or updates a comprehensive plan, disagreement and costly competition among agencies/jurisdictions can be averted if the watershed-based plan and the plans of neighboring communities and sister agencies (such as parks departments or districts) are considered. This level of coordination benefits the watershed. As the primary entity responsible for maintaining the lakes within the Chain, the FWA will take the lead coordinating with other jurisdictions to implement this plan. See Table 3-57 for more jurisdiction roles and responsibilities.

Table 3-57: Jurisdiction Roles and Responsibilities

TYPE OF JURISDICTIONS	ROLES & RESPONSIBLITIES						
	LAND USE PLANNING & REGULATION	STORMWATER ORDINANCE ADMIN.	STORMWATER INFRAST. MGMT.	PRACTICE MGMT.	NPS MGMT.	ROAD MGMT.	WASTEWATER & SANITARY SEWER MGMT.
*County	X	X	X	X	X	X	X
*Municipalities	X	X	X	X	X	X	X
*State	X	X	X	X	X	X	
*Townships			X	X	X	X	
Forest Preserve District			X	X	X		
Water Reclamation & Sanitary Districts		X	X	X			X

**Street, Highway and Transportation Departments are included in these jurisdiction categories*

3.11.3 Population

Based on the 2020 U.S. census estimate, the total population within the planning area is approximately 46,849 as shown in Figure 3-110.

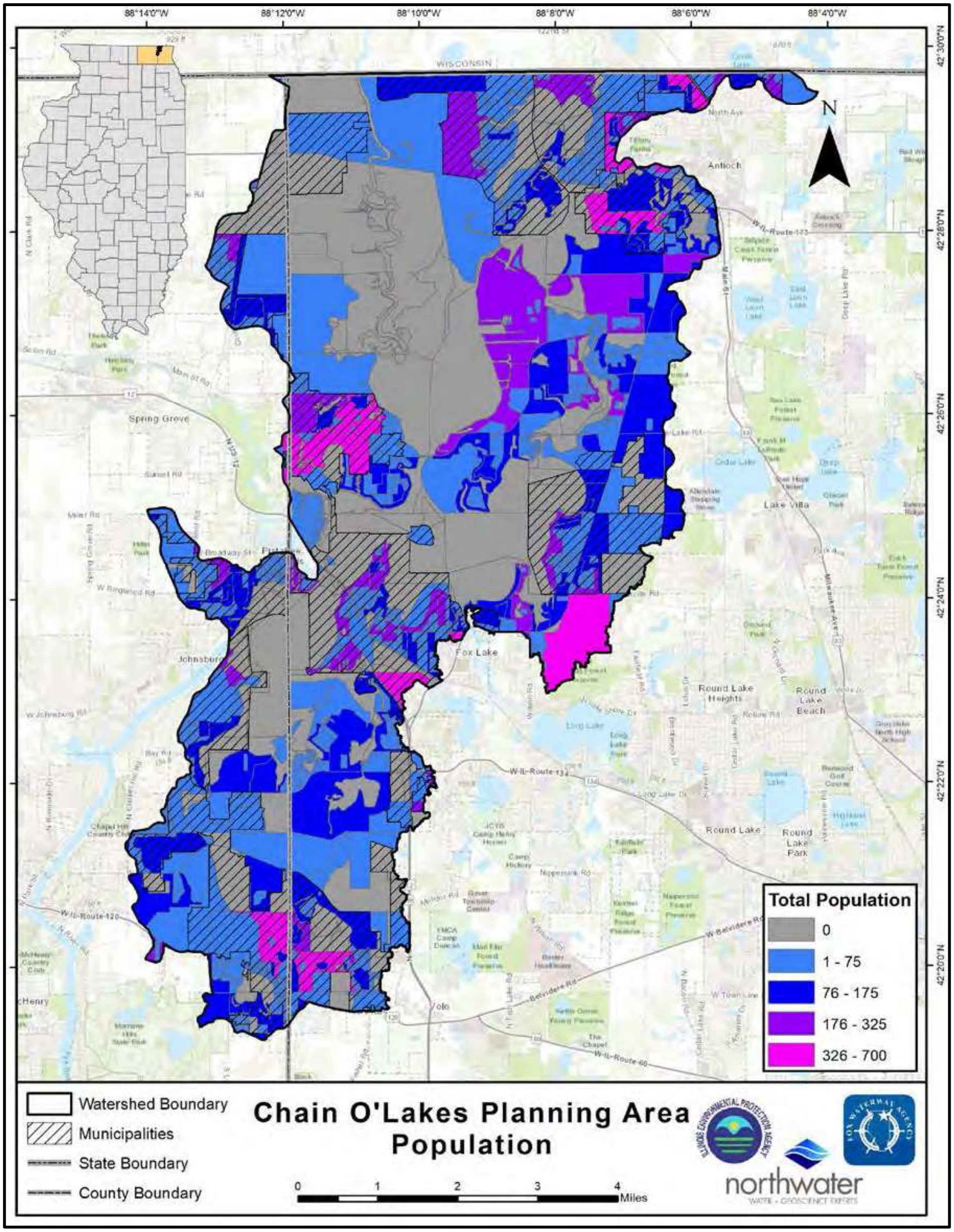

Figure 3-110: Population

3.11.4 Population Change

Population change is derived from estimates compiled by the Chicago Metropolitan Agency for Planning (CMAP) and is forecasted to increase to 69,358 (+48%) in the planning area by 2050 (Figure 3-111).

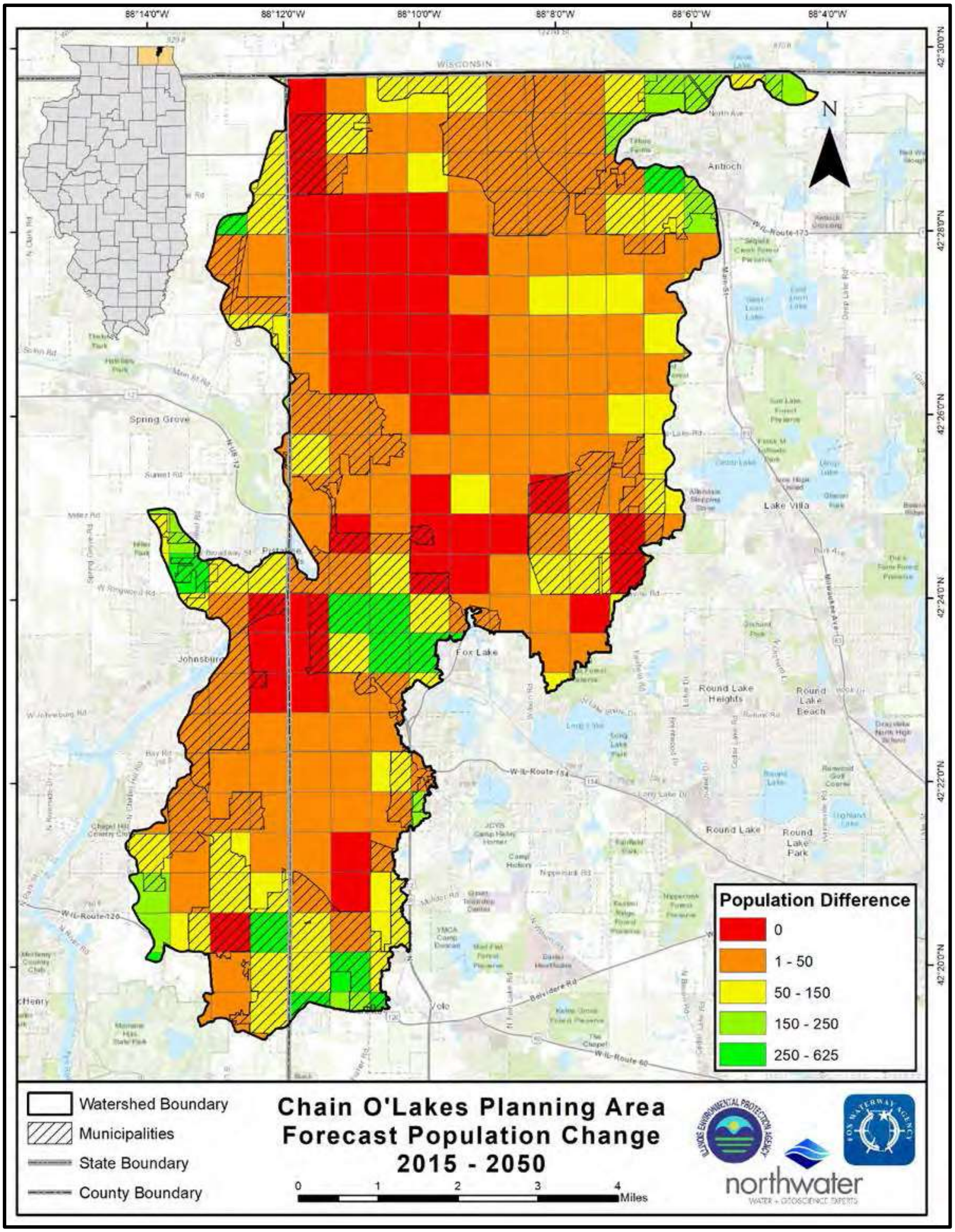

Figure 3-111: Population Change (2015-2050)
Note: Each "square" on the map represents a quarter section of the Public Land Survey System, or a 160-acre square, 0.5 miles per side.

3.11.5 Growth Forecasts

The population change that is described in Section 3.11.4 is expected to increase the number of homes in the planning area, especially in those areas where population growth is expected to increase the most (see Figure 3-112). The number of households is predicted to increase by 7,910, by 2050 using 2015 as the baseline. As of 2015, there were approximately 8,287 jobs in the planning area, but CMAP forecasts employment to increase to 13,229 by the year 2050 (Figure 3-113). The population and employment forecast are based on a model that accounts for local future development and land use plans, as well as other land use, demographic, and economic variables and trends. Results are an example or indicator of how the planning area could develop over the next few decades. This plan does not draw conclusions or recommendations from any single evaluation unit (square) in the forecast map.

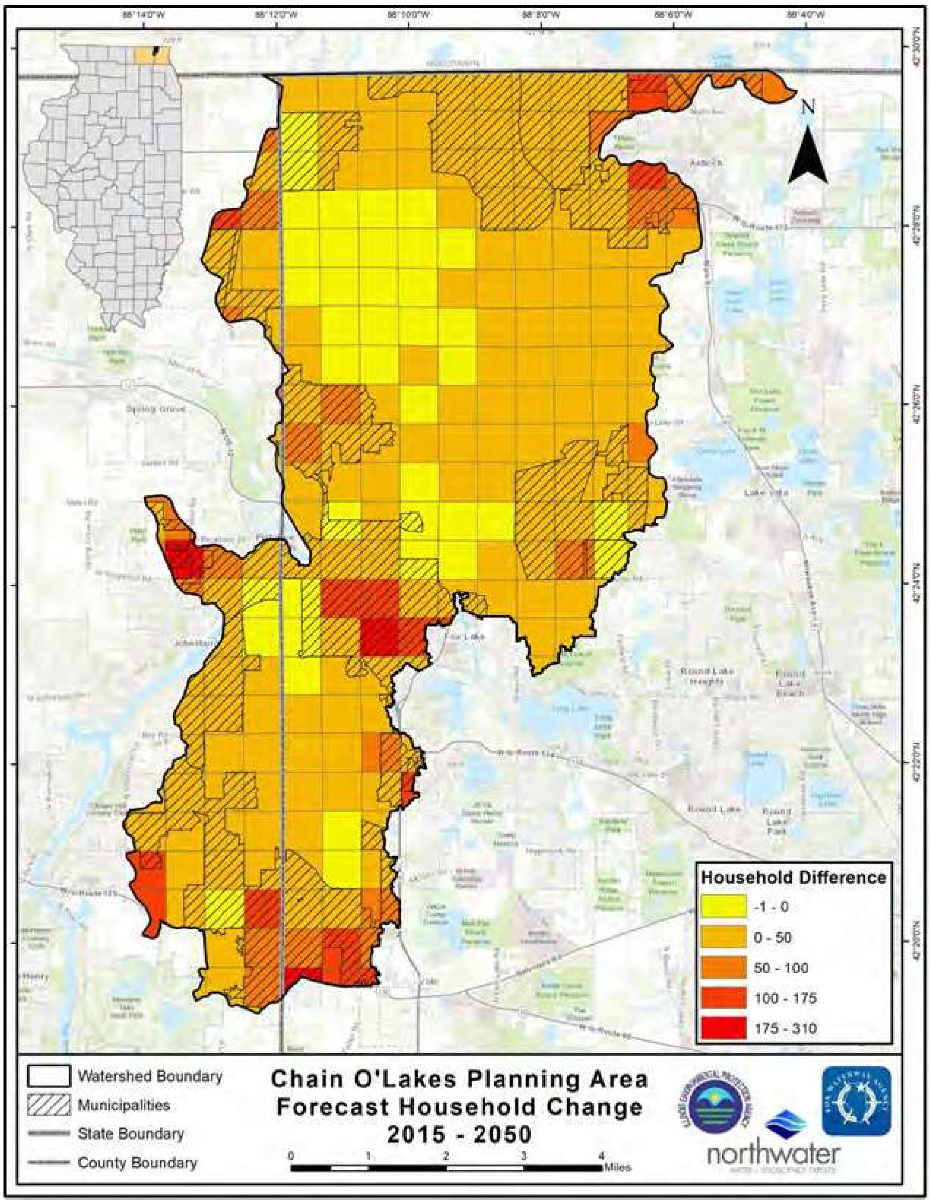

Figure 3-112: Forecasted Household Change (2015 – 2050)

Note: Each "square" on the map represents a quarter section of the Public Land Survey System, or a 160-acre square, 0.5 miles per side

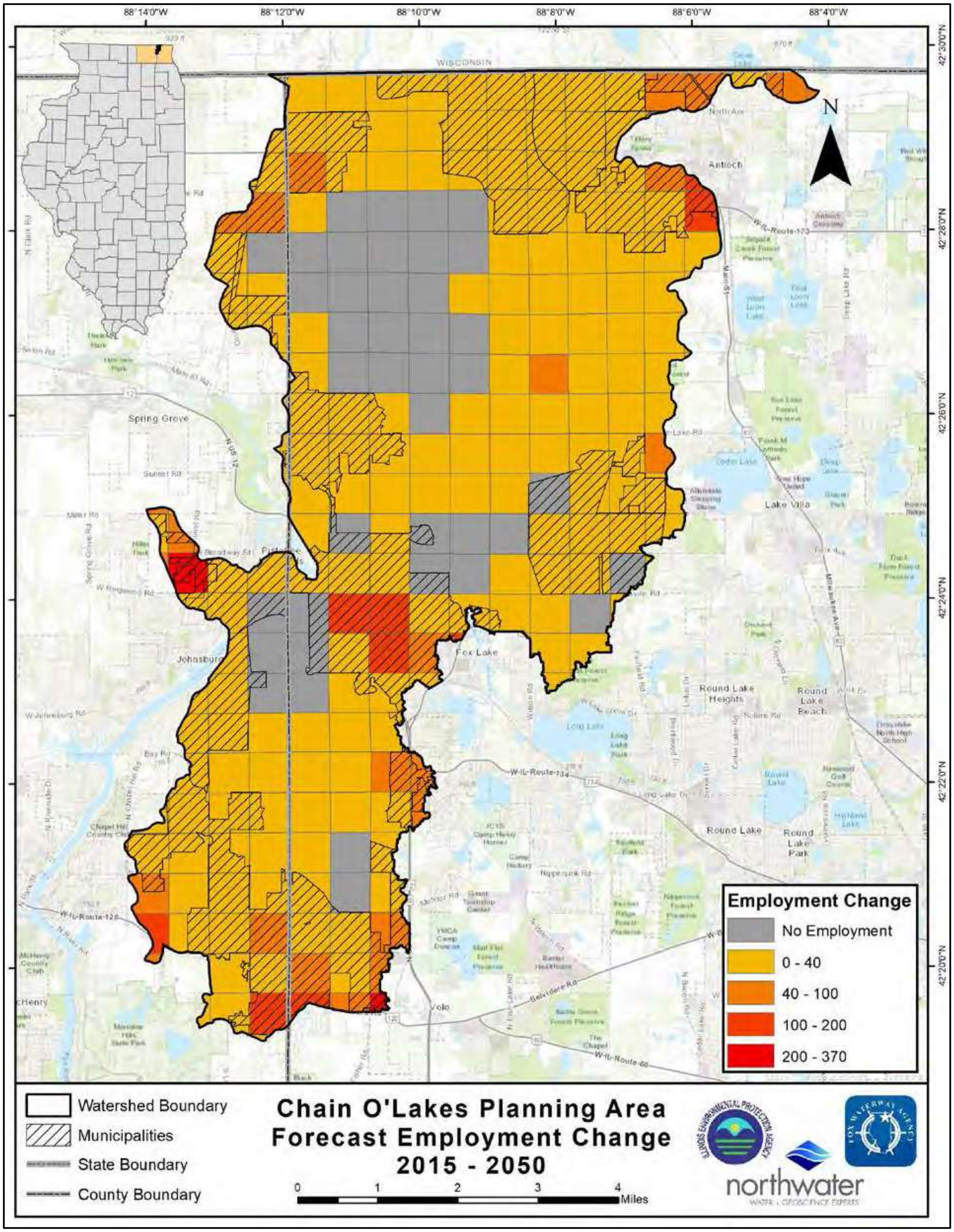

Figure 3-113: Forecasted Employment Change (2015 -2050)

Note: Each "square" on the map represents a quarter section of the Public Land Survey System, or a 160-acre square, 0.5 miles per side

3.11.6 Median Age

Median age is a statistic that provides information on the age distribution of a population. When considered with other factors, this information can inform estimates of future consumption, mobility, and development patterns, which impact water resources. The median age in Lake County in 2022 was 39.3, compared to 41.3 in McHenry County (2022 American Community Survey 1-year estimates). Median age in the State of Illinois in 2022 was 39.1.

3.11.7 Median Income

The median household income for Lake County is $122,042 compared to $98,907 in McHenry County. (2022 American Community Survey 1-year estimates). The median household income for the State of Illinois in 2022 was $76,408. The U.S. Census Bureau includes incomes of people 15 or older in calculations. Median incomes are used as measures because the values are less skewed by extremely high or low outliers.

3.12 LAND USE

3.12.1 Existing Land Use

To characterize watershed land use and aid in pollution load modeling, a custom map layer was developed from 1998 and 2021 aerial imagery and verified to the extent possible through field surveys. Table 3-58 lists the results of classification.

As depicted in Figure 3-114, the predominant land use in the planning area is open water pond/reservoir at 25% (8,238 acres), followed by forest which makes up 18% (5,840 acres) of the total.

Open space and wetlands are the third and fourth most prevalent, at 15% (4,854 acres) and 13% (4,411 acres), respectively. Agricultural row crops cover 1,318 acres or 4% and are concentrated to the north and around the periphery of the Chain. Residential and developed urban areas (including all associated land use categories) cover approximately 13% and are concentrated around major waterbodies. A combined 112 acres of pasture and small, open livestock feed areas are scattered throughout. No livestock confinement operations are in the Chain. Animal units from pasture operations are unknown.

Table 3-58: Land use Categories

LAND USE TYPE	AREA (AC)	PERCENT TOTAL AREA	LAND USE TYPE	AREA (AC)	PERCENT TOTAL AREA
Open Water Pond/Reservoir	8,238	25%	Recreational Facility	11	0.03%
Forest	5,840	18%	Orchard	11	0.03%
Open Space	4,854	15%	Industrial (non-discharging)	11	0.03%
Wetlands	4,411	13%	Construction Yard	9.9	0.03%
Grasslands	2,174	6.6%	Tree Farm	9.6	0.03%
Residential	1,973	6%	Parking Lot - Marina	8.7	0.03%
Row Crops	1,318	4%	Manufacturing	7.5	0.02%

LAND USE TYPE	AREA (AC)	PERCENT TOTAL AREA	LAND USE TYPE	AREA (AC)	PERCENT TOTAL AREA
Roads	926	2.8%	Solar Array (non-discharging)	7.3	0.02%
Driveway	364	1.1%	Cemetery	6.9	0.02%
Resource Extraction (non-discharging)	332	1%	Driveway - Dirt	6.6	0.02%
Parking Lot	327	1%	Junkyard	6	0.02%
Resource Extraction	313	1%	Boat House	5.6	0.02%
Open Water Stream	229	0.7%	Dewatering Basin	5.5	0.02%
Golf Course	202	0.6%	Beach	5	0.02%
Open Water Pond - Resource Extraction	190	0.6%	Impervious Landscape Feature	5	0.02%
Parks and Recreation	153	0.5%	Storage Shed	4.4	0.01%
Commercial	107	0.3%	Recreational Court	4.4	0.01%
Forest/Scrub	104	0.3%	Industrial	4.1	0.01%
Garage	74	0.2%	Driveway (non-discharging)	3.9	0.01%
Pasture - Equestrian	72	0.2%	Greenhouse	3.7	0.01%
Compost Facility	70	0.2%	Farm Building - Equestrian	3.3	0.01%
Grass/Scrublands	64	0.2%	Storage Yard	2.9	0.01%
Warehousing	55	0.2%	Dirt Pile	2.7	0.01%
Wet Detention Basin	54	0.2%	Train Station	1	0.003%
Dry Detention Basin	52	0.2%	Pool	0.8	0.003%
Farm Building	40	0.1%	Other Agriculture - Garden	0.8	0.002%
Pasture	39	0.1%	Campgrounds	0.8	0.002%
Institutional	35	0.1%	Feed Lot	0.8	0.002%
Paved Path/Trail	32	0.1%	Parking Lot - Dirt	0.5	0.002%
RV Park	28	0.1%	Nursery - Building	0.5	0.002%
Marina	27	0.1%	Boat Launch	0.3	0.001%
Mobile Home Park	25	0.1%	Rain Garden	0.3	0.001%
Railroad	24	0.1%	Feed Lot - Equestrian	0.2	0.001%
Boat Storage Yard	12	0.04%	Nursery	0.1	0.0002%
Utilities	11	0.03%	Dog Park	0.03	0.0001%
-	-	-	TOTAL:	32,922	100%

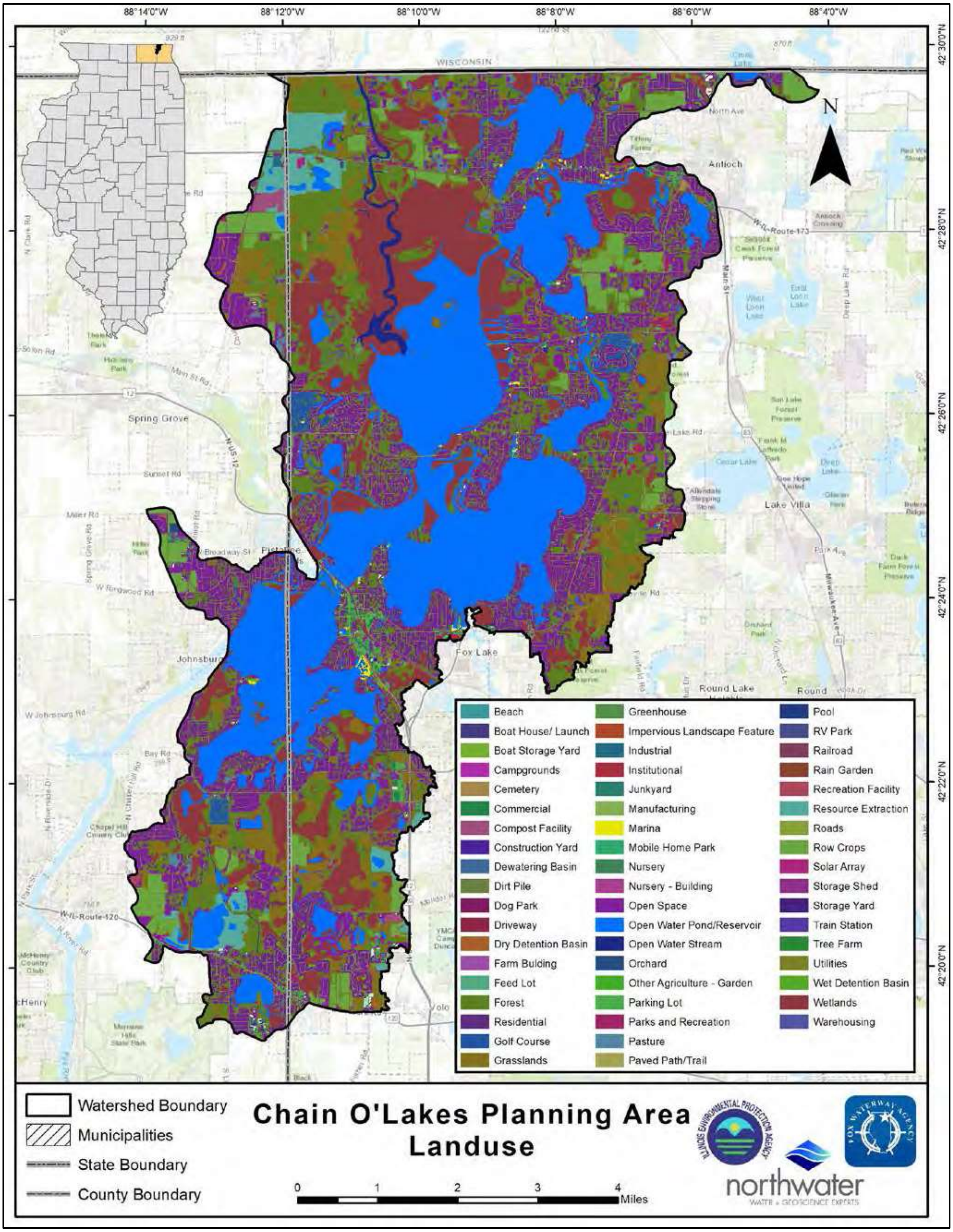

Figure 3-114: Current Land Use

3.12.2 Impervious Cover

Impervious cover is the direct result of altering a native soil's permeability by replacing natural surfaces with impermeable/impervious ones. Surfaces such as buildings, roads, parking lots, sidewalks, and compacted open space, which are common in urban areas, prevent precipitation from infiltrating into the ground. This increases direct storm water runoff and **NPS pollution** stressors into wetlands, ponds, streams, and rivers, thereby impacting local water quality (USEPA Impervious Surface Growth Model, 2017).

Nonpoint Source Pollution: The cumulative effect of rainfall runoff that flows over or through the land and collects pollutants and nutrients prior to entering waterways. The cumulative effect of this pollution throughout the watershed represents the contribution of nonpoint source pollution.

Analysis of impervious surface impacts in the planning area was conducted using the land use map layer. This dataset delineated the footprint of impervious surfaces including roads and parking lots. Buildings and other structures were also delineated and assigned a "density" rating of very high (98% impervious), High (90% impervious), medium (75% impervious) and low (50% impervious). Impervious area for buildings or structures was calculated using density values.

Approximately 4,139 acres (13%) of the planning area is believed to be impervious. Results are displayed in Figure 3-115**.** Table 3-59 provides statistics by subwatershed. The Channel Lake and Pistakee Lake subwatershed contain the highest percentage, or 15% of land area. Bassett Creek contains the least, or only 5.5%.

Table 3-59: Impervious Area by Subwatershed

SUBWATERSHED	AREA (AC)	IMPERVIOUS AREA (AC)	% IMPERVIOUS
Bassett Creek-Fox River	4,324	237	5.5%
Channel Lake	2,886	430	15%
Nippersink Lake-Fox River	15,878	2,019	13%
Pistakee Lake-Fox River	9,834	1,454	15%
TOTAL:	**32,922**	**4,139**	**13%**

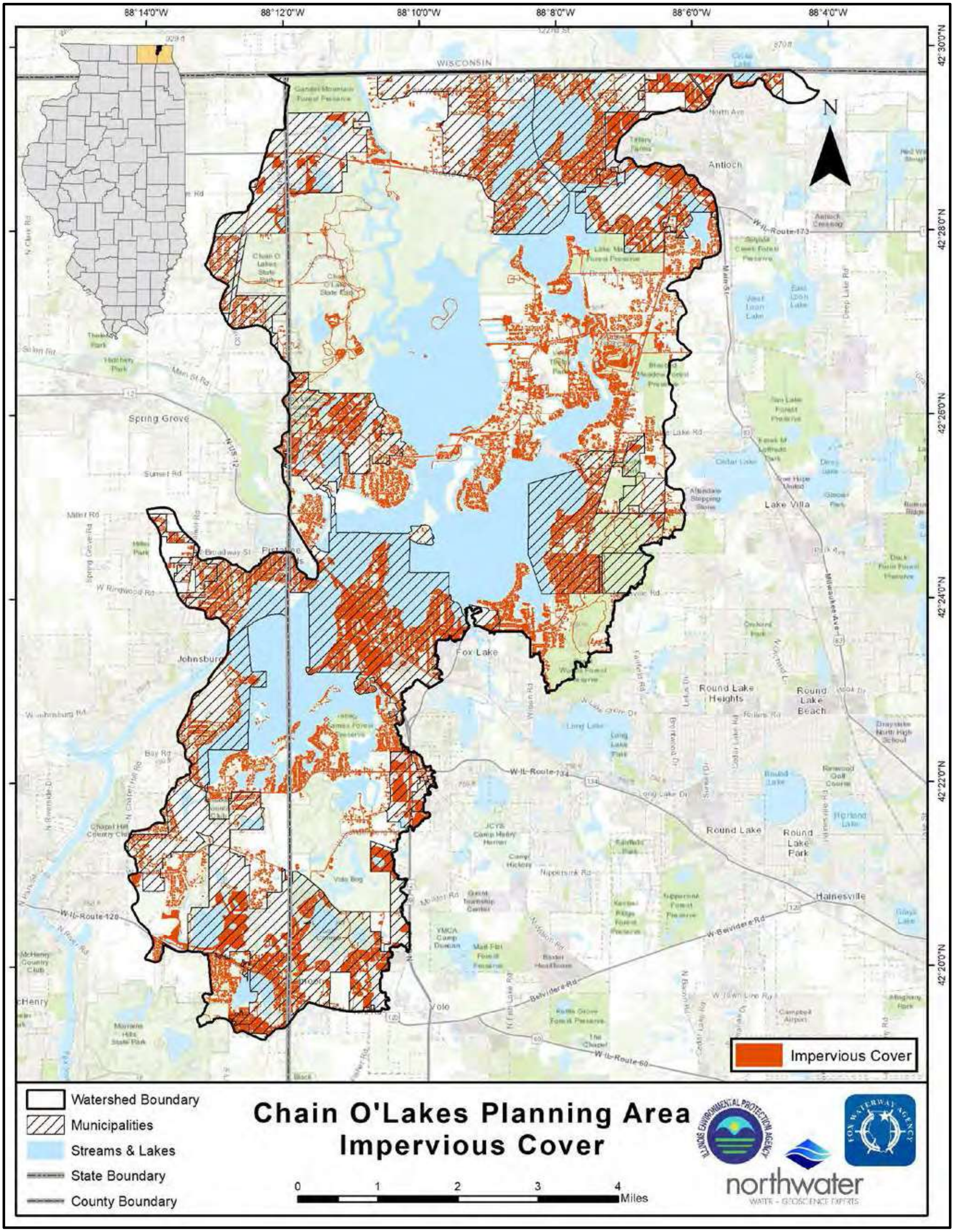

Figure 3-115: Impervious Cover

3.12.3 Future Land use Projections

Future land use projections were based on a review of county maps and are of interest in watershed planning because changes may result in additional impervious acres or may otherwise affect water resources. Datasets used in this plan do not necessarily have a "date," i.e., there may not be an estimated year at which the planned use will be present. Land use plans from which the data are gleaned, however, may have dates or planning "windows" sometime into the future (typically around 20 years from the time of publication/adoption).

Some caveats are warranted in discussion of future data and mapping. Precisely comparing current land use with the Lake and McHenry County future land use datasets was not possible due to a difference in map scale and how types we categorized. Existing maps were generated at a very fine scale versus much more generalized into a smaller subset of categories. For example, the existing dataset identifies residential yards as open space versus future land use where open space areas are lumped into surrounding categories such as residential or government/institutional.

Despite these differences, it is still possible to analyze the potential future changes. Agricultural, open space, and likely industrial should experience a decrease, whereas residential, retail, commercial, and mixed are likely to increase. Other categories should remain the same in the future. Table 3-60 lists projected future land use and Figure 3-116 depicts it in the planning area.

Table 3-60: Projected Land Use by Type

LAND USE TYPE	PROJECTED FUTURE ACRES
Agriculture	1,667
Government/Institutional	234
Industrial	385
Open Space	9,621
Residential	10,664
Retail/Commercial/Mixed Use	1,185
Transportation/Utility/Waste Facility	98
Water	9,068

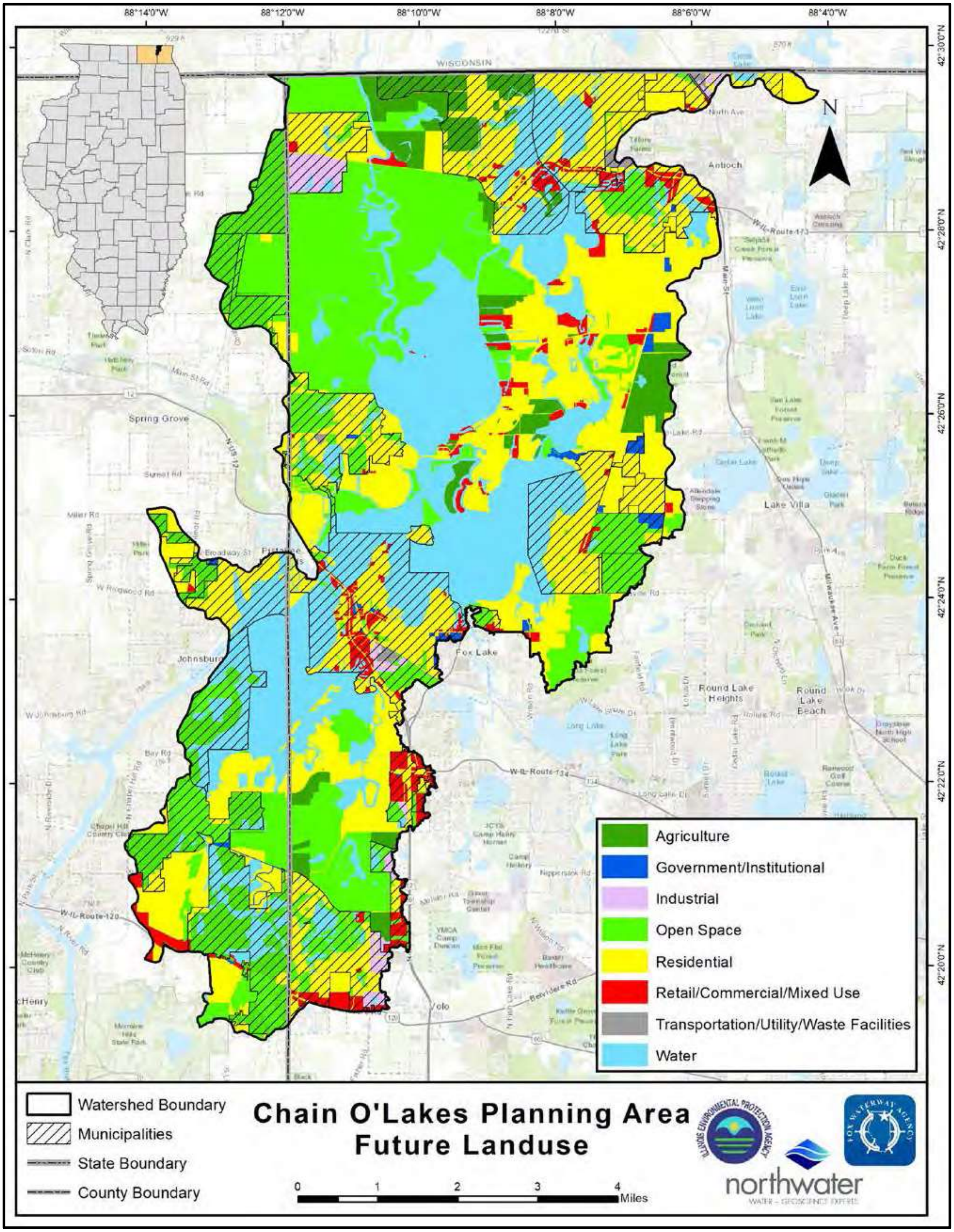

Figure 3-116: Future Land Use Projections

3.13 NATURAL AREAS, OPEN SPACE AND SIGNIFICANT SPECIES

The Chain O' Lakes plan addresses the condition and quality of water. Stormwater runoff is a major cause of water pollution in developed and semi-developed watersheds such as the Chain. Impervious surfaces, such as rooftops, driveways, parking lots, and streets, generate stormwater runoff that conveys pollutants to components of the natural drainage or green infrastructure system (ex. wetlands, lakes, and streams). Higher flows of stormwater can also cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure. Natural and protected areas help to mitigate some of these issues by acting as filters. Their protected status ensures what is natural, stays that way. Since existing natural areas and green infrastructure substantially influences how water moves in and on the landscape, it is an important element in this plan.

Local natural areas and other green infrastructure work in concert to infiltrate and store precipitation, thereby reducing the amount of stormwater runoff and the need to treat the water. Protected areas also bring many other environmental, social, and economic benefits. These benefits promote urban livability by improving the environment and preserving open space, which supports sustainable communities.

This section characterizes existing natural and protected areas in the planning area, including critical species, parks, and other open space.

3.13.1 Protection Status

Protected and managed land differs from unprotected land because it can't be utilized for developed land uses. The land is either permanently chartered as open land or in a permanent deed restriction such as a conservation easement. Publicly protected and managed lands include forest preserve districts, state nature preserves, and parks. Privately protected and managed lands include land with deed restrictions or conservation easements, and land owned by land trusts and other conservation organizations. The conversion of open space to other uses reduces the watershed benefits provided by open land. Conversion of open space to traditionally developed land uses may increase runoff, water quality degradation, and loss of wildlife habitat area and connectivity.

3.13.2 Protected Natural Areas and Open Space

Approximately 7,831 acres of managed parks, forest preserves, and various other natural areas exist within the planning area. Of this, 5,931 acres are managed by the IDNR, with the Chain O'Lakes State Park alone contributing 5,087 acres. Additionally, there is 137 acres of smaller parks that are managed by various municipal agencies and are shown in Table 3-61 and Figure 3-118. Use of these lands is varied, and includes active and passive recreation, wildlife management, hunting, and fishing. Additionally, many of the sites, or portions of them are Illinois Natural Areas Inventory (INAI) sites, Illinois Nature Preserves Commission (INPC) sites, or both.

Several dedicated Illinois Nature Preserves and Lake County Forest Preserve District (LCFPD) properties are found in the planning area. There are 5 forest preserves (LCFPD) totaling 1,602 acres and 6 INPC areas totaling 1,024 acres. Figure 3-118 shows forest preserves, INPC sites, INAI sites, and other protected or managed areas. The network of forest preserves, nature preserves and parks and open space provide significant flood damage reduction, water quality, habitat, and quality of life benefits. Forest preserves, State parks, INAI and INPC sites, and other protected and managed areas within the planning area are listed in Table 3-62.

Table 3-61: Non-State-Owned Parks and Management Authorities

MANAGEMENT AUTHORITY	AREA OF PARKS (AC)
Village of Lake Villa	41
Unincorporated	40
Village of Antioch	24
Village of Lakemoor	18
Village of Fox Lake	14
McHenry Township	0.7
TOTAL:	137

Table 3-62: Forest Preserves, State Parks, INAI and INPC sites, and Other Protected Areas

SITE NAME	AREA (AC)	SITE NAME	AREA (AC)
ILLINOIS NATURE PRESERVE COMMISSION SITES		FOREST PRESERVES AND STATE PARKS	
Weingart Road Sedge Meadow Nature Preserve	48	Chain O'Lakes State Park (IDNR)	5,087
Black Crowned Night Heron Marsh Land and Water Reserve	3.1	Volo Bog State Natural Area (IDNR)	796
Pistakee Bog Nature Preserve	436	Bluebird Meadow Forest Preserve (LCFP)	201
Gavin Bog and Prairie Nature Preserve	263	Grant Woods Forest Preserve	796
Turner Lake Fen Nature Preserve	94	Lake Marie Forest Preserve	226
Volo Bog Nature Preserve	180	Tanager Kames Forest Preserve	90
INPC TOTAL:	1,024	Gander Mountain Forest Preserve	288
ILLINOIS NATURAL AREAS INVENTORY SITES		Moraine Hills State Park	48
Lac Louette	163	FOREST PRESERVES/STATE PARKS TOTAL:	7,532
Lily Lake	88	OTHER PROTECTED AREAS	
Channel Lake	366	Openlands	100
Black - Crown Marsh	3	McHenry County Conservation District	50
Stanley Road Bog	13	Land Conservancy of Lake County	6.5
Weingart Road Sedge Meadow	78	The Land Conservancy of McHenry County	4.7
Gander Mountain Geological Area	292	OTHER PROTECTED AREAS TOTAL:	161
Turner Lake	162		
Cross Lake	25		
Gavin Bog and Prairie	169		
Grass Lake Wetlands	2,314		
Pistakee - Brandenburg Bog	494		
Volo Bog	331		
Wadley Marsh	124		
INAI TOTAL:	4,622		

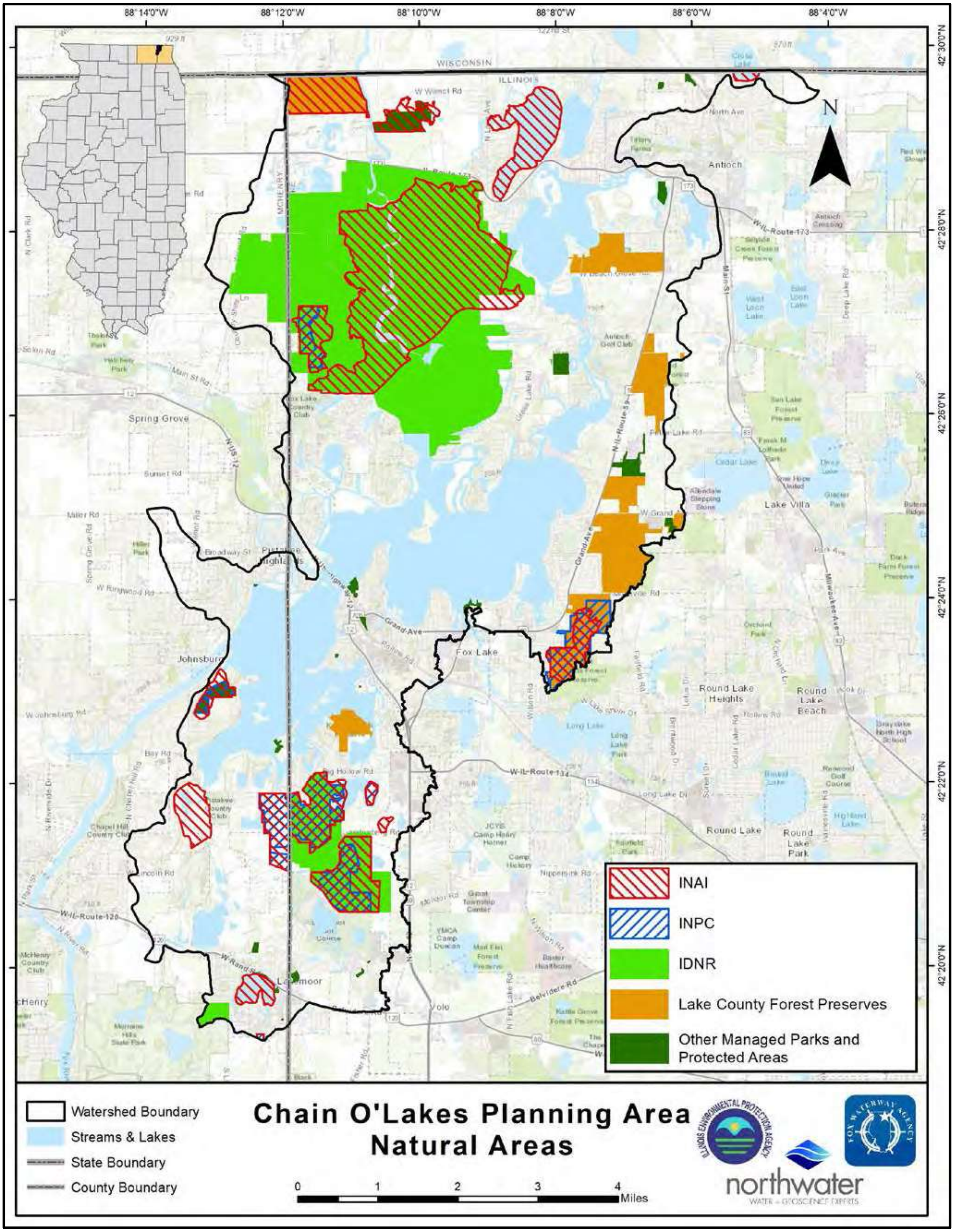

Figure 3-118: Natural Areas

3.13.3 Threatened and Endangered Species

ENDANGERED SPECIES: A species in danger of extinction throughout all or a substantial portion of its range.

THREATENED SPECIES: A species likely to become endangered in the near future.

ADID SITES: Aquatic sites that have been determined to provide biological value by the USACE, Chicago District and the USEPA.

High quality natural resources in the watershed include **threatened** and **endangered** species and communities, rare habitats, and important natural areas, including natural area inventory sites, forest preserves, nature preserves, and high quality **ADID** wetlands.

67 threatened and endangered species are found in the planning area including 50 vascular plant species, 16 vertebrate animal species, and 1 invertebrate animal species.

Table 3-63 includes the Illinois listed threatened or endangered species in the Chain. Ecologically significant and protected areas in the watershed provide habitat for these species and contain examples of high-quality natural communities. These areas include high quality wetlands, INAI sites, INPC sites, and forest preserves.

Table 3-63: Threatened and Endangered Species in the Planning Area

SCIENTIFIC NAME	COMMON NAME	COUNTIES	TYPE
Coccyzus erythropthalmus	Bunchberry	McHenry	Vascular Plant
Carex disperma	Shortleaf Sedge	Lake	Vascular Plant
Rhynchospora alba	Beaked Rush	Lake	Vascular Plant
Potamogeton robbinsii	Fern Pondweed	McHenry	Vascular Plant
Notropis heterolepis	Blacknose Shiner	Lake	Vertebrate Animal
Schoenoplectus smithii	Smith's Bulrush	Lake	Vascular Plant
Rubus pubescens	Dwarf Raspberry	Lake	Vascular Plant
Chamaedaphne calyculata	Leatherleaf	Lake	Vascular Plant
Ribes hirtellum	Northern Gooseberry	Lake	Vascular Plant
Carex viridula	Little Green Sedge	Lake	Vascular Plant
Cardamine pratensis var. palustris	Cuckoo Flower	Lake, McHenry	Vascular Plant
Eriophorum virginicum	Rusty Cotton Grass	Lake	Vascular Plant
Utricularia intermedia	Flat-leaved Bladderwort	Lake	Vascular Plant
Cypripedium parviflorum	Small Yellow Lady's Slipper	Lake	Vascular Plant
Larix laricina	Tamarack	Lake	Vascular Plant
Carex chordorrhiza	Cordroot Sedge	Lake	Vascular Plant
Drosera rotundifolia	Round-leaved Sundew	Lake	Vascular Plant
Sarracenia purpurea	Pitcher Plant	Lake	Vascular Plant
Vaccinium oxycoccos	Small Cranberry	Lake	Vascular Plant
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	Lake	Vertebrate Animal
Sterna forsteri	Forster's Tern	Lake	Vertebrate Animal
Vaccinium corymbosum	Highbush Blueberry	Lake	Vascular Plant
Cypripedium acaule	Moccasin Flower	McHenry	Vascular Plant
Vaccinium macrocarpon	Large Cranberry	Lake	Vascular Plant
Notropis heterodon	Blackchin Shiner	Lake	Vertebrate Animal
Carex trisperma	Three-seeded Sedge	Lake, McHenry	Vascular Plant

SCIENTIFIC NAME	COMMON NAME	COUNTIES	TYPE
Emydoidea blandingii	Blanding's Turtle	Lake	Vertebrate Animal
Fundulus diaphanus menona	Western Banded Killifish	Lake	Vertebrate Animal
Carex brunnescens	Brownish Sedge	Lake	Vascular Plant
Boltonia decurrens	Decurrent False Aster	Lake	Vascular Plant
Potamogeton gramineus	Grass-leaved Pondweed	Lake	Vascular Plant
Triglochin palustris	Slender Bog Arrow Grass	Lake	Vascular Plant
Trientalis borealis	Star-flower	Lake	Vascular Plant
Chlidonias niger	Black Tern	Lake	Vertebrate Animal
Ixobrychus exilis	Least Bittern	Lake	Vertebrate Animal
Trichophorum cespitosum	Tufted Bulrush	Lake	Vascular Plant
Salix serissima	Autumn Willow	Lake	Vascular Plant
Carex oligosperma	Few-seeded Sedge	Lake	Vascular Plant
Notropis anogenus	Pugnose Shiner	Lake	Vertebrate Animal
Veronica scutellata	Marsh Speedwell	Lake	Vascular Plant
Carex canescens	Hoary Sedge	Lake, McHenry	Vascular Plant
Epilobium strictum	Downy Willow Herb	Lake, McHenry	Vascular Plant
Betula alleghaniensis	Yellow Birch	Lake	Vascular Plant
Cypripedium reginae	Showy Lady's Slipper	Lake, McHenry	Vascular Plant
Triglochin maritima	Common Bog Arrow Grass	Lake	Vascular Plant
Rhamnus alnifolia	Alder Buckthorn	Lake	Vascular Plant
Menyanthes trifoliata	Buckbean	Lake	Vascular Plant
Calla palustris	Water Arum	Lake	Vascular Plant
Pogonia ophioglossoides	Snake-mouth	Lake	Vascular Plant
Scirpus hattorianus	Bulrush	Lake	Vascular Plant
Calopogon tuberosus	Grass Pink Orchid	Lake	Vascular Plant
Eleocharis rostellata	Beaked Spike Rush	Lake	Vascular Plant
Amelanchier interior	Shadbush	Lake	Vascular Plant
Gallinula galeata	Common Gallinule	Lake	Vertebrate Animal
Lechea intermedia	Pinweed	Lake, McHenry	Vascular Plant
Utricularia minor	Small Bladderwort	Lake	Vascular Plant
Canis lupus	Gray/Timber Wolf	Lake	Vertebrate Animal
Fundulus dispar	Starhead Topminnow	Lake	Vertebrate Animal
Coccyzus erythropthalmus	Black-billed Cuckoo	Lake, McHenry	Vertebrate Animal
Carex diandra	Sedge	Lake	Vascular Plant
Haliaeetus leucocephalus	Bald Eagle	Lake	Vertebrate Animal
Lathyrus ochroleucus	Pale Vetchling	Lake	Vascular Plant
Potamogeton praelongus	White-stemmed Pondweed	Lake	Vascular Plant
Setophaga cerulea	Cerulean Warbler	Lake	Vertebrate Animal
Pandion haliaetus	Osprey	Lake	Vertebrate Animal
Carex echinata	Sedge	Lake	Vascular Plant
Bombus affinis	Rusty Patched Bumble Bee	Lake, McHenry	Invertebrate Animal

3.14 EXISTING MANAGEMENT PRACTICES

Existing Best Management Practices (BMPs) exist within the planning area and include detention/retention basins and ponds, rain gardens, native prairie, riparian buffers, shoreline stabilization, grass filter strips, grass waterways, shoreline stabilization, and cover crops. Table 3-64 shows the total number or extent of each known practice and Figure 3-119 depicts their location within the Chain. In addition to those listed, other relevant work has included numerous education and outreach events related to conservation and water quality, as well as dredging completed by the FWA.

With relatively large reductions still required to meet water quality goals stated in this plan, substantial opportunities exist to install new practices. This is especially true where nutrient loading is the greatest or where pollutants may bypass existing BMPs. It is important to note that each practice varies in its ability to effectively remove pollutants, however, these practices are providing benefits to water quality and have been accounted for in the watershed pollutant loading estimates (Chapter 4). Historical efforts to address water quality cannot be understated.

Recently Stabilized Shoreline and Riparian Area

Table 3-64: Existing BMPs in the Planning Area

TYPE	Quantity	Unit
Waterway	12	acres
Filter Strip	3.2	acres
Grass Buffer	3.5	acres
Cover Crop	136	acres
Rain Garden	2	number
Pond	143	number
Dry Detention Basin	78	number
Wet Detention Basin	68	number
Shoreline Stabilization[1]	77	miles
Permeable Pavement/Pavers	3,663	square ft

1 – Refer to section 3.4.3.2 for breakdown of shoreline stabilization type

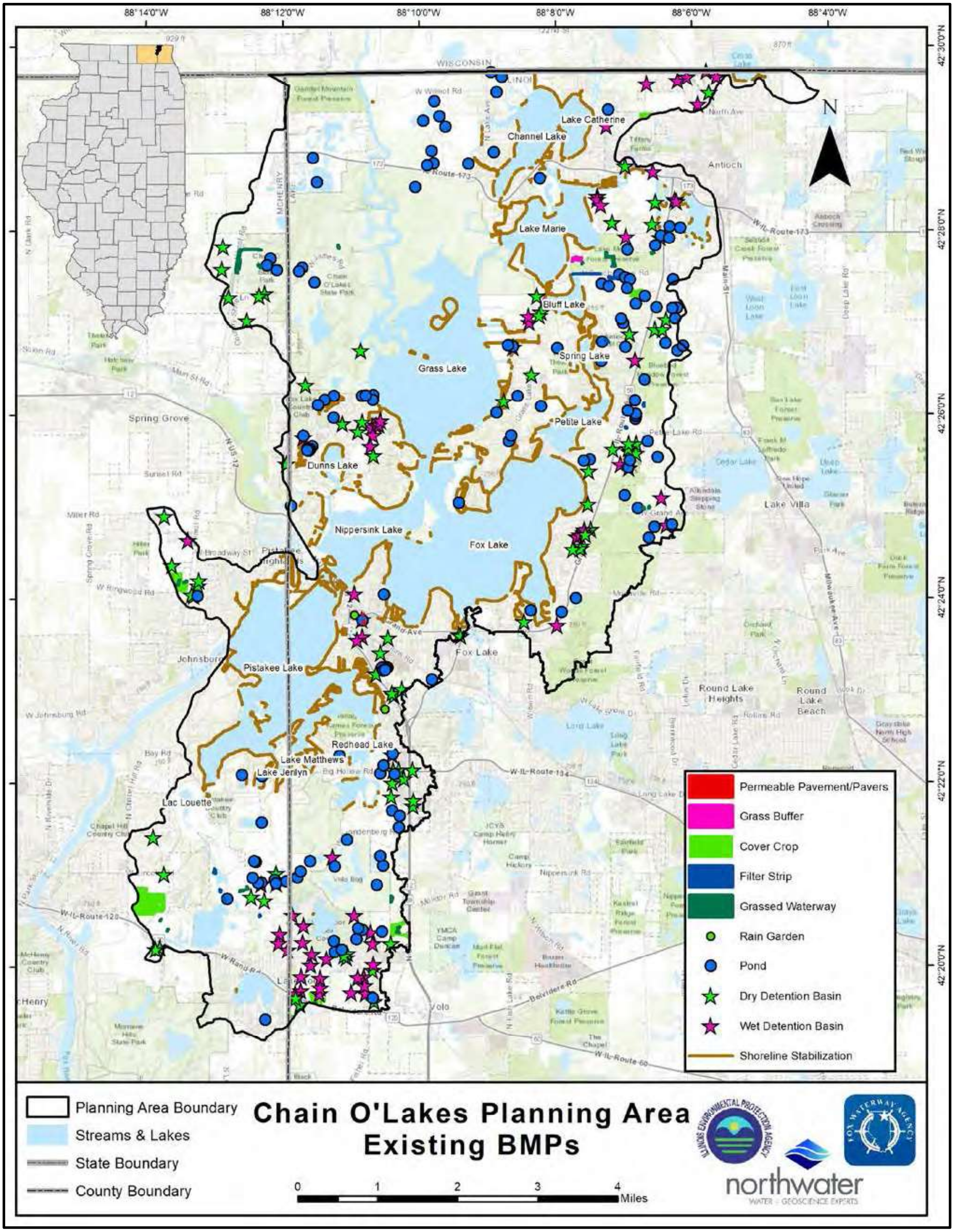

Figure 3-119: Existing BMPs

3.14.1 Detention Basin Inventory

WET DETENTION BASINS: A stormwater control structure that provides both retention and treatment of contaminated stormwater runoff. It contains a perennial pool of water, which holds runoff from one rainfall event until displaced by a new rainfall event.

DRY DETENTION BASINS: - Basins that temporarily stores water before discharging to river or lake and usually dry up following large rainstorms or snow melt events. Typically, not effective at removing pollutants.

Detention basins, a specific type of pond, are associated with urban and suburban development beginning in the second half of the twentieth century. Detention basins can be wet (ponds), wetland-bottom, or dry and are specifically designed to reduce peak runoff discharges from developed sites. Prior to watershed development regulations, detention ponds were constructed in both upland and wetland locations. Regulations now discourage or prohibit the construction of stormwater detention facilities in wetlands, which are typically constructed in upland areas in more recent developments. Detention basins are a component of the designed drainage system and stormwater infrastructure, and typically have a direct or eventual hydrologic connection to rivers, streams, lakes, and wetlands through storm sewers, drainage ditches, and other detention basins.

In 2022, an inventory was completed for all known areas being used for detention in the planning area. Detention basins were identified using aerial imagery analysis and during a watershed windshield survey. Basins were evaluated for location and retrofit opportunities. The assessment identified 146 basins (Table 3-65 and Figure 3-120).

Of the 146 basins, 68 are classified as **wet** and 78 classified as **dry**. The assessment identified 5 basins with naturalized retrofit opportunities and are included as site-specific project recommendations in Chapter 5.

Table 3-65: Number and Type of Detention Basins Inventoried by Subwatershed

SUBWATERSHED	NUMBER OF BASINS	NUMBER OF WET BASINS	NUMBER OF DRY BASINS
Bassett Creek-Fox River	8	0	8
Channel Lake	8	7	1
Nippersink Lake – Fox River	72	32	40
Pistakee Lake – Fox River	58	29	29
TOTAL:	**146**	**68**	**78**

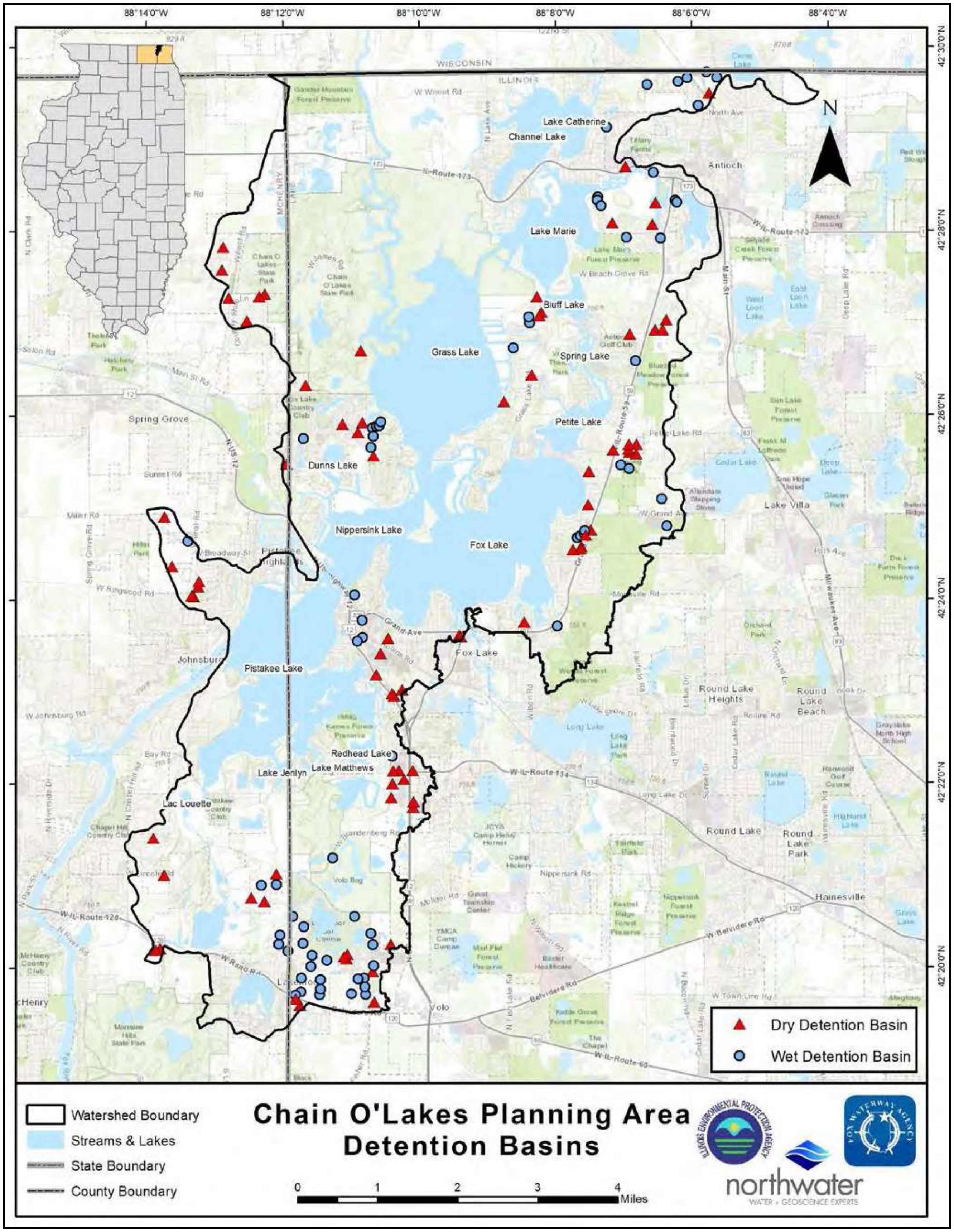

Figure 3-120: Inventoried Detention Basins

3.15 POINT SOURCES

The USEPA, under the Federal Water Pollution Control Act Amendments of 1972, regulates and monitors point source industrial and wastewater pollutant discharges into the nation's waterways (Public Law 92-500; 33 U.S.C. 1251 et seq.). Authorized under amendments made to the 1977 CWA in 1987 and implemented in 1990, the USEPA developed a two-phased National Pollutant Discharge Elimination System (NPDES) permit program to address industrial and Municipal Separate Storm Sewer Systems (MS4s) serving populations of greater than 100,000, requiring a permit to discharge stormwater from their outfalls into waterways. The NPDES Phase 2, enacted into law in 1999 and implemented in 2003, builds upon the existing Phase I program by regulating stormwater discharges from small MS4s located in urbanized areas (as defined by the latest decennial census) and construction sites that disturb 1-5 acres obtain a permit to discharge stormwater from their outfalls into waterways. Additional information regarding the NPDES program and specifically permit basics and definitions are available from the USEPA NPDES website (USEPA WMPD, 2012; USEPA, 2017).

Point sources are defined as discrete conveyances including, but not limited to, any pipe, ditch, channel, or conduit from which pollutants are or may be discharged into waterways. Point source regulation through NPDES includes wastewater treatment plants, industrial discharges, concentrated animal feeding operations, combined sewer overflows, sanitary sewer overflows, urban stormwater runoff and MS4 urban stormwater discharges. The NPDES program plays a key role in restoring water quality since it sets discharge limits, requires monitoring and reporting requirements, and limits discharge of pollutants.

3.15.1 Wastewater Treatment Plants & Combined Sewer Overflows

Wastewater Treatment Plants are vital to public health. Sewers collect wastewater from homes, businesses, and industries and deliver it to treatment facilities to remove pollutants from water impacted by human waste which can be either discharged to water bodies or land or reused.

Sewage treatment processes typically use a series of processes to treat wastewater prior to discharge. The typical series of unit processes includes:

- preliminary treatment or screening to remove large solids,
- primary clarification (or preliminary sedimentation) to remove floating and settleable solids,
- biological treatment (also referred to as secondary treatment) to remove biodegradable organic pollutants and suspended solids, and
- disinfection to deactivate pathogens.

Some facilities also provide more advanced treatment which is designed to reduce constituents, such as nitrogen and phosphorus, that are not removed in any significant quantity by traditional biological treatment processes. Many older sewer systems were built as combined systems, where storm sewers flow into the sanitary sewer system. During wet weather, these combined systems can be overwhelmed, and overflow into surface waters at designated outfalls. This untreated wastewater stream can be a source of harmful bacteria and nutrients. There are no such combined sewer overflow points in the planning area.

There are no active WWTPs currently located in or discharge directly to waterbodies in the planning area (USEPA, 2023). Prior to 2022, the Fox Lake Tall Oaks WWTP discharged an average flow of 0.2 - 0.4 million gallons per day (MGD) into Dunns Lake. This plant is no longer operating. There are, however, 18 WWTPs that are located outside the planning area and discharge into tributaries entering the planning area. Fifteen of these are in Wisconsin and 3 are in Illinois. Notable plants include the Village of Antioch plant at 2 MGD (Permit #IL0020354), the City of Waukesha (Wisconsin) WWTP at 14 MGD (Permit #WI0029971), and the Village of Sussex (Wisconsin) WWTP at 2.2 MGD (Permit #WI0020559). The Fox Lake Northwest Regional Water Reclamation Facility (Permit #IL0020958) is located on Manitou Creek, a tributary to Fox Lake, but discharges to the Fox River downstream of the planning area.

3.15.2 NPDES Phase II Stormwater Permits

The NPDES Phase II Program regulates stormwater discharges from small MS4s, industrial and construction site activities. Stormwater runoff is identified as a key method of conveying pollutants from impervious surfaces into local rivers and streams causing untreated water to degrade water quality. Polluted runoff or NPS pollution substantially impacts water quality. Polluted runoff is caused by rainfall or snowmelt moving over and through the ground picking up natural and human–made pollutants, depositing them into rivers, lakes, wetlands, and groundwater.

Under the permitting requirements of the NPDES Phase II, permittees are required to implement certain practices that control pollution in stormwater runoff. The Phase II program is intended to reduce negative impacts to water quality and aquatic habitats by preventing and controlling unregulated sources of storm water discharge, educating communities about water quality, and improving water quality. All 8 villages or municipalities in the planning area are MS4 communities in addition to all 7 townships.

3.15.3 Industrial Activity Storm Water Point Source Discharge

Stormwater discharges from industrial activities into waters of the United States require a permit under the USEPA NPDES. This permit is applicable to stormwater discharges associated with industrial activity from areas where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water in the state of Illinois. Runoff from rainfall or snowmelt that comes in contact with these industrial activities can pick up pollutants and transport them directly to a nearby river or lake coastal water or indirectly via a storm sewer and degrades water quality. The permit provides a list of facilities that are included and excluded under a General permit for Industrial Storm Water Discharge into waters of the United States.

In Illinois, the Industrial Activity Storm Water Point Source Discharge falls under NPDES Permit No. ILR00 (Illinois EPA, 2020). There are 2 Industrial Activity Storm Water Point Source Discharge permits located within the planning area (Illinois EPA, 2020); Bald Knob Marina (Permit #ILR006142) and Inland Harbor Marina (Permit #ILR006750).

3.15.4 Construction Site Activities Storm Water Discharge

A permit is required for stormwater discharges into waters of the United States from construction sites where one or more acres of land is disturbed. Smaller sites within a larger construction project or development must consider the total disturbance of the project when determining if a NPDES permit is required. Many permittees in Illinois obtain permit coverage for their construction projects under the State's General Stormwater NPDES Permit for construction activities. For stormwater discharges from construction sites to be authorized under this General Permit, the owner must submit a notice of intent in accordance with the requirements of the general permit. Permittees must develop and implement a Stormwater Pollution Prevention Plan (SWPP) to effectively manage the discharge of pollutants from the site.

In Illinois, the Construction Site Activities Storm Water Discharge is Permit No. ILR10 (Illinois EPA, 2018). Within the study area are 3 NPDES ILR10 construction permits as of 2023. These are Menards – Fox Lake (ILR10J569), Unnamed Warehouse (ILR10I163) and Wilmot Farms of Spring Grove (ILR106858).

3.15.5 ILR40, Discharges from Small Municipal Separate Storm Sewer Systems (MS4)

Per Permit number ILR40 (Illinois EPA, 2016), stormwater discharges from small MS4s into waters of the United States require a permit under the USEPA NPDES program as many units of government have distinct roles and responsibilities related to water quality and NPS pollution control.

The permit requires that MS4 operators develop, implement, and enforce a stormwater management program to reduce the discharge of pollutants. A permittee's stormwater management program must include 6 minimum control measures:

1. Public education and outreach on storm water impacts.
2. Public involvement and participation.
3. Illicit discharge detection and elimination.
4. Construction site storm water runoff control.
5. Post-construction storm water management in new development and redevelopment.
6. Pollution prevention / good housekeeping for municipal operations.

To define its storm water management program, a permittee must define BMPs and measurable goals for each of the 6 minimum control measures. In the Chain planning area, there are 2 units of county government, 1 unit of township government, and 2 units of municipal government operating as MS4's with distinct roles and responsibilities related to activities and water quality control. These include McHenry County (ILR4000264), Lake County (ILR400517), Lake Villa Township (ILR400074), Village of Fox Lake (ILR400339), and Village of Lakemoor (ILR400371).

3.16 SEPTIC SYSTEMS

Outside of sewered areas, septic systems provide treatment of wastewater from individual properties and structures. Failing septic systems can be an active source of pollutants. Those that are faulty or leaking are sources of bacteria, nitrogen, and phosphorus.

Within the Chain, roughly 4,550 acres of homes are served by a sewer system. Of the 8 municipalities, all but 3 provide some level of sewer service. Of the 9 unincorporated places, 5 do not have any sewer. Fox Lake has the greatest sewered acreage at 1,220 acres but this only represents 28% of the Village's total area within the planning area.

Typical national septic system failure rates are 10-20% but vary widely depending on the local definition of failure; no failure rates are reported specifically for Illinois (USEPA, 2002). Other watershed plans in Lake County have noted failure rates of 2-3%. Personal correspondence with individuals immediately outside of the planning area involved in regulating septic systems indicate failure rates are very likely much higher than 2-3% Therefore, a conservative 8.5% failure rate was used for analysis.

Every home and structure in the watershed not served by a sewer system were located and mapped to estimate the number of individual structures using septic systems. Corresponding bacteria, nitrogen and phosphorus loads were estimated using the USEPA Spreadsheet Tool for the Estimation of Pollutant Load (STEPL).

There are an estimated 8,872 septic systems within the planning area (Figure 3-121). Assuming a rate of 8.5%, it is possible that 754 structures have failing systems. Potentially failing systems may be contributing an estimated 24,353 lbs/yr of nitrogen, 9,534 lbs/yr of phosphorous, and 1,051,064 billion CFU/yr of bacteria. For the purposes of this report, it is assumed that these loadings do make it to waterways, however, loading is a function of location to a waterway, and it is possible that some portion of septic water may be absorbed or filtered prior. Systems range from roughly 15 ft to 5,876 ft from a receiving waterbody. Average distance is 579 ft and the median is 322 ft. Approximately 19% of all are at or less than 100 ft with 86% being within 1,000 ft.

Lakes County Public Works is conducting a feasibility study to add 3 new sewered service areas. If implemented, these new service areas, the Channel Lake/Lake Catherine Service area with 1,900 connections, the Grass Lake/Petite Lake Service Area with 2,400 connections, and the Loon Lakes Service Area with 1,100 connections, will add a total of 5,400 new connections. The Loon Lakes Service Area, however, is not within the Chain, so the total number of new connections within the planning area is 4,300. If the Channel Lake/Lake Catherine and the Grass Lake/Petite Lake Service areas are added, an estimated total of 9,807 lbs/yr of nitrogen, 3,839 lbs/yr of phosphorus, and 423,266 billion CFU/yr of bacteria could be reduced.

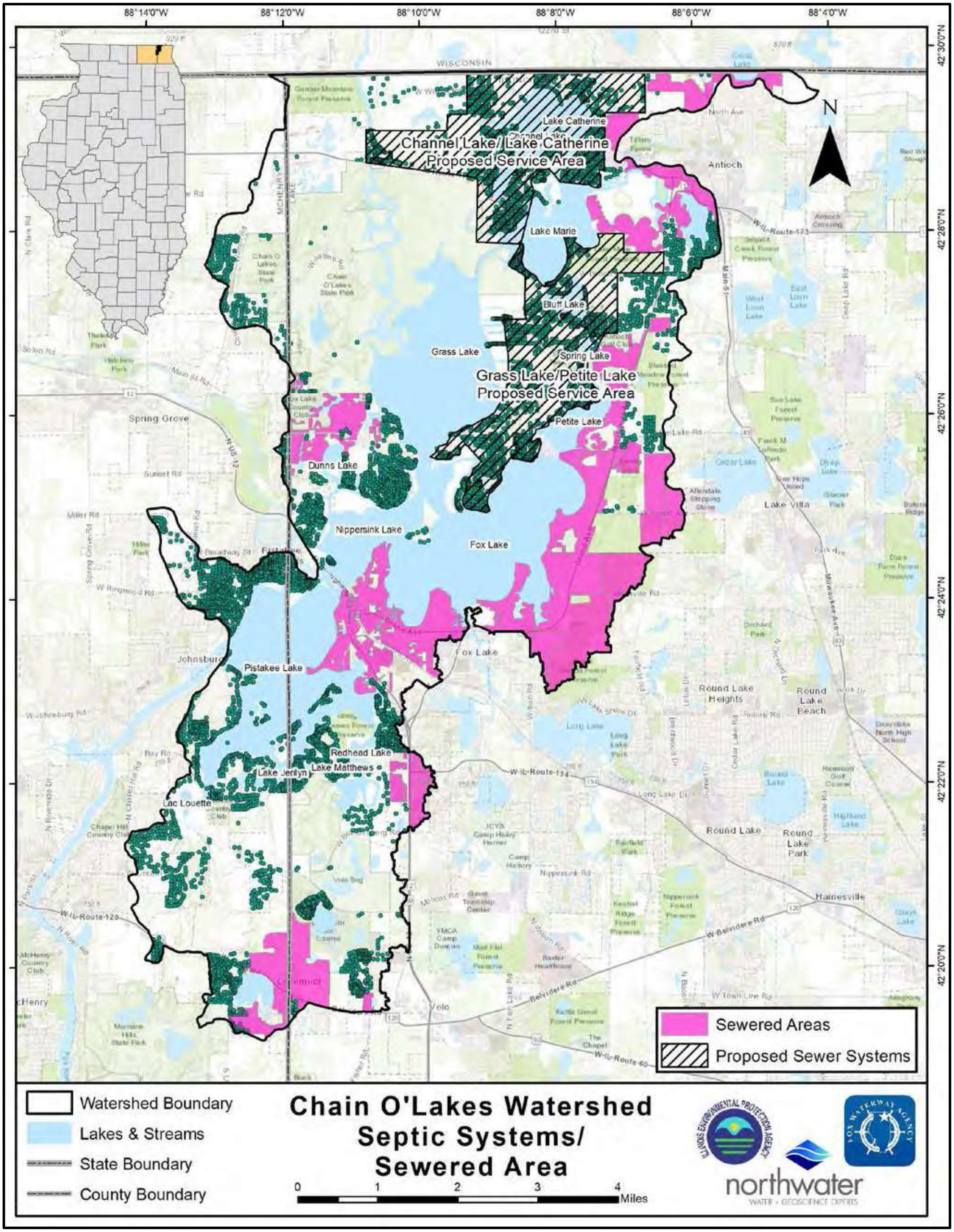

Figure 3-121: Septic Systems/Sewered Area

3.17 REFERENCES

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CHAPTER FOUR: WATERSHED PROBLEM ASSESSMENT

CONTENTS

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COMMON ACRONYMS/ABBREVIATIONS USED IN CHAPTER 4

BMP – Best Management Practices
CFU - Colony Forming Unit
CMAP – Chicago Metropolitan Agency for Planning
EMC - Event Mean Concentration
EPA – Environmental Protection Agency
FWA – Fox Waterway Agency
GIS- Geographic Information System
IC – Impervious Cover
IDNR – Illinois Department of Natural Resources
IDOT- Illinois Department of Transportation
LCFPD- Lake County Forest Preserve District
LCHD- Lake County Health Department
LID - Low Impact Development
MCCD – McHenry County Conservation District
NPDES- National Pollutant Discharge Elimination System
NPS – Nonpoint Source
NRCS- Natural Resources Conservation Service
PAH – Polycyclic Aromatic Hydrocarbons
SMC – Lake County Stormwater Management Commission
SEWRPC – Southeastern Wisconsin Regional Planning Commission
SMO – Stormwater Management Ordinance
SWCD - Soil and Water Conservation District
TMDL – Total Maximum Daily Load
TSS – Total Suspended Solids
TP – Total Phosphorus
TN - Total Nitrogen
USACE- United States Army Corps of Engineers
USEPA- United States Environmental Protection Agency
WDO – Watershed Development Ordinance
WDNR- Wisconsin Department of Natural Resources
WWTP- Wastewater Treatment Plant

4 WATERSHED PROBLEM ASSESSMENT

This chapter assesses in more detail the problems identified in Chapter 3. The Watershed Problem Assessment describes the effect of land use and land cover change on water resources in the Chain O' Lakes planning area, estimates the most prevalent causes and sources of pollution, quantifies nonpoint source (NPS) pollutant loading, and identifies water quality issues that can be addressed by programmatic or site-specific actions or projects. This chapter also assesses how jurisdictional roles, including regulatory oversight, can be better coordinated to improve the condition of water resources.

4.1 LAND USE IMPACTS AND IMERVIOUS COVER CHANGES

As discussed in Chapter 3, Impervious Cover (IC) is the result of altering or replacing native soil permeability as a result of land cover changes. Impervious surfaces produce an increase in direct stormwater runoff and NPS pollution stressors into wetlands, lakes, streams, and rivers, thereby impacting local water quality. Stressors increase pollutant loads in runoff, alter stream flow, decrease bank stability, especially lake shorelines, increase water temperatures, and reduce wetland capacity and function. These impacts affect terrestrial and aquatic wildlife, plant establishment, habitat function, recreational opportunities, environmental health, and property use and value.

Research also shows that impervious cover impacts water quality at relatively low levels of development and land use (0-9% IC or **low Impervious Cover)**. Symptoms of water quality impact from land use stressors have been observed at 10-29% IC (or **Medium**), and research has quantified and observed degradation of natural water bodies when the percentage is between 30-100% (**High**) of a watershed. Figure 4-1 visualizes percent imperviousness based on impacted land use (Chabaeva, 2007).

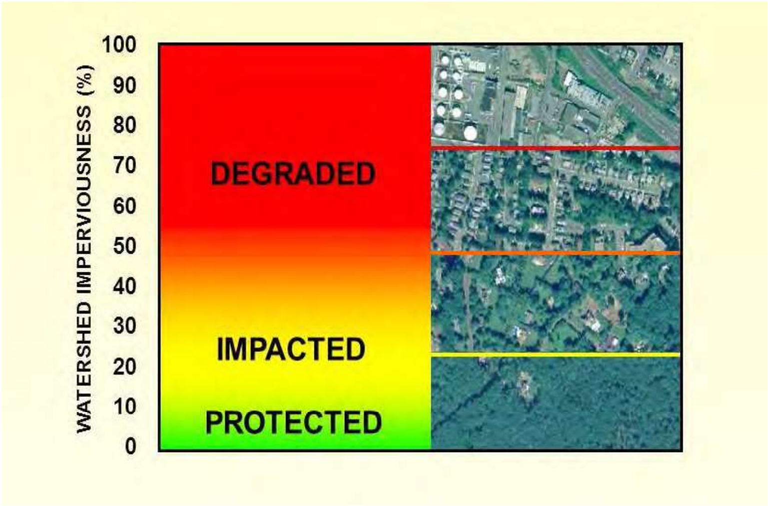


Figure 4-1: Comparison of Percent Imperviousness to Land Use

IMPERVIOUS COVER (IC) CLASSIFICATION: As mentioned in Section 3.12.2 Impervious Cover, water quality is impacted at 10% and degradation of water quality is consistent at greater than 30% impervious cover. The IC is analyzed by impacts:

Low IC – Land use changes increase impervious cover to 0-9% of the watershed with minimal impact to water quality.

Medium IC – Land use changes increase impervious cover to 10-29% of the watershed with water quality impacts noticeable.

High IC – Land use changes increase impervious cover to 30-100% of the watershed with water quality degradation expected.

4.1.1 Effects of Land Use Change on Water Quantity

Land disturbance associated with land use modification has a direct effect on stormwater quantity. Disturbance of a natural site alters hydrology due to impacts to the native soils and vegetation. Plowing, clearing, and tree removal eliminate vegetation that reduces stormwater runoff volumes through the hydrologic processes of interception, evaporation, and transpiration. Earthwork and grading disturb native soils and may remove or fill areas with natural depressions that collect, infiltrate, and retain rainfall and stormwater runoff onsite. Increased impervious surfaces, such as roads, parking lots, and rooftops, further reduce the infiltration capacity of an area and increase stormwater runoff volume and velocity.

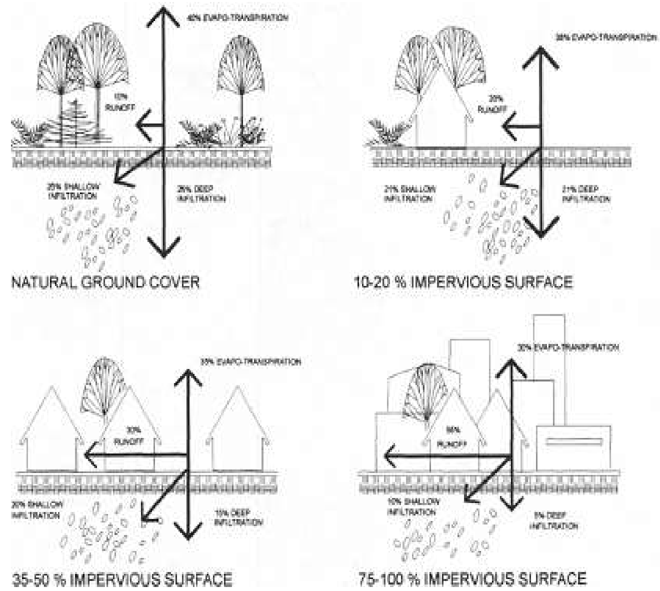
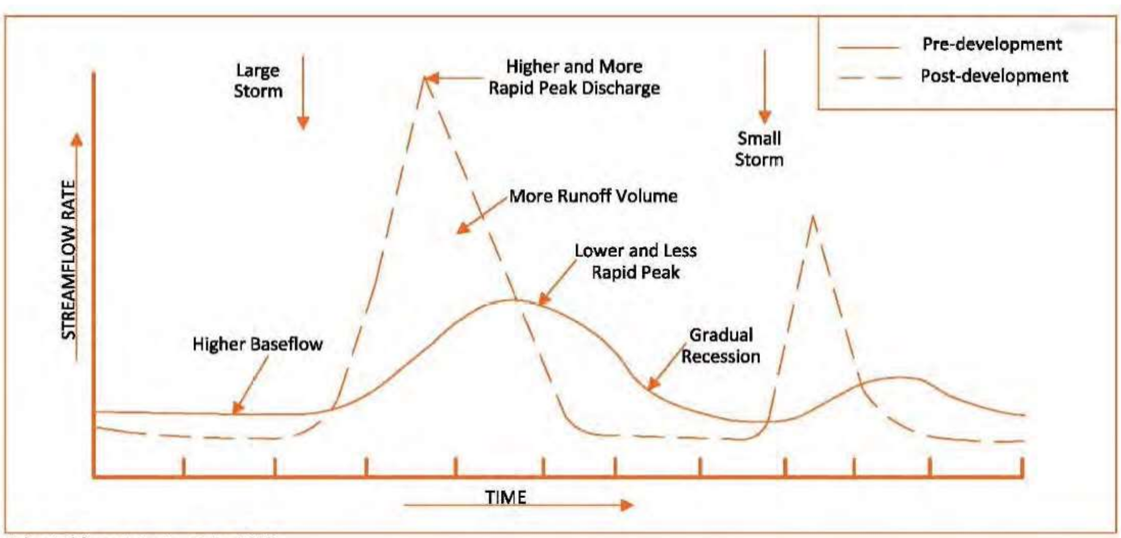


Figure 4-2: Influence of Impervious Surface on the Fate of Precipitation

The installation of drainage improvements (e.g., channelization, dredging, or artificial drainage systems) further reduces a site's ability to retain rainfall. Collectively, these impacts result in substantially increased stormwater runoff volumes and velocities (Figure 4-2) and reductions in groundwater recharge (Pitt, 1994; Shueler, 1987; Thompson, 2009). Increased stormwater runoff volumes and velocities result in increased peak discharge rates, which can be at least two to five times higher on developed sites than undeveloped sites, resulting in increased flooding risk (Figure 4-3). Reduced groundwater recharge decreases baseflow to aquatic resources, including streams and wetlands. In recently developed areas, these impacts are partially offset by modern stormwater-related land development regulations.



Adapted from Schueler, T. R., 1994

Figure 4-3: Pertinent Impacts of Urbanization on Hydrology

4.1.2 Effects of Land Use Change on Water Quality

Land use change also affects stormwater quality. Impervious and compacted surfaces, such as parking lots, roads, lawns, parks, and athletic fields, accumulate pollutants during dry weather. These pollutants are quickly transferred to receiving waters during precipitation events, often through artificial drainage systems, resulting in increased loading to aquatic resources (Figure 4-4). Tables in Sections 3.3 characterize water quality impacts, causes and sources to lakes and streams.

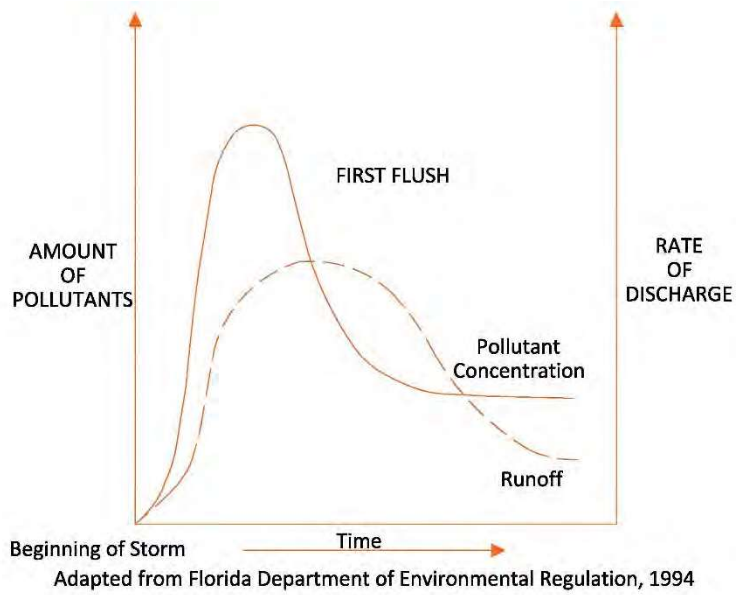


Figure 4-4: Influence of Impervious Surface on Fate of Pollutant Concentrations

Stormwater pollutants come from a variety of diffuse and scattered sources, many of which are a direct or indirect result of land use change. These NPS pollutants include:

- Sediment: Sources of sediment to stormwater runoff include land disturbing activities, atmospheric deposition, and surface or streambank erosion. Sediment particles can adsorb other stormwater pollutants, such as nutrients, metals, hydrocarbons, and pesticides, and transport them into receiving streams, wetlands, and other aquatic resources.
- Nutrients: Sources of nutrients, such as nitrogen and phosphorus to stormwater runoff include fertilizer, pet and animal waste, leaves, grass clippings, sanitary sewer overflows and illicit connections, septic system discharges, and atmospheric deposition.
- Bacteria: Sources of bacteria and pathogens to stormwater runoff, include pet and animal waste, sanitary sewer overflows and septic system discharges. Runoff impacted by these sources typically exceeds public health standards for recreational contact.
- Organic Matter: Sources of organic matter to stormwater runoff include leaves, grass clippings, pet and animal waste, sanitary sewer overflows, and septic system discharges. The decomposition of this organic matter can decrease dissolved oxygen to levels that are detrimental to aquatic life.
- Metals: Sources of heavy metals, such as lead, zinc, copper, and cadmium, to stormwater runoff include atmospheric deposition, vehicle wear, and commercial, industrial, and hazardous waste sites.
- Hydrocarbons: Sources of hydrocarbons (i.e., PAHs or coal tar sealants) to stormwater runoff include vehicle wear, chemical spills, restaurant grease traps, and improper handling and disposal of waste oil and grease.
- Pesticides: Sources of insecticides, herbicides, and other pesticides to stormwater runoff include farming activities, lawn care and maintenance activities, chemical spills, and atmospheric deposition.
- Chlorides: Sources of chlorides to stormwater runoff include winter sidewalk, driveway, roadway, and parking lot anti-icing and deicing activities, and water softeners.

- Additional Chemical Sources: Sources of chemicals, such as chlorine, solvents, soaps and detergents, degreasers, drain cleaners, vehicular liquids, and paint, to stormwater runoff include residential, commercial, and industrial sites.
- Trash and Debris: Considerable quantities of trash and debris typically accumulate on impervious or compacted pervious surfaces and are transferred to receiving waters by stormwater runoff. This trash and debris can accumulate in conveyance systems, potentially causing clogging and nuisance flooding.

As outlined below, an extensive and ever-growing body of research shows that these NPS pollutants have substantial negative impacts on lakes, streams, wetlands, and other aquatic resources. Negative impacts include impaired water quality, reduced oxygen levels, increased primary productivity (e.g., eutrophication, algal blooms), sediment contamination, degradation of habitat, and a general decline in the abundance and diversity of wildlife and aquatic animals.

4.1.3 Effects of Land Use Change on Stormwater Temperature

Land use changes also affect stormwater temperature. The compacted pervious and impervious surfaces resulting from land use change absorb and retain heat, especially when exposed to sunlight. The heating of these surfaces is exacerbated by reduced shade resulting from the clearing of vegetation. During precipitation events, these heated surfaces increase the temperature of stormwater runoff, resulting in increased water temperatures and decreased dissolved oxygen in receiving waters.

4.1.4 Impacts on Aquatic Resources

Changes in hydrology and stormwater runoff characteristics (e.g., increased stormwater runoff rates, volumes, and pollutant loads) resulting from changes in land use can have a wide range of negative impacts on the aquatic resources of the Chain planning area. Additional information about these impacts is provided below.

4.1.4.1 *Streams, Lakes and Wetlands*

Changes in stormwater quantity, quality, and temperature can have multiple negative impacts on freshwater streams, lakes and wetlands. The water quality of lakes is negatively impacted by increased stormwater pollutant loads. Since lakes function as sinks within the landscape, incoming sediment, nutrients, bacteria, metals, hydrocarbons, pesticides, chlorides, and trash and debris can remain in a lake for a long time. The accumulation of these various pollutants can reduce overall water quality, contaminate sediments, increase primary productivity (e.g., increase algal growth), and negatively impact many of the important ecological functions that lakes provide. These well-documented impacts (CWP, 2003; CWP, 2009; Cruse et al., 2012) include:

- Increased Channel Forming Events: Increased stormwater runoff rates and volumes resulting from land use changes increase the frequency and duration of channel forming events, resulting in changes in channel form, stream channel enlargement (e.g., stream downcutting and widening), and erosion.
- Increased Flooding: Increased stormwater runoff rates and volumes resulting from land use changes also increase the frequency, duration, and severity of overbank and extreme flooding events. These flooding events can cause property damage and endanger public health and safety.

- Increased Ponding: Increased stormwater runoff rates and volumes resulting from land use changes can cause increased ponding within wetlands. This can stress native wetland plant communities, especially in those that did not previously receive large inputs of stormwater runoff.
- Decreased Baseflow: Increased runoff volumes resulting from land use changes reduce the amount of recharge to shallow groundwater aquifers which supply baseflow to streams and wetlands.
- Stream Channel Enlargement: Stream channels enlarge (e.g., downcut and widen) to accommodate the increased peak discharges resulting from land use changes.
- Streambank Erosion: As stream channels enlarge to accommodate an increased frequency and duration of channel forming events and the increased peak discharges resulting from land use changes, streambanks are gradually undercut, scoured, and eroded away.
- Shoreline Erosion: Increased ponding and water level fluctuations and decreased baseflow resulting from land use changes can stress native wetland plant communities and leave portions of wetland shorelines unvegetated, making them vulnerable to undercutting, scour, and erosion.
- Loss of Riparian Vegetation: As stream channels enlarge and streambanks are gradually eroded away, the roots of vegetation along the stream corridor may become exposed, undercut, uprooted, and conveyed downstream.
- Degradation of Habitat: Increased stormwater scour stream beds, degrade aquatic habitat, and stress native vegetation. The increased sediment loads that result from land use changes and erosion can also impact aquatic habitat.
- Increased Temperatures: Increased stormwater runoff temperatures can raise the temperature of freshwater lakes and streams. Since aquatic organisms can only survive within a specific range (e.g., some darter fish species and other cool water species), increased stream temperatures can lead to a decline in wildlife abundance and diversity.
- Degradation of Water Quality: Increased stormwater pollutant loads reduce the overall water quality of freshwater systems. This water quality degradation negatively impacts many of the ecological functions that these important natural resources provide.
- Sediment Contamination: Metals, hydrocarbons, and pesticides can become attached to sediment particles and accumulate within bodies of water. This can cause sediment contamination and expose aquatic and terrestrial organisms to the harmful effects of these pollutants.
- Reduced Dissolved Oxygen Levels: Increased amounts of organic matter found in urban stormwater runoff and increased temperatures reduce the amount of dissolved oxygen found in freshwater systems which can lead to fish kills and the loss of other aquatic organisms. Low oxygen levels can also cause the release of harmful pollutants such as metals, nutrients, hydrocarbons, and pesticides that have accumulated within sediment.
- Decline in Wildlife Abundance and Diversity: Increased stormwater runoff rates, volumes, and pollutant loads degrade habitat and water quality. This reduces the abundance and diversity of aquatic organisms. Sensitive organisms that require high quality habitat may become stressed and be gradually replaced by organisms more tolerant of degraded conditions. For more detailed information on threatened and endangered species see Section 3.13.3.
- Reduced Recreational and Aesthetic Value: Increased trash, debris, and pollutant loads found in stormwater runoff can accumulate in freshwater streams, lakes, and wetlands and detract from their natural beauty and recreational value.

4.1.5 Impacts of Impervious Surfaces on Runoff

Assessing impacts of impervious surfaces and developed areas within the planning area involves further analysis of annual average runoff volumes. Section 3.12.2 presents a data source used to evaluate impervious surfaces, the land use map layer. This custom data layer was used to calculate impervious cover in each subwatershed. Section 4.2.4.2 analyzes nutrient, sediment and bacteria loading by land use category, including just those contributions from developed/impervious areas.

Given that impervious surfaces are known to generate more runoff, an analysis was performed of average annual volumes using the NPS model described in the next section. Volume of annual runoff in acre-ft corrected for area is presented for both impervious and pervious surfaces in Table 4-1. Excluding open water streams, lakes, and wetlands, impervious surfaces in the Chain generate 97% more runoff, on average, for the same land area.

Table 4-1: Runoff from Impervious Surfaces

SUBWATERSHED	IMPERVIOUS ANNUAL RUNOFF (AC-FT/AC)	PERVIOUS ANNUAL RUNOFF (AC-FT/AC)	PERCENT DIFFERENCE
Bassett Creek	1.3	0.31	123%
Channel Lake	1.4	0.56	86%
Nippersink Lake	1.0	0.49	68%
Pistakee Lake	1.5	0.44	109%
AVERAGE:	**1.3**	**0.45**	**97%**

4.1.6 Reducing Land Use Impacts Through Development Standards and Policy

The Chain O' Lakes watershed plan recommends actions for protecting and restoring natural resources and improving water quality. These actions include both remedial and preventative measures for communities to support. Among the most significant and influential are preventative measures such as policies and regulatory programs, which are proactive practices rather than costly remedial measures after the problems become unavoidable.

This watershed-based plan does not recommend specific land uses or zoning, however, it does consider the health of watershed streams, waters and wetlands, which is a direct reflection of land use and land management. Therefore, consideration of land management and development impacts by local authorities is necessary for effective watershed planning. Resolution of water resource issues may be supported by review and modification of policies, standards, and practices guiding land development and land management.

FLOODPLAINS: Floodplains are lowlands, adjacent to rivers, streams and creeks that are subject to recurring floods. Mapped regulatory floodplains are defined as the area of land, which is inundated with water during 100-year flood events.

FLOODWAY: A "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

It is anticipated that stormwater runoff volume and pollution will continue to increase as impervious surfaces increase within the Chain. Municipalities and counties should review relevant ordinances to evaluate policies, standards, and regulations for new and retrofitted development, and for land management as it pertains to stormwater runoff volume, detention, water quality, **floodplains/floodways**, and wetlands. Both watershed development regulations and policies focused on stormwater management and local ordinances and policy that direct development practices that influence IC and drainage should be reviewed based on their potential to positively influence watershed health by preventing negative land development impacts.

4.1.6.1 *Stormwater Management*

Current stormwater regulations are enforced locally with minimum standards for development based on local ordinance and National Pollutant Discharge Elimination System (NPDES) minimum requirements. Section 4.3 identifies roles and jurisdictions of development programs. Section 3.15.2 identifies national stormwater requirements. Future local ordinance revisions could consider conditions unique to individual subwatersheds that warrant consideration for developing and administering watershed-specific stormwater management regulations to address the technical issues of concern.

The primary technical issues of concern related to stormwater management are:

- Current IC and land use vary within an individual subwatershed or jurisdiction.
- Current drainage infrastructure varies within an individual subwatershed or jurisdiction with inadequate infrastructure to retain/detain and filter urban runoff.
- Nonpoint source pollution from urban land uses, transportation infrastructure, and additional volume from urban runoff may contribute to impairment of streams, lakes and wetlands.

The effects of increased runoff volume resulting from land use changes can be addressed in a variety of ways, including the following policy examples:

- Adopt more effective and consistent runoff volume reduction practices, including detention in residential and urban areas.
- Review the detention volume/release rate requirements for the watershed and determine if unique conditions warrant adjustments or changes to storage and release regulations.
- Review and revise ordinance and policy language to ensure that the disconnection and minimization of impervious surfaces are allowed by right.
- Low impact development practices and the use of green infrastructure best practices (that maintain natural hydrology post-development) could be expanded by municipal and county ordinances for all new development and significant redevelopment.
- Mitigate unavoidable wetland loss where the wetland impact/loss occurs and restore wetlands and runoff-reducing wetland function(s) where feasible.

Water quality has been identified as a watershed issue and concern. Local community ordinances can be reviewed and revised to ensure that development codes do not preclude but rather encourage Best Management Practices (BMPs) to protect and improve water quality. Examples of such BMPs include:

- The use of native vegetation in home and business landscaping.

- Sustainable street designs, including alternative transportation opportunities (complete streets) and bio-swales or other vegetated conveyance systems for stormwater management instead of traditional curb and gutter.
- Infiltration for a significant portion of increased runoff volume due to land development. County stormwater management ordinances provide runoff volume reduction measures.
- Preservation of natural retention and infiltration areas recognized as green infrastructure to reduce polluted runoff.
- Rainwater harvesting using rain gardens and cisterns.

4.1.6.2 *Local Municipal and County Policies and Ordinances*

Policy and regulatory changes regarding land use are the responsibility of the county and municipal planning and development departments. Those entities should consider developing and implementing sound environmental long-term planning goals in their guiding documents. Planning documents vary in function (e.g., master plans, comprehensive plans, overlay or area-specific plans) but can seek balanced land use, land preservation, and development guidelines to positively affect watershed response. Development guidelines may be the best avenue for incorporating watershed-specific development standards and practices that protect water quality. Considering elected officials change, long-term planning guidelines support county and municipal staff in preserving watershed health through the available resources for enforcement and recommendations.

NOTEWORTHY: COMMUNITY PROGRAMS AND REGULATIONS INFLUENCE WATERSHED HEALTH

Many codes and ordinances influence the health and function of a watershed. The table below includes typical types of codes and ordinances to evaluate and potentially change or modify to help improve watershed conditions.

Code or Ordinance Types with Ties to Watershed Health

SUBJECT OF REGULATION	CODE/ORDINANCE/REGULATION
Erosion and Sediment Control	Zoning Ordinance, Stormwater Ordinance
Environmental Regulations (e.g., Buffers, Water Quality, Wetlands, Threatened/Endangered Species)	Subdivision Codes, Stormwater Ordinance, Planned Unit Development Agreements, Special Use Permits
Floodplain Regulations	Zoning Ordinance, Stormwater Ordinance, Subdivision Codes, Building Code
Stormwater Management and Drainage	Stormwater Ordinance, Subdivision Codes, Zoning Ordinance, Planned Unit Development Agreements, Street Standards and Road Design, Building Code, Fire Code
Tree Protection and Landscaping	Tree Protection Ordinance, Landscape Ordinance, Nuisance Ordinance, Planned Unit Development Agreements, Building Code, Fire Code
Parking Requirements	Zoning Ordinance, Planned Unit Development Agreements, Special Use Permit, Grading Ordinance

Planning and zoning guidance provides the next level of watershed protection. Most planning and zoning regulations are in the form of local comprehensive land use plans and development-related ordinances that regulate onsite land use practices to ensure adequate floodplain, wetland, stream, lake, pond, soil conservancy, and other natural resource protection. Zoning ordinances, and overlay districts in particular, define the allowed type of development and where it can be located relative to natural resources. Other examples of planning/zoning resource protection include riparian and wetland buffers, impervious area reduction, open space/greenway dedication, and conservation development.

An excellent source of information on model development principles and a sample code and ordinance review worksheet can be found in *Better Site Design: A Handbook for Changing Development Rules in Your Community* (CWP, 1998). In addition, the Center for Watershed Protection and the United States Environmental Protection Agency (USEPA) have self-appraisal checklists that watershed communities may use to evaluate their existing codes and ordinances. Adopting watershed-friendly codes and ordinances will elevate protection and enhancement of watershed resources. Watershed communities should perform this self-appraisal and establish an action plan to revise ordinances and codes where needed.

Improved coordination and communication between county and local government would benefit water resource protection. Municipal stormwater officials, local planners, and zoning boards should be very familiar with watershed development regulations and should consider revising local ordinances that address watershed and site-specific water, natural resource, and flooding issues not covered by county, regional, or state program requirements.

Noteworthy: Conservation Development and Low Impact Development (LID)

County and local governments can work together to develop incentives for conservation development and LID. Some ways to incorporate conservation development into projects and provide incentives for developers include:

- Allow conservation development "by-right" (does not require variances)
- Establish a joint review department/agency application process that reduces review time
- Reduce fees for conservation development application review
- Require all developments have a certain percentage of preserved open space
- Develop native landscaping ordinances
- Reduce setback requirements between lots and encourage multi-level and clustered residential development to reduce land consumption
- Provide credit for combining natural buffers with recreational opportunities
- Require native plantings in all detention basins

Communities may incorporate conservation development and LID using several methods and strategies. Conservation development zoning could be applied to rezoning. The conservation development zoning classification should outline the intent, design guidelines, density bonus, and the specific areas where conservation development zoning changes would be permitted. The areas that may be rezoned to a conservation development might include areas that are adjacent to ecologically significant lands or are identified in local green infrastructure plans. Rural residential districts or less productive agricultural areas may also be considered. Areas that are defined as rural residential could provide a transition from higher density residential to rural.

Design guidelines for conservation developments should include LID practices, a detailed outline of the process used to define the environmentally sensitive areas on the site, and identify areas on the site that are developable. Because each site will have different developable areas and sizes, design guidelines should be flexible and should consider different development characteristics, such as roadway length, width, and lot size. Density bonuses may be written into the zoning code and could include bonuses for the following: use of native vegetation throughout the development including individual lots, reduction in pavement or impervious surface, use of permeable pavements, increased percentages of open space, trail or sidewalk connections to other developments or regional trails, additional expanded buffering of natural areas and adjacent spaces, and creation of wildlife habitat.

4.2 WATERSHED RESOURCE PROBLEMS ASSESSMENT

This section assesses the problems and concerns identified in Chapter 2 and Chapter 3 to better understand them and guide informed and prioritized actions to address them. Many water resources in the planning area have water quality impairments which negatively affect aesthetic value, aquatic habitat, recreational value and access, and fish consumption uses.

The following subsections describe further analysis used to assess how watershed conditions are affecting the water quality, natural resources, and natural areas throughout the planning area.

4.2.1 LAKE IMPAIRMENTS

Based on the 2020/2022 Illinois EPA 305(b) list, 18 inland lakes in the planning area have designated use impairments, as detailed extensively in Chapter 3. In addition, 27 lakes are subject to an approved Total Maximum Daily Load (TMDL) for Total Phosphorus (TP) and Total Suspended Solids (TSS). Most impairments are for aesthetic quality caused by high TP and TSS levels, with a small number of fish consumption impairments caused by sediments contaminated with legacy industrial and agricultural chemicals. Overwhelmingly, stakeholders' highest concerns related to lake impairments are high levels of sedimentation and aesthetic problems such as unnaturally high levels of aquatic plants and algae.

4.2.2 STREAM IMPAIRMENTS

Only one stream segment is assessed in the planning area, the Fox River between Grass Lake and the Illinois/Wisconsin state line. This segment is listed in the 2020/2022 Illinois EPA 303d list of impaired waters for fish consumption and aquatic life caused by several legacy agricultural and industrial chemicals, as well as sedimentation/siltation and bacteria. These stream impairments are similar to those in the lakes, and public input emphasized the importance of the sedimentation/siltation impairments in the planning process.

4.2.3 CAUSES AND SOURCES

Chapter 3 introduced and identified problems and impairments. This section considers that assessment and prioritizes the level to which causes and sources of water quality impairment are addressed in this plan. Various sources of quantitative and qualitative data and information were analyzed with the goal of identifying the causes and sources of impairments that will need to be managed to achieve the goals and objectives of this plan.

Table 4-2 provides a planning level inventory of impairments, causes and sources based on the characterization and inventory of the Chain. This table serves as a summary to document the issues and provides a priority ranking. High priority causes and sources are directly addressed in this plan.

Table 4-2: Summary of Causes and Sources of Pollution and Impairments

IMPAIRMENT	CAUSES	SOURCES	PRIORITY	HIGHEST PRIORITY WATERS
Aquatic Life and Aesthetic Quality	Phosphorus	• Urban Runoff • Agricultural Runoff • Erosion • Internal release from legacy sediments	High	All lakes in Chain
	Total Suspended Solids (TSS)	• Bank Erosion • Altered hydrology • Urban runoff • Agricultural runoff • Streambank modifications/destabilization • Resuspension of legacy sediments	High	All lakes in Chain
Primary Contact Recreation	Fecal Coliform Bacteria	• Urban runoff (septic systems) • Birds/Wildlife/Domestic Animals	High	Fox River, all lakes in Chain
Fish Consumption	Aldrin, Dieldrin, Endrin, Heptachlor, Mirex, PCBs, Toxaphene	• Contaminated Sediment • Atmospheric Deposition • Hydrodynamic transport/cycling • Industrial Point Source Discharge	Low	Grass Lake, Fox Lake
	Mercury	• Atmospheric Deposition	Low	

4.2.4 Pollution Loading and Nonpoint Sources

Pollutant loading from a watershed is the sum of point and NPS. Nonpoint source pollution is a primary concern related to water quality in the planning area. Based on the data available, the watershed plan identifies priority impairments and problems to address as detailed in Table 4-2.

Point sources from within the watershed are not measurable contributors to the overall planning area pollutant loads, however, external sources are, such as from communities upstream within the Fox River basin and Sequoit Creek, a tributary to Lake Marie and the receiving stream for the Village of Antioch wastewater treatment plant (WWTP). Although not directly assessed as part of plan development, existing regulatory permit processes and enforcement address point source pollution. All permitted facilities are subject to regulatory monitoring and reporting requirements, which are all public records.

This section provides an analysis of source loading by major category and by subwatershed. Chapter 3 describes methods and quantifies sources (e.g., septic systems, streambank and lake shoreline) for the entire planning area or by individual waterbody.

4.2.4.1 *Nonpoint Source Pollution Load Model*

A Geographic Information System (GIS) model was developed to estimate NPS pollutant loads from direct runoff for 4 parameters: sediment, TP, Total Nitrogen (TN), and Bacteria measured in Colony Forming Units or **CFU**. The output illustrates and quantifies the estimated spatial distribution of loading in the Chain.

The model used to estimate pollutant loads incorporates the land use described in Chapter 3. Runoff volumes are based on a given land use, soils and average annual rainfall and intensity. **Event Mean Concentrations (EMCs)** were applied to the runoff volumes based on land use category. The EMCs are established based on literature sources, water quality studies, and professional experience. The model was adjusted to match measured water quality data and accounts for loading generated from outside the planning area (e.g., Fox River). It does not include contributions from shoreline erosion, streambank erosion, gullies, internal lake loading, or septic systems which are quantified in Section 4.2.4.3.

> **EVENT MEAN CONCENTRATION (EMC):** Method for characterizing pollutant concentrations in stormwater runoff. The pollutant concentrations are measured in studies and on-going research that collects and analyzes runoff from various land-use practices in different geographic and climatic regions. The values are determined by compositing (in proportion to flow rate) a set of samples, taken at various points in time during a runoff event, into a single sample for analysis.
>
> **COLONY FORMING UNIT (CFU):** CFU is a measure of viable bacterial or fungal numbers. Unlike direct microscopic counts where all cells, dead and living, are counted, CFU measures viable cells.

4.2.4.2 *Nonpoint Source Loading, Current Conditions*

Figure 4-5 through Figure 4-8 illustrate the spatial distribution of NPS loading for sediment, TP, TN, and bacteria, respectively. Table 4-3 displays totals by subwatershed. Total load estimates indicate which subwatersheds are estimated to contribute the greatest amount of a pollutant annually. Loading rate estimates indicate which contribute greater amounts of a pollutant per acre (yield) and are listed in Table 4-4. A larger subwatershed may contribute a high pollutant load as a function of its size while one with a greater yield might because it contributes a higher pollutant load per unit area. Table 4-5 breaks down NPS contributions from direct runoff for major land use categories by subwatershed and Table 4-6 presents loading by major land use category and subwatershed as a percentage of the total.

Total annual NPS loading from direct runoff is estimated to be 159,997 lbs of nitrogen, 12,352 lbs of phosphorus, 490 tons of sediment, and 21,632 billion CFU of bacteria. The Nippersink Lake subwatershed contributes the most total load for all pollutants, due to its size (48% of the planning area). Channel Lake contributes the third greatest total despite covering the least land as a percentage of the planning area.

Table 4-3: Annual NPS Loading Estimates by Subwatershed

SUBWATERSHED	NITROGEN (LBS/YR)	PHOSPHORUS (LBS/YR)	SEDIMENT (TONS/YR)	FECAL COLIFORM (BILLION CFU/YEAR)
Bassett Creek	14,020	872	35	1,306
Channel Lake	16,582	1,243	82	2,263
Nippersink Lake	87,757	6,821	243	12,352
Pistakee Lake	41,638	3,416	129	5,710
TOTAL:	**159,997**	**12,352**	**490**	**21,632**

Pollutant yield or rate is greatest in the Channel Lake and Nippersink Lake subwatersheds for all pollutants. Bassett Creek has the smallest annual yield, and is lower than the planning area average of 4.9 lbs/ac for nitrogen, 0.38 lbs/ac for phosphorus, 0.015 tons/ac sediment, and 0.66 billion CFU/ac.

Table 4-4: Annual NPS Loading Rate by Subwatershed

SUBWATERSHED	NITROGEN (LBS/AC/YR)	PHOSPHORUS (LBS/AC/YR)	SEDIMENT (TONS/AC/YR)	FECAL COLIFORM (BILLION CFU/AC/YR)
Bassett Creek	3.2	0.20	0.008	0.30
Channel Lake	5.7	0.43	0.029	0.78
Nippersink Lake	5.5	0.43	0.015	0.78
Pistakee Lake	4.2	0.35	0.013	0.58
TOTAL:	**4.9**	**0.38**	**0.015**	**0.66**

Bassett Creek Subwatershed - an analysis by major land use category shows that water and wetlands are responsible for much of the nitrogen, phosphorus, and bacteria, 50%, 39%, and 47%, respectively. This is due to the large overall acreage of these land use types. Sediment, however, is primarily from agricultural areas or 25 tons/yr (70% of the total). This land use also contributes the second greatest percentage of nitrogen (21%). Developed and impervious surfaces are responsible for the second highest percentage of phosphorus and bacteria. The focus should be on crop practices in this subwatershed to reduce NPS sediment and nitrogen, and on urban or developed areas to mitigate phosphorus and bacteria.

Channel Lake Subwatershed – in Channel Lake, developed and impervious areas contribute most of the nitrogen, phosphorus and bacteria, or 29%, 47%, and 53%, respectively. Agricultural areas contribute the most sediment, or 61 tons/yr (73%). The focus should be on cropland practices in this subwatershed to reduce NPS sediment and on urban or developed areas to mitigate nitrogen, phosphorus and bacteria through retention/detention and filtering prior to entering the Chain.

Nippersink Lake Subwatershed – as a percentage of the overall NPS loading from direct runoff, 48% of the phosphorus and 45% of the bacteria is originating from developed urban areas, whereas most nitrogen is from water and wetlands, due to the very large percentage of open water. Most of the sediment is from agricultural areas, or 47% (114 tons/yr) followed by developed urban or 37% of the total (90 tons/yr). The focus in Nippersink Lake should be on cropland practices to reduce NPS sediment and on urban or developed areas to mitigate phosphorus and bacteria through retention/detention and filtering prior to entering the Chain.

Pistakee Lake Subwatershed – developed urban areas are responsible for 51% of the NPS phosphorus from direct runoff (1,736 lbs/yr) and 50% of the bacteria. Similar to all other subwatersheds, agriculture (row crops) are responsible for most of the sediment, or 50%, which translates to 65 tons/yr. Developed urban areas also contribute a relatively high percentage of sediment, or 35% and nitrogen (31%). The focus in Pistakee Lake should be on cropland practices to reduce NPS sediment and on urban or developed areas to mitigate phosphorus, nitrogen, and bacteria through retention/detention and filtering prior to entering the Chain.

Table 4-5: Annual NPS Loading by Land Use Category and Subwatershed

LAND USE CATEGORY	NITROGEN LOAD (LBS/YR)	PHOSPHORUS LOAD (LBS/YR)	SEDIMENT LOAD (TONS/YR)	BACTERIA LOAD (BILLION CFU/YR)
BASSETT CREEK				
Agriculture (row crops)	2,942	115	25	97
Developed/Impervious	1,625	197	5.1	307
Livestock/Equestrian	226	25	0.3	69
Natural/Urban Open Space	2,145	189	3.8	198
Resource Extraction	73	10	0.1	18
Water/Wetlands	7,008	336	1.4	616
TOTAL:	**14,020**	**872**	**35**	**1,306**
CHANNEL LAKE				
Agriculture (row crops)	4,118	165	61	126
Developed/Impervious	4,732	587	15	1,207
Livestock/Equestrian	450	42	0.5	131
Natural/Urban Open Space	3,224	243	5.0	227
Water/Wetlands	4,058	206	1.4	572
TOTAL:	**16,582**	**1,243**	**82**	**2,263**
NIPPERSINK LAKE				
Agriculture (row crops)	10,241	398	114	303
Developed/Impervious	25,723	3,270	90	5,521
Livestock/Equestrian	84	7.2	0.1	28
Natural/Urban Open Space	16,586	1,286	26	1,181
Water/Wetlands	35,123	1,860	14	5,320
TOTAL:	**87,757**	**6,821**	**243**	**12,352**
PISTAKEE LAKE				
Agriculture (row crops)	6,216	256	65	200
Developed/Impervious	13,106	1,736	46	2,849
Livestock/Equestrian	191	21	0.2	61
Natural/Urban Open Space	7,748	595	12	544
Resource Extraction	573	90	1.3	99
Water/Wetlands	13,805	718	5.0	1,957
TOTAL:	**41,638**	**3,416**	**129**	**5,710**

Table 4-6: Annual NPS Loading – Percent of Total by Subwatershed

LANDUSE CATEGORY	NITROGEN LOAD (% TOTAL)	PHOSPHORUS LOAD (% TOTAL)	SEDIMENT LOAD (% TOTAL)	BACTERIA LOAD (% TOTAL)
BASSETT CREEK				
Agriculture (row crops)	21%	13%	70%	7%
Developed/Impervious	12%	23%	14%	23%
Livestock/Equestrian	2%	3%	1%	5%
Natural/Urban Open Space	15%	22%	11%	15%
Resource Extraction	0.5%	1.1%	0.3%	1.4%
Water/Wetlands	50%	39%	4.1%	47%
CHANNEL LAKE				
Agriculture (row crops)	25%	13%	73%	5.6%
Developed/Impervious	29%	47%	18%	53%
Livestock/Equestrian	2.7%	3.4%	0.6%	5.8%
Natural/Urban Open Space	19%	20%	6%	10%
Water/Wetlands	24%	17%	2%	25%
NIPPERSINK LAKE				
Agriculture (row crops)	12%	6%	47%	2%
Developed/Impervious	29%	48%	37%	45%
Livestock/Equestrian	0.1%	0.1%	0.04%	0.2%
Natural/Urban Open Space	19%	19%	11%	9.6%
Water/Wetlands	40%	27%	6%	43%
PISTAKEE LAKE				
Agriculture (row crops)	15%	7%	50%	4%
Developed/Impervious	31%	51%	35%	50%
Livestock/Equestrian	0.5%	0.6%	0.2%	1.1%
Natural/Urban Open Space	19%	17%	9%	10%
Resource Extraction	1.4%	2.6%	1%	1.7%
Water/Wetlands	33%	21%	3.9%	34%

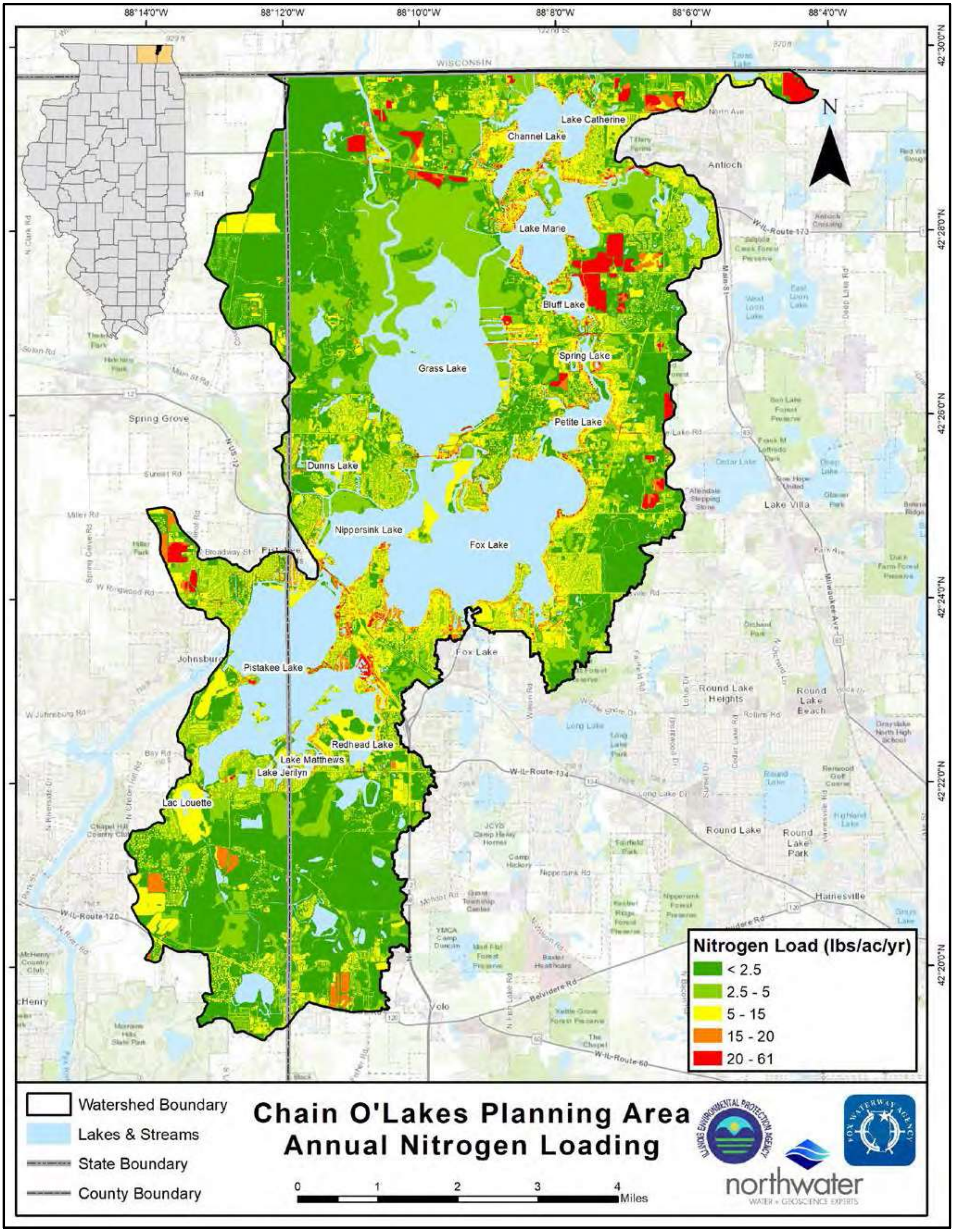


Figure 4-5: Estimated Annual NPS Total Nitrogen Loading

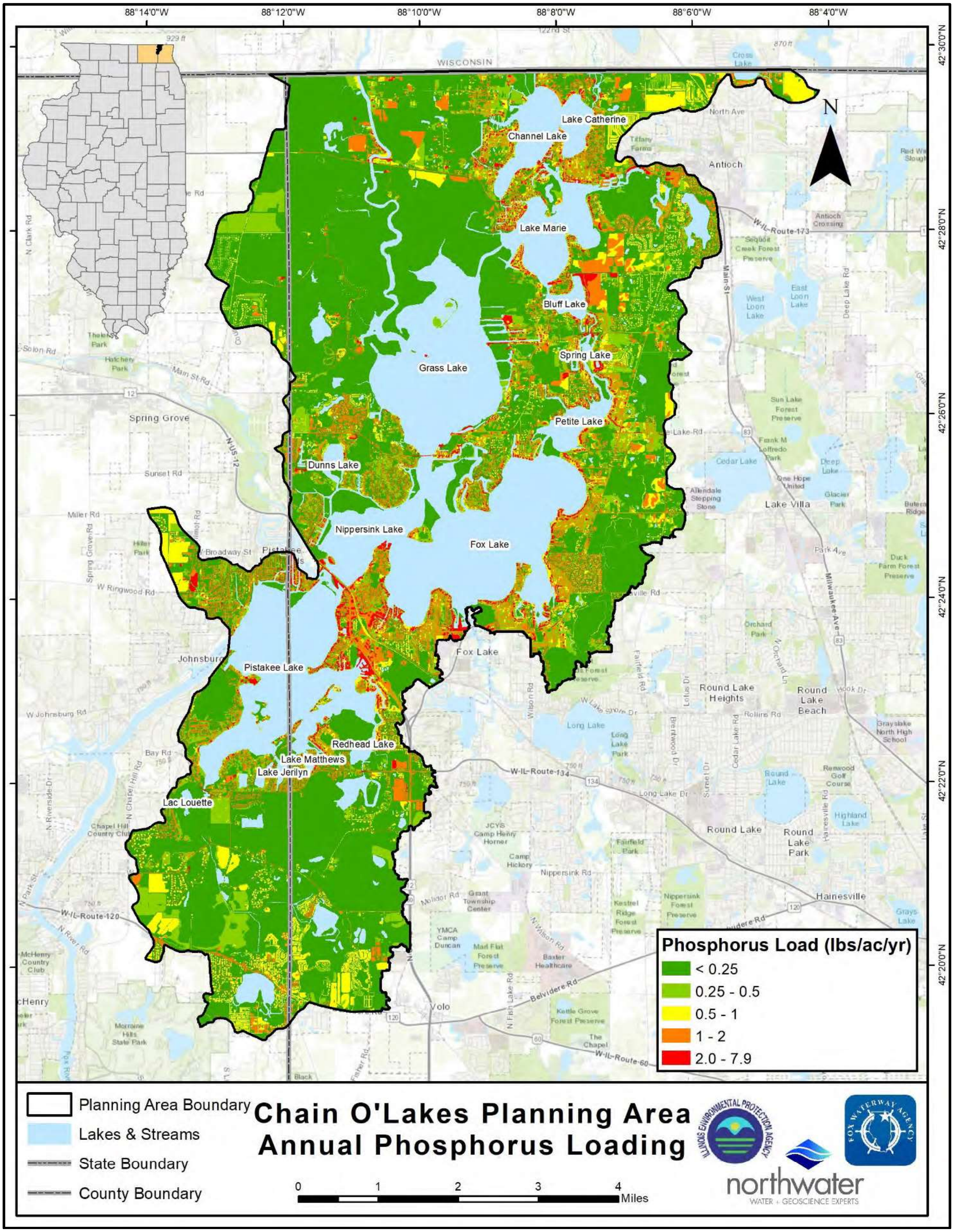


Figure 4-6: Estimated Annual NPS Total Phosphorus Loading

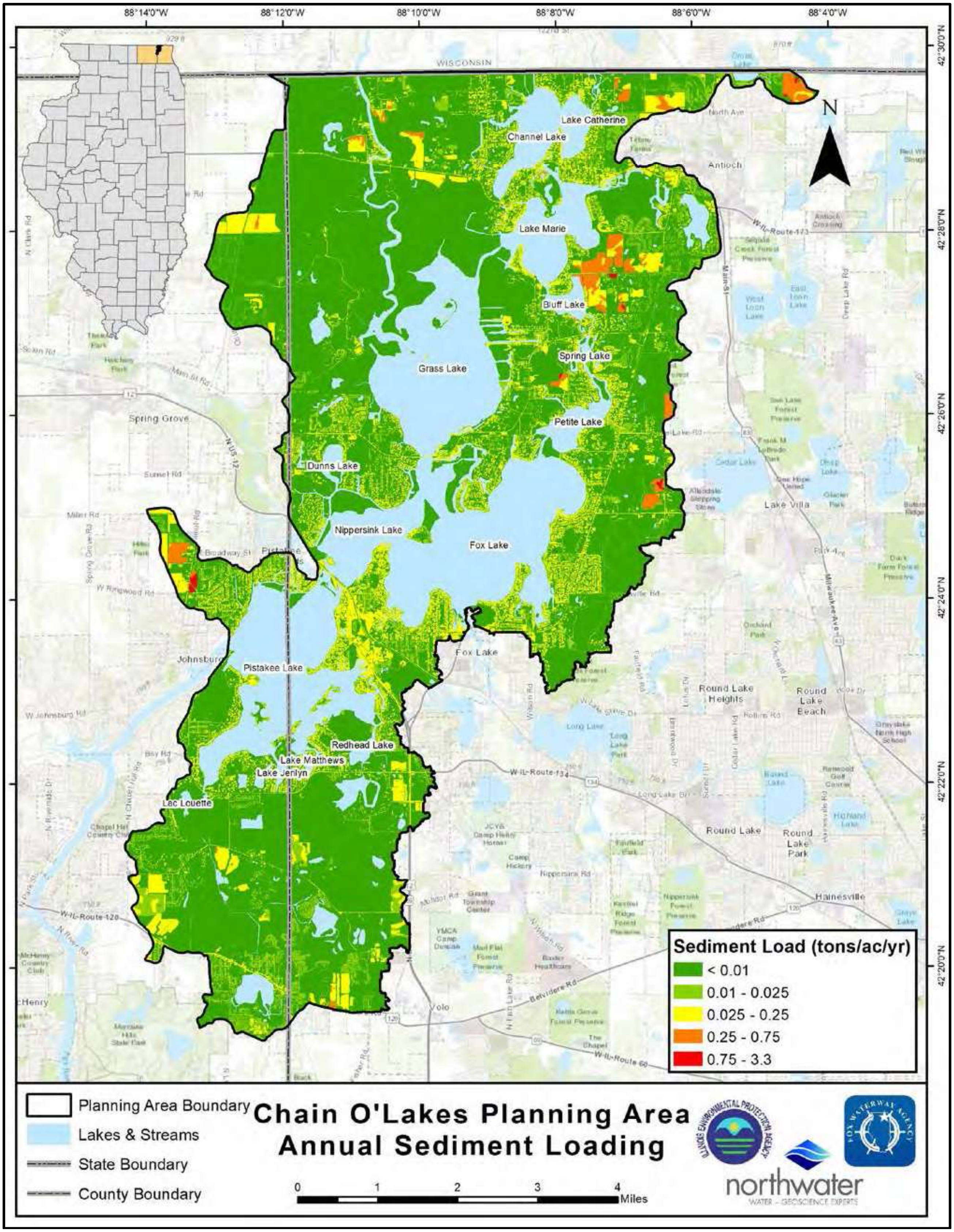


Figure 4-7: Estimated Annual NPS Total Sediment Loading

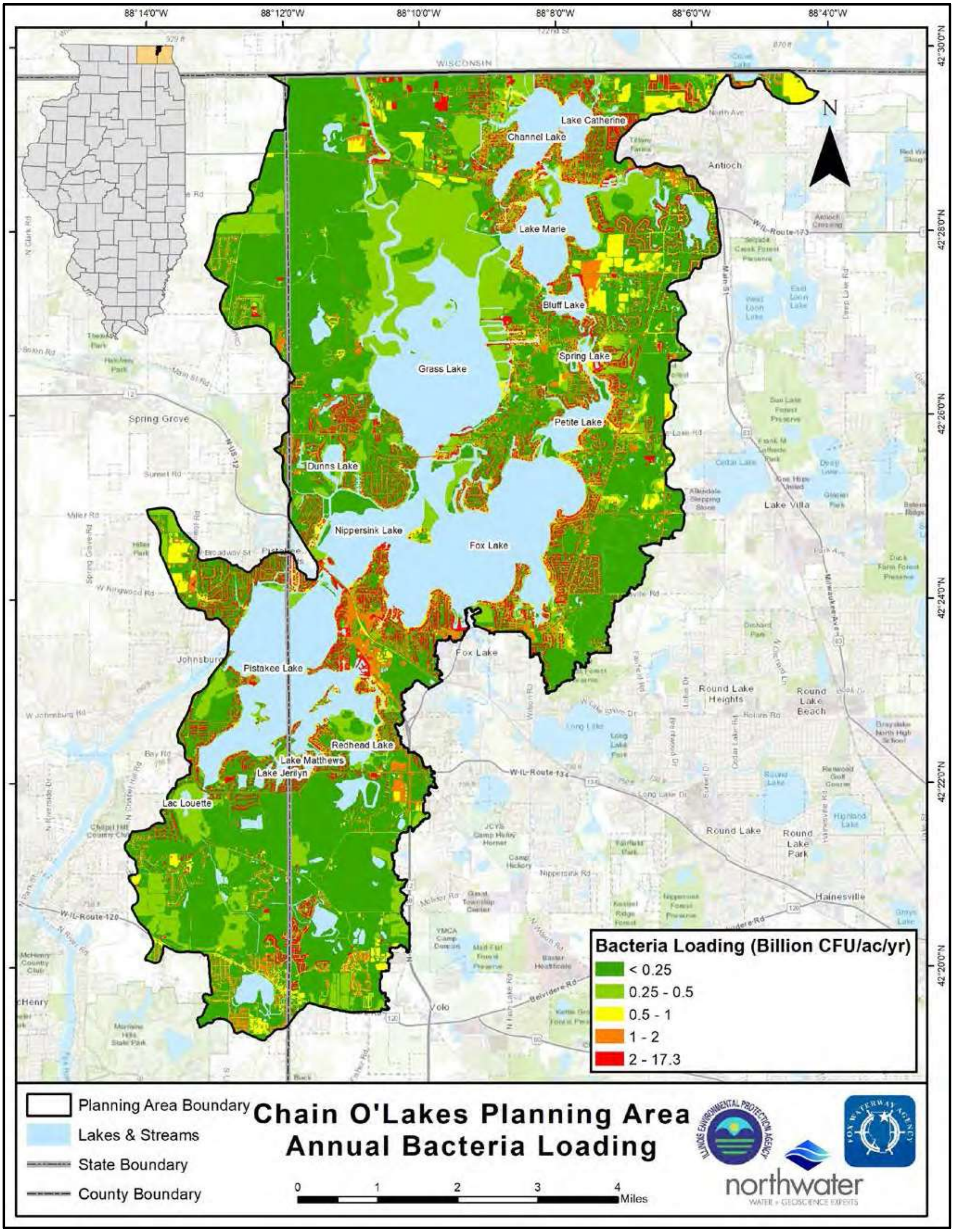


Figure 4-8. Estimated Annual Nonpoint Source Fecal Coliform Loading

4.2.4.3 *Source Analysis*

The NPS model does not directly account for internal lake nutrient release, potentially failing septic systems, or significant sources of streambank, lake shoreline, and gully erosion. Estimates for these sources were made based on information gathered during field assessments and inventories in 2022, and from existing datasets described in Chapter 3. This section breaks down each major source for the entire planning area and by subwatershed for those other than direct surface runoff.

Table 4-7 lists all sources and their annual loading and Table 4-8 lists them as a percentage of the total. Total annual nitrogen loading is greatest from direct runoff, or 159,997 lbs (48%), followed closely by shoreline erosion (43%). Gully erosion contributes the least nitrogen, or only 43 lbs/yr (0.01%). Internal lake loading, or the release of phosphorus from deposited and resuspended sediment, is responsible for the most phosphorus, or 23,399 lbs/yr (47%), followed by direct runoff from developed areas and potentially failing septic systems. Shoreline erosion in the Chain is contributing the most annual sediment at 5,867 tons, or 88% of the total, followed by agricultural land (4%). Approximately 98% of the bacteria is estimated to be originating from potentially failing septic systems.

Table 4-7: Pollutant Loading by Source

SOURCE	NITROGEN LOAD (LBS/YR)	PHOSPHORUS LOAD (LBS/YR)	SEDIMENT LOAD (TONS/YR)	BACTERIA LOAD (BILLION CFU/YR)
Agriculture	23,517	934	264	726
Developed/Impervious	45,186	5,790	155	9,884
Livestock/Equestrian	951	95	1.1	288
Natural/Urban Open Space	29,704	2,312	47	2,151
Resource Extraction	646	100	1.4	117
Water/Wetlands	59,994	3,120	21	8,465
Direct Runoff Subtotal	***159,997***	***12,352***	***490***	***21,632***
Lake Shoreline Erosion	143,947	4,537	5,867	N/A
Streambank Erosion	6,192	208	294	N/A
Gully Erosion	43	15	27	N/A
Potentially Failing Septic Systems	24,354	9,534	N/A	1,051,064
Internal Lake Loading	N/A	23,399	N/A	N/A
TOTAL:	**334,533**	**50,044**	**6,678**	**1,072,696**

Table 4-8: Pollutant Loading by Source as a Percentage of the Total Load

SOURCE	NITROGEN LOAD (% PLANNING AREA TOTAL)	PHOSPHORUS LOAD (% PLANNING AREA)	SEDIMENT LOAD (% PLANNING AREA)	BACTERIA LOAD (% PLANNING AREA)
Agriculture	7%	1.9%	4%	0.1%
Developed/Impervious	14%	12%	2.3%	0.9%
Livestock/Equestrian	0.3%	0.2%	0.02%	0.03%
Natural/Urban Open Space	8.9%	4.6%	0.7%	0.2%
Resource Extraction	0.2%	0.2%	0.02%	0.01%
Water/Wetlands	18%	6.2%	0.3%	0.8%
Direct Runoff Subtotal	***48%***	***25%***	***7.3%***	***2%***
Lake Shoreline Erosion	43%	9.1%	88%	N/A
Streambank Erosion	1.9%	0.4%	4.4%	N/A
Gully Erosion	0.01%	0.03%	0.4%	N/A
Septic Systems	7.3%	19%	N/A	98%
Internal Lake Loading	N/A	47%	N/A	N/A

4.2.4.3.1 Streambank Erosion

Table 4-9 summarizes streambank pollutant load estimates using data collected throughout the planning area and methods described in Chapter 3. It is estimated that at least 294 tons of sediment, 6,192 lbs of nitrogen, and 208 lbs of phosphorus are delivered to lakes in the Chain annually as the result of streambank erosion. The Bassett Creek subwatershed which includes the Fox River contributes over 75%, whereas Channel Lake contributes the least, or approximately 2%. Areas of significant streambank erosion were identified for further inclusion in the site-specific action plan (Chapter 5).

Table 4-9: Streambank Pollutant Loading Estimates

SUBWATERSHED	TOTAL NITROGEN (LBS/YR)	TOTAL PHOSPHORUS (LBS/YR)	TOTAL SEDIMENT (TONS/YR)	NOTES
Channel Lake	86	3.4	5.7	Nitrogen and phosphorus calculated from sediment totals
Bassett Creek	5,224	170	229	Nitrogen and phosphorus calculated from sediment totals
Nippersink Lake	552	22	37	Nitrogen and phosphorus calculated from sediment totals
Pistakee Lake	330	13	22	Nitrogen and phosphorus calculated from sediment totals
TOTAL:	**6,192**	**208**	**294**	

4.2.4.3.2 Gully Erosion

Contributions from gully erosion in the planning area are considered low. Noted in Chapter 3, only 3.7 miles were identified, 37% within forested areas and 31% from cropland. This source is responsible for delivering 27 tons/yr of sediment, 15 lbs/yr of phosphorus, and 43 lbs/yr of nitrogen to the Chain (Table 4-10). Despite only having 23% of the total planning area gully length, most is from the Channel Lake subwatershed, or 65% of the nitrogen, 55% of the phosphorus, and 51% of the sediment. Nippersink Lake has the greatest length (72% of the total) and is the second highest in terms of loading. No gullies were identified in Bassett Creek.

Table 4-10: Gully Pollutant Loading Estimates

SUBWATERSHED	GULLY LENGTH (FT)	TOTAL NITROGEN (LBS/YR)	TOTAL PHOSPHORUS (LBS/YR)	TOTAL SEDIMENT (TONS/YR)	NOTES
Channel Lake	4,605	28	8.3	13.8	Nitrogen and phosphorus calculated from sediment totals
Bassett Creek	0	0	0	0	Nitrogen and phosphorus calculated from sediment totals
Nippersink Lake	14,120	12	5.3	11.4	Nitrogen and phosphorus calculated from sediment totals
Pistakee Lake	920	3.2	1.7	2	Nitrogen and phosphorus calculated from sediment totals
TOTAL:	**19,645**	**43**	**15**	**27**	

4.2.4.3.3 Lake Shoreline Erosion

As detailed in Chapter 3, annual loading of sediment and nutrients from lake banks were estimated using a combination of field surveys and interpretation of historical imagery. Chapter 3 also summarizes methods and relative contributions by individual lake or waterbody in the planning area. Results presented in Table 4-11 below allocate loading by subwatershed.

Shoreline erosion is a major source of both sediment and nutrients. The Nippersink Lake subwatershed is responsible for almost 90% of all shoreline sediment, and associated nutrients. Channel Lake contributes the least amount, or less than 1%.

Table 4-11: Lake Shoreline Pollutant Loading Estimates

SUBWATERSHED	TOTAL NITROGEN (lbs/yr)	TOTAL PHOSPHORUS (lbs/yr)	TOTAL SEDIMENT (tons/yr)	NOTES
Channel Lake	111	5.9	12	Nitrogen and phosphorus calculated from sediment totals
Bassett Creek	109	11	27	Nitrogen and phosphorus calculated from sediment totals
Nippersink Lake	130,981	4,102	5,258	Nitrogen and phosphorus calculated from sediment totals
Pistakee Lake	12,746	418	570	Nitrogen and phosphorus calculated from sediment totals
TOTAL:	**143,947**	**4,537**	**5,867**	

4.2.4.3.4 Septic Systems

As detailed in Chapter 3, annual loading of nutrients from potentially failing systems was estimated by applying an 8.5% failure rate to the number of buildings believed to be on septic and in the planning area. It is possible that up to 754 systems could be failing and contributing 143,947 lbs of nitrogen, 4,537 lbs of phosphorus, and 1,051,064 billion CFU to the Chain each year (Table 4-12). The greatest number of systems and loading can be found in the Nippersink Lake subwatershed, followed by Pistakee Lake. Bassett Lake contains the least, or 435 septic systems.

Table 4-12: Potentially Failing Septic System Loading Estimates

SUBWATERSHED	TOTAL NITROGEN (LBS/YR)	TOTAL PHOSPHORUS (LBS/YR)	TOTAL BACTERIA (BILLION CFU/YR)	# SYSTEMS	# FAILING SYSTEMS
Bassett Creek	1,147	449	49,521	435	37
Channel Lake	3,280	1,284	141,545	1243	106
Nippersink Lake	10,433	4,084	450,252	3921	333
Pistakee Lake	9,494	3,717	409,746	3273	278
TOTAL:	**24,354**	**9,534**	**1,051,064**	**8,872**	**754**

4.2.4.3.5 Internal Lake Nutrient Release

Internal loading refers to nutrients that are released from sources within a water body, including previously deposited sediments. Phosphorus is highly associated with sediments and is typically chemically bound to particles. Internal phosphorus loading occurs when this nutrient is released from the sediment and becomes available in the water column. As the nutrient-rich sediments can release phosphorus many years after they are deposited on the lake bottom, this sediment-released nutrient pollution is often referred to as "legacy phosphorus." The nutrient becomes available through two main processes:

1. Released from nutrient rich sediments during anoxic (low oxygen) bottom water conditions that occur during seasonal stratification. This release is governed by temperature and several chemical reactions, and typically releases phosphorus at the highest rate per area in a lake system.
2. Phosphorus can be released from oxygenated sediments, though at a lower rate than during anoxic conditions, primarily through resuspension. However, resuspension of sediments into the water column by physical disturbance can increase the rate of release in oxygenated conditions.

The 2020 Fox Chain O' Lakes TMDL calculated internal release from 12 lakes in the chain at nearly 24,000 lbs/yr, a significant contributor to the TP load (Table 4-13).

Table 4-13 Estimate of Internal Phosphorus Loading Calculated by TMDL

SUBWATERSHED	TOTAL PHOSPHORUS (LBS/YR)	NUMBER OF LAKES	WATER SURFACE ACRES
Channel Lake	1,299	2	536
Nippersink Lake	21,899	8	5,224
Pistakee Lake	201	2	1,791
TOTAL:	**23,399**	**12**	**7,551**

4.3 WATERSHED JURISDICTIONAL COORDINATION

Watershed protection, which is a shared responsibility of multiple jurisdictions in the planning area, may be problematic because the jurisdictions operate with different policies, practices, and regulations, that is, management practices and development requirements related to land and water resources may vary from place to place. Requirements for and application of BMPs also vary based on local policies, standards, requirements, and incentives. Coordination and consistency of watershed management efforts by the multiple authorities and jurisdictions could (and should) be improved.

While public policies and regulations can significantly influence the prevention of further watershed degradation, private efforts need to be combined with public initiatives to address issues, such as poor water quality and degraded aquatic habitat. Private landowners and homeowner groups should voluntarily incorporate BMPs in the landscapes they manage to resolve existing watershed problems and improve conditions. Education and outreach can substantially influence voluntary participation in watershed improvement activities and improve the general public's understanding of the need for jurisdictional projects and programs. For more information on education and outreach strategies and tools, see Chapter 7, Education and Communication Strategy and Tools.

Considering the Chain O' Lakes planning area comprises multiple jurisdictions, lack of coordination is a primary limitation in adopting consistent preventative practices. The ability to coordinate also presents challenges in completing BMP projects or instituting programs and policies that may provide broad watershed benefits. The following section describes watershed jurisdictional coordination roles and responsibilities.

The planning process identified multiple issues that could be effectively addressed at the watershed level through a coordinated effort of jurisdictions, with the support of private stakeholders. Chapter 5 includes a series of tables that list issues, goals and actions and those responsible. Those with more than one responsible entity are best addressed through coordinated partnership efforts.

4.3.1 WATERSHED ROLES AND RESPONSIBILITIES

Watershed management is a shared responsibility of both public and private interests. Watershed protection provided by jurisdictional entities and private stakeholders comes in several forms: policy, regulation, planning, zoning, development and land management standards/incentives, education, outreach, and on-the-ground BMP projects.

Municipal, townships and county governments share the greatest responsibility for watershed protection because they influence and oversee development impacts to the watershed and, ultimately, the Chain through land use planning, land management and development policies, and regulatory oversight. Although the Fox Waterway Agency (FWA) is limited to activities within the waterway, they are responsible for working with other entities in the planning area to protect and enhance lake water quality and recreational access.

Transportation infrastructure improvements are necessary to accommodate business and population growth. The operation, maintenance, and construction of roadways can substantially influence water resources.

Roadways are constructed and maintained by multiple stakeholders, including townships, municipalities, counties, and the Illinois Department of Transportation (IDOT).

Other agencies and private entities with jurisdictional or potential coordination roles include the Illinois Department of Natural Resources (IDNR), the Lake County Forest Preserve District (LCFPD), the McHenry County Conservation District (MCCD), the Lake County Stormwater Management Commission (SMC), the Chicago Metropolitan Agency for Planning (CMAP), Soil and Water Conservation Districts (SWCDs), and the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS). A complete list is provided in Chapter 5.

The forest preserves and conservation districts provide important recreation opportunities and protect natural resources such as rare or high-quality habitat and threatened or endangered species. They protect and manage land that often contains wetlands, lakes, ponds, and streams. County SWCDs provide technical resource assistance to the public and other regulatory agencies, including soil erosion and sediment control inspections. The NRCS, SMC and CMAP may provide technical assistance and participate in educational outreach programs to watershed stakeholders. Local environmental groups, lake associations, watershed volunteers and the Lake County Health Department (LCHD) can coordinate on water quality monitoring.

Importantly, IDNR has regulatory and coordination roles in the planning area and is a major landowner. The IDNR Office of Water Resources issues permits for development within Lake Michigan and along the shoreline. The IDNR also manages the Chain O' Lakes State Park, Moraine Hills, Black Crowned Night Heron Marsh, and Volo Bog, covering more than 11,500 acres within the planning area.

Watershed development practices that affect water resources (rivers, streams, lakes, isolated wetlands, and floodplains) are largely regulated by the Stormwater Management Ordinance (SMO) in McHenry County and the Watershed Development Ordinance (WDO) in Lake County, along with county and municipal ordinances and land use plans. In addition to local regulations, the United States Army Corps of Engineers (USACE) regulates discharge of "fill" material into wetlands, and the IDNR has floodplain/floodway regulatory and oversight authority. The IDOT designs and constructs roadways in the watershed. State and federal projects are not required to meet local regulatory requirements but are governed by state and federal policies and regulations.

Also critical to future improvements in water quality is coordination with entities outside the planning area, from within Illinois and Wisconsin. For example, an expanded partnership with the Village of Antioch and their WWTP could help to address external loading from Sequoit Creek. Coordinating with the Wisconsin Department of Natural Resources (WDNR) and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) is a first step in managing contributions from the larger Fox River watershed.

4.3.1.1 *Chain O' Lakes Watershed Projects*

Projects to manage and improve conditions of water resources are encouraged and incentivized when local units of government adopt a watershed management plan. Plan adoption should be followed by close coordination and development of funding mechanisms, timelines, and shared responsibilities for implementing the projects prioritized by watershed planning efforts. Implementation of projects identified within the watershed-based plan requires partnerships between stakeholder groups, including homeowner associations, nonprofit organizations, businesses, schools, and community agencies, who must coordinate, fundraise, secure grants, and oversee project implementation. The experience and success that partnerships often gain from working together on a watershed project can improve regulatory efficiency and increase cooperation among policymakers.

The watershed action plan (Chapter 6) identifies lead and support roles for multiple units of government to assist private landowners and watershed groups. Specific types of aid that governments can provide to private landowners can include BMP project cost-share funding or technical assistance, particularly for studies or plans. Private entities as partners can also provide cost-share for design, consulting, and construction work for projects, and in-kind BMP services, such as seeding, planting, restoration work, trail construction, and interpretive education. Watershed projects benefit from partnerships that share design, permitting, material, and labor costs. Public/private partnerships are also important for securing state or federal funding for in-the-ground projects. Projects with shared costs and benefits often result in more successful outcomes because of the relationships built among partners who share a vested interest in the success of their projects. Partnership on a first project may establish an institutional relationship that results in implementation in the future.

4.4 REFERENCES

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ACRONYMS/ABBREVIATIONS USED IN CHAPTER 5

BMP – Best Management Practices
FWA – Fox Waterway Agency
TSS – Total Suspended Solids
USEPA – United States Environmental Protection Agency

Note: all other acronyms/abbreviations can be found in Table 5-1

5 PRIORITIZED ACTION PLAN SUMMARY

NOTEWORTHY – ACTION PLAN RECOMMENDATIONS

The action plan recommendations in this Prioritized Action Plan Summary are to be interpreted as guidance recommendations (projects) for watershed stakeholders and not a regulatory document.

A variety of Best Management Practices (BMPs) and programs are discussed in this plan as potential options for the mitigation of watershed issues in the Chain O' Lakes planning area. In this chapter, specific ***recommendations*** are made to meet the goals of the watershed plan, including the identification of specific locations for BMPs. This chapter presents specific recommended action items developed jointly by watershed stakeholders and the planning team to meet the goals of this watershed-based plan. Due to the sheer number of site-specific action recommendations developed during the planning process, readers of the plan are encouraged to use the ***online mapping application***. The critical implementation partners for the watershed are identified in Section 5.1.

There are two primary types of action plan recommendations presented in this chapter: 1) programmatic actions and 2) site-specific project actions, including critical areas. The action plan recommendations identify specific locations for projects and activities recommended for implementation at the watershed-scale.

1. "Programmatic Basin-Wide Actions" represent program, policy, regulatory, and project actions that are applicable throughout the watershed. The actions are based on achieving the goals and objectives of the watershed-based plan as outlined in **Chapter 2**.
2. "Site-Specific Actions" address location-specific project opportunities or issues that have been identified. Projects were identified through the lake and watershed inventories, local stakeholders and agency staff, and the planning team. Some were also identified using existing map data and have not been field verified, however, they do represent actual locations where recommended BMPs are applicable. Overall, these site-specific actions are the result of watershed assessment activities, a detailed analysis of existing watershed data, and stakeholder input.
3. "Site-Specific Critical Area Actions" are practices that should be prioritized and will provide the greatest "bang-for-the-buck" and benefits to water quality. Critical areas focus on maximizing reductions in sediment and nutrients.

SITE-SPECIFIC ACTION PLAN ONLINE MAPPING APPLICATION

An online mapping application was developed for stakeholders to view the action recommendations from this plan. Because the planning area covers 51 square miles and there are thousands of individual action recommendations across numerous jurisdictions, it is likely easier for plan users to navigate to their individual areas of interest or browse areas they are familiar with for certain types of project recommendations. Maps are provided in this plan but due to the scale of the planning area, most users will likely find more utility in the online application, which can be accessed at: https://lakecountyil.maps.arcgis.com/apps/webappviewer/index.html?id=20c7a25b4c844f21b8127637030252c7

For each of the five watershed goals identified in **Chapter 2**, there is a table that describes each recommended action including its 1) priority, 2) cost estimate (if applicable), 3) lead partners and support partners (if applicable) and 4) recommended implementation timeframe.

1. Priority was assigned to each of the recommended actions and classified as H (high), M (medium) or L (low). Priority was based on multiple factors including lead partners, land ownership, cost, and technical requirements based on circumstances and conditions observed at the time the plan was written. These circumstances and conditions will likely change over time resulting in changes to the priority of projects. This watershed-based plan is considered a living document that can be updated and adapted as conditions and priorities change.
2. Cost estimates are provided only for site-specific actions, such as shoreline stabilization, retrofitting detention basins, etc. Cost estimates are not provided for preventative measures such as education and regulatory action. Cost estimates should not be considered price quotes but used as a way to compare the relative expenditures of proposed treatments. Furthermore, BMP implementation projects vary drastically by specific technique employed, size of area, access to location, property values, and other factors.
3. Lead and support partners are those organizations or agencies that have the greatest potential to implement each recommended action.
4. Timeframe refers to the period of time in which the recommended action could be implemented. Timeframe is classified into three categories including:
   - S (Short = 1-5 years)
   - M (Medium = 6-10 years)
   - L (Long = 10+ years)

Chapter 6 outlines an implementation and evaluation strategy for the action plan, and **Chapter 7** identifies outreach and education strategies and tools that will provide watershed stakeholders with the knowledge and skills necessary to implement the watershed-based plan.

5.1 IMPLEMENTATION PARTNERS

Throughout the prioritized action plan tables and narrative, responsible parties are suggested for taking the lead partner role or providing a supporting partner role in plan implementation. This section presents the responsible parties, as well as a brief description of their role. Table 5-1 provides a concise reference or key of implementation partners for reviewing the programmatic and site-specific action plan tables that follow. Implementation partners do not necessarily have the resources to complete a recommendation, but these recommendations can be implemented through coordination with other partners, grant funding, and more.

LEAD PARTNERS: Identify the lead public or private landowner, agency or other stakeholder with the greatest potential to implement the action.

SUPPORT PARTNERS: Include parties that could be involved in assisting in the action implementation related to regulation, permitting, coordination, technical needs and funding assistance.

Table 5-1: Planning Area Implementation Partners

ACRONYM	RESPONSIBLE PARTY	GENERAL RESPONSIBILITY
AG	Agricultural Producers	Management and operation of cropped and other agricultural lands.
C	Counties	Land use and development, technical and financial support, and drainage system management.
CBL	Corporate and Business Landowners	Grounds management and maintenance. Implementation and maintenance of stormwater BMPs.
MCHD	McHenry County Health Department	Permit well and private sewage disposal systems (septic systems) in McHenry County. Regularly inspect, monitor, regulate, educate, and advise the public on environmental health concerns that adversely impact human health.
CMAP	Chicago Metropolitan Agency for Planning	Technical, planning, training, and funding assistance.
DH	Developers and Homebuilders	Land development, stormwater management system design and construction.
DOT	Departments/Divisions of Transportation	Maintain, design, and construct transportation infrastructure in the watershed including stream, lake, and wetland crossings. *Includes State, County, Municipal and Township Highway and Streets Departments.
EIG	Environmental Interest Groups	Advocate group positions on topics including environmental and land management, i.e. Sierra Club, Environmental Defenders of McHenry County, Openlands, Lake County Preservation Foundation, etc.
EO	Elected Officials	Decision-making authority for county policies and ordinances
EXT	County Extension Services	Provides education and technical support. *Includes University of Illinois Extension.
FB	Farm Bureaus	Promotes farming practices that promote environmental stewardship. *Includes McHenry and Lake County Farm Bureaus.
FEMA	Federal Emergency Management Agency	National Flood Insurance Program, floodplain mapping and enforcement, and mitigation funding.
FFR	Friends of the Fox River	Friends of the Fox River is a nonprofit organization made up of citizens and organizations taking action to protect and maintain the quality of the Fox River and its tributaries
FPD	Forest Preserve District	Manage and maintain green infrastructure, natural areas, and open space. Includes McHenry and Lake County Forest Preserve Districts.
FCCL	Friends of Catherine and Channel Lakes'	Maintain the quality of Lake Catherine and Channel Lakes, to improve and maintain the lakes' ecosystem, and to establish and implement value-enriched programs to enhance the overall quality of lake life
FRSG	Fox River Study Group	A diverse coalition of stakeholders using science to guide the region toward a cleaner, safer and more beautiful Fox River. They use research, data and collaboration to support sustainable policies and development across the Fox River watershed.
FWA	Fox Waterway Agency	Improve and maintain the Fox River and Chain O' Lakes public waterway for recreational uses, restore environmental quality, minimize flooding through BMPs, promote tourism, and enhance the quality of life along the waterway.
HOA	Homeowners Associations (including Property Owners Associations)	Management of common areas and natural and constructed drainage systems.
IDNR	Illinois Department of Natural Resources	Natural area preservation and management, research, technical, and financial assistance.

ACRONYM	RESPONSIBLE PARTY	GENERAL RESPONSIBILITY
Illinois EPA	Illinois Environmental Protection Agency	Water resource monitoring, pollution regulation and control, technical assistance and project funding.
ISGS/USGS	Illinois State Geological Survey & United States Geological Survey	Gather and manage geologic and water quality data.
ISWS	Illinois State Water Survey	Monitoring, flood risk modeling and floodplain mapping
LCLC	Land Conservancy of Lake County	A non-profit organization with a shared vision to help maintain and restore the local wild lands of Lake County, IL. They preserve, conserve, and manage open lands, natural areas, and ecosystems through full or partial interest in real property. They are a land trust that provides tax relief to landowners and developers who donate natural areas of easements.
LCHD	Lake County Health Department	Monitor, manage, and provide technical support for water resources. Includes environmental services unit. Permit well and private sewage disposal systems (septic systems) in Lake County.
LCPW	Lake County Public Works Department	Manages water and wastewater facilities in Lake County.
LCPF	Lake County Preservation Foundation	The Charitable partner of the Lake County Forest Preserves. As an independent 501c3 charity, the Preservation Foundation accepts gifts at every level to help the Forest Preserves do more
M	Municipalities	Land use and development, technical and financial support, and drainage system management.
MCCD	McHenry County Conservation District	Manage and maintain green infrastructure, natural areas, and open space in McHenry County.
MCCF	McHenry County Conservation Foundation	The McHenry County Conservation Foundation supports, sustains, and advances the public conservation, education, and recreation programs of the McHenry County Conservation District and its partners
MA	Marinas	Management of marinas, boat storage yards and other commercial activities in the Chain O' Lakes.
NRCS/SWCD	Natural Resources Conservation Service Soil and Water Conservation District	Provide technical and financial assistance for natural resource management. Includes McHenry-Lake SWCD.
N/L	Nursery and Landscaping Business	Grow and maintain landscaping plant materials. This includes irrigation or watering and storage of equipment and materials.
PB&D	County Planning, Building, and Development (includes McHenry and Lake Counties)	Land use planning and permitting for unincorporated areas, natural resources and system management.
PC	Snow Removal and Deicing Private Contractors & Consultants	Land and pavement management and maintenance for snow removal and deicing.
SEWRPC	Southeastern Wisconsin Regional Planning Commission	Provides objective information and professional planning initiatives to help solve problems and to focus regional attention on key issues of regional consequence within the 7 covered counties in Wisconsin.
SEWFRC	Southeast Wisconsin Fox River Commission	The area of jurisdiction for the SEWFRC consists of the tributary drainage area to the 63.5-mile-long reach of the Fox River between the Illinois border and the northern limits of the City of Waukesha. SEWFRC conducts surveys and research.

ACRONYM	RESPONSIBLE PARTY	GENERAL RESPONSIBILITY
PO	Property Owner	The owner on record for a particular tax parcel.
RR	Railroad	Land management in railroad right-of-way.
SI	Schools and Institutions	Schools and institutions with large properties or campus settings.
SMC	Lake County Stormwater Management Commission	Technical and financial assistance for flooding, watershed planning, and water quality. Administers the Watershed Development Ordinance in Lake County.
T	Townships	Road maintenance and support for watershed improvement projects.
USACE	U.S. Army Corps of Engineers	Wetland protection and regulation and restoration funding.
USFWS	U.S. Fish and Wildlife Service	Threatened and endangered species protection, technical and financial assistance for habitat restoration.
WDNR	Wisconsin Department of Natural Resources	Charged with conserving and managing Wisconsin's natural resources. The Wisconsin Natural Resources Board has the authority to set policy for the WDNR
WPC	Watershed Planning Committee(s)	Coordinate watershed plan implementation, education and outreach. Planning and support for watershed improvement projects.
WWTP	Wastewater Treatment Plants	Maintain wastewater treatment regulatory standards. *Includes privately and publicly owned treatment works

5.2 PROGRAMMATIC ACTION PLAN (BASIN-WIDE)

5.2.1 GOAL #1, #2, AND #3

GOAL 1: Our water is clear enough that you can see the bottom in shallow water. **GOAL 2:** Our water is free of excessive nutrients, so algae growth does not turn our water green. **GOAL 3:** Our water is clean enough that there are no recreational restrictions for boating, swimming and fishing.

OUTCOMES: 1) Increased water clarity is indicated by reduced turbidity and suspended solids 2) Eliminate harmful algae blooms from the Chain O' Lakes 3) Eliminate beach closures from the Chain O' Lakes.

Table 5-2: Actions for Goal #1

ACTION #	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS	TIME FRAME
1	Implement lake-specific recommendations listed in 2014-2015 summary reports developed by the LCHD: Dunns Lake, Bluff Lake, Cross Lake, Channel Lake, Fox Lake, Nippersink Lake, Grass Lake, Lake Marie, Lake Matthews, Petite Lake, Pistakee Lake, Antioch Lake, Redhead Lake, and Spring Lake.	H	FCCL, HOA, PO	FWA, EIG, LCHD, WPC	L
2	Evaluate, preserve, and enhance the stormwater storage functions of existing depressional, floodplain, and riparian areas in open and undeveloped parcels.	M	M, C, T, SMC, LCPF, FPD, PO, MCCF, LCLC, DOT	IDNR, WPC, PB&D, CMAP, FEMA, EIG	L
3	Expand sediment removal in the Chain O' Lakes and pursue large-scale partnerships with businesses and landowners for the beneficial re-use of dredged material.	H	CBL, FWA, PO, IDNR	WPC, USACE, M, C, T	L
4	Encourage wet or wetland detention basins for new development and retrofit existing dry basins to these types, where feasible.	M	PB&D, M, C, T, CBL, HOA, DOT	SMC, CMAP, DH	M
5	Install porous or permeable surfaces in parking areas.	H	PO, CBL, SI, M, PD, DH, MA	SMC, FWA, PB&D, M	M
6	Reduce construction-related erosion.	L	M, PO, PD, FPD, HOA	Illinois EPA, SMC, IDNR, DOT, PB&D, USACE, NRCS/SWCD	M
7	Design and install stormwater BMPs to capture stormwater runoff from roads, parking lots, and other transportation infrastructure.	H	CBL, DOT, M, C, T, DH, SI	SMC, Illinois EPA, FWA, HOA	M
8	Eliminate yard waste dumping along lake shorelines and streambanks.	H	PO, CBL, HOA, SI, FWA, EIG, FCCL	M, PB&D, FPD, WPC, N/L	M

ACTION #	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS	TIME FRAME
9	Develop aquatic plant management plans for lakes that target the reduction of invasive species, promotes native plant diversity and recreational use. Conduct vegetation management based on plan recommendations.	M	FCCL, IDNR, LCHD, FWA	Illinois EPA, FPD, USACE, USFWS, IDNR, WPC	M
10	Reduce the potential for internal lake nutrient release and resulting algal growth using aeration and other techniques, where applicable. Priority should be given to Lake Catherine and Channel Lake.	H	FCCL, PO, EIG	WPC, FWA	M
11	Reduce the rate and volume of stormwater runoff from existing or new development by minimizing impervious cover and implementing green infrastructure practices.	H	PO, DH, CBL, M, PB&D, HOA, SI, LCPW, DOT	SMC, FWA, T, CMAP	M
12	Preserve, restore, and create wetlands in the planning area, wherever feasible.	L	SMC, PB&D, Illinois EPA, M, T, IDNR, FPD, MCCD, USACE	EO, CMAP, EIG, LCPF, MCCF, LCLC, FWA	L
13	Identify potential wetland mitigation banking sites in the watershed and encourage private and/or public investment for in-watershed mitigation.	L	SMC, FPD, LCPF, MCCF, LCLC, USACE, PB&D	M, C, T, CMAP, IDNR	L
14	Identify and preserve natural areas that provide important ecological, environmental education, and recreational opportunities.	L	FPD, MCCD, CMAP, SI, M, T, SMC, IDNR	Illinois EPA, LCPF, MCCF, LCLC, WPC	L
15	Incorporate naturalized stream restoration as part of new developments, where applicable.	M	DH, HOA	SMC, CMAP, M, C, PB&D, EO	L
16	Pass ordinances that restrict the use of lawn fertilizer with phosphorus.	M	M, T, C, EO, HOA	PB&D, Illinois EPA, CMAP, FWA, LCHD, SMC, WPC, N/L	S
17	Maintain, expand, or restore high quality native plant buffers along river, streams, lakes, and wetlands.	M	CBL, HOA, SMC, FPD, MCCD, IDNR, PO, AG, EIG, FCCL	USACE, NRCS/SWCD, CMAP, USFWS, PO, FWA, WPC	L
18	Install bioretention BMPs to capture rooftop runoff.	M	DH, CBL, C, M, SI, T, PO	SMC, PB&D, Illinois EPA, FWA, WPC	M
19	Support efforts by Lake County and others to add 3 new sewer service areas in the planning area. This has the potential to connect up to 4,300 homes currently using septic systems.	H	LCHD, MCHD, T, M, C, WWTP, EO, LCHD	FWA, WPC, SMC, CMAP, PO, EIG	L

ACTION #	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS	TIME FRAME
20	Install stormwater green infrastructure BMPs in new or existing developed areas with a focus on those along or within close proximity to a lake or stream. This includes practices such as bioswales, rain barrels and rain gardens, permeable pavement, infiltration basins, and naturalized detention basins.	H	DH, PO, CBL, M, C, HOA, FCCL, SI	FWA, WPC, PB&D, CMAP	M
21	Remove invasive species.	M	PO, FPD, LCPF, MCCD, MCCF, LCLC, IDNR, PO, CBL, DOT, HOA, SI, EIG	FWA, SMC, CMAP, WPC, Illinois EPA	L
22	Stabilize eroding shoreline and streambanks.	H	PO, M, T, FPD, IDNR	USACE, FWA, WPC, SMC,	M
23	Manage goose and other nuisance wildlife populations along lake banks, primarily in public parks and beaches.	L	IDNR, HOA, PO, M, T, FPD	FWA, WPC, FCCL, EIG	S
24	Expand funding opportunities, including alternative funding mechanisms, technical assistance, and maintenance resources for improving stormwater green infrastructure and best management practices.	H	CMAP, IDNR, USFWS, Illinois EPA, FEMA, FWA	FPD, WPC, SMC, WWTP, EIG, M, T	L
25	Where feasible, retrofit existing swales and open drainage-ways to infiltrate runoff with natural landscaping.	L	PO, HOA, CBL, DOT, AG, RR, SI	DH, SMC, Illinois EPA, NRCS/SWCD	M
26	Marina operators participate and maintain certification in the Clean Marina Program.	L	MA	FWA, WPC	L
27	Incorporate watershed plan recommendations into community and county comprehensive land use plans.	H	M, C, PB&D, CMAP, FPD, LCPF, MCCF, LCLC, T	SMC, WPC, IDNR, FWA, DOT	S
28	Seek funding to update expired watershed-based plans for the Sequoit Creek and Manitou Creek drainages.	M	T, M, CMAP	SMC, FWA, EO, EIG, WPC	S
29	Seek funding to create watershed-based plans for those HUC12 subwatersheds without a current, approved 9-element plan along the Fox River downstream of Pistakee Lake.	L	FWA, FRSG	SMC, FWA, EO, EIG, IDNR, WPC	L
30	Develop treatment wetlands on lower Sequoit Creek to filter Wastewater Treatment Plant Discharge from Antioch.	M	T, M, WWTP	USACE, USFWS, FWA, SMC	M
31	Coordinate with entities in Wisconsin to develop collaborative projects that address sediment and nutrient loading from outside the planning area.	M	WDNR, SEWFRC, SEWRPC	FWA, FRSG, WPC, SMC, CMAP	L

5.2.2 Goal #4

GOAL: Our community and stakeholders are knowledgeable and engaged in the preservation of our watershed.

OUTCOME: There is an active watershed group driving education and clean up and advocating for policies and projects in the watershed.

Table 5-3: Actions for Goal #4

ACTION #	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS	TIME FRAME
1	Provide information and training to riparian landowners on best practices for stream and lake shoreline restoration and maintenance that will reduce erosion and increase water quality.	H	WPC, FWA, NRCS/SWCD, FB, LCHD, HOA, FCCL, EIG	SMC, M, C, T, FPD, CMAP, FRSG, NL	S
2	Promote installation of property level green infrastructure projects such as rain gardens, bioswales, vegetative buffers, etc. to reduce stormwater runoff and gully formation through public informational meetings and web site-based resources.	M	FWA, WPC, EIG, FCCL	IDNR, FPD, FFR, FRSG, FB, NRCS/SWCD, SMC, CMAP, SEWRPC	S
3	Forward activities and plan implementation through the hire of a watershed coordinator. Responsibilities to include outreach and education, coordinating volunteers, supporting WPC, stakeholder engagement, and grant applications.	H	WPC, FWA	Illinois EPA, SMC, M, T, C, FPD, CMAP, IDNR, FCCL	S
4	Establish a formal "volunteer team" to support education and outreach.	M	WPC, FWA	Illinois EPA, SMC, M, T, C, FPD, CMAP, IDNR, FCCL	M
5	Issue a press release about the watershed plan upon approval by Illinois EPA in McHenry and Lake Counties.	H	WPC, FWA	M, T, C, FPD, CMAP, SMC, IDNR, FFR, FRSG, FCCL	S
6	Offer meetings with local stakeholders about the watershed upon approval by Illinois EPA in McHenry and Lake Counties.	M	WPC, FWA	M, T, C, FPD, CMAP, SMC, IDNR, FFR, FRSG	S
7	Solicit local governmental bodies and nongovernmental organizations to promote the use of phosphorus-free lawn fertilizers by homeowners and other private individuals who maintain their lawns.	M	M, T, C, EO, FWA, EIG	WPC, HOA, DH, PO, N/L, CMAP, SMC, FCCL	M
8	Conduct a watershed outreach campaign to inform and engage the public about watershed issues, landowner responsibilities, available resources and the benefits of implementing the watershed plan.	H	WPC, FWA	SMC, CMAP, LCHD, HOA, M, C, T, EIG	S
9	Implement the Education and Communication strategy through the Planning Committee which will meet 6 times per year.	H	WPC	FWA, All Partners	S

ACTION #	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS	TIME FRAME
10	Provide education and outreach to homeowners with septic systems on proper maintenance and potential impacts to the Chain O' Lakes.	H	WPC, FWA, EIG, FCCL, LCHD, MCHD	LCHD, M, T, C, HOA, Illinois EPA, CMAP, SMC, CBL, DH, LCPW	S
11	Encourage homeowner association participation in watershed implementation by providing them with information on funding opportunities and support for project development.	M	WPC, FWA, SMC, FCCL	M, T, C, CMAP, EIG, CBL	M
12	Provide information and referrals to municipalities and private property owners and managers who retain contractors for salt applicators and snow removal to encourage lower application rates and limit unnecessary salt applications.	L	M, T, C, PC	CBL, DH, FFR, FRSG, FWA, SMC, EIG	L
13	Promote the Izaak Walton League Salt Watch Program as a mechanism to educate private homeowners and businesses on how to reduce winter salt usage.	L	WPC, FWA, EIG	DOT, DH, SMC, CMAP, PO, HOA	L
14	Build on cross-coordination between agencies, units of government, organizations and the public for assistance in implementation of goals and objectives and to provide the necessary tools to become watershed stewards to help implement the watershed plan.	M	M, T, C, FWA, WPC, EO	All Partners	M
15	Developing a marketing plan through which direct involvement of the public in watershed improvement activities can be promoted.	L	FWA, WPC	All Partners	M
16	Develop a cleanup contest or other initiative to encourage area cleanup of manmade debris.	L	EIG, WPC, FCCL	FWA, FFR, FRSG, SMC, CMAP, LCHD, Illinois EPA, M, T	L
17	Increase the amount of watershed-related informational signage on the watershed.	L	WPC, FWA, FCCL, MA	FFR, FRSG, EIG, FPD, MCCD, LCLC, LCPF, MCCF, EXT	L
18	Develop an educational program for homeowners on how to implement small-scale dredging projects.	H	FWA, WPC, USACE	ISGS/USGS, CBL, Illinois EPA, SMC	S
19	Educate landowners along lake and streams regarding the negative impacts of yard waste dumping	M	EIG, LCLC, WPC	FWA, SMC, M, C, CBL, PB&D, T, N/L, EXT, FB	M
20	Offer and provide technical assistance to the public and local government for funding and cost-share opportunities and support with project development to implement the watershed plan.	M	WPC, FWA, SMC, NRCS/SWCD, CMAP,	LCHD, M, Illinois EPA, T, C, EIG	L
21	Provide watershed residents with a 5 and 10-year report card that reports progress towards watershed goals, specifically, water quality.	H	WPC, FWA	All Partners	M

ACTION #	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS	TIME FRAME
22	Support and promote programs such as Conservation@Home and Rain Ready to reduce stormwater runoff, protect their property from flooding, and protect natural resources.	L	WPC, FPD, NRCS/SWCD, EIG	SMC, FWA, CMAP, EXT, FB	M
23	Facilitate public training and engage the public, schools, youth groups, and HOAs to volunteer for stream, beach and natural area stewardship and maintenance.	L	WPC, HOA, LCHD, SI, CMAP	SMC, Illinois EPA, EXT, FWA, LS, T, FFR, FB, LCPF, MCCF, LCLC	M
24	Promote the removal of invasive plants by providing trainings aimed at species identification/control.	L	SI, EXT, EIG, HOA, USWS, FCCL	LCHD, SMC, CMAP, N/L, WPC, FPD, FWA, LCPF, MCCF, LCLC	S
25	Establish and publish watershed-wide recommended guidance for winter de-icing BMPs, including road salt application rates and alternatives.	L	DOT, SI, LCHD, M, T, SMC	Illinois EPA, PC, WPC, IDNR, PB&D, CMAP, CBL	L
26	Incorporate watershed signage and information at public properties, such as forest preserves, public parks, and public lake boating areas.	L	M, C, T, MA	SMC, FWA, FPD, WPC, LCPF, MCCF, LCLC, LCHD, SI	L
27	Promote invasive species awareness at public boat launches regarding boat transport, live-well water, and use of live bait.	L	FWA, IDNR, MA	M, FPD, HOA, WPC, EIG	S

5.2.3 Goal #5

GOAL: Our communities have land within the watershed so activities to monitor, maintain and improve water quality can be implemented.

OUTCOME: Water quality in the Chain makes for an appealing destination.

Table 5-4: Actions for Goal #5

ACTION #	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS	TIME FRAME
1	Develop and implement a more robust watershed monitoring program and plan to collect, assess and report physical, chemical, and biological water quality data on lakes and streams on a regular basis. Ensure more regular and expanded monitoring of bacteria is included.	H	FWA, WPC, LCHD, ISWS, ISGS/USGS, EIG, FCCL	Illinois EPA, FPD, IDNR, SMC, FWA, FFR, FRSG, CMAP, FFR, FRSG	S
2	Continue to support (and improve) LCHD and Illinois EPA's Volunteer Lake Monitoring Programs, as applicable to inland lakes in the planning area.	M	LCHD, IDNR, Illinois EPA, WPC, EIG, FCCL	FWA, SMC, M, SI, CMAP	S
3	Continue to conduct intensive basin surveys for Illinois Integrated Water Quality Report on five-year rotational basis.	M	Illinois EPA, IDNR	LCHD, SMC, WPC	M
4	Conduct regular bathymetric mapping of the Chain O' Lakes to monitor sediment accumulation.	L	FWA, IDNR, FCCL	FRSG, FFR, WPC	L
5	Conduct a monitoring study specifically to determine the impact of septic leachate on Chain O' Lakes water quality.	L	EIG, FCCL, FWA, LCHD	WPC, IDNR, USGS, ISWS, Illinois EPA, FRSG, M, T, SMC, CMAP	L
6	Promote the use of the USEPA's How's My Watershed website to planning area residents and stakeholders.	L	WPC, FWA, EIG	FCCL, Illinois EPA, IDNR, CMAP, SMC, HOA	L
7	Conduct routine septic evaluations and repairs. Conduct testing of septic system for bacteria and nutrients at least once per year and compare to county standards.	H	LCHD, LCHD, MCHD, HOA	FWA, FCCL, WPC, EIG, PO	M
8	Watershed committee annually assesses progress on plan implementation and updates the watershed-based plan no less frequently than every 10 years.	H	WPC	Illinois EPA, FWA, IDNR, M, T, FPD	L

5.2.4 Regulatory and Policy Programmatic Actions

This watershed-based plan does not include land use recommendations because land use planning and development decisions are the right and responsibility of municipalities, townships and counties. It does consider the health of area lakes, streams, and wetlands, which is a direct reflection of land use and management. Therefore, municipal, township and county consideration of land management and development impacts is necessary for effective watershed planning. Modifications and changes to local regulations and policy can have a significant influence on improving the ecological, environmental, safety and economic conditions. Design standards, ordinances, codes, and other regulatory tools are key mechanisms for implementing a vision that will prevail into the future. The way that many codes and ordinances are written may encourage or require design approaches that unintentionally neglect preserving and enhancing watershed health. Local regulating entities are encouraged to provide incentives for design approaches, development and redevelopment standards, codes and ordinances that allow innovative watershed development that reduces flood damage, improves water quality and preserves or includes green infrastructure.

Recommended opportunities for policy and regulatory review and modification are based on stakeholder input during planning meetings and specific issues identified through the watershed assessment process. Some key issues to be addressed by regulatory/policy actions detailed in Table 5-5 and opportunities include:

Development and Stormwater Runoff – local land development standards should:

1. Allow, incentivize, and/or credit Low Impact Development standards/practices, infiltration BMPs, and maintaining pre-development hydrology.
2. Offset the impact of future impervious cover to ensure that additional impervious cover does not degrade water quality.
3. Reduce the rate and volume of stormwater runoff from areas that are already developed.
4. Protect land from activities that cause or exacerbate erosion.

Pollution Prevention

1. Reduce the quantity of road salt (sodium chloride) needed for safe and cost-effective winter maintenance to reverse the current trend of rising chloride levels in water bodies. Adopt standards for the use of deicing chemicals/practices.
2. Regulate and limit the use of lawn chemicals, such as fertilizers and pesticides, and tar for seal coating asphalt surfaces.
3. Reduce phosphorus loads by watershed municipalities, townships and counties by passing an ordinance that bans the use of fertilizer with phosphorus unless a soil test indicates it is needed.

Wetlands and Floodplains

1. Maintain riparian and depressional floodplain and wetlands to maximize flood storage and conveyance.
2. Restore and create wetlands where feasible.

Open Space and Natural Areas

1. Identify and preserve open space as green infrastructure or greenways to promote flood damage reduction, water quality improvement, natural resource protection, and wetland restoration.

Table 5-5 lists regulatory/policy actions, priority, lead and supporting partners most relevant to the planning area.

Table 5-5: Regulatory/Policy Action Recommendations

ID	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS
RP-1	Review and modify land and transportation development standards, practices, codes and ordinances for new development and redevelopment to allow and incentivize Low Impact Development design and green infrastructure practices to reduce runoff volumes and rates and mitigate water quality impacts.	M	M, T, PB&D, DOT	SMC, CMAP, Illinois EPA
RP-2	Develop a blanket shoreline restoration permit for property owners	H	FWA, USACE	WPC, SMC, Illinois EPA, IDNR, FEMA
RP-3	Require downspout and sump pump discharges be disconnected from the storm sewer system and be directed to rain gardens, lawns, drywells or other practices for infiltration.	H	M, T, PB&D	HOA, CMAP, SMC, PO
RP-4	Regulatory agencies and units of government determine if current enforcement supports existing regulations and is adequate.	L	M, PB&D, DOT, SMC, Illinois EPA, IDNR, USACE	EO
RP-5	Jurisdictions with transportation maintenance authority should have an adopted winter maintenance/snow and ice removal policy that includes snow removal priorities, practices and products used. Municipalities should require that all chemical applicators, whether public or private must be registered with the jurisdiction and have appropriate training.	M	M, DOT, T	SMC, LCHD, LCHD, MCHD, Illinois EPA, CCPW, LCPW
RP-6	Ban the use of fertilizer with phosphorus unless a soil test indicates it is needed.	H	M, T, PB&D	LCHD, WPC
RP-7	McHenry County adopt a stormwater ordinance.	M	C	EO
RP-8	Establish stormwater utility fee systems for all major jurisdictions in planning area and encourage the use of stormwater green infrastructure BMPs for detention credit.	H	M, T, C	SMC, CMAP, FWA
RP-9	In compliance with Illinois EPA, establish total suspended solids (TSS) or other numerical water quality performance standards for new developments and redevelopment in the planning area.	L	SMC, Illinois EPA	M, T, PB&D
RP-10	Support the Chain O' Lakes Regional Multiuse trail expansion	L	LCFPD	MCCD, LCPF, MCCF, LCLC, EIG
RP-11	Review effectiveness of wetland regulations and develop watershed-specific provisions if needed.	L	SMC, USACE, IDNR	M, T, PB&D
RP-12	Implement street-sweeping and inlet clearing programs, particularly during autumn months	H	DOT, M, T	LCHD, MCHD

ID	ACTION	PRIORITY	LEAD PARTNERS	SUPPORTING PARTNERS
RP-13	Consider impervious surface coverage regulations at appropriate scales such as parcels or subwatershed to reduce runoff volumes from new development and redevelopment.	L	M, T, PB&D, WPC, SMC, CMAP	USACE, IDNR, Illinois EPA, EIG
RP-14	Require that developers demonstrate measures taken to minimize impervious surfaces (i.e., parking ratios, multi-level parking, permeable surface parking, reduced street widths, and sidewalks on one side of street, etc.).	L	CBL, DOT, M, T, SI, EIG	SMC, Illinois EPA, PB&D, EO
RP-15	Identify, repair, or disconnect all illegal discharges (illicit storm drain and/or sump pump hookups).	M	M, T, CBL, HOA, PO	SMC, LCHD, MCHD, Illinois EPA

See Section 5.1, Implementation Partners for descriptions of the Lead/Support Partners.

5.3 SITE-SPECIFIC ACTION PLAN

Project - or site-specific action items and recommendations are tied to a particular location or locations in the watershed. As with the programmatic actions, these site-specific recommendations were developed to address watershed problems, to improve watershed resources and to achieve goals and objectives. Due to the size of the planning area and sheer number of site-specific action recommendations developed during the course of the planning process, readers of the plan are encouraged to use the ***online mapping application***

(https://lakecountyil.maps.arcgis.com/apps/webappviewer/index.html?id=20c7a25b4c844f21b8127637030252c7).

NOTEWORTHY: PROJECT - SPECIFIC ACTIONS

Site-specific watershed projects/actions include BMPs, detention basin retrofits, problem hydrologic/hydraulic structure modification, flood mitigation solutions, streambank and ravine stabilization, and wetland preservation/restoration and creation priorities.

During development of the watershed-based plan, many methods were used to identify specific project sites, which are outlined below:

- Direct stakeholder input.
- Watershed windshield survey.
- Stream and lake inventory and assessment.
- Map analysis and water quality monitoring data.
- Previously planned projects.

This chapter is not a comprehensive inventory of all possible projects in the Chain. It is only intended to provide guidance on where to "kick start" implementation with a focus on improvements in water quality.

This section outlines and summarizes **site-specific actions/practices** and **site-specific critical areas/projects**. Where applicable, the action recommendations are coded by primary jurisdictions and project type category (Table 5-6). Chapter 6 includes overall cost estimates, pollutant load reductions, and implementation strategies. There are thousands of site-specific

NOTEWORTHY: SITE-SPECIFIC ACTIONS VS. BASIN-WIDE SITE-SPECIFIC ACTIONS

SITE-SPECIFIC ACTIONS:

Recommendations for a specific geographic location in the planning area. Sites may be represented by single points, linear features (such as stream banks), or polygons (specific areas, such as a wetland).

action recommendations. These are summarized in Table 5-7 which lists all practices, organized by category and priority. High priority has a short-term timeframe, medium a medium timeframe and low, a long-term timeframe. High priority are also considered "critical" and are discussed in Section 5.3.2. If implemented, the actions would benefit over 6,000 acres and nearly 7 miles of lake shoreline. Chapter 6 describes expected load reductions and estimated costs.

Table 5-6: Site-Specific Practice Categories

PRACTICE CATEGORY	DESCRIPTION
Agricultural	Agricultural practices focus on fields being actively cropped and address both sediment and nutrient loading. Practices include in-field practices of tillage management (no-till and strip-till or leaving the previous year's crop residue) and cover crops or the planting of vegetative cover after harvest. Structural practices include filter strips and vegetated field borders, grassed waterways and water and sediment control basins to control gully erosion and filter sediment and nutrients.
Sediment Removal/Dredging	As a primary goal of planning area stakeholders and the FWA is, removal of deposited sediment in the Chain to promote navigation and recreational access and to mitigate external loading from outside the planning area. Dredging will also remove phosphorus-rich sediment that is contributing to internal nutrient loading.
Habitat Improvement	Habitat improvement practices involve the restoration of existing and degraded habitats through invasive species removal. These practices do not generate substantial load reductions, but they are important for habitat diversity and wildlife. Recommended actions include Timber Stand Improvement, removal of invasive species from an existing wetland and the restoration of hydrologic function to an existing/degraded wetland.
In-Lake	In-lake practices will achieve substantial reductions in both sediment and nutrients and include shoreline stabilization (a primary source of sediment), lake aeration to reduce internal nutrient release and small-scale, and targeted vegetation management to address nuisance aquatic plant growth contributing to nutrient enrichment.
Stream Restoration	Degraded stream channel and floodplain areas are addressed with this practice category and include daylighting an urban stream channel and constructing adjacent treatment wetlands, reconnecting a stream channel to its natural floodplain and wetland creation in the floodplain, rock grade control/stream riffles to address streambank erosion and channel deepening, and the large-scale restoration of an old meander bend cut off from the Fox River.
Septic Systems and Sewer	Potentially failing septic systems are believed to be a large contributor of bacteria and phosphorus to the Chain. Addressing contributions from septic systems can be achieved by education and outreach to homeowners on proper management and by expanding a sewer system into the planning area. A sewer expansion is being proposed for an area around Channel Lake/Lake Catherine and Grass Lake/Petite Lake that would eliminate 4,300 septic systems. All other recommendations focus on education and outreach to ensure failing systems are repaired and/or properly maintained.
Urban	Urban practices can be applied across a broad area and address direct stormwater runoff and NPS pollution through infiltration, detention/retention, and filtering. Included are bioswales, converting existing dry to wet basins, naturalizing existing basins with native vegetation, installing infiltration and new wet basins, converting existing pavement and parking lots to permeable pavement, native prairie buffers between residential areas and lakes/streams, converting lawns to native prairie, installing rain gardens/rain gardens/green roofs, and retrofitting existing stormwater conveyance systems with catch basins and sediment traps.
Wetland Creation	Creating new wetlands can be applied in both urban and natural areas and are recommended to trap and filter sediment, nutrients and bacteria. This practice benefits wildlife and native biodiversity by creating critical habitat in the planning area.

Table 5-7: Summary of Site-Specific Actions by Priority

PRACTICE CATEGORY	BMP TYPE	HIGH PRIORITY	MEDIUM	LOW	PRACTICE TOTAL
Agricultural	Bioreactor	1	0	0	1
	Cover Crop	37	0	0	37
	Field Border	8	0	0	8
	Filter Strip	2	0	0	2
	Grassed Waterway	1	0	0	1
	No-till or Strip-till	11	0	0	11
	WASCB	1	1	0	2
Agricultural Practices Subtotal		***61***	***1***	***0***	***62***
Habitat Improvement	Invasive Removal - Wetland	1	0	1	2
	Timber Stand Improvement	1	5	3	9
	Wetland Restoration[1]	1	0	1	2
Habitat Improvement Subtotal		***3***	***5***	***5***	***13***
In-Lake	Lake Vegetation Management	0	6	0	6
	Lake Aerators	6	51	0	57
	Shoreline Stabilization	45	16	17	78
	Dredging	1	16	0	17
In-Lake Practices Subtotal		***52***	***89***	***17***	***158***
Septic/Sewer	Septic to Sewer (Channel Lake/Lake Catherine and the Grass Lake/Petite Lake Service Areas)	n/a	n/a	n/a	n/a
	Septic System Repair/Maintenance	45	709	0	754
Septic/Sewer Subtotal		***45***	***709***	***0***	***754***
Stream Restoration	Floodplain Re-Connection	1	0	0	1
	Grade Control	1	0	1	2
	Stream Channel Daylighting and Wetland Creation	1	0	0	1
	Stream Meander Bend Restoration	0	1	0	1
Stream Restoration Practices Subtotal		***3***	***1***	***1***	***5***
Urban	Bioswale	5	25	25	55
	Dry to Wet Detention Conversion	1	0	1	2
	Infiltration Basin	4	1	0	5
	Naturalize Detention Basin	1	3	3	7
	Permeable Pavement	5	39	40	84
	Prairie Buffer	53	7	0	60
	Prairie Conversion	5	7	7	19
	Rain Garden/Rain Barrel/Green Roof	47	528	1,283	1,858
	Sediment Trap	2	1	2	5
	Stormwater Catch Basin	2	2	6	10
	Wet Detention Basin	1	6	6	13
Urban Practices Subtotal		***126***	***619***	***1,373***	***2,118***
Wetland Creation		4	10	11	25
TOTAL:		**294**	**1,434**	**1,407**	**3,135**

[1] – Includes Trinskis Island restoration, under jurisdiction of FWA, low priority

5.3.1 Site-Specific Actions By Jurisdiction

The following section summarizes site-specific actions recommendations for each jurisdictional area within the Chain planning area. Due to the large number of practices, specific details on individual actions are included in through the Lake County SMC web application which includes attribute information containing jurisdiction, type, quantities and units, cost estimates (if applicable), implementation priority and timeline, critical status, and load reductions.

Site-specific actions are comprised of project recommendations and are based on watershed inventories, and coordination with stakeholders. The practice applies to a single specific geographic location and stakeholder recommendations tied to a physical location. Table 5-8 summarizes all actions by jurisdiction. Figure 5-1 through Figure 5-4 show the location of all site-specific practices.

Table 5-8: Number of Site-Specific Actions by Jurisdiction

JURISDICTION	AGRICULTURAL	HABITAT IMPROVEMENT	IN-LAKE[1]	SEPTIC/ SEWER[2]	STREAM RESTORATION	URBAN	WETLAND CREATION	JURISDICTION TOTAL
Municipalities								
Antioch	0	1	1	1	0	54	2	59
Fox Lake	6	0	2	31	0	357	2	398
Johnsburg	2	0	0	31	0	115	0	148
Lake Villa	4	0	0	0	0	1	0	5
Lakemoor	6	0	0	48	0	5	0	59
Spring Grove	0	0	0	10	0	0	0	10
Townships								
Antioch	23	2	36	427	4	1,135	8	1,635
Burton	0	0	0	6	0	0	0	6
Grant	3	0	13	57	0	238	1	312
Lake Villa	2	6	2	8	0	70	4	92
McHenry	6	2	10	127	1	142	6	294
Nunda	0	0	0	7	0	0	0	7
Wauconda	1	0	0	0	0	0	0	1
Other								
IDNR	2	1	16	1	0	1	0	21
Lake County Forest Preserves	7	0	2	0	0	0	2	11
Land Conservancy of Lake County	0	0	3	0	0	0	0	3
Fox Waterway Agency	0	1	73	0	0	0	0	74
TOTAL:	**62**	**13**	**158**	**754**	**5**	**2,118**	**25**	**3,135**

[1]-Lake aerators and shoreline stabilization are the responsibility of the property owners or lake/homeowner association. The total for Fox Waterway Agency is comprised of 6 aerators and 1 dredging project. All other in-lake practices are shoreline stabilization for the remaining jurisdictions [2]-The proposed sewer service areas are not included in this count.

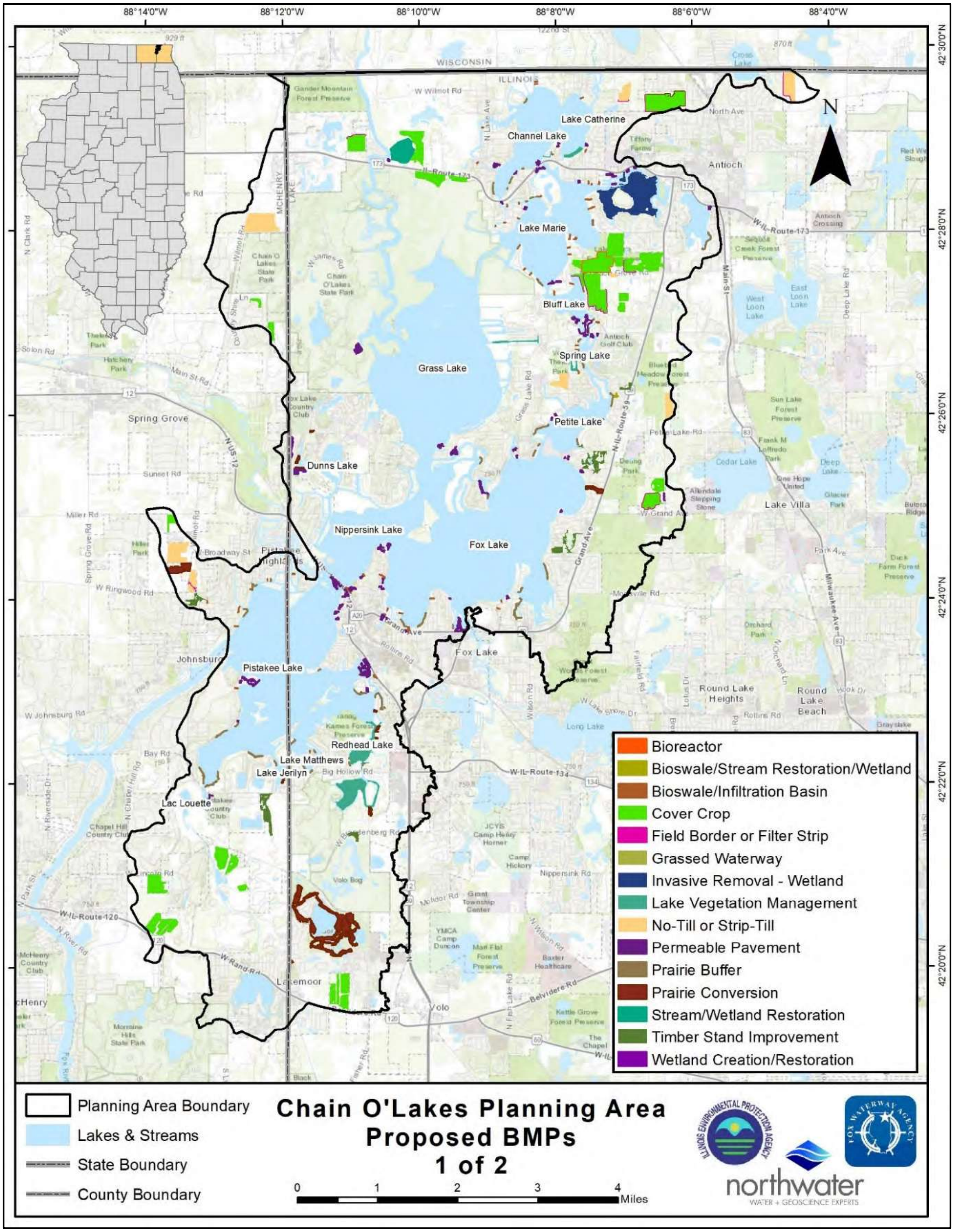

Figure 5-1: Site-Specific Practices - Map 1 of 2

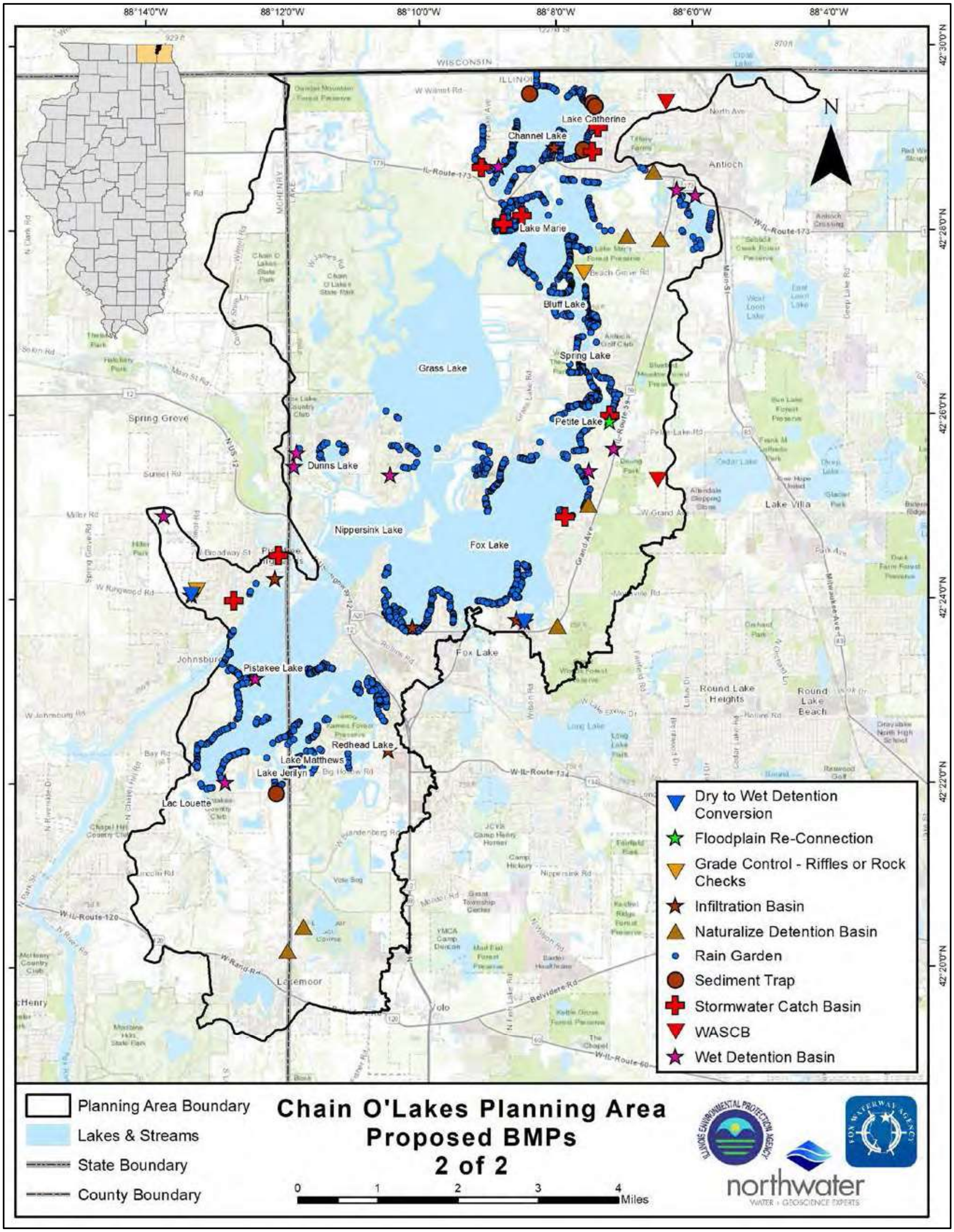

Figure 5-2: Site-Specific Practices - Map 2 of 2

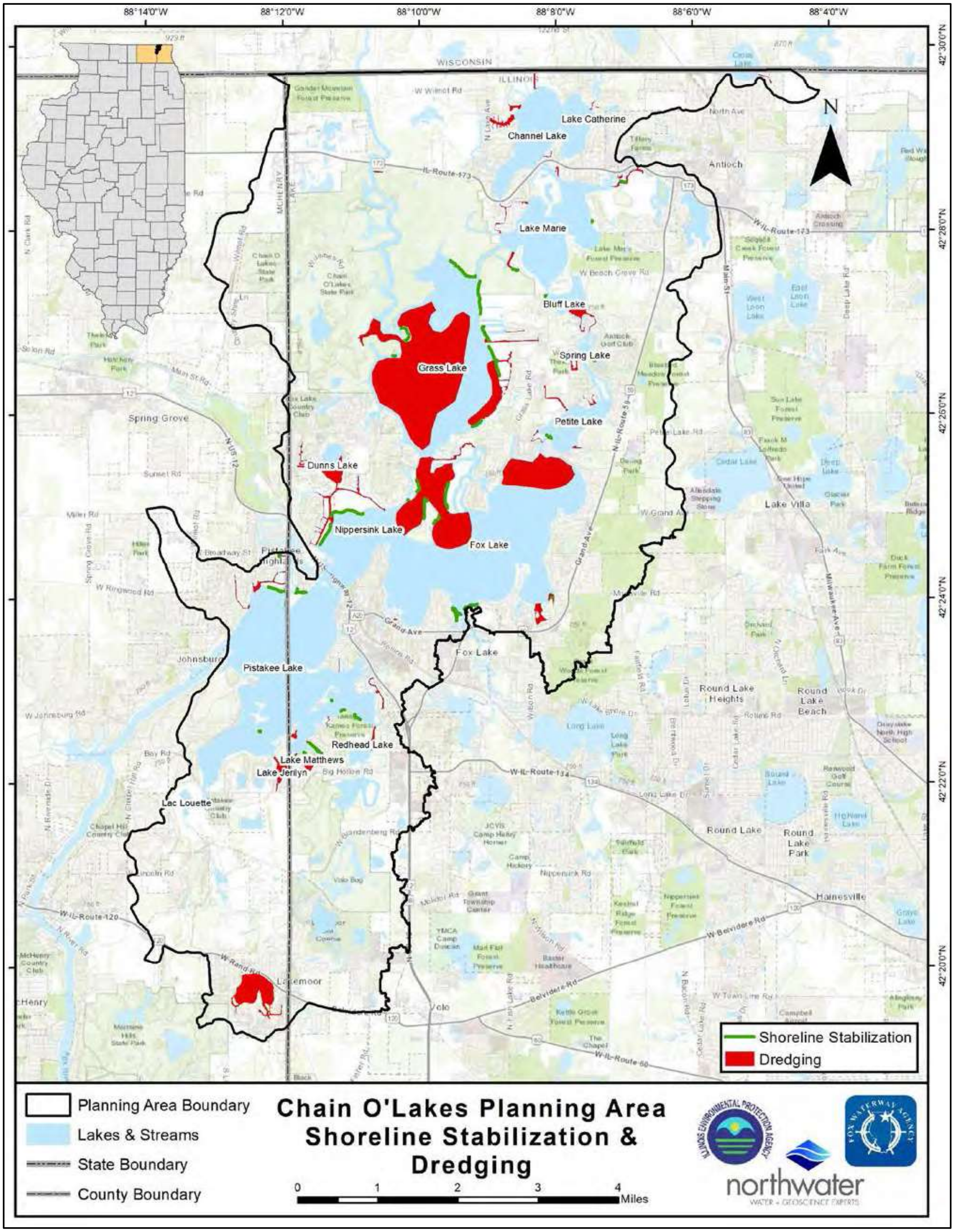

Figure 5-3: Site-Specific Practices - Shoreline Stabilization and Dredging

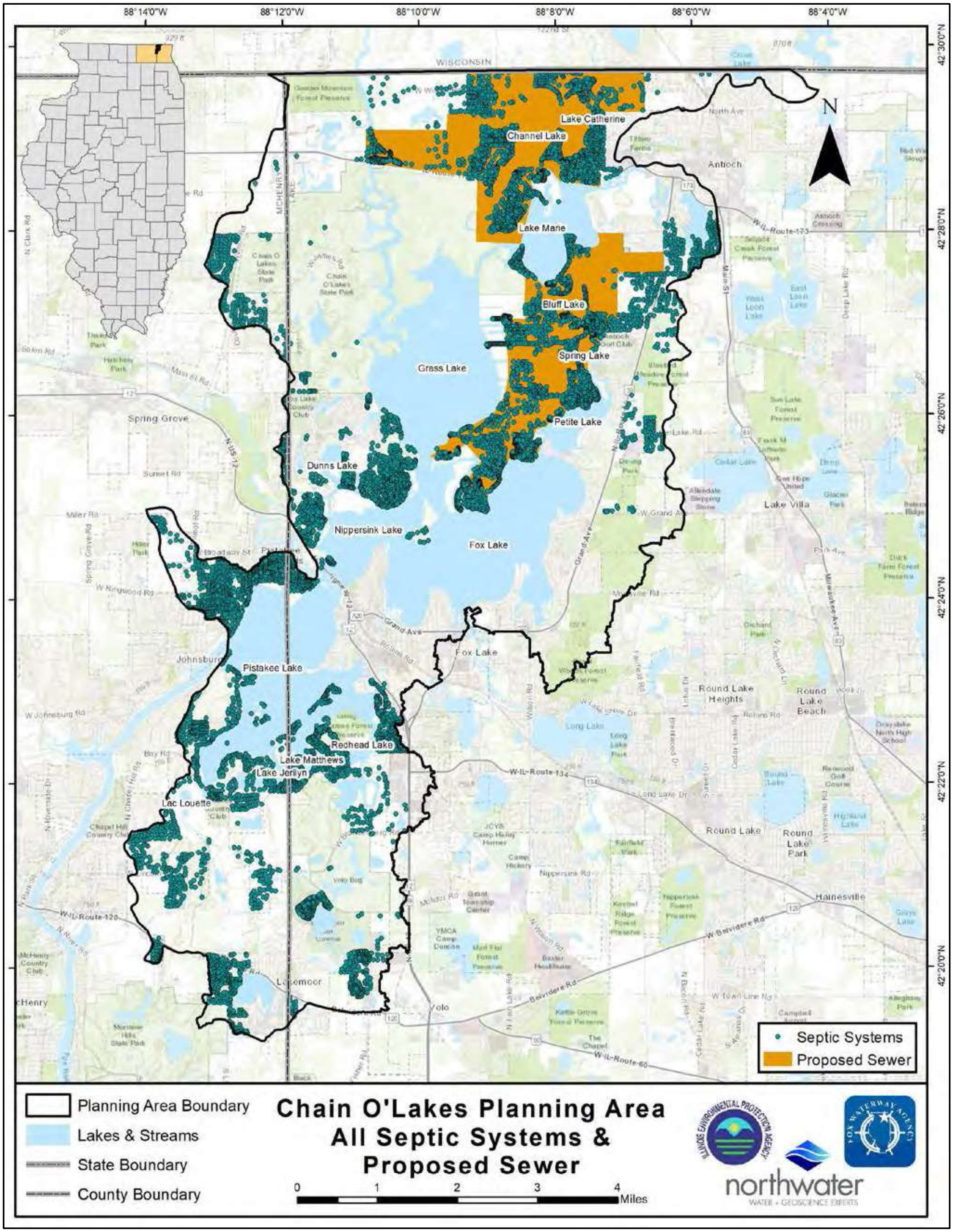

Figure 5-4: Site-Specific Practices - Septic System and Sewered Area Expansion

5.3.2 Critical Areas

Critical areas are defined as practices or BMPs in the watershed best suited to focus implementation efforts to help achieve the goals and objectives of the watershed-based plan and will provide the greatest "bang-for-the-buck". The majority of critical BMPs focus on maximizing reductions in sediment and phosphorus by practice category (Table 5-9) plus those that have been identified by local stakeholders. For septic systems, critical areas are based on soil conditions (presence of hydric soils) and maximizing reductions in bacteria and phosphorus. Those practices that address phosphorus and sediment also achieve outsized nitrogen reductions. One critical area was selected for dredging, Grass Lake. Although specific reductions of sediment and nutrients could not be quantified, it is believed that a dredging program in this location will remove deposited sediment available for internal nutrient release and act as a sink or basin to capture external loading from the larger Fox River, if periodic maintenance dredging is performed.

Actions addressing these critical areas first will have added value and benefit to the planning area. Table 5-10 summarizes the critical area practices and relevant primary jurisdictions. Jurisdictions can reference this table to review which critical areas are relevant to them. Figure 5-5 through Figure 5-8 illustrate the critical practices in map format. These practices are considered a high priority and are attributed with this information in the online mapping system.

Table 5-9: Critical Site-Specific Actions Quantity

PRACTICE CATEGORY	BMP TYPE	QUANTITY
Agricultural	Bioreactor	1 (location), 45 (ac)
	Cover Crop	797 (ac)
	Field Border	20 (ac)
	Filter Strip	1 (ac)
	Grassed Waterway	3 (ac)
	No-till or Strip-till	195 (ac)
	WASCB	1 (basin)
Habitat Improvement	Invasive Removal - Wetland	3 (ac)
	Timber Stand Improvement	20 (ac)
	Wetland Restoration	0.1 (ac restored wetland)
In-Lake Practices	Lake Aerators	6 (lake aerators)
	Shoreline Stabilization	18,634 (ft rip-rap)
	Dredging (Grass Lake)	4,456,632 (cubic yards sediment removed)
Septic/Sewer	Septic to Sewer (Channel Lake/Lake Catherine and the Grass Lake/Petite Lake Service Areas)	4,300 (sewer connections)
	Septic System Repair/Maintenance	45 (potentially failing septic systems)
Stream Restoration	Stream Channel Daylighting and Wetland Creation	41,967 (square ft), 4 (rock checks), 1 (basin), 0.1 (ac wetland)
	Floodplain Re-Connection	4 (rock riffles), 1 (ac wetland)
	Grade Control	3 (rock riffles)
	Stream Meander Bend Restoration	0 (ac wetland)
Urban Practices	Bioswale	12,401 (square ft), 12 (rock checks), 1 (basin)
	Dry to Wet Detention Conversion	1 (location)

PRACTICE CATEGORY	BMP TYPE	QUANTITY
	Infiltration Basin	4 (locations)
	Naturalize Detention Basin	0.2 (ac)
	Permeable Pavement	433,058 (square ft)
	Prairie Buffer	18 (ac)
	Prairie Conversion	64 (ac)
	Rain Garden/Rain Barrel/Green Roof	47 (locations)
	Sediment Trap	105 (ft rip-rap), 2 (ac wetland), 1,210 (cubic yards sediment removal)
	Stormwater Catch Basin	12 (basins)
	Wet Detention Basin	1 (basin)
Wetland Creation	Wetland Creation	2 (ac wetlands)

Table 5-10: Critical Site-Specific Actions by Jurisdiction

JURISDICTION	AGRICULTURAL	HABITAT IMPROVEMENT	IN-LAKE[1]	SEWER/ SEPTIC[2]	STREAM RESTORATION	URBAN	WETLAND CREATION	JURISDICTION TOTAL
Townships								
Antioch	23	2	18	31	2	51	1	128
Grant	3	0	9	0	0	27	0	39
Lake Villa	2	1	0	0	0	6	0	9
McHenry	6	0	6	8	1	11	1	33
Wauconda	1	0	0	0	0	0	0	1
Municipalities								
Antioch	0	0	1	0	0	6	1	8
Fox Lake	6	0	1	0	0	17	0	24
Johnsburg	2	0	0	2	0	8	0	12
Lake Villa	3	0	0	0	0	0	0	3
Lakemoor	6	0	0	4	0	0	0	10
Other								
Illinois Department of Natural Resources	2	0	7	0	0	0	0	9
Lake County Forest Preserve	7	0	2	0	0	0	1	10
Land Conservancy of Lake County	0	0	1	0	0	0	0	1
Fox Waterway Agency	0	0	7	0	0	0	0	7
TOTAL:	**61**	**3**	**52**	**45**	**3**	**126**	**4**	**294**

[1]-Lake aerators and shoreline stabilization are the responsibility of the property owners or lake/homeowner association. The total for Fox Waterway Agency is comprised of 6 aerators and 1 dredging project. All other in-lake practices are shoreline stabilization for the remaining jurisdictions [2]-The proposed sewer service areas are not included in this count.

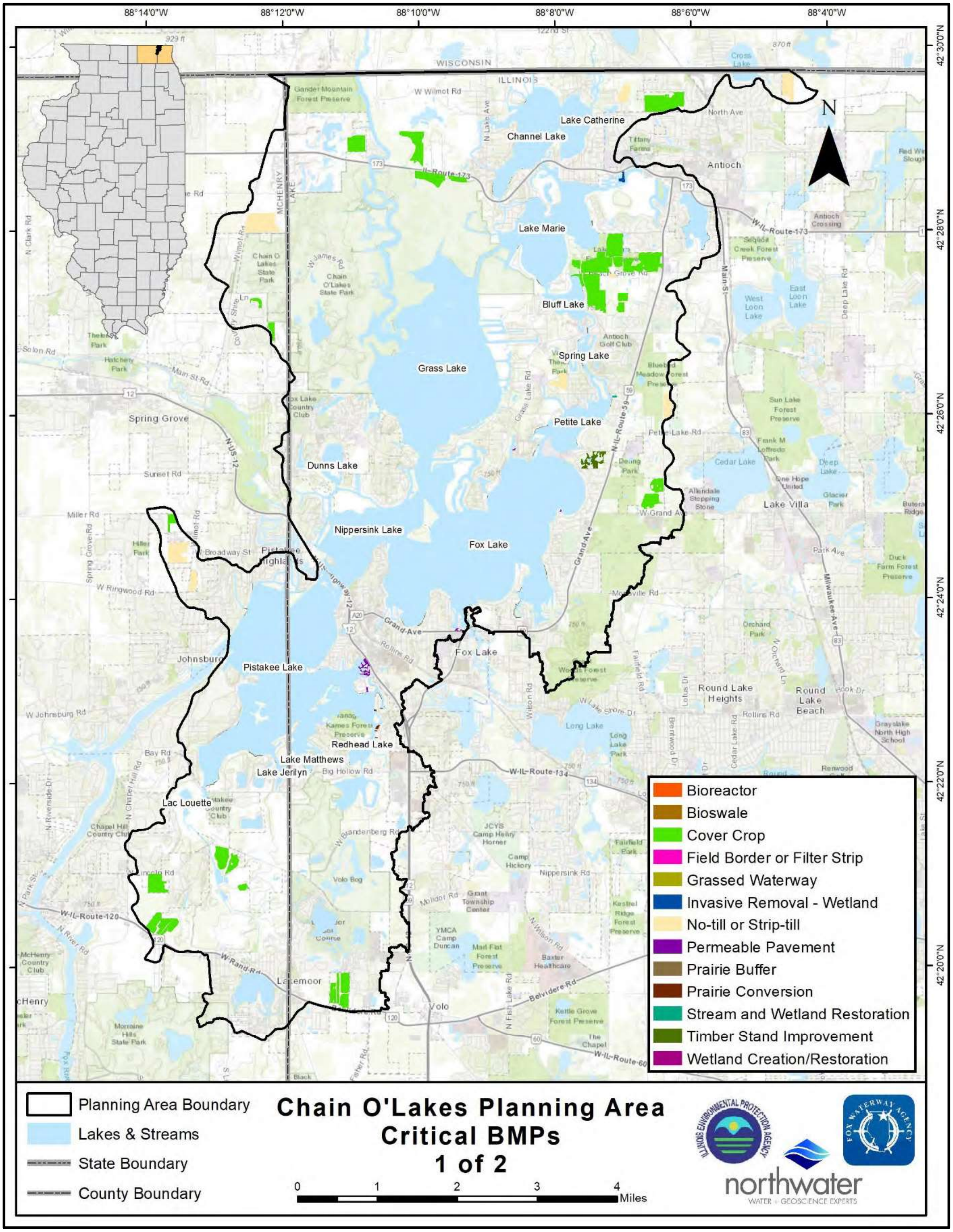

Figure 5-5: Critical Practices - Map 1 of 2

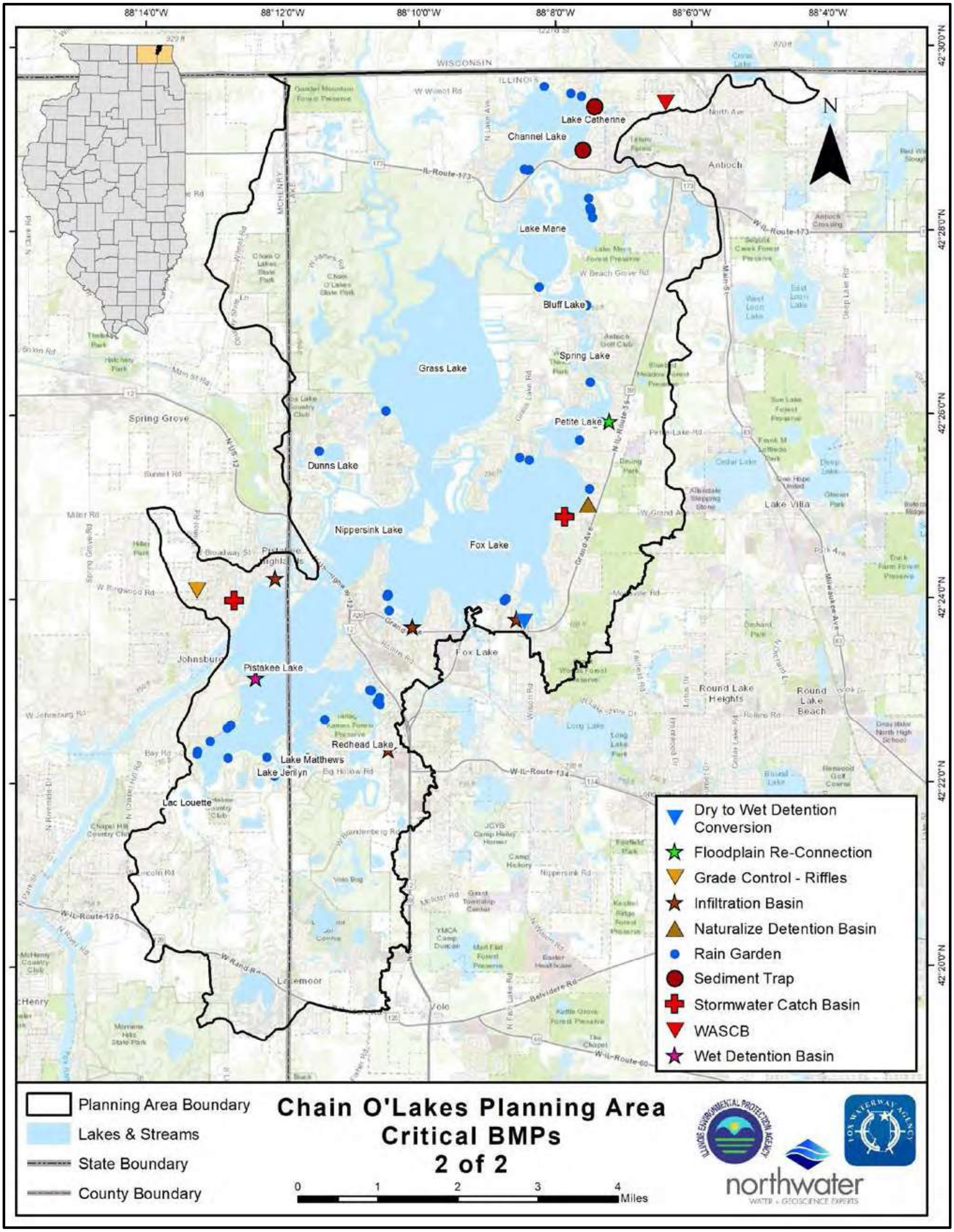

Figure 5-6: Critical Practices - Map 2 of 2

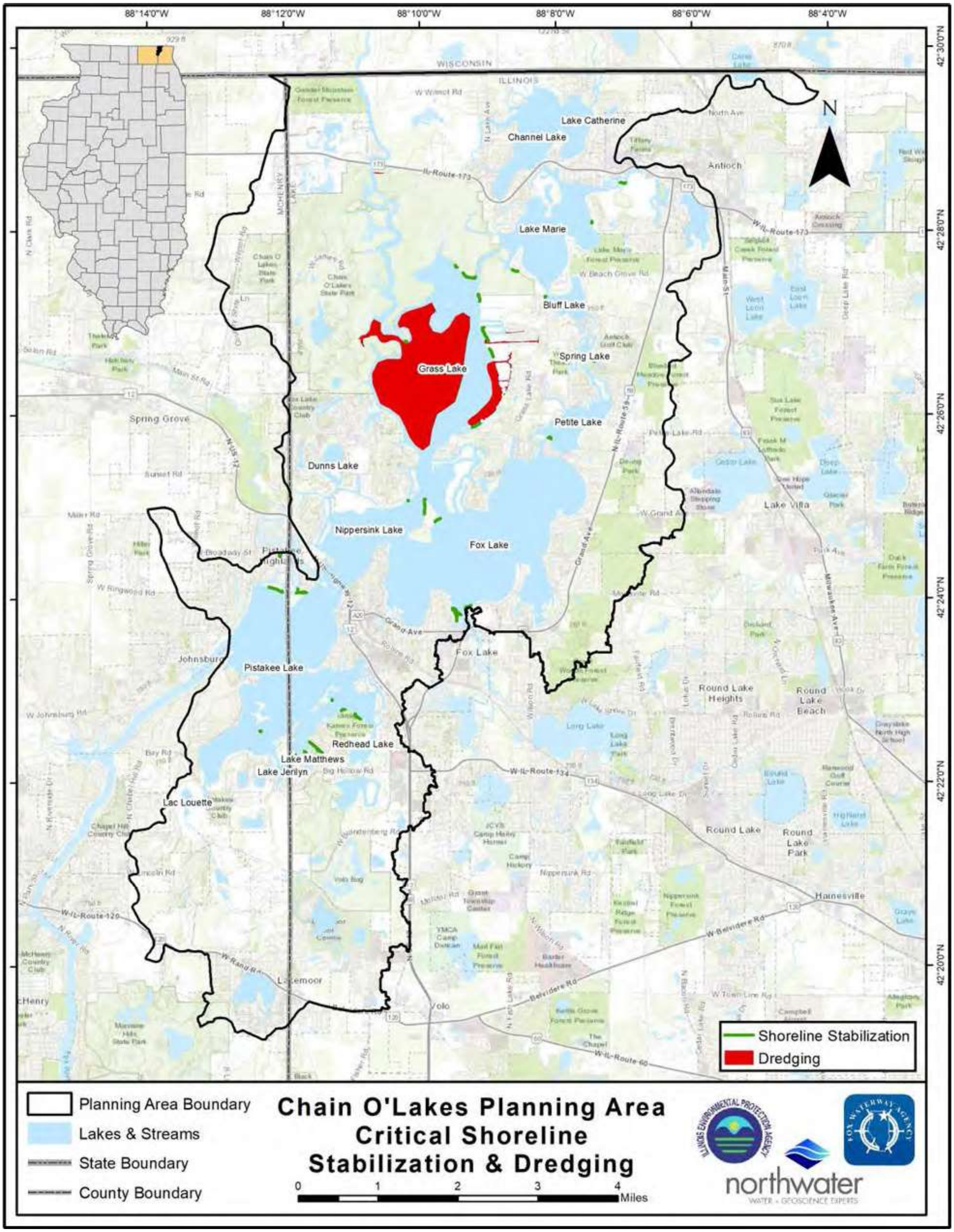

Figure 5-7: Critical Practices - Shoreline Stabilization and Dredging

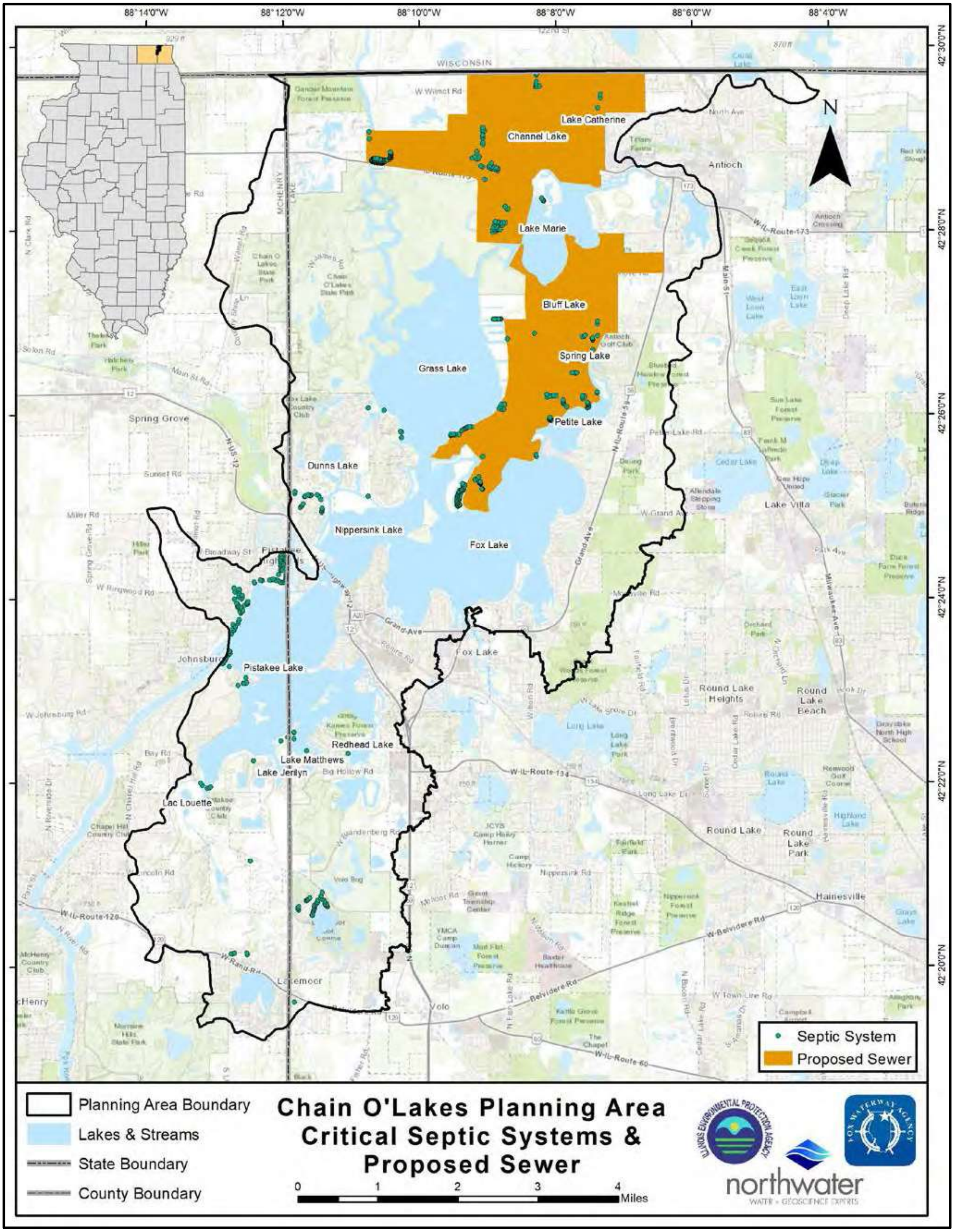

Figure 5-8: Critical Practices - Septic System and Sewered Area Expansion

5.4 REFERENCES

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ACRONYMS/ABBREVIATIONS USED IN CHAPTER 6

BMP – Best Management Practices
CFU – Colony Forming Unit
DO – Dissolved Oxygen
FWA – Fox Waterway Agency
FRSG – Fox River Study Group
IDNR – Illinois Department of Natural Resources
EPA – Illinois Environmental Protection Agency
INLRS – Illinois Nutrient Loss Reduction Strategy
LCFPD – Lake County Forest Preserve District
LCHD – Lake County Health Department
NPS – Nonpoint Source
QAPP – Quality Assurance Project Plan
SMC – Lake County Stormwater Management Commission
TKN - Total Kjeldahl Nitrogen
TMDL – Total Maximum Daily Load
TSS – Total Suspended Solids
TP – Total Phosphorus
USDA – United States Department of Agriculture
VLMP – Illinois Volunteer Lake Monitoring Program
WPC – Watershed Planning Committee

6 PLAN IMPLEMENTATION AND EVALUATION

This chapter identifies a strategy and provides guidance to support transition from planning to implementation and to evaluate the effectiveness of actions toward the goals and objectives of the plan. The primary components of this chapter include:

- Pollution load reduction estimates of recommended management measures.
- Estimated costs.
- Leaders and supporters for plan implementation.
- Initial steps.
- Funding resources and opportunities.
- Schedule.
- Evaluating plan performance – programmatic monitoring.
- Indicator and milestone grading system.
- Water quality monitoring strategy.
- Updating the watershed plan.

How readily this plan is used and implemented by stakeholders is a major indicator of its success and is easily measured by tracking the actions taken. Improvement in lake and watershed resources or water quality are other indicators of success achieved through monitoring. Successful plan implementation will require significant cooperation and coordination among lead and support partners to secure and allocate resources and apply them to actions. The watershed-based plan can be considered a living document and has the flexibility for stakeholders to make revisions over time that reflect shifts in local priorities or conditions.

6.1 ESTIMATE OF POLLUTANT LOAD REDUCTIONS AND TARGETS

Pollution load estimates were made using the nonpoint source (NPS) model described in Chapter 4. The purpose of estimating pollutant load reductions and targets is to present a general idea of Best Management Practice (BMP) implementation benefits and to outline the practices that result in the greatest benefit to the watershed and achieve plan goals.

Load reduction estimates were **not** performed for all actions identified in Chapter 5. Estimates were made for projects with specific on-the-ground locations, where project information was collected, and reduction efficiencies are available in literature sources or from other watershed plans in the area. Many actions presented in Chapter 5 are planning level or policy actions, and do not have the detail of information at this time to support load reduction estimates. Table 6-1 outlines the average expected load reduction efficiencies for site-specific practices.

Table 6-1: Best Management Practice Average Expected Load Reduction Efficiencies

BEST MANAGEMENT PRACTICE	NITROGEN REDUCTION	PHOSPHORUS REDUCTION	SEDIMENT REDUCTION	BACTERIA REDUCTION
Bioswale/Infiltration Basin[1]	6%-35%	30%-60%	45% -70%	20%-50%
Filter Strip/Field Border/Prairie Buffer	5% - 25%	20%-40%	35%-60%	20%-40%
Cover Crop	30%	30%	40%	35%
Bioreactor[2]	40%	5%	N/A	N/A
Water and Sediment Control Basin	20%	60%	70%	35%
Prairie Conversion (footprint)	90%	80%	90%	60%
Grass Waterway	25%	20%	30%	50%
No-Till	10%	50%	70%	20%
Permeable Pavement	45%	50%	80%	40%
Stormwater Catch Basin	5%	5%	15%	1%
Sediment Trap[3]	2%-28%	5%-35%	35%-70%	8%-60%
Invasive Species Removal/Timber Stand Improvement	1%-5%	1%-5%	1%-5%	1%
Naturalized Detention Basin	1%-5%	1%-8%	2%-10%	1%-12%
Wet Detention Basin	10%-30%	30%-55%	35%-70%	40%-55%
Rain Garden/Rain Barrels/Green Roof	40%	45%	50%	50%
Shoreline and Streambank Stabilization	100%	100%	100%	0%
Stream Restoration/Re-connect to Floodplain	12%-15%	15%-25%	20%-32%	30%
Grade Control (rock check/riffle)[4]	1%-5%	2%-10%	2%-12%	1%-2%
Wetland Creation	5%-38%	8%-50%	10%-70%	15%-60%
Wetland Restoration	15%	20%	25%	20%
Conversion of Septic to Sewer	100%	100%	N/A	100%
Dredging	N/A	N/A	100%	N/A
Lake Aeration[5]	N/A	90%	N/A	N/A

[1]High end of reductions for combined bioswale and infiltration basin.[2] Only treats tile water. [3] High end of reductions for practice combined with grade control and turbidity curtain. [4] Also includes streambank erosion reductions.[5] Maximum efficiency possible under optimal conditions – may not provide any reductions.

6.1.1 Reduction Estimates for Site-Specific Actions

Load reduction estimates are provided for site-specific recommendations in the action plan (Chapter 5). Table 6-2 summarizes the annual estimates by project type for all new BMPs. This inventory includes projects throughout the entire planning area. Estimates also do not account for programmatic, education and outreach, and policy and regulatory actions since direct impacts are not easily determined at this stage of the planning process. Chapter 5 also describes "critical" areas or practices representing a subset of those actions that should be considered priority because they are expected to reduce the greatest amount of a given pollutant for the lowest unit cost or have been identified by planning area stakeholders. Load reductions are also presented for critical practices in Section 6.1.1.2.

Based on the review of reduction estimates, project/site-specific actions identified in the watershed-based plan are effective for addressing water quality problems and impairments in the Chain, such as sediment, nitrogen, phosphorus, and bacteria. Well over 2,000 individual practices have been identified and are expected to reduce 177,885 lbs/yr of nitrogen, 18,175 lbs/yr of phosphorus, 5,724 tons/yr of sediment, and 1,053,044 billion Colony Forming Units (CFU)/yr of bacteria.

Agricultural practices and in-lake shoreline stabilization will be the most effective at reducing sediment, addressing internal nutrient release using aeration (Section 6.1.1.1), shoreline stabilization, mitigating potentially failing septic systems, and select urban BMPs will be most effective in addressing phosphorus. Nitrogen reductions can be realized primarily from shoreline stabilization, agricultural practices, addressing potentially failing septic systems, and some urban BMPs such as rain gardens that filter or trap NPS pollution. Addressing potentially failing septic systems are likely needed to generate most of the expected bacteria reductions. Figure 6-1 through Figure 6-4 show the location of recommended practices in the planning area.

Table 6-2: Estimated Annual BMP Load Reductions

BMP CATEGORY	BMP	QUANTITY	NITROGEN REDUCTION (LBS/YR)	PHOSPHORUS REDUCTION (LBS/YR)	SEDIMENT REDUCTION (TONS/YR)	BACTERIA REDUCTION (BILLION CFU/YR)
Agricultural	Bioreactor	1 (location), 45 (ac)	131	4.8	0.7	n/a
	Cover Crop	797 (ac)	5,620	208	88	176
	Field Border	20 (ac)	571	82	41	52
	Filter Strip	1 (ac)	55	11	9.0	7.1
	Grassed Waterway	3 (ac)	219	13	16	11
	No-Till or Strip Till	195 (ac)	436	91	55	26
	Water and Sediment Control Basin	4 (basins)	118	17	12	5.3
Agricultural Practices Subtotal			***7,150***	***427***	***222***	***277***
Habitat Improvement	Invasive Removal - Wetland	152 (ac)	7.4	0.1	0.001	0.7
	Timber Stand Improvement	85 (ac)	6.9	1.1	1.5	0.1
	Wetland Restoration	17.6 (ac restored)	91	4.6	4.9	3.5
Habitat Improvement Subtotal			***105***	***5.8***	***6.4***	***4.3***
In-Lake	Lake Vegetation Management	135 (ac)	n/a	n/a	n/a	n/a
	Lake Aerators	57 (aerators)	n/a	2,927	n/a	n/a
	Shoreline Stabilization	35,021 (ft rip-rap)	137,762	4,255	5,341	n/a
In-Lake Practices Subtotal			***137,762***	***7,182***	***5,341***	***0***
Septic/Sewer	Septic to Sewer (proposed new service areas)	4,300 (connections)	9,807	3,839	0	423,266
	Septic System Repair/Maintenance[1]	529 (systems)	24,353	9,534	0	1,051,064
Septic/Sewer Subtotal			***24,353***	***9,534***	***0***	***1,051,064***
Stream Restoration	Stream Channel Daylighting and Wetland Creation	41,967 (square ft stream), 4 (rock checks), 0.1 (ac wetland)	32	17	2.2	19
	Floodplain Re-Connection	4 (rock riffles), 1 (ac wetland)	360	48	8.7	92

BMP CATEGORY	BMP	QUANTITY	NITROGEN REDUCTION (LBS/YR)	PHOSPHORUS REDUCTION (LBS/YR)	SEDIMENT REDUCTION (TONS/YR)	BACTERIA REDUCTION (BILLION CFU/YR)
	Grade Control	3 (rock riffles), 6 (rock checks)	419	26	23	2.6
	Stream Meander Bend Restoration	39 (ac)	383	30	5.7	74
Stream Restoration Subtotal			***1,194***	***121***	***39***	***187***
Urban	Bioswale	275,414 (square ft), 150 (rock checks), 1 (basin)	223	122	3.7	139
	Dry to Wet Detention Conversion	2 (locations)	0.4	0.1	0.002	0.03
	Infiltration Basin	5 (locations)	142	20	0.6	26
	Naturalize Detention Basin	6 (ac)	24	3.8	0.1	9.4
	Permeable Pavement	3,033,486 (square ft)	555	90	6.8	83
	Prairie Buffer	20 (ac)	256	72	5.0	127
	Prairie Conversion	186 (ac)	1,329	58	25	44
	Rain Garden/Ranin Barrel/Green Roof	1,858 (locations)	1,536	248	6.8	653
	Sediment Trap	255 (ft rip-rap), 2 (ac wetland), 1,210 (cubic yards sediment removal)	543	43	17	96
	Stormwater Catch Basin	59 (basins)	64	6.8	0.5	2.2
	Wet Detention Basin	13 (basins)	156	36	0.6	48
Urban Practices Subtotal			***4,828***	***701***	***65***	***1,227***
Wetland Creation		20 (ac)	2,493	204	50	284
ALL PRACTICES REDUCTIONS TOTAL:			**177,885**	**18,175**	**5,724**	**1,053,044**

[1]- systems overlapping with the proposed sewer service areas are not counted in overall totals

As presented in Table 6-3, a total of 8,728,982 cubic yards of sediment removal may be needed in the planning area based on previous studies, local stakeholder and Fox Waterway Agency (FWA) priorities, and recent lake assessments performed to support this plan. Large-scale removal from Grass Lake, combined with periodic maintenance dredging, should be prioritized as this will also act to capture external sediment loads from the Fox River.

Table 6-3: Estimated Sediment Removal Volumes by Lake

LAKE	SEDIMENT REMOVED (CUBIC YARDS)	LAKE	SEDIMENT REMOVED (CUBIC YARDS)
Bluff Lake	87,010	Lake Maire	83,423
Channel Lake	88,983	Lake Matthews	24,487
Cross Lake	4,871	Lily Lake	479,404

LAKE	SEDIMENT REMOVED (CUBIC YARDS)	LAKE	SEDIMENT REMOVED (CUBIC YARDS)
Dunns Lake	295,097	Nippersink Lake	1,869,398
Fox Lake	987,268	Petite Lake	45,999
Grass Lake[1]	**4,456,632**	Pistakee Lake	128,702
Lake Catherine	800	Redhead Lake	43,540
Lake Catherine/Trevor Creek	3,095	Spring Lake	31,977
Lake Jerilyn	98,297	**TOTAL:**	**8,728,982**

1- This project is also a critical practice

6.1.1.1 Lake Destratification and Aeration

Internal nutrient release makes up a significant portion of the phosphorus load that originates within the planning area. This has several causes, including resuspension of sediments and phosphorus release from anoxic (low oxygen) sediments during seasonal stratification. Installation of aeration or destratification devices in areas of lakes that seasonally stratify may provide significant internal reductions. However, there are many factors that contribute to the effectiveness of this practice.

A rigorous study should be completed before implementation to ensure the efficacy of this practice, as oxic (adequate oxygen) sediments may be a larger component of phosphorus release. Preliminary recommendations for installation sites and rough estimated load reductions are found in Table 6-4. For the purposes of estimating load reductions, it was assumed that anoxic sediments release phosphorus at eight times the rate of oxic sediments, and destratification has a 90% efficiency in preventing phosphorus release from formerly anoxic areas. These assumptions are derived from a variety of sources in scientific literature.

Table 6-4: Estimated Load Reductions from Destratification/Aeration

LAKE NAME	APPROXIMATE STRATIFIED AREA (ACRES)	APPROXIMATE PERCENTAGE OF LAKE AREA THAT STRATIFIES	INTERNAL LOAD ESTIMATE (LBS/DAY)	ESTIMATED LOAD REDUCTION WITH DESTRATIFICATION/AERATION (LBS/YR)
Bluff Lake	23	23%	1.36	315
Channel Lake	83	22%	2.8	642
Lake Catherine	50	27%	1.32	337
Lake Marie	60	10%	6.57	1,020
Petite Lake	3	2%	4.82	176
Pistakee Lake	66	4%	5.52	437
TOTAL:	**285**	**-**	**-**	**2,927**

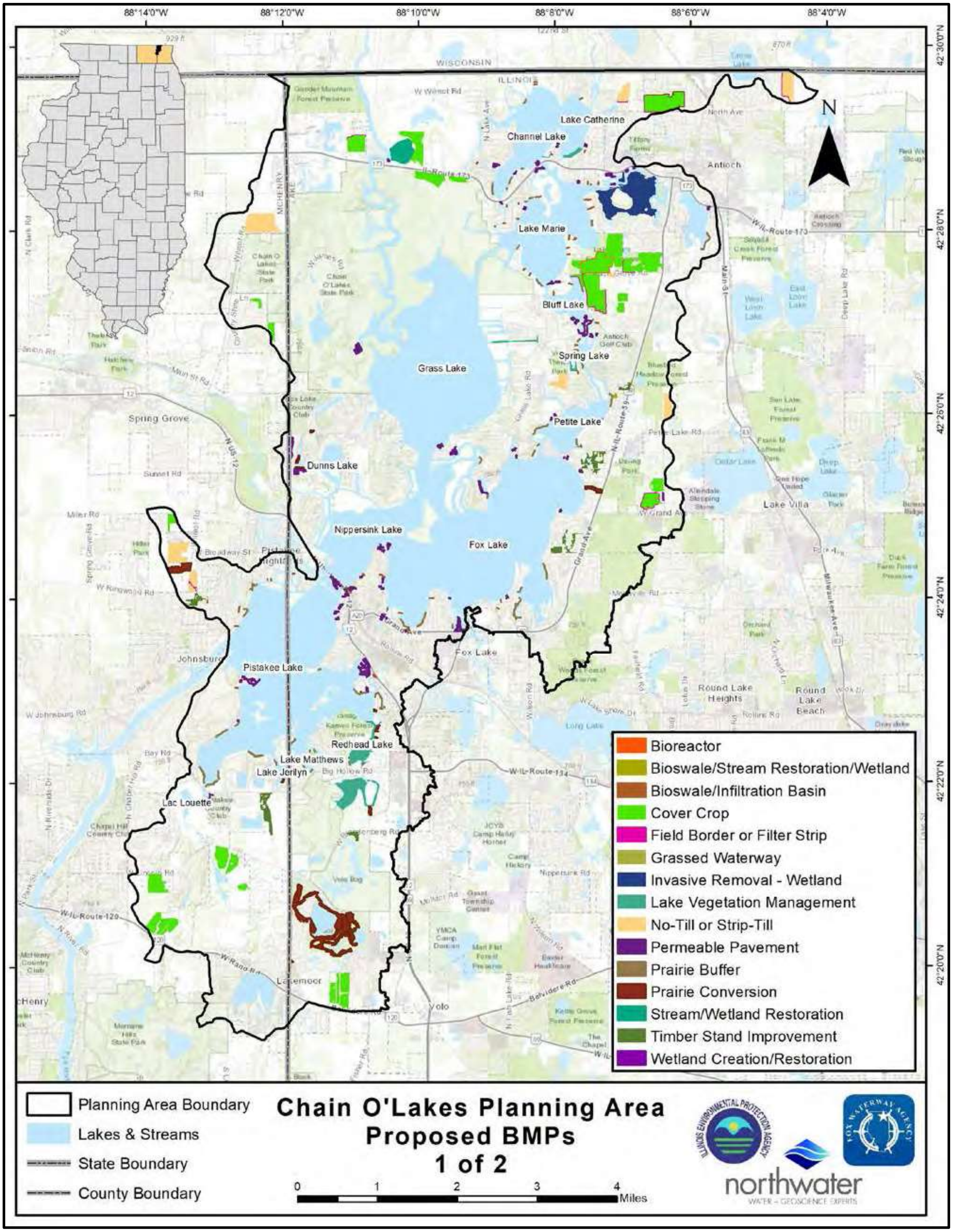


Figure 6-1: Proposed BMPs, Map 1 of 2

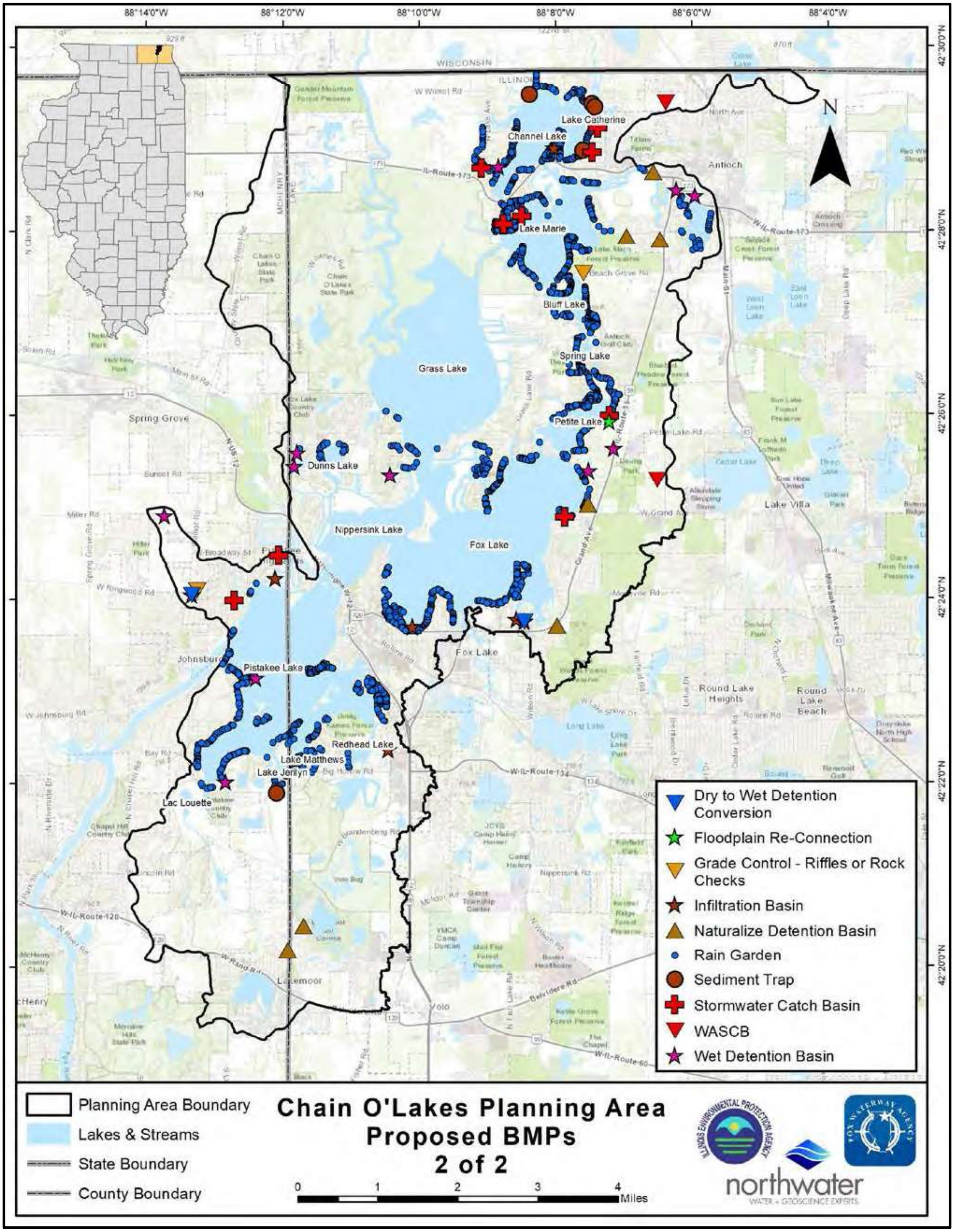


Figure 6-2: Proposed BMPs, Map 2 of 2

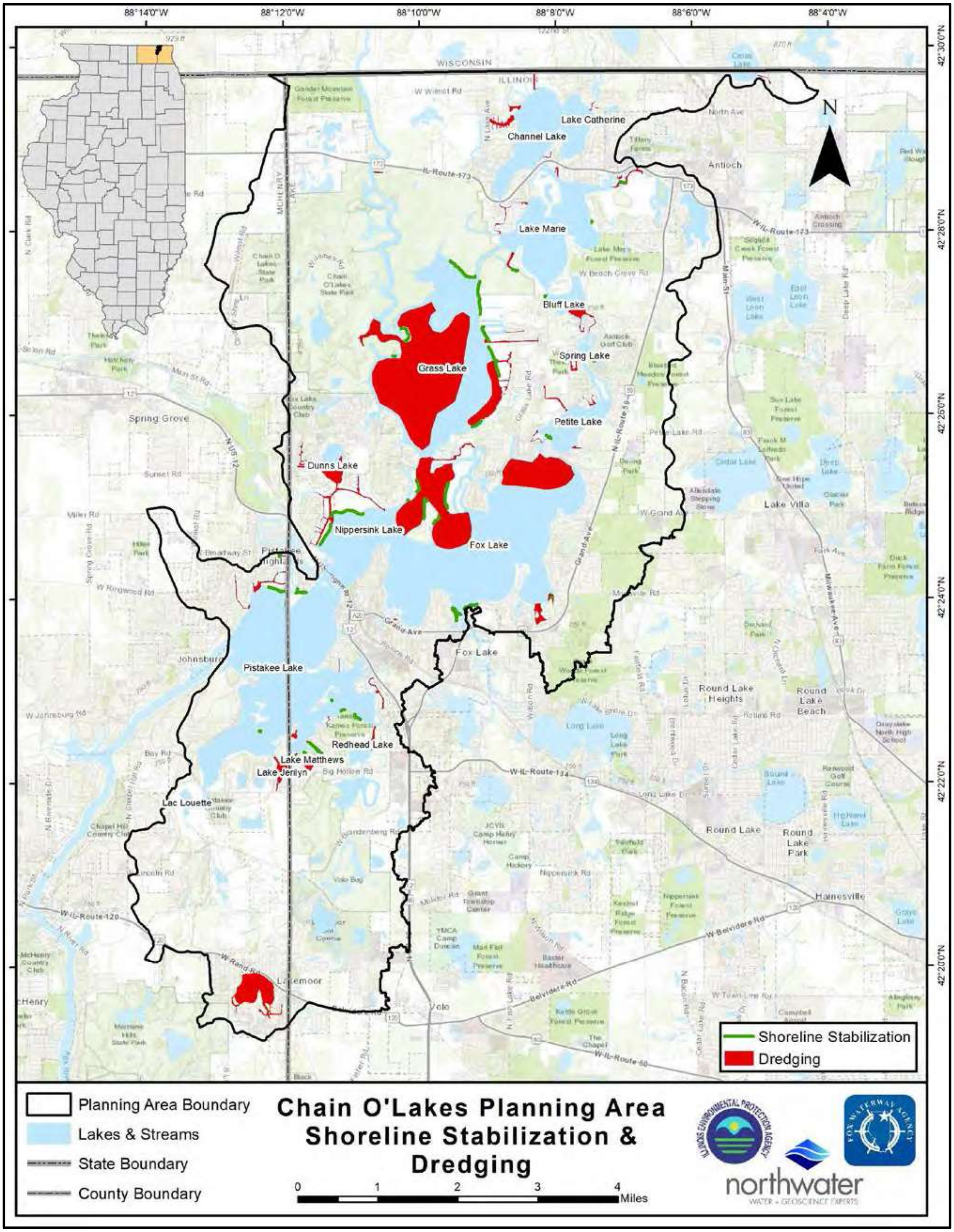


Figure 6-3: Proposed BMPs, Shoreline Stabilization and Dredging

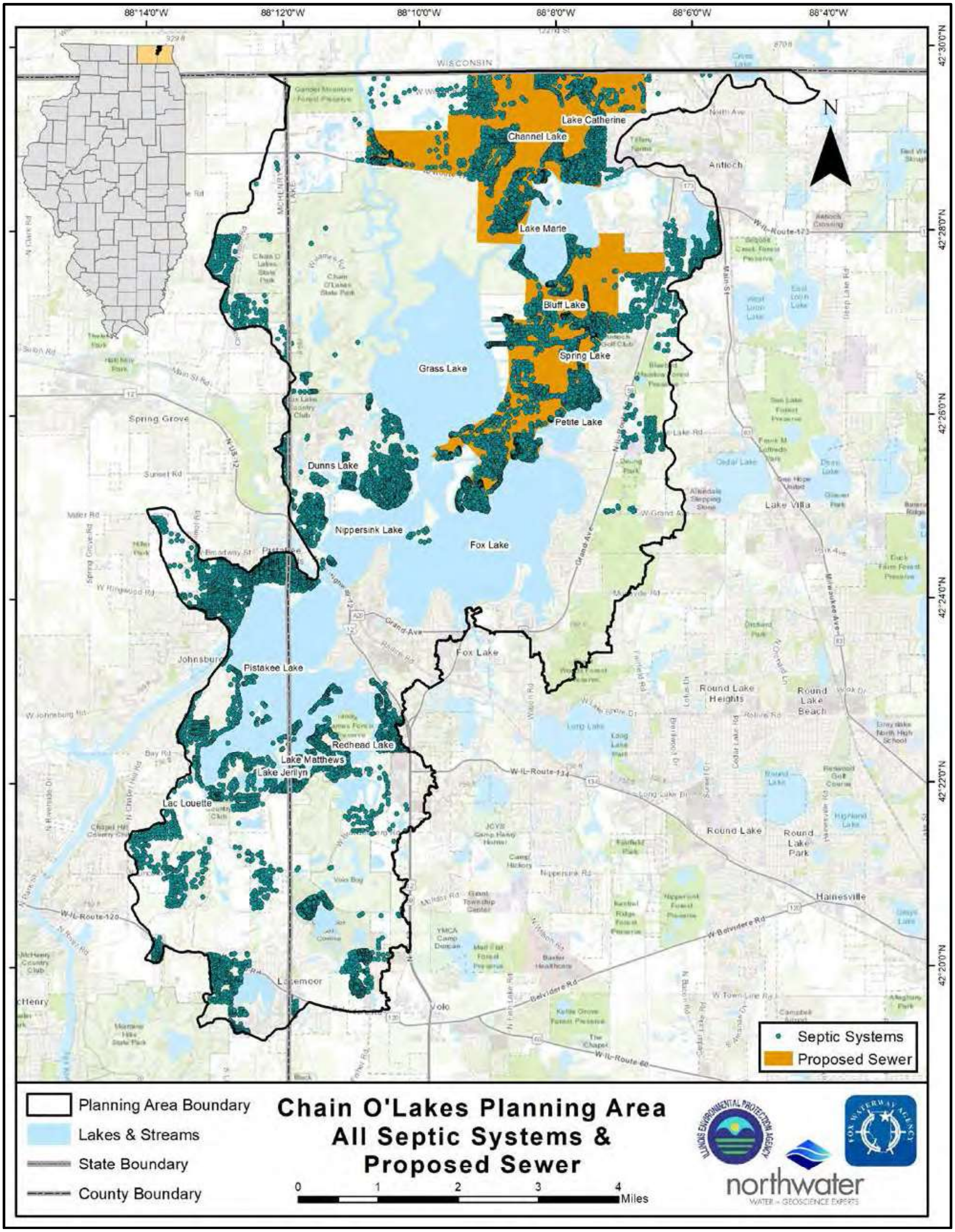


Figure 6-4: Proposed BMPs, Septic Systems and Sewered Area Expansion

6.1.1.2 Reduction Estimates for Critical Site-Specific Actions

As detailed in Chapter 5, critical areas or practices are those that will maximize reductions in sediment, phosphorus and bacteria within a given BMP category and represent stakeholder priorities. Table 6-5 lists expected reductions by category and the percentage of total sediment and phosphorus achieved compared to all recommended practices combined. Excluding sediment removal or dredging, critical practices are expected to achieve 61% of the total nitrogen, 45% of the total phosphorus, 64% of the total sediment and 46% of the total bacteria reductions from all site-specific actions combined. Costs presented in Section 6.2.1 show this represents only 15% of the total estimated expenditure.

Critical in-lake practices will achieve 58% of the sediment and 16% of the total expected phosphorus reductions. Focusing education and outreach to homeowners in critical septic areas to ensure failing systems are repaired, and proper maintenance is performed, will likely address 16% of the total expected phosphorus and 46% of the bacteria if the campaign is successful at reaching all potentially failing systems. If a new, proposed sewer service area materializes, significant additional nutrient and bacteria reductions are expected.

Critical agricultural practices will also contribute substantially to sediment and nutrient reductions from direct runoff, despite a relatively low percentage when compared against all sources of pollutants (direct runoff, streambank/lake shoreline/gully erosion, septic systems, and internal lake nutrient release). It is estimated that 55% of the nitrogen, 29% of the phosphorus, 57% of sediment, and 14% of the bacteria reductions from direct NPS runoff can be achieved. As described further in Section 6.2, this can be realized at only 0.3% of the cumulative cost and only 1.8% of the cost for all critical practices combined. Addressing agricultural areas will achieve outsized reductions and value, especially for nitrogen and sediment entering the Chain from surface runoff.

Although more costly per unit of sediment reduced, critical shoreline stabilization will achieve 91% of the expected critical practice reductions for sediment and 58% of the total for all site-specific BMPs. Critical urban practices will help to mitigate phosphorus from direct surface runoff, but far less when compared to all sources of loading, or 2% versus only 0.49%.

Table 6-5: Critical Practice Expected Load Reductions

BMP CATEGORY	NITROGEN REDUCTION (LBS/YR)	PHOSPHORUS REDUCTION (LBS/YR)	SEDIMENT REDUCTION (TONS/YR)	BACTERIA REDUCTION (BILLION CFU/YR)	% OF ALL BMP PHOSPHORUS REDUCTIONS	% OF ALL BMP SEDIMENT REDUCTIONS
Agricultural	7,134	425	220	276	2.3%	3.8%
Habitat Improvement	14	2.2	1.5	3.6	0.01%	0.04%
In-Lake Practices	85,043	2,925	3,313	0	16%	58%
Septic (maintenance/repair)	11,168	4,372	N/A	482,001	24%	N/A
Stream Restoration	761	89	31	113	0.49%	0.54%
Urban Practices	2,306	244	49	366	1.3%	0.86%
Wetland Creation	1,469	111	32	143	0.61%	0.56%
TOTAL:	**107,895**	**8,168**	**3,647**	**482,903**	**45%**	**64%**

6.1.1.3 Load Reduction Targets

Water quality targets were established based on review of the Upper Fox River/Chain O' Lakes (phosphorus and E. coli) Total Maximum Daily Load (TMDL) report, review of targets from watershed-based plans in other regional watersheds, the Illinois Nutrient Loss Reduction Strategy (INLRS) and coordination with stakeholders. Pollutant load reduction targets for nitrogen, phosphorus, sediment, and bacteria are shown in Table 6-6. Load reductions realized based on BMPs for which expected load reductions were estimated are included in Table 6-7.

Comparing targets to estimated reductions that can be achieved by recommendations in this plan where reductions could be quantified, phosphorus will likely not be met without additional practices and policies. Substantial sediment removal or dredging and addressing re-suspension of nutrient-rich sediment through wind and wave action will likely be needed to meet the phosphorus target. Although associated phosphorus reductions cannot be quantified at this time, it is believed that wide-spread dredging from the Chain O' Lakes system will result in the phosphorus target being met. Bacteria targets are likely met but will require mitigating potentially failing septic systems beyond the currently proposed Channel Lake/Lake Catherine and the Grass Lake/Petite Lake sewer system expansion.

Table 6-6: Load Reduction Targets

POLLUTANT	REDUCTION TARGET (%)	NOTES
Nitrogen (lbs/yr)	45%	Based on the INLRS
Phosphorus (lbs/yr)	82%	Based on highest percentage in TMDL.
Sediment (tons/yr)	68%	Based on highest value in TMDL - Load Reduction Strategy for Total Suspended Solids in lakes
Bacteria (billion CFU/yr)	70%	Based on an average of the TMDL value for Deep Lake (91%) and targets used by the Lake County Stormwater Management Commission (SMC) in other watershed plans (50%). Note that Deep Lake is within the larger Fox River, Chain O' Lakes watershed and not within the area covered by this watershed-based plan.

Table 6-7: Estimated Pollutant Load Reductions from BMPs

POLLUTANT	TOTAL ESTIMATED POLLUTANT LOADING	ESTIMATED ANNUAL POLLUTANT LOAD REDUCTIONS (TOTAL)	ESTIMATED ANNUAL LOAD REDUCTIONS (%)
Nitrogen (lbs/yr)	334,533	177,885	53% (target met)
Phosphorus (lbs/yr)	50,044	18,175	36% (target not met)
Sediment (tons/yr)	6,678	5,724	86% (target exceeded)
Bacteria (billion CFU/yr)	1,072,696	1,053,044	98% (target met)

6.2 COST ESTIMATES

Actions recommended in this plan will be implemented by numerous lead and supporting partners (as indicated in Chapter 5) and the estimated costs are spread across various watershed stakeholders. The summary that follows is intended to provide a general idea of the scope of all projects considered in the plan but is not to be construed as a single "project cost" to be borne by a lone watershed entity. Estimates are for direct implementation projects and not the administrative, project management, and watershed coordinator costs. For all BMPs, an additional 20-40% should be considered to account for engineering/permitting and annual maintenance.

Cost estimates are generated from a combination of local technical experience, previous subwatershed plans, and the United States Department of Agriculture (USDA) average practice cost list. They are generalized for watershed-scale planning purposes and these estimates should not be used to calculate costs for individual projects, as they may range significantly depending on site conditions. Appendix B includes unit cost estimates used to calculate total cost listed in Table 6-8. Potential funding sources are also included in Appendix B.

The total estimated cost to implement all site-specific action recommendations in this plan, excluding dredging and the sewer extension, is approximately $89 million. Dredging is estimated to cost between $349 million and $873 million. A breakdown by lake is in Table 6-9. Financial resources needed for the proposed Channel Lake/Lake Catherine sewer expansion is estimated to range between $63,575,000 and $81,814,000. The Grass Lake/Petite Lake sewer is expected to cost between $76,500,000 and $101,650,000. Estimates provided for septic system maintenance and repair represent costs associated with education and outreach to homeowners for a select number of critical areas described in Chapter 5.

It is important to consider that there are many complementary benefits in addition to water quality improvements that are not necessarily quantified in this estimate. When evaluating implementation strategies, it is important to consider the benefits such as green infrastructure enhancement, improved habitat, increased recreational value, and reduced flooding issues.

Table 6-8: Cost Estimates for Site-Specific Action Recommendations

BMP CLASS	BMP	QUANTITY	COST ESTIMATE
Agricultural	Bioreactor	1 (location), 45 (ac)	$40,804
	Cover Crop	797 (ac)	$82,185
	Field Border	20 (ac)	$79,837
	Filter Strip	1 (ac)	$3,713
	Grassed Waterway	3 (ac)	$24,725
	No-till or Strip-till	195 (ac)	$4,433
	WASCB	4 (basins)	$19,200
Agricultural Practices Subtotal			***$254,897***
Habitat Improvement	Invasive Removal - Wetland	152 (ac)	$151,781
	Timber Stand Improvement	85 (ac)	$85,072

BMP CLASS	BMP	QUANTITY	COST ESTIMATE
	Wetland Restoration	17.6 (ac restored)	$2,953,300
Habitat Improvement Subtotal			***$3,190,154***
In-Lake	Lake Vegetation Management	135 (ac)	$1,346,263
	Lake Aerators	57 (aerators)	$410,400
	Shoreline Stabilization	35,021 (ft rip-rap)	$6,128,743
In-Lake Practices Subtotal			***$7,885,406***
Septic/Sewer	Septic to Sewer (proposed new service area)	4,300 (connections)	$183,464,000[1]
	Septic System Repair/Maintenance[2]	754 (septic systems)	$190,000
Septic/Sewer Subtotal			$190,000
Stream Restoration	Bioswale/Stream Restoration/Wetland	41,967 (square ft), 4 (rock checks), 1 (basin), 0.1 (ac wetland)	$736,130
	Floodplain Re-Connection	4 (rock riffles), 1 (ac wetland)	$157,000
	Grade Control	3 (rock riffles), 6 (rock checks)	$157,500
	Stream/Wetland Restoration	39 (ac wetland)	$3,408,905
Stream Restoration Subtotal			***$4,459,535***
Urban Practices	Bioswale	275,414 (square ft), 150 (rock checks), 1 (basin)	$5,381,642
	Dry to Wet Detention Conversion	2 (locations)	$225,000
	Infiltration Basin	5 (locations)	$32,000
	Naturalize Detention Basin	6 (ac)	$385,000
	Permeable Pavement	3,033,486 (square ft)	$46,412,341
	Prairie Buffer	20 (ac)	$203,860
	Prairie Conversion	186 (ac)	$1,857,072
	Rain Garden/Rain Barrel/Green Roof	1,858 (locations)	$14,718,080
	Sediment Trap	255 (ft rip-rap), 2 (ac wetland), 1,210 (cubic yards sediment removal)	$369,625
	Stormwater Catch Basin	59 (basins)	$295,000
	Wet Detention Basin	13 (basins)	$1,462,500
Urban Practices Subtotal			***$71,342,120***
Wetland Creation		20 (ac. wetlands)	$1,699,110
ALL PRACTICES TOTAL COST:			**$89,021,221**

[1] – High end estimate from feasibility study for gravity sewer. Cost not included in total or subtotal. [2] – represents costs associated with education and outreach

Table 6-9: Cost Estimates for Dredging by Lake

LAKE NAME	COST ESTIMATE (LOW END)	COST ESTIMATE (HIGH END)
Bluff Lake	$3,480,386	$8,700,965
Channel Lake	$3,559,312	$8,898,279
Cross Lake	$194,833	$487,083
Dunns Lake	$11,803,866	$29,509,666
Fox Lake	$39,490,708	$98,726,772
Grass Lake[1]	**$178,265,294**	**$445,663,252**
Lake Catherine	$32,000	$80,000
Lake Catherine/Trevor Creek	$123,788	$309,470
Lake Jerilyn	$3,931,878	$9,829,695
Lake Maire	$3,336,917	$8,342,293
Lake Matthews	$979,488	$2,448,719
Lily Lake	$19,176,172	$47,940,432
Nippersink Lake	$74,775,930	$186,939,826
Petite Lake	$1,839,965	$4,599,912
Pistakee Lake	$5,148,068	$12,870,169
Redhead Lake	$1,741,600	$4,354,000
Spring Lake	$1,279,087	$3,197,718
TOTAL:	**$349,159,291**	**$872,898,251**

[1]- This project is a critical practice

6.2.1 Critical Practice Cost Analysis

Prioritizing critical BMPs will be the most cost-effective. As previously stated, 61% of the total nitrogen, 45% of the total phosphorus, 64% of the total sediment and 46% of the total bacteria reductions from all site-specific recommendations are expected to be achieved. At only 15% of the cost, or $13,499,544, critical practices should be considered first (Table 6-10). Agricultural BMPs will be the most effective at the lowest overall expenditure, or 0.27% of the total, when accounting for reductions only achieved from direct runoff. Critical habitat improvement practices are very low overall, although they will not generate measurable reductions as quantified in Section 6.1.1.2. Septic system maintenance and repair is very cost-effective, however, any load reductions achieved will rely on a wide-spread education and outreach campaign that may or may not yield results.

In-lake practices are not inexpensive compared to other categories, but they will generate outsized reductions in sediment and phosphorus and should receive priority. Lake aeration is more cost-effective than shoreline stabilization but only for phosphorus, and is limited to a relatively small number of areas experiencing internal nutrient release from lakebed sediment. Urban practices are costly overall but will achieve a reasonable amount of phosphorus reduction from direct runoff. The few critical wetland creation practices that also mitigate urban runoff should be prioritized in the short-term given the low overall cost per unit of pollutant reduced.

Table 6-10: Critical Practice Cost Estimates

BMP CATEGORY	COST ESTIMATE	% OF TOTAL CRITICAL PRACTICE COST	% OF TOTAL - ALL SITE-SPECIFIC PRACTICES
Agricultural	$240,497	1.8%	0.27%
Habitat Improvement	$26,341	0.2%	0.03%
In-Lake	$3,304,097	24%	3.7%
Septic (maintenance/repair)	$190,000	1.4%	0.21%
Stream Restoration	$945,630	7%	1.1%
Urban Practices	$8,625,940	64%	9.7%
Wetland Creation	$167,040	1.2%	0.19%
TOTAL:	**$13,499,544**	**100%**	**15%**

Sediment removal or dredging is a priority of local stakeholders and the FWA and is needed to manage external sources of sediment, maintain recreational access and mitigate internal nutrient release. At a low-end total cost of just over 178 million dollars, Grass Lake should be considered first (Table 6-9).

6.3 NEXT STEPS FOR PLAN IMPLEMENTATION

Often, the greatest challenge of any watershed management program is its coordinated implementation. Success requires widespread coordination, effective partnerships and support, local leadership, financial and technical resources, time, and a genuine willingness to translate planning to action on-the-ground. The Chain O' Lakes planning area includes many partners and supporters that will have to coordinate efforts to implement the recommendations in the action plan. No single partner has the financial or technical resources to accomplish the goals and objectives. Partners working together are necessary to achieve meaningful results. Responsible entities are defined as jurisdictions. These entities have primary responsibility for actions or practices within their boundaries and include municipalities, the FWA, townships, counties, forest preserve districts, the State of Illinois, and others. Supporting partners are described in Section 5.1.

Combining and coordinating resources, funding, effort, and leadership will be the most efficient and effective means of maintaining watershed health. Implementation of this plan will also require the development of partnerships with local, state, and federal organizations for execution, technical assistance, and funding. These efforts require the investment of a significant amount of time and resources.

Table 6-11 below shows five immediate, year-one priorities. The following subsections describe the key components of successful and sustainable plan execution.

Table 6-11: Year One Plan Priorities

RECOMMENDED ACTION/PRIORITY
1. Work with FWA and watershed stakeholders to determine specific year-1 implementation actions and short-term monitoring priorities alongside the existing Watershed Planning Committee. Focus on critical practices.
2. Research funding and technical assistance to implement recommendations identified in the action plan.
3. Submit grant applications, if applicable, and secure additional funding sources.

RECOMMENDED ACTION/PRIORITY
4. Coordinate available programs, policy changes, and other local initiatives and programs where private landowners are responsible for participation or implementation.
5. Promote and adopt the plan, prioritize and incorporate plan recommendations into existing programs, activities, and budgets.

6.3.1 Plan Adoption

Support of the goals, objectives and recommendations of the plan should be formalized through its adoption by primary implementation entities (the FWA and jurisdictions) and lead and support partners. Jurisdictions should adopt the plan so that there is a basis for the incorporation of recommendations into the operations and procedures of the organization and its pursuit of project funding and implementation relevant to the planning area. Chapter 5 outlines the planning area jurisdictions and lead and support partners responsible for implementing the action recommendations.

6.3.2 Establish, Support and Maintain a Watershed Planning Committee

One important step will be continued support for watershed organizations to lead, organize, and coordinate plan actions. Groups of stakeholders have coalesced around lakes and planning area issues pre-dating the development of this plan, participated in development of this plan, and will continue to be active in the future. These groups should continue to provide input and support to the recently established Chain O' Lakes Watershed Planning Committee (WPC). Responsibilities of the committee include administration, coordination of stakeholders to support individual watershed projects, and working with regulatory partners on recommended policies and programs.

Throughout the planning process, stakeholders have provided valuable input regarding issues, resources, priorities, and actions. The WPC can continue to hold regular meetings, take a lead in facilitating plan recommendations, organize watershed field trips, host educational workshops and forums, and bring stakeholders and multiple units of government together to discuss issues and opportunities. Supporting partners can consider whether staff positions are needed or merging with existing collaborative organizations would be beneficial in the future. The committee is encouraged to generate stakeholder interest and involvement with implementation. As projects are initiated, the positive environmental, aesthetic, and community benefits will lead to additional participation.

6.3.3 Stakeholder Participation and Engagement

There are tangible benefits to stakeholder participation in watershed activities, from positive media attention to improved quality of life for residents. Increased involvement also can yield and leverage significant local, state, and federal funding opportunities to help share the cost. Some actions can be added to existing capital improvement and maintenance plans, budgets, and schedules. This is a quick and easy approach to implementing recommendations within the purview of specific jurisdictions. In other cases, an action recommendation will require the involvement of multiple stakeholders, such as residents, a municipality, and a county, state, or federal agency to provide financial and technical support. Some actions require interjurisdictional coordination for issues and may require a longer time frame for implementation. Other actions will require the cooperation of individuals or groups of landowners, whether they are residents, homeowners' or lake associations, businesses, or institutions.

6.3.4 Identify Implementation Champions

A leader or a single champion is required to organize resources and keep project(s) moving forward. This champion may be a watershed organization, or a single entity such as a landowner, a citizens group, the FWA, or a municipality. In some cases, actions recommend the adoption of new policies, plans, or standards that modify the form, intensity, or type of development or redevelopment in the Chain in a way that better protects resources. These actions will require some effort on the part of municipalities and the FWA to understand how plans and policies can be modified and to discuss and adopt new, or adjust existing, policies, plans, and standards.

6.3.5 Resources and Funding

Funding implementation and watershed coordination actions is a priority. Securing sources of funding engages contract-level accountability and performance requirements that stakeholders are often more responsive to. There are numerous sources available to help support projects or provide cost-share to match other sources of funds. Most of the programs require a local match of funds or in-kind services. Although these funding pools can provide a good source of revenue, significant local investment of time and money will be required to move this plan forward. These soft costs must be evaluated and incorporated into the operating strategies of the individual partners.

Many federal, state, local, and private programs are available. There are numerous sources of funding available to support projects or provide cost-share to match other sources of funds. Appendix B outlines the most common and available potential sources of funding for the technical assistance and actions identified in this plan. Most BMPs recommended **are** eligible for some form of funding. Information regarding potential sources is readily available online and applicants should research available programs ahead of time to understand the funding cycles, conditions, and terms. Most grant programs require financial or labor match, thus, applications that leverage multiple sources also have the highest probability of being successful.

6.3.6 Implementation Partners

Parties who are key potential partners whose support will lead to the realization of identified goals for the planning area are listed in Chapter 5 and in the site-specific action plan tables in Chapter 5. These organizations are listed as such because they are expected to fulfill one or more of the following functions:

- Oversee or implement watershed protection, restoration, and remediation strategies.
- Acquire funding for watershed plan implementation.
- Organize or participate in data collection.
- Provide regulatory or technical guidance and issue permits.
- Monitor the success of the watershed plan.

- Develop education strategies.

Implementation of the watershed-based plan will largely rest with local units of government and the FWA, therefore, it is critical that they be involved from the beginning. They usually have the most to gain by participating and the most up-to-date information on the structure, needs, and available resources of the community. In addition, some of the most powerful tools, such as planning, controlling development standards, and zoning, reside at the local, jurisdictional level.

6.4 EVALUATING PLAN PERFORMANCE

An important component of any watershed planning initiative is the ability to monitor performance towards goals and objectives. This section focuses on the administrative-based or programmatic monitoring that tracks the activities of stakeholders and the range of actions that are implemented. Section 6.5 discusses direct monitoring of quantitative criteria such as water quality and aquatic health that indicate the effectiveness of actions.

6.4.1 EVALUATING PLAN IMPLEMENTATION PERFORMANCE

It is necessary to monitor the progress towards achieving the five goals of this watershed-based plan outlined in Chapter 2, also called "programmatic monitoring". Tracking progress relevant to these is as simple as an organized system in each jurisdiction to keep track of what is happening in their portion of the planning area. Communicating and reporting progress towards goals is equally as important as tracking them in the first place. The following recommendations are included to help track progress and achieve the goals with plan implementation.

- In the early stages of plan implementation, the existing WPC should meet at least quarterly to discuss activities and progress towards goals. A list of completed actions, proposed, and in-progress actions should be tracked for each jurisdiction.
- The plan should be evaluated every five years to assess the progress made, as well as to revise the plan, if appropriate, based on the progress achieved. The plan should also have a comprehensive review and update after 10 years (section 6.7). Amendments and changes may be made more frequently as laws change or new information becomes available that will assist in providing a better outlook for the watershed. As goals are accomplished and additional information is gathered, efforts may need to be shifted to issues of higher priority.
- The watershed planning committee should request each major jurisdiction and project partner provide an annual update, which could be in the form of a scorecard that tracks progress towards goal objectives via measurable milestones. It is an easy and effective way to compile and track progress in a measurable way and evaluate the effectiveness of achieving short, medium, and long-term goals. Scorecards are an effective way to identify what needs attention and what stakeholders should focus on in the next year.
- Other opportunities for evaluating the status of plan implementation include the completion of quarterly project reports or group meeting minutes. Since this plan is a flexible tool,

changes/modifications are anticipated based on usability and changes in priority throughout implementation.

6.4.2 Measurable Milestones and Programmatic Monitoring

Interim measurable milestones are directly tied to the Chain O' Lakes planning area performance indicators. Milestones are essential when determining if management measures are being implemented and how effective they are at achieving plan goals and objectives over given time periods. This allows for periodic plan updates and changes that can be made if milestones are not being met.

Watersheds are complex systems with varying degrees of interaction and interconnection between physical, chemical, biological, hydrological, habitat, and social characteristics. Indicators that reflect these may be used as a measure of health. Goals and objectives in the plan determine which indicators should be monitored to assess success. Physical indicators could include amount of sediment entering a lake or presence or lack of adequate buffers, whereas chemical and biological indicators could include nutrient loads. Social indicators can be measured using demographic data or, for example, the number of landowners adopting conservation practices.

Scorecards should be developed by the planning committee for each goal. Table 6-12 provides an example indicator and associated milestones for each goal as taken from the complete list in Section 6.6.

Table 6-12: Example Indicators and Milestones for Each Goal

GOAL	EXAMPLE INDICATOR	SHORT TERM MILESTONE (1-5 YRS)	MEDIUM TERM MILESTONE (6-10 YRS)	LONG TERM MILESTONE (10+ YRS)
1. Our watershed is clear enough that you can see the bottom in shallow water	Feet of stabilization projects implemented	3,000	8,000	20,000
2. Our water is free of excessive nutrients, so algae growth does not turn our water green	Number of structural BMP projects implemented	5	10	25
3. Our water is clen enough that there are no recreational restrictions for boating, swimming and fishing	Number of waters from which Illinois EPA removes bacteria impairment	1 waterbody	5 waterbodies	All waterbodies
4. Our community and stakeholders are knowledgeable and engaged in the preservation of our watershed	Number of people reached by outreach campaign.	Establish outreach campaign	5,000	10,000

GOAL	EXAMPLE INDICATOR	SHORT TERM MILESTONE (1-5 YRS)	MEDIUM TERM MILESTONE (6-10 YRS)	LONG TERM MILESTONE (10+ YRS)
5. Our communities have land within the watershed so activities to monitor, maintain and improve water quality can be implemented	Number of volunteers involved in monitoring program	10	20	30

A scorecard system should serve as a programmatic monitoring tool for tracking progress toward meeting plan goals and specific recommendations and action items. Realistic short, medium, and long-term milestones are included for each indicator in Section 6.6. Each is a specific action and is intended to fulfill objectives if executed. Indicators are to be used as measurement tools when determining if each milestone has or has not been met. If the measurement of each indicator becomes problematic, the WPC should revisit and adjust where needed. It is up to local stakeholders to determine the priority of each milestone based on their ability to follow through with them. Scorecard evaluation on an annual basis is an effective way to identify priorities and where focus should be in the next year.

Milestones in the scorecards can be graded based on the following criteria: A = Met or exceeded milestone(s); B = Milestone(s) 75% achieved; C = Milestone(s) 50% achieved; D = Milestone(s) 25% achieved; F = Milestone(s) not achieved.

6.4.3 Plan Implementation Schedule

Implementing actions should occur immediately where specific projects and willing stakeholders have been identified. A general implementation schedule is presented in Table 6-13. Short (1-5 years), medium (5-10 years) and long-term (10+ years) timeframes are also included in Section 6.5.

Table 6-13: General Implementation Schedule

TASK	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Promote and adopt the plan	X									
Determine specific year-1-5 implementation actions; establish short-term monitoring priorities.	X	X								
Research funding and technical assistance to implement priority/critical recommendations identified in the action plan.	X	X	X	X						
Submit grant applications, if applicable, and secure additional funding sources for plan implementation.	X	X	X	X	X	X	X	X		
Coordinate available programs, policy changes and other local initiatives and those programs where private landowners are responsible for signing up.	X	X	X	X	X	X	X	X	X	
Project planning, site surveys and project design and budget development.		X	X	X	X	X	X	X	X	

TASK	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
Prioritize and incorporate plan recommendations into existing programs, activities, and budgets.	X	X	X	X	X	X	X	X	X	X
Implementation and construction of projects.			X	X	X	X	X	X	X	X
Report and monitor progress.	X	X	X	X	X	X	X	X	X	X
Communicate success stories.		X	X	X	X	X	X	X	X	X
Evaluate accomplishments.			X			X				X
Update Watershed-Based Plan.										X

6.5 WATER QUALITY MONITORING STRATEGY

In-lake water quality monitoring is a great strength in the Chain. The long-term and robust datasets collected by multiple organizations such as Illinois EPA and the Lake County Health Department (LCHD) are essential to understanding water quality, ecology and changing conditions. However, there exists an additional need in the planning area that will support a quantitative means to assess the effectiveness of plan implementation and the cumulative contribution towards goals and objectives, water quality and flow on the major tributaries that empty into the Chain.

Tributary monitoring allows for better characterization of watershed inputs and prioritization of management actions. The Fox River and Nippersink Creek have substantial monitoring of both flow and water quality, however, others like Trevor Creek, Lily Lake Drain, Sequoit Creek, and Manitou Creek, have no data. The need for additional data collection has clearly been prioritized by stakeholders.

Another data gap is a systematic bacteria monitoring program. The LCHD does monitor bacteria levels at swimming beaches, but with the very heavy recreational use of the entire Chain, this monitoring is insufficient for assessment of levels and sources and provides little information for mitigating system-wide issues.

Section 3.3.4 summarizes existing programs and identifies location of monitoring sites and water quality data that provided valuable information to support this plan. Several gaps were identified, and data collection recommendations are presented in the following subsections. Additional volunteers, coordination with existing entities, and new partnerships such as engaging the Fox River Study Group (FRSG) will be needed to ensure adequate resources and assist with data management.

Prior to expanding current programs based on this strategy, a more detailed monitoring plan or Quality Assurance Project Plan (QAPP) should be developed by volunteers and agencies already conducting data collection activities in the planning area. A more detailed plan will formalize sampling locations, parameters and frequency, equipment and techniques, responsible entities, quality control procedures, data management, estimated costs, resources needed, and reporting.

6.5.1 Lake Water Quality Monitoring

Current lake and stream water quality monitoring programs administered by the Illinois EPA and LCHD are detailed in Chapter 3. These programs should be continued and strengthened. Stakeholders should consider advocating for annual data collection on at least a subset of the lakes in the system to create a higher temporal resolution dataset that will provide better insight into water quality conditions across time. A list of the minimum baseline parameters that should be collected are listed in Table 6-14.

Table 6-14: Recommended Minimum Parameters for Baseline Water Quality Monitoring

PARAMETERS	PARAMETERS
Total Phosphorus (TP)	Nitrate-N
Total Suspended Solids (TSS)	Chloride
Total Dissolved Solids (TDS)	Fecal Coliform Bacteria
Ammonia-N	Dissolved Oxygen (DO)
Total Kjeldahl Nitrogen (TKN)	Temperature
Conductance, Specific	pH
Secchi Depth	-

6.5.1.1 Expanded Lake Monitoring – Illinois EPA and LCHD

Several waterbodies in the Chain O' Lakes system have not been monitored consistently. Lac Louette, Lake Jerilyn, and Lake Matthews all should be considered as additions to a future program. A single site on each lake is likely sufficient for monitoring baseline conditions, with frequency matching that of the other lakes.

6.5.1.2 Bacteria Monitoring and Source Study

Fecal coliform bacteria, such as E. coli, has been a persistent issue in the Chain. Current monitoring is limited to public beaches to protect public health. Beach closures are issued if bacterial concentrations reach health advisory levels. Other than this seasonal and localized beach monitoring, bacteria sampling has been limited and, thus, there is little information on the sources of contamination and the spatial extent of the issue. A systematic program should be considered over a larger area and should include differentiation of bacterial species. This type of program can help to understand sources, such as human waste from failing septic systems, and other sources such as pet waste and wildlife. With this information, specific management practices may be implemented to mitigate sources of contamination.

6.5.1.3 Continuous Monitoring

Continuous water quality monitoring with sensors allows for high temporal resolution data collection and capturing of daily minima and maxima of parameters like DO and pH that vary daily. In addition, parameters such as turbidity and conductivity can provide insight into processes that occur on short time scales which are not captured with typical grab sampling. Installation of one or more continuous monitoring stations should be considered to provide real-time high-resolution data. The goals of such monitoring will dictate what type of equipment should be installed and where. Location options include fixed stations attached to infrastructure like seawalls or bridge piers or floating options such as data collection buoys.

6.5.1.4 Illinois Volunteer Lake Monitoring Program (VLMP)

The Illinois EPA established the VLMP program in 1981 to engage and educate the public about lake health and lake management while developing a means to collect data and observations about lakes throughout Illinois. The program historically funded volunteer training programs, technical and administrative support to volunteers, and laboratory analysis costs. As volunteers gained experience, they graduated to higher tiers of data collection and lake assessment as shown in Table 6-15. Not only is the data useful, but volunteers often feel an enhanced sense of ownership of the subject of their work and become champions of work to enhance their lake.

The VLMP was suspended indefinitely by the Illinois EPA in 2019, though historic data and methods documents remain available online. Historically, the Chain has had several very strong volunteer groups or lake associations that collected data as part of the program. The measurements collected by participants represent a long-term dataset, making it highly useful, and the value only grows with each additional year of data.

Stakeholders should strongly consider leveraging the history of involvement and continue to collect data under the VLMP protocols, formalizing a program under the leadership of a local organization such as the LCHD. Provisions should be made for a locally managed database or repository so that any data that has been collected since the suspension of the VLMP is brought into one location. If Illinois EPA restarts the program, data can be submitted to the state-wide database.

Table 6-15: Monitoring Tiers of the Illinois VLMP

TIER LEVEL	DESCRIPTION OF VLMP MONITORING TIERS
Tier 1	Volunteers perform Secchi disk transparency monitoring and field observations only. Monitoring is conducted twice per month from May - October, typically at 3 in-lake sites. Field observations include the presence of invasive species, including installation and monthly observations of zebra mussel plate installed near boat launch.
Tier 2	In addition to Tier 1, volunteers collect water samples for nutrient and suspended solid analysis at the representative lake site (site 1). Water quality samples are taken only once per month, May - August, and October in conjunction with one Secchi transparency monitoring trip.
Tier 3	In addition to Tier 1 and 2, volunteers collect water samples at up to 3 sites on their lake. Their samples are analyzed for nutrients and suspended solids. They also collect and filter their own chlorophyll samples. Dissolved Oxygen and temperature profiles may also be performed, depending on equipment availability. Data collected in Tier 3 is used in the category 5 Integrated Report and is subject for use in designating state impaired waters.

6.5.2 TRIBUTARY WATER QUALITY AND FLOW MONITORING

The Illinois EPA monitors the Fox River and Nippersink Creek as part of the existing ambient water quality monitoring network. However, several other tributaries have no monitoring at all. A sustainable tributary monitoring program with basic water quality and nutrient data should be established and financed to support further characterization of water quality entering the system. Streamflow and stage monitoring stations should be established alongside water quality sites to allow for load calculations. Having these tributary sites will allow for tracking improvements in the watershed through time and further focusing of management activities. Flow monitoring should be continuous and water quality sampling should occur quarterly at minimum with a monthly frequency preferred. In addition, for the streams outside the planning area with existing monitoring programs, increasing the frequency of data collection should be considered. Currently, the Fox River upstream of Grass Lake (IL_DT-35) and Nippersink Creek (IL_DTK-04) are monitored approximately 8 times per year by Illinois EPA. Increasing the frequency should be considered, especially during the spring months when runoff is higher. Additional samples during this period will allow for more precise quantification of nutrient and sediment loads, as this is when loading to the Chain O' Lakes is greatest.

Trevor Creek and Lily Lake Drain are streams within the planning area that have no data. Manitou Creek and Sequoit Creek are significant tributaries outside the planning area without data but contribute to water quality in the Chain. Each should be considered for monitoring of flow and basic water parameters. A program on these tributaries will allow for quantitative tracking of water quality improvements over time.

6.5.3 Physical conditions and Sedimentation Monitoring

Sedimentation and physical conditions are all important issues to track as evidenced by the information synthesized in other sections of this plan. Monitoring recommendations include lake bathymetry or water depth, tracking of sediment removal and shoreline erosion.

6.5.3.1 Lake Bathymetry

Bathymetric mapping of the lake bottoms has been sporadic across time and, thus, there is little information on the specific effects of sedimentation on the Chain. This type of survey should be completed routinely across the whole system, on no less than a 10-year cycle. In addition, several cross-sections should be surveyed more frequently to have a better understanding of the changes that occur on a finer time scale. This type of bathymetric monitoring is recommended to elucidate the rate and patterns of sediment deposition, internal movement, and export.

6.5.3.2 Dredging

Sediment removal is an important part of managing the Chain O' Lakes, though it is only a treatment for a symptom of issues. Detailed records of dredging activities should be maintained by the FWA, including geospatial data of the extent. In addition, bathymetric surveys should be completed immediately after dredging activities and every 2-3 years to help track where sedimentation causes issues and how quickly those treated areas may fill back in.

6.5.3.3 Shorelines

Unprotected shorelines and failing structures are a significant source of sediment and nutrients. As described in Chapter 3, a complete inventory of erosion was completed in 2022 and can serve as a baseline. Continuing to inventory shorelines periodically will help to track additional changes over time and help to prioritize where shoreline stabilizations or repairs are needed. In addition, areas with natural shoreline or areas with large, vegetated mats should utilize direct survey techniques, such as bank pins or aerial imaging, to monitor the rate of retreat to help prioritize areas that are most in need of management as conditions change.

6.5.4 Biological and Ancillary Monitoring

Biological monitoring can provide important indicators of water quality and ecosystem health. For example, periodic assessments of fish populations by the Illinois Department of Natural Resources (IDNR) can provide important insight into conditions or issues that are not apparent in water chemistry results. Another important program is Illinois RiverWatch that trains volunteers to adopt a stream section and collect macroinvertebrates (bugs) that act as indicators of water quality. In most cases, data collected by volunteers can provide an important record of water and habitat quality.

Local agencies and existing groups also conduct important monitoring, which should be continued and encouraged. The Lake County Forest Preserve District (LCFPD) is one example. The district monitors wildlife populations to detect trends and the impacts of management of lands in their portfolio. Specifically, monitoring of species of conservation concern is emphasized, and should be expanded. In the planning area, the Blanding's Turtle is of concern and the LCFPD should lead additional monitoring on conservation lands such as the Chain O' Lakes State Park, Grant Woods, Gander Mountain, and Bluebird Meadow. While these activities are not directly related to water quality in the planning area, they do provide important indicators of quality habitat which often translates to improved water quality.

6.6 PLAN IMPLEMENTATION MILESTONES

This section includes goals, objectives, indicators, and measurable milestones. Table 6-16 through Table 6-20 list all milestones established for the watershed plan. The "Objective ID" columns reference Chapter 2, Section 2.2 goals (number) and objectives (letter).

6.6.1 Watershed Goal #1 Milestones

Our water is clear enough that you can see the bottom in shallow water - *increased water clarity is indicated by reduced turbidity and suspended solids*. Timeframe: Short (**S**): 1-5 years, Medium (**M**): 6-10 years, Long (**L**): 10+ years.

Table 6-16: Goal 1 Milestones

OBJECTIVE ID	INDICATOR	TIMEFRAME	MILESTONE
1a	Feet of stabilization projects implemented.	S	3,000
		M	8,000
		L	20,000
1b	Number of structural BMP projects implemented.	S	10
		M	30
		L	80
1c	Cubic yards of sediment removed.	S	600,000
		M	800,000
		L	1,000,000

OBJECTIVE ID	INDICATOR	TIMEFRAME	MILESTONE
1d	Acreage under riparian area management and restoration including practices such as buffers and conversion to native prairie.	S	10
		M	30
		L	80
	Number of waters from which Illinois EPA removes the aquatic life use impairment.	**S**	1 waterbody
		M	5 waterbodies
		L	All waterbodies
1e	Number of public agencies with winter maintenance responsibilities that use alternative de-icing products.	S	4
		M	8
		L	all
1f	Number of green infrastructure projects.	S	2
		M	6
		L	12

6.6.2 Watershed Goal #2 Milestones

Our water is free of excessive nutrients, so algae growth does not turn our water green - *eliminate harmful algae blooms from the Chain O' Lakes*. Timeframe: Short (**S**): 1-5 years, Medium (**M**): 6-10 years, Long (**L**): 10+ years.

Table 6-17: Goal 2 Milestones

OBJECTIVE ID	INDICATOR	TIMEFRAME	MILESTONE
2a	Number of structural BMP projects implemented	S	10
		M	30
		L	80
2b	Number of urban retention/detention BMPs implemented.	S	3
		M	5
		L	10
2c	Acreage under riparian area management and restoration including practices such as buffers and conversion to native prairie.	S	10
		M	30
		L	80

6.6.3 Watershed Goal #3 Milestones

Our water is clean enough that there are no recreational restrictions for boating, swimming and fishing - *eliminate beach closures from the Chain O' Lakes*. Timeframe: Short (**S**): 1-5 years, Medium (**M**): 6-10 years, Long (**L**): 10+ years.

Table 6-18: Goal 3 Milestones

OBJECTIVE ID	INDICATOR	TIMEFRAME	MILESTONE
3a	Cubic yards of sediment removed.	S	600,000
		M	800,000
		L	1,000,000

OBJECTIVE ID	INDICATOR	TIMEFRAME	MILESTONE
3b	Number of waters from which Illinois EPA removes bacteria impairment.	S	1 waterbody
		M	5 waterbodies
		L	All waterbodies
3c	Increase in native plant diversity.	S	1% above baseline (2023)
		M	2% increase
		L	5% increase
3d	Increase in native fish species and health.	S	1% above baseline (2023)
		M	2% increase
		L	5% increase
	Number of waters from which Illinois EPA removes fish consumption impairment.	S	Grass Lake
		M	Fox Lake
		L	Maintain Grass Lake /Fox Lake

6.6.4 Watershed Goal #4 Milestones

Our community and stakeholders are knowledgeable and engaged in the preservation of our watershed - *there is an active watershed group driving education and clean up and advocating for policies and projects in the watershed*. Timeframe: Short (**S**): 1-5 years, Medium (**M**): 6-10 years, Long (**L**): 10+ years.

Table 6-19: Goal 4 Milestones

OBJECTIVE ID	INDICATOR	TIMEFRAME	MILESTONE
4a	Number of people reached by watershed outreach campaign	S	Establish outreach campaign / 2,000
		M	3,000
		L	6,000
	Number of workshops, educational events, and meetings held	S	40
		M	50
		L	60
	Number of volunteers and volunteer organizations active in the Chain.	S	50 volunteers / 2 organizations
		M	100 volunteers / 2 organizations
		L	200 volunteers / 3 organizations
4b	Number of entities reached by watershed outreach campaign.	S	5
		M	10
		L	15
	Number of workshops, educational events, and meetings held.	S	40
		M	50
		L	60
4c	Number of private landowners reached.	S	500
		M	1,000
		L	2,000
	Number of recommended BMPs installed on private ground.	S	8
		M	20
		L	40
4d	Number of educational events and workshops specific to septic system maintenance.	S	10
		M	10
		L	15
	Number of septic systems eliminated and connected to sewer.	S	0
		M	0
		L	4,300

6.6.5 Watershed Goal #5 Milestones

Our communities have land within the watershed so activities to monitor, maintain and improve water quality can be implemented - *there is sufficient monitoring that there is an accurate picture for the Illinois EPA to determine if the watershed is impaired, and there is access and supporting land that major maintenance within the Chain can be completed on a regular basis*. Timeframe: Short (**S**): 1-5 years, Medium (**M**): 6-10 years, Long (**L**): 10+ years.

Table 6-20: Goal 5 Milestones

OBJECTIVE ID	INDICATOR	TIMEFRAME	MILESTONE
5a	Number of water bodies meeting applicable standards.	S	1 waterbody
		M	5 waterbodies
		L	All waterbodies
5b	Implementation and support of watershed monitoring program.	S	Develop monitoring program
		M	Implement program
		L	Continued implementation/adaptation of program
	Regular reports on water quality monitoring to community and stakeholders.	S	Develop monitoring program
		M	Collect data, baseline report
		L	Subsequent reporting
	Number of volunteers involved in monitoring program.	S	15
		M	20
		L	30

6.7 UPDATING THE WATERSHED-BASED PLAN

Watershed-based plans are required by the Illinois EPA to be updated every 10 years. Furthermore, the watershed-based plan should be revised, as necessary, as new information is received, and progress is made. For example, as additional data becomes available, it can be used to revise loading estimates and determine if implementation efforts are achieving stated goals, milestones, and reduction targets. Plan updates do not require an entire rewrite; typical elements that will likely require a major update or revision are summarized in Table 6-21.

Table 6-21: Plan Update Elements and Responsibilities

MAJOR PLAN ELEMENT REQUIRING UPDATE	ELEMENT COMPONENT REQUIRING UPDATE	LEAD RESPONSIBLE ENTITY (S)	PRIMARY SUPPORTING PARTNERS
Watershed Characterization	• Land use information • Water quality data/analysis • Stream/lake impairments • Climate, demographics, jurisdictions • Pollution loading	FWA	• Jurisdictions • Watershed Planning Committee • CMAP
Action and Implementation Plan Components	• Project recommendations • Expected load reductions • Milestones, timeframes, and priorities • Responsible parties and support partners • Monitoring plan	FWA	• Jurisdictions • Watershed Planning Committee • CMAP

CHAPTER SEVEN: EDUCATION & COMMUNICATION STRATEGY & TOOLS

CONTENTS

LIST OF TABLES

COMMON ACRONYMS/ABBREVIATIONS USED IN CHAPTER 7

BMP – Best Management Practices

CMAP – Chicago Metropolitan Agency for Planning

FWA – Fox Waterway Agency

HOA – Homeowners Association

IDNR – Illinois Department of Natural Resources

Illinois EPA – Illinois Environmental Protection Agency

ILMA – Illinois Lakes Management Association

LCHD – Lake County Health Department

LCFPD – Lake County Forest Preserve District

MCHD – McHenry County Health Department

MCCD – McHenry County Conservation District

NRCS – Natural Resources Conservation Service

PSA- Public Service Announcement

SMC – Lake County Stormwater Management Commission

SWCDs –Soil and Water Conservation Districts (McHenry-Lake)

USEPA – U.S. Environmental Protection Agency

USGS – United States Geological Survey

WPC – Watershed Planning Committee

7 EDUCATION AND COMMUNICATION STRATEGY AND TOOLS

This chapter provides a strategy for all watershed stakeholders for information, education, and public involvement to address watershed topics and issues. The education and communication strategy provides messaging and motivation for each target audience (Section 7.3) to help achieve watershed goals and objectives.

7.1 WATERSHED INFORMATION AND EDUCATION NEEDS

Community engagement, outreach and education are essential components of the Chain O' Lakes Watershed-Based Plan. The education and communication strategy is designed to:

- Raise public awareness about watershed issues and foster support for solutions.
- Educate stakeholders, the public, and other identified target audiences to increase awareness and encourage behavioral changes.
- Provide engaged stakeholders the knowledge and skills they need to become watershed stewards and implement action recommendations (Chapter 5).
- Leverage public and private partnerships to implement action items.

7.2 RECOMMENDED PROGRAMS

Development of an education and communication program begins by defining goals and objectives. During the planning process, the Watershed Planning Committee (WPC) discussed and approved the following goal and objectives related to education and communication.

WATERSHED EDUCATION & COMMUNICATION GOAL: Our community and stakeholders are knowledgeable and engaged in the preservation of our watershed.

OUTCOME: *Stakeholders have adequate information, knowledge and opportunity to implement the watershed plan.*

OBJECTIVES:

a) Conduct an outreach campaign to inform and engage the public about watershed issues and solutions, landowner responsibilities and opportunities, available resources, and the benefits of implementing the plan recommendations.

b) Build on cross-coordination between agencies, units of government, and the public for assistance in implementing goals and objectives, and to provide the necessary tools to become watershed stewards.

c) Educate local government officials and agencies, consultants and contractors working in the watershed, landscapers and nurseries, and landowners on best practices related to Chain O'Lakes shoreline and shoreline maintenance/management to reduce erosion.

d) Educate local government officials and agencies, consultants and contractors working in the watershed, landscapers and nurseries, property managers, and landowners on road salt alternatives and application

Best Management Practices (BMPs) to minimize the use or impact of road salt by public and private snow removal providers.

e) Promote the use of phosphorus-free lawn fertilizers by homeowners and the contractors who maintain those turf areas.

f) Promote proper septic management and maintenance and support new sewer infrastructure where and when feasible.

g) Promote the appropriate BMPs to reduce the nutrient transmission from turf and surfaces into the waterways due to pets and waterfowl.

h) Promote installation of property level green infrastructure projects such as rain gardens, bioswales, vegetative buffers, etc., to reduce stormwater runoff and gully formation and sedimentation.

i) Utilize training, workshops, public meetings, personal site visits, newsletters, websites, media, campaigns, and stakeholder word-of-mouth to provide stakeholders opportunities to participate in watershed programs and projects.

j) Facilitate and engage the public and homeowner associations to volunteer for stream, shoreline, beach and natural area stewardship and maintenance.

k) Include information on funding and grant resources to interested stakeholders to encourage the implementation of recommended BMPs when appropriate.

l) Support watershed data collection and monitoring and increase a volunteer pool of monitors.

m) Increase the amount of watershed-related informational signage.

7.3 TARGET AUDIENCES

The audiences for specific education and communication activities and topics include public and private organizations, watershed residents and landowners, the general public, and professionals within the Chain. These audiences have a wide range of understanding of watershed issues and needs for further education and communication. Education and communication aim to be responsive to existing partners, attract stakeholders that have not previously participated in watershed improvement activities, and align messages with audience knowledge levels and motivations. Education and communication partners include the entities listed and discussed below.

7.3.1 Local Government Officials and Agencies

Continued support from local governments and public landowners will be critical to the education and communication strategy. These officials and agencies develop policies and regulations and manage the land and projects within the watershed. They will need to commit to projects on public lands and communicate with and motivate residents to participate in watershed improvements. The local government target audience includes:

- Municipalities.
- Townships.
- County agencies.
- Elected officials and policy-makers.
- Park districts, forest preserve, and conservation districts.
- Public works agencies.
- Transportation agencies (including Highway Commissioners).

7.3.2 Residents and Landowners

Numerous residents and landowners in the watershed have participated in one or more plan or WPC meetings. The target audience includes the following groups or residents:

- All residents and landowners.
- Not-for-profit and environmental interest groups.

7.3.2.1 Riparian and Lakeshore Landowners

Riparian landowners may have a disproportionate impact on stream, lakeshore and wetland areas, and often have a vested interest in improving watershed conditions to protect their property, comply with regulations, or enhance property values. These areas are critical locations because they contribute to problems or hold the key to solutions. Therefore, this subset of property owners should be targeted for special attention in the education and communication strategy. The target audience includes the following groups of landowners:

- Homeowner associations (HOAs).
- Single family residences.
- Commercial and multifamily residential properties.
- Owners of undeveloped land.
- Agricultural land operators.
- Utility companies located in floodplains or along streams, lakes, and wetlands.
- Public landowners.

7.3.3 Developers, Homebuilders, Consultants, and Contractors

The land development process has the potential to adversely affect watershed conditions, but interests can be balanced with goals, if identified prior to or early on in the design and development process. Developers and homebuilders should adopt a variety of best development standards and comply with regulations, codes, and ordinances to protect watershed resources.

Several engineering, environmental and other consultants have participated in stakeholder meetings and provided their expertise to the planning process. This plan will provide them with resources to share with their clients and support for prioritization of future projects. They can then communicate messages to motivate BMP adoption for watershed improvements. The target audience of consultants and contractors includes:

- Engineering, landscape architectural and environmental consulting firms.
- Restoration contractors.
- Legal counsel.
- Insurance companies.
- Realtors.
- Winter maintenance product/equipment suppliers.
- Winter maintenance (snow removal) contractors.

7.3.4 Landscapers and Nurseries

Landscapers, landscaper suppliers, lawn and garden centers, nurseries, hardware stores, large retail establishments, and snow removal contractors can make a huge impact by learning and following watershed-friendly lawn care and winter maintenance practices, especially by reducing their use of pollutants such as chloride and phosphorus.

- Landscapers and property managers/caretakers.
- Large landscape/property manager suppliers.
- Lawn and garden centers.

7.3.5 Marinas and Waterfront Businesses

Marinas and waterfront businesses depend on the Chain for a large portion of their summer income due to the recreational resources available in the area. They exhibit their support for a clean watershed through management of impervious parking surfaces, BMP implementation where feasible, posting educational signage, and overall support. Training to be provided in the future can influence where waterway users spend their hard-earned funds.

- Marina owners/managers.
- Watercraft dealers and rental companies.
- Food and food service providers.
- Resorts, hotel, campgrounds and other service providers.

7.4 PARTNER ORGANIZATIONS

Organizations that will be responsible for implementing plan recommendations can assist in education and communication and can also be one of the targeted audiences. Each partner should couple implementation efforts with parallel initiatives to inform and educate. Several educational programs are currently being executed by other organizations that watershed stakeholders may take advantage of. See Table 7-1 below for a list of potential partner organizations to work alongside the Fox Waterway Agency (FWA) and WPC.

Table 7-1: Partner Organizations

POTENTIAL PARTNER ORGANIZATIONS	
Watershed Residents and Landowners	Park Districts
Businesses, Realtors and Chambers of Commerce	Natural Resource Conservation Service (NRCS)
Chicago Metropolitan Agency for Planning (CMAP)	Soil and Water Conservation Districts (SWCD)
Lake and McHenry Counties	Master Gardeners, Garden Clubs
Local Environmental Groups	Schools and Colleges/Universities
Lake County Forest Preserve District (LCFPD) and McHenry County Conservation District (MCCD)	Lake County Stormwater Management Commission (SMC)
HOAs	Townships
Illinois Department of Natural Resources (IDNR)	Transportation Departments
Illinois Environmental Protection Agency (Illinois EPA)	United States Environmental Protection Agency (USEPA)
Illinois Lakes Management Association (ILMA)	United States Geological Survey (USGS)
Lake and McHenry County (including Planning, Building and Development)	WPC and volunteers
Lake County Health Department (LCHD)	Youth Groups
McHenry County Health Department (MCHD)	Municipalities (including Public Works Departments)

7.5 GUIDANCE FOR IMPLEMENTATION

The following list provides general guidance for the education and communication strategy. More detailed recommendations for addressing specific watershed issues are included in Table 7-3.

- Use words that the general public can understand and speak to their existing values and priorities.
  - Basic watershed science education (e.g., biology, the water cycle, and stream ecology) may be needed when the audience has little knowledge about streams, lakes, wetlands, or watersheds.
  - Identify and provide for different levels of understanding and the needs of various audience groups. When interacting with a group, stress the dimensions of the project that apply most to them. For example, with homeowners, focus on items such as rain gardens, lawn care, pollution prevention and restoration, and management of riparian areas/shorelines. Develop a similarly targeted menu of topics and look for opportunities to "cross train" target audiences.
  - Inform the audience about actions they can take, and behaviors they can change to help address watershed problems and issues.
- Develop multiple messages and update existing messages as needed. Use one broad theme for the general public and a series of more specifically targeted messages for specific audiences (e.g., landowners, business owners, and municipalities).
  - Keep the message simple and straightforward with only two or three take-home points at a time; use graphics and photos, and repeat it frequently. Keep messages positive.
  - Emphasize the connections between the message and watershed stakeholder issues. For example, connect to the Chain, storms, streams, land management, the urban landscape, and streets.

- Coordinate the education and communication strategy with partner organizations to combine efforts, achieve economies of scale, tap into one another's networks, share costs, and ensure consistent messages.
- Use websites and other social media, as well as public places, such as libraries and village newsletters, to post and promote.
  - All materials and messages should promote the local watershed groups, with contact information and information on how to get involved.
  - Develop materials and messages that anyone can use.

7.6 MESSAGE FORMATS AND DELIVERY MECHANISMS

Numerous existing programs, tools and materials are available that can be used or customized to accelerate education and communication efforts. See Table 7-2 below for examples of education and communication through print, electronic, visual, and personal contact communication efforts.

Table 7-2: Examples of Education and Outreach Formats and Delivery Mechanisms

PRINT	ELECTRONIC	VISUALS	PERSONAL CONTACT
Brochures	Social Media	Displays/Exhibits	Demonstrations, field trips, lakes/watershed tours
Fact sheets	Websites/Interactive Maps	Signage	Presentations (meetings, seminars, etc.)
Newsletters	E-News/Emails	Posters	Interviews
News releases	Videos	Bulletin boards	Surveys
Grant application technical resources	Public Service Announcements (PSA)	Presentations	Targeted/one-on-one discussions and technical assistance
Inserts/FWA Stickers	Bulletin Boards		
Flyers	Surveys		
Feature articles			
Media kit			

7.7 EVALUATING PLAN OUTREACH

Watershed plan evaluation provides a feedback mechanism for ongoing improvement of a communication effort and for assessing whether the effort is successful to further activities and generate/support funding. The entity or persons responsible for implementing the education and information campaign should customize it using information gathered.

Collect baseline information or survey current knowledge before the activities begin and check periodically throughout the campaign to help measure progress and effectiveness. Evaluations conducted early in the effort will help determine which programs are working and which ones are not. Based on this information, money and time can be saved by focusing on the programs that work and discarding those that do not. Indicators to evaluate and monitor and a timeframe for each watershed goal are listed in **Chapter 6**.

7.8 WATERSHED INFORMATION AND EDUCATION RESOURCES

Watershed education and outreach is not new. There are many resources already available that include effective messages, delivery techniques, watershed management planning, media relations, and strategies to assist with developing a campaign. Although larger educational activities, such as training workshops and demonstration projects, may require public or private grant sources, many can be established into partner work activities, projects, and education programs.

Table 7-3 provides educational messages, outreach vehicles and methods, target audiences, and partner leads to implement the Chain O' Lakes watershed education and communication strategy. It is important to note that it is based on issues, opportunities, goals, and objectives presented in Chapter 2. The vehicles and methods, partner leads, and messages columns listed are not comprehensive, but are noted as the most effective means of disseminating education and outreach topics to that target audience. This table and plan chapter were created to act as strategy and roadmap for stakeholders and to help guide partner leads (identified below) for their own objectives and activities. Although partner leads are identified below, there could be other appropriate partner and support leads not listed.

Table 7-3: Educational Topics, Messages and Partners

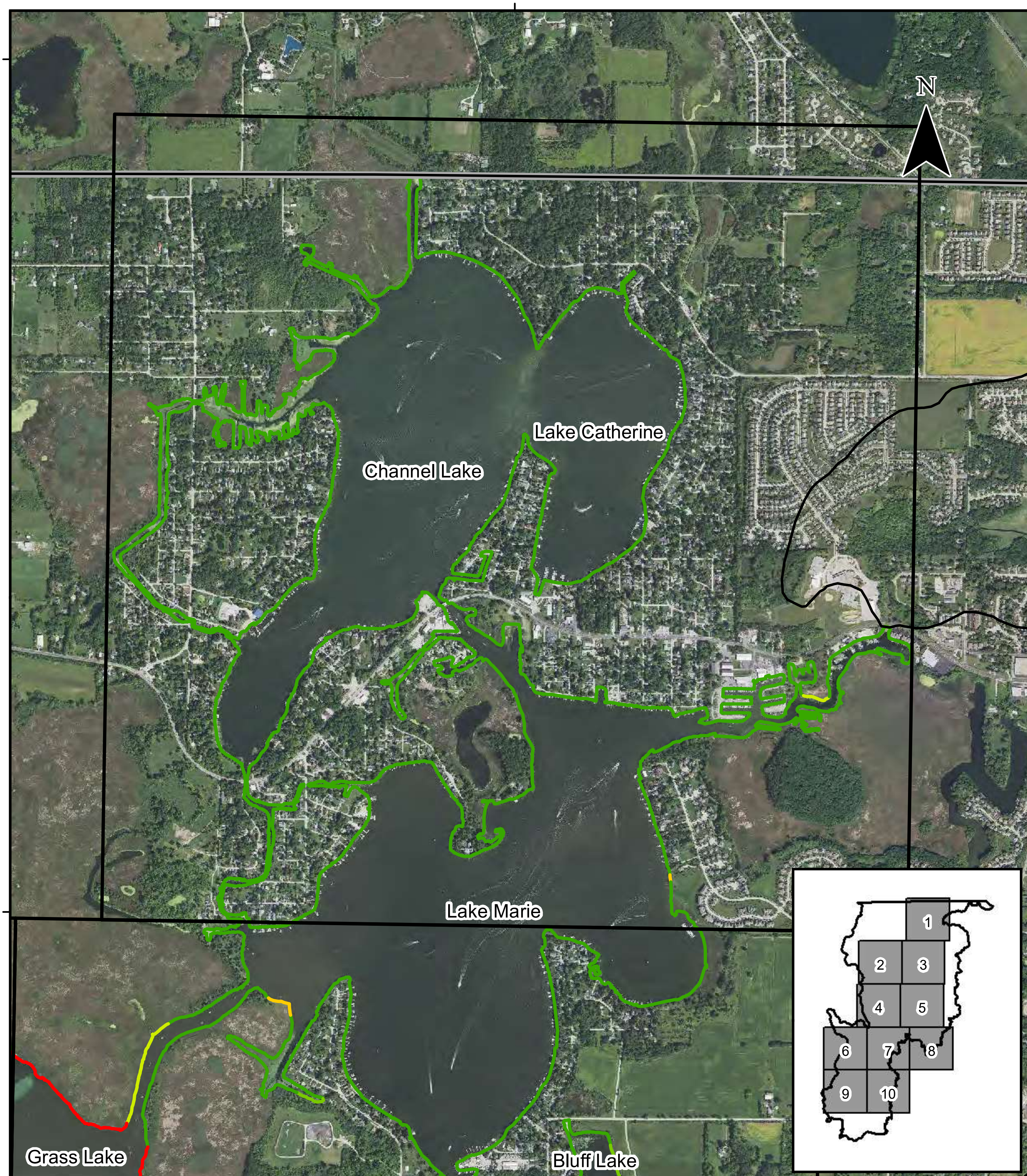
TARGET AUDIENCE	WATERSHED GOALS	VEHICLE/ METHOD	PARTNER LEADS	MESSAGES (TOPICS/ACTIONS)
Local Government Officials and Agencies	1, 2, 3, 4, 5	Emails, newsletters, websites, social media, targeted/one-on-one discussions and technical assistance, technical resources, seminars, or training	FWA, Watershed Planning Committee, Counties, Municipalities, CMAP, LCFPD, MCCD, SMC, IDNR, Illinois EPA, HOAs	Adoption and implementation of the Chain O' Lakes Watershed-Based Plan
				Promote installation of property-level green infrastructure projects such as rain gardens, bioswales, vegetative buffers, etc. to reduce stormwater runoff, shoreline erosion, and gully formation
				Build on existing coordination for public and governmental participation in implementation of goals and objectives and to provide the necessary tools to become watershed stewards through creation of a watershed working group
				Promote the use of phosphorus-free lawn fertilizers by homeowners and contractors who maintain their lawns
				Promote the use of animal control BMPs to reduce pet and waterfowl waste through homeowners, governmental agencies, and businesses to reduce nutrient runoff
				Promote watershed data collection, monitoring and increase volunteer pool of monitors
				Increase the amount of watershed-related informational signage on the watershed

TARGET AUDIENCE	WATERSHED GOALS	VEHICLE/ METHOD	PARTNER LEADS	MESSAGES (TOPICS/ACTIONS)
Residents Landowners	1, 2, 3, 4, 5	Social media, brochures, newsletters, factsheets, inserts/FWA stickers, education signage at demonstration sites	FWA, WPC, SMC, counties, municipalities, LCFPD, MCCD, Park Districts	Promote the economic/quality of life benefits of water quality improvement.
		Social media, brochures, newsletters, factsheets, and trainings	FWA, WPC, SMC, counties, municipalities, local environmental groups, LCFPD, MCCD	Promote installation of property-level green infrastructure projects such as rain gardens, bioswales, vegetative buffers, etc. to reduce stormwater runoff.
				Role and responsibility of landowners and BMPs related to shoreline stabilization and riparian management.
				Educate the public on winter de-icing BMPs as used by the counties, to share with their private snow and ice removal companies.
		Targeted/one-on-one discussions and technical assistance, specific outreach programs (e.g. Conservation@Home), social media, brochures, newsletters, factsheets	WPC, local environmental groups, LCHD, MCHD, volunteers	Promote installation of property-level green infrastructure projects such as rain gardens, bioswales, vegetative buffers, etc. to reduce stormwater runoff.
		Social media, brochures, newsletters, factsheets	FWA, WPC, municipalities, counties, LCHD, MCHD, LCFPD, MCCD, local environmental groups, HOAs	Participate in stream, beach, and natural area stewardship and maintenance opportunities, develop a contest or other initiative to encourage area clean-up of man-made debris.
				Promote the use of animal control BMPs to reduce pet and waterfowl waste to reduce nutrient runoff.
				Promote proper septic and sanitary sewer maintenance by providing education and outreach to homeowners with septic systems.

TARGET AUDIENCE	WATERSHED GOALS	VEHICLE/ METHOD	PARTNER LEADS	MESSAGES (TOPICS/ACTIONS)
Developers, Homebuilders, Consultants and Contractors	1, 2, 3, 4, 5	Presentations (meetings), emails, newsletters, websites, targeted/one-on-one discussions	FWA, WPC, counties, municipalities, SMC, CMAP	Implement designs that reduce impervious areas and include green infrastructure and BMPs to reduce runoff beyond current development requirements.
				Participation in Watershed Planning Committee and/or public meeting forums.
				Promote installation of property-level green infrastructure projects such as rain gardens, bioswales, vegetative buffers, etc. to reduce stormwater runoff.
				Implement plan action recommendations.
Landscapers and Nurseries	1, 2, 3, 4, 5	Brochures, newsletters, social media, websites, educational signage at demonstration sites, targeted/one-on-one discussions	WPC, Master gardeners, LCHD, MCHD, Park Districts, SMC, local environmental groups, HOAs	Promote installation of property-level green infrastructure projects such as rain gardens, bioswales, vegetative buffers, etc. to reduce stormwater runoff.
				Promote road salt application BMPs and alternatives.
				Promote the use of phosphorus-free lawn fertilizers by homeowners and contractors who maintain their lawns.
				Potential soil sales, dredge drop zones for personal dredging.

TARGET AUDIENCE	WATERSHED GOALS	VEHICLE/ METHOD	PARTNER LEADS	MESSAGES (TOPICS/ACTIONS)
Marinas and Waterfront Businesses	1, 2, 3, 4, 5	Social media, brochures, newsletters, website, educational signage, targeted/one-on-one discussions	FWA, WPC, municipalities, Chamber of Commerce, realtors, local environmental groups	Increase the amount of watershed-related informational signage.
				Protect shorelines with bank stabilization and monitor condition, and install permeable pavement or materials in yard.
				Landscaping buffers, chemical collection and offsite disposal, and recycle shrink wrapping.
				Promote road salt application BMPs and alternatives.
				Implement designs that reduce impervious areas and include green infrastructure and BMPs to reduce runoff beyond current development requirements.
				Promote proper septic and sanitary sewer maintenance by providing education and outreach to business owners with septic systems and septic waste disposal sites.

APPENDIX A: SHORELINE EROSION MAP BOOK



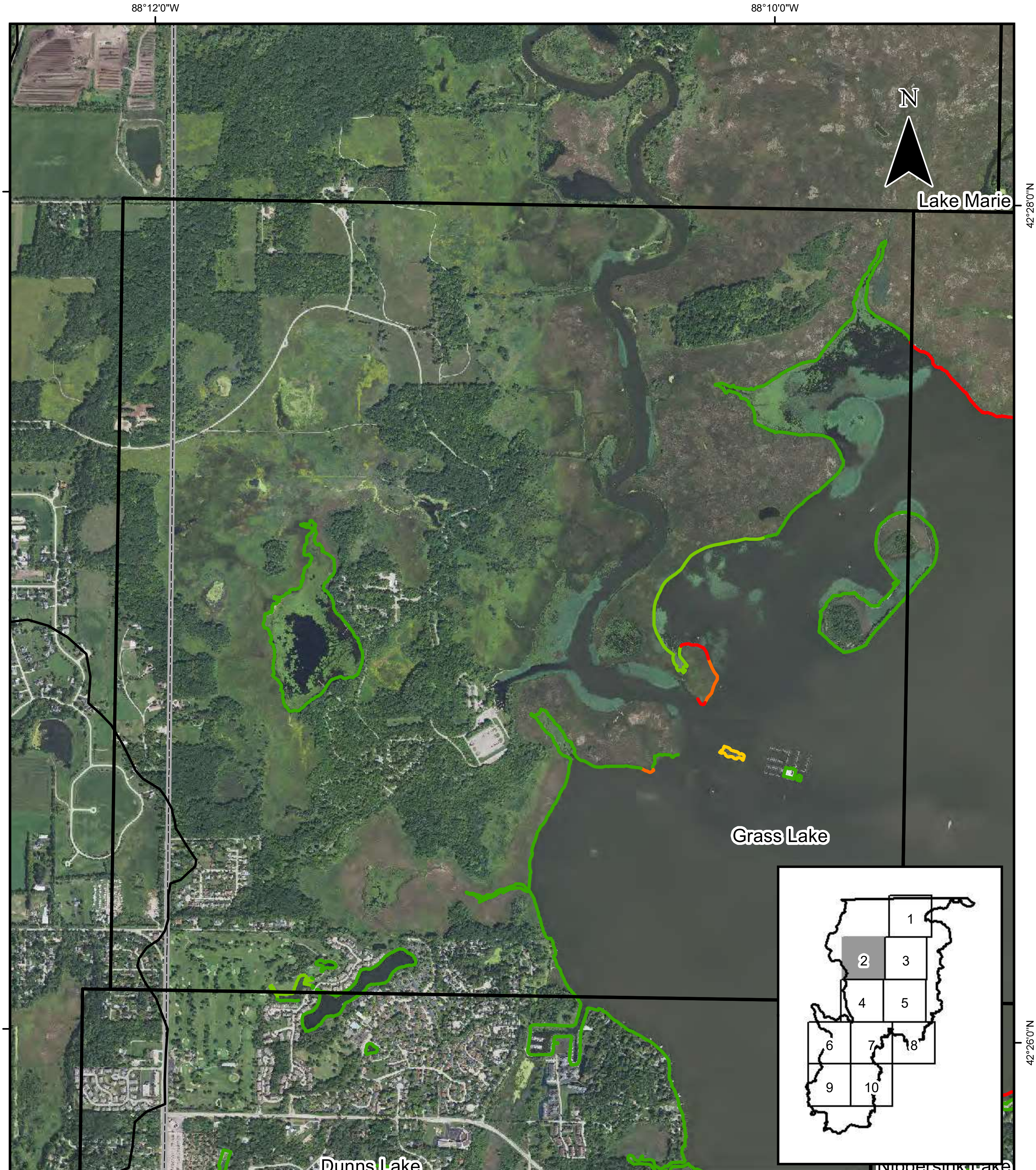
Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

Chain O'Lakes Planning Area
Shoreline Erosion
Page 1 of 10

0 0.25 0.5 0.75 1 Miles

northwater
WATER + GEOSCIENCE EXPERTS

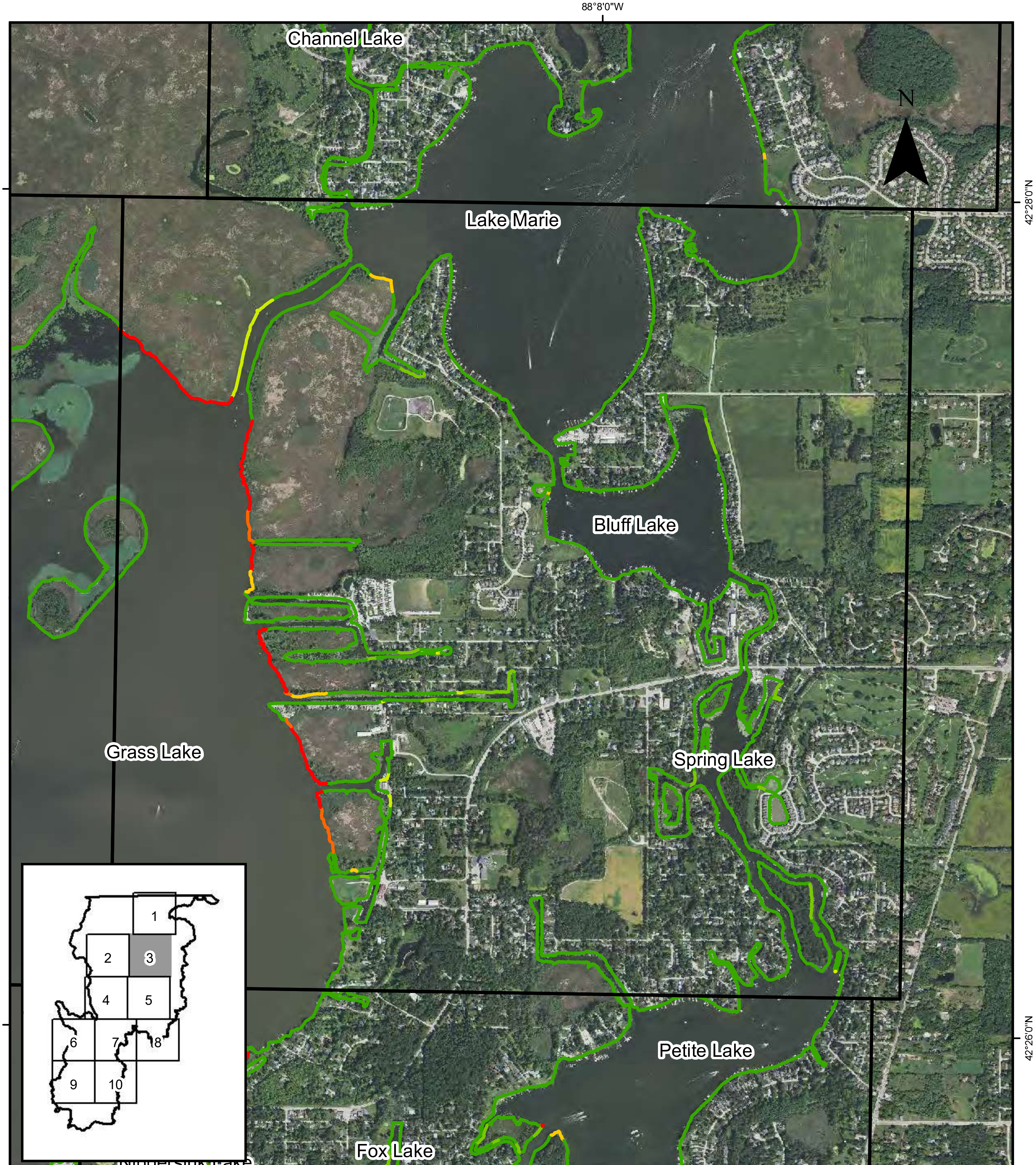


Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

Chain O'Lakes Planning Area Shoreline Erosion Page 2 of 10

0 0.25 0.5 0.75 1 Miles



Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

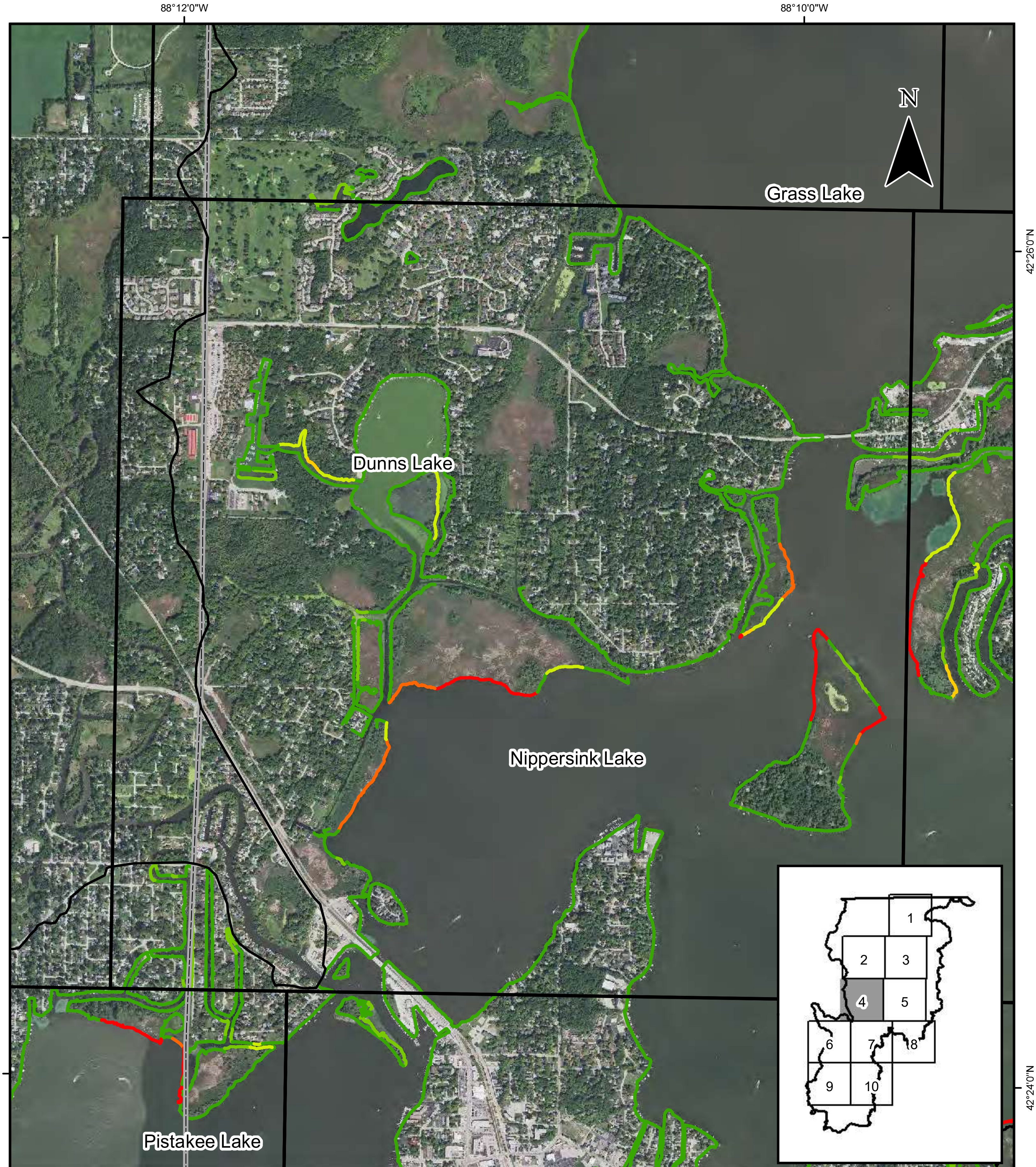
Chain O'Lakes Planning Area
Shoreline Erosion
Page 3 of 10

0 0.25 0.5 0.75 1 Miles

Illinois Environmental Protection Agency

Fox Waterway Agency

northwater
WATER + GEOSCIENCE EXPERTS



Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

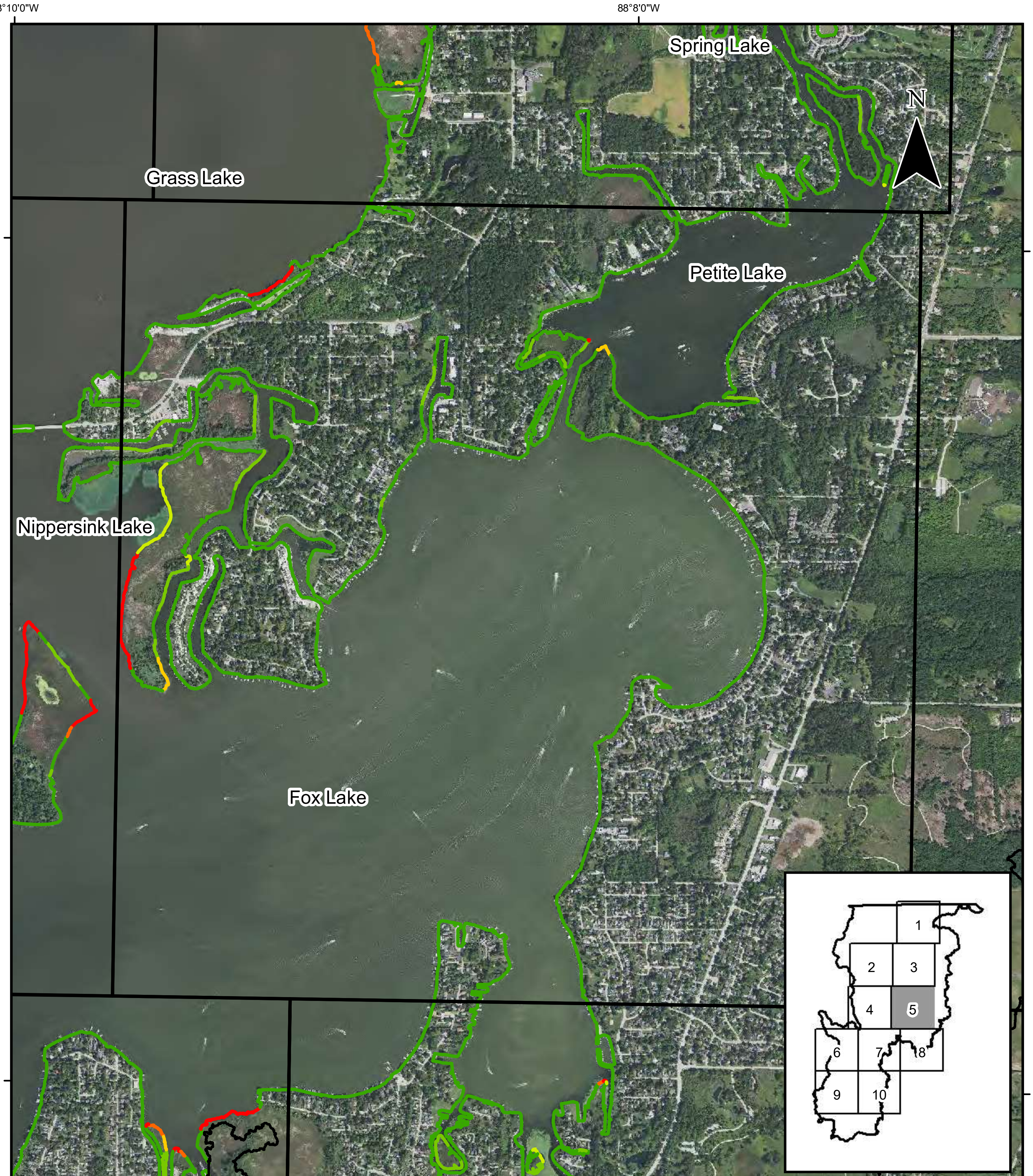
Chain O'Lakes Planning Area
Shoreline Erosion
Page 4 of 10

0 0.25 0.5 0.75 1 Miles

Illinois Environmental Protection Agency

Fox Waterway Agency

northwater
WATER + GEOSCIENCE EXPERTS



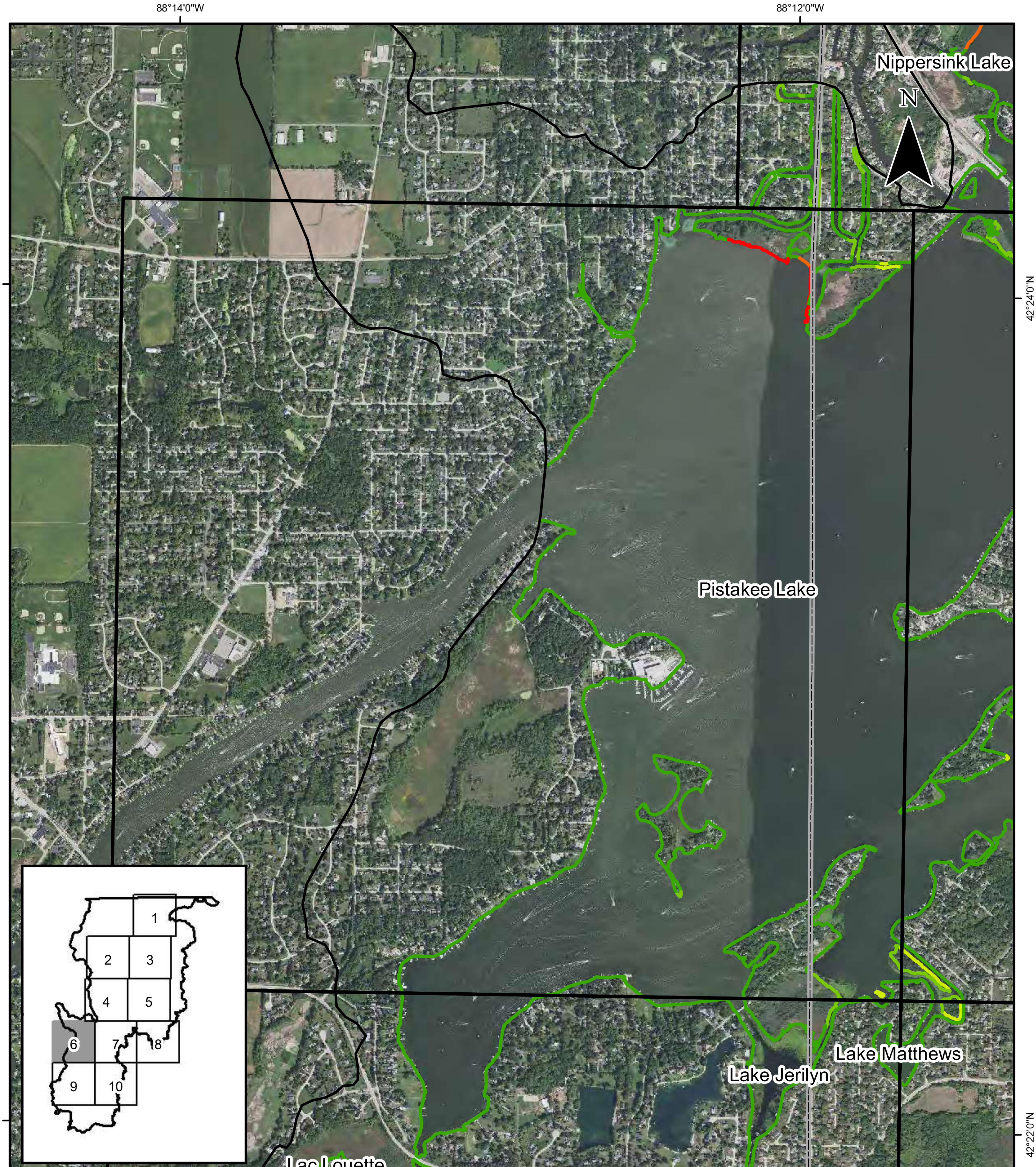
Chain O'Lakes Planning Area
Shoreline Erosion
Page 5 of 10

Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

0 0.25 0.5 0.75 1 Miles

northwater
WATER + GEOSCIENCE EXPERTS



Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

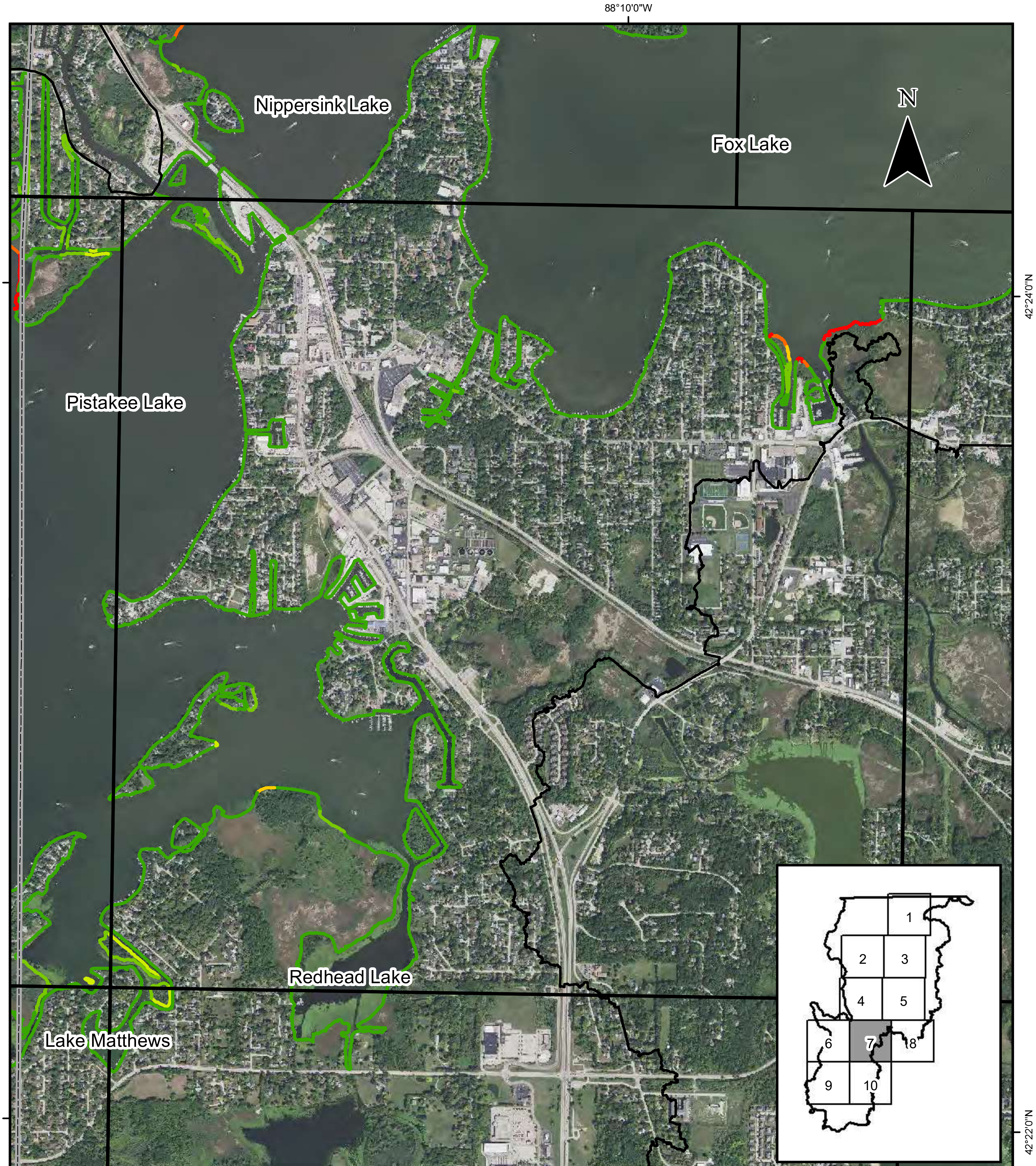
Chain O'Lakes Planning Area
Shoreline Erosion
Page 6 of 10

0 0.25 0.5 0.75 1 Miles

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

FOX WATERWAY AGENCY

northwater
WATER + GEOSCIENCE EXPERTS



Sediment Load (lbs/ft/yr)

> 3	50 - 100
3 - 15	100 - 200
15 - 50	200 - 1400

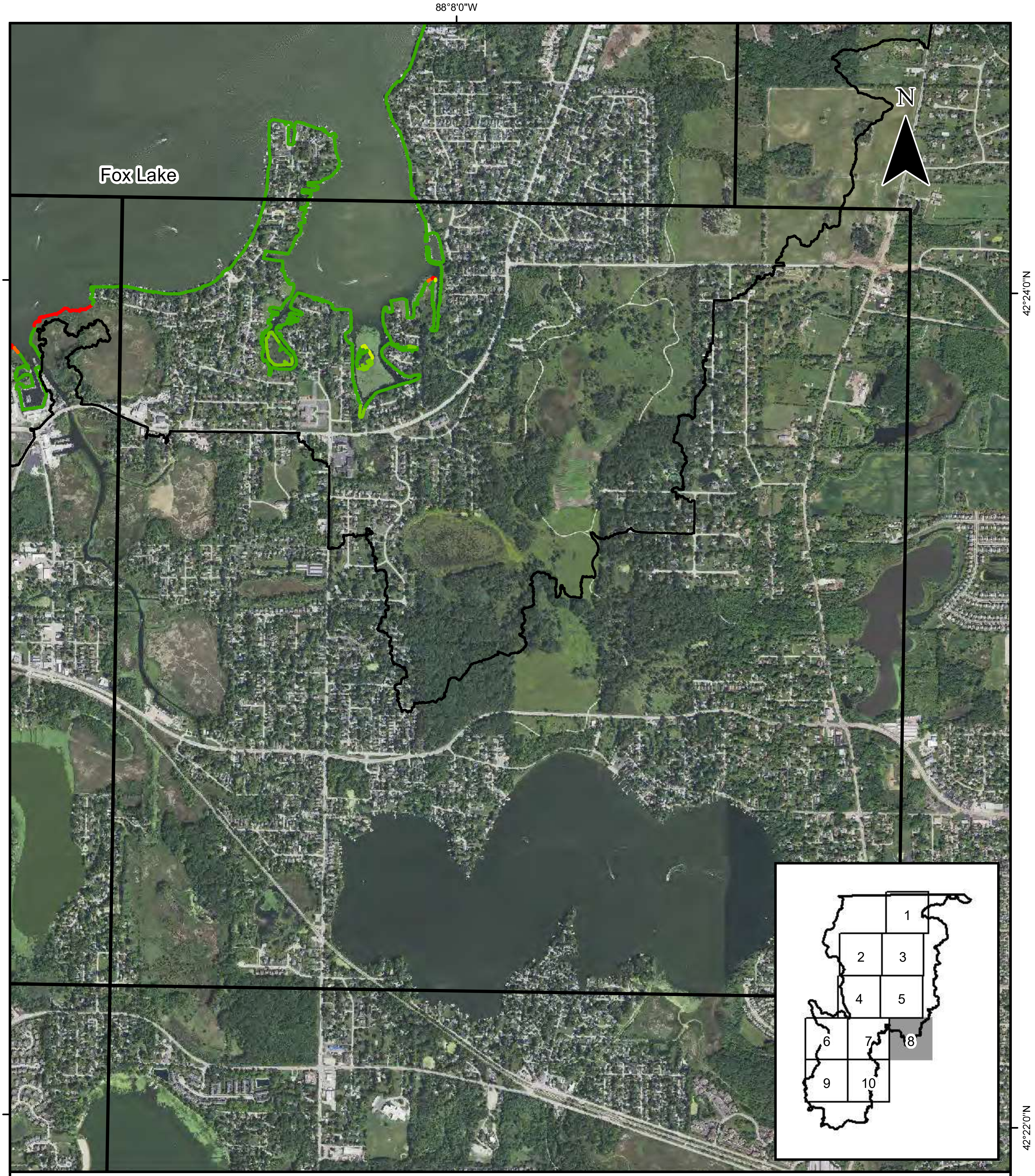
Chain O'Lakes Planning Area
Shoreline Erosion
Page 7 of 10

0 0.25 0.5 0.75 1 Miles

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

FOX WATERWAY AGENCY

northwater
WATER + GEOSCIENCE EXPERTS



Chain O'Lakes Planning Area
Shoreline Erosion

Sediment Load (lbs/ft/yr)

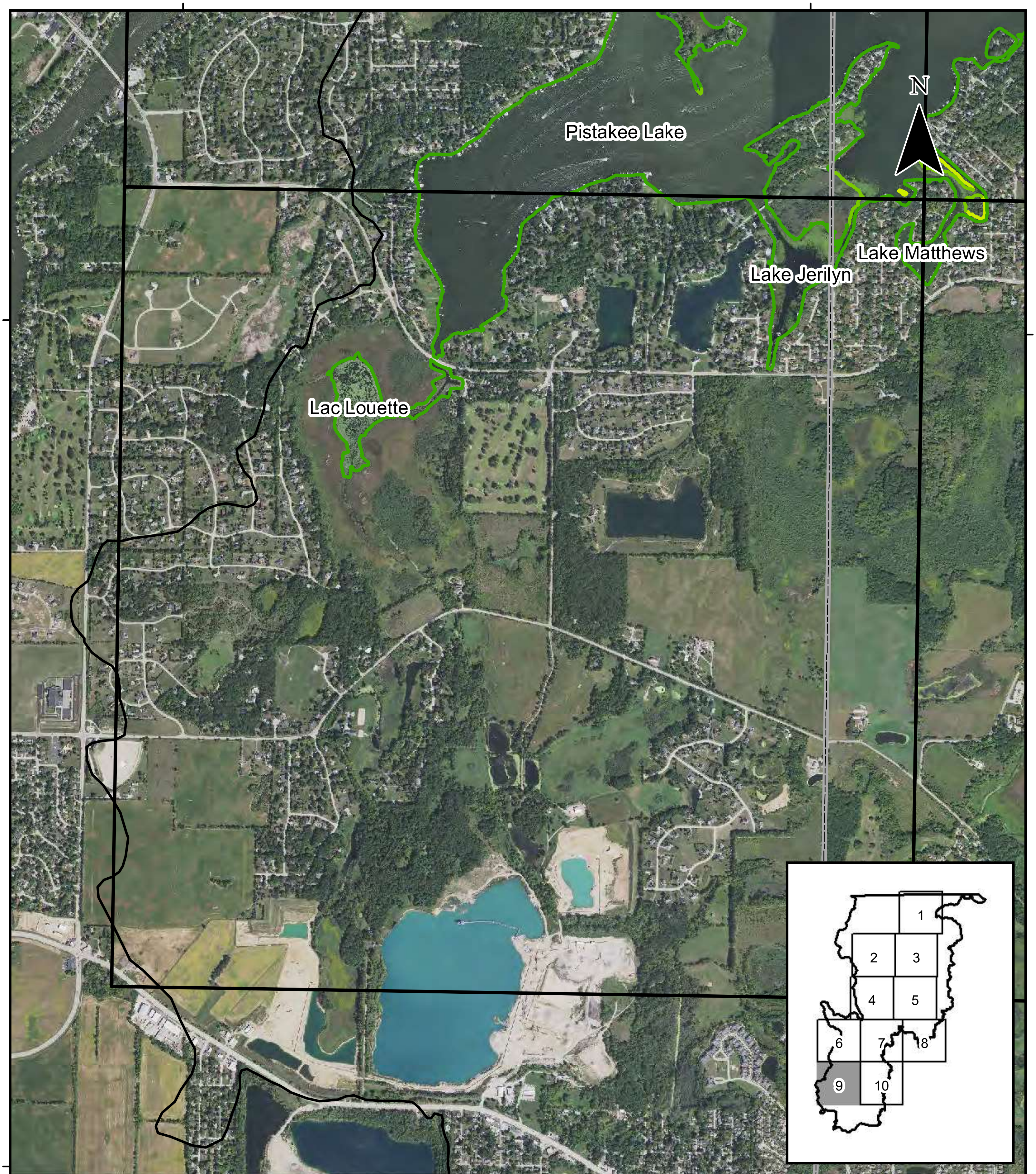
- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

0 0.25 0.5 0.75 1 Miles

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

FOX WATERWAY AGENCY

northwater
WATER + GEOSCIENCE EXPERTS



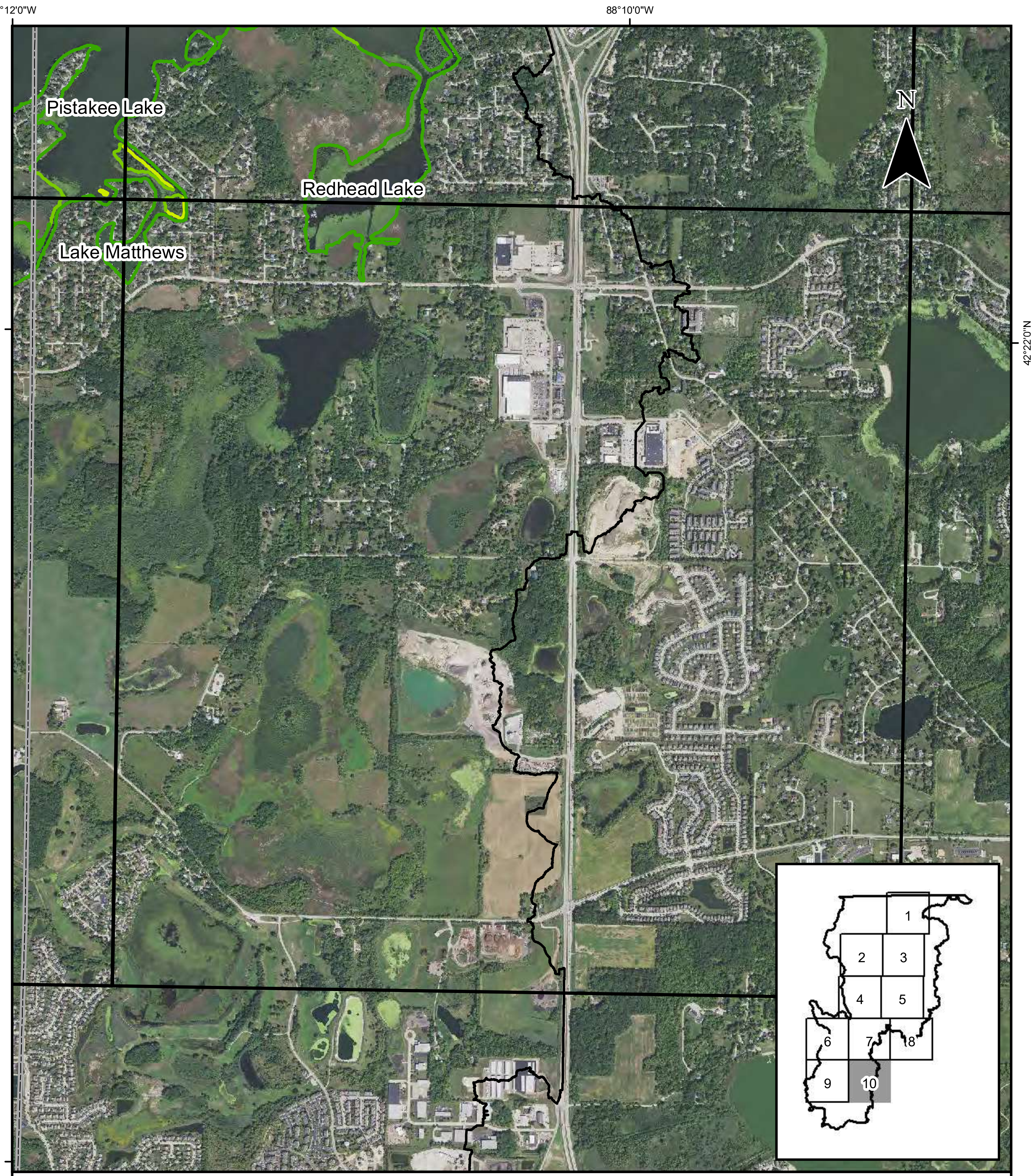
Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

Chain O'Lakes Planning Area Shoreline Erosion

0 0.25 0.5 0.75 1 Miles

northwater
WATER + GEOSCIENCE EXPERTS



Sediment Load (lbs/ft/yr)

- > 3
- 3 - 15
- 15 - 50
- 50 - 100
- 100 - 200
- 200 - 1400

Chain O'Lakes Planning Area Shoreline Erosion

0 0.25 0.5 0.75 1 Miles

northwater
WATER + GEOSCIENCE EXPERTS

APPENDIX B: UNIT COSTS & FUNDING SOURCES

Chain O' Lakes Watershed-Based Plan Unit Cost Estimates

PRACTICE	UNIT COST
Bioreactor	$20,401.78 each
Bioswale	$16.87 per square foot
Cover Crop	$103.08 per acre
Dredging	$40-$100 per cubic yard
Naturalize Detention Basin	$55,000
No-Till	$22.75 per acre
Lake Aeration	$7,200 per unit including annual operation cost
Filter Strip/Field Border	$4,000 per acre
Grass Waterway	$9,600 per acre
Prairie Buffer / Prairie Conversion	$10,000 per acre
Infiltration Basin/Rain Garden with Rain Barrel/Green Roof	$6,400 each
Invasive Species Control/ Timber Stand Improvement	$1,000 per acre
Rock Check / Rock Riffle	$17,500 each
Vegetation Management	$10,000 per acre
Permeable Pavement	$15.30 per square foot
Streambank and Shoreline Stabilization	$175 per linear foot
Stormwater Catch Basin	$5,000 each
Wet Detention Basin	$112,500 each
Wetland Creation	$87,000 per acre
Wetland Restoration[1]	$33,000 per acre
Water and Sediment Control Basin	$4,800 each

[1] – Trinskis Island restoration project falls within this category with a total estimated cost of $2,950,000

This list of potential funding sources is compiled from a variety of sources. Funding and program availability are contingent upon federal, state, and local budgets and appropriations for the budget year in which funding is being sought, so changes may have occurred that are not reflected in the list. Contact the program representative or funding agency for updates or changes to program details. Watershed-specific funding sources are identified where appropriate.

Reference Sources

Several grant search engines and organizations exist to help identify funding sources. Fees for services or products may be charged by these organizations. When searching, be sure to clarify whether charges will be incurred. For "do-it-your-selfers," local grant data collection centers are available throughout Illinois.

Resources	Reference information
Catalog of Federal Domestic Assistance (CFDA) listed through the System for Award Management (SAM)	https://sam.gov/content/assistance-listings The catalog lists all federal funding programs available, including those for conservation. All organizations applying for federal funding must have a Unique Entity ID, a 12-character alphanumeric ID assigned by SAM.gov.
Federal Tax Incentives for Conservation	Owners of environmentally sensitive land that has been donated for conservation purposes, or has been placed in a conservation easement, or simply managed for conservation. Individuals, organizations, and others are all eligible. Websites: https://www.irs.gov/, https://ailt.org/, https://www.irs.gov/pub/irs-drop/n-04-41.pdf, https://www.irs.gov/pub/irs-utl/introduction-to-conservation-easements.pdf, and https://www.irs.gov/pub/irs-soi/17resconlooney.pdf. You can also contact the Illinois EPA, 1021 North Grand Avenue East, P.O. Box 19276, Springfield, Illinois, 62794-9276. Phone: 217-782-3397.
Illinois Catalog of State Financial Assistance	https://gata.illinois.gov/grants/csfa.html The Catalog of State Financial Assistance (CSFA) is a single, authoritative, statewide, comprehensive source document of State financial assistance program information.
USEPA Green Infrastructure Funding Opportunities	https://www.epa.gov/green-infrastructure/green-infrastructure-funding-opportunities
Environmental Grantmakers Association	Provides a list of environmental grant foundations. https://ega.org/collaborate/grant-seekers
Forefront (formerly the Donors Forum of Chicago)	200 W. Madison St., 2nd Floor, Chicago, IL 60606. Phone: 312-578-0090. Website: https://myforefront.org/ E-mail: info@myforefront.org
eCivis Grants Network	Assistance for local governments to improve their grants success through expert grant research, information, grant training, and technology. eCivis, Inc. 3452 E. Foothill Blvd, Floor 9, Pasadena, CA 91107. Website: http://www.ecivis.com/ Phone: 877-232-4847. Email sales@ecivis.com or fill out the following contact form: https://ecivis.com/contact-us/

FUNDING SOURCE	DESCRIPTION	ELIGIBILITY	ASSISTANCE	WEBSITE	CONTACT
U.S. Environmental Protection Agency (USEPA) - issues federal environmental regulations, enforces federal environmental law, and manages many grant programs. (https://www.epa.gov/grants)					
Brownfields Grants – Assessment Grants, Revolving Loan Fund Grants, Cleanup Grants, Multipurpose Grants, Job Training Grants	EPA's Brownfields program provides direct funding for Brownfields assessment, cleanup, revolving loans, environmental job training, technical assistance, and research. EPA's Brownfields Program collaborates with other EPA programs, other federal partners, and state agencies to identify and make available resources that can be used for Brownfields activities. In addition to direct Brownfields funding, EPA also provides technical information on Brownfields financing matters.	Local governments, private not-for-profit (501C3) groups, and others	Assessment: Up to $500,000 $2,000,000 Cleanup: Up to $500,000, up to $1 million, or up to $2 million per application Revolving Loan: Up to $1,000,000 (see website link for more opportunities) Multipurpose: Up to $800,000 Job Training: For FY 2024 anticipated total estimated funding of $12 million and an estimated 24 grants awarded	https://www.epa.gov/brownfields/types-epa-brownfield-grant-funding	EPA Region 5 John Jurevis 77 West Jackson Boulevard Mail Code SB-5J Chicago, IL 60604-3507 312-886-1446 Jurevis.John@epa.gov
Environmental Education (EE) Grants	The EE Grants Program funds environmental education projects that promote awareness and stewardship and help provide people with the skills to take responsible actions to protect the environment. This program supports projects that design, demonstrate, and/or disseminate environmental education practices, methods, or techniques. The EPA's ability to fund EE grants depends on budget appropriations. To stay up to date on when funding becomes available and on other EPA Environmental Education information, subscribe to the EE Grants Listserv; under "All Topics", click on "Interest" and select "Environmental Education": https://www.epa.gov/newsroom/email-subscriptions-epa-news-releases	Local and state educational organizations, private not-for profit groups, and local governments	3-4 annual grant projects chosen for $50,000 - $100,00 grant funding; cost Sharing requirement of at least 25% of total costs from non-federal matching funds	https://www.epa.gov/education/grants	Megan Gavin U.S. EPA, Region 5 77 West Jackson Boulevard Mail Code AT-18J Chicago, IL 60604 gavin.megan@epa.gov

FUNDING SOURCE	DESCRIPTION	ELIGIBILITY	ASSISTANCE	WEBSITE	CONTACT
Environmental Justice (EJ) Grants, Funding, and Technical Assistance	The **Environmental Justice Thriving Communities Grantmaking (EJ TCGM) Program** is a competition to select multiple Grantmakers around the nation to reduce barriers to the application process communities face and increase the efficiency of the awards process for environmental justice grants. The **Environmental and Climate Justice (ECJ) Block Grant Program** provides funding for financial and technical assistance to carry out environmental and climate justice activities to benefit underserved and overburdened communities. The **Collaborative Problem-Solving (EJCPS) Cooperative Agreement Program** provides funding for projects that address local environmental and public health issues within an affected community. The **Government-to-Government (EJG2G) Program** provides funding to governmental entities at the state, local, territorial, and tribal level to support and/or create model government activities that lead to measurable environmental or public health results in communities disproportionately burdened by environmental harms and risks. The **Thriving Communities Technical Assistance Centers (EJ TCTAC) Program** aims to establish technical assistance centers across the nation providing technical assistance, training, and related support to communities with environmental justice concerns. The **Small Grants (EJSG) Program** supports and empowers communities working on solutions to local environmental and public health issues. The program is designed to help communities understand and address exposure to multiple environmental harms and risks.	Varies	Varies	https://www.epa.gov/environmentaljustice/environmental-justice-grants-funding-and-technical-assistance EJ TCGM Webinar Slides: https://www.epa.gov/system/files/documents/2023-05/EJ%20TCGM_%20Webinar_FINAL_5.30.23.pdf	US EPA, REGION 5 Kathy Triantafillou triantafillou.kathy@epa.gov 77 West Jackson Blvd. (E-19J) Chicago, IL 60604-3507 312-353-4293

FUNDING SOURCE	DESCRIPTION	ELIGIBILITY	ASSISTANCE	WEBSITE	CONTACT
Smart Growth Technical Assistance Opportunities	Offers grants to support activities that improve the quality of development and protect human health and the environment	Local governments, private not-for-profit groups, and others	In-kind contributions with assistance preferred	https://www.epa.gov/smartgrowth/epa-smart-growth-grants-and-other-funding	Office of Community Revitalization (MC 1807T) U.S. EPA 1200 Pennsylvania Avenue NW Washington, DC 20460smartgrowth@epa.gov
Five Star and Urban Waters Restoration Grant Program	This program brings together citizen groups, corporations, youth groups and students, landowners, and government agencies to undertake projects that restore streambanks and wetlands. Projects must include a strong wetland or riparian restoration component, and should include education, outreach, and community stewardship.	Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, Tribal Governments and Organizations, and educational institutions Requires at least five or more partnering organizations	$10,000 - $40,000 (avg. $20,000) grant funding	Overview: https://www.epa.gov/wetlands/5-star-wetland-and-urban-waters-restoration-grants Application Information: https://www.nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program	Myra Price price.myra@epa.gov USEPA Wetlands Division Room 7410G (4502 T) 1200 Pennsylvania Avenue, NW Washington, DC 202-566-1225 Kristen Faulhaber Region 5 Wetlands Grants 312-353-4378 faulhaber.kristen@epa.gov
USEPA Office of Wastewater Management (OWM)	OWM supports the Clean Water Act by promoting effective and responsible water use, wastewater treatment, disposal and management and by encouraging the protection and restoration of watersheds. OWM provides regulatory standards, voluntary management approaches, and financial and technical assistance to states, Tribes, communities, and regulated entities to protect human health and aquatic ecosystems, reduce flooding, and protect the nation's infrastructure investment.	Varies	Informational only inks available to multiple grant funding opportunities	https://www.epa.gov/aboutepa/about-office-water#wastewater	Environmental Protection Agency OWM (Mail Code: 4201M) 1200 Pennsylvania Avenue, N.W. Washington, DC 20460 202-564-0748 Andrew Sawyers sawyers.andrew@epa.gov

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Wetland Program Development Grants (WPDG)	WPDGs provide eligible applicants an opportunity to conduct projects that promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys and studies relating to the causes, effects, extent, prevention, reduction and elimination of water pollution.	States, tribes, local governments, interstate associations, and intertribal consortia are eligible to apply for the Regional WPDG Request for Proposals (RFPs). Nonprofits, interstate associations and intertribal consortia are eligible to apply for the National WPDG RFPs.	$75,000 - $220,000 with 25% local match requirement "WPDG Match Calculator (xlsx)" file is available on the website	https://www.epa.gov/wetlands/wetland-program-development-grants-and-epa-wetlands-grant-coordinators	Dertera Collins collins.dertera@epa.gov EPA Region 5 77 West Jackson Blvd., MC WW16J Chicago, IL 60604 312-353-6291
Voluntary School and Child Care Lead Testing and Reduction Grant Program	The Water Infrastructure Improvements for the Nation (WIIN) Act established this grant program to award funding to states, territories, and tribes to assist local and tribal educational agencies in voluntary testing for lead contamination in drinking water at schools and childcare facilities. The Bipartisan Infrastructure Law amended the program and allowed funding for lead remediation in addition to testing. The Illinois Department of Public Health (IDPH) is implementing the Illinois lead program.	States, the District of Columbia, and territories, and tribes within the U.S The grant program is a noncompetitive voluntary program.	Funding is awarded to states based on an allocation formula that includes factors such as population including a set-aside for tribal allotments.	https://www.epa.gov/dwcapacity/wiin-grant-voluntary-school-and-child-care-lead-testing-and-reduction-grant-program#state%C2%A0 https://dph.illinois.gov/topics-services/environmental-health-protection/lead-poisoning-prevention.html	Kori Johnson-Lane EPA Region 5 johnsonlane.kori@epa.gov IDPH Asbestos and Lead Programs Phone: 217-782-3517
People, Prosperity and the Planet (P3) Student Design Competition	P3 is a competitive grants program that provides teams of undergraduate and graduate students an opportunity to gain invaluable experience through classroom learning, laboratory and field work to address environmental issues. These projects promote a shift towards more environmentally benign products, processes, and systems with the aim of improving quality of life, promoting economic prosperity, and protecting the planet.	Teams of undergraduate and/or graduate students attending U.S. colleges, universities and other post-secondary educational	Two-year award of up to $75,000	https://www.epa.gov/P3	Angela Page Office of Science Advisor, Policy & Engagement Office of Research and Development Washington, DC 202-564-7957 page.angelad@epa.gov

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		institutions; student team members and faculty advisors must be U.S. citizens or be lawfully admitted to the U.S.			
Source Reduction Assistance (SRA) Grants	SRA grants support research, investigation, experiments, surveys, study, demonstration, education and training using source reduction approaches (also known as P2 or pollution prevention). EPA is particularly interested in projects that promote practical source reduction practices, tools, and training on P2 approaches to measurably improve human and environmental health by reducing the use of hazardous substances, reducing toxic pollutants, reducing resource use (e.g., water and energy) and reducing expenditures and liability costs to businesses, non-profit organizations and/or communities.	States, local, interstate, and intrastate government agencies and instrumentalities, federally recognized tribes, inter-tribal consortia and Section 501 (c)(3) non-profit organizations (not 501(c)(4) organizations that lobby)	$1,135,000 in federal funds awards ranging from $40,000 to $250,00 5% match requirement	https://www.epa.gov/p2/source-reduction-assistance-grants	Christine Clark U.S. EPA Region 5 77 West Jackson Boulevard (LM-8J) Chicago, IL 60604-3590 312-886-9749 clark.christine@epa.gov
Small Business Innovation Research (SBIR) Program	The SBIR program funds small businesses to develop and commercialize innovative environmental technologies. The main purpose is to perform research and development – not purchase equipment or commercialize a technology that has already been developed, or one that has very low risk and only needs capital. Broad areas of focus typically include clean and safe water, air quality and climate, land revitalization, homeland security, sustainable materials management, safer chemicals, and risk assessment. More specific topics under each of these broad areas change from year to year.	Company must be for profit, U.S. owned/operated, and under 500 people. Work must be done in the U.S.	Phase I (6 months) -Up to $100,000 Phase II (2 years) -Up to $400,000 -Funding based on the Phase I results Further Funding for Commercialization -Up to $100,000 -“Commercialization option” in Phase II for	https://www.epa.gov/sbir	Office of Science Advisor, Policy & Engagement U.S. Environmental Protection Agency 1200 Pennsylvania Avenue NW Room: 8104R Washington, D.C. 20460 OSAPE_Communications@epa.gov

FUNDING SOURCE	DESCRIPTION	ELIGIBILITY	ASSISTANCE	WEBSITE	CONTACT
			companies that secure third-party investment		
Illinois Environmental Protection Agency (Illinois EPA) administers state and federal environmental programs and regulations.					
Clean Water Act Section 319 Grants	These grants provide funding for implementing corrective and preventative best management practices (BMPs) on a watershed scale, for the demonstration of innovative BMPs on a sub-watershed scale, and the development of information and education nonpoint source pollution control programs.	State and local governments, nonprofits, individuals, businesses	Federal cost share at 60% maximum, 40% local match	https://epa.illinois.gov/topics/water-quality/watershed-management/nonpoint-sources/grants.html	Illinois EPA, Bureau of Water Watershed Management Section Nonpoint Source Unit 1021 North Grand Avenue East P.O. Box 19276 Springfield, Illinois 62794-9276 217-782-3362 epa.bowgrants@illinois.gov
Green Infrastructure Grant Opportunities (GIGO)	The new GIGO Program funds projects to construct green infrastructure best management practices (BMPs) that prevent, eliminate, or reduce water quality impairments by decreasing stormwater runoff into Illinois' rivers, streams, and lakes. Projects that implement treatment trains and/or multiple BMPs within the same watershed may be more effective and efficient than a single large green infrastructure BMP.	State and local governments, nonprofits, individuals, businesses	Up to 75% cost share for approved project costs; 25% local match Assistance may increase up to 85% for disadvantaged areas	https://epa.illinois.gov/topics/grants-loans/water-financial-assistance/gigo.html	Illinois EPA, Bureau of Water Watershed Management Section Green Infrastructure Grant Opportunities 1021 North Grand Avenue East P.O. Box 19276 Springfield, Illinois 62794-9276 217-782-3362
Unsewered Communities Construction Grant Program (UCCGP) and Unsewered Communities Planning Grant Program (UCPGP)	The IL EPA is aware of over 200 IL communities that have inadequate or nonexistent wastewater collection and treatment facilities, resulting in illegal surface discharges. To assist in providing solutions to this human health hazard and the adverse environmental impacts these situations harbor, IL EPA is making $100 million available through the Rebuild Illinois Capital Plan over five years for Construction Grants for wastewater collection and/or treatment facilities and making $1 million available for the next 4 years for Planning Grants to assist small and disadvantaged communities in developing a Project Plan that identifies a solution to their wastewater collection and treatment needs.	Applicants must be in good standing with the Secretary of State. Eligible proposals will come from a local government unit within the State of Illinois, as defined in Title 35 of the Illinois Administrative Code Part 365.	Varies; learn more at the following links: https://epa.illinois.gov/topics/grants-loans/unsewered-communities/uccgp.html https://epa.illinois.gov/topics/grants-loans/unsewered-communities/ucpgp.html	https://epa.illinois.gov/topics/grants-loans/unsewered-communities.html	Lanina Clark Unsewered Communities Grant Program Project Manager Lanina.Clark@illinois.gov

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Streambank Cleanup and Lakeshore Enhancement (SCALE)	SCALE provides funds to assist groups that have established a recurring stream or lakeshore cleanup. Funds are typically used for safety attire, dumpster rentals, landfill tipping fees and promotional materials.	Organizations that have an established streambank/ lakeshore cleanup	100% cost share, awards range from $500 to $3,500	https://epa.illinois.gov/topics/water-quality/surface-water/scale.html	Illinois EPA, Bureau of Water Watershed Management Section Green Infrastructure Grant Opportunities 1021 North Grand Avenue East P.O. Box 19276 Springfield, Illinois 62794-9276 (217) 782-3362
State Revolving Fund (SRF)	SRF provides financial assistance for the design and construction of projects that protect or improve the quality of Illinois' water resources. It includes two loan programs: the Water Pollution Control Loan Program (WPCLP) which funds both wastewater and storm water projects, and the Public Water Supply Loan Program (PWSLP) for drinking water projects.	State and local governments, nonprofits, individuals, businesses	Funds projects at 100% Loan Interest Rate is adjusted annually and is based on the State of IL Fiscal Year	https://epa.illinois.gov/topics/grants-loans/state-revolving-fund.html	Illinois EPA, Infrastructure Financial Assistance Section 1021 North Grand Avenue East, P.O. Box 19276, Springfield, Illinois, 62794-9276. 217-782-2027
Lake Volunteers Program	Each year, volunteers help the Lake County Health Department monitor the county's numerous lakes. A primary goal of this program is to familiarize volunteers with lake processes and the cause-and-effect relationships that exist between their lake, its watershed, weather and human activities.	Lake owners	Technical assistance; training and equipment available through LCHD	https://www.lakecountyil.gov/2381/Ecological-Services	Alana Bartolai, Lake County Health Department 500 W. Winchester Road, Unit 102 Libertyville, IL 60048 847-377-8009
Federal Emergency Management Agency (FEMA) manages programs that assist communities in disaster planning and hazard mitigation					
Flood Mitigation Assistance (FMA)	FMA helps states and communities identify and implement measures to reduce the risk of flood damage to structures insured under the National Flood Insurance Program (NFIP). These projects lessen the frequency or severity of flooding and decrease flood damage.	States, tribes and territories can submit applications on behalf of sub applicants. Homeowners, business operators, and non-profit organizations can be included in a sub application submitted by an eligible sub applicant.	Federal cost share maximum of 75%, see website for funding caps	https://www.fema.gov/grants/mitigation/floods	FEMA Region 5, 536 South Clark Street, Chicago, IL 60605 312-408-5500

FUNDING SOURCE	DESCRIPTION	ELIGIBILITY	ASSISTANCE	WEBSITE	CONTACT
Hazard Mitigation Grant Program (HMGP)	HMGP provides funding to state, local, tribal and territorial governments so they can rebuild in a way that reduces, or mitigates, future disaster losses in their communities. Funding assistance for implementing long-term hazard mitigation planning and projects follows a Presidential major disaster declaration.	State and local governments, qualified nonprofit organizations, tribal governments	Funding subject to a sliding scale formula. Federal cost share maximum of 75%.	https://www.fema.gov/grants/mitigation/hazard-mitigation	Sam M. AL-Basha Illinois Emergency Management Agency 1035 Outer Park Drive Springfield, Illinois 62704 217-785-9942 sam.m.al-basha@illinois.gov
Pre-Disaster Mitigation (PDM) Grant Program	The PDM grant program provides funding to state, local, tribal, and territorial governments to plan for and implement sustainable cost-effective measures designed to reduce the risk to individuals and property from future natural hazards, while also reducing reliance on federal funding from future disasters.	Only states, territories, or federally recognized tribal governments identified by Congress are eligible to apply; local governments identified in the funding opportunity are considered sub applicants.	Funding varies each year. Federal cost share is generally 75%; small, impoverished communities are eligible for up to 90% federal cost share.	https://www.fema.gov/grants/mitigation/pre-disaster	
National Flood Insurance, Increased Cost of Compliance Program (ICC)	ICC provides flood insurance policyholders with flood damaged homes and businesses in high-risk areas, also known as Special Flood Hazard Areas, with assistance to help pay the costs to bring their home or business into compliance with their community's floodplain ordinance, including building elevation, relocation, demolition, or floodproofing. The buildings must have been substantially or repetitively damaged.	Flood insurance policy holders	Federal assistance up to $30,000	https://www.fema.gov/floodplain-management/financial-help/increased-cost-compliance	For more information on ICC coverage, call your insurance company or agent, or call the NFIP toll-free at 1-800-427-4661

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Building Resilient Infrastructure and Communities (BRIC) *Replaced the Pre-Disaster Mitigation Program (PDM)*	BRIC program aims to categorically shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. FEMA anticipates BRIC funding projects that demonstrate innovative approaches to partnerships, such as shared funding mechanisms, and/or project design.	States, territories and federally recognized tribal governments may serve as applicants; local governments may be included as sub applicants; homeowners, business operators and nonprofit organizations can be included in a sub application submitted by an eligible sub applicant	Varies by applicant type; cost share required for all sub applications Learn more about funding and cost share requirements on the website.	https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities	Sam M. AL-Basha Illinois Emergency Management Agency 1035 Outer Park Drive Springfield, Illinois 62704 217-785-9942 sam.m.al-basha@illinois.gov
U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS) partners with state conservationist offices and provides funding and technical assistance to landowners to promote soil and water conservation.					
Agricultural Conservation Easement Program (ACEP)	ACEP helps to protect, restore, and enhance wetlands or protect working farms and ranches through conservation easements. ACEP includes the following: -Agricultural Land Easements (ALE) help private and tribal landowners, land trusts, and other entities such as state and local governments protect croplands and grasslands on working farms and ranches by limiting non-agricultural uses of the land through conservation easements. -Wetland Reserve Easements (WRE) help private and tribal landowners protect, restore and enhance wetlands which have been previously degraded due to agricultural uses. -The Wetland Reserve Enhancement Partnership (WREP) is a voluntary program through which NRCS helps partners to leverage resources to carry out high priority wetland protection, restoration, and enhancement and to improve wildlife habitat.	Landowners, land trusts, and other entities	Check with the county-based USDA Service Centers for application deadlines and most current information.	https://www.nrcs.usda.gov/programs-initiatives/acep-agricultural-conservation-easement-program	Paula Setchell Farm Service Agency Office Woodstock Service Center 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 Ext 2 paula.setchell@usda.gov Rebecca Briggs Natural Resources Conservation Service Office Woodstock Service Center 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 rebecca.briggs@usda.gov

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Conservation Innovation Grants (CIG) Program	CIG is a competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. A national CIG funding notice is announced each year; funds for single- or multi-year projects, not to exceed three years, will be awarded through a nationwide competitive grants process. The CIG state component emphasizes projects that benefit a limited geographical area. Participating states announce their funding availability for CIG competitions through their state NRCS offices.	State or local governments, federally-recognized American Indian tribes, non-governmental organizations, and individuals in all 50 states, District of Columbia, Caribbean Area, and Pacific Islands Area	Check with the county-based USDA Service Centers for application deadlines and most current information.	https://cig.sc.egov.usda.gov/?utm_source=nrcs-cig&utm_medium=site&utm_campaign=obv-redirect	Paula Setchell Farm Service Agency Office Woodstock Service Center 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 Ext 2 paula.setchell@usda.gov Rebecca Briggs Natural Resources Conservation Service Office Woodstock Service Center 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 rebecca.briggs@usda.gov
Conservation Reserve Program (CRP)	CRP is a land conservation program administered by FSA. In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Through the State Acres for Wildlife Enhancement (SAFE) initiative, landowners restore vital habitat in alignment with high-priority state wildlife conservation goals.	Non-federal landowners engaged in farming or ranching	Annual rental payments, as well as certain incentive payments and cost share assistance	https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/	
Conservation Stewardship Program (CSP)	CSP promotes the conservation of soil, water, air, energy, plant and animal life located on working lands. This program can help identify natural resource problems in your farming operation and provide technical and financial assistance to solve those problems or attain higher stewardship levels in an environmentally beneficial and cost-effective manner.	Individuals, organizations, and others	Check with the county-based USDA Service Centers for application deadlines and most current information. In-kind services or operations are required	https://www.nrcs.usda.gov/programs-initiatives/csp-conservation-stewardship-program	
Conservation Partners Program (CPP)	CPP provides competitive grants that support the adoption of conservation practices and regenerative agriculture principles on working lands. Some of these principles include: 1) minimizing chronic disturbances to the soil and biological community; 2) enhancing wildlife habitat; 3) maximizing crop diversity; 3) keeping the soil covered; 4) keeping a living root in the ground at all times; 5) efficiently managing water	Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, tribal governments and organizations, and	$100,000 - $600,000 Matching contributions are not required, but projects that offer higher match ratios may be more competitive.	https://www.nfwf.org/programs/conservation-partners-program#:~:text=The%20Conservation%20Partners%20Program%20provides,Bill%20programs%20on%20working%20lands.ht	Todd Hogrefe Central Regional Office 612-564-7286 todd.hogrefe@nfwf.org

FUNDING SOURCE	DESCRIPTION	ELIGIBILITY	ASSISTANCE	WEBSITE	CONTACT
	resources; and 6) integrating livestock into agricultural systems.	educational institutions			
Regional Conservation Partnership Program (RCPP)	RCPP promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. It combines the authorities of four former conservation programs – the Agricultural Water Enhancement Program, the Chesapeake Bay Watershed Program, the Cooperative Conservation Partnership Initiative and the Great Lakes Basin Program. Assistance is delivered in accordance with the rules of other NRCS programs. RCPP encourages partners to join in efforts with producers to increase restoration and sustainable use of soil, water, wildlife, and related natural resources on regional or watershed scales. Through RCPP, NRCS and its partners help producers install and maintain conservation activities in selected project areas.	Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, tribal governments and organizations	Check with the county-based USDA Service Centers for application deadlines and most current information	https://www.nrcs.usda.gov/programs-initiatives/rcpp-regional-conservation-partnership-program	Rebecca Briggs Natural Resources Conservation Service Office Woodstock Service Center 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 rebecca.briggs@usda.gov
Emergency Watershed Protection Program (EWP)	EWP provides assistance to relieve imminent threats to life and property caused by floods, fires, windstorms and other natural disasters that impair a watershed. May be used to establish vegetative cover, open restricted channels, repair diversions and levees, and purchase floodplain easements on flooded land in non-urban areas. Formal requests for assistance are due 60 days from the disaster or 60 days from when the site becomes accessible.	Public and private landowners with a project sponsor, i.e., a state or local government or special government district	Up to 75% federal cost-share for projects; Up to 90% cost-share for locations that meet the limited-resource areas (LRA) criteria as determined by the NRCS Find the LRA definition and map here: https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection/ewp-floodplain-buyout-option-for-limited	https://www.nrcs.usda.gov/programs-initiatives/ewp-emergency-watershed-protection	Emergency Watershed Protection Program State Points of Contact: Paula Hingson 217-353-6602 paula.hingson@usda.gov

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Rural Development Water & Environmental Programs	WEP provides funding for the construction of water and waste facilities in rural communities and is proud to be the only Federal program exclusively focused on rural water and waste infrastructure needs. WEP also provides funding to organizations that provide technical assistance and training to rural communities in relation to their water and waste activities.	Rural communities with populations of 10,000 or less	Varies	https://www.rd.usda.gov/programs-services/water-environmental-programs	Betsy Dirksen Londrigan 2118 West Park Court, Suite A Champaign, IL 61821 217-403-6200
Environmental Quality Incentives Program (EQIP)	EQIP provides financial and technical assistance to agricultural producers and forest landowners through contracts up to a maximum term of ten years in length. Funding can help plan and implement conservation practices that address natural resource concerns and for opportunities to improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland.	Non-federal landowners engaged in farming or ranching	Federal share maximum of 75%; some exemptions may qualify for a 90% cost-share.	https://www.nrcs.usda.gov/programs-initiatives/eqip-environmental-quality-incentives	Paula Setchell Farm Service Agency Office Woodstock Service Center 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 Ext 2 paula.setchell@usda.gov Rebecca Briggs Natural Resources Conservation Service Office Woodstock Service Center 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 rebecca.briggs@usda.gov
National Water Quality Initiative (NWQI)	NWQI is a partnership among NRCS, state water quality agencies and the U.S. EPA to identify and address impaired water bodies through voluntary conservation. NRCS provides targeted funding for financial and technical assistance in small watersheds most in need and where farmers can use conservation practices to make a difference. Conservation systems include practices that promote soil health, reduce erosion and lessen nutrient runoff. These practices also enhance agricultural productivity and profitability. State water quality agencies and other partners contribute additional resources for watershed planning, implementation, outreach, and monitoring.	Landowners	Check with the county-based USDA Service Centers for application deadlines and most current information.	https://www.nrcs.usda.gov/programs-initiatives/national-water-quality-initiative	John Bullough Conservation Initiatives Coordinator: Water Quality john.bullough@usda.gov

FUNDING SOURCE	DESCRIPTION	ELIGIBILITY	ASSISTANCE	WEBSITE	CONTACT
Streambank Stabilization and Restoration Program	The Streambank Stabilization and Restoration Program is designed to demonstrate effective, inexpensive vegetative and bio-engineering techniques for limiting stream bank erosion. Program monies fund demonstration projects at suitable locations statewide and provide cost-share assistance to landowners with severely eroding stream banks.	All landowners and project sites (rural and urban) in each Illinois county	Check with the McHenry-Lake County Soil & Water Conservation District for details	https://agr.illinois.gov/resources/conservation.html	McHenry-Lake County Soil & Water Conservation District Spring Duffey Executive Director Spring.Duffey@il.nacdnet.net 1648 S. Eastwood Drive Woodstock, IL 60098 815-338-0444 x3
Watershed and Flood Prevention Operations Program (WFPO)	The WFPO Program provides technical and financial assistance to States, local governments and Tribes (project sponsors) to plan and implement authorized watershed project plans.	Public sponsorship Watershed projects up to 250,000 acres Agricultural benefits, including rural communities, must be ≥ 20% of the total benefits for the project	Varies	https://www.nrcs.usda.gov/programs-initiatives/watershed-and-flood-prevention-operations-wfpo-program	Matt Robert NRCS Illinois Watershed Program Manager 217-353-6629 matthew.robert@usda.gov
U.S. Department of Agriculture, Forest Service (USDA-FS) manages programs that promote forestry and natural enhancement of urban areas through urban forestry programs.					
Urban and Community Forestry (UCF) Program and Inflation Reduction Act Grants	The UCF program provides technical, financial, and educational assistance, delivering nature-based solutions for climate and environmental justice, and green jobs where more than 84% of Americans live, work, and play. Some of the program goals include: • Conserving working forest landscapes • Protecting forests from harm • Enhancing benefits associated with trees and forests • Advancing environmental justice • Training the future workforce for green jobs Under the Inflation Reduction Act, the UCF Program received a historic $1.5 billion to support urban tree-planting, urban forest planning and management, and	Local governments, educational organizations, individuals, and others	Varies	https://www.fs.usda.gov/managing-land/urban-forests/ucf	Michael Brunk Illinois Urban Forestry Administrator Illinois Department of Natural Resources One Natural Resources Way Springfield, IL 62702 217-558-2517Michael.Brunk@illinois.gov

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	related activities, particularly in disadvantaged communities. Learn more at the website.				
U.S. Department of Energy (USDOE) compiles and distributes a list of monthly funding opportunities relating to energy and the environment. Go to https://www.energy.gov/eere/office-energy-efficiency-renewable-energy and click on "Clean Energy Funding".					
U.S. Department of the Interior, Fish and Wildlife Service (USFWS) manages programs to protect wildlife and habitat by means such as issuing rules for hunters and anglers, administering the Endangered Species Act, and awarding grants for environmental restoration.					
Bring Back the Natives (BBN)	BBN seeks to restore, protect and enhance native fish species of conservation concern nationwide, especially in areas on or adjacent to federal agency lands. BBN awards grants to projects that address the leading factors in native fish species decline such as habitat alteration, environmental change, and invasive species.	Local, state, federal, and tribal governments and agencies, special districts, non-profit 501(c) organizations, and educational institutions	Up to $510,000; 1:1 non-federal cash, in-kind donations, and/or volunteer labor	https://www.nfwf.org/programs/bring-back-native-fish?activeTab=tab-1	Kirstin Neff Southwest Rivers Program Manager 303-222-6485 kirstin.neff@nfwf.org
Monarch Butterfly and Pollinators Conservation Fund	The Monarch Butterfly and Pollinators Conservation Fund helps to protect, conserve and increase habitat for the monarch butterfly and other pollinators. This program supports implementation of technical assistance to increase pollinator conservation practices on private working lands and improves the availability of high-quality pollinator habitat.	*BBN: Priority Projects to Great Lakes native fishes*	$150,000 - $300,000; Matching requirements vary, see website for details	https://www.nfwf.org/programs/monarch-butterfly-and-pollinators-conservation-fund	Crystal Boyd Pollinator Programs Senior Manager crystal.boyd@nfwf.org
Partners for Fish and Wildlife Programs	The Partners for Fish and Wildlife Program provides technical and financial assistance to landowners interested in restoring and enhancing wildlife habitat on their land. Projects are custom designed to meet landowners' needs.	Non-state and non-federal landowners, individuals, local government, and non-government organizations	Varies	https://www.fws.gov/program/partners-fish-and-wildlife	Michael Redmer One Natural Resources Way Springfield, IL 62702 217-557-4474 michael_redmer@fws.gov
Resilient Communities Program	The program emphasizes community inclusion and assistance to traditionally underserved populations in vulnerable areas. Regional awards will provide both natural habitat enhancement and improved protections afforded by natural resources.	Non-profit 501(c) organizations, local governments, state government agencies, and federally recognized tribes in the US	$100,000 - $500,000	https://www.nfwf.org/programs/resilient-communities-program/resilient-communities-2020-request-proposals	Carrie Clingan Program Director, Community Stewardship and Youth 202-595-2471 carrie.clingan@nfwf.org

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National Coastal Wetlands Conservation Grants	The program supports long-term wetland conservation by awarding up to $1 million for wetland conservation projects. Between $18 million and $23 million are available for projects annually. Funding for the grant program is provided by the Sport Fish Restoration and Boating Trust Fund. Priority is given to projects that: support the goals of the National Wetlands Priority Conservation Plan, provide long-term conservation, conserve maritime forest on coastal barrier islands, benefit threatened and endangered species, encourage public-private partnerships, or complement other conservation projects.	Coastal and Great Lakes states, U.S. commonwealths, and territories; Tribes, local governments, conservation organizations, and private landowners are encouraged to work with state agencies to develop a project and apply.	States provide 50% of the project cost or 25% if the state has a land conservation program. Match can be provided by the state or partners and may include the value of previously conserved land and in-kind contributions.	https://www.fws.gov/story/national-coastal-wetlands-conservation-grants	Christie Deloria-Sheffield Great Lakes Coastal Program Coordinator Contact Form: https://www.fws.gov/staff-profile/christie-deloria-sheffield
National Park Service (NPS) manages the nation's system of national parks, historic sites, etc. and serves as a conduit for some recreation-related conservation funding. (https://www.nps.gov/index.htm)					
Rivers, Trails, and Conservation Assistance Program (RTCA)	NPS-RTCA provides planning, design, and technical expertise for conservation and outdoor recreation projects. The program strives to build healthy communities, conserve lands and waters, develop organizational capacity, support public land management collaboration, and engage youth. While NPS-RTCA does not provide financial assistance or monetary grants, the program can help organizations identify potential funding sources for their projects.	Nonprofit organizations, community groups, tribal governments, national parks, and local, state, and federal government agencies	Technical Assistance	https://www.nps.gov/orgs/rtca/index.htm	David Thomson Midwest Program Manager MWR_RTCA@nps.gov
U.S. Department of Transportation (DOT) regulates the federally mandated metropolitan planning process and administers federal transportation funding.					

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Illinois Transportation Enhancement Program (ITEP)	ITEP allocates resources to well-planned projects that provide and support alternate modes of transportation, enhance the transportation system through preservation of visual and cultural resources, and improve the quality of life for members of the communities. These set-aside funds include projects such as pedestrian and bicycle facilities, streetscapes, conversion of abandoned railroad corridors to trails, historic preservation, vegetation management, stormwater management, and habitat connectivity.	Local entities with taxing authority	80% federal share of project costs in general, 50% for acquisition Awards up to $3 million	https://idot.illinois.gov/transportation-system/local-transportation-partners/county-engineers-and-local-public-agencies/funding-opportunities/ITEP	General Contact: Illinois Department of Transportation Illinois Transportation Enhancement Program Room 307 2300 South Dirksen Parkway Springfield, Illinois 62764 DOT.ITEP@illinois.gov Bureau of Programming Contact: Brian McCoy Program Manager 217-782-5482 Brian.McCoy@illinois.gov District 1 (Lake County) Contact: Charles Riddle 847-705-4201
Illinois Department of Natural Resources (IDNR) manages, conserves and protects Illinois' natural, recreational and cultural resources, further the public's understanding and appreciation of those resources, and promotes the education, science and public safety of Illinois' natural resources for present and future generations.					
IDNR Grant Opportunities	The IDNR offers multiple funding opportunities. All grants administered by the department are subject to available funding.	Varies	Varies	https://dnr.illinois.gov/grants.html	Illinois Department of Natural Resources One Natural Resources Way Springfield, IL 62702 217-782-6302 DNR.Grants@illinois.gov
Federal Recreational Trails Program (RTP)	This program provides funding assistance for acquisition, development, rehabilitation and maintenance of both motorized and non-motorized recreation trails. By law, 30% of each state's RTP funding must be earmarked for motorized trail projects, 30% for non-motorized trail projects and the remaining 40% for multi-use (diversified) motorized and non-motorized trails or a combination of either.	Federal, state and local government agencies, not-for-profits organizations and private operators of motorized recreational facilities open to the public	Up to 80% project funding Max. grant of $200,000 per application for nonmotorized development projects (represents a total min.	https://dnr.illinois.gov/aeg/federalrecreationaltrailsprogram.html	Illinois Department of Natural Resources, Office of Grant Management and Assistance One Natural Resources Way Springfield, Illinois 62702 217-782-7481 DNR.Grants@illinois.gov

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			project cost of $250,000 per application) No max. grant award amount for acquisition projects and for motorized projects		
Illinois Habitat Fund	The Illinois Habitat Fund Grant Program includes projects that are seeking to preserve, protect, acquire or manage habitat (all wetlands, woodlands, grasslands, and agricultural lands, natural or altered) in Illinois that have the potential to support populations of wildlife in any or all phases of their life cycles.	Not-for-profit organizations or government agencies that have the expertise, equipment, and permission from landowners (if applicable) to develop and/or manage habitat	$10,000 - $300,000, no match requirement	https://dnr.illinois.gov/grants/habitat-funding-opportunity.html	Susan Duke, IDNR One Natural Resources Way Springfield, Illinois 62702-1271 217-785-4416 susan.duke@illinois.gov
Open Space Lands Acquisition and Development (OSLAD) Program **Land & Water Conservation Fund program (LWCF)**	OSLAD is a state-financed grant program that provides funding assistance to local government agencies for acquisition and/or development of land for public parks and open space. LWCF is a similar program with similar objectives. Projects vary from small neighborhood parks or tot lots to large community and county parks and nature areas.	Local units of government	Up to 50% of approved project costs; grant amount varies depending on project type and number of residents	https://dnr.illinois.gov/grants/openspacelandsaquisitiondevelopment-grant.html	Illinois Department of Natural Resources One Natural Resources Way Springfield, IL 62702-1271 217-782-7481 DNR.Grants@illinois.gov
Schoolyard Habitat Action Grants	Support enhancement of wildlife habitat, with emphasis on youth involvement and education	Teachers, nature center personnel and adult youth group leaders	Maximum annual award of $2,000 per project	https://dnr.illinois.gov/education/grants/grantsshag.html	Illinois Department of Natural Resources' Division of Education One Natural Resources Way Springfield, IL 62702-1271 217-524-4126 dnr.teachkids@illinois.gov
Illinois Biodiversity Field Trip Grants & Free Educational Materials	This program supports field trips for students to visit natural areas, natural history museums, and other natural resource related activities, so they can study some aspect of Illinois' biodiversity. Conservation education materials, including lesson plans, can be used separately.	Teachers of grades prekindergarten – 12 (including home-schooling teachers)	$500 limit per teacher	https://dnr.illinois.gov/education/grants/grantsibftg.html	

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Illinois Natural Areas Stewardship Grant Program	This program provides grants to Conservation Land Trusts to 1. increase stewardship on dedicated Illinois Nature Preserves and registered Land and Water Reserves and 2. increase stewardship capacity within Conservation Land Trusts. Funding for this grant program is derived from the Illinois Natural Areas Acquisition Fund (NAAF) and must be used by the Department of Natural Resources for the acquisition, protection, and stewardship of natural areas, including habitats for endangered and threatened species.	Conservation Land Trusts exempt from taxation under Section 501 (c) (3) of the federal Internal Revenue Code and include in purposes the restoration and stewardship of land for conservation	Up to $100,000 Match of 5% or $1000, whichever is less	https://dnr.illinois.gov/grants/stewardshipgrants.html	Susan Duke Department of Natural Resources Office of Grant Management and Assistance One Natural Resources Way, Springfield, IL 62702-1271 217-785-4416 susan.duke@illinois.gov
Illinois Department of Agriculture (IDOA)					
Sustainable Agriculture Grant Program	This grant program supports practices that maintain producers' profitability while conserving soil, protecting water resources and controlling pests through means that are not harmful to natural systems, farmers or consumers. The grant program funds sustainable agriculture research, education and demonstration through conferences, training, on-farm research and educational outreach.	Organizations, governmental units, educational institutions, non-profit groups and individuals	Varies	https://agr.illinois.gov/resources/conservation.html	Illinois Department of Agriculture Bureau of Land and Water Resources State Fairgrounds P.O. Box 19281 Springfield, IL 62794-9281 217-785-5593
Illinois State Board of Education (ISBE) Useful website to search for educational grants: https://www.isbe.net/Pages/Grants.aspx					
Lake County: https://www.lakecountyil.gov/553/Stormwater-Management-Commission					
Lake County SMC Watershed Management Board (WMB) **Watershed Management Assistance Grant (WMAG)**	Watershed Management Board (WMB) grants provide up to 50% cost-share for projects that address flood damage mitigation, water quality improvement and natural resources enhancement within Lake County (includes green infrastructure). Flood mitigation/reduction criteria receive the greatest weight in determining funding awards. WMAG supports the growth and sustainability (i.e., organizational capacity) of local watershed partnerships in Lake County. For this program, a "watershed partnership" is defined as an inclusive,	WMB/WMAG/SIRF: All project proposals must be signed and supported by a WMB member. A WMB Board Member can be a Chief Elected Official of any Lake County Municipality, a Lake County Township Supervisor, the President of an Active Lake County	Cost-share at least 50% with funds or in-kind services or a combination of both $12,000 set aside for WMAG applications; no cost-share requirement	https://www.lakecountyil.gov/3635/Watershed-Management-Board-WMB	Lake County Stormwater Management Commission 500 W Winchester Road Libertyville, IL 60048847-377-7700 stormwater@lakecountyil.gov

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	enduring, diverse, community-based group organized to identify and resolve watershed problems and issues.	Drainage District, a Lake County Board Member, or a Delegate of one of the above.			
Stormwater Infrastructure Repair Fund (SIRF)	The $100,000/year SIRF can assist local units of government in resolving interjurisdictional drainage and flooding related problems (i.e., stormwater management system infrastructure needs). The SIRF program is a 50/50 cost share match for SIRF eligible projects in Lake County.		$100,000 - $150,000 available each year for planning, engineering analysis, alternate solution evaluation, design, capital construction, maintenance and repairs projects	https://www.lakecountyil.gov/2308/Flooding-Flood-Protectionhttp	
Stream & River Clean Up Projects	SMC offers small grants for stream and river clean-up projects.		Up to $500 for stream and river clean-up projects		
Lake County Deicing Workshop	The Annual Lake County Deicing Workshop provides an opportunity to focus on sensible salting practices for roadways, parking lots and sidewalks. This workshop's snow and ice removal presentations include the effects of weather conditions & storing materials, surface safety, environmental effects (chloride use), materials selection, maintenance best management practices and application rate & calibration.	All winter maintenance operators, planners, supervisors, product distributers, and maintenance personnel	Technical and informational assistance	https://www.lakecountyil.gov/2284/Winter-Maintenance-Best-Practices	Alana Bartolai 847-377-8009 ABartolai2@lakecountyil.gov
Lake County Voluntary Buyout Program	Using federal and state matching grants, SMC offers a voluntary buyout program for repetitively flood damaged structures in Lake County.	SMC maintains a list of properties that are candidates for buyouts when funds become available.	Buyouts are typically 75% federal and 25% local cost share for qualified structures	https://www.lakecountyil.gov/DocumentCenter/View/20510/Voluntary-Floodplain-Buyout-Program-Brochure-PDF?bidId=	Sharon Osterby 847-377-7706 sosterby@lakecountyil.gov
Chicago Metropolitan Agency for Planning (CMAP)					
Local Technical Assistance Program (LTA)	LTA addresses local issues at the intersection of transportation, land use, and housing, including the natural environment (including green infrastructure components), economic growth, and community development. The program provides assistance to communities across the Chicago metropolitan region to undertake planning projects that advance the principles of GO TO 2040.	Local governments, nonprofits, and intergovernmental organizations	Technical Assistance & CMAP recommendations Local match between 5-20% of the value of the assistance for larger planning projects	https://www.cmap.illinois.gov/programs/lta	Chicago Metropolitan Agency for Planning 433 West Van Buren Street, Suite 450 Chicago, Illinois 60607 312-454-0400

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			Contribution depends on the type, size, and community cohort		Can also contact applications@cmap.illinois.gov for questions about the application process
Congestion Mitigation and Air Quality Improvement Program (CMAQ)	CMAQ is a federally funded program of surface transportation improvements designed to improve air quality and mitigate congestion. The primary consideration for CMAQ projects is the cost-effectiveness of their air emissions reductions, measured as either the cost per kilogram of volatile organic compounds (VOC) reduced or the cost per kilogram of fine particulate matter (PM2.5) and nitrogen oxides (NOx) reduced.	Any state agency or unit of government having the authority to levy taxes and those agencies authorized to receive FTA Section 5307 funding Private for-profit and non-profit organizations are required to partner with a public sponsor.	80% federal / 20% local match	https://www.cmap.illinois.gov/mobility/strategic-investment/cmaq	Refer to the Project Contacts webpage: https://www.cmap.illinois.gov/mobility/strategic-investment/cmaq/project-contacts
Transportation Alternatives Program (TAP-L)	The locally programed TAP-L is a federally funded program of surface transportation improvements designed to support non-motorized transportation. The TAP-L program is designed to fund non-motorized transportation projects and in northeastern Illinois those funds are focused on the completion of the Regional Greenways and Trails Plan. For TAP-L funding, only bicycle facility projects are eligible.	Regional trans. authorities, transit agencies, natural resource or public land agencies, school districts, & local or regional gov't entities	65-80% federal funding The local match does not necessarily have to be provided directly by the sponsor but must be a non-federal funding source to qualify. Learn more here: https://www.cmap.illinois.gov/documents/10180/1512766/CMAQ_TAP_CRP_24-28_App_Booklet.pdf/a4315f12-be1a-4375-f391-1dab300939a4?t=1673962249591	https://www.cmap.illinois.gov/mobility/strategic-investment/transportation-alternatives	CMAP Program Manager Doug Ferguson 312-386-8824 dferguson@cmap.illinois.gov

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Surface Transportation Program (STP)	STP supports larger-scale regional projects that address regional performance measures and the goals of ON TO 2050. Project eligibility is focused on projects of significant cost and multijurisdictional projects in eight categories that address federal performance measures and priorities of ON TO 2050: bicycle and pedestrian barrier elimination, bus speed improvements, bridge rehabilitation or reconstruction, highway/rail grade crossing improvements, road reconstruction, road expansion, corridor or small area safety, transit station improvements, and truck route improvements.	Any state agency or unit of government having the authority to levy taxes	Lake County: 80% federal/20% local STP funding match Jurisdictions in the highest need group (Cohort 4) are considered eligible to utilize TDCHs as local match for STP-L.	https://www.cmap.illinois.gov/committees/advisory/council-of-mayors/stp	Mike Klemens, 847-377-7455 mklemens@lakecountyil.gov
Other Public & Private Organizations					
Section 4 Capacity Building for Community Development and Affordable Housing Program	The Section 4 Program strengthens the nation's lower-income rural and urban communities by bolstering non-profit community developers that build and invest in those neighborhoods. Section 4 provides grants on a competitive basis to national intermediary community development organizations, which in turn provide training, education, financial support and development assistance to local organizations throughout the country.	Community Development Corporations (CDCs), Community Housing Development Organizations (CHDOs), Tribes, Tribally Designated Housing Entities (TDHEs), Tribal Housing Authorities (THAs), and Native CDFIs Learn more on page 10 of this document: https://www.enterprisecommunity.org/sites/default/files/2023-03/fy21-s4-rfp-rural-tribal-3-29-23.pdf	Varies	https://www.hudexchange.info/programs/section-4-capacity-building/ https://www.enterprisecommunity.org/news/hud-section-4-capacity-building-grants	Office of Policy Development and Coordination in HUD's Office of Community Planning and Development capacitybuilding@hud.gov Enterprise Community Partners, Inc. 70 Corporate Center 11000 Broken Land Parkway, Suite 700 Columbia, MD 21044 rfp@enterprisecommunity.org

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Illinois Clean Energy Community Foundation	This program's mission is to improve energy efficiency, advance the development and use of renewable energy resources, and protect natural areas and wildlife habitat in communities across Illinois.	Private not-for-profit organizations, educational organizations, local governments	Call for details, which change year to year	https://www.illinoiscleanenergy.org/	Contact Form: https://www.illinoiscleanenergy.org/contact-us/ Gabriela Martin Program Director Illinois Clean Energy 2 N. LaSalle St., Suite 1140 Chicago, IL 60602 312-372-5191 gmartin@illinoiscleanenergy.org
RiverWatch	RiverWatch is a volunteer-driven effort to collect stream data from Illinois streams and submit the data to the Illinois Natural History Survey. RiverWatch utilizes trained volunteers to collect quality assured data on wadeable streams and fosters coordination among groups involved in similar monitoring efforts.	All Illinois streams	Monitoring training, forms, and kits	http://www.ngrrec.org/riverwatch/about/	Danelle Haake, RiverWatch Director and Stream Ecologist NGRREC/L&C One Confluence Way East Alton, IL 62024 618-468-2784 dhaake@lc.edu
Trust for Public Lands (TPL)	From helping to raise funds for conservation; to protecting and restoring natural spaces; to collaborating with communities to plan, design, and create parks, playgrounds, gardens, and trails; TPL works with communities to ensure that development happens for them, and not to them. For example, TPL created the "Natural Solutions Tool Greater Chicago: A Watershed Approach" to guide green infrastructure investment in portions of Cook, Will, and DuPage Counties: https://www.tpl.org/resource/natural-solutions-tool-greater-chicago	Local government, private not-for-profit organizations, educational organizations, and others	Technical and informational assistance to identify lands to be protected and assist in financing and land transactions	https://www.tpl.org/	The Trust for Public Land Chicago Office 120 S. LaSalle Street, Suite 2000 Chicago, Illinois 60603 312-750-9820 chicago@tpl.org
Illinois Farm Bureau Nutrient Stewardship Grant Program	The Nutrient Stewardship Grant Program funds County Farm Bureau (CFB) projects focused on improving soil health and water quality throughout the state. Since 2015, IFB has dedicated over $1,000,000 to CFBs to complete a wide range of unique projects, including planting test plots of cover crops, watershed planning, water testing, hosting education and outreach activities.	County Farm Bureau offices (Lake and McHenry)	Conservation demonstrations, research, agricultural Best Management Practices, education, outreach, watershed planning.	https://www.ilfb.org/ifb-in-action/what-were-working-on/protecting-our-environment/nutrient-stewardship-grant-program	Raelynn Parmely IFB Environmental Program Manager Email: rparmely@ilfb.org

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Illinois American Water Environmental Grant Program	This program offers funding for innovative, community-based environmental projects that improve, restore or protect the watersheds, surface water and groundwater supplies in Illinois American Water's local communities.	A proposed project must be located within an American Water service area, completed between May and November of the grant funding year, and be a new or innovative community initiative or serve as significant expansion to an existing program.	Maximum grant amount of $5,000	https://www.amwater.com/ilaw/News-Community/environmental-grant-program/	Mike Jones Illinois American Water mike.jones@amwater.com