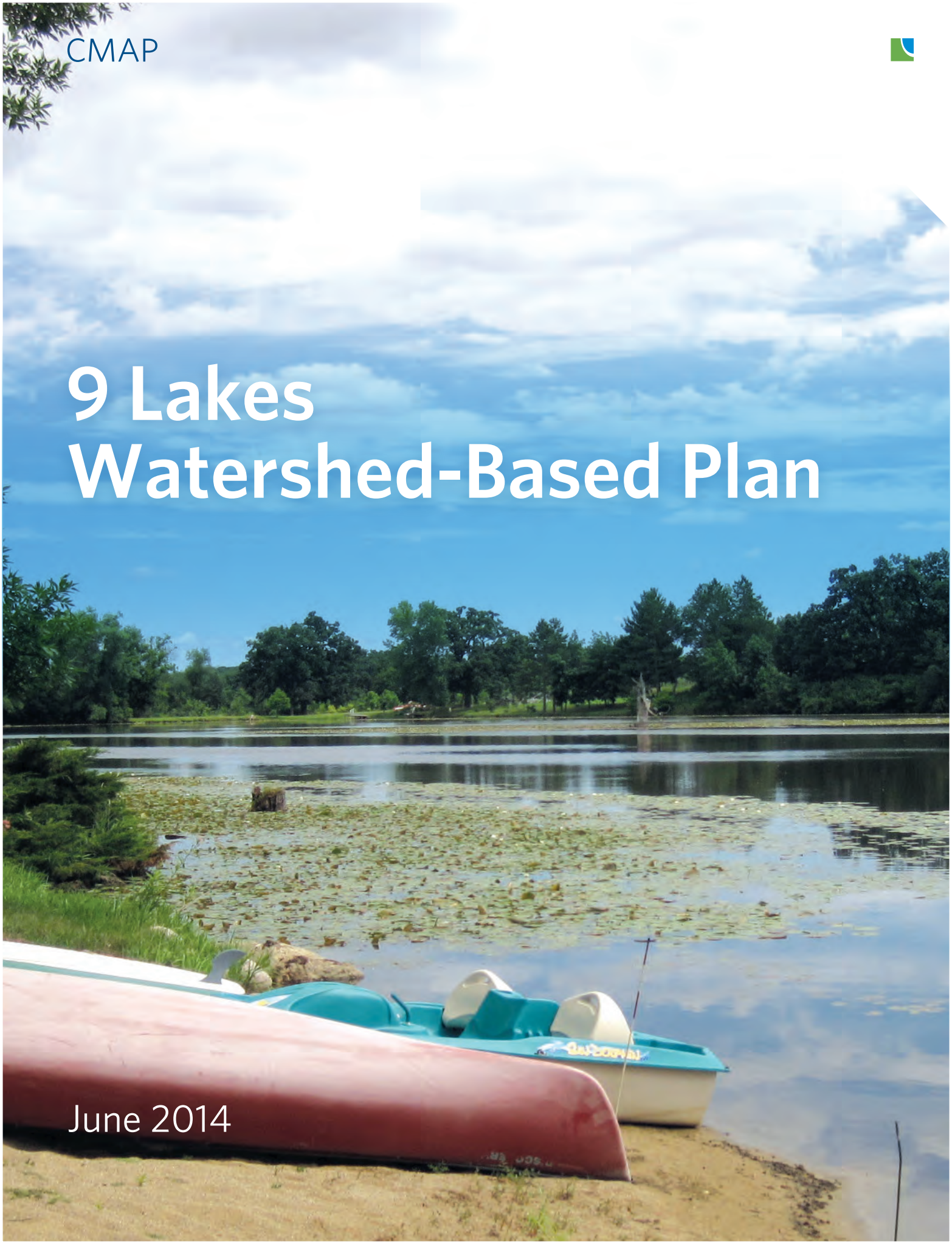
CMAP

9 Lakes Watershed-Based Plan



June 2014

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1. Introduction

Watershed planning is a public process involving all parties with an interest or "stake" in the environmental health and quality of life of the area at issue. A watershed, the land area from which precipitation and resulting surface runoff drain to a lake or river, serves as the organizational framework for thinking about, planning, and management of land use and other activities that affect both land and water resources.

Everyone lives in a watershed and smaller watersheds are typically nested within increasingly larger ones since water runs downhill. Thus, watershed boundaries are defined by topography or the "lay of the land." Human activities within the watershed affect local water quality and the waters of their downstream neighbors. While watersheds grow in spatial extent when one stream joins with one another, watersheds typically end when a river drains into the ocean, large lake, or, more rarely, an inland point such as a relatively low lying wetland that serves to recharge groundwater.

More often than not, watershed planning is driven by the need to correct water pollution problems in streams and/or lakes. Planning can also focus on protecting water resources that are not impaired by any number of potential sources and causes of pollution that typically stem from land-use change or land-management activities that do not fully account for off-site impacts. When remedy for water pollution is sought, it is usually made possible by funding that stems from the Clean Water Act.[1] Such is the case with this plan.

The Chicago Metropolitan Agency for Planning (CMAP) received a Clean Water Act grant from the Illinois Environmental Protection Agency to develop a watershed plan for nine lakes in southwestern Lake County. While the plan was originally undertaken to develop recommendations for purposes of achieving Total Maximum Daily Loads (TMDL), the latter were never finalized by Illinois Environmental Protection Agency (Illinois EPA) and their consultant as expected.[2] Thus, the purpose of this plan is to work with local stakeholders to develop recommendations that upon implementation will help restore the water quality of local streams and the nine lakes that are situated in three adjacent watersheds that drain to the Upper Fox River.

[1] Federal Water Pollution Control Act of 1972 (Public Law 92-500) as amended, also known as the Clean Water Act.

[2] A Total Maximum Daily Load or TMDL is a pollution budget that quantifies the amount of a pollutant that a waterbody can receive while still meeting its designated uses and water quality standards. When Illinois EPA deems that a waterbody is impaired for one or more of its designated uses, the Clean Water Act stipulates that a TMDL must be developed to inform a remediation plan.

1.1 Problem Statement, Goals, and Objectives

Early in the planning process, stakeholders developed the following problem statement, goals, and objectives for this plan:

Problem Statement: Surface waterbodies (i.e., lakes and streams) must meet water quality standards sufficient to achieve designated uses. The nine lakes within the watershed planning area fail to meet all of their designated uses due to known causes that are often related to land use. Best management practices, including new or improved policy initiatives, must be identified and implemented by landowners and managers as resources allow to improve water quality and to restore designated use attainment. A plan to solve the problem must be finalized by June 1, 2014, to guide remedial activities during the following 5-10 years.

The following goals and objectives list the primary goal first. Goals that follow are secondary and of equal importance.

Goal: Improve water quality to attain designated uses of aquatic life support, aesthetic quality, and primary contact recreation.

- Objective: Reduce phosphorus pollutant loads consistent with implementation plan recommendations.
- Objective: Reduce suspended solids pollutant loads consistent with implementation plan recommendations.
- Objective: Improve dissolved oxygen levels consistent with implementation plan recommendations.
- Objective: Reduce fecal coliform pollutant loads consistent with implementation plan recommendations.

Goal: Build local partnerships and expertise to protect our streams, lakes, and wetlands via plan implementation.

- Objective: Support sustainability and effectiveness of local watershed groups.
- Objective: Involve private landowners in resource protection efforts.

Goal: Protect the quality and quantity of groundwater.

- Objective: Advance water-use conservation and efficiency efforts.
- Objective: Practice sensible salting to minimize chlorides in runoff.
- Objective: Identify groundwater recharge areas.

Goal: Provide guidance on conservation of open space within the context of regional green infrastructure.

Objective: Align watershed planning area with local, county, and regional green infrastructure vision.

Objective: Identify neighborhood- and site-scale opportunities for implementing green infrastructure (i.e., protect open space / natural areas) in concert with other plans.

Goal: Raise public awareness and increase understanding of the impacts of land-use and land / water management decisions on water quality.

Objective: Provide information and educational resources to elected officials, schools, and the general public.

Goal: Enhance the quality of fishing, boating, and other recreational opportunities.

Objective: Promote long-term maintenance of balanced, native aquatic plant communities in our lakes.

Objective: Promote long-term maintenance of balanced fish communities in our lakes.

Objective: Maintain water clarity for aesthetics and to support balanced aquatic macrophyte and fish communities.

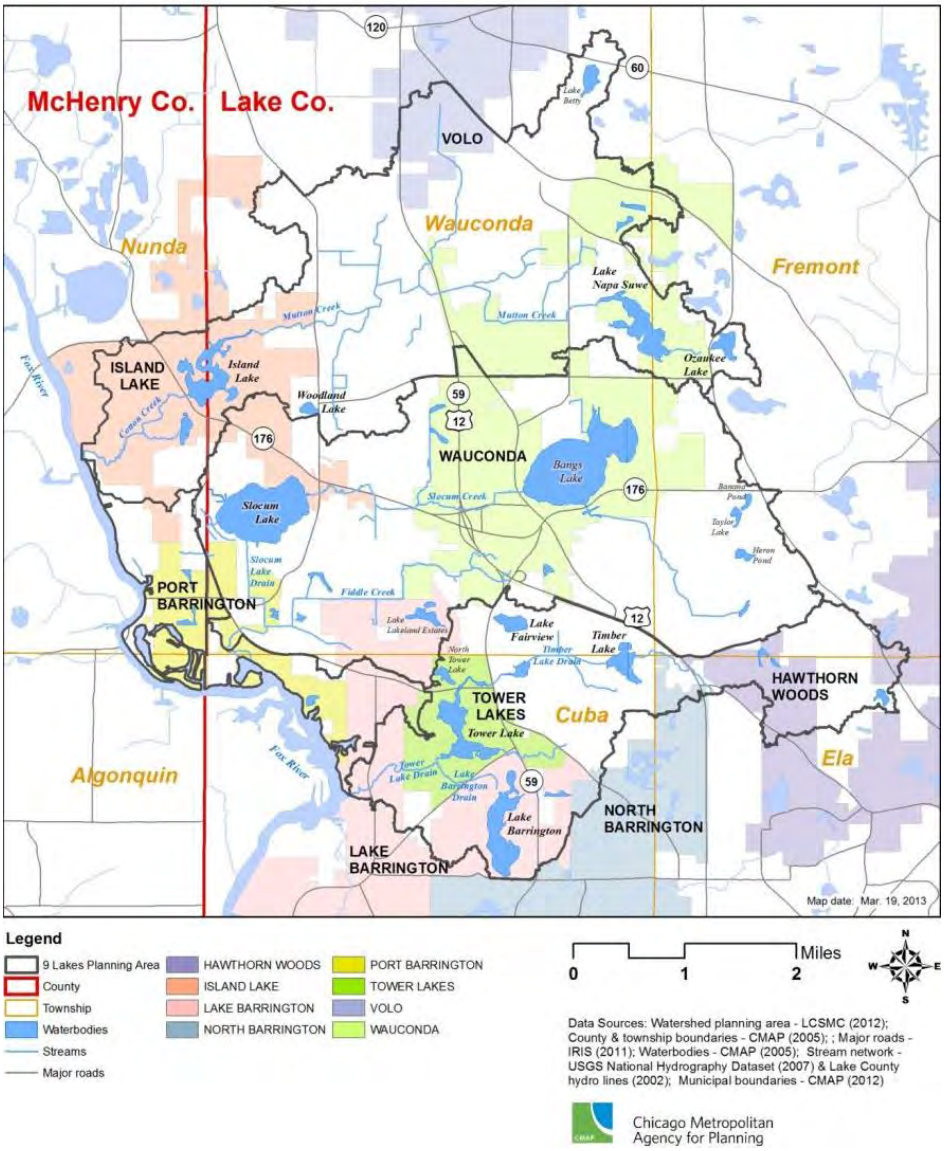
2. Watershed Resource Inventory

2.1 9 Lakes Watershed Planning Area

The 9 Lakes Watershed Planning Area lies within the Upper Fox River Subbasin3 and is situated primarily in southwest Lake County (92 percent) and partially in McHenry County (eight percent). The 29.3 square mile area contains three primary watersheds: Cotton-Mutton Creek (HUC – 0712000611xx; 10.2 sq. mi.), Slocum Lake Drain / Fiddle Creek (HUC – 0712000611xx; 11.3 sq. mi.), and Tower Lake Drain (HUC – 0712000611xx; 5.9 sq. mi.). Additionally, over six percent or 2.0 sq. mi. of the planning area is direct drainage to the Upper Fox River Subbasin (Figure 1).

[3] The Fox River Basin (FRB) is split between Upper and Lower with the divide running through Elgin and Streamwood. Tyler Creek and Poplar Creek are the southernmost watersheds of the Upper FRB.

Figure 1. The 9 Lakes Watershed Planning Area.



2.1.1 Population and Demographics

The population of the planning area is approximately 34,584 people; 13.6 percent greater than the 2000 population of 30,438.[4] This rate of change was more robust than the 3.3 percent change for the state of Illinois during the same 10-year period. CMAP's GO TO 2040 forecasts a population of 48,121 or 31.4 percent growth as compared to the forecast base of 36,617 which was a slight underestimate of the actual 2010 census of 37,492 that followed the forecast

[4] Using ESRI ArcMap 10.0 geoprocessing methodology and U.S. Census Bureau (2010 and 2000) census block data, watershed population (i.e., planning area) will be somewhat overestimated.

process.[5] Thus, population is estimated to grow at an approximate rate of 11-12 percent per decade between 2010 and 2040; likely maintaining a stronger rate of growth than the state as a whole, but at a slightly lower rate than that of the past decade. Table 1 features additional demographic data that characterize the planning area population relative to Lake County and the State of Illinois.

Table 1. Select demographic characteristics of planning area, county, and state.

Characteristic	*9 Lakes Planning Area*	*Illinois*[6]	*Lake County*[7]
Median age	42	-----	36.7
Age 65 & over	12.3%	12.7%	10.4%
< 5 years of age	6.2%	6.4%	6.7%
< 18 years of age	25.0%	24.1%	27.4%
Female population	49.8%	50.9%	50.1%
Race/One Race/White	89.3%	78.0%	75.1%
Housing Tenure - Owner occupied	85.7%	----	76.6%

2.2 Units of Government

In northeastern Illinois, over 1,200 units of government collect revenues and provide services to the seven-county region's residents, businesses, and visitors. Municipal jurisdictions account for approximately 47 percent (13.7 sq. mi.) of the 9 Lakes watershed planning area and include portions of eight communities (Table 2). The majority of the planning area, therefore, is unincorporated land.

Table 2. Incorporated area within the 9 Lakes Watershed Planning Area.

Municipality	*Square Miles*	*Percent of Planning Area*
Hawthorn Woods	0.65	2.2
Island Lake	2.49	8.5
Lake Barrington	2.36	8.0
North Barrington	0.19	1.0
Port Barrington	1.17	4.0
Tower Lakes	1.05	3.6
Volo	0.55	1.9
Wauconda	5.30	18.0
total	13.76	47.2

[5] CMAP population and employment forecasts use a "subzone" unit of geography that is different from census blocks or tracts. A subzone is equivalent to a quarter of a section.

[6] U.S. Census Bureau. State and County QuickFacts: Illinois. http://quickfacts.census.gov/qfd/states/17000.html

[7] U.S. Census Bureau. Profile of General Population and Housing Characteristics: 2010, Lake County. http://factfinder2.census.gov/bkmk/table/1.0/en/DEC/10_DP/DPDP1/0500000US17097

Six townships partially overlap with the planning area: Wauconda, Fremont, Cuba, and Ela in Lake County, and Nunda and Algonquin Townships in McHenry County. Two park districts lie partially within the planning area: Wauconda Park District and Lake Barrington Countryside Park District. There are four library districts that will likely play an important role in the education component of the plan: Wauconda Area Public Library District, Fremont Public Library District, Ela Area Public Library District, and Barrington Public Library District. There is one regional wastewater treatment agency, the Northern Moraine Wastewater Reclamation District, seven elementary/secondary school districts, and three community college districts.

The Fox Waterway Agency is a special-purpose unit of local government and has a unique territory that captures the Fox River and land on either side of the river. Lastly, the Lake County Forest Preserve District and McHenry County Conservation District are other special-purpose units of government with land management jurisdiction within the planning area. Thus, there are at least 36 units of government that are at least partially within the planning area not including state government, county board, and Congressional districts.

2.2.1 Local Jurisdictions with Water Quality Roles

Of the many units of government listed above, several have distinct roles and responsibilities related to water quality and nonpoint-source pollution control. For example, 16 units of government are operators of small municipal separate storm sewer systems: the eight municipalities listed in Table 2, the six townships listed above, and both Lake County and McHenry County municipal separate storm sewer systems – MS4s – are intended to collect urban stormwater runoff, an important contributor to nonpoint-source pollution, and, consequently, are regulated under the National Pollutant Discharge Elimination System (NPDES, discussed in subsection 2.6.5).

In Illinois, discharges from small MS4s are regulated under Illinois EPA's General NPDES Permit No. ILR40. The central feature of this permit is a requirement 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 six 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 best management practices (BMPs) and measureable goals for each of the six minimum control measures.

In order to obtain coverage under the permit, permittees must submit to Illinois EPA a completed Notice of Intent (NOI)[8] describing its BMPs and measurable goals, providing other program specifics, and identifying any arrangements made with others to share program responsibilities. Once coverage has been granted, a permittee must submit an annual report to Illinois EPA by June 1 which must include the following:

1. The status of compliance with the permit conditions, including an assessment of the BMPs and progress toward the measurable goals;
2. Results of any information collected and analyzed, including monitoring data;
3. A summary of the storm water activities planned for the next reporting cycle;
4. A change in any identified best management practices or measurable goals;
5. If applicable, notice of relying on another governmental entity to satisfy some of the permit obligations.[9]

In addition to the MS4 program, both Lake County and McHenry County have stormwater management or watershed development ordinances which are enforced by the counties in unincorporated areas and noncertified communities and represent a minimum standard to be met by certified communities.[10] These county ordinances specify many provisions including one pertaining to stormwater detention basins that are usually designed and installed by a developer. Once construction is complete, however, long-term responsibility (i.e., maintenance) is typically transferred to a homeowner's association (HOA) since the detention basin involves land in private ownership. While HOA's are not jurisdictions on par with various units of government, they play key roles in the scheme of local stormwater management nonetheless and, as it turns out, often unwittingly.

At the municipal level, there may be codes and ordinances that either directly or indirectly protect water quality from nonpoint-source pollution. Thus, county, township, and municipal governments all play key roles in nonpoint-source pollution control.

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[8]Illinois EPA, Bureau of Water. Notice of Intent for New or Renewal of General Permit for Discharges from Small Municipal Separate Storm Sewer Systems – MS4's. http://www.epa.state.il.us/water/permits/storm-water/forms/notice-intent-ms4.pdf

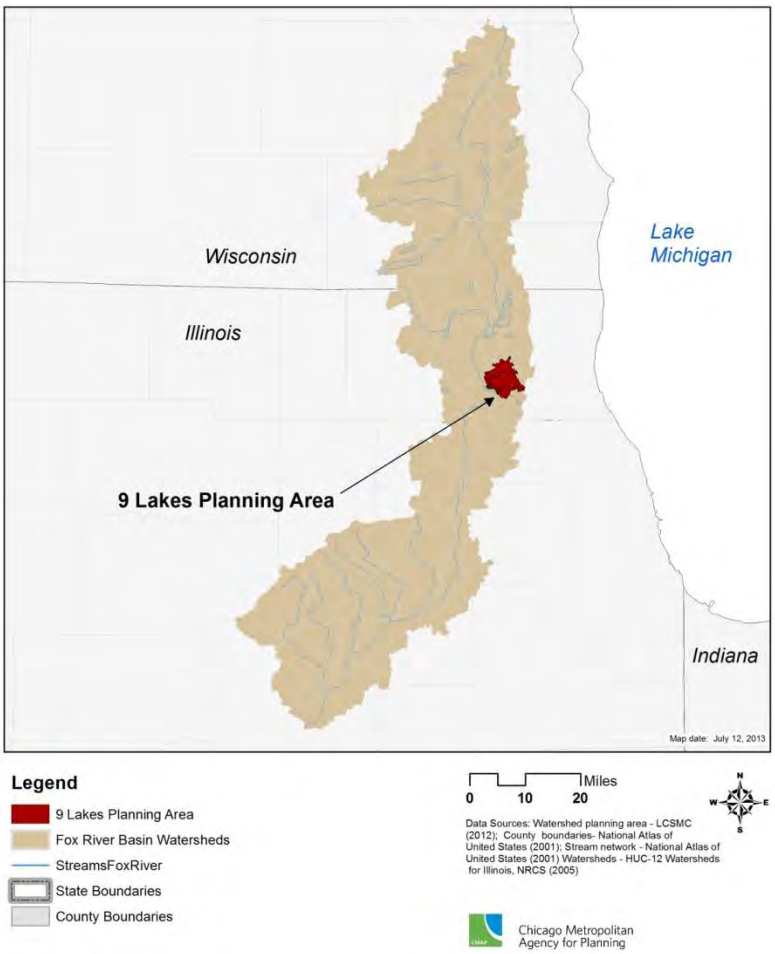
[9] M. Novotney. Lake Co. Stormwater Management Commission. 2013. *Personal communication*. There are several other noteworthy requirements of the program, including: (1) annual program review as part of annual report preparation; and, (2) at least annual monitoring of receiving waters, use of indicators to gauge the effects of stormwater discharges on the physical/habitat-related aspects of receiving waters, and/or monitoring BMP effectiveness.

[10]Certified Communities are those communities that have been delegated authority by a County to administer all, or portions of, the watershed development/stormwater management regulations within their community limits. Certified Communities apply for re-certification every three years. Communities may have regulations that are more stringent than the county ordinance. For more information, see, for example, http://www.lakecountyil.gov/Stormwater/FloodplainStormwaterRegulations/PermitsApprovals/Pages/CertifiedCommunities.aspx.

2.3 Fox River Basin

The Fox River is the third largest tributary of the Illinois River and extends approximately 185 miles from its headwaters near Waukesha, Wisconsin to its confluence with the Illinois River near Ottawa, Illinois (Figure 2). The Fox River Basin (FRB) is an area of about 2,658 square miles, of which 65 percent (1,720 sq. mi.) is in Illinois, and includes portions of 11 Illinois counties including six that are the most populated in the state: Cook, DuPage, Lake, Will, Kane, and McHenry. Kendall County, one of the other five FRB counties, was the fastest growing county in the country between 2000 and 2010.

Figure 2. The Fox River Basin.



A primary reason for the large population living in the Illinois section of the FRB is its proximity to Chicago. For people looking for something other than an urban/big city environment, communities and unincorporated areas of the FRB offer either a suburban or rural lifestyle with good access to recreational opportunities and high-quality natural resources. Increasingly, jobs are also found throughout the FRB; another reason for preference to reside nearby. Employment opportunities aside, however, those same natural resources, once abundant and widely connected, along with the river itself, have been depleted or

compromised by historic land-use change and a type of development that is often inconsistent with water quality protection and sustainable development. Newer ideas, development practices, and initiatives seek to reverse historic trends that have unduly impacted water and natural resources.

The Fox River features many designated uses. For the stretch of river (i.e., reach) closest to the planning area, there are five designated uses of which four have been assessed and two are deemed impaired (Table 3). Water quality improvements in the planning area will also help to improve overall Fox River water quality.

Table 3. Fox River, Water ID: IL_DT-22, water quality status (2012)[11]

Designated Use	*Assessed?*	*Source of Impairment*	*Cause of Impairment*
Aquatic life	Yes	Highway/road/bridge runoff, urban runoff/storm sewers, unknown, dam or impoundment, habitat modification other than hydromodification, impacts from hydrostructure flow regulation/modification	Chloride, copper, sedimentation / siltation, aquatic algae, other flow regime alterations, alteration in streamside or littoral vegetative covers
Fish consumption	Yes	Unknown	Polychlorinated biphenyls
Primary contact	Yes	None; in full support	n/a
Secondary contact	Yes	None; in full support	n/a
Aesthetic Quality	No	n/a	n/a

2.4 Land Use

Land use has been classified using CMAP's 2005 Land Use Inventory Classification Scheme.[12] CMAP's scheme features 49 land-use types that are aggregated within nine series or categories of related types. Land-use classification is different from land cover in that among other differences, ownership status is considered in the former. For example, forest or grassland is classified one way if the land is owned by a forest preserve or conservation district (i.e., permanently placed in a protected status that is not likely to change) while an adjacent forest or prairie in private ownership will be classed differently. Thus, aggregation of land-use types includes a combination of logic and art and resultant maps are a function of a particular purpose rather than a singular way of featuring a landscape.

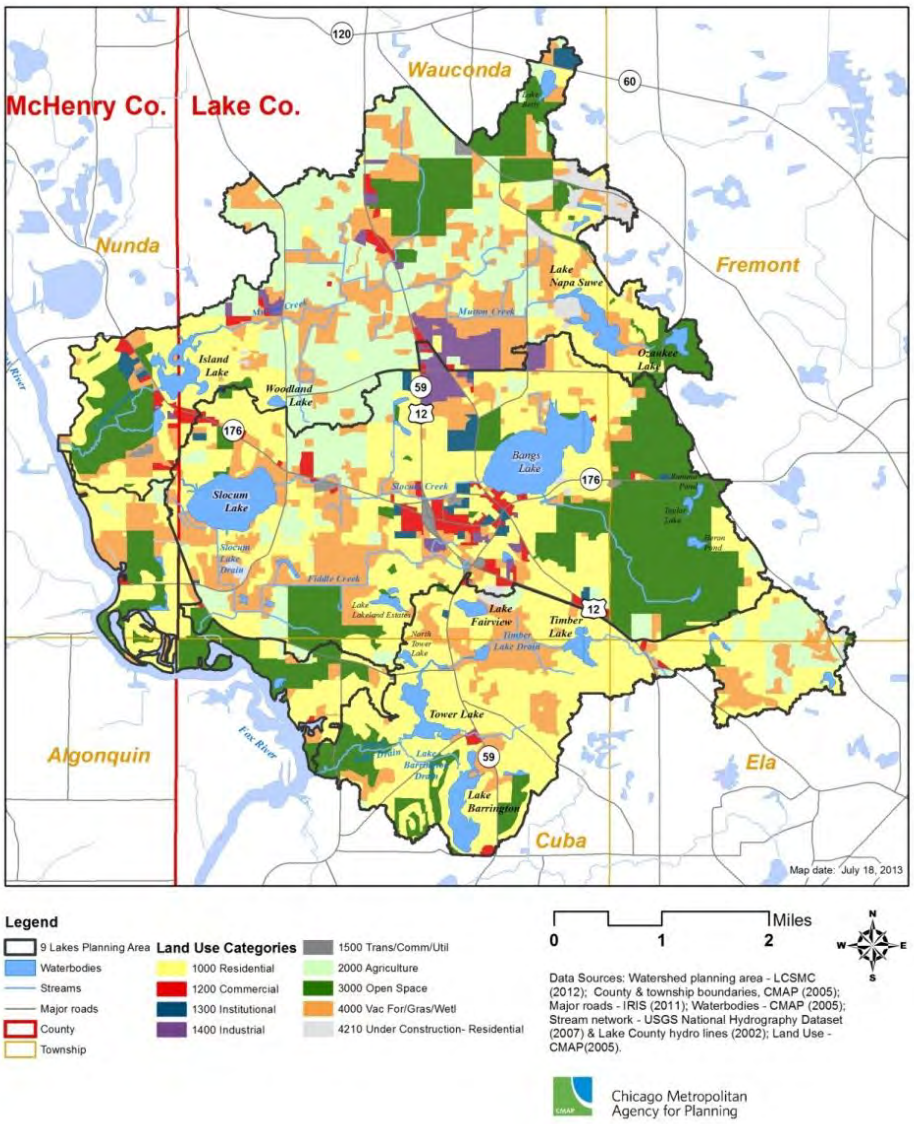
Figure 3 illustrates land use by these nine categories for the planning area. Given that the pollutant-load model employed in this plan uses CMAP's land-use data as an input, some explanation is warranted. The most common land-use category is residential. The residential

[11] Illinois EPA, Bureau of Water. Illinois Integrated Water Quality Report and Section 303(d) List – Volume 1: Surface Water – 2012, plus Appendices http://www.epa.state.il.us/water/tmdl/303d-list.html#2012.

[12] A 2010 land-use inventory is underway at CMAP, but is incomplete as this section was written.

category includes four types of property[13] and accounts for 36 percent of the planning area. The next most common category of land use is a virtual tie between Vacant Forest and Grassland, Wetlands Greater than 2.5 Acres (series 4000), and Open Space (series 3000), each at about 19 percent.

Figure 3. Land use in the 9 Lakes planning area.



The Open Space category includes golf courses and other "open" land holdings such as recreational open space[14], land in a natural state[15] including public land (e.g., federal, state,

[13] The four residential types are: single-family, farmhouse, multi-family, and mobile-home parks and trailer courts.

[14] Recreational open space features greater than 50 percent combined impervious surface and manicured turf, botanical gardens, and arboretums.

county parks and preserves, local parks), private campgrounds and hunting clubs, and linear corridors such as bikeways and greenways with a minimum width of 125 feet.

The Vacant Forest and Grassland, Wetlands Greater than 2.5 Acres category includes private property that has not been classified as open space (i.e., series 3000) and has not been developed (and thus, classified elsewhere). The 4000 series includes riparian corridors with a sustained width of 200 feet or greater summing both sides of the stream, and scraped Earth/construction activity for both residential and nonresidential property.

The Transportation, Communications, and Utilities category (1500 series) features seven different types including Interstate Highways and Tollways. Roads other than Interstate Highways and Tollways, however, must meet a minimum width of 200 feet[16] to be included and thus, featured on a map. Two-lane highways that are most common with state, county, and local roads will not be included in the land-use data. The pollutant-load model results, therefore, will be somewhat conservative given that such roads are well known for generating nonpoint-source pollution; particularly chlorides from wintertime road salt applications. Table 4 enumerates the distribution of land-use categories for the entire planning area.

Table 4. CMAP land-use categories and extent within planning area.

Land-Use Category	*Area (acres)*	*Area (sq. mi.)*	*% of Planning Area*
Residential (1100 series)	6727	10.5	35.8
Commercial (1200)	378	0.6	2.0
Institutional (1300)	184	0.3	1.0
Industrial (1400)	350	0.6	1.9
Transportation, Communications, and Utilities (1500)	87	0.1	0.5
Agriculture (2000)	2835	4.4	15.1
Open Space including public land (3000)	3543	5.5	18.9
Vacant Forest and Grassland, Wetlands (>2.5 ac.) (4000)	3594	5.6	19.1
Water	1070	1.7	5.7

[15] Open space in a natural state features less than 50 percent combined impervious surface and manicured turf.

[16] The 200 feet minimum width includes the rights-of-way and landscaped medians.

2.4.1 Impervious Surface

Impervious surface, the part of the landscape that is paved or covered with nonporous material, generates runoff and nonpoint-source pollution, and warrants special attention in any plan that aims to protect or restore local water quality. A detailed analysis of impervious surface in each of the 14 study units delineated within the planning area will be addressed elsewhere in this chapter. Here, an introduction is presented about the data used for analysis.

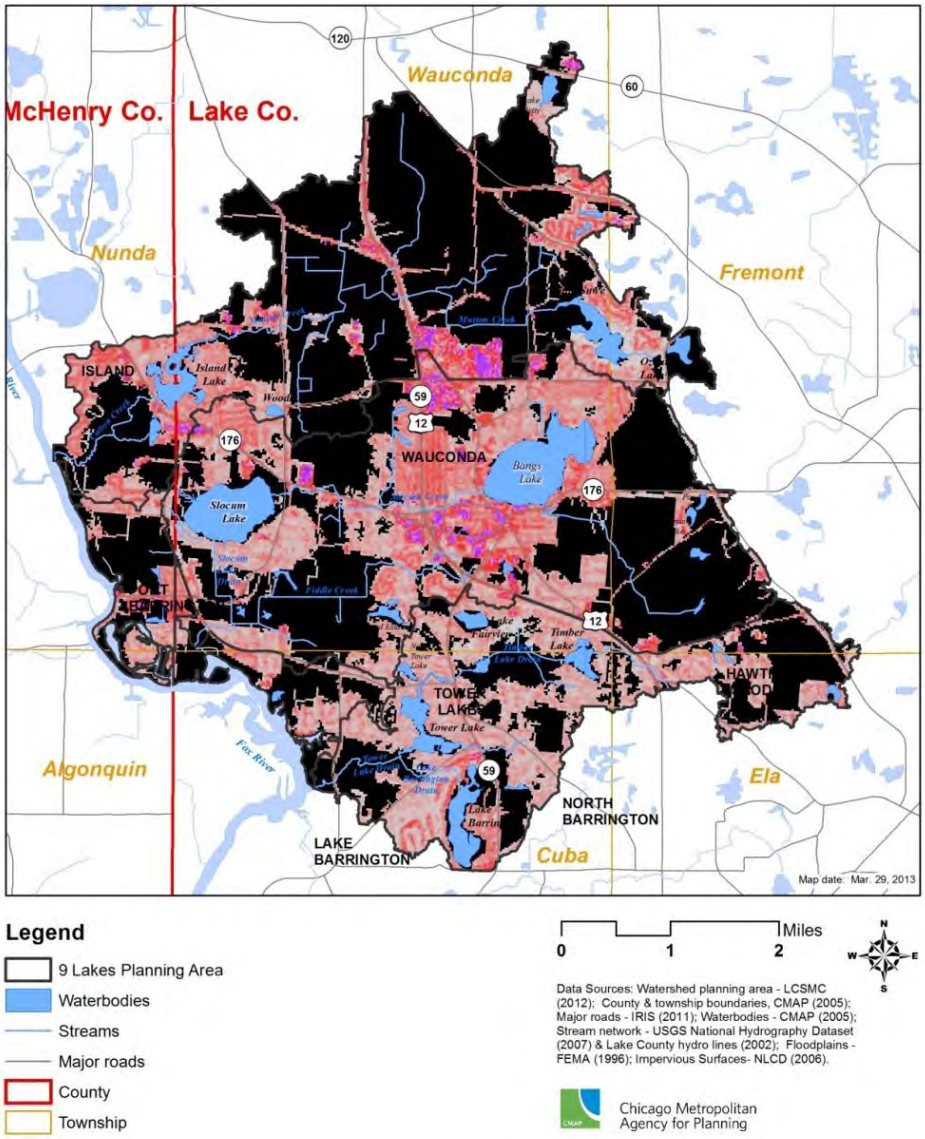
The National Land Cover Database 2006 (NLCD 2006) is employed for any and all analyses presented in this plan.[17] The NLCD 2006 is based on Landsat Enhanced Thematic Mapper+ (i.e., satellite) data. One product derived from these data is the NLCD 2006 Percent Developed Imperviousness, an estimate for the conterminous United States. Each data point or pixel represents a 30 meter^2 unit of geography and has a value of imperviousness ranging from 0-100 percent.

Figure 4[18] illustrates where and to what degree imperviousness exists. In the aggregate, impervious surface covers 13.7 percent of the 9 Lakes planning area and for purposes of this plan can be understood in the context of its impact on water quality (Figure 5).

17 Multi-Resolution Land Characteristics Consortium (MRLC), National Land Cover Database. Available at: http://www.mrlc.gov/nlcd06_data.php.

18 Pixels shaded black feature zero percent impervious surface. Beginning with shades of gray, from light to dark, and then switching to shades of red, from pink to purple, feature pixels from 1-100 percent impervious surface.

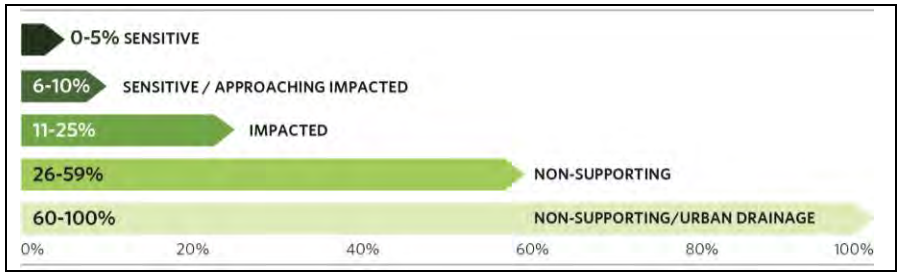
Figure 4. Impervious surface (0-100 percent) in the 9 Lakes planning area.



At over 29 square miles, however, the relationship between impervious surface and water quality is best explored at smaller units of geography than the entire planning area. Smaller land areas have more direct impacts on the water quality of individual lakes and local segments of the stream network. This relationship is explored in greater detail at the scale of our 14 study areas or subunits[19] presented in section 2.6.3.

19 For modeling and related purposes, the planning area has been subdivided into 14 subunits, each of which will be described at length in Subsection 2.6.3 of the plan.

Figure 5. Stream health categories as a function of impervious cover (%) within a watershed.



Source: Center for Watershed Protection (2003)[20]

Whereas each of the 14 subunits has a current level of impervious surface and impact on water quality (Figure 6), an estimate of future impervious surface is also presented and based largely on a combination of population growth forecasts and land use; some categories of which are more developable than others.

The estimate of future impervious surface methodology and results for each of the 14 subunits are discussed and presented below (Figure 7). At the scale of the entire planning area, impervious surface is estimated to grow from 13.7 to 17.9 percent for an increase of 31 percent by 2040.[21] While the increase will keep the planning area as a whole in the "impacted" category, the increase will only make water quality improvement more difficult. This conclusion holds especially true if traditional stormwater management practices (i.e., near total reliance on gray infrastructure with the single objective of conveyance) are followed.

To estimate future impervious surfaces in the planning area, each subunit is assessed individually for its developable land acreage. Here, we define developable land as agricultural land, unprotected (i.e., nonpermanent conservation status) outdoor recreation areas, residential areas under construction, and vacant (i.e., privately owned) forests and grassland. The number of new people expected to move into the area by 2040 were divided by the total acres of developable land in the planning area. Thus, x number of new people are assigned to each acre and distributed according to the number of developable acres in each of the 14 subunits. Since the current ratio of population to impervious surface is 13.5 people per one acre, a new acre of impervious surface was estimated to occur for every 13.5 new people that were assigned to each subunit.[22]

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[20] Center for Watershed Protection. 2003. Impacts of Impervious Cover on Aquatic Systems: Watershed Protection Research Monograph. Center for Watershed Protection, Ellicott City, MD. Pages 1-158. Available at: http://www.cwp.org/online-watershed-library/cat_view/63-research/72-impacts

[21] The estimated increase in impervious surface (%) is expected to mirror the forecast increase in population as a percentage since the current ratio of population to impervious surface is applied in the methodology developed to estimate future impervious surface. The estimation methodology, then, provides a rational for how new people and thus, impervious surface, might diffuse across the planning area.

[22] This assumption of status quo regarding the ratio of impervious surface area to population is conservative and akin to worse-case scenario. In other words, if a commitment to low-impact development and principles of conservation design was to be made by the units of government that set standards for development, this ratio could increase and thus, help protect water quality and/or reduce the historic rate of degradation.

Figure 6. Current relationship between impervious surface and water quality.

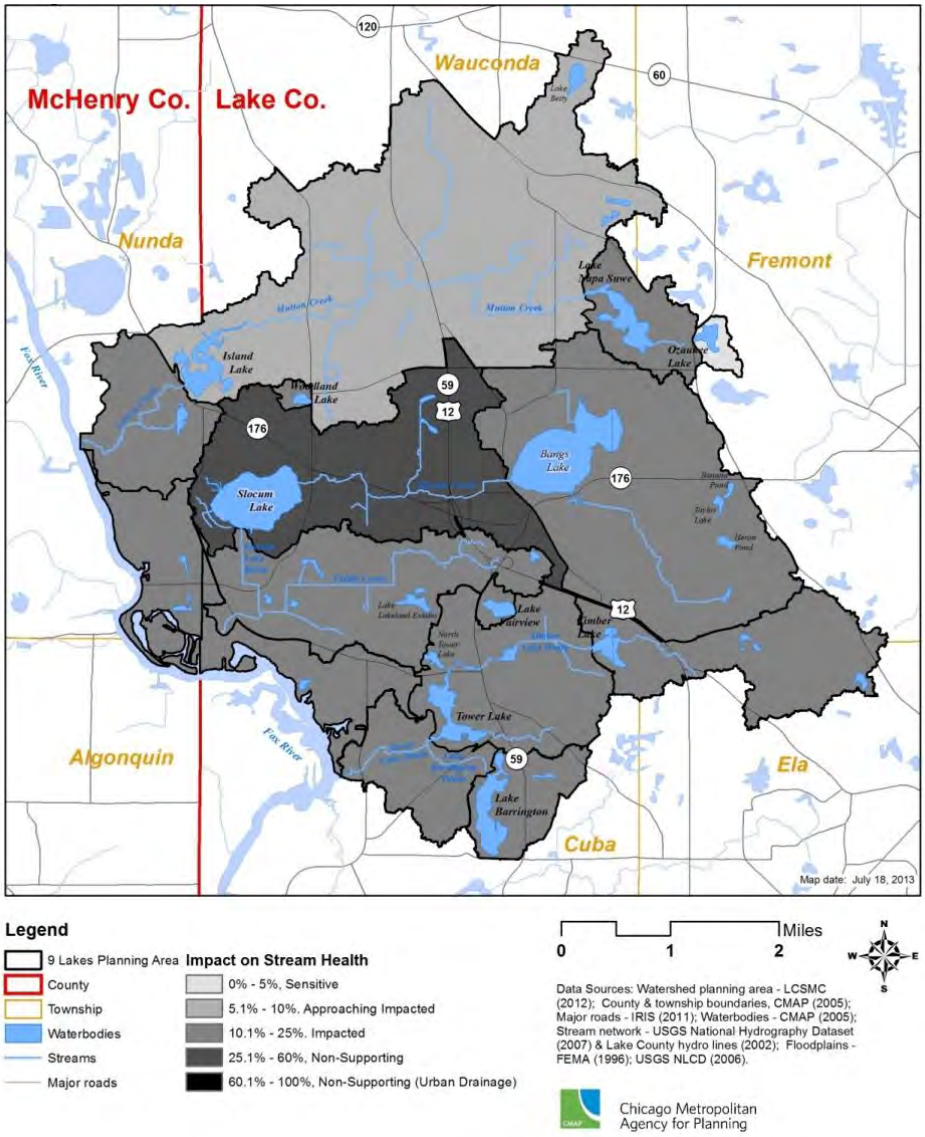
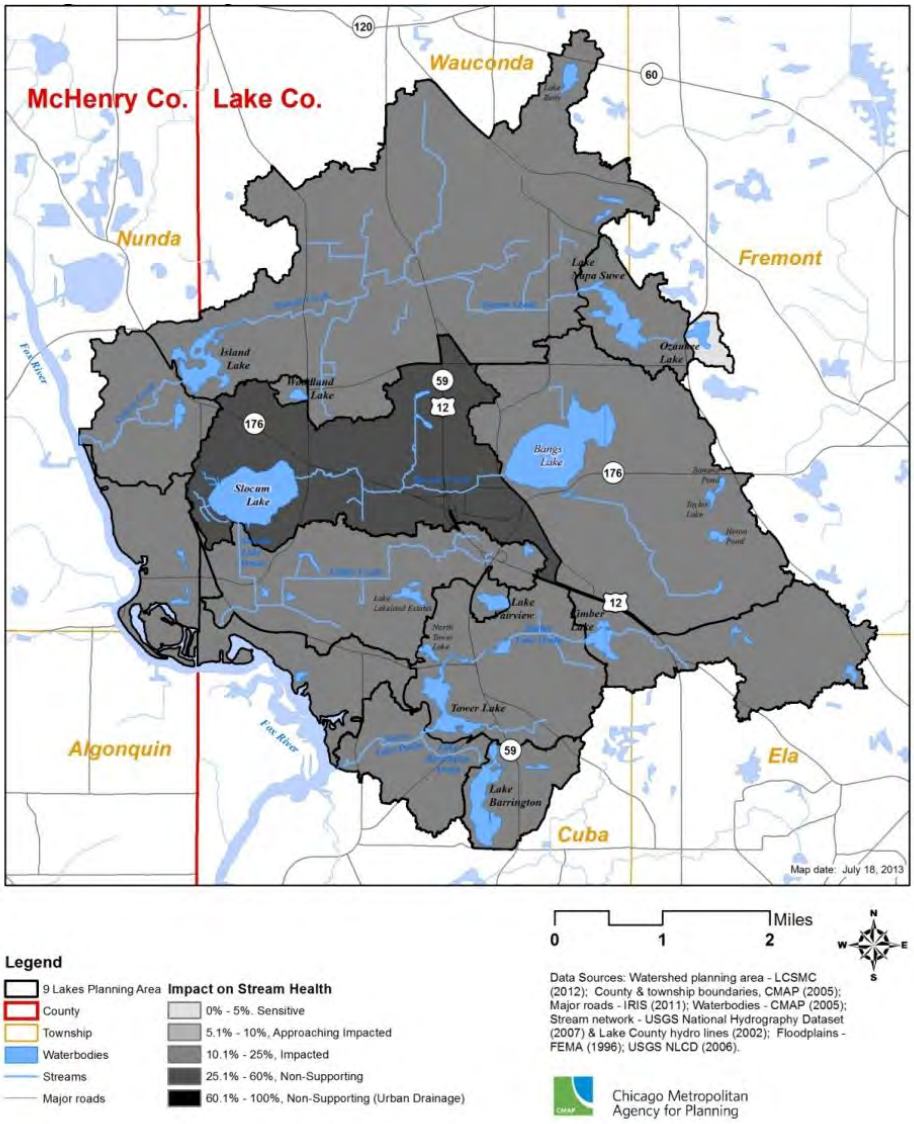


Figure 7. Estimated relationship (2040) between impervious surface and water quality.



Since the purpose of the plan is to protect and improve water quality, it will be helpful to see where the greatest potential lies for future land-use change and its attendant increase in impervious surface in order that recommendations can be made to avoid the deleterious impacts on water quality. Thus, Table 5 is presented below and indicates the degree of impact that both current and projected impervious surface has on water quality for each of the 14 subunits. Table 5 also lists the primary jurisdictions within each subunit and is suggestive of the importance of their ordinances and decisions as they shape growth and development and ultimately, the water quality of lakes and streams.

Table 5. Relationship between impervious surface (percent) and water quality in planning area subunits.

14 Subunits	*Primary Local Jurisdiction*	*Current Stream Health Category*	*Projected Stream Health Category*
Ozaukee Lake	Lake Co. Forest Preserve District	Sensitive (2.0% Impervious)	Sensitive (2.0% Impervious)
Lake Napa Suwe	Wauconda	Impacted (13.9% Impervious)	Impacted (15.6% Impervious)
Island Lake	Wauconda / Island Lake	Approaching Impacted (9.6% Impervious)	Impacted (18.2% Impervious)
Woodland Lake	Island Lake	Impacted (23.6% Impervious)	Impacted (23.7% Impervious)
Cotton Creek	Island Lake	Impacted (17.3% Impervious)	Impacted (19.3% Impervious)
Bangs Lake	Wauconda	Impacted (12.4% Impervious)	Impacted (13.6% Impervious)
Slocum Lake	Wauconda / Island Lake	Non-Supporting (25.2% Impervious)	Non-Supporting (29.2% Impervious)
Slocum Lake Drain / Fiddle Creek	Lake Barrington / Port Barrington	Impacted (13.4% Impervious)	Impacted (17.6 % Impervious)
Timber Lake	Hawthorn Woods/ North Barrington	Impacted (11.8% Impervious)	Impacted (15.9% Impervious)
Tower Lake	Tower Lakes / Hawthorn Woods	Impacted (13.1% Impervious)	Impacted (15.8% Impervious)
Lake Fairview	Wauconda Twp. / Lake County	Impacted (17.9% Impervious)	Impacted (19.2% Impervious)
Lake Barrington	Lake Barrington	Impacted (13.1% Impervious)	Impacted (14.2% Impervious)
Tower Lake Drain	Tower Lakes / Lake Barrington	Impacted (12.9% Impervious)	Impacted (13.5% Impervious)
Direct Drainage Area	Port Barrington / Lake Barrington	Impacted (12.7% Impervious)	Impacted (14.3% Impervious)

2.4.2 Agriculture

Agricultural land use is a broadly researched and well documented source of nonpoint-source pollution. While comprising only 15 percent of the entire 9 Lakes planning area, it covers over 30 percent of the Cotton-Mutton Creek Watershed, home to Island Lake. The spatial extent of agricultural land-use within the Cotton-Mutton Creek Watershed, therefore, accounts for 70 percent of this land-use series within the entire planning area. Agriculture is identified as a potential source of impairment in the Slocum Lake Watershed (see Table 10, pg. 42) where it is a relatively minor component of the land-use mix: eight percent; whereas sources of impairment

for Island Lake are currently identified as "unknown."[23] In any event, agricultural land use plays a key role in preventing or reducing pollutant loads wherever it exists and especially in Cotton-Mutton Creek given its spatial extent upstream of Island Lake.

Conventional row crop agriculture dominates the various types of agricultural land use within the planning area. Equestrian facilities are the next most common type agricultural land use followed by nurseries/greenhouses and pasture/grazing land as the fourth most common type of agricultural land use. There is one confined animal feeding operation (CAFO), Golden Oaks Farm, and approximately 32 acres of their farmland have been assigned to this type of land use. Table 6 quantifies agricultural land use according to CMAP's 2005 land-use inventory.[24]

Table 6. Type and extent of agriculture within planning area.

CMAP Agricultural Land Use Code	*Agricultural Land Use Type*	*Area (Sq. mi.)*	*Area (Acres)*
2100	Row crops	2.60	1,661.0
2100	Pasture / grazing land	0.22	143.3
2200	Nurseries / greenhouses, etc.	0.30	193.5
2300	Other - CAFO	0.05	31.7
2400	Equestrian	0.37	238.2
	Totals	3.54	2,267.7

Data on types and prevalence of tillage practices were sought from the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), USDA National Agricultural Statistics Service (NASS), and the Illinois Department of Agriculture (IDA), Bureau of Land and Water Resources. Neither federal agency tracks tillage trends or acreage by tillage type.[25] However, the IDA has data collected from the 2013 Illinois Soil Conservation Transect Survey.[26] These data are county-level, but Lake County is no longer conducting this survey given their relatively small amount of agricultural land use. While there is only a small amount

[23] This observation is not meant as a critique of sources of impairment identified by Illinois EPA. For example, gross watershed statistics don't take into consideration the specific location and proximity of agricultural fields to the lakes themselves. That said, the percentage of ag land use affecting Slocum Lake is much less than 8% as some of that total is in either the Fiddle Creek subwatershed or below the outlet of Slocum Lake; neither one of which affects water quality in Slocum Lake.

[24] Table 6 numbers differ somewhat from ag totals in Table 4 as the former table's data are derived from the Northwater model that performed some land-use "fine-tuning". Furthermore, CMAP agricultural land-use data does not differentiate between the two types of series 2100 as the Northwater model does.

[25] Personal communication with Eric Gerth, Assistant State Conservationist, Financial Assistance Programs, USDA NRCS (8/13/13) and Harvey Roemer, Agriculture Statistician, USDA NASS (8/14/13).

[26] Personal communication with Alan Gulso, Land and Water Resource Specialist, Illinois Dept. of Agriculture, Bureau of Land and Water Resources (8/14/13).

of McHenry County acreage in the planning area, these data are instructive nonetheless (Table 7).[27]

Table 7. Percent (number) of fields with indicated tillage system for McHenry County.

Crop	*Conventional Tillage*	*Reduced Tillage*	*Mulch-till*	*No-till*	*Total*
Soybean	30 (37)	20 (25)	5 (6)	45 (55)	(123)
Corn	71 (164)	17 (38)	6 (13)	7 (15)	(230)
Small grain	100 (17)	0 (0)	0 (0)	0 (0)	(17)

2.4.3 Open Space Reserve

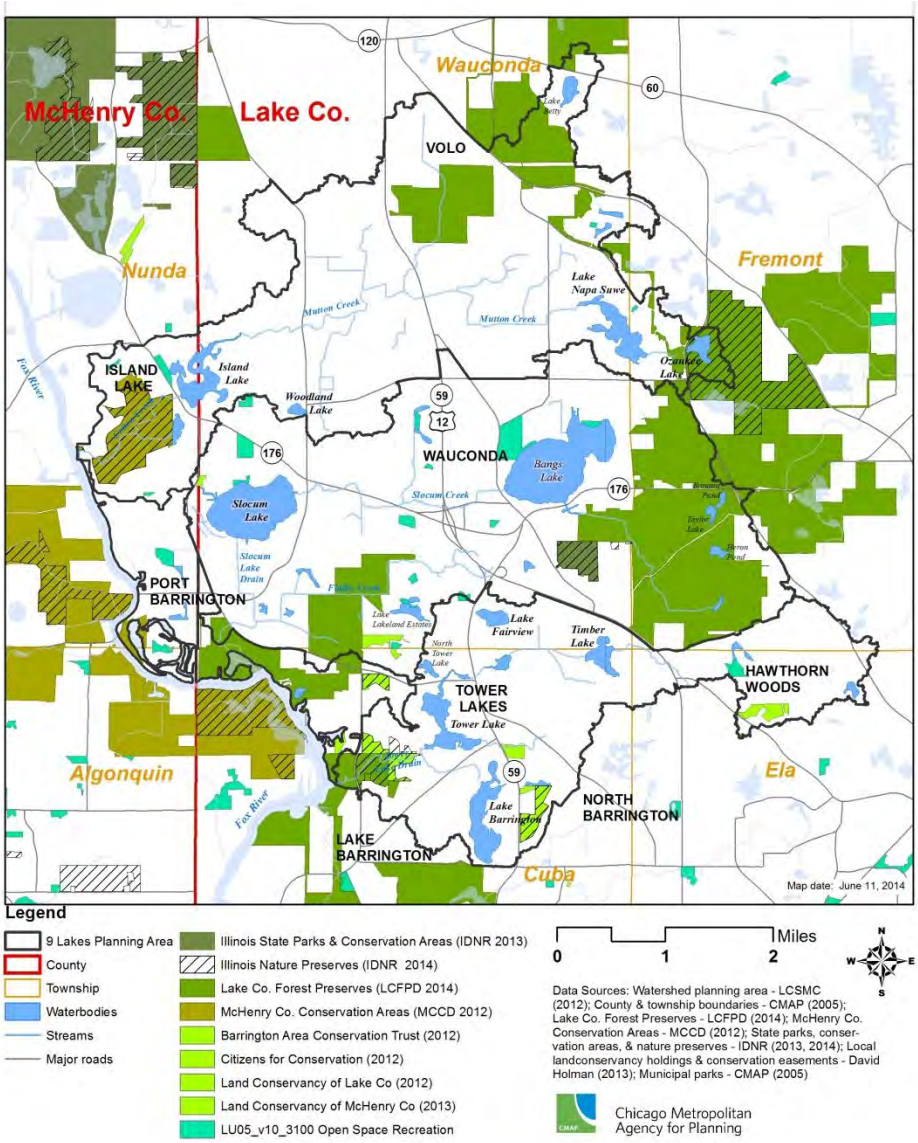
Open space reserve is an area of land and/or water that is protected or conserved such that development will not occur on this land at any time in the future[28]. Land that is owned and managed by forest preserve or conservation districts is a core component of the open space reserve. To that, public parks are included along with private land on which a conservation easement is placed. Strictly speaking, the open space reserve in the 9 Lakes area (Figure 8) will be a subset of CMAP's open space series, because the latter includes golf courses and other land that is privately held and could be sold and converted to a type of land use that is neither protected nor considered to be in a conservation status.

The green infrastructure vision, discussed in greater detail in section 3.2.3, builds on the open space reserve to include land of special character that warrants conservation or protection on the grounds of its unique ecology or proximity to land that is also ecologically important. To that larger landscape and by way of local preference, parcels can be recommended as part of the green infrastructure because of their role in protecting water quality among other conservation-oriented objectives.

[27] The survey methodology involves driving a route that samples a minimum number of 456 sample sites. Frequency of stops (i.e., distance between data collection points) depends on number of acres of cropland. The complete methodology is on file at CMAP.

[28] In lieu of a "textbook" definition, a defensible description of the phrase is offered here: http://en.wikipedia.org/wiki/Open_space_reserve

Figure 8. Open space reserve in the 9 Lakes planning area.



2.4.4 Presettlement Land Cover

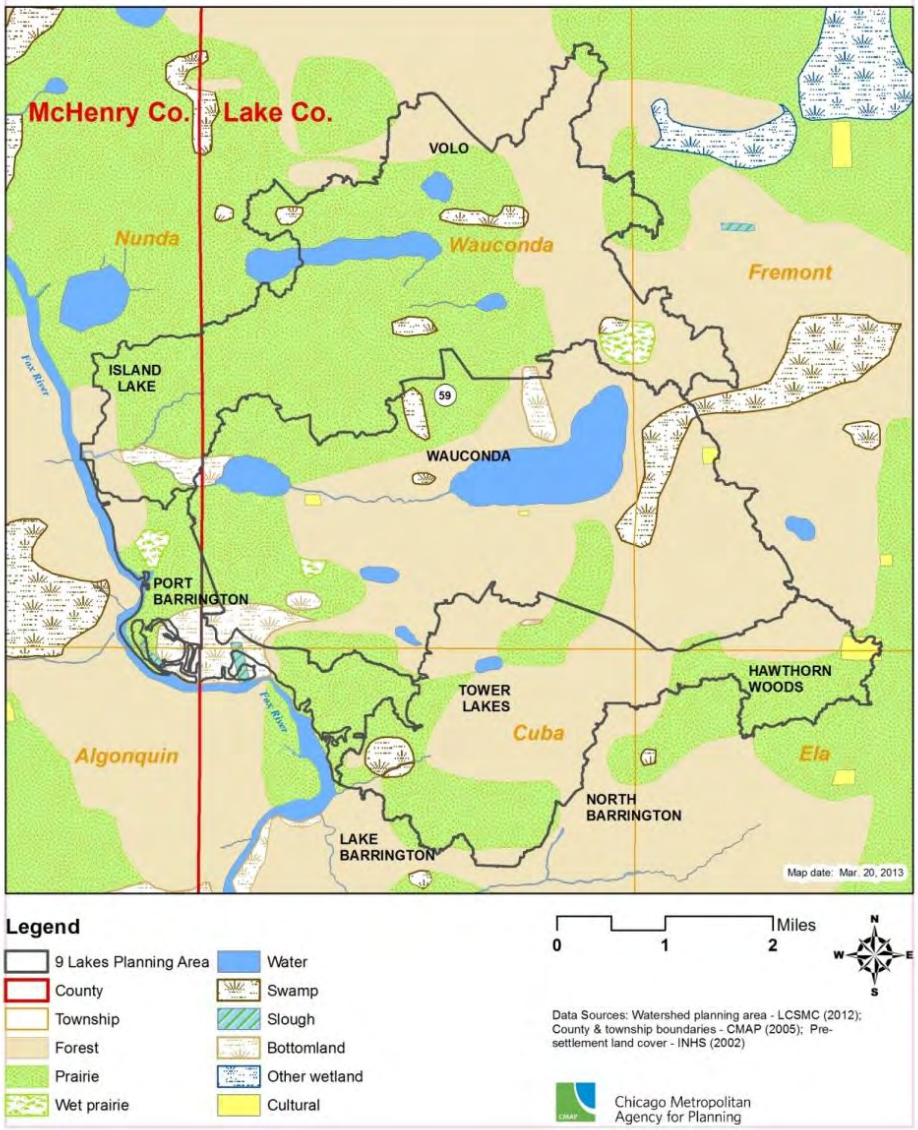
For a qualitative sense of historical land use change, Figure 9 shows the presettlement land cover – primarily vegetation – in the 9 Lakes Planning Area as surveyed in the early stages of Euro-American settlement in the early 1800s[29]. At that time, the land cover was comprised primarily of forest and prairie along with wetlands (categorized as bottomland, slough, swamp, or other wetland types)[30] and open water. The two glacial lakes that were later named Slocum

[29] Illinois Natural History Survey. INHS GIS database. *Land cover of Illinois in the early 1800s*. (August 2002) http://wwx.inhs.illinois.edu/resources/gis/glo/.

[30] Several terms are used to describe different types of wetlands. A swamp is a wetland dominated by trees or shrubs. In the northern and midwestern United States, slough is another term for a swamp or shallow lake system.

and Bangs are evident (as is Griswold Lake to the northwest of the 9 Lakes Planning Area). This historic land cover can be informative for current land use planning and ecological restoration project purposes.

Figure 9. Presettlement land cover in the 9 Lakes planning area.

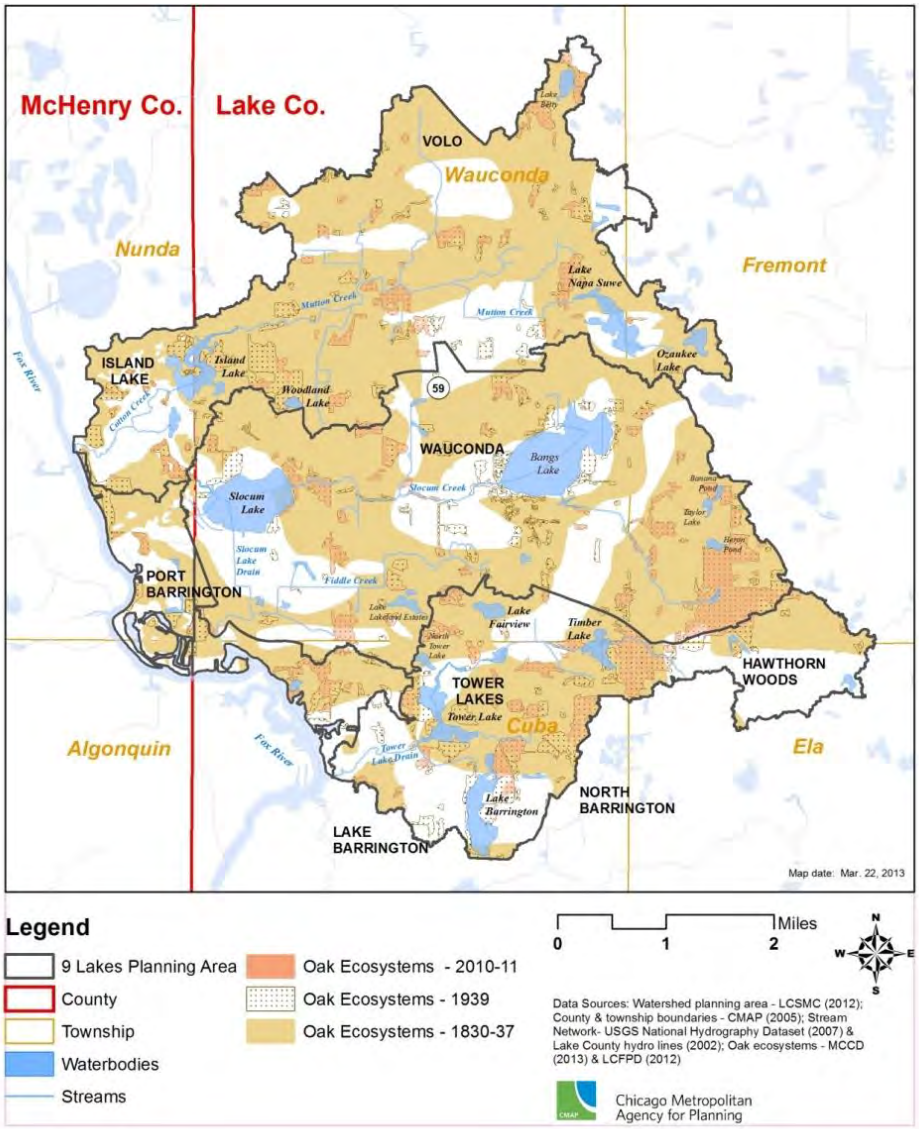


Bottomland wetlands are lowlands along streams and rivers, usually on alluvial floodplains that are periodically flooded (from Mitsch, W.J. and J.G. Gosselink. 1986. *Wetlands*. Van Nostrand Reinhold Co. Ltd., New York, NY).

2.4.5 Oak Communities

Prior to European settlement, oak-dominated communities (oak barrens, savanna, woodland, or forest) covered much of McHenry and Lake Counties[31]. Within the 9 Lakes Planning Area in the 1830s, approximately 12,331 acres were occupied by oak communities, representing 65.7 percent of the land area. By 2010-11, the area had decreased to just 6.5 percent or 1213 acres – indicating an overall decrease of 59.2 percent (Figure 10).

Figure 10. Oak ecosystems change: 1830 - 2011.



[31] McHenry Co. Conservation District. *The Oaks of McHenry County*. Woodstock, IL: MCCD, 2009. https://www.mccdistrict.org/web/assets/publications/brochures/OaksofMcHenryspreads_WC.pdf (accessed March 22, 2013).

Identification of remaining natural areas, including oak communities, supports conservation efforts and should be used as a tool to preserve important natural landscapes for water resource and habitat benefits, as well as for establishing greenway links between fragmented habitats.

2.4.6 Forest Management Plans

The Illinois Department of Natural Resources, Division of Forestry, works with private landowners to reforest agricultural land and help with managing private woodlots. The Illinois Forestry Development Act (IFDA; 525 ILCS 15), funded in part by the USDA-Forest Service, provides for this program. The IFDA created the Illinois Forestry Development Council, the Forestry Development Cost Share Program, and the Forestry Development Fund. Timber harvests in the State of Illinois are subject to a 4% harvest fee, and that money helps to fund the cost-share component of the program[32].

Ten acres of woods is the minimum land-area requirement, 11 acres if a home is present on the property. The program requires a landowner to develop an IFDA-approved management plan. With passage of the IFDA, the Illinois Property Tax Code was amended in order to provide a tax incentive to timber growers. In counties with less than 3,000,000 residents (i.e., all Illinois counties other than Cook), any land being managed in the IFDA is considered as "other farmland." Thus, the land is valued at one-sixth of its equalized assessed value based on cropland.

In northeastern Illinois, the program emphasizes exotic species removal and oak regeneration. Within the 9 Lakes Planning Area, there are eight management plans in the IFDA program for a total of 63.6 acres.[33]

2.5 Physical and Natural Features

2.5.1 Geography and Surficial Geology

Ecoregion maps have been compiled "on the premise that ecological regions can be identified through the analysis of the patterns and the composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity." Put another way, ecoregions organize space around ecosystems that are similar and take into consideration such phenomena as geology, physiography, climate, soils, hydrology, wildlife, vegetation, soils, and land use. Ecoregion maps are useful in the development of ecosystem management strategies, especially since land use – human alteration and occupation of the land – informs ecoregion delineation at

[32] IDNR. *Information Sheet: Illinois Forestry Development Act*. Springfield, IL: IDNR, June 2006. http://dnr.state.il.us/conservation/forestry/IFDA/ (accessed March 20, 2013).

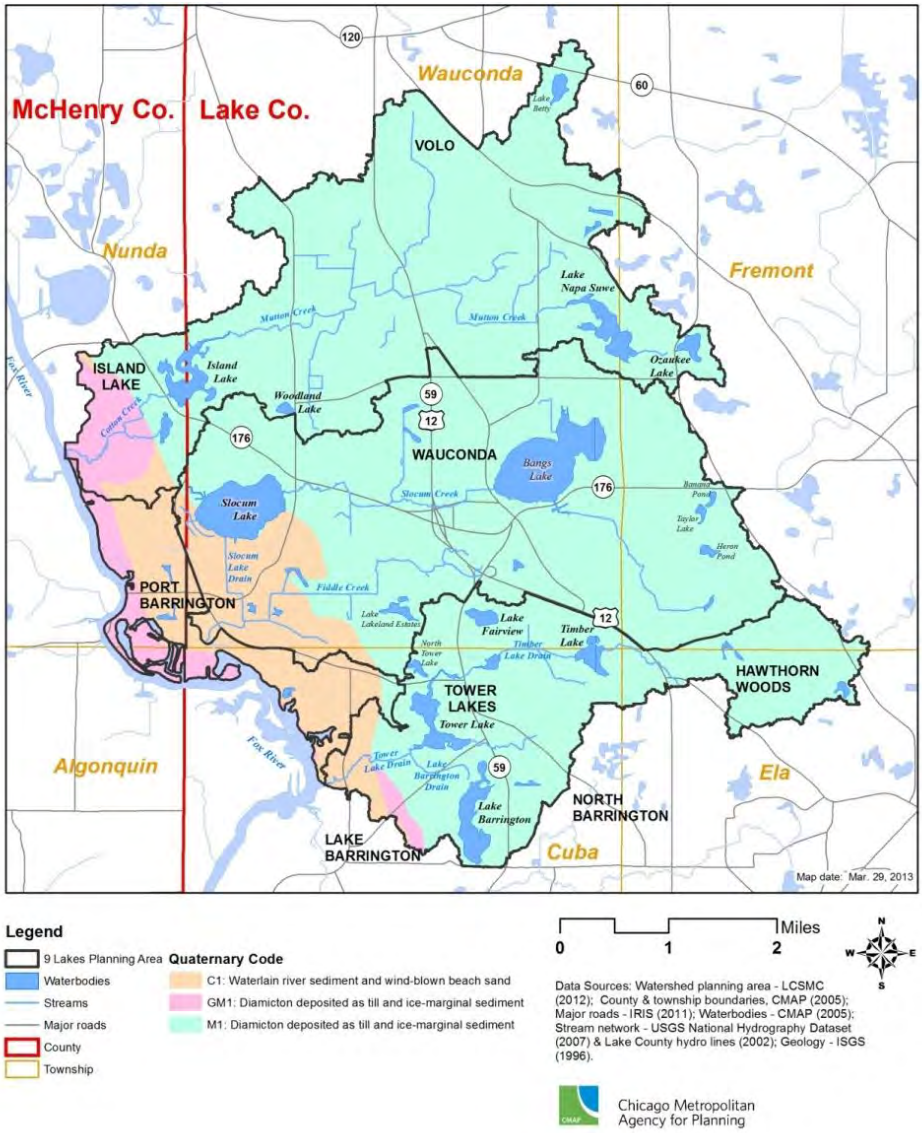
[33] Most of the plans are less than 10 acres from a time when the program's minimum acreage was five. The eight plans range in area from 5 to 12.2 acres (avg. ~8). This part of Lake County had higher program participation when the minimum acreage was five (*personal communication, Dave Griffith, IDNR Division of Forest Resources, 10/17/13*).

levels III and IV which are smaller (i.e., spatial extent) subdivisions of levels II and III, respectively.

The planning area lies entirely within the Southeastern Wisconsin Till Plains, Kettle Moraines (Level 4) Ecoregion. While perhaps not as relevant here as within areas of greater spatial extent that also feature large federal or state land holdings, the information can be instructive nonetheless to more local land conservation efforts. Since the planning area lies entirely within one ecoregion, ecosystem management strategies can be somewhat more consistent across the planning area than might be appropriate for a more ecoregionally diverse area. At a minimum, a description is provided of the planning area relative to a rich geographic framework that classifies the entire continental United States.

Geologically, the area is dominated by glacial end moraines that are composed of unsorted clay, silt, sand, and gravel; a product of surface deposits from the most recent glaciation – the Wisconsin Episode. Roughly coincident with the Fox River floodplain and terrace, surface deposits feature two divisions of recent stream sediments and glacial outwash (Figure 11). Surficial geology is important because it is often exposed during mass grading for new development.

Figure 11. Surficial geology in the 9 Lakes planning area.



2.5.2 Climate and Topography

The planning area has a continental climate with warm summers and cold winters. The average annual temperature is 47.9˚F. January is the coldest month with an average temperature of 20.9˚F (28.8˚F average high/13.1˚F average low) while July is the warmest with an average of 72.3˚F (82.1˚F average high/62.6˚F average low). Annual precipitation averages 36.55 inches. Consistent with a continental climate, there is no pronounced wet or dry season. Meteorological winter features the three driest months (December 1.97 in., January 1.53 in., and February 1.97 in.) while meteorological summer features the wettest months (June 4.05 in., July 3.82 in., and

August 4.19 in.) Spring and fall are similar for their average seasonal precipitation totals, 9.97 and 9.05 in. respectively.[34]

The climate is notable for two reasons: 1) the threat of rain storms and resultant nonpoint-source pollution is a year-round phenomenon, and 2) the lengthy winter season in combination with an extensive road network results in large amounts of applied road salts whose fate has a negative impact on both local surface waters[35] and shallow groundwater[36].

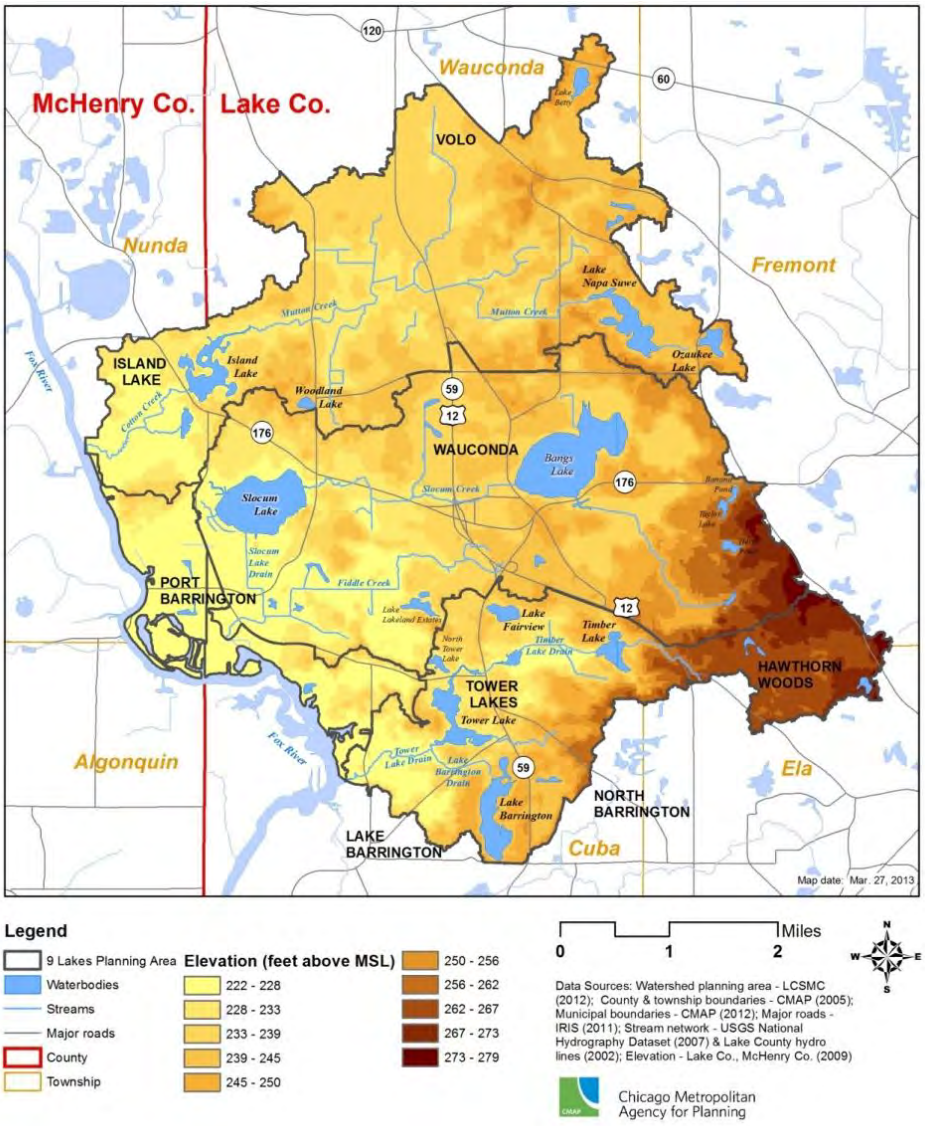
Elevation within the planning area ranges from a high of 915 ft. above mean sea level (MSL) in the southeastern "corner" to a low point at the Fox River of 728 ft. MSL for area relief of 187 feet. Generally speaking, elevation decreases from east to west with the lowest areas not surprisingly along the Fox River (Figure 12).

[34] U.S. Dept. of Commerce, National Oceanic & Atmospheric Administration, National Climatic Data Center. 1981-2010 Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days. Station: Mundelein 4 WSW, IL US. Requested and received on 6/11/13.

[35] Illinois EPA, Bureau of Water. 2012. Illinois Integrated Water Quality Report and Section 303(d) List, 2012.http://www.epa.state.il.us/water/tmdl/303-appendix/2012/iwq-report-surface-water.pdf.

[36] Walton R. Kelly and Steven D. Wilson, 2008. An Evaluation of Temporal Changes in Shallow Groundwater Quality in Northeastern Illinois Using Historical Data. Illinois State Water Survey, Center for Groundwater Science. Scientific Report 2008-01. Champaign, Illinois.

Figure 12. Elevation in the 9 Lakes planning area.



2.5.3 Wetlands

Only during the past 20-30 years have wetlands and the functions they provide (i.e., ecosystem services valued by society) become more fully understood and appreciated. At the regional landscape scale, wetlands are an integral part of the movement to conserve green infrastructure and thus, employ nature to help manage hydrology in the built environment. Wetlands provide many other social, economic, and ecological benefits. For example, wetlands provide temporary storage of rainfall and runoff (i.e., function) and as a result, reduce potential property damage due to floods (i.e., a service that is valued by society). Wetlands can cleanse stormwater and other polluted runoff before recharging an aquifer or outletting to a river that humans use as a

drinking water supply. There are many other wetland functions that generate ecosystem services that are valued by society. Despite this, the extent of America's wetlands continues to decline.[37]

Wetland extent in presettlement Illinois is estimated to have covered over 9.4 million acres or approximately 25 percent of the state.[38] Since then, Illinois has lost over 90 percent of its original wetland acreage. The most recent estimate of remaining natural wetlands in Illinois is now 20 years old.[39]

Illinois' glacial past bestowed upon Lake County a disproportionate share of the state's presettlement wetland acreage. Even today, the county ranks among the top in Illinois for wetland acreage. Thirty-five percent of the planning area is covered by wetlands[40] with approximately 14 percent of the area covered by the ADvance IDentification of disposal areas planning process (ADID) high-functional value type of wetlands (Figure 13).[41] These numbers overstate the extent of wetlands insofar as they include the area of lake bottoms (i.e., Bangs Lake, for example, will be included among ADID high value wetlands displayed on a map.) Functional wetlands within the 9 Lakes planning area will provide many benefits to residents if they are properly conserved. Of the approx. 10.3 sq. miles of delineated wetlands (of which ADID wetlands are a subset) that exist within the 9 Lakes Planning Area, 4.3 sq. miles of wetlands lie within dedicated open space (i.e., permanent conservation) areas. Therefore, about 42 percent of these wetlands are protected, and 58 percent are vulnerable to development subject to federal laws and regulations of the Lake County Watershed Development Ordinance administered by the Lake County Stormwater Management Commission.[42]

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[37] U.S. Fish and Wildlife Service, 2011. National Wetlands Inventory. http://www.fws.gov/wetlands/Status-And-Trends-2009/index.html ; the National Land Cover Database 2006 estimates that Woody and Emergent Herbaceous Wetlands account for 5.12 percent of land cover in the conterminous United States http://www.mrlc.gov/nlcd06_stat.php.

[38] Illinois Natural History Survey, 1995. Illinois Wetland Strategy http://www.inhs.illinois.edu/inhsreports/jul-aug95/wetland.html.

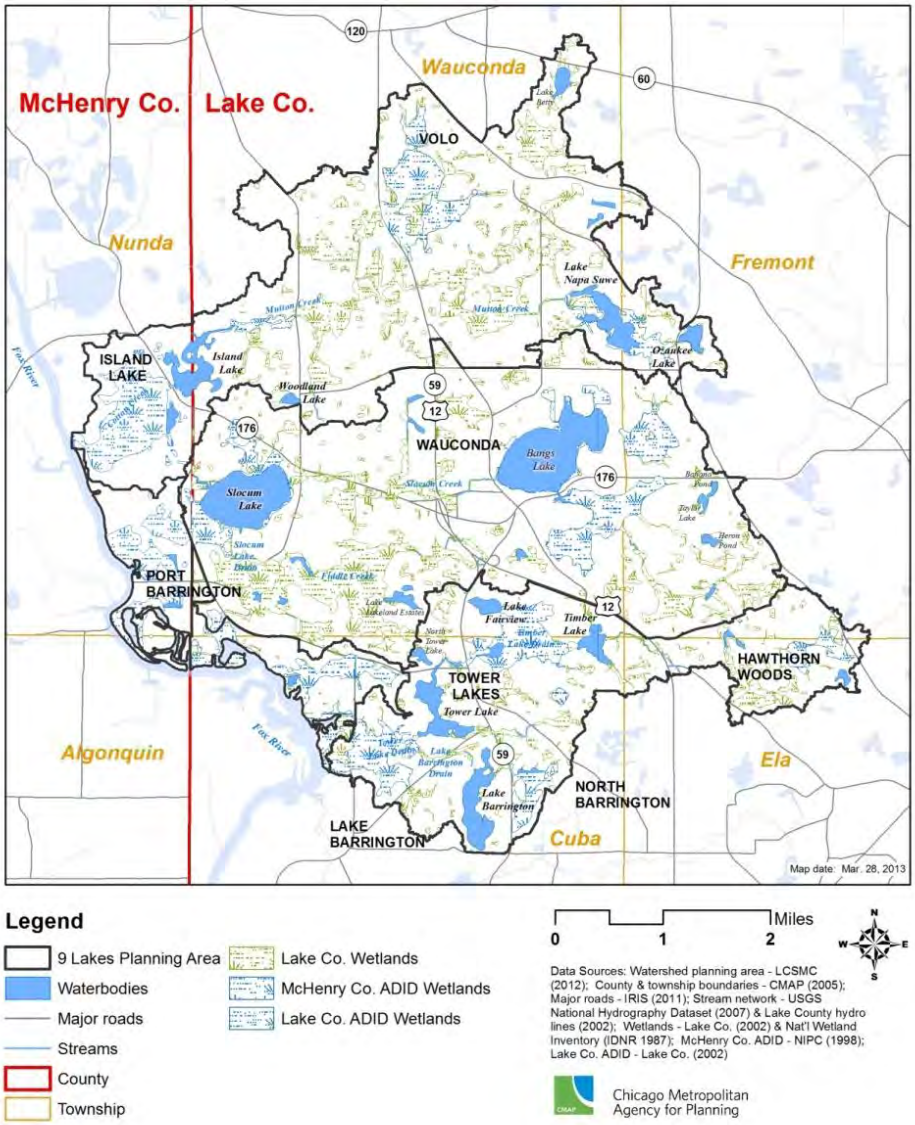
[39] Illinois Department of Natural Resources. http://dnr.state.il.us/wetlands/ch3b.htm The 2007 National Resources Inventory offers a complementary scheme of wetlands quantification: USDA, 2009 http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1041379.pdf.

[40] These numbers will differ from those presented in the land use section above due to different methodologies used to quantify the areal extent of wetlands.

[41] The ADvance IDentification of disposal areas planning process (ADID) is used to identify wetlands and other waters that are either suitable or unsuitable for the discharge of dredged and fill material. Wetlands that meet certain criteria are deemed 'high-functional value' and thus, are unsuitable for accepting dredged and fill material. For more information, see http://water.epa.gov/type/wetlands/outreach/fact28.cfm

[42] Lake County Stormwater Management Commission, Watershed Development Ordinance (June 2013). See, http://www.lakecountyil.gov/stormwater/floodplainstormwaterregulations/wdoandtrm/Pages/watersheddevelopmentordinance.aspx

Figure 13. Wetlands in the 9 Lakes planning area.

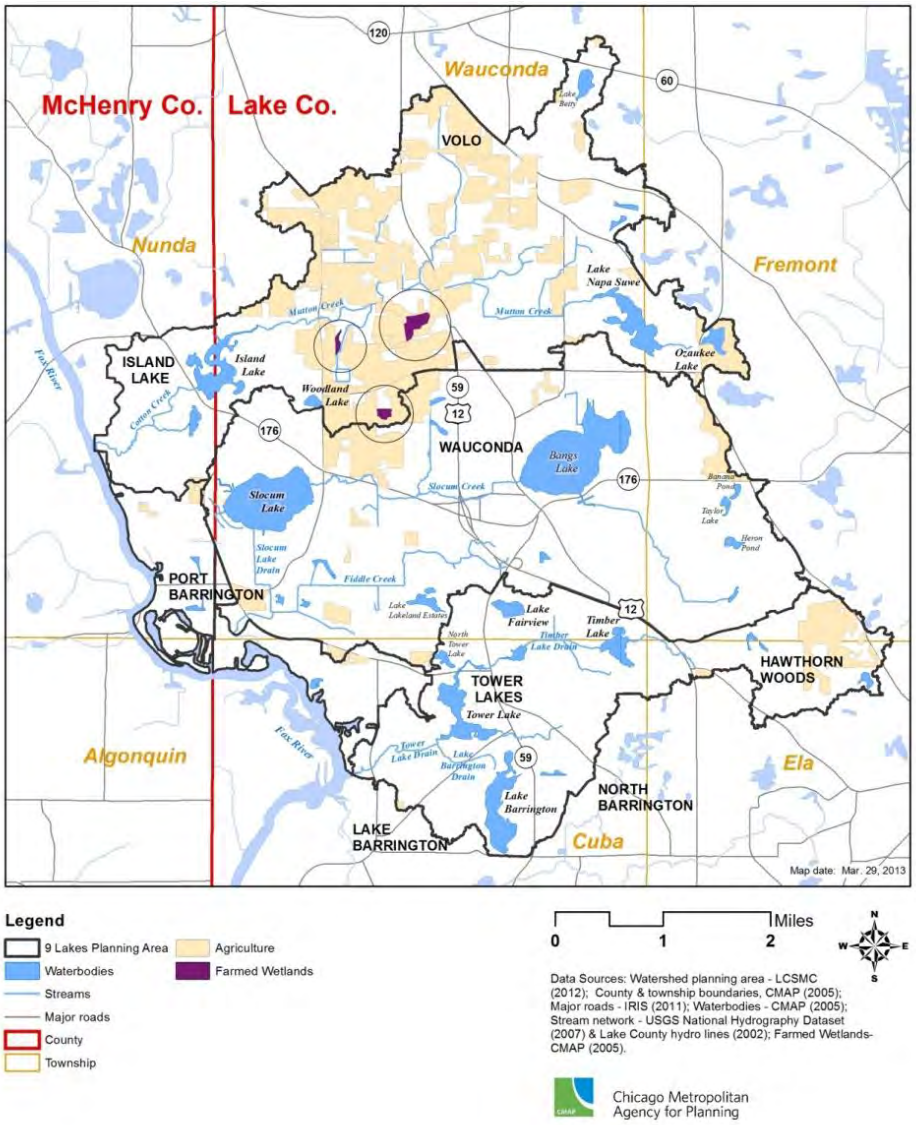


There are three sites in the planning area identified as "Wetlands Being Farmed" in the NIPC/CMAP 2005 Land Use Inventory. In total, these farmed wetlands cover 33 acres or just 0.2 percent of the planning area (Figure 14). All three sites are within the Cotton-Mutton Creek Watershed. Officially, a farmed wetland is one that has been modified to produce agricultural goods and also meets certain hydrologic conditions.[43] "Wetlands being Farmed" were identified for the NIPC 2005 Land Use Inventory using the National Wetlands Inventory for wetlands greater than 2.5 acres, on agricultural lands, and verified to be a farmed at least part of the year

[43] "Highly Erodible Land and Wetland Conservation." Code of Federal Regulations. Title 7, Part 12 (1996) http://edocket.access.gpo.gov/cfr_2011/janqtr/pdf/7cfr12.2.pdf (accessed September 14, 2011).

through digital imagery. Farmed wetlands meeting the federal definition are often still wet enough to act as valuable wetland habitats that are subject to Swampbuster, the Wetland Conservation provision in the Farm Bill; and the Clean Water Act Section 404, which regulates the management of wetland areas. Consequently, these three sites with the CMAP "Wetlands Being Farmed" classification might be potential BMP implementation sites for wetland restoration given sufficient interest and ability on the part of landowners. Additionally, they may require further investigation to determine whether they meet the federal Farmed Wetlands classification.

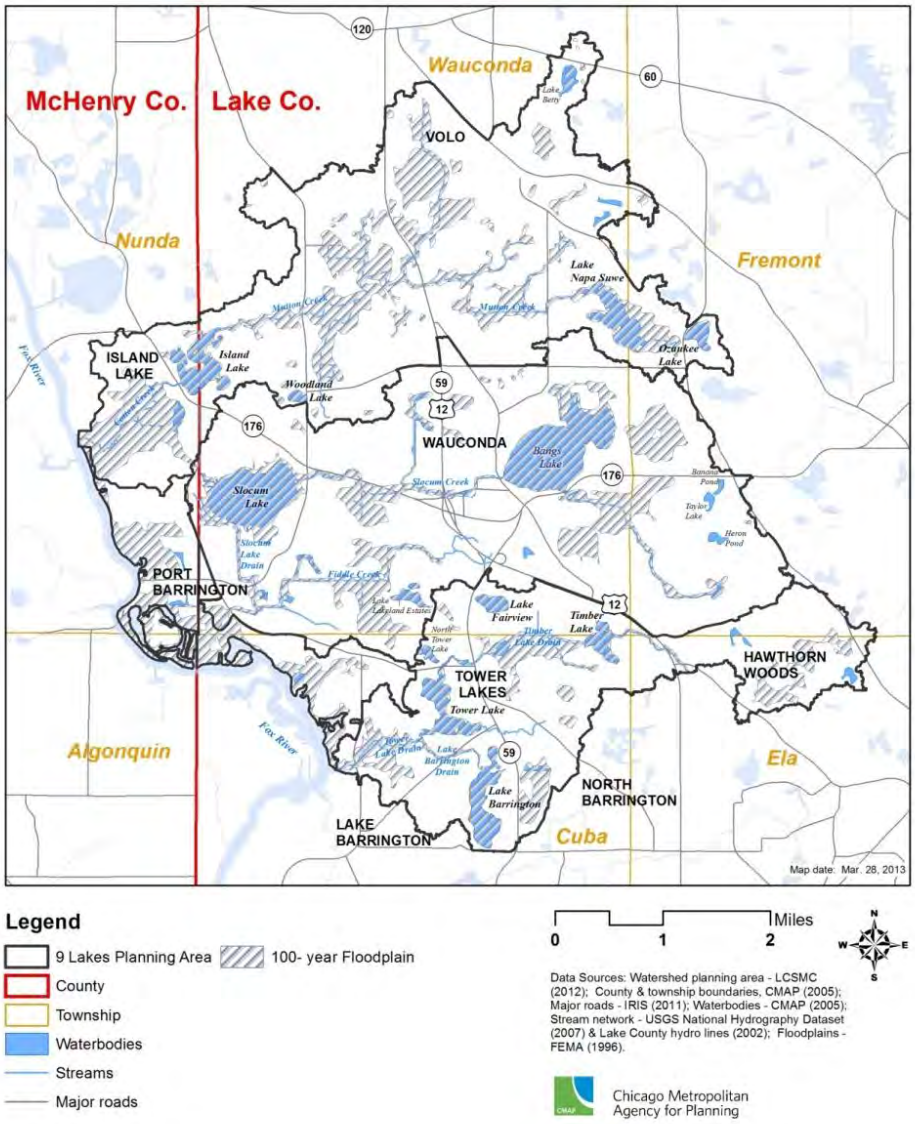
Figure 14. Farmed wetlands in the 9 Lakes planning area.



2.5.4 Floodplains

Floodplain data were derived from the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) as of 1996. Floodplain data received by CMAP from FEMA in 2012 are no different for the planning area. About 23 percent of the planning area lies within the base floodplain, an area defined by FEMA that is subject to a "base flood" or a one percent annual chance flood (a.k.a. the 100-year floodplain). On FEMA's National Flood Insurance Program maps, the base floodplain is the called the Special Flood Hazard Area (SFHA). The lakes in this planning area are included in the base floodplain (Figure 15).

Figure 15. 100-year floodplains in the 9 Lakes planning area.



2.5.5 Hydrologic Soil Groups

Hydrologic soil groups (HSGs) feature similar physical and runoff characteristics. Along with land use, management practices, and hydrologic conditions, HSGs determine a soil's associated runoff curve number which is used in turn to estimate direct runoff from rainfall. This information is particularly useful to planners, builders, and engineers to determine the suitability of sites for projects and their design. Projects might include, for example, stormwater management systems and septic tank/field location or more broadly, new neighborhood design.

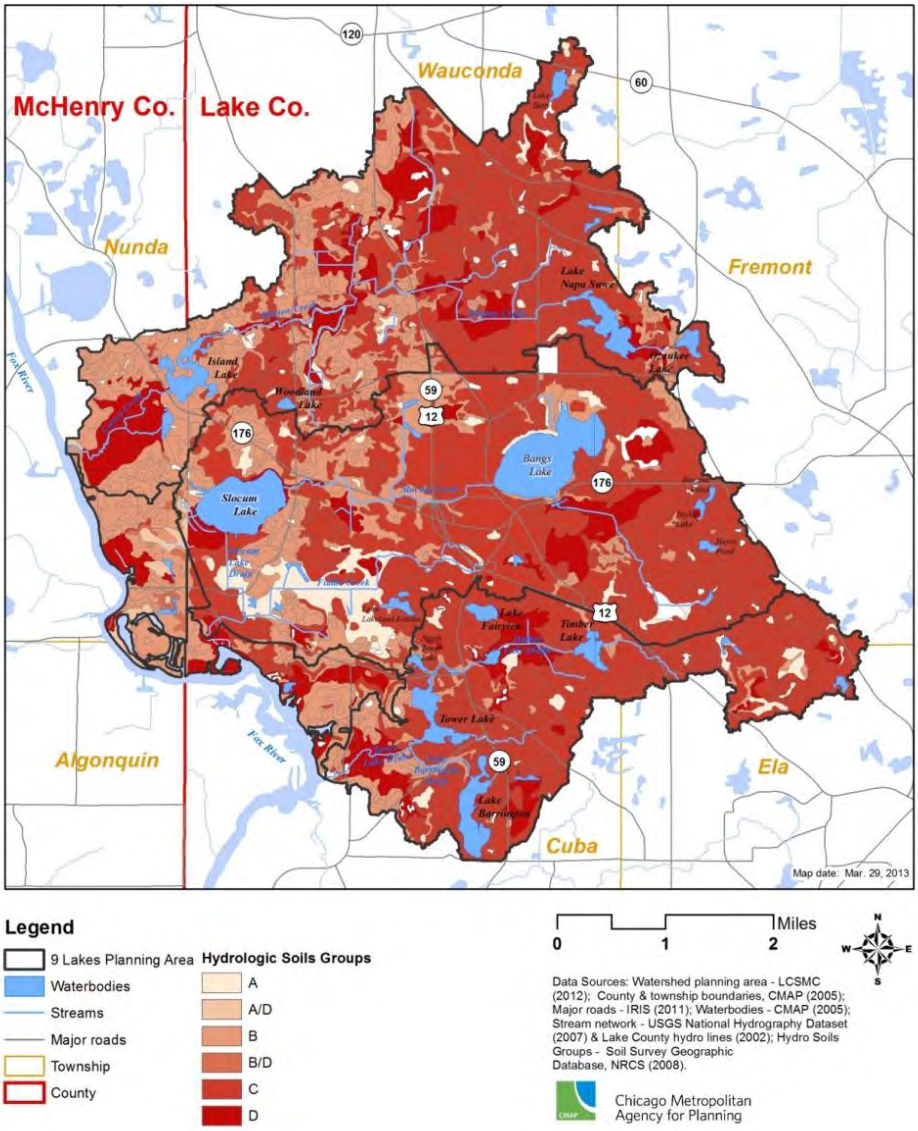
The four hydrologic soil groups are described as A – soils with low runoff potential when wet / water is transmitted freely through the soil, B – moderately low runoff potential when wet / water transmission through the soil is unimpeded, C – moderately high runoff potential when wet / water transmission is somewhat restricted, and D – high runoff potential when wet / water movement through the soil is restricted or very restricted. If certain wet soils can be drained, they are assigned to dual HSGs (e.g., A/D, B/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter refers to the drained condition and the second to an undrained condition (Table 8).

Table 8. Extent and characteristics of hydrologic soil groups in 9 Lakes planning area.

Hydrologic Soil Group	*Area (acres)*	*Percent of Watershed*	*Definition/Characteristics*
A	780.1	4.1	Soils have a low runoff potential when thoroughly wet. Water is transmitted freely through the soil.
A/D	99.6	0.5	The first letter applies to the drained condition and the second to the undrained condition.
B	4606.4	24.5	Soils have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded.
B/D	48.3	0.3	The first letter applies to the drained condition and the second to the undrained condition.
C	9885.9	52.7	Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted.
D	2112.4	11.3	Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted.
Unclassified	1234.0	6.6	n/a

The majority of the planning area features Group C soils (53 percent). The next most common HSG is Group B (25 percent). Leaving aside the dual groups that represent less than one percent of the area, Group A soils are least represented (four percent) and are found predominantly (66 percent) in the Slocum Lake Drain watershed (Table 8). Figure 16 illustrates a general pattern of HSG distribution such that from east to west, soil infiltration capacity increases and runoff potential lessens.

Figure 16. Hydrologic soil groups in the 9 Lakes planning area.



2.5.6 Hydric Soils

Hydric soils are those soils that developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation and are sufficiently wet in the upper part of the soil profile to develop anaerobic conditions during the growing season. The presence of hydric soils is used as one of three key criteria for identifying the historic existence of wetlands. Knowledge of hydric soils has both agricultural and nonagricultural applications including land-use planning and conservation-area planning. Much like an understanding of hydrologic soils groups, knowledge of the location and pattern of hydric soils can inform planners, builders, and engineers and influence their project design and location decisions.

Approximately two-thirds of the planning area features "not hydric" soils. "All hydric" soils are distributed throughout the planning area despite representing just 26 percent of soils present. A small amount of soils (seven percent) are unknown for their status in this otherwise dichotomous scheme (Figure 17 and Table 9). Lake bottoms also fall into the unknown category.

Figure 17. Hydric soils in the 9 Lakes planning area.

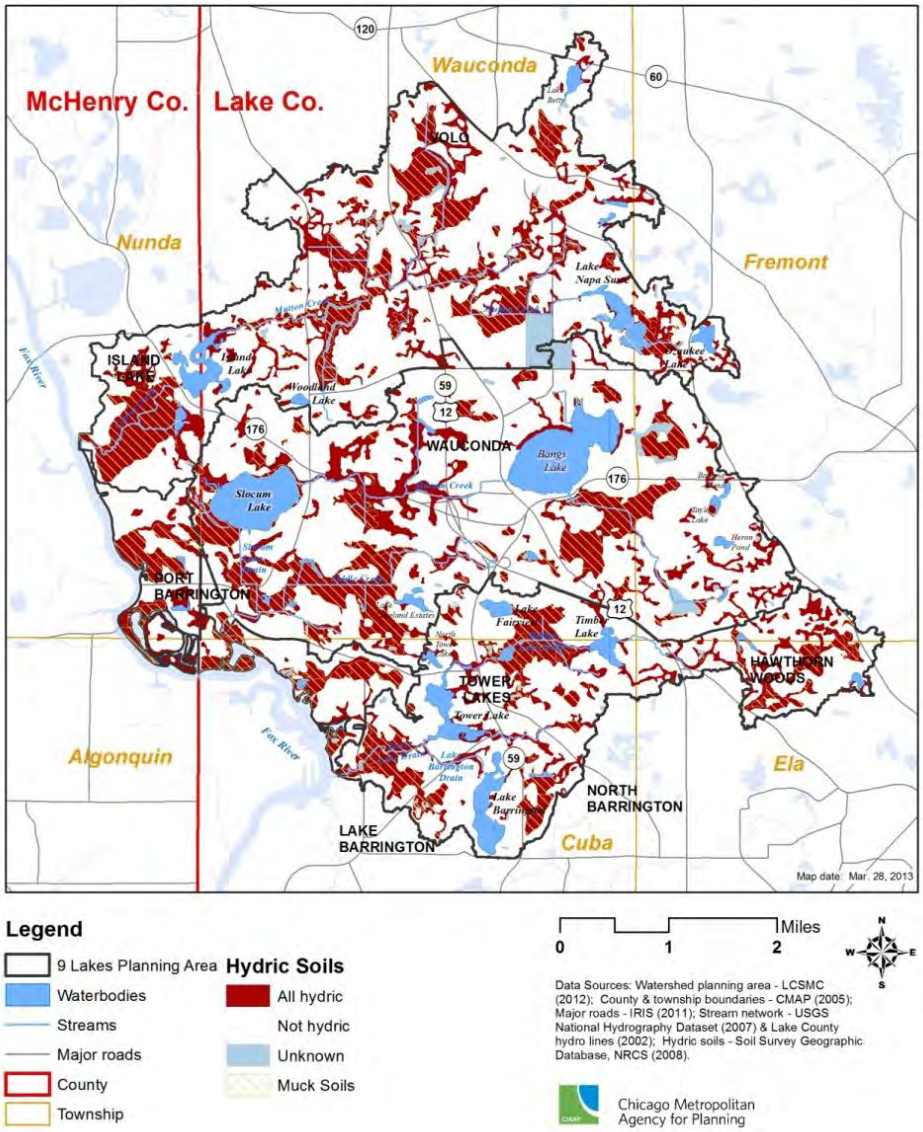


Table 9. Hydric soil status in 9 Lakes planning area.

Hydric Soil Class	*Area (Acres)*	*% of Watershed*
All hydric	4933.5	26.3
Not hydric	12,525.0	66.7
Unknown	1307.4	7.0

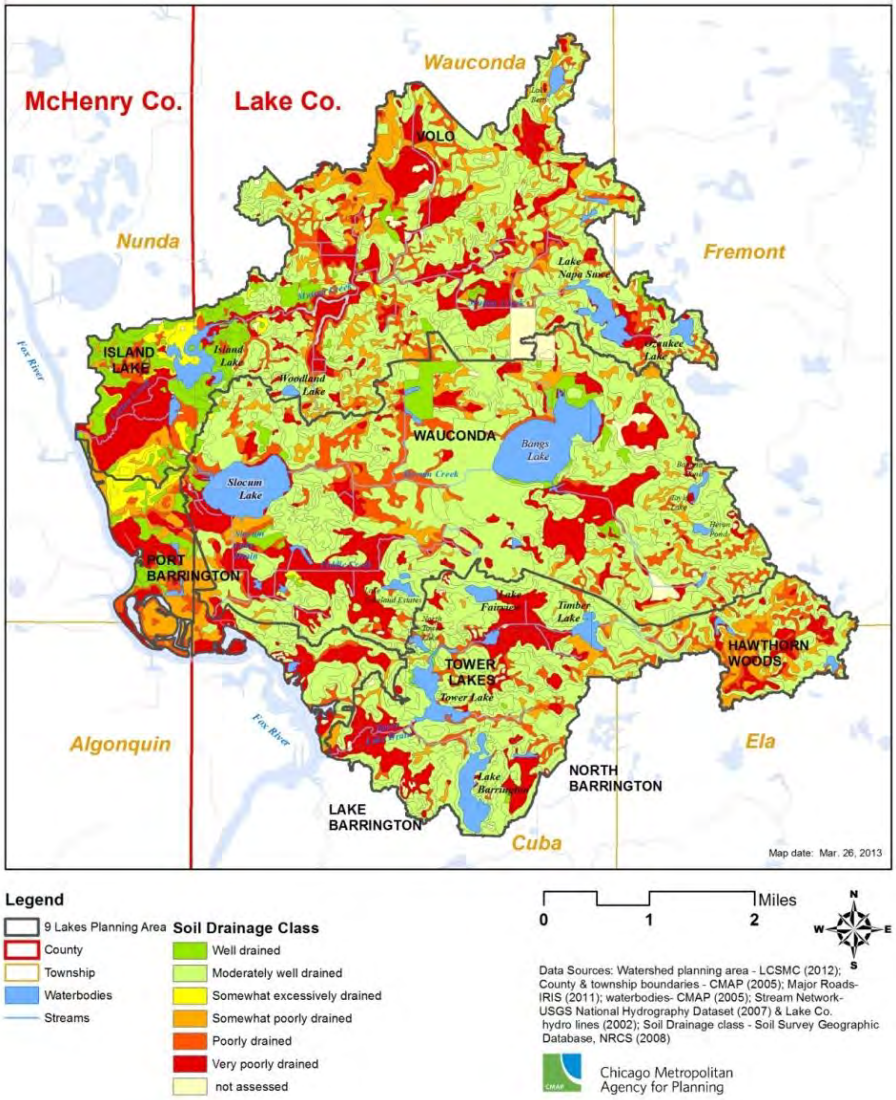
2.5.7 Soil Drainage Class

Soils are categorized in drainage classes based on their natural drainage condition in reference to the frequency and duration of wet periods[44]. The classes are Excessively Drained, Somewhat Excessively Drained, Moderately Well Drained, Well Drained, Somewhat Poorly Drained, Poorly Drained, and Very Poorly Drained[45]. The extent of soils in these drainage classes within the 9 Lakes Planning Area is shown in Figure 18.

[35] Soil Survey Staff, USDA-NRCS. Soil Survey Geographic (SSURGO) Database. SSURGO 2.2.6 Table Column Descriptions, dated June 26, 2012. Available online at http://soils.usda.gov/survey/geography/ssurgo/index.html. Accessed March 26, 2013.

[36] Soil Conservation Service, Soil Survey Staff. *Soil Survey Manual*. USDA Handbook 18. Washington, D.C.: USDA NRCS, 1993. http://soils.usda.gov/ technical/manual/ (accessed September 14, 2011).

Figure 18. Soil drainage classes in the 9 Lakes planning area.



Knowledge of soil drainage class has both agricultural and nonagricultural applications. For example, the Well Drained drainage classes indicate areas where stormwater infiltration BMPs may best be utilized. On the other hand, Excessively Drained soils may not be good locations for siting infiltration BMPs where shallow groundwater is used for drinking water supplies.

The Poorly Drained drainage classes indicate soils which limit or exclude crop growth unless artificially drained. Soils in the Somewhat Poorly Drained, Poorly Drained, or Very Poorly Drained drainage class occur on 35 percent of the agricultural land as well as 35.5 percent of the entire planning area. These areas can be taken as an approximation of the likely extent of

artificial drainage on currently farmed agricultural lands, given that crop growth on these lands would be severely impacted or even impossible without artificial drainage.

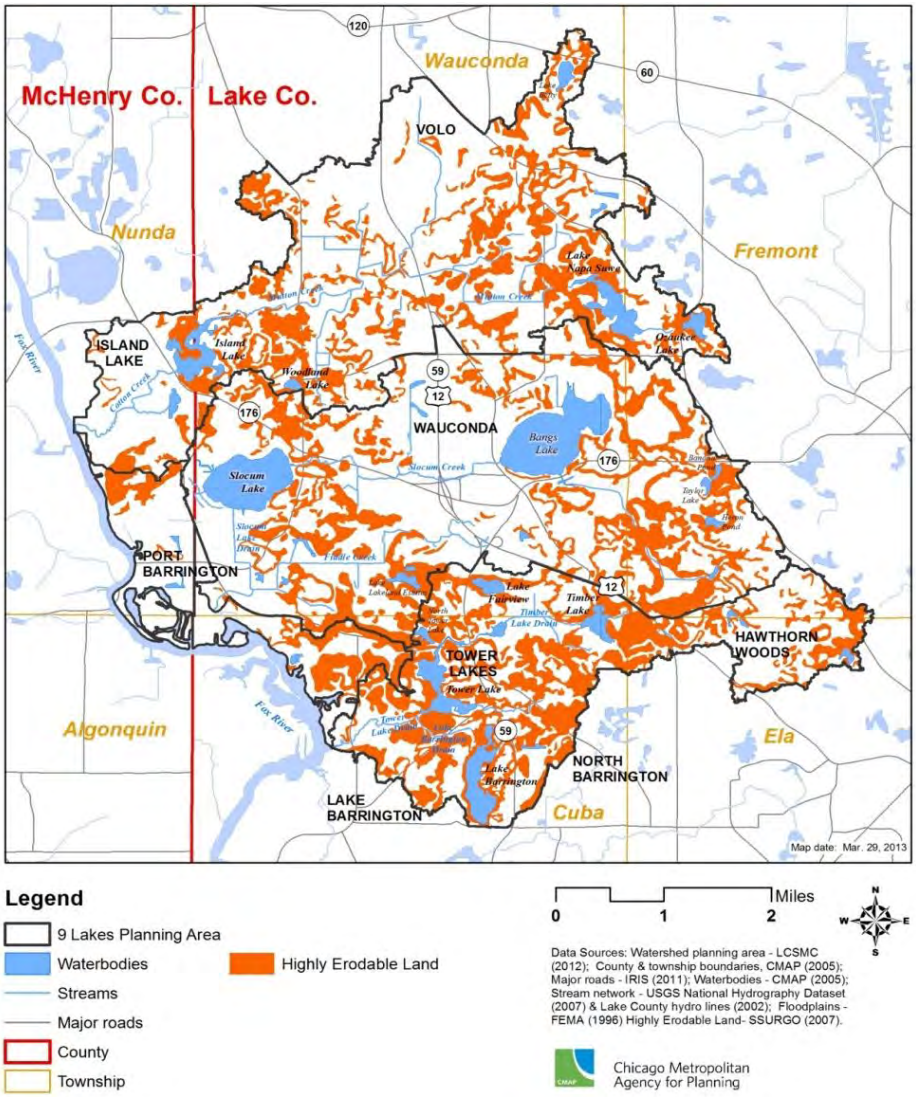
2.5.8 Highly Erodible Lands

The USDA NRCS defines highly erodible lands (HEL) as those with soils that have potential to equal or exceed an erodibility index of eight or soils that can erode at eight times the soil loss tolerance rate (T).[46] The NRCS assigns a T value to most soils based on its sheet and rill erosion rate.

Highly erodible lands are of agricultural concern as cropland is either designated HEL or non-HEL. The NRCS uses the Universal Soil Loss Equation (USLE) to determine a soil's erosion rate by analyzing rainfall effects, characteristics of the soil, slope length and steepness, and cropping and management practices. Figure 19 illustrates the pattern of HEL in the planning area.

[46] USDA NRCS, 2010. 2007 National Resources Inventory. The soil loss tolerance rate (T) is the maximum rate of annual soil loss that will permit crop productivity to be sustained economically and indefinitely on a given soil. Erosion is considered to be greater than T if either the water (sheet & rill) erosion or the wind erosion rate exceeds the soil loss tolerance rate. Available at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012269.pdf.

Figure 19. Highly erodible land in the 9 Lakes planning area.



Legend

- 9 Lakes Planning Area
- Waterbodies
- Streams
- Major roads
- County
- Township
- Highly Erodable Land

0 1 2 Miles

Data Sources: Watershed planning area - LCSMC (2012); County & township boundaries, CMAP (2005); Major roads - IRIS (2011); Waterbodies - CMAP (2005); Stream network - USGS National Hydrography Dataset (2007) & Lake County hydro lines (2002); Floodplains - FEMA (1996) Highly Erodable Land- SSURGO (2007).

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2.6 9 Lakes Planning Area Water Resources

Water quality impairments for the nine lakes of interest plus Fiddle Creek, the only impaired stream in the planning area, are outlined in Table 10.

Table 10. Water quality impairments in 9 Lakes planning area.[47]

Waterbody / ID	*Surface Area (ac)*	*Watershed Area (ac)*	*Impaired Designated Use*	*Cause of Impairment(s)*	*Source of Impairment(s)*
Island Lake IL_RTZI	78	5,949	Aesthetic quality	Total phosphorus, TSS	Unknown, On-site treatment systems, Yard maintenance
Lake Barrington IL_RTZT	91	191	Aesthetic quality	Total phosphorus, TSS, Aquatic plants	Unknown
			Primary contact recreation	Fecal coliform	Unknown
Lake Fairview IL_STK	20	30	Aesthetic quality	Total phosphorus, TSS, Aquatic plants	Unknown
Lake Napa Suwe IL_STO	61	1,069	Aesthetic quality	Total phosphorus, TSS, Aquatic plants	Unknown
Ozaukee (Drummond) Lake IL_UTI	21	66	Aesthetic quality	Total phosphorus, TSS, Aquatic plants	Unknown
Slocum Lake IL_RTP	211	5,310	Aesthetic quality	Total phosphorus, TSS, Aquatic plants	Contaminated sediments, Agriculture, Urban runoff/storm sewers, Runoff from F/G/P, Unknown
Timber Lake IL_RTZQ	33	1,228	Aesthetic quality	Total phosphorus, TSS, Aquatic plants	Unknown
Tower Lake IL_RTZF	69	3,148	Aesthetic quality	Total phosphorus, TSS, Aquatic plants	Unknown
			Prim. Con. Recr.	Fecal coliform	Unknown
Woodland Lake IL_STV	8	52	Aquatic life	Total phosphorus, TSS, Dissolved oxygen	Pesticide application, Urban runoff/storm sewers, Runoff from F/G/P, Rural (residential areas)
			Aesthetic quality	Total phosphorus, TSS, Nonnative aquatic plants	Introduction of nonnative organisms (accidental or intentional)
Fiddle Creek IL_DTRA-W-C1	2.04 miles		Aquatic life	Total phosphorus, Sedimentation/sil-tation, Chloride, Unknown	Municipal point-source discharges, Site clearance (land (re)development), Unknown

F/G/P is forestland, grassland, and parkland

[47] Acreage data from Upper Fox River/Flint Creek Watershed TMDL Final Stage 1 Report. AECOM document no. 60133219-106 (March 2010) prepared for Illinois EPA. Water quality information from Illinois Integrated Water Quality Report and Section 303(d) List – Volume 1: Surface Water – 2012, plus Appendices http://www.epa.state.il.us/water/tmdl/303d-list.html#2012.

A description of the watershed drainage system follows and features the results of various field assessments concerned with degree of channelization, condition of riparian area, and degree of bank erosion. The watershed drainage system is organized by the three primary watersheds and the area of direct drainage to the Fox River.

For purposes of pollutant-load and other analyses, however, the planning area is subdivided into fourteen subunits: nine lake watersheds for the lakes listed in Table 10, Fiddle Creek, direct drainage to the Fox River, Bangs Lake, and two separate drainage areas below Tower Lake/Lake Barrington and Island Lake each (Table 11 and Figure 37, the latter found in Subsection 2.6.3).

Table 11. Annual pollutant loads by subunit in 9 Lakes planning area.

Subunit	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs/yr)*	*Cl (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos-phor-us (lbs /yr)*	*P (lbs /ac)*	*TSS (lbs/yr)*	*TSS (lbs /ac)*	*Bac-teria (bill col /yr)*	*Bac-teria (bill col /ac)*
Bangs Lake	3,165	2,626	476,702	151	8,493	2.68	1,018	0.32	444,070	140	6,967	2.20
Cotton Creek	779	544	58,321	75	1,452	1.86	189	0.24	82,513	106	1,090	1.40
Direct Drainage Area	1,290	736	70,183	54	2,302	1.78	274	0.21	119,376	93	2,005	1.55
Fiddle Creek	1,606	1,081	131,548	82	4,445	2.77	457	0.28	250,822	156	3,199	1.99
Island Lake	5,074	4,098	416,689	82	29,883	5.89	2,745	0.54	4,037,126	796	10,390	2.05
Lake Barrington	485	525	157,560	325	2,199	4.53	228	0.47	119,453	246	2,191	4.51
Lake Fairview	73	80	21,792	299	250	3.43	29	0.40	8,094	111	235	3.22
Lake Napa Suwe	525	500	110,224	210	1,594	3.04	163	0.31	75,355	144	1,530	2.92
Ozaukee Lake	96	76	17,822	185	119	1.23	17	0.18	2,439	25	76	0.79
Slocum Lake	2,433	2,324	463,845	191	11,941	4.91	1,214	0.50	1,136,110	467	6,522	2.68
Timber Lake	1,174	891	89,873	77	6,103	5.20	618	0.53	557,388	475	3,547	3.02
Tower Lake Drain	637	395	50,911	80	1,812	2.84	236	0.37	80,505	126	1,546	2.43
Tower Lake	1,382	1,056	157,913	114	4,069	2.95	473	0.34	141,711	103	3,845	2.78
Woodland Lake	46	47	12,426	267	204	4.38	23	0.50	9,025	194	210	4.51
Grand Totals	18,766	14,978	2,235,810	119	74,865	3.99	7,685	0.41	7,063,987	376	43,353	2.31

Cell shading denotes highest per unit area pollutant load value of the 14 subunits.

2.6.1 Watershed Drainage System

2.6.1.1 Cotton-Mutton Creek Watershed

As noted earlier, water in the planning area generally flows from east to west. In the northernmost watershed, Cotton-Mutton Creek, the easternmost Ozaukee Lake and its small watershed begins collecting water that outlets to the west under Fairfield Road into a series of ponds and wetlands that flow into Lake Napa Suwe. Mutton Creek begins with the outflow of Lake Napa Suwe and is the main stem of the stream network that flows west into Island Lake. Among the tributaries to Mutton Creek is one that apparently includes Woodland Lake outflow and its very small watershed. Such outflow and its pathway are neither obvious nor entirely natural and above ground. Mutton Creek also collects unnamed tributaries that flow from the northern parts of the watershed that drain the largest concentration of agricultural land in all of the planning area. Cotton Creek begins with the outflow of Island Lake and captures one main ephemeral or intermittent tributary before it empties into the Fox River. The Cotton-Mutton Creek Watershed contains five of the fourteen planning area subunits. Figure 20 illustrates waterbodies, the segmented/coded stream network, wetlands, and detention basins. There are 54 detention basins throughout the watershed.[48] Table 12 and Figure 21 provide data and a map, respectively, on stream and tributary channelization. Table 13 and Figure 22 provide data and a map, respectively, on riparian area condition. Table 14 and Figure 23 provide data and a map, respectively, on stream and tributary bank erosion by stream segment (i.e., reach) code. The total length of streams and tributaries is 13.7 miles.

[48] The matter of detention basins is not straightforward; the details of which are explained in subsection 2.6.2.

Figure 20. Cotton-Mutton Creek Watershed drainage system.

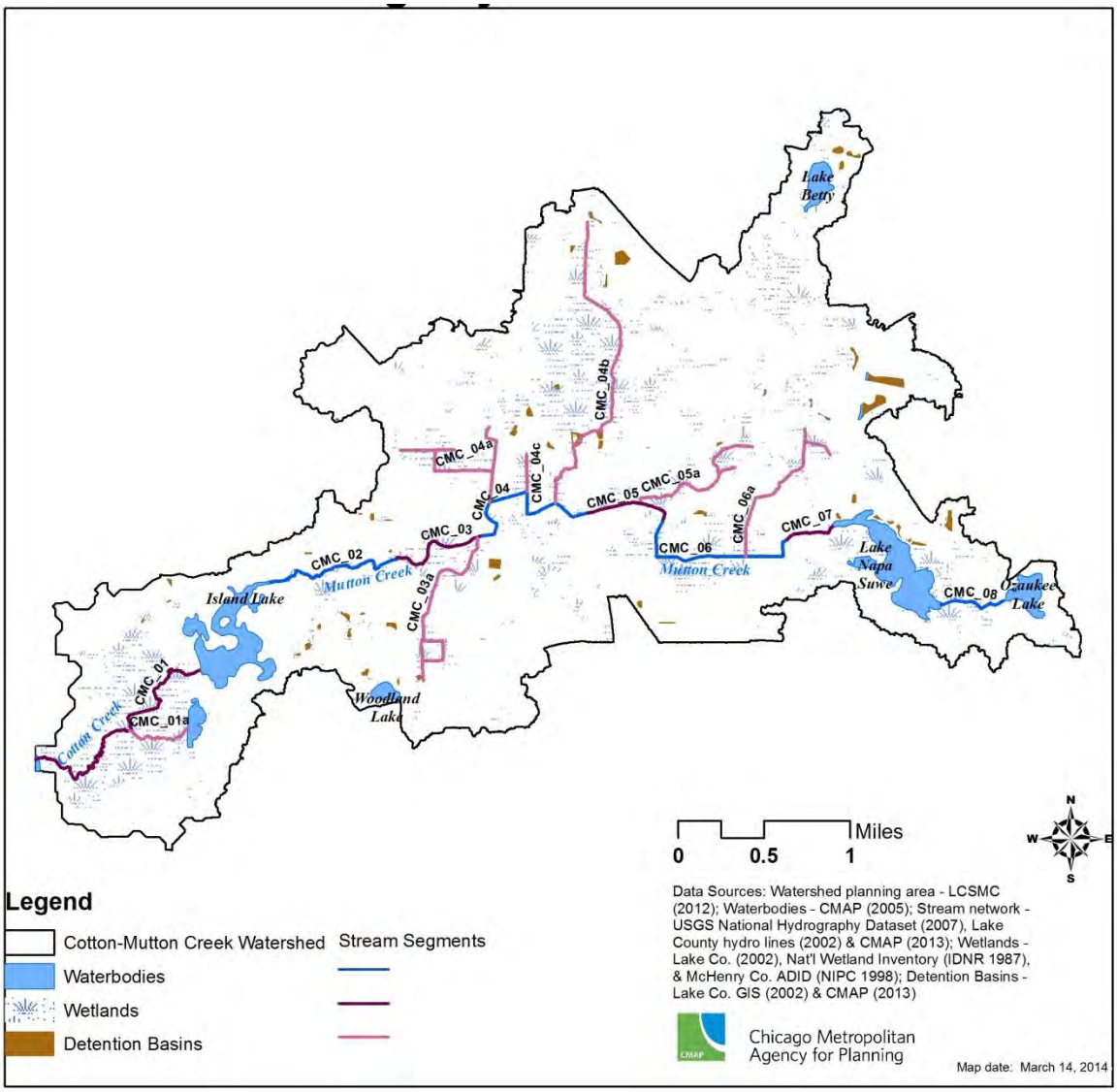


Table 12. Summary of stream and tributary channelization within the Cotton-Mutton Creek Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*None or Low Channelization (ft./percent)*		*Moderate Channelization (ft./percent)*		*High Channelization (ft./percent)*	
Cotton Creek	CMC_01	8,810	7,800	88	0	0	1,010	12
	CMC_01a	2,270	2,270	100	0	0	0	0
Mutton Creek	CMC_02	4,630	1,200	26	3,430	74	0	0
Mutton Creek	CMC_03	3,160	0	0	3,160	100	0	0
	CMC_03a	7,430	0	0	1,480	20	5,950	80
Mutton Creek	CMC_04	5,540	0	0	830	15	4,710	85
	CMC_04a	6,730	0	0	0	0	6,730	100
	CMC_04b	10,500	2,100	20	1,570	15	6,830	65
Mutton Creek	CMC_05	2,840	0	0	0	0	2,840	100
	CMC_05a	5,520	0	0	3,020	55	2,500	45
Mutton Creek	CMC_06	5,570	0	0	0	0	5,570	100
	CMC_06a	5,830	1,160	20	290	5	4,380	75
Mutton Creek	CMC_07	1,640	0	0	1,640	100	0	0
Mutton Creek	CMC_08	2,110	2,000	95	0	0	110	5
Totals		72,580	16,530	22.8	15,420	21.2	40,630	56.0

Figure 21. Cotton-Mutton Creek stream and tributary channelization

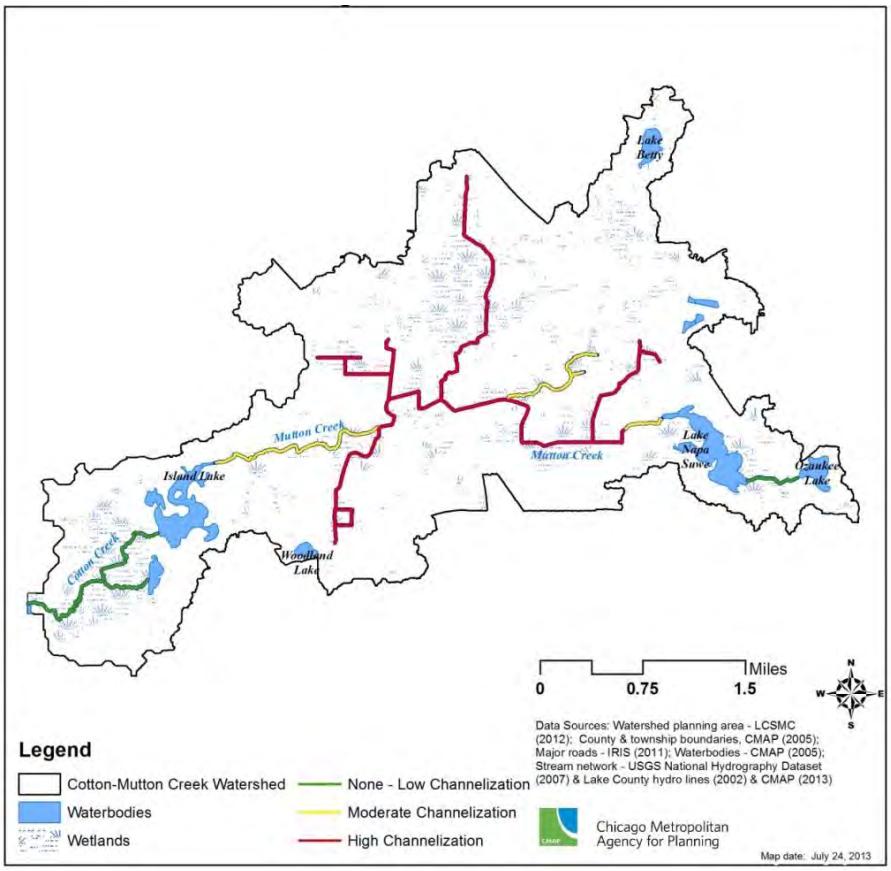


Table 13. Summary of stream and tributary riparian area condition within the Cotton-Mutton Creek Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Cotton Creek	CMC_01	8,810	8,640	98	170	2	0	0
	CMC_01a	2,270	2,270	100	0	0	0	0
Mutton Creek	CMC_02	4,630	3,935	85	695	15	0	0
Mutton Creek	CMC_03	3,160	3,160	100	0	0	0	0
	CMC_03a	7,430	6,315	85	1,115	15	0	0
Mutton Creek	CMC_04	5,540	3,600	65	1,940	35	0	0
	CMC_04a	6,730	4,710	70	2,020	30	0	0
	CMC_04b	10,500	10,000	95	500	5	0	0
Mutton Creek	CMC_05	2,840	2,840	100	0	0	0	0
	CMC_05a	5,520	3,590	65	1,930	35	0	0
Mutton Creek	CMC_06	5,570	4,460	80	1,110	20	0	0
	CMC_06a	5,830	5,830	100	0	0	0	0
Mutton Creek	CMC_07	1,640	980	60	660	40	0	0
Mutton Creek	CMC_08	2,110	2,110	100	0	0	0	0
Totals		72,580	62,440	86.0	10,140	14.0	0	0

Figure 22. Cotton-Mutton Creek stream and tributary riparian area condition

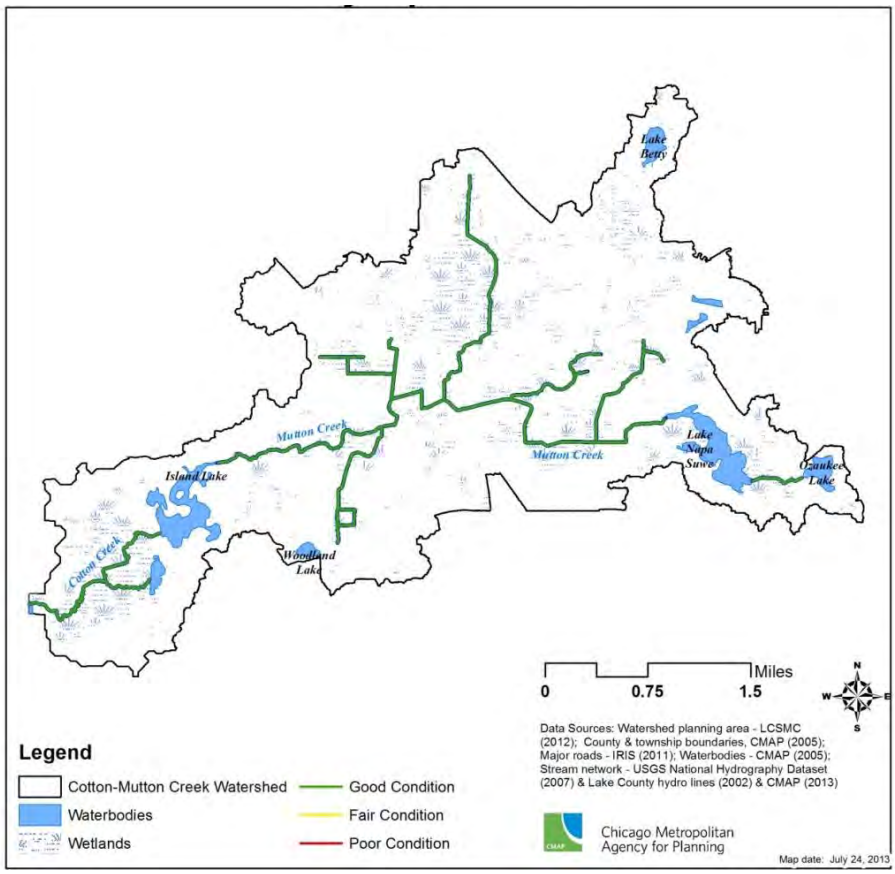
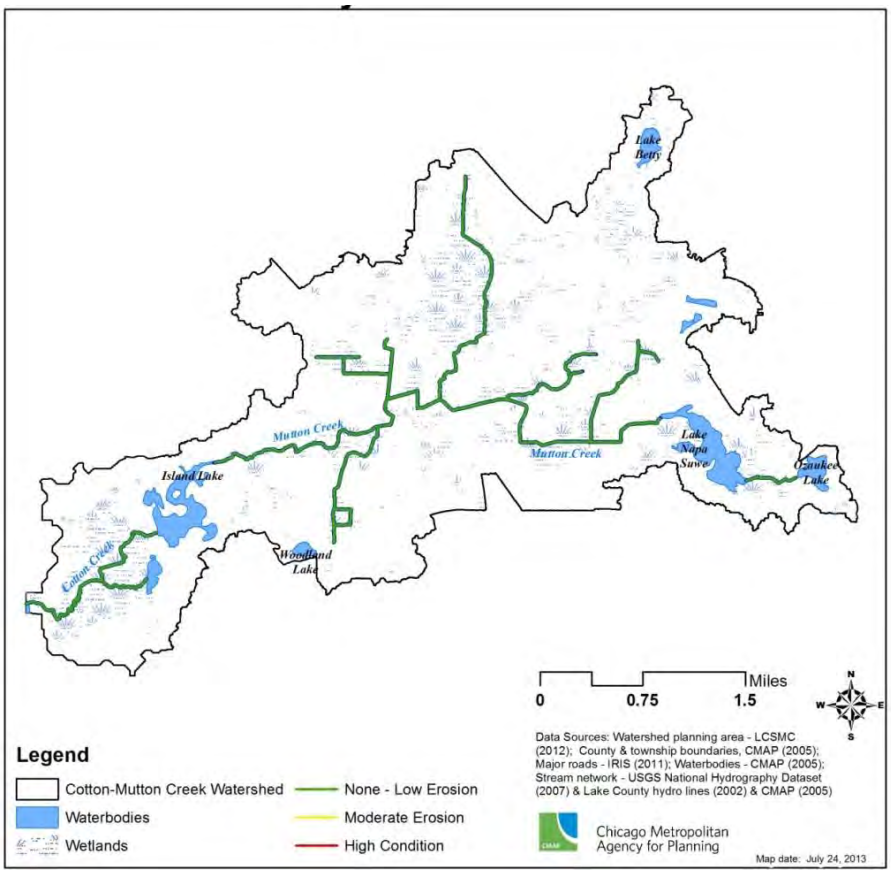


Table 14. Summary of stream and tributary bank erosion within the Cotton-Mutton Creek Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*None or Low Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Cotton Creek	CMC_01	8,810	8,810	100	0	0	0	0
	CMC_01a	2,270	2,270	100	0	0	0	0
Mutton Creek	CMC_02	4,630	3,935	85	0	0	695	15
Mutton Creek	CMC_03	3,160	3,160	100	0	0	0	0
	CMC_03a	7,430	7,430	100	0	0	0	0
Mutton Creek	CMC_04	5,540	5,540	100	0	0	0	0
	CMC_04a	6,730	6,730	100	0	0	0	0
	CMC_04b	10,500	10,500	100	0	0	0	0
Mutton Creek	CMC_05	2,840	2,840	100	0	0	0	0
	CMC_05a	5,520	5,520	100	0	0	0	0
Mutton Creek	CMC_06	5,570	5,570	100	0	0	0	0
	CMC_06a	5,830	5,540	95	290	5	0	0
Mutton Creek	CMC_07	1,640	1,640	100	0	0	0	0
Mutton Creek	CMC_08	2,110	2,110	100	0	0	0	0
Totals		72,580	71,595	98.6	290	0.4	695	1.0

Figure 23. Cotton-Mutton Creek stream and tributary bank erosion



2.6.1.2 Slocum-Lake Drain / Fiddle Creek Watershed

The Slocum Lake Drain / Fiddle Creek Watershed is situated in the middle of the planning area. Largest in size among the three primary watersheds, a number of small lakes are found here. Most notably, Bangs Lake drains the majority of the eastern part of the watershed and feeds Slocum Creek which eventually flows into Slocum Lake at the western end of the watershed. Fiddle Creek and its watershed occupy the southwestern portion and joins Slocum Lake Drain (below Slocum Lake) before flowing into the Fox River. The Slocum Lake Drain / Fiddle Creek Watershed contains three of the fourteen planning area subunits. There are 62 stormwater detention basins throughout this watershed. Figure 24 illustrates waterbodies, the segmented/coded stream network, wetlands, and detention basins. Table 15, Table 16, and Table 17 provide other data by stream segment (i.e., reach) code. Figure 25, Figure 26, and Figure 27 provide the corresponding maps. The total length of streams and tributaries is 12.4 miles.

Figure 24. Slocum Lake Drain Watershed drainage system

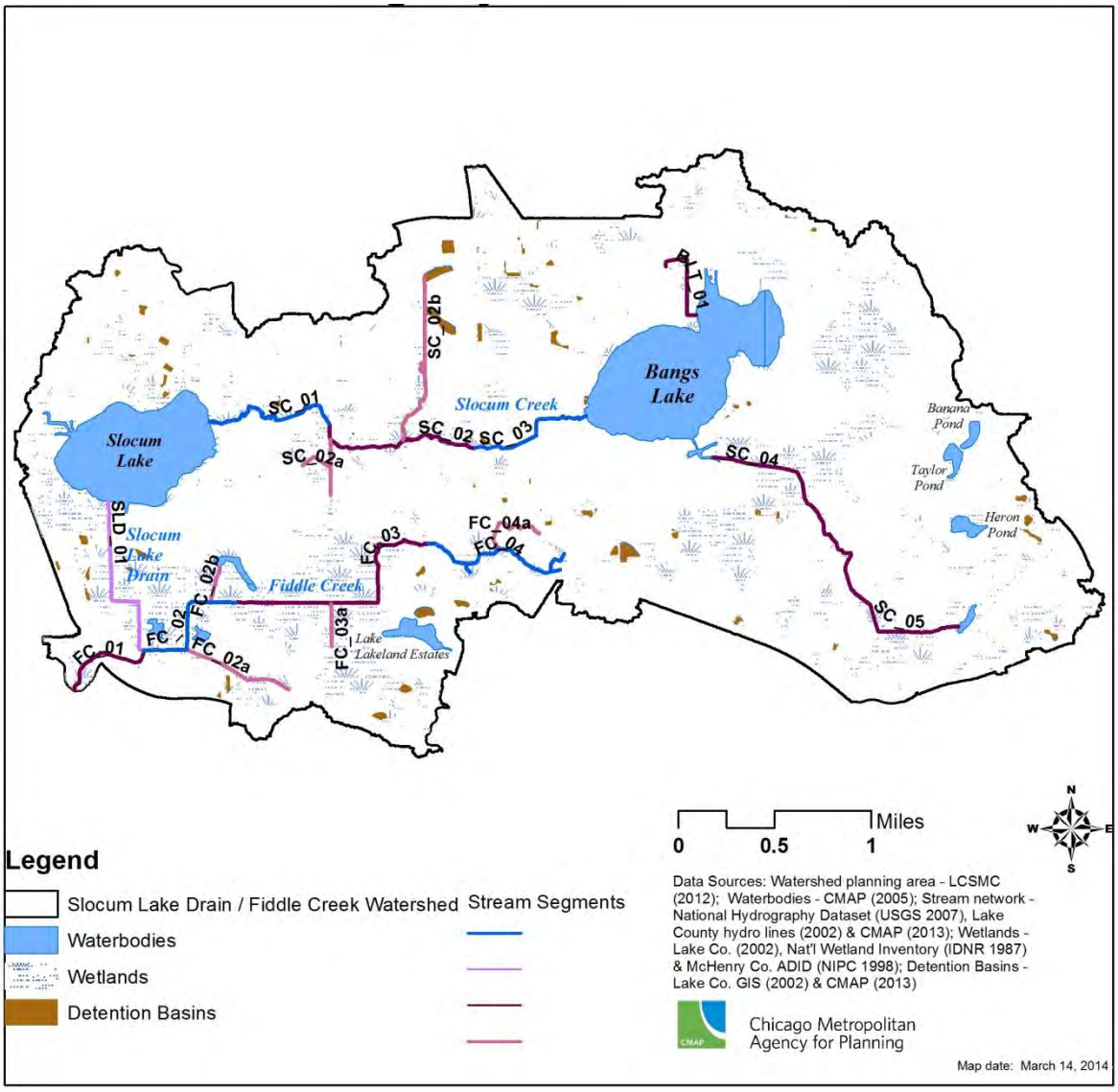


Table 15. Summary of stream and tributary channelization within the Slocum Lake Drain / Fiddle Creek Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*None or Low Channelization (ft./percent)*		*Moderate Channelization (ft./percent)*		*High Channelization (ft./percent)*	
	BLT_01	2,530	0	0	0	0	2,530	100
	FC_01	2,820	0	0	1,270	45	1,550	55
Fiddle Creek	FC_02	3,720	0	0	0	0	3,720	100
	FC_02a	3,100	0	0	1,580	51	1,530	49
	FC_02b	1,040	210	20	0	0	830	80
Fiddle Creek	FC_03	7,090	710	10	710	10	5,670	80
	FC_03a	1,170	0	0	0	0	1,170	100
	FC_04	5,410	0	0	540	10	4,870	90
	FC_04a	2,210	0	0	220	10	1,990	90
Slocum Creek	SC_01	4,630	2,320	50	1,390	30	920	20
Slocum Creek	SC_02	5,040	505	10	3,025	60	1,510	30
	SC_02a	2,460	0	0	0	0	2,460	100
	SC_02b	5,320	0	0	1,330	25	3,990	75
	SC_03	3,700	0	0	185	5	3,515	95
	SC_04	5,800	1,450	25	1,450	25	2,900	50
	SC_05	4,240	3,390	80	850	20	0	0
Slocum Lake Drain	SLD_01	4,860	0	0	0	0	4,860	100
Totals		65,140	8,585	13.2	12,550	19.3	44,015	67.6

Figure 25. Slocum Lake Drain stream and tributary channelization

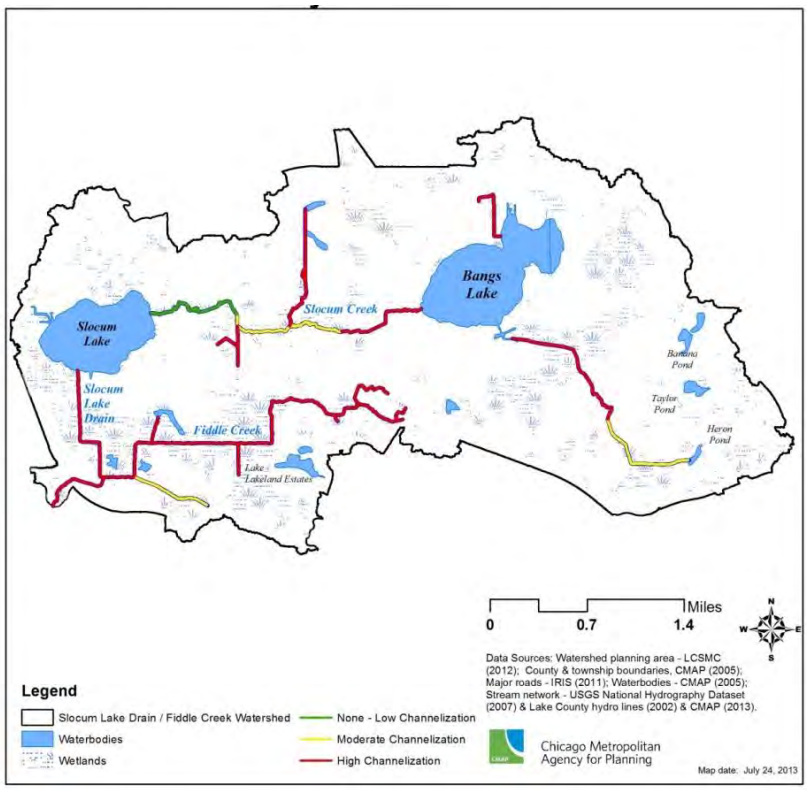


Table 16. Summary of stream and tributary riparian area condition within the Slocum Lake Drain / Fiddle Creek Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
	BLT_01	2,530	505	20	2,025	80	0	0
	FC_01	2,820	1,270	45	1,550	55	0	0
Fiddle Creek	FC_02	3,720	3,720	100	0	0	0	0
	FC_02a	3,100	2,330	75	470	15	310	10
	FC_02b	1,040	1,040	100	0	0	0	0
Fiddle Creek	FC_03	7,090	7,090	100	0	0	0	0
	FC_03a	1,170	1,170	100	0	0	0	0
	FC_04	5,410	3,790	70	1,620	30	0	0
	FC_04a	2,210	330	15	665	30	1,215	55
Slocum Creek	SC_01	4,630	3,935	85	695	15	0	0
Slocum Creek	SC_02	5,040	2,770	55	1,010	20	1,260	25
	SC_02a	2,460	0	0	2,460	100	0	0
	SC_02b	5,320	4,520	85	800	15	0	0
	SC_03	3,700	1,295	35	1,480	40	925	25
	SC_04	5,800	5,800	100	0	0	0	0
	SC_05	4,240	4,240	100	0	0	0	0
Slocum Lake Drain	SLD_01	4,860	3,400	70	1,460	30	0	0
Totals		65,140	47,205	72.5	14,235	21.9	3,710	5.7

Figure 26. Slocum Lake Drain stream and tributary riparian area condition

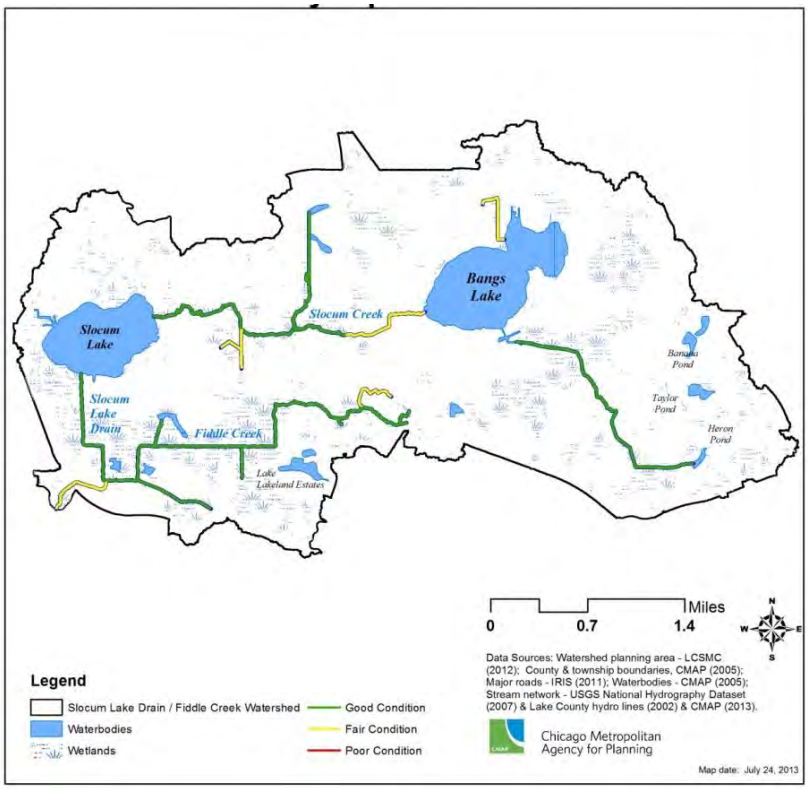
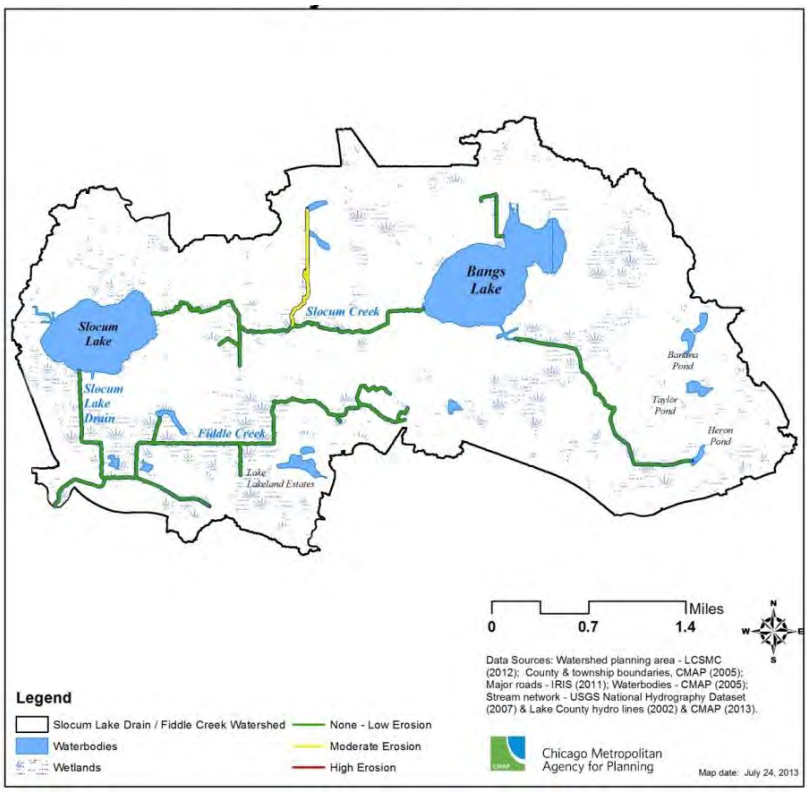


Table 17. Summary of stream and tributary bank erosion within the Slocum Lake Drain / Fiddle Creek Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*None or Low Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
	BLT_01	2,530	2,530	100	0	0	0	0
	FC_01	2,820	1,550	55	1,270	45	0	0
Fiddle Creek	FC_02	3,720	3,720	100	0	0	0	0
	FC_02a	3,100	2,800	90	310	10	0	0
	FC_02b	1,040	1,040	100	0	0	0	0
Fiddle Creek	FC_03	7,090	7,090	100	0	0	0	0
	FC_03a	1,170	1,170	100	0	0	0	0
	FC_04	5,410	5,410	100	0	0	0	0
	FC_04a	2,210	2,210	100	0	0	0	0
Slocum Creek	SC_01	4,630	4,630	100	0	0	0	0
Slocum Creek	SC_02	5,040	3,780	75	750	15	510	10
	SC_02a	2,460	2,460	100	0	0	0	0
	SC_02b	5,320	1,330	25	2,660	50	1,330	25
	SC_03	3,700	3,330	90	370	10	0	0
	SC_04	5,800	5,800	100	0	0	0	0
	SC_05	4,240	4,240	100	0	0	0	0
Slocum Lake Drain	SLD_01	4,860	3,400	70	1,460	30	0	0
Totals		65,140	56,490	86.7	6,820	10.5	1,840	2.8

Figure 27. Slocum Lake Drain stream and tributary bank erosion



2.6.1.3 Tower Lake Drain Watershed

The smallest of the three watersheds, Tower Lake Drain, occupies the southern portion of the planning area. Timber Lake collects water from the easternmost area and outlets to Timber Lake Drain (aka, Mud Creek) which also captures the outflow and watershed of Lake Fairview before entering Tower Lake to the west. Outflow from Tower Lake is via Tower Lake Drain and the latter captures outflow from Lake Barrington via Lake Barrington Drain. Lake Barrington resides on the very southern end of this watershed. The Tower Lake Drain Watershed contains five of the fourteen subunits. Figure 28, Figure 29, Figure 30, and Figure 31, and Table 18, Table 19, and Table 20 provide additional information and data, respectively, regarding the drainage system. The total length of streams and tributaries is 5.8 miles. There are 14 stormwater detention basins throughout this watershed.

Figure 28. Tower Lake Drain Watershed drainage system

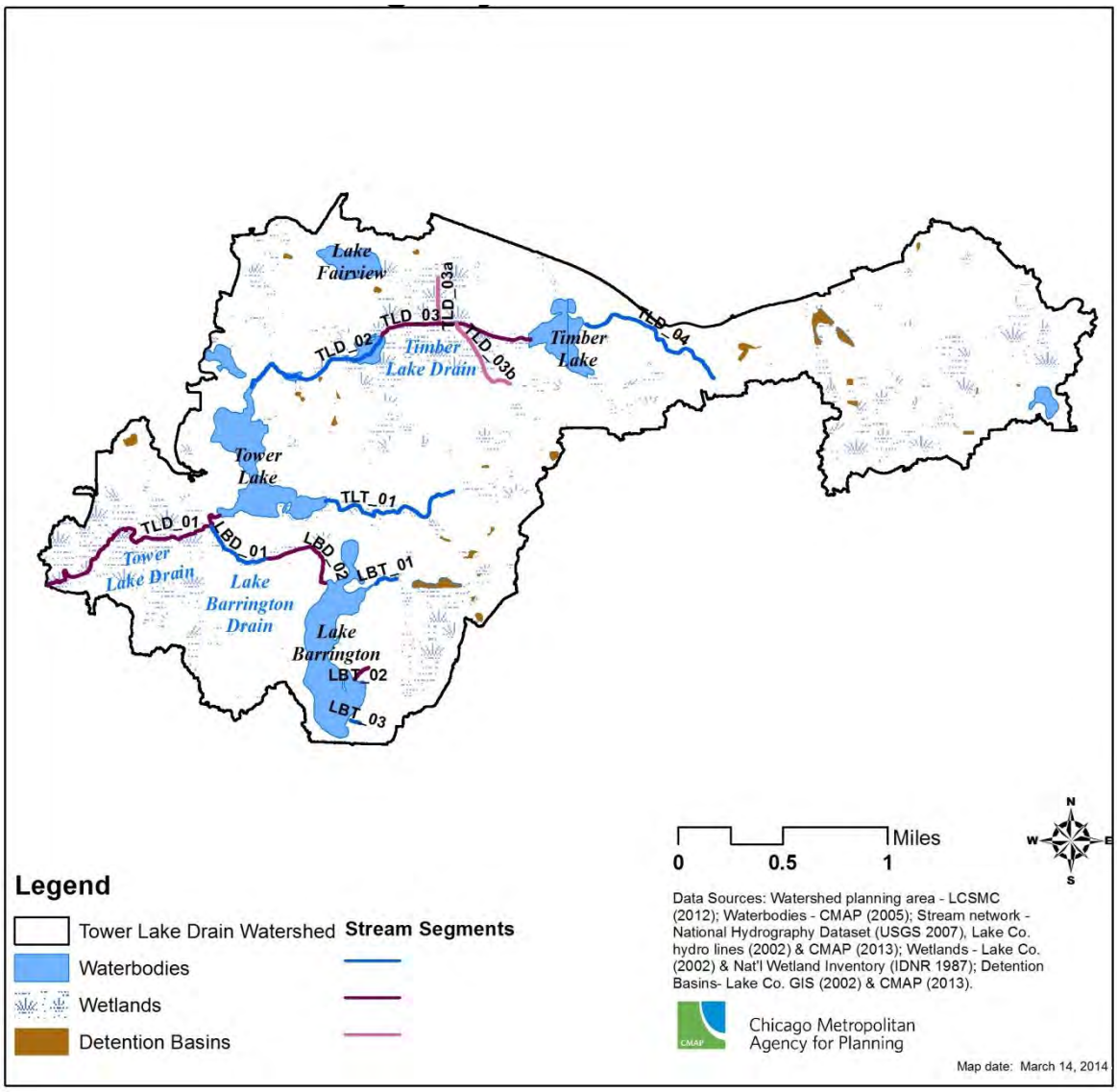


Table 18. Summary of stream and tributary channelization within the Tower Lake Drain Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*None or Low Channelization (ft./percent)*		*Moderate Channelization (ft./percent)*		*High Channelization (ft./percent)*	
Lake Barrington Drain	LBD_01	1,960	0	0	1,960	100	0	0
Lake Barrington Drain	LBD_02	1,990	0	0	0	0	1,990	100
Tower Lake Tributary	TLT_01	4,280	0	0	2,995	70	1,285	30
Tower Lake Drain	TLD_01	6,500	6,500	100	0	0	0	0
Timber Lake Drain	TLD_02	4,310	0	0	2,585	60	1,725	40
Timber Lake Drain	TLD_03	3,960	0	0	0	0	3,960	100
	TLD_03a	1,170	0	0	0	0	1,170	100
	TLD_03b	2,240	0	0	200	30	1,570	70
	TLD_04	4,290	3,430	80	860	20	0	0
Totals		30,700	9,930	32.3	9,070	29.5	11,700	38.1

Figure 29. Tower Lake Drain stream and tributary channelization

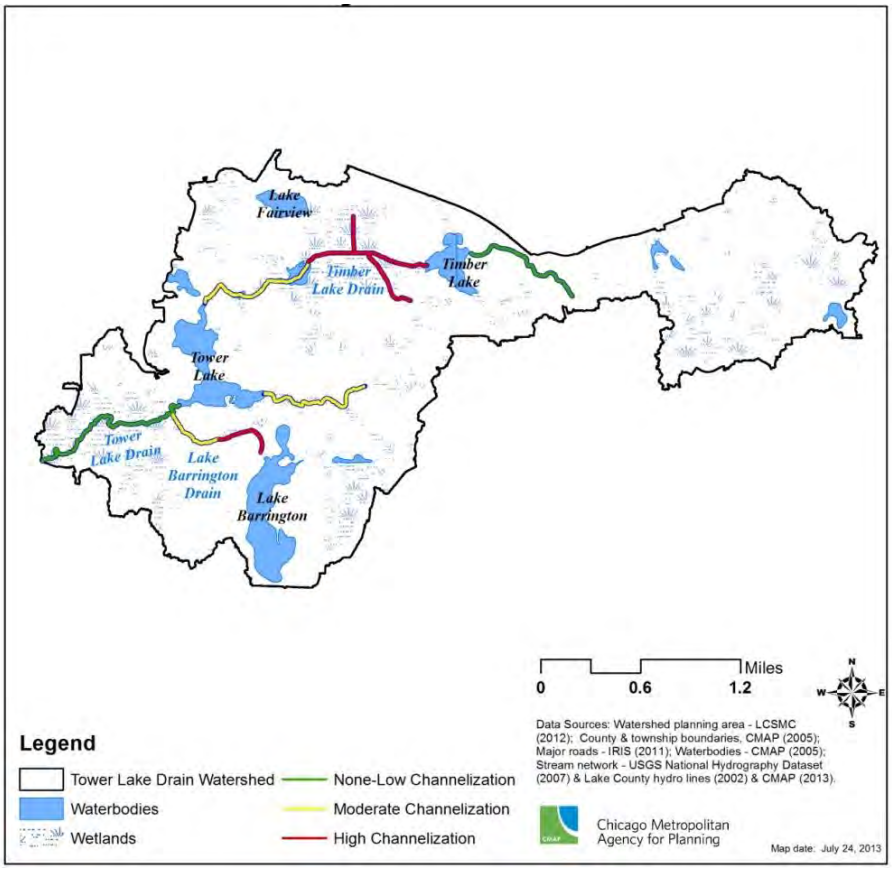


Table 19. Summary of stream and tributary riparian area condition within the Tower Lake Drain Watershed.

Stream / Tributary Name	*Reach Code*	*Length Asssessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Lake Barrington Drain	LBD_01	1,960	1,960	100	0	0	0	0
Lake Barrington Drain	LBD_02	1,990	0	0	1,990	100	0	0
Tower Lake Tributary	TLT_01	4,280	1,500	35	2,780	65	0	0
Tower Lake Drain	TLD_01	6,500	6,500	100	0	0	0	0
Timber Lake Drain	TLD_02	4,310	3,450	80	860	20	0	0
Timber Lake Drain	TLD_03	3,960	3,960	100	0	0	0	0
	TLD_03a	1,170	1,170	100	0	0	0	0
	TLD_03b	2,240	2,240	100	0	0	0	0
	TLD_04	4,290	3860	90	215	5	215	5
Totals		30,700	24,640	80.2	5,845	19.0	215	0.7

Figure 30. Tower Lake Drain stream and tributary riparian area condition

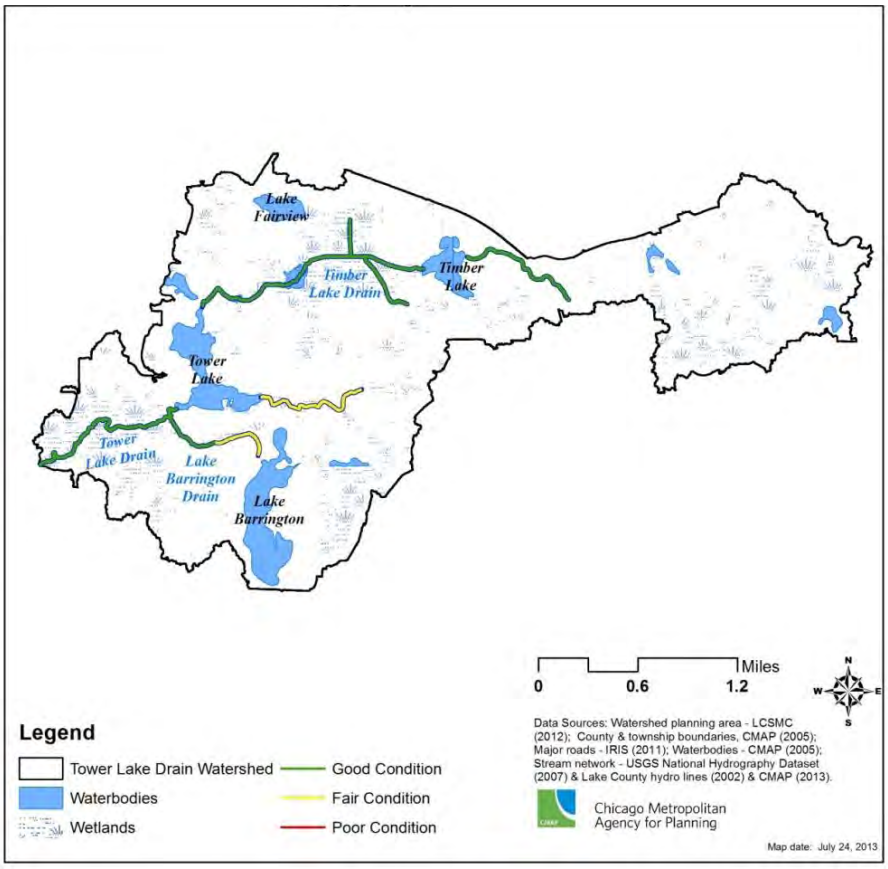
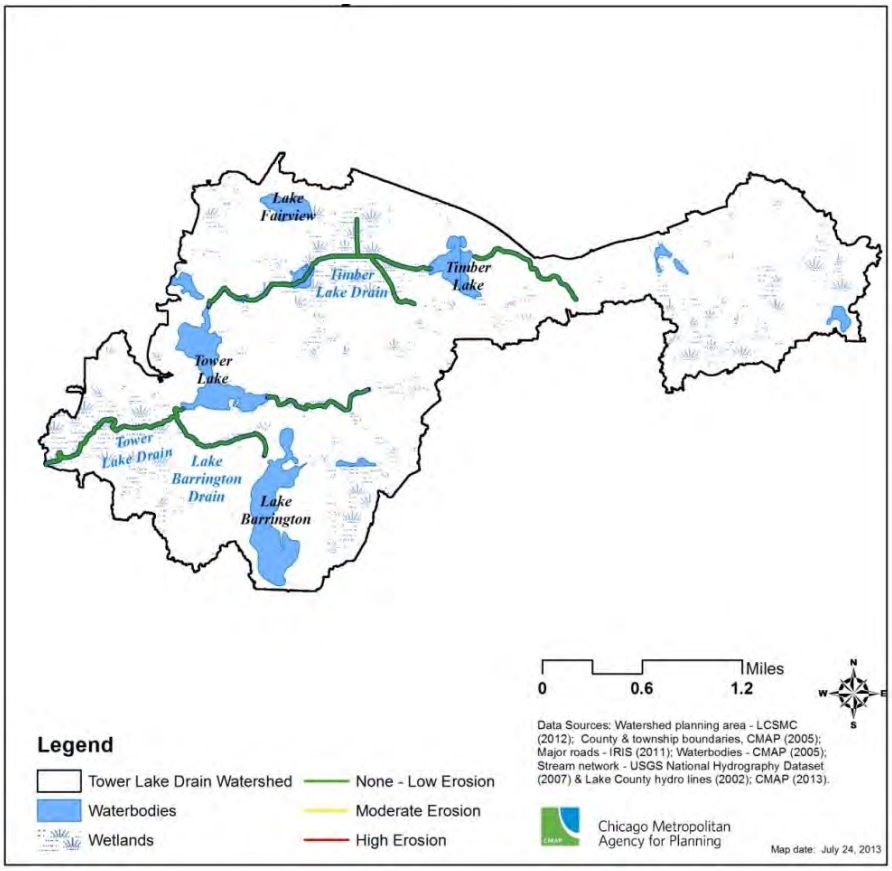


Table 20. Summary of stream and tributary bank erosion within the Tower Lake Drain Watershed.

Stream / Tributary Name	*Reach Code*	*Length Assessed (ft.)*	*None or Low Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Lake Barrington Drain	LBD_01	1,960	1,760	90	100	5	100	5
Lake Barrington Drain	LBD_02	1,990	1,390	60	600	30	0	0
Tower Lake Tributary	TLT_01	4,280	3,880	90	200	5	200	5
Tower Lake Drain	TLD_01	6,500	6,500	100	0	0	0	0
Timber Lake Drain	TLD_02	4,310	4,310	100	0	0	0	0
Timber Lake Drain	TLD_03	3,960	3,960	100	0	0	0	0
	TLD_03a	1,170	1,170	100	0	0	0	0
	TLD_03b	2,240	2,240	100	0	0	0	0
	TLD_04	4,290	4,290	100	0	0	0	0
Totals		30,700	29,500	96.1	900	2.9	300	1.0

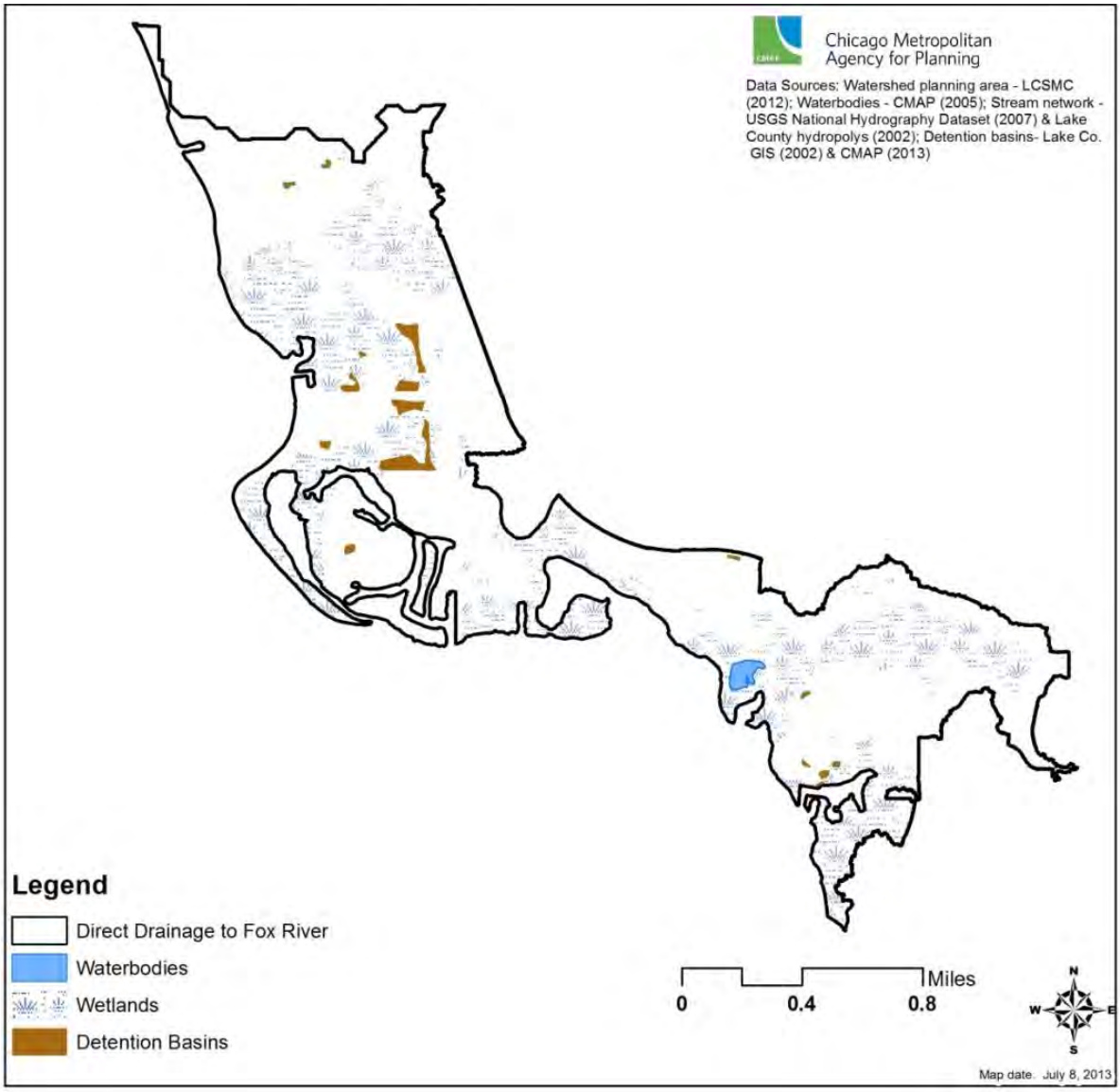
Figure 31. Tower Lake Drain stream and tributary bank erosion



2.6.1.4 *Direct Drainage to the Fox River*

There are 17 stormwater detention basins within the Direct Drainage to Fox River area. These detention basins are generally interspersed throughout the area. There are no perennial streams other than the Fox River itself (Figure 32).

Figure 32. Direct Drainage to Fox River watershed drainage system



2.6.2 Stormwater Detention Basins

Stormwater detention is accomplished by way of a variety of means. For example, most of the lakes that are the focus of this plan serve a stormwater detention function. Historic wetlands and ponds are now very often the recipients of stormwater that is expedited to such

depressional areas via culverts and other traditional gray infrastructure. Of these, some have no natural outlet while others spill downhill or are evacuated via a lift station. Yet other detention basins are purposefully built in conjunction with newer developments. Of this last type, some basins are normally dry (i.e., dry bottom) and others retain water virtually year round (i.e., wet bottom) unless designed as infiltration basins.

Some wetlands may not have direct stormwater inputs but receive overland flow from other waterbodies that receive piped stormwater. All things considered, the planning area appears to have 147 engineered features of the landscape that serve a stormwater detention role at a minimum (Table 21). Of this total, 46 are unassessed basins of which 18 could not be accessed.

Table 21. Summary of stormwater detention basin assessment in planning area.[49]

Location	*Number of Detent. Basins*	*Detention Basin Type*					*Water Quality Assessment*		
		Wet	*Dry*	*Wet-extended*	*Constr. wetland*	*Unas-sessed*	*Good*	*Fair*	*Poor*
Vil. of Volo	6	3	0	0	0	3	3	0	0
Vil. of Island Lake	26	10	5	2	4	5	9	2	10
Vil. of Wauconda	59	23	13	1	2	20	18	7	14
Vil. of Port Barrington	21	14	2	1	0	4	3	7	7
Vil. of Lk. Barrington	2	1	0	1	0	1	1	0	1
Vil. of Tower Lakes	1	0	0	0	0	1	0	0	0
Vil. of No. Barrington	1	0	0	0	0	1	0	0	0
Vil. of Hawthorn Woods	4	2	1	1	0	0	2	2	0
Wauconda Township	20	5	5	0	0	10	3	4	3
Cuba Township	5	1	2	1	1	0	4	0	1
Ela Township	1	0	0	0	0	1	0	0	0
Fremont Township	1	0	0	0	0	1	0	0	0
Nunda Township	0	0	0	0	0	0	0	0	0
Totals	**147**	**59**	**28**	**7**	**7**	**46**	**43**	**22**	**36**

In an attempt to first create a comprehensive inventory of detention basins, the most current database (2002) of such was obtained from the Lake County GIS Department.[50] These data were

[49] This accounting does not include any of the lakes that serve a stormwater detention role as noted in the narrative. Township locations indicate unincorporated areas.

[50] The Lake County Stormwater Management Commission has not conducted a current inventory of detention basins in the planning area as it has in other watersheds for which it has been the lead for developing a watershed plan.

either assigned to a known detention basin category or another category titled, "ponds with possible stormwater function." This latter category was field checked or verified by a local unit of government to determine if it was an engineered stormwater detention basin. Another category, "Detention Basins post-2002" (i.e., since the 2002 Lake Co. database was created) was crafted by comparing digital aerial imagery between 2001 and 2011. These too have been verified where possible.

For potential assessment of detention basin condition, relevant units of local government were approached for assistance. They were each asked the following questions:

1. Do you possess a comprehensive inventory of detention basins with your municipal boundaries?
2. If 'yes' to the above, does your inventory include identification of the responsible party?
3. Will you share these data with us?

This process of inquiry finds that virtually all of the detention basins are on private property. A homeowners association is typically the responsible party for maintenance. Municipal governments are very rarely responsible for maintenance or condition assessment/repair of a detention basin. Most communities had the information requested but only spread among numerous documents and maps and not organized for easy access and sharing as sought.

The number, type[51], condition, and location of detention basins have been determined for this plan (Figure 33). Unless something unique or unusual was obvious, condition for providing overall water quality benefits – good, fair, poor – is largely a function of detention basin type.

To assess the basins in the field, a "rapid assessment" was conducted based on protocols developed by the Lake County Stormwater Management Commission (LCSMC). A field assessment "short form" was prepared that condensed the "long form" used by LCSMC. The following aspects of each detention basin were assessed:

- Type of basin (wet, wet with extended dry detention, dry, constructed wetland)
- Side Slope Cover types (turf grass, native plants, invasive plants, rip rap)
- Side Slope Angle (horizontal : vertical)
- Buffer Width (native plants)
- Water's Edge Cover types (not applicable, turf grass, native/wetland plants, invasive plants, rip rap)
- Basin Bottom Cover types (unknown, turf grass, native/wetland plants, submersed aquatic vegetation, invasive plants, concrete-lined channel)
- Shoreline Erosion (not applicable, minimal, slight, moderate, high)
- Safety Shelf presence (yes/no/unknown) and Wetland Vegetation presence (yes/no)

[51] Four types of detention basins are noted: 1) dry bottom, most typically turf grass, 2) wet bottom, 3) wet bottom with an extended dry shelf, and 4) constructed wetland.

- Sediment Forebay presence (yes/no/unknown)
- Stilling Basin presence at Inlets and Outlets (yes/no/unknown)
- Short Circuiting (yes/no)
- Overall Water Quality Benefits Assessment (good, fair, poor)

Generally, basins providing "good" water quality benefits were either a) wet detention with a vegetated wetland shelf, native plant side slopes, and submersed aquatic vegetation, or b) constructed wetlands (Figure 34). Basins providing "fair" water quality benefits were generally either a) wet detention with a vegetated wetland shelf, turf grass side slopes, and possibly submersed aquatic vegetation, or b) dry detention containing a native vegetation waterway or bioswale, or a native vegetation pre-outlet area (Figure 35). Basins providing "poor" water quality benefits were typically either a) wet detention with turfgrass side slopes, no or minimum vegetated wetland shelf, and possibly short-circuiting, or b) dry detention with turfgrass bottom, possibly a concrete-lined channel, and/or possibly short circuiting (Figure 36).

Figure 33. Detention basin assessment in the 9 Lakes planning area.

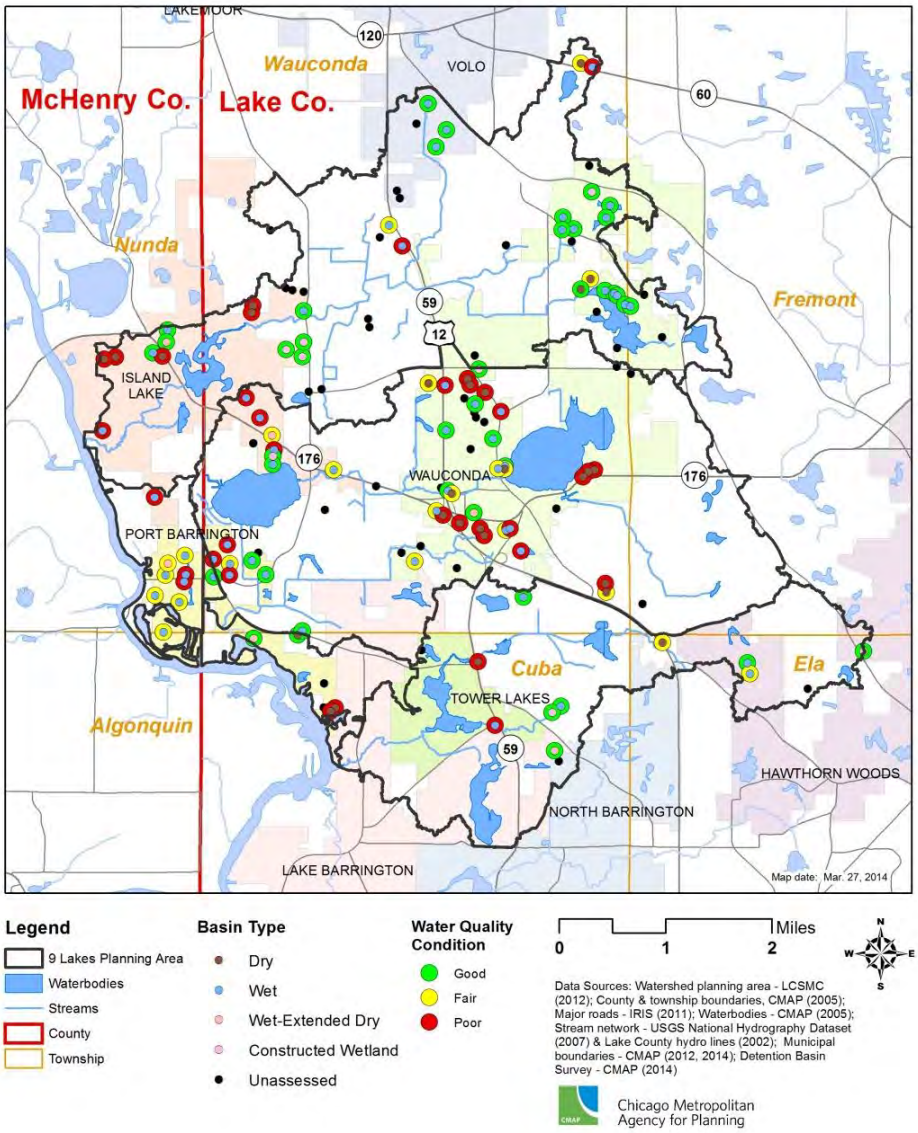


Figure 34. Examples of detention basins within the 9 Lakes planning area providing "good" water quality benefits.

Figure 35. Examples of detention basins within the 9 Lakes planning area providing "fair" water quality benefits.

Figure 36. Examples of detention basins in the 9 Lakes planning area providing "poor" water quality benefits.

Here, it is noted that there appears to be a disconnect between the role that stormwater detention basins play in the regulated community's stormwater management plans and the highly decentralized nature of ownership and/or maintenance responsibility. Impacts include little or no incentive on either party's part for retrofits that might be appropriate from a water quality improvement perspective. Anecdotally and beyond mowing a dry basin, a homeowners association has neither the means nor inclination to pay much attention to their special properties until such time as a problem occurs.

2.6.3 The 14 Subunits

As presented above, the 9 Lake planning area is comprised of three primary watersheds and an area of direct drainage to the Fox River. But given the plan's aim to improve the water quality of 9 lakes, a GIS-based modeling tool was applied during the planning process that further subdivided the planning area as described in the opening paragraph to Section 2.6. Figure 37 illustrates the 14 subunits and Table 22 lists them by size[52], ranked from largest to smallest. Information about each subunit is presented below, organized by the three primary watersheds and direct drainage area.

[52] The subunit area is calculated independent of any other 'upstream' subunit that might be part of the former subunit's larger watershed.

Figure 37. The planning area subdivided into 14 subunits.

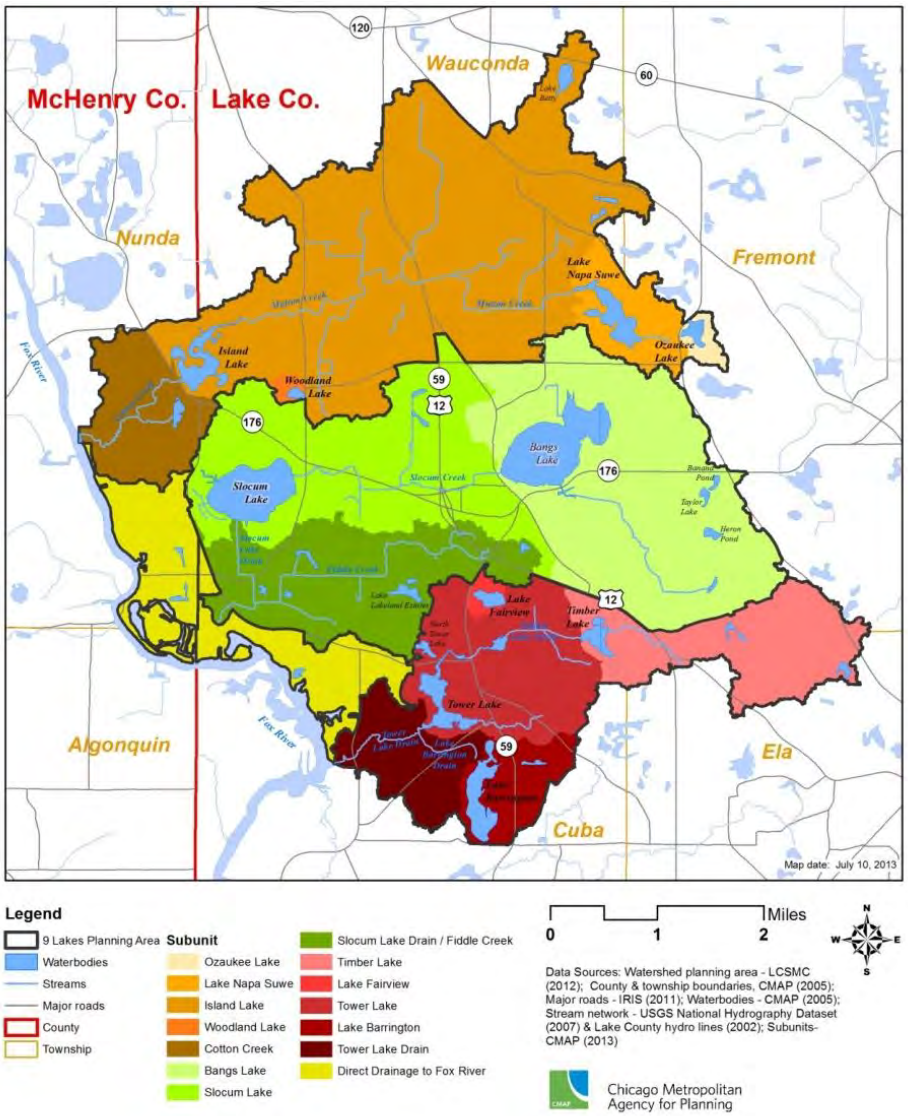


Table 22. Subunits within the 9 Lakes TMDL Planning Area.

Subunit	*Area (acres)*	*Area (sq. mi.)*	*Percent of Planning Area*
Ozaukee Lake	96.2	0.2	0.5
Lake Napa Suwe	524.9	0.8	2.8
Woodland Lake	46.5	0.07	0.2
Island Lake	5074.5	7.9	27.0
Cotton-Mutton Creek	778.7	1.2	4.1
Bangs Lake	3164.8	5.0	16.9
Slocum Lake	2433.3	3.8	13.0
Slocum Lake Drain / Fiddle Creek	1606.0	2.5	8.6
Timber Lake	1173.7	1.8	6.3
Lake Fairview	72.9	0.1	0.4
Tower Lake	1381.7	2.2	7.4
Lake Barrington	485.4	0.8	2.6
Tower Lake Drain	637.3	1.0	3.4
Direct Drainage to Fox River	1289.8	2.0	6.9

Cotton-Mutton Creek Watershed

2.6.3.1 Subunit #1 - Ozaukee Lake

Lake Location, Ownership, Use, and Morphometry

This impoundment lake sits in the far eastern, headwaters area of the Cotton-Mutton Creek Watershed in Freemont Township, unincorporated Lake County, and upstream of nearby Lake Napa Suwe. Formerly known as Drummond Lake, it is owned by the Lake County Forest Preserve District (LCFPD). Its entire watershed lies completely within LCFPD property – the McLean Woods and Wetlands Nature Preserve – which was dedicated by the Illinois Nature Preserves Commission as a state nature preserve in May 2012. Habitat is the lake's primary use. Ozaukee Lake's morphometric data is presented in Table 23.

Table 23. Ozaukee Lake morphometric information.

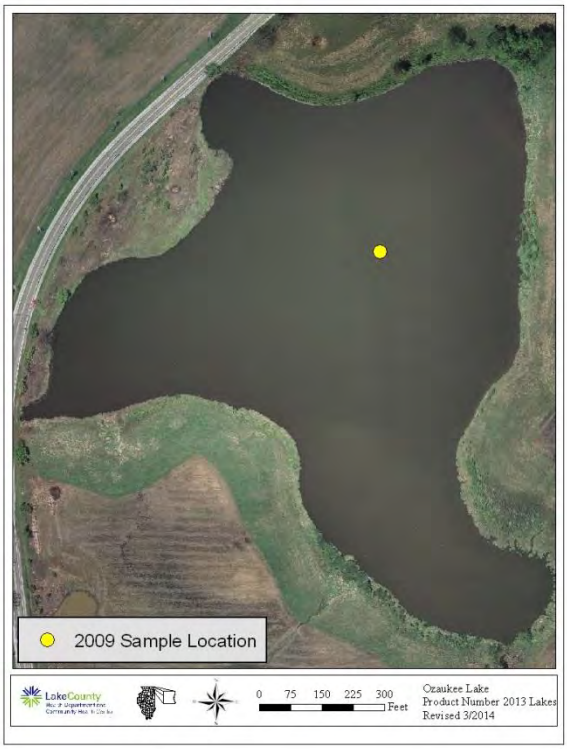
Illinois EPA lake code	IL_UTI
Surface Area[a]	20.4 ac
Maximum Depth[a]	3.0 ft
Average Depth[a]	1.6 ft
Volume (estimated)[a]	33.4 ac-ft
Shoreline Length[a]	0.9 mi
Lake Elevation[a]	804.0 ft above MSL
Watershed Area[b]	75.8 ac
Watershed to lake ratio	4:1
Average Water Residence Time / Flushing Time	0.44 yr (160 days) / 2.3 times per yr

[a] from 2009 Summary Report of Ozaukee Lake, Lake Co. Health Dept. (undated)
[b] determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area

Water Quality Conditions

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[53] is based on water sampling conducted at Ozaukee Lake by the Lake County Health Department (LCHD) Lakes Management Unit in 2002 and 2009. The monitoring site is centrally located in the deepest area of the lake (Figure 38). Ozaukee Lake exhibited very poor water quality conditions with low Secchi transparencies (average of less than one foot water clarity) and high total phosphorus, total suspended solids, total solids, and total volatile solids concentrations (two-year average of 0.186, 66.1 , 406, and 144 mg/L, respectively). A mean trophic state index ($TSI_{phosphorus}$) of 79 for the two monitoring seasons places Ozaukee Lake into the hypereutrophic category.

Figure 38. Water quality monitoring site location in Ozaukee Lake.



Dissolved oxygen levels remained adequate during the day (above 5 mg/L) during both monitoring seasons to support aquatic life. However, the planktonic algal blooms frequently seen in the lake, which were more prevalent in 2002 than in 2009, could lead to low D.O. concentrations overnight in association with nighttime respiration.

Conductivity measurements averaged 580 µS/cm in 2002 and 496 µS/cm in 2009. Chloride concentrations (which are one of the factors influencing conductivity readings) were measured in 2009 and were relatively low as would be expected for a largely undeveloped watershed, averaging 58 mg/L. Water quality parameter averages based on LCHD data[54] are provided in Table 24.

Aquatic plants were sparse, inhabiting only about five to six percent of the lake's area in 2009, a decrease from the 10 percent coverage recorded in 2002. The plants present consisted of the invasive, exotic species Eurasian water milfoil (*Myriophyllum spicatum*) and curlyleaf pondweed (*Potamogeton crispus*) along with the

[53] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA, 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012

[54] Mike Adam, Sr. Biologist, Lake County Health Dept. (LCHD), e-mail message with data attachment to author(s), February 2013.

native species coontail (*Ceratophyllum demersum*), sago pondplant (*Stukenia pectinata*), and duckweed (*Lemna spp*.).

Table 24. Average annual water quality characteristics for Ozaukee Lake.

IEPA lake code		IL_UTI	
Year		2002	2009
Parameter	*Units*	*Average*	
Secchi transparency	feet	0.81	0.51
	inches	10	6
Total Phosphorus (TP)	mg/L	0.151	0.220
Soluble Reactive Phosphorus (SRP)	mg/L	0.018	0.024[k]
Dissolved Phosphorus (DP)	mg/L	---	---
Total Kjeldahl Nitrogen (TKN)	mg/L	2.21	2.75
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	0.156[k]
Nitrate Nitrogen (NO_3)	mg/L	0.166[k]	---
Ammonia Nitrogen (NH_3)	mg/L	0.155[k]	0.210[k]
Total Suspended Solids (TSS)	mg/L	52.1	80.1
Volatile Suspended Solids (VSS)	mg/L	---	---
Total Solids (TS)	mg/L	426	385
Total Volatile Solids (TVS)	mg/L	163	124
Chloride (Cl)	mg/L	---	58
Conductivity	µS/cm	580	496
pH	units	8.27	8.83
Alkalinity	mg/L	167	149
Chlorophyll *a* (corrected)	µg/L	---	---

k = denotes that actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

LCHD's complete Ozaukee Lake 2002 and 2009 summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx).

Lakeshore Buffer Condition

During summer 2013, lakeshores were assessed by CMAP staff using a qualitative methodology that considered an area up to 15 feet inland from the shoreline and for the width of a coded segment. Segments are variable in width as they are typically based on land cover, parcel boundary, or a combination of both. Area percentages are estimated for each of five land cover categories: trees and shrubs, unmowed grasses and forbs, mowed turfgrass, beach, and impervious surface. Good condition was assessed when trees and shrubs, and unmowed grasses and forbs tallied greater than 60 percent. Fair condition was assessed when these same two categories averaged 50-60 percent and a poor condition was assessed when the combination of mowed turfgrass, beach, and impervious surface tallied 55 percent or more.

From a water quality perspective, lakeshore assessments are based largely on the assessment area's ability to filter and/or slow down overland flow and promote infiltration before surface runoff reaches the lake. Additionally, the presence of mowed turfgrass within the 15 feet buffer zone increases the likelihood that fertilizer and pesticides might be applied relatively close to the lake. It is acknowledged that landowners also value views, easy access to the shoreline, and other objectives.

For Ozaukee Lake, full details for each segment are featured in Appendix A. Here, a summary is provided in Table 25 and Figure 39.

Table 25. Ozaukee Lake 2013 lakeshore buffer condition assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Ozaukee Lake	1	4,945	4,945	100	0	0	0	0
a) from CMAP lake shoreline assessment for buffer zone condition (2013)								

Figure 39. Ozaukee Lake 2013 lakeshore buffer zone condition.

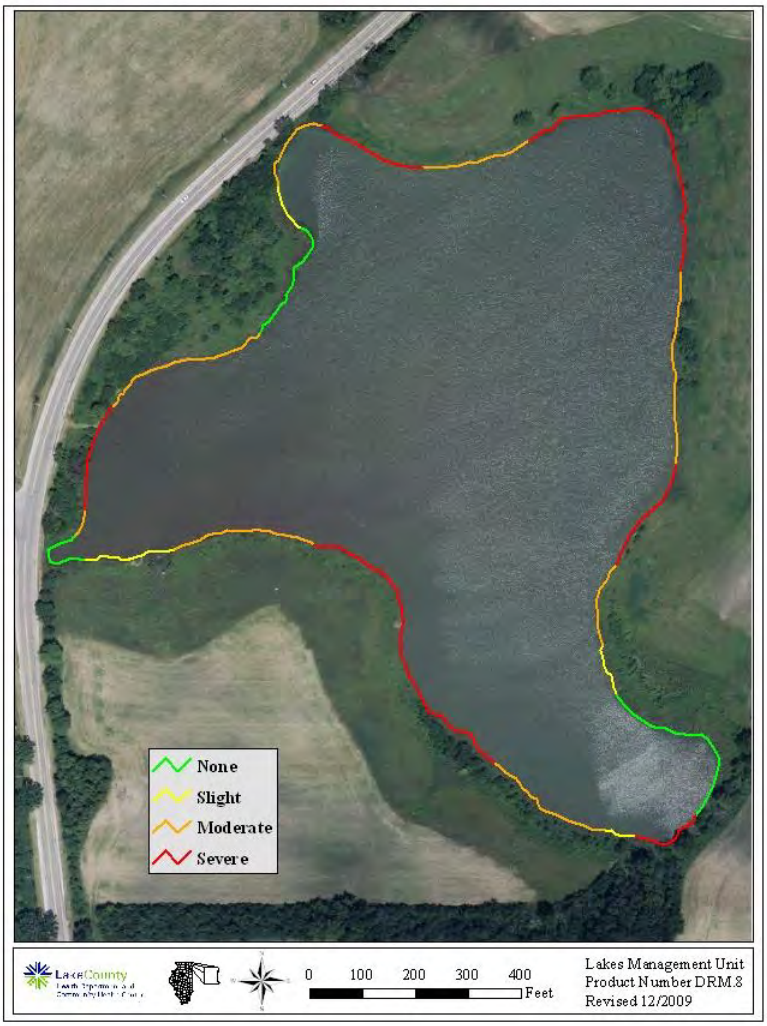
Shoreline Erosion Condition

Shoreline erosion assessments were conducted by the LCHD, Lakes Management Unit. Year of assessment varies by lake. For Ozaukee Lake, the 2009 assessment of shoreline erosion conditions revealed that about 85 percent of the shoreline had some degree of erosion: 40 percent severe, 36 percent moderate, and 9 percent slight (Table 26 and Figure 40).

Table 26. Ozaukee Lake 2009 shoreline erosion assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Ozaukee Lake	36	4,993	768	15.4	428	8.6	1,820	36.5	1,976	39.6
from Lake Co. Health Department lake shoreline erosion assessment GIS data (2009)										

Figure 40. Ozaukee Lake 2009 shoreline erosion condition.



The following information summarizes the land use, soil classifications and impervious surface cover within the Ozaukee Lake subunit.

Land Use

The Ozaukee Lake subunit is dominated by open space, which covers 78.8 percent of the subunit (Table 27). This open space is classified as primarily conservation space, which includes forest preserve land (Figure 41).

Figure 41. Land use distribution within Ozaukee Lake subunit.

Table 27. 2005 Land use distribution within Ozaukee Lake subunit.

Land Use Category	*Area (acres)*	*Area (sq. mi.)*	*Percent of Subunit*
Open Space	75.8	0.1	78.8
Water	20.5	0.03	21.3
Totals	96.2	0.2	100.0

Soils

The soils in the Ozaukee Lake subunit are predominantly "Not Hydric". "All Hydric" soils make up 24.8 percent of the watershed (Table 28), and are spatially dispersed below Ozaukee Lake (Figure 42).

Figure 42. Hydric soils within Ozaukee Lake subunit.

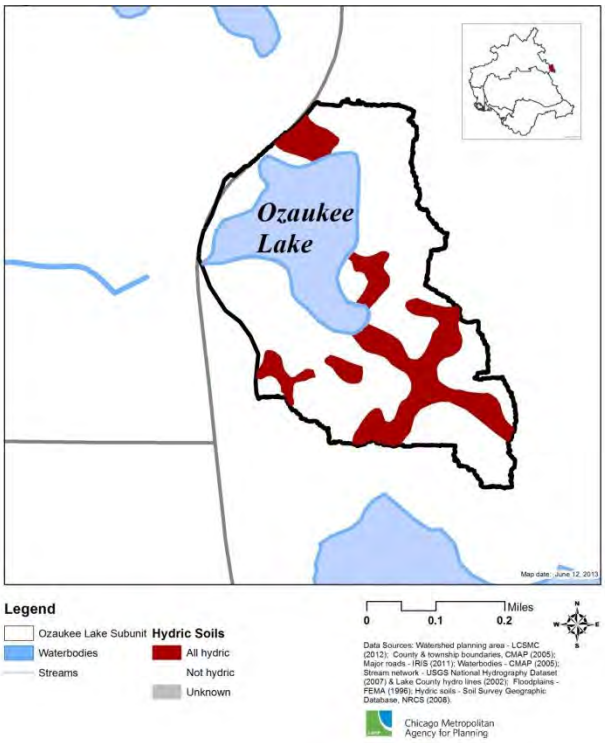


Table 28. Hydric soil acreage within Ozaukee Lake subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	130.4	24.8
Not hydric	330.1	62.9
Unknown	64.4	12.3

The dominant hydrologic soil group is Group C, comprising over 70 percent of the subunit (Table 29). Lake bottoms are considered Unclassified, therefore this category also makes up a significant portion of the subunit (22.1 percent; Figure 43).

Figure 43. Hydrologic soil groups within OzaukeLake subunit.

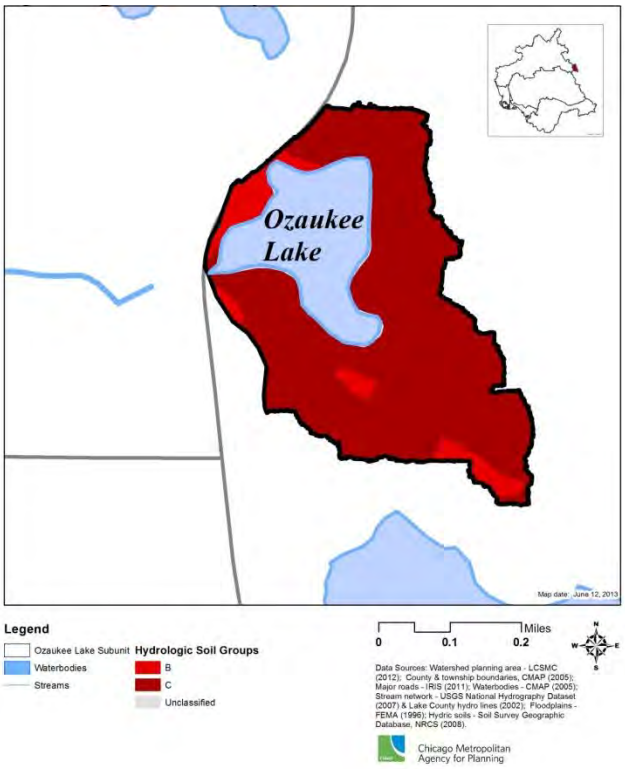


Table 29. Hydrologic soil groups within Ozaukee Lake subunit.

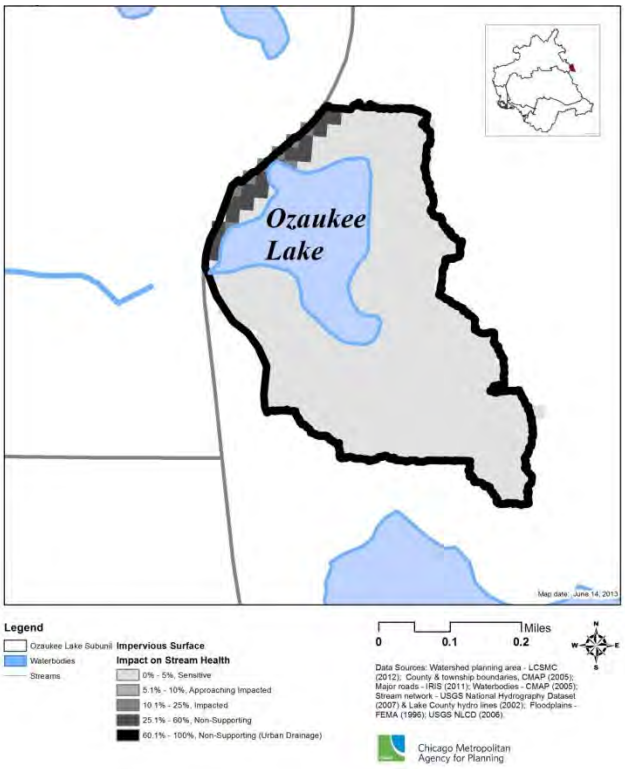
Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
B	7.5	7.8
C	67.4	70.1
Unclassified	21.3	22.1

Impervious Cover

Impervious surfaces cover approximately two percent of the Ozaukee Lake subunit. Due to this low level of imperviousness, the stream health in the subunit is classified as "Sensitive" (Figure 44 and Table 5, the latter is featured in subsection 2.4.1).

The projection for impervious surfaces implies that there will be no change within the Ozaukee Lake subunit by the year 2040 and stream health, therefore, will remain classified as "Sensitive."

Figure 44. Impervious cover within Ozaukee Lake subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment & Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads to Ozaukee Lake are found in Table 30.

Table 30. Ozaukee Lake subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chloride (lbs/yr)*	*CL (lbs /ac)*	*Nitrogen (lbs /yr)*	*N (lbs /ac)*	*Phosphor (lbs /yr)*	*P (lbs /ac)*	*Bact (bill col /yr)*	*Bact (bill col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1512 OTHER ROADWAY	0.1	0.3	55.5	431.7	0.9	6.7	0.1	1.0	0.3	2.0	117.0	910.1
3300 OPEN SPA/CONSR	75.6	32.0	81.3	1.1	62.6	0.8	13.4	0.2	46.2	0.6	2144.7	28.4
5200 LAKE/ RES/LAGOO	20.5	43.4	17685.4	863.8	55.3	2.7	3.7	0.2	29.3	1.4	176.9	8.6
Grand Totals	**96.2**	**75.7**	**17822.2**	**185.2**	**118.7**	**1.2**	**17.2**	**0.2**	**75.7**	**0.8**	**2438.6**	**25.3**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Ozaukee Lake's epilimnion[55] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[56] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 17 lbs/yr P from average annual land runoff (Table 30).[57]

Together with other model parameters set for Ozaukee Lake – mean depth: 1.64 ft (0.5 m); lake retention or residence time: 0.44 yr.[58]; surface area: 20.37 ac – the CB model predicted an average annual epilimnetic TP of 0.037 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that meets the applicable water quality standard.

Data available from samples taken from Ozaukee Lake reveal TP concentrations with an average of 0.186 mg/L over two growing seasons (2002, 2009).[59] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield the observed average TP concentration of 0.186 mg/L. This exercise resulted in an average influx of 226 lbs/yr, of which land runoff explains only 7.5 percent (17/226) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 24 lbs/yr. When compared to the estimated total influx of 226 lbs/yr, an 89 percent reduction in annual TP influxes (201 lbs/yr) will be needed. Because only 17 lbs/yr is contributed by land runoff, in-lake management practices will be required in addition to any on-the-ground BMPs implemented within the lake's watershed.

---

[55] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[56] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[57] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[58] Lake residence time is lake volume divided by avg. annual inflow. For Ozaukee Lake: 33.36 ac-ft / 76 ac-ft per yr = 0.439 yr. The reciprocal equation is "lake flushing time" or 2.28 times per year which is the value used in the CB model.

[59] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.2 Subunit #2 - Lake Napa Suwe

Lake Location, Ownership, Use, and Morphometry

This impounded, shallow slough lake is located in the eastern portion of the Cotton-Mutton Creek Watershed in southwestern Lake County, about 2,000 feet downstream from Ozaukee Lake. A majority of the lake lies within the Village of Wauconda with the remainder in unincorporated Wauconda Township. Lake bottom ownership is a mix of private individuals and organizations (homeowners associations). Residential lots surround much of the lake except for two parks, one owned by the Orchard Hills Homeowners Association and the other by the Apple Country Homeowners Association. The lake is used by its residents for fishing, aesthetics, and non-motorized boating. Water flows from lake over a spillway constructed at its northwestern-most point, flowing to Mutton Creek and Island Lake approximately 4 river miles downstream. Lake Napa Suwe's morphometric data is presented in Table 31.

Table 31. Lake Napa Suwe morphometric information.

Illinois EPA lake code	IL_STO
Surface Area[a]	85.3 ac
Maximum Depth[a]	3.5 ft
Average Depth[a]	1.4 ft
Volume (estimated)[a]	126.2 ac-ft
Shoreline Length[a]	4.6 mi
Lake Elevation[a]	789.8 ft above MSL
Watershed Area[b]	535.8 ac
Watershed to lake ratio	6:1
Average Water Residence Time / Flushing Time	0.21 yr (78 days) / 4.7 times per yr

[a)] from 2009 Summary Report of Lake Napa Suwe, Lake Co. Health Dept. (undated)
[b)] determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area

Water Quality Conditions

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[60] is based on water sampling conducted by the LCHD Lakes Management Unit in 2002 and 2009 at two locations, one near the lake's outlet at the northwest end and the other in the main body of the lake within its southern basin (Figure 45). In 2002, water quality was poor with low Secchi transparencies (average of less than 1 foot water clarity) and high total phosphorus, total suspended solids, total solids, and total volatile solids concentrations (average of 0.217, 52, 652, and 200 mg/L, respectively, between the two monitoring sites). In 2009, water quality conditions were better with an average Secchi transparency of 2.25 feet and total phosphorus, total

[60] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA, 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012

suspended solids, total solids, and total volatile solids average concentrations of 0.063, 19, 405, and 102 mg/L, respectively, between the two sites. Overall, Lake Napa Suwe is a hypereutrophic to eutrophic to lake system as indicated by its trophic state index ($TSI_{phosphorus}$) of 83 in 2002 and 62 in 2009.

Figure 45. Water quality monitoring site locations in Lake Napa Suwe.

Dissolved oxygen levels remained adequate during the day (above 5 mg/L) during both monitoring seasons to support aquatic life. However, the planktonic algal blooms frequently seen in the lake, which were nearly constant in 2002 as compared to 2009, could lead to low D.O. concentrations overnight in association with nighttime respiration.

Conductivity measurements averaged 968 µS/cm in 2002 and 952 µS/cm in 2009 for both monitoring sites together. Chloride concentrations (which are one of the factors influencing conductivity readings) were measured in 2009 and averaged 106 mg/L between the two monitoring sites, lower than the 145 mg/L median for Lake County lakes. Water quality parameter averages based on LCHD data[61] are provided in Table 32.

An increase in Lake Napa Suwe's rooted aquatic plant population between 2002 and 2009 likely contributed to the improvement in water clarity, decreased nutrient concentrations, decreased turbidity, and reduction in nuisance algal blooms (Table 32). In 2002, only about 10 percent of the lake was inhabited by aquatic plants, while in 2009, coverage reached 99 percent. In 2002, nine species were documented while in 2009, seven species were found, dominated by coontail (*Ceratophyllum demersum*), the invasive exotic Eurasian water milfoil (*Myriophyllum spicatum*), and watermeal (*Wolffia columbiana).*

LCHD's complete Lake Napa Suwe 2002 and 2009 summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). LCHD's 2013 Lake Napa Suwe summary report is expected to be added to this website in 2014.

[61] Mike Adam, Sr. Biologist, Lake County Health Dept. (LCHD), e-mail message with data attachment to author(s), February 2013.

Table 32. Average annual water quality characteristics for Lake Napa Suwe.

IEPA lake code		IL_STO			
Year		2002		2009	
Parameter	*Units*	*Southern basin*	*Near-outlet*	*Southern basin*	*Near-outlet*
Secchi transparency	feet	0.98	0.81	2.25	2.00
	inches	12	10	27	24
Total Phosphorus (TP)	mg/L	0.203	0.230	0.069	0.057
Soluble Reactive Phosphorus (SRP)	mg/L	0.006[k]	0.015[k]	0.005[k]	0.012[k]
Dissolved Phosphorus (DP)	mg/L	---	---	---	---
Total Kjeldahl Nitrogen (TKN)	mg/L	2.85	3.50	1.46	1.29
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	---	0.050[k]	0.050[k]
Nitrate Nitrogen (NO_3)	mg/L	0.050[k]	0.051[k]	---	---
Ammonia Nitrogen (NH_3)	mg/L	0.128[k]	0.235[k]	0.100[k]	0.100[k]
Total Suspended Solids (TSS)	mg/L	43.4	60.4	12.1	26.4
Volatile Suspended Solids (VSS)	mg/L	---	---	---	---
Total Solids (TS)	mg/L	653	652	412	398
Total Volatile Solids (TVS)	mg/L	201	198	98	105
Chloride (Cl)	mg/L	---	---	105	107
Conductivity	µS/cm	975	961	664	639
pH	units	8.18	7.90	9.12	9.53
Alkalinity	mg/L	227	232	145	124
Chlorophyll *a* (corrected)	µg/L	---	---	---	---

k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

Lakeshore Buffer Condition

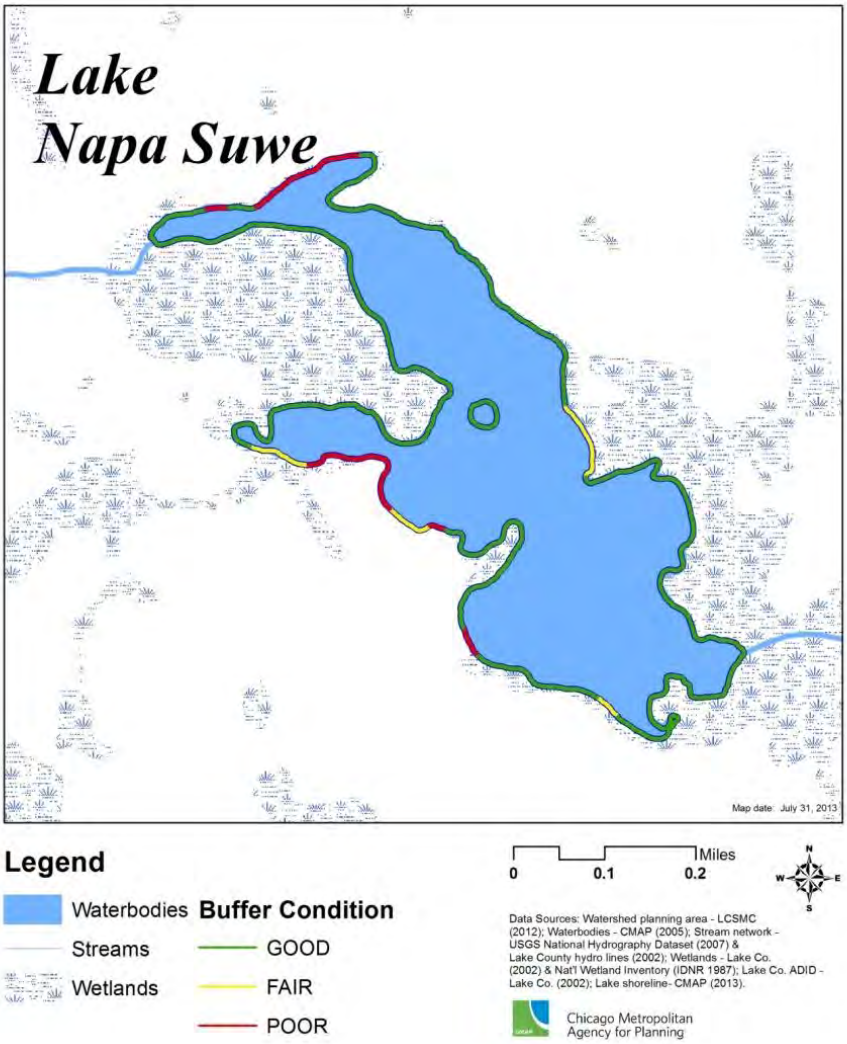
An explanation of the lakeshore buffer condition assessment methodology is provided under the Ozaukee Lake section.

A summary of Lake Napa Suwe's lakeshore buffer condition assessment is provided here in Table 33 and Figure 46. Full details for each segment are provided in Appendix A.

Table 33. Lake Napa Suwe 2013 lakeshore buffer condition assessment summary.

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Lake Napa Suwe	37	17,190	14,140	82.4	1,525	8.8	1,525	8.8
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 46. Lake Napa Suwe 2013 lakeshore buffer condition.



Shoreline Erosion Condition

LCHD's 2013 assessment of shoreline erosion conditions indicated that about 21 percent had some degree of erosion: two percent severe, eight percent moderate, and 11 percent slight (Table 34, Figure 47).

Table 34. Lake Napa Suwe 2013 shoreline erosion assessment summary.

Lake Name	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Lake Napa Suwe	19,751	15,521.3	78.6	2,238	11.3	1,555	7.9	436	2.2
from Lake Co. Health Department lake shoreline erosion assessment GIS data (2013)									

Figure 47. Lake Napa Suwe 2013 shoreline erosion condition.

Figure provided by Lake County Health Dept. (2014)

Land Use

Land use in the Lake Napa Suwe subunit, consisting of 525 acres, is dominated by residential use that characterizes over 50 percent of the area (Table 35) and is concentrated around Lake Napa Suwe (Figure 48). A significant expanse of open space extends throughout the southeast portion of the subunit, and an expanse of wetland borders the southeast section of Lake Napa Suwe. Other land use types are minimal within the study area.

Figure 48. Land use within Lake Napa Suwe subunit.

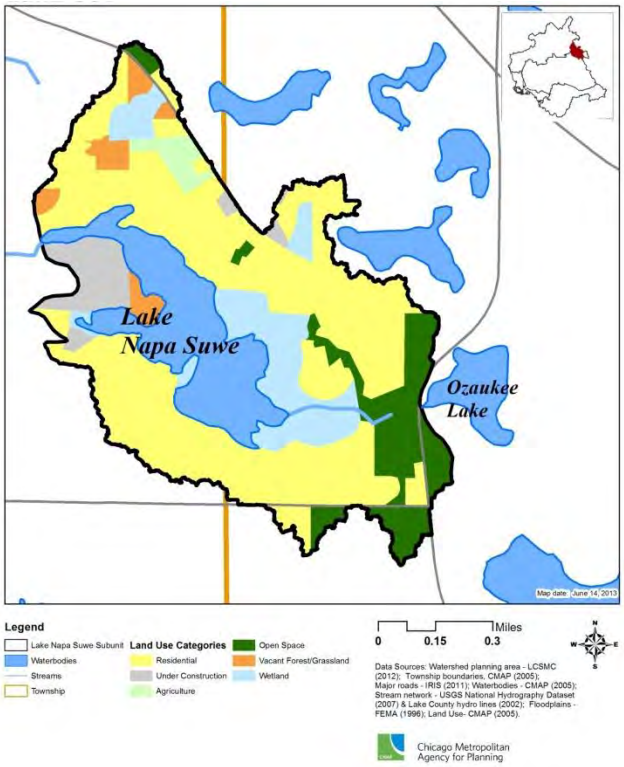


Table 35. 2005 Land use distribution within Lake Napa Suwe subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	273.1	0.4	52.0
Under Construction	27.2	0.04	5.2
Agriculture	9.4	0.01	1.8
Open Space	59.1	0.09	11.3
Vacant Forest/Grassland	16.6	0.03	3.2
Wetland	60.2	0.09	11.4
Water	79.3	0.1	15.1
Total	524.9	0.8	100.0

Soils

Soils within the Lake Napa Suwe subunit are predominantly "Not Hydric." Soils considered "All Hydric" make up 24.8 percent of the subunit, and are primarily concentrated below Lake Napa Suwe (Table 36, Figure 49).

Figure 49. Hydric soils within Lake Napa Suwe subunit.

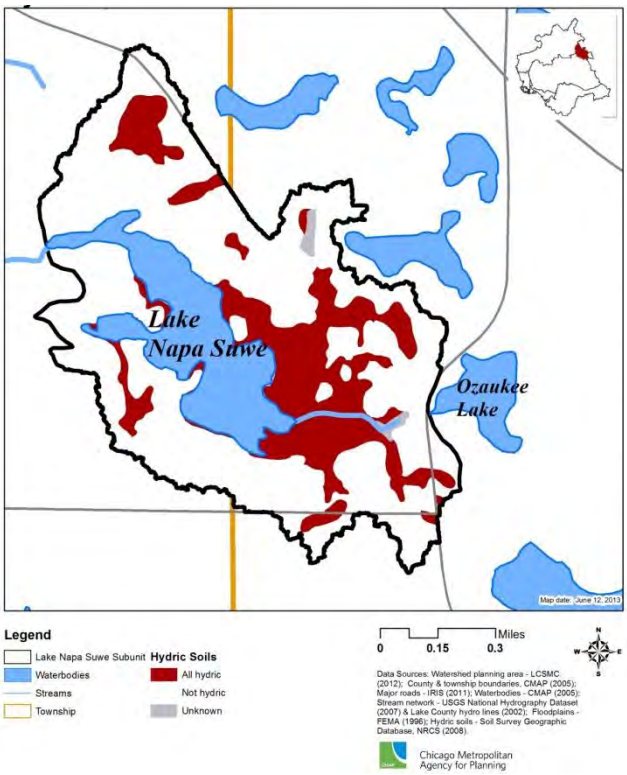


Table 36. Hydric soil acreage within Lake Napa Suwe subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	130.4	24.8
Not hydric	330.1	62.9
Unknown	64.4	12.3

The major hydrologic soil group in the Lake Napa Suwe subunit is Group C, this classification characterizes 57 percent of the subunit (Table 37). An extensive area of C soils is located west and north of Lake Napa Suwe (Figure 50).

Figure 50. Hydrologic soil groups within Lake Napa Suwe subunit.

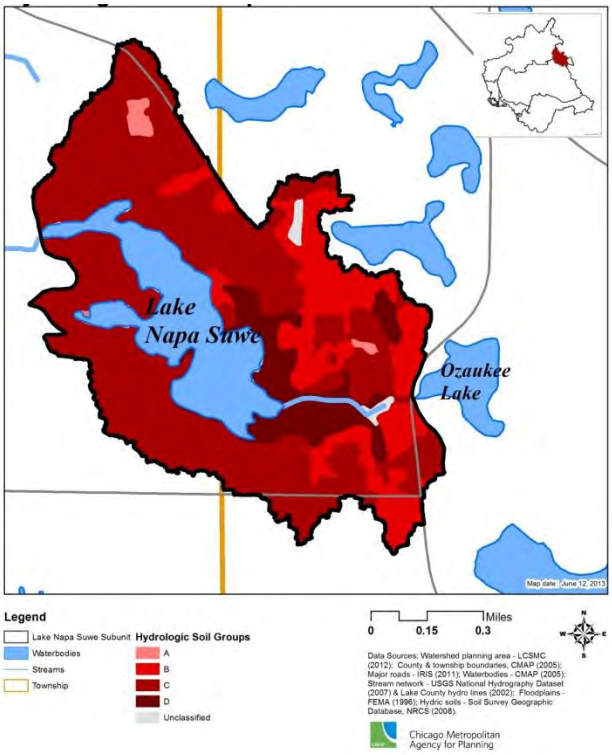


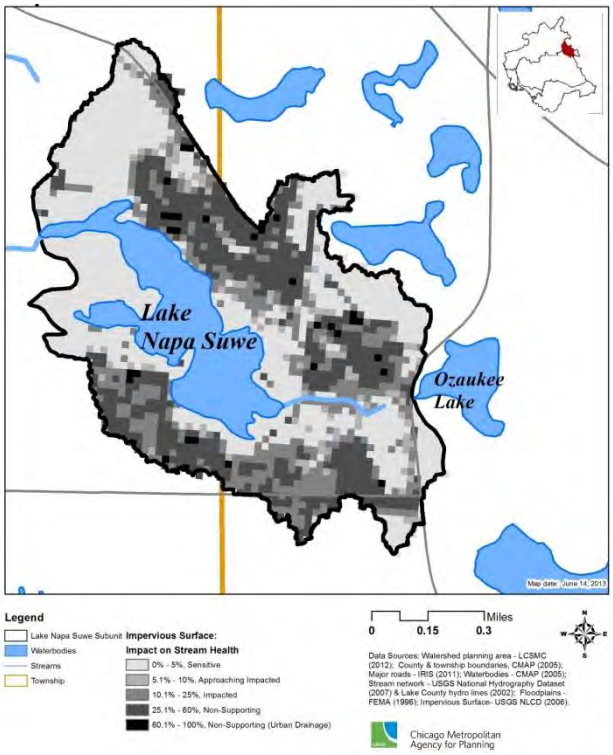
Table 37. Hydrologic soil groups within LakeNapa Suwe subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	9.1	1.7
B	1.3	17.4
C	299.6	57.1
D	60.5	11.5
Unclassified	64.4	12.3

Impervious Cover

The estimated impervious surface coverage in the Lake Napa Suwe subunit is 13.9 percent, a figure derived from the National Land Cover Dataset (Figure 51). This level of imperviousness translates to a stream health classification of "Impacted" within the subunit. Future impervious surface projections suggest that the Lake Napa Suwe subunit will be comprised of 15.6 percent imperviousness by the year 2040. This increase is relatively slight, and therefore the stream health category for the study area remains "Impacted."

Figure 51. Impervious cover in Lake Napa Suwe subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment & Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads to Lake Napa Suwe are found in Table 38.

Table 38. Lake Napa Suwe subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chloride (lbs/yr)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos-phor. (lbs /yr)*	*P (lbs /ac)*	*Bac. (bill col /yr)*	*Bac (bil col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	260.0	216.0	41164.8	158.3	1157.2	4.5	126.6	0.5	1316.4	5.1	67792.5	260.7
1120 RES/FARM	3.3	2.2	154.3	47.1	6.7	2.1	0.9	0.3	7.8	2.4	278.2	85.0
1512 OTHR ROADWAY	3.2	6.9	1687.5	520.8	26.2	8.1	3.9	1.2	7.7	2.4	3557.5	1098.0
2100 CROP/ GRAIN/ GRAZING	0.4	0.3	0.4	0.9	2.8	7.0	0.2	0.5	1.4	3.5	76.7	190.1
2400 EQUESTRI	0.1	0.1	0.0	0.7	0.4	5.1	0.0	0.4	0.2	2.6	9.5	137.5
3100 OPEN SPA/RECRE	1.2	0.7	2.0	1.7	2.7	2.3	0.7	0.6	2.3	1.9	113.4	96.2
3300 OPEN SPA/CONS	49.9	17.6	40.0	0.8	30.8	0.6	6.6	0.1	22.7	0.5	1055.2	21.1
3400 OPEN SPA/PRIVA	43.5	17.7	39.4	0.9	30.3	0.7	6.5	0.1	22.3	0.5	1037.9	23.9
3500 OPEN SPA/CORRI	4.8	1.7	2.5	0.5	1.9	0.4	0.4	0.1	1.4	0.3	64.9	13.4
4110 VAC FOR/GRASS	13.5	6.7	10.9	0.8	16.8	1.2	1.6	0.1	6.2	0.5	575.6	42.6
4120 WETLAND	59.9	50.1	141.3	2.4	108.7	1.8	1.6	0.0	30.9	0.5	124.3	2.1
5200 LAKE/ RES/LAGO	85.0	180.1	66981.4	788.2	209.3	2.5	14.0	0.2	110.9	1.3	669.8	7.9
Grand Totals	**524.9**	**500.1**	**110224.5**	**210.0**	**1593.9**	**3.0**	**162.8**	**0.3**	**1530.2**	**2.9**	**75355.4**	**143.6**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Lake Napa Suwe's epilimnion[62] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[63] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 164 lbs/yr P from average annual land runoff (Table 38 + estimated P export of 1 lb/yr from Ozaukee Lake).[64]

Together with other model parameters set for Lake Napa Suwe—mean depth: 1.44 ft (0.44 m); lake retention or residence time: 0.21 yr.[65]; surface area: 85.3 ac—the CB model predicted an average annual epilimnetic TP of 0.048 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that meets the applicable water quality standard.

Data available from samples taken from Lake Napa Suwe reveal TP concentrations with an average of 0.144 mg/L over two growing seasons (2002, 2009).[66] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield the observed average TP concentration of 0.144 mg/L. This exercise resulted in an average influx of 761 lbs/yr, of which land runoff explains only 22 percent (164/761) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 159 lbs/yr. When compared to the estimated total influx of 761 lbs/yr, a 79 percent reduction in annual TP influxes (602 lbs/yr) will be needed. Because only 164 lbs/yr is contributed by land runoff, in-lake management practices will be required in addition to any on-the-ground BMPs implemented within the lake's watershed.

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[62] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[63] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[64] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[65] Lake residence time is lake volume divided by avg. annual inflow. For Lake Napa Suwe: 123.2 ac-ft / 576 ac-ft per yr = 0.2139 yr. The reciprocal equation is "lake flushing time" or 4.68 times per year which is the value used in the CB model.

[66] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.3 Subunit #3 - Woodland Lake

Lake Location, Ownership, Use, and Morphometry

This small lake is located in the southwest quadrant of the Cotton-Mutton Creek Watershed, approximately ¾ miles to the east-southeast of Island Lake, in unincorporated Wauconda Township. While its exact origin is unknown, it may be a dug marsh[67]. The lake bottom is owned by the individual residential landowners surrounding it. The lake is used by the residents for aesthetic enjoyment, fishing, swimming, and no- or low-power boating (electric trolling motors). The lake outflows at its southeastern end to a tributary to Mutton Creek. Woodland Lake's morphometric data is presented in Table 39.

Table 39. Woodland Lake morphometric information.

Illinois EPA lake code	IL_STV
Surface Area[a]	7.7 ac
Maximum Depth[a]	7.5 ft
Average Depth (estimated)[a]	3.8 ft
Volume (estimated)[a]	28.9 ac-ft
Shoreline Length[a]	0.5 mi
Lake Elevation[a]	785 ft above MSL
Watershed Area[b]	38.8 ac
Watershed to lake ratio	5:1
Average Water Residence Time / Flushing Time	0.61 yr (224 days) / 1.6 times per yr

a) From 2004 Summary Report of Woodland (Highland) Lake, LCHD (2005).
b) Determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area.

Water Quality Conditions

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[68] is based on water sampling conducted by the LCHD–Lakes Management Unit in 2004. Sampling was conducted at a central in-lake location (Figure 52). The lake exhibited degraded water quality conditions with low Secchi transparencies (average of 1.72 feet of water clarity) and high total phosphorus, total suspended solids, and total volatile solids concentrations (average of 0.0.099, 21, and 63 mg/L, respectively). A trophic state index ($TSI_{phosphorus}$) of 70 places Woodland Lake into the hypereutrophic category.

Daytime dissolved oxygen levels remained adequate for the support of aquatic life throughout the water column (above 5 mg/L) except on one occasion in the bottom two feet of the lake on

[67] LCHD. *2004 Summary Report of Woodland (Highland) Lake*, by Adam, M., M. Colwell, C. Sanders, J. Wudi, M. Pfister. Waukegan, IL: LCHD 2005. http://health.lakecountyil.gov/Population/LMU/Lakes/WoodlandLake.pdf.

[68] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012.

the August 2004 monitoring date. Conductivity measurements averaged 453 µS/cm. Chloride concentrations were not assessed in 2004. Water quality parameter averages calculated from LCHD data[69] are provided in Table 40.

Very few aquatic plants were present in the lake, and only of three species: the exotic invasive curlyleaf pondweed (*Potamogeton crispus*) and the natives leafy pondplant (*Potamogeton foliosus*) and watermeal (*Wolffia columbiana*). Historically, management activities against rooted aquatic were conducted using aquatic herbicides and triploid grass carp (stocked in the mid-1980s). In the early 2000s, the lake apparently shifted to an algae-dominated system, and algicide applications have been made on a nearly annual basis.[70]

Figure 52. Water quality monitoring site location in Woodland Lake.

LCHD's complete Woodland Lake 2004 summary report can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). LCHD's 2013 Woodland Lake summary report is expected to be added to this website in 2014.

[69] Mike Adam, Sr. Biologist, LCHD, email message with data attachment to author(s), February 13, 2013.

[70] LCHD. *2004 Summary Report of Woodland (Highland) Lake*, by Adam, Michael, M. Colwell, C. Sanders, J. Wudi, M. Pfister. Waukegan, IL: LCHD 2005. http://health.lakecountyil.gov/Population/LMU/Lakes/WoodlandLake.pdf.

Table 40. Average annual water quality characteristics for Woodland Lake.

	IEPA lake code	IL_STV
	Year	2004
Parameter	*Units*	*Average*
Secchi transparency	feet	1.72
	inches	21
Total Phosphorus (TP)	mg/L	0.099
Soluble Reactive Phosphorus (SRP)	mg/L	0.005[k]
Dissolved Phosphorus (DP)	mg/L	---
Total Kjeldahl Nitrogen (TKN)	mg/L	1.34
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---
Nitrate Nitrogen (NO_3)	mg/L	0.050[k]
Ammonia Nitrogen (NH_3)	mg/L	0.113[k]
Total Suspended Solids (TSS)	mg/L	21.2
Volatile Suspended Solids (VSS)	mg/L	---
Total Solids (TS)	mg/L	285
Total Volatile Solids (TVS)	mg/L	63
Chloride (Cl)	mg/L	---
Conductivity	µS/cm	453
pH	units	8.45
Alkalinity	mg/L	110
Chlorophyll *a* (corrected)	µg/L	---

k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

Lakeshore Buffer Condition

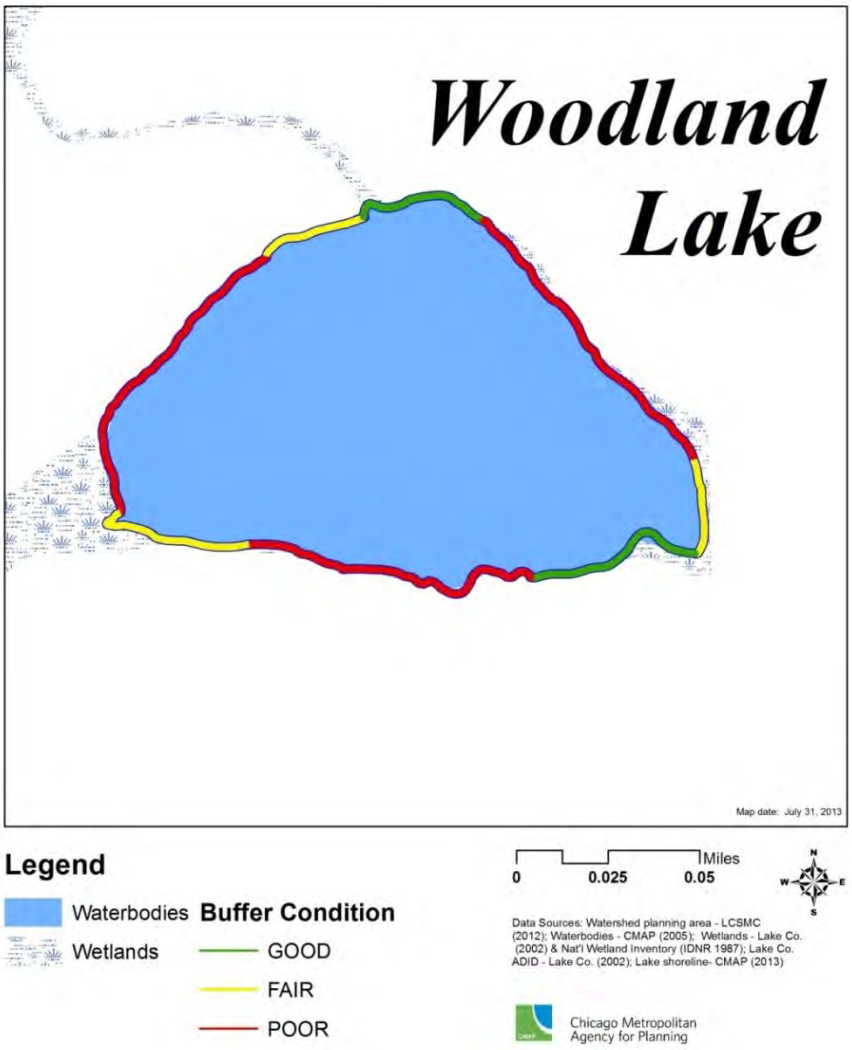
An explanation of the lakeshore buffer condition assessment methodology is provided under the Ozaukee Lake section.

A summary of Woodland Lake's lakeshore buffer condition assessment is provided here in Table 41 and Figure 53. Full details for each segment are provided in Appendix A.

Table 41. Woodland Lake 2013 lakeshore buffer condition assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Woodland Lake	12	2405	1010	42.0	365	15.2	1030	42.8
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 53. Woodland Lake 2013 lakeshore buffer zone condition.



Shoreline Erosion Condition

LCHD's 2013 assessment of shoreline erosion conditions indicated that about 11 percent had some degree of erosion: one percent moderate and ten percent slight (Table 42, Figure 54).

Table 42. Woodland Lake 2013 shoreline erosion assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Woodland Lake	13	2,387	2,120	88.8	239	10	28	1.2	0	0
from Lake Co. Health Department lake shoreline erosion assessment GIS data (2014)										

Figure 54. Woodland Lake 2013 shoreline erosion condition.

Land Use

The majority of land use within the 46.5 acre Woodland Lake subunit is residential (Table 43). The lake itself covers the balance of the subunit area (Figure 55).

Figure 55. Land use within Woodland Lake subunit.

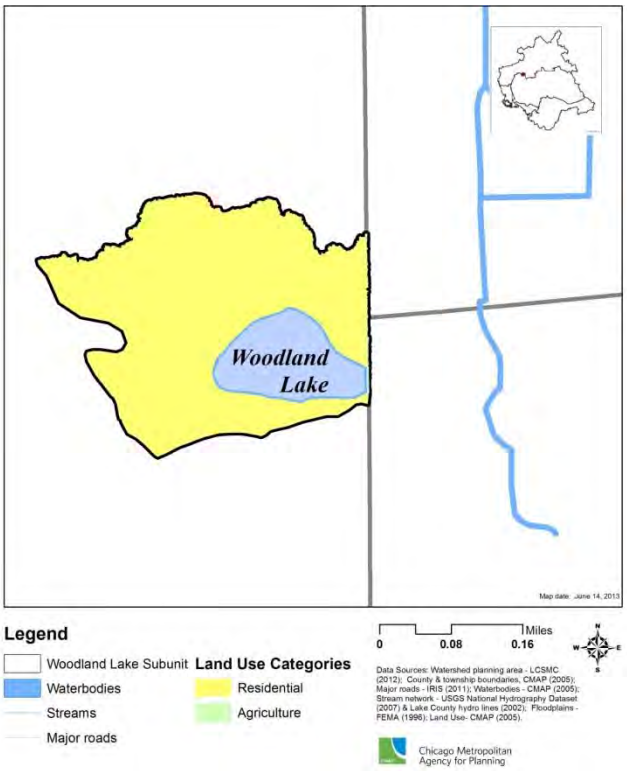


Table 43. 2005 Land use distribution within Woodland Lake subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	38.4	0.06	82.6
Agriculture	0.2	<0.01	0.4
Water	7.9	0.01	17.0
Totals	46.5	0.07	100.0

Soils

Soils within the Woodland Lake subunit are predominantly "Not Hydric" (Table 44). "All Hydric" soils are present in small portions west of Woodland Lake (Figure 56).

Figure 56. Hydric soils within Woodland Lake subunit.

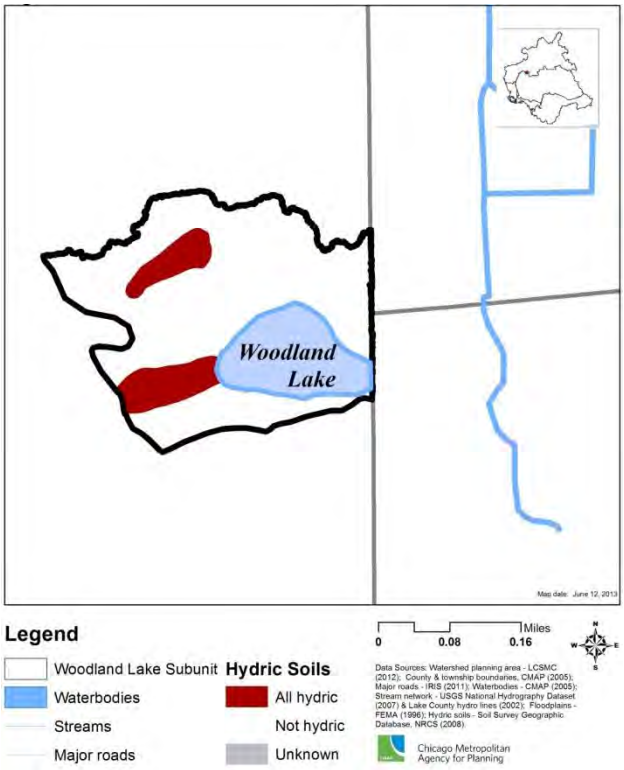


Table 44. Hydric soil acreage within Woodland Lake subunit.

Hydric Soil Class	*Area (Acres)*	*Percent of Subunit*
All hydric	5.2	11.2
Not hydric	33.9	72.9
Unknown	7.4	15.9

The dominant hydrologic soil group in the subunit are Group C soils (Table 45 and Figure 57).

Figure 57. Hydrologic soil groups within Woodland Lake subunit.

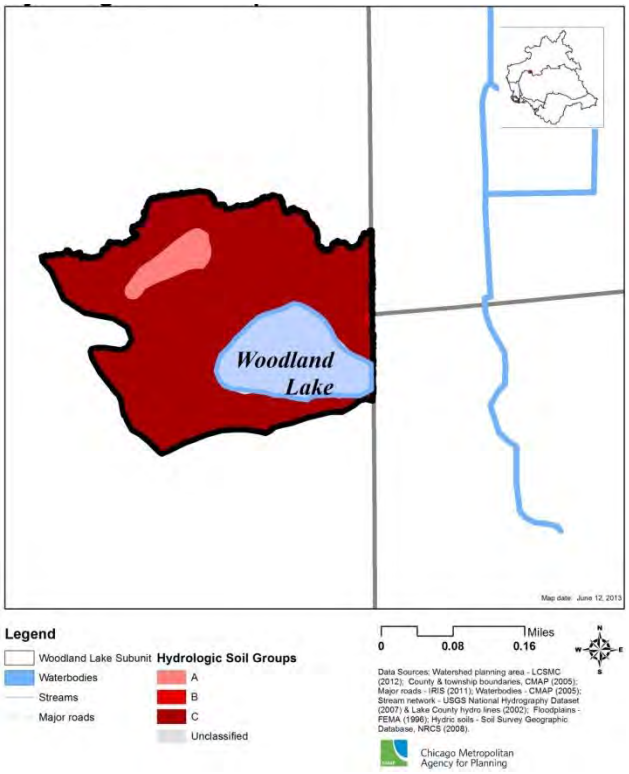


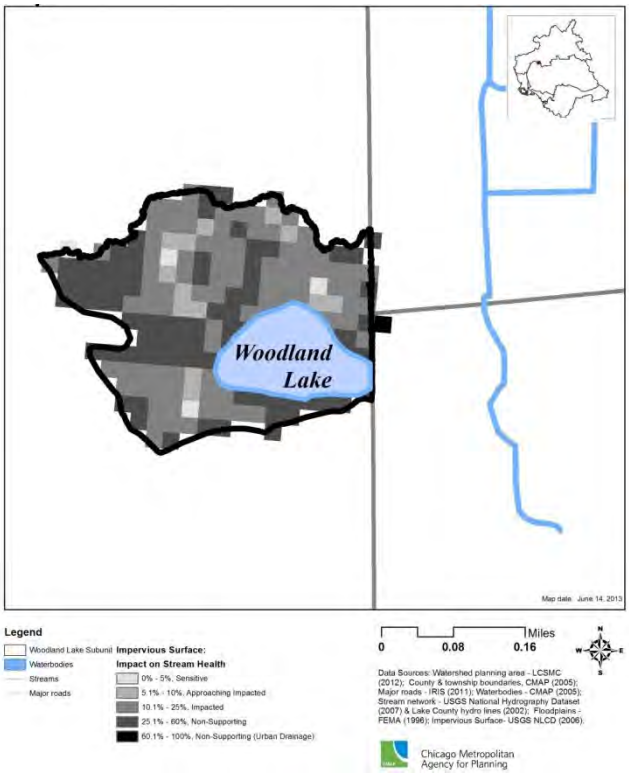
Table 45. Hydrologic soil groups within Woodland Lake subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	2.1	4.6
B	0.1	0.2
C	36.9	79.3
Unclassified	7.38	15.9

Impervious Cover

Calculations from the National Land Cover Dataset demonstrate that 23.6 percent of the Woodland Lake subunit is comprised of impervious surfaces (Figure 58). This is the second highest degree of imperviousness within the 9 Lakes Planning Area subunits. Subsequently, the stream health within the Woodland Lake subunit is considered "Impacted" (Table 5). Future impervious surface projections estimate that the Woodland Lake subunit will be increase its impervious surfaces by 0.1 percent by 2040 and thus, maintain its stream health class as "Impacted."

Figure 58. Impervious cover within Woodland Lake subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment & Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for the Woodland Lake subunit are found in Table 46.

Table 46. Woodland Lake subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs/yr)*	*CL (lbs/ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos-phor. (lbs /yr)*	*P (lbs /ac)*	*Bac. (bill col /yr)*	*Bac. (bill col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	37.5	28.3	5055.4	134.8	177.8	4.7	21.5	0.6	196.9	5.3	8421.7	224.6
1512 OTHER ROADWAY	0.0	0.0	10.3	1065.4	0.2	16.6	0.0	2.4	0.0	4.9	21.7	2246.0
2100 CROP/ GRAIN/ GRAZING	0.1	0.1	0.3	2.6	2.7	20.5	0.2	1.7	0.4	3.0	507.7	3838.7
3400 OPEN SPA/PRIVAT	0.0	0.0	0.0	0.8	0.0	0.6	0.0	0.1	0.0	0.5	0.2	21.0
5200 LAKE/ RES/LAGOO	8.8	18.7	7359.8	833.6	23.0	2.6	1.5	0.2	12.2	1.4	73.6	8.3
Grand Totals	**46.5**	**47.1**	**12425.8**	**267.3**	**203.7**	**4.4**	**23.2**	**0.5**	**209.5**	**4.5**	**9024.9**	**194.2**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Woodland Lake's epilimnion[71] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[72] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 23 lbs/yr P from average annual land runoff (Table 46).[73]

[71] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[72] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[73] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

Together with other model parameters set for Woodland Lake—mean depth: 3.75 ft (1.14 m); lake retention or residence time: 0.61 yr.[74]; surface area: 7.7 ac—the CB model predicted an average annual epilimnetic TP of 0.060 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that exceeds the applicable water quality standard.

Data available from samples taken from Woodland Lake reveal TP concentrations with an average of 0.099 mg/L over one growing season (2004).[75] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield the observed average TP concentration of 0.099 mg/L. This exercise resulted in an average influx of 50 lbs/yr, of which land runoff explains about 46 percent (23 / 50) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 17 lbs/yr. When compared to the estimated total influx of 50 lbs/yr, a 67 percent reduction in annual TP influxes (33 lbs/yr) will be needed. Because only 23 lbs/yr is contributed by land runoff, in-lake management practices will likely be required in addition to any on-the-ground BMPs implemented within the lake's watershed.

[74] Lake residence time is lake volume divided by avg. annual inflow. For Woodland Lake: 28.9 ac-ft / 47 ac-ft per yr = 0.615 yr. The reciprocal equation is "lake flushing time" or 1.63 times per year which is the value used in the CB model.

[75] Samples taken over just one growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.4 Subunit #4 - Island Lake

Lake Location, Ownership, Use, and Morphometry

Island Lake (IL_RTZT) is located in the western quarter of the Cotton-Mutton Creek Watershed on the Lake-McHenry County border within the Village of Island Lake. Mutton Creek enters the lake at its northeast corner and exits as Cotton Creek over the dam along the lake's southwest shoreline. There are differing accounts of the lake's origin. One indicates that Island Lake was initially created in 1940 by placing a 12 foot high fill across Cotton Creek, flooding a large slough area[76]. Another account states that the lake originated as a gravel pit and was dammed in the early 1930s to create the lake, and soon thereafter land around the lake was sold for residential development[77]. Once an organizationally-owned lake, the lake has been publicly-owned and managed by the Village of Island Lake since the early 1980s[78].

The lake is used recreationally for fishing, swimming, boating (Village boat sticker required), and aesthetic enjoyment. There are a number of parks, beaches, and boat launches. Island Lake's morphometric data is presented in Table 47.

Table 47. Island Lake morphometric information.

Illinois EPA lake code	IL_RTZI
Surface Area[a]	83.8 ac
Maximum Depth[a]	9.8 ft
Average Depth[a]	5.3 ft
Volume[a]	443.3 ac-ft
Shoreline Length[a]	4.0 mi
Lake Elevation[a]	750.14 ft above MSL
Watershed Area[b]	5,658.3 ac
Watershed to lake ratio	68:1
Average Water Residence Time / Flushing Time	0.09 yr (34 days) / 10.6 times per yr

a) From 2003 Summary Report of Island Lake, LCHD (2005).
b) Determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area.

Water Quality Conditions

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[79] is based on water sampling conducted by the LCHD Lakes Management Unit in 2003 and by Illinois EPA in

[76] IDNR. *McHenry County Surface Water Resources*, by Tichacek, Gregg. Springfield, IL: IDNR, 1968.

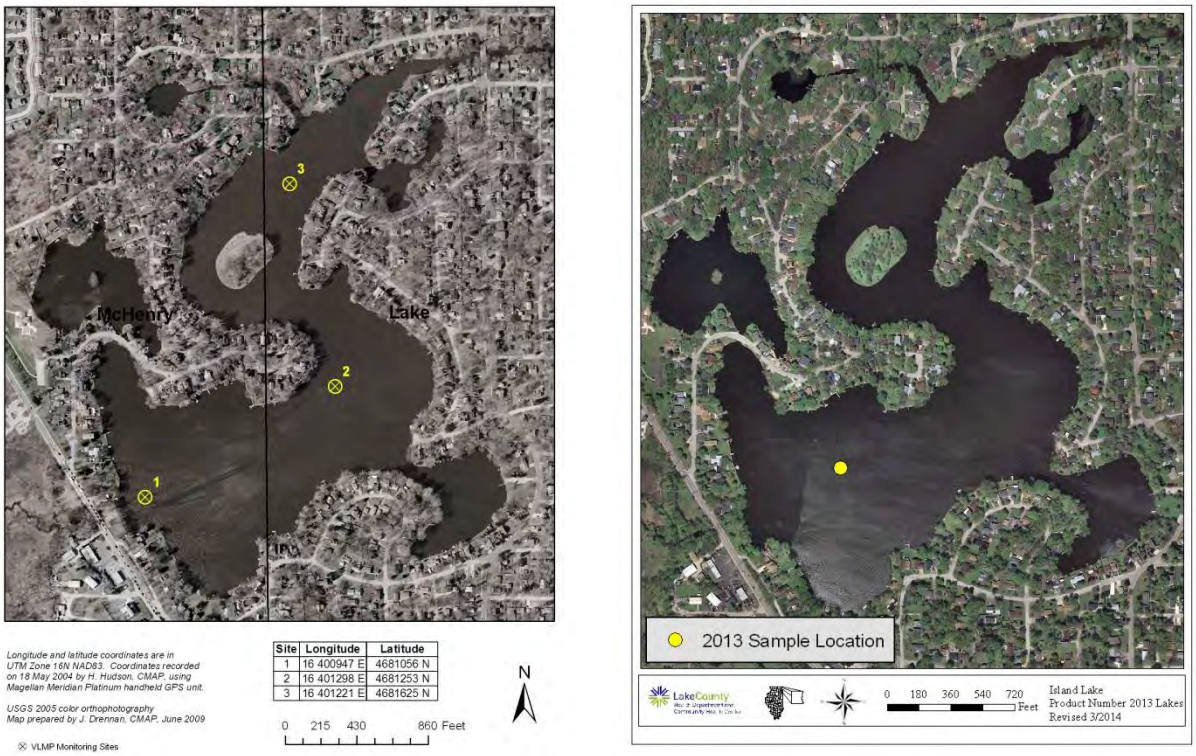
[77] LCHD. *2003 Summary Report of Island Lake*, by Brant, Christina, M. Colwell, M. Adam, J. Marencik, M. Pfister. Waukegan, IL: LCHD 2005.

[78] Connie, Village of Island Lake, e-mail message to the author(s), August 2013.

[79] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA, 2012 http://www.epa.state.il.us/water/tmdl/303d-list.html#2012.

2009[80]. LCHD sampling was conducted at one in-lake location in the deepest area of the lake about 200 yards from the dam. Illinois EPA sampling was conducted at three in-lake locations including Site 1 in the deepest area of the lake near the dam, Site 2 mid-lake, and Site 3 upper lake (Figure 59).

Figure 59. Water quality monitoirng site locations in Island Lake.



The lake exhibited degraded water quality conditions with generally low Secchi transparencies (average of 2.66 feet of water clarity between the two, near-dam monitoring sites) and high total phosphorus, total suspended solids, and volatile suspended solids concentrations (average of 0.144, 14.0, and 11.4 mg/L, respectively). A trophic state index ($TSI_{phosphorus}$) of 70 places Island Lake into the hypereutrophic category.[81]

Daytime dissolved oxygen levels remained adequate for the support of aquatic life throughout the water column (above 5 mg/L) except on two dates in the bottom two feet of the lake at Site 1 during July and August 2009.

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[80] While Island Lake has participated in the Illinois Volunteer Lake Monitoring Program (VLMP) for many years, including the collection of water samples, the samples have been collected under the "Tier 2" part of the program and thus are not used by Illinois EPA for use impairment assessment purposes.

[81] LCHD. *2003 Summary Report of Island Lake,* by Brant, Christina, M. Colwell, M. Adam, J. Marencik, M. Pfister. Waukegan, IL: LCHD 2005. http://health.lakecountyil.gov/Population/LMU/Lakes/Island%20Report.pdf.

Very few aquatic plants were present in the lake, and only a few species were noted by LCHD during their 2003 monitoring trips including the exotic invasives Eurasian watermilfoil (*Myriophyllum spicatum;* EWM) and curlyleaf pondweed (*Potamogeton crispus,* CLP) and the natives sago pondplant (*Stukenia pectinata*) and water stargrass (*Heteranthera dubia*). Management activities against algae, EWM, and CLP have been conducted since 1987, typically targeting the bays, using aquatic algicides and herbicides on an as-needed basis. Additionally, an aeration system is run in the north bay from May - October.[82]

Conductivity measurements averaged 765 µS/cm over the two sampling seasons. Chloride concentrations averaged 91 mg/L in 2009. Water quality parameter averages based on LCHD[83] and IEPA[84] data are provided in Table 48.

Table 48. Average annual water quality characteristics for Island Lake.

IEPA lake code		IL_RTZI			
Year		2003	2009		
Parameter	*Units*		*Site 1*	*Site 2*	*Site 3*
Secchi transparency	feet	2.90	2.42	2.23	2.17
	inches	35	29	27	26
Total Phosphorus (TP)	mg/L	0.099	0.128	0.130	0.130
Soluble Reactive Phosphorus (SRP)	mg/L	0.006[k]	---	---	---
Dissolved Phosphorus (DP)	mg/L	---	0.032	0.027	0.037
Total Kjeldahl Nitrogen (TKN)	mg/L	2.10	1.76	1.78	1.58
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	0.021[k]	0.027[k]	0.057[k]
Nitrate Nitrogen (NO_3)	mg/L	1.092[k]	---	---	---
Ammonia Nitrogen (NH_3)	mg/L	0.150[k]	0.147	0.135[k]	0.120[k]
Total Suspended Solids (TSS)	mg/L	14.9	13	11	12
Volatile Suspended Solids (VSS)	mg/L	---	11	11	10
Total Solids (TS)	mg/L	569	---	---	---
Total Volatile Solids (TVS)	mg/L	189	---	---	---
Chloride (Cl)	mg/L	---	91.0	89.9	96.3
Conductivity	µS/cm	838	692	693	723
pH	units	8.40	8.2	8.2	8.0
Alkalinity	mg/L	209	222	223	230
Chlorophyll *a* (corrected)	µg/L	---	35.2	35.6	58.7

k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

[82] Ibid.

[83] Mike Adam, Sr. Biologist, LCHD, e-mail message with attached data to the author(s), February 2013.

[84] Illinois EPA, e-mail message with attached data to the author(s), January 2013.

LCHD's full Island Lake 2003 summary report can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). It is expected that LCHD's 2013 Island Lake summary report will be added to this website in 2014.

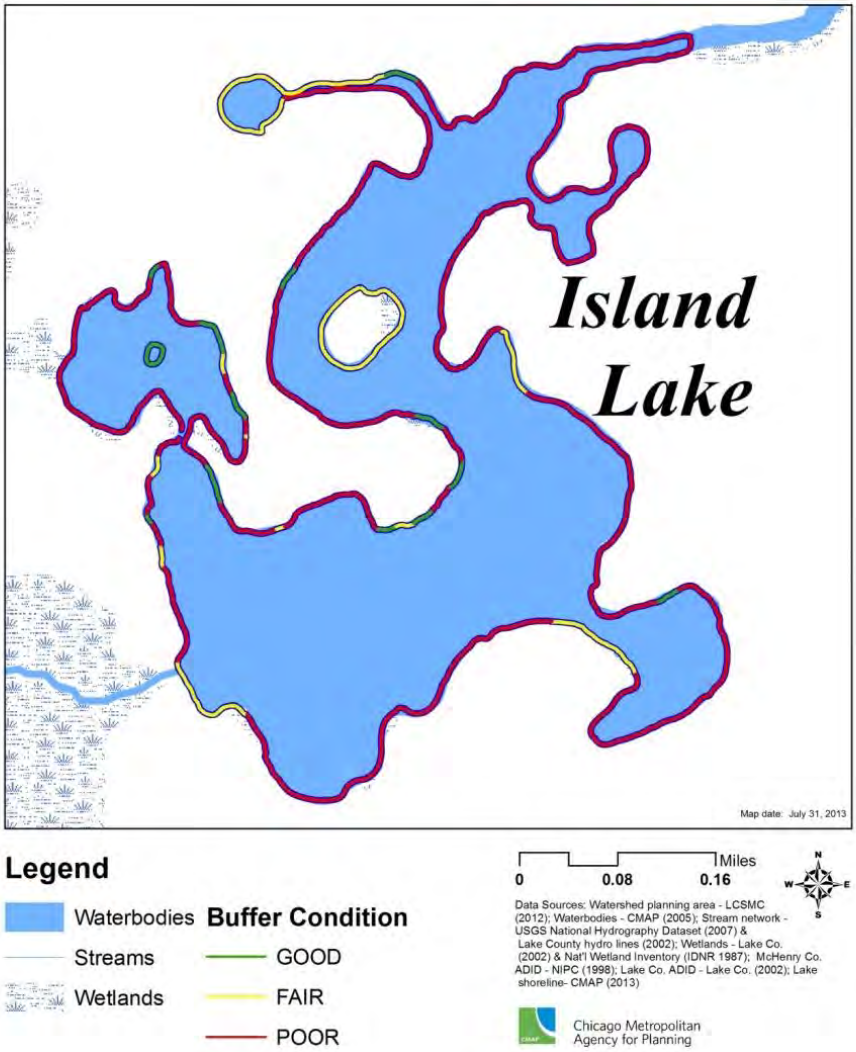
Lakeshore Buffer Condition

For Island Lake, full details for each segment are featured in Appendix A. Here, a summary is provided in Table 49 and Figure 60.

Table 49. Island Lake 2013 lakeshore buffer condition assessment summary

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Island Lake	102	24,105	8,075	33.5	2,390	9.9	13,640	56.6
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 60. Island Lake 2013 lakeshore buffer condition.



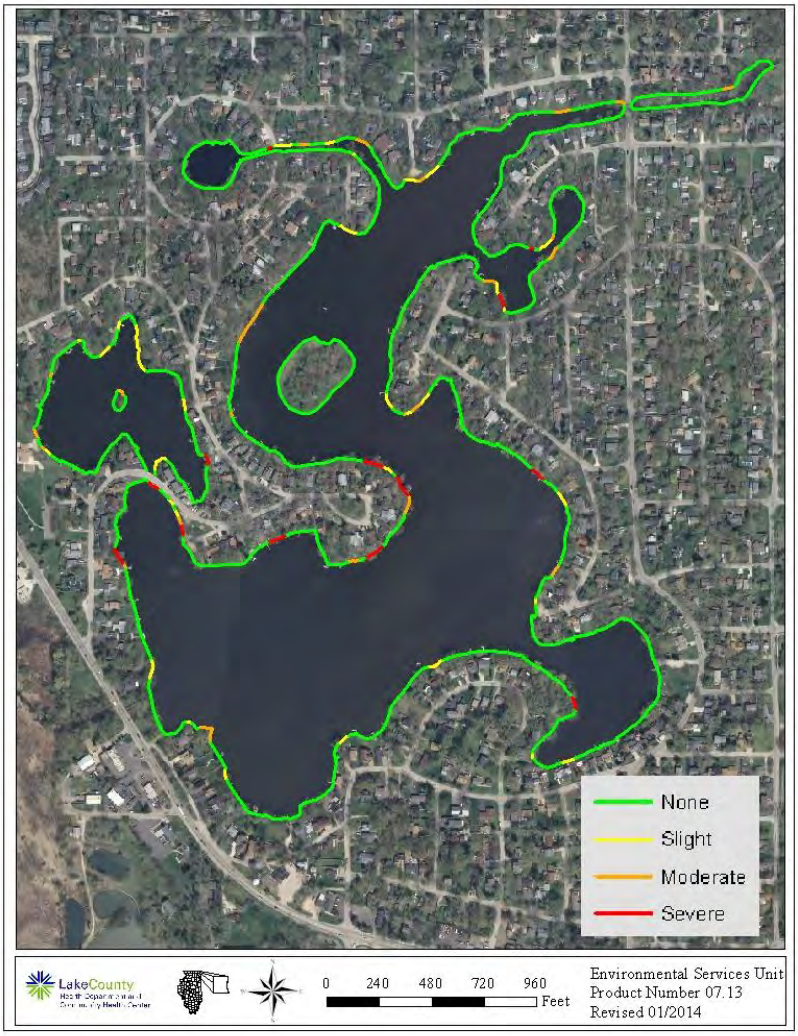
Shoreline Erosion Condition

LCHD's 2013 assessment of shoreline erosion conditions indicated that nearly 16 percent had some degree of erosion, about a 13 percent increase since LCHD's 2003 assessment. In 2013, approximately seven percent of the shoreline exhibited slight, five percent moderate, and four percent severe erosion (Table 50, Figure 61).

Table 50. Island Lake 2013 shoreline erosion condition assessment summary.

Lake Name	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Island Lake	25,572	21,605	84.5	1,749	6.8	1,320	5.2	899	3.5
from Lake Co. Health Department's Island Lake shoreline erosion assessment GIS data (2013)									

Figure 61. Island Lake 2013 shoreline erosion condition.



Land Use

Land use within the 5,075 acre Island Lake subunit is diverse, but predominantly agricultural (38.8 percent; Table 51). Agricultural land use is spatially dispersed throughout the subunit. Residential land use is concentrated around the lake itself and makes up nearly 14 percent of the subunit area. Industrial land use is concentrated along Bonner Road within the subunit (Figure 62).

Figure 62. Land use within Island Lake subunit.

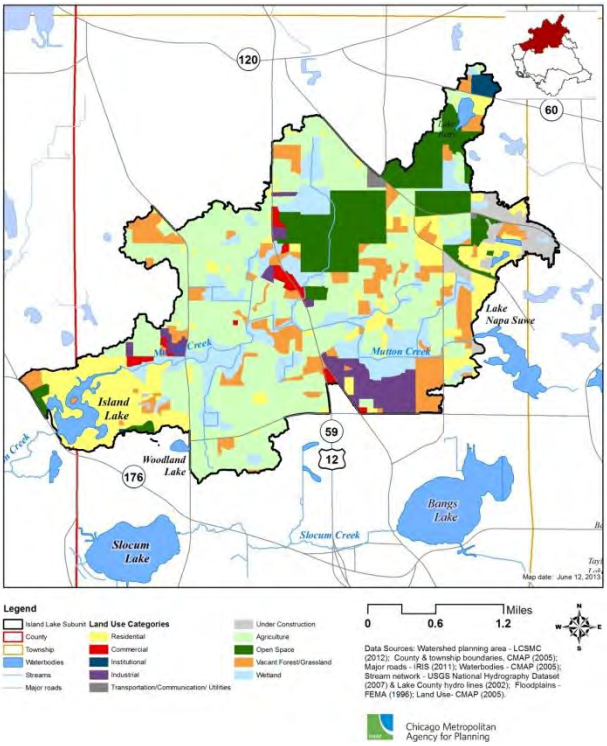


Table 51. 2005 Land use distribution within Island Lake subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	697.1	1.1	13. 7
Commercial	61.2	0.1	1.2
Institutional	28.1	0.04	0.6
Industrial	194.3	0.3	3.8
Transportation/ Communication /Utilities	14.7	0.02	0.3
Under Construction	143.0	0.2	2.8
Agriculture	1970.8	3.1	38.8
Open Space	623.5	0.9	12.3
Vacant Forest/Grassland	569.7	0.9	11.2
Wetland	662.6	1.0	13.1
Water	109.4	0.2	2.2
Totals	5074.5	7.9	100.0

Soils

The majority of soils within the Island Lake subunit are "Not Hydric," yet "All Hydric" soils make up approximately 25 percent of the study area (Table 52 and Figure 63).

Figure 63. Hydric soils within Island Lake subunit.

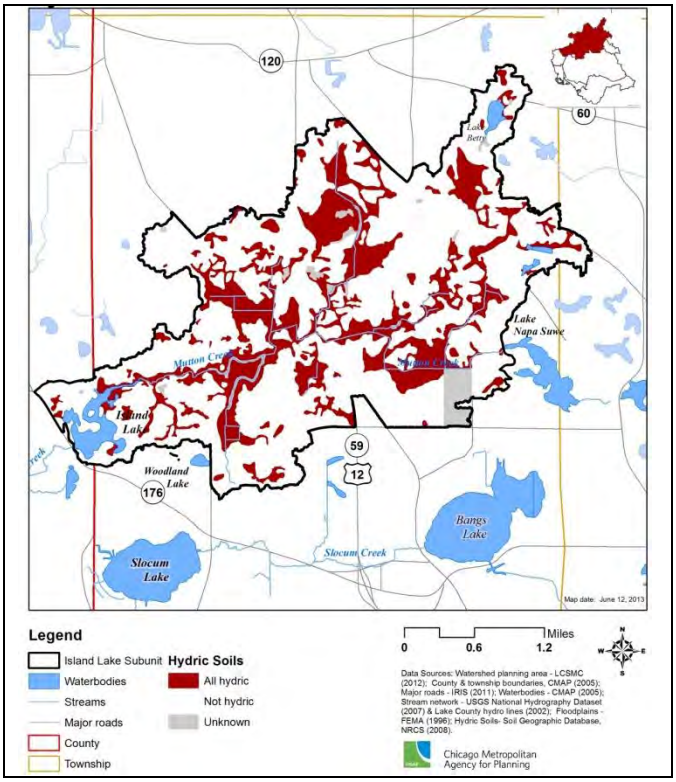


Table 52. Hydric soil acreage within Island Lake subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	1299.1	25.6
Not hydric	3544.3	69.9
Unknown	231.1	4.5

The predominant hydrologic soil group in the subunit is Group C (Table 53). These soils are most heavily concentrated in the northeastern portion of the area. Group B soils are concentrated around Island Lake, and make up nearly 30 percent of the subunit (Figure 64).

Figure 64. Hydrologic soil groups within Island Lake subunit.

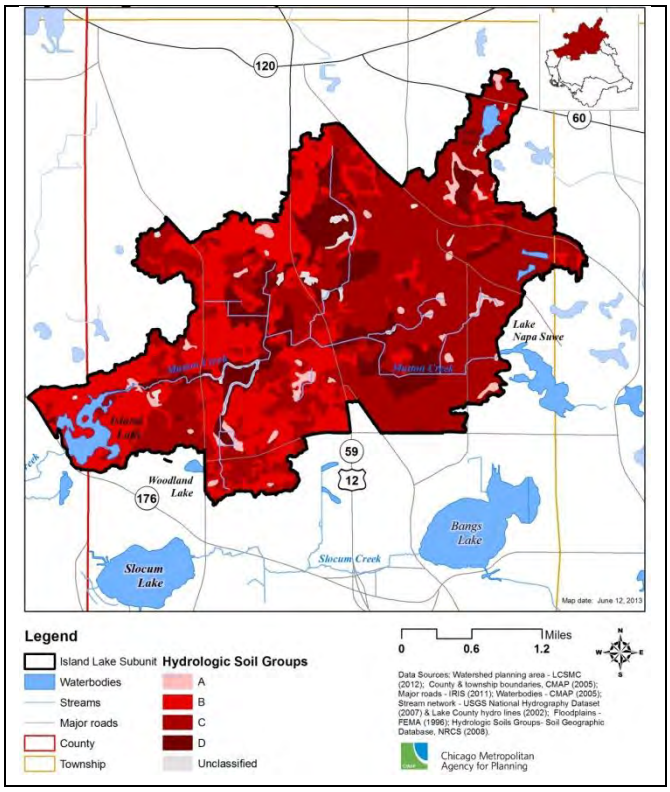


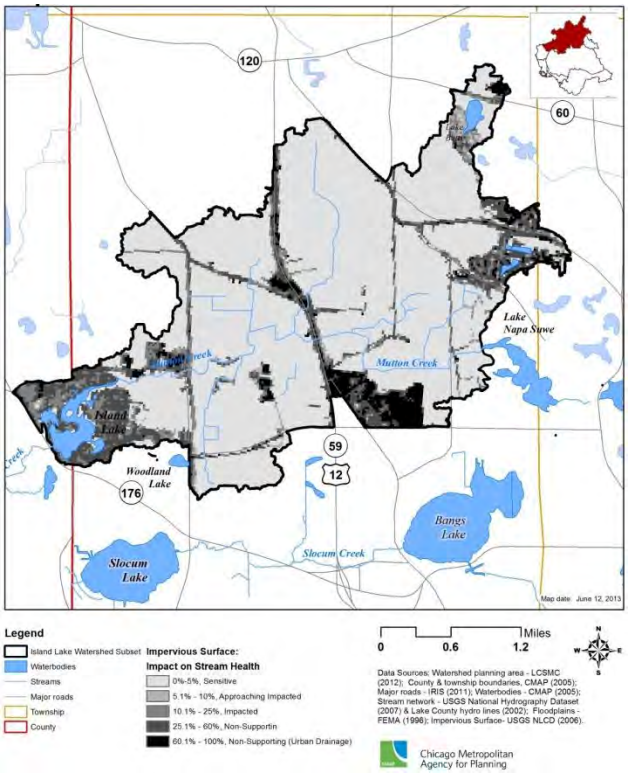
Table 53. Hydrologic soil groups within Island Lake subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	129.0	2.5
B	1474.9	29.2
C	2679.3	52.8
D	630.7	12.4
Unclassified	160.7	3.2

Impervious Cover

The Island Lake subunit has approximately 9.6 percent impervious surface coverage that is most heavily concentrated in the residential, commercial, and industrial land use areas, surrounding Island Lake, and along Route 59 (Figure 65). The calculated level of imperviousness results in the stream health category of "Approaching Impacted" (Table 5). Impervious surface in the year 2040 is projected to nearly double, to 18.2 percent. This is the largest projected increase in impervious surface within the 9 Lakes Planning Area and will result in a downgrade of the stream health classification to "Impacted." The projections should be of great concern to those who wish to seek improvement in Island Lake water quality.

Figure 65. Impervious cover within Island Lake subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for the Island Lake subunit are found in Table 54.

Table 54. Island Lake subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chloride (lbs/yr)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos-phor. (lbs /yr)*	*P (lbs /ac)*	*Bac. (bill col /yr)*	*Bac. (bill col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	771.6	652.9	123282.1	159.8	3182.2	4.1	332.8	0.4	3602.0	4.7	200715.2	260.1
1120 RES/FARM	62.9	37.6	3966.2	63.1	152.9	2.4	19.0	0.3	194.1	3.1	7324.1	116.5
1231 URBN MX W/PRK	58.2	81.0	26499.6	455.7	506.7	8.7	62.7	1.1	177.9	3.1	29507.6	507.4
1240 CULT/ENT	3.3	4.6	1784.7	542.6	26.0	7.9	3.5	1.1	12.0	3.6	1476.0	448.7
1320 EDUCATIO	0.0	0.0	0.0	182.2	0.0	3.9	0.0	0.5	0.0	1.2	0.0	150.7
1330 GOVT	1.5	2.3	355.3	232.6	7.7	5.0	1.0	0.7	2.4	1.6	293.8	192.4
1350 RELIGIOUS	16.7	24.7	9995.4	599.7	216.1	13.0	28.4	1.7	67.1	4.0	8266.5	496.0
1370 INST/ OTHER	19.4	21.8	6391.3	328.6	103.6	5.3	13.0	0.7	42.9	2.2	2487.4	127.9
1410 MINRL EXTRACT	1.4	1.7	585.0	413.3	7.1	5.0	1.2	0.9	3.9	2.8	296.9	209.8
1420 MANU /PROCESSN	24.1	24.2	11127.1	460.8	195.5	8.1	23.3	1.0	74.7	3.1	13833.7	572.8
1430 WARE/ DIST/WHO	27.3	37.9	15781.9	577.9	277.3	10.2	33.1	1.2	106.0	3.9	17573.4	643.5
1440 INDUS PARK	153.8	228.7	47520.0	309.0	834.8	5.4	99.5	0.6	319.1	2.1	59078.9	384.2
1512 OTHR ROADWAY	73.3	155.3	44128.4	602.1	685.8	9.4	101.4	1.4	201.5	2.7	93027.4	1269.3
1560 UTILI/ WASTE/WA	8.4	10.0	4305.1	515.1	61.1	7.3	9.9	1.2	16.2	1.9	3560.4	426.0
2100 CROP/ GRAIN/ GRAZING	1323.9	1148.6	2312.8	1.7	18044.9	13.6	1513.8	1.1	3191.4	2.4	3467843.8	2619.4
2200 NRSRY GRNHS/OR	143.8	54.6	121.8	0.8	482.0	3.4	53.6	0.4	138.4	1.0	25704.9	178.8
2300 AG/OTHER	31.7	29.0	69.2	2.2	273.9	8.6	34.2	1.1	78.6	2.5	7304.7	230.1
2400 EQUESTRI.	105.9	87.2	189.7	1.8	1480.2	14.0	110.5	1.0	745.8	7.0	40028.5	378.0
3100 OPEN SPA/RECRE	16.9	9.3	12.8	0.8	17.6	1.0	4.2	0.2	14.6	0.9	732.3	43.2
3200 GOLF COURSE	54.2	25.7	63.3	1.2	250.5	4.6	41.7	0.8	71.9	1.3	4675.6	86.3
3300 OPEN	538.7	245.2	621.2	1.2	477.8	0.9	102.4	0.2	352.7	0.7	16382	30.4

SPA/CONS											.7	
3400 OPEN SPA/PRIVT	272.3	103.8	216.7	0.8	166.7	0.6	35.7	0.1	123.1	0.5	5715.1	21.0
3500 OPEN SPA/CORRI	11.3	4.5	9.3	0.8	7.1	0.6	1.5	0.1	5.3	0.5	244.5	21.7
3600 OPEN SPA/OTHR	1.8	0.6	1.9	1.0	1.4	0.8	0.3	0.2	1.1	0.6	49.2	27.4
4110 VAC FOR/GRASS	523.0	232.8	535.0	1.0	823.0	1.6	76.4	0.1	303.8	0.6	28217.6	54.0
4120 WETLAND	673.1	562.8	1605.4	2.4	1235.0	1.8	17.6	0.0	350.6	0.5	1411.4	2.1
4300 OTHR VACANT	10.7	3.7	4.2	0.4	6.5	0.6	0.6	0.1	2.4	0.2	222.8	20.8
5200 LAKE/ RES/LAGO	145.3	307.9	115204.0	793.1	360.0	2.5	24.0	0.2	190.8	1.3	1152.0	7.9
Grand Totals	**5074.5**	**4098.2**	**416689.5**	**82.1**	**29883.4**	**5.9**	**2745.4**	**0.5**	**10390.3**	**2.0**	**40371 26.5**	**795.6**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Island Lake's epilimnion[85] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[86] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 2,759 lbs/yr P from average annual land runoff (Table 54 + estimated P export of 15 lbs/yr from upstream lakes).[87]

Together with other model parameters set for Island Lake—mean depth: 5.3 ft (1.62 m); lake retention or residence time: 0.09 yr.[88]; surface area: 83.8 ac—the CB model predicted an average annual epilimnetic TP of 0.088 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that exceeds the applicable water quality standard.

[85] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[86] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[87] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[88] Lake residence time is lake volume divided by avg. annual inflow. For Island Lake: 443.3 ac-ft / 4,721 ac-ft per yr = 0.0939 yr. The reciprocal equation is "lake flushing time" or 10.65 times per year which is the value used in the CB model.

Data available from samples taken from Island Lake reveal TP concentrations with an average of 0.114 mg/L over two growing seasons (2003, 2009).[89] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield the observed average TP concentration of 0.114 mg/L. This exercise resulted in an average influx of 3,409 lbs/yr, of which land runoff explains about 81 percent (2,759 / 3,409) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 1,151 lbs/yr. When compared to the estimated total influx of 3,409 lbs/yr, a 66 percent reduction in annual TP influxes (2,258 lbs/yr) will be needed. Because 2,759 lbs/yr is potentially contributed by land runoff, it is theoretically possible that the necessary P reduction could be achieved by on-the -ground BMPs implemented throughout the lake's watershed.

[89] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.5 Subunit #5 - Cotton Creek

The Cotton Creek subunit consists of 779 acres in the northwestern portion of the 9 Lakes Planning Area (Figure 37).

Land Use

Land use in the Cotton Creek subunit is dominated by a combination of open space (38 percent) and residential (35.1 percent; Table 55). Open space is located in the central portion of the subunit (Figure 66). Areas of commercial and institutional land use exist along Route 176 and other types of land use are present in lesser extents.

Figure 66. Land use within Cotton Creek subunit.

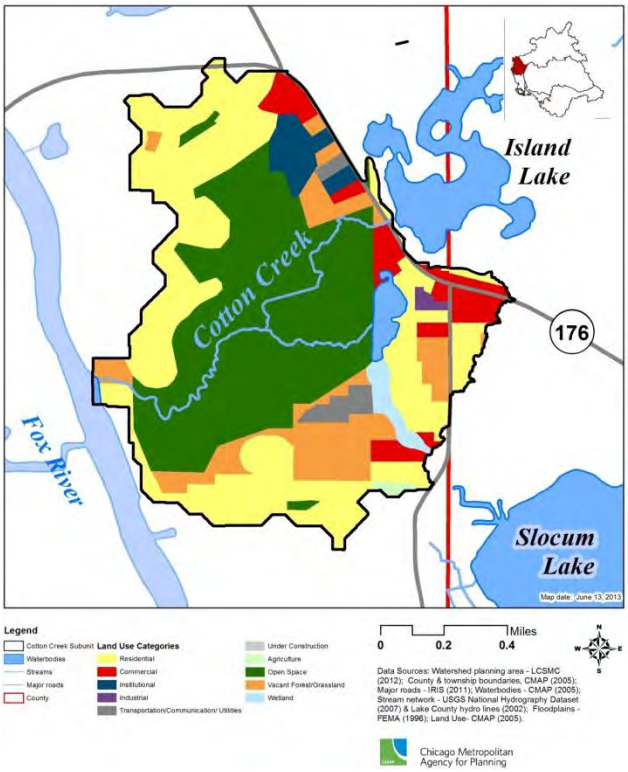


Table 55. 2005 Land use distribution within Cotton Creek subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	273.0	0.4	35.1
Commercial	51.9	0.08	6.7
Institutional	23.1	0.04	3.0
Industrial	3.4	0.01	0.4
Transportation/ Communication/ Utilities	13.6	0.02	1.7
Agriculture	3.1	0.01	0.4
Open Space	296.0	0.5	38.0
Vacant Forest/Grassland	90.0	0.1	11.6
Wetland	11.5	0.02	1.5
Water	13.0	0.02	1.6
Totals	778.7	1.2	100.0

Soils

The majority of soils in the Cotton Creek subunit are classified as "Not Hydric" (52.4 percent), yet a significant proportion of the soils are considered "All Hydric" (45.7 percent; Table 56). A sizable area of "all hydric" soils exists in central portion of the subunit (Figure 67).

Figure 67. Hydric soils within Cotton Creek subunit.

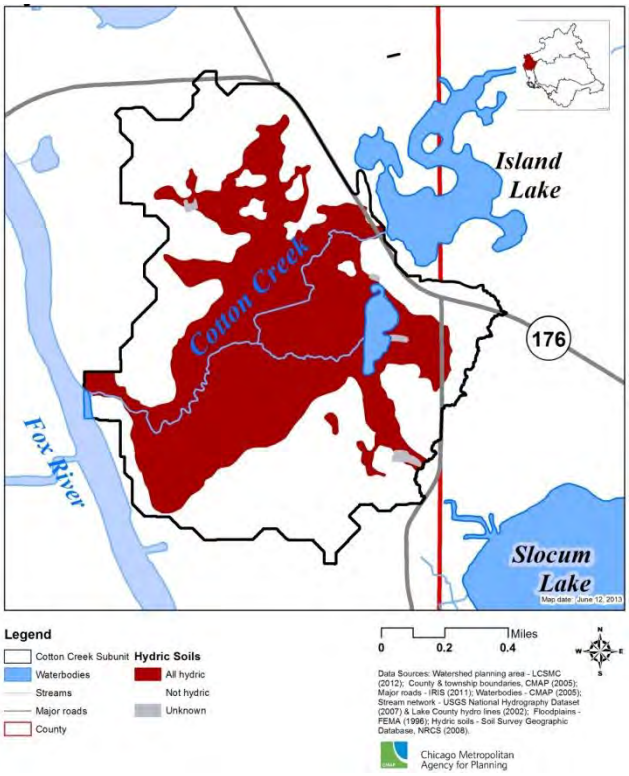


Table 56. Hydric soil acreage within Cotton Creek subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	355.4	45.7
Not hydric	407.8	52.4
Unknown	15.5	1.9

Out of the five hydrologic soil groups present in the Cotton Creek subunit, the dominant group is "B" which makes up 60.9% of the subunit (Table 57). "Group D" soils make up over one-third of the subunit (Figure 68).

Figure 68. Hydrologic soil groups within Cotton Creek subunit.

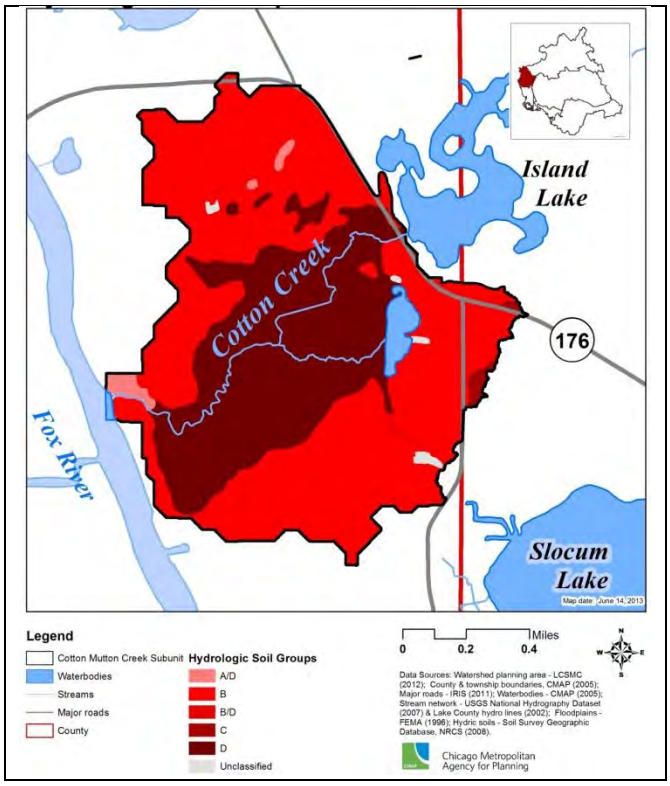


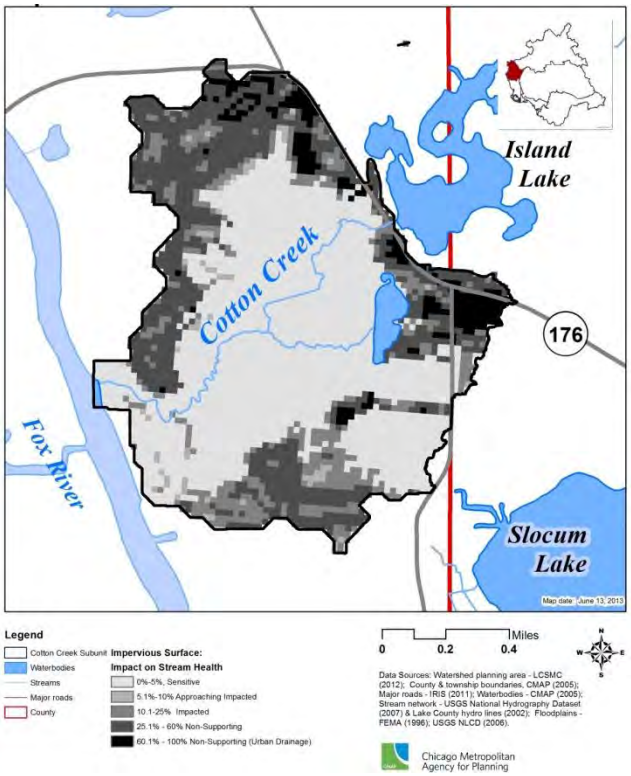
Table 57. Hydrologic soil groups within Cotton Creek subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A/D	8.8	1.1
B	479.5	60.9
B/D	1.5	.2
C	5.1	.7
D	268.3	34.1
Unclassified	15.5	2.0

Impervious Cover

Impervious surfaces account for 17.3 percent of the Cotton Creek subunit and results in a stream health category of "Impacted" (Table 5). Imperviousness is more highly concentrated along Route 176 and along the north and northwestern edge of the subunit (Figure 69). The 2040 estimate of imperviousness shows over 11 percent growth from the current amount for a future total of 19.3 percent of the subunit. This projection will result in an unchanged stream health category.

Figure 69. Impervious cover within Cotton Creek subunit.



Pollutant Loads

Pollutant loads were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for the Cotton Creek subunit are found in Table 58.

Table 58. Cotton Creek subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs/yr)*	*CL (lbs /ac)*	*Nitro -gen (lbs /yr)*	*N (lbs /ac)*	*Phos-phor. (lbs /yr)*	*P (lbs /ac)*	*Bac. (bill col /yr)*	*Bac. (bill col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	241.2	184.9	25534.3	105.9	586.2	2.4	57.2	0.2	647.2	2.7	40687.4	168.7
1130 RES/MF	2.6	2.2	285.7	110.1	6.2	2.4	0.6	0.2	6.7	2.6	449.4	173.1
1231 URBN MX W/PRK	43.7	56.8	11268.9	257.7	215.5	4.9	26.6	0.6	75.7	1.7	12548.0	287.0
1240 CULT/ENT	4.1	5.3	698.1	168.6	10.2	2.5	1.4	0.3	4.7	1.1	577.3	139.4
1320 EDUCATIN	9.1	11.7	1674.5	184.1	36.2	4.0	4.8	0.5	11.2	1.2	1384.8	152.3
1350 RELIGIOUS	2.6	3.3	481.2	186.5	10.4	4.0	1.4	0.5	3.2	1.3	397.9	154.2
1370 INST/ OTHER	0.1	0.1	9.4	118.0	0.2	1.9	0.0	0.2	0.1	0.8	3.7	45.9
1430 WARE/ DIS/WHOL	3.4	4.3	868.2	257.4	15.3	4.5	1.8	0.5	5.8	1.7	966.7	286.6
1512 OTHR ROADWAY	4.9	10.5	1869.5	378.2	29.1	5.9	4.3	0.9	8.5	1.7	3941.0	797.3
1560 UTILI/ WASTE/WA	9.8	9.7	1638.0	167.9	23.2	2.4	3.8	0.4	6.2	0.6	1354.7	138.9
2100 CROP/ GRAIN/ GRAZING	3.1	2.3	1.9	0.6	14.9	4.9	1.3	0.4	2.2	0.7	5679.7	1847.6
2400 EQUESTRI	0.1	0.0	0.0	0.5	0.2	4.2	0.0	0.3	0.1	2.1	6.0	113.5
3100 OPEN SPA/RECRE	4.5	1.8	1.4	0.3	2.0	0.4	0.5	0.1	1.6	0.4	81.6	18.1
3300 OPEN SPA/CONS	289.5	155.4	451.7	1.6	347.5	1.2	74.5	0.3	256.5	0.9	11913.4	41.2
3400 OPEN SPA/PRIVA	5.7	1.9	3.3	0.6	2.5	0.4	0.5	0.1	1.9	0.3	86.8	15.3
3500 OPEN SPA/CORRI	2.8	0.8	1.0	0.4	0.8	0.3	0.2	0.1	0.6	0.2	27.5	9.7
3600 OPEN SPA/ OTHR	10.4	2.7	2.9	0.3	2.3	0.2	0.5	0.0	1.7	0.2	77.3	7.4
4110 VACA FOR/GRASS	102.8	37.5	40.5	0.4	62.4	0.6	5.8	0.1	23.0	0.2	2138.2	20.8
4120 WETLAND	22.3	18.7	47.5	2.1	36.6	1.6	0.5	0.0	10.4	0.5	41.8	1.9
5100 RIVER /CANALS	1.2	2.5	589.9	493.2	10.5	8.8	0.9	0.8	1.7	1.4	20.9	17.5
5200 LAKE/	14.9	31.7	12852.8	860.2	40.2	2.7	2.7	0.2	21.3	1.4	128.5	8.6

RES/LAGO												
Grand Totals	**778.7**	**544.1**	**58320.9**	**74.9**	**1452.2**	**1.9**	**189.1**	**0.2**	**1090.2**	**1.4**	**82512.7**	**106.0**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Slocum Lake Drain / Fiddle Creek Watershed

2.6.3.6 Subunit #6 - Bangs Lake

The Bangs Lake subunit consists of 3,165 acres in the eastern portion 9 Lakes Planning Area (Figure 37).

Bangs Lake Location, Ownership, Use, and Morphometric Information

This glacial lake is located at the western end of the Bangs Lake subunit. An unnamed tributary enters the lake along its southeastern shore. Water overflows a spillway constructed at the lake's western end, forming Slocum Creek (a.k.a. Bangs Lake Drain) which wends its way approximately 2¼ miles downstream to Slocum Lake. The lake bottom is owned by a mix of homeowners associations, private landowners, the Wauconda Park District, Lake County, and the Village of Wauconda. Bangs Lake is used extensively for fishing, swimming, non- and power boating, and aesthetic enjoyment. The lake can be accessed by the public through two Wauconda Park District properties and several private business locations. Bangs Lake morphometry is presented in Table 59.

Table 59. Bangs Lake morphometric information.

Illinois EPA lake code	IL_RTG
Surface Area[a]	306.1 ac
Maximum Depth[a]	32.0 ft
Average Depth[a]	10.9 ft
Volume[a]	3,323.6 ac-ft
Shoreline Length[a]	6.3 mi
Lake Elevation[a]	766.2 ft above MSL
Watershed Area[b]	2858.7 ac
Watershed to lake ratio	9:1
Average Water Residence Time / Flushing Time	1.27 yr (462 days) / 0.8 times per yr

a From 2008 Summary Report of Bangs Lake, LCHD (undated). b Determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area.

Water Quality Conditions

In 2005, LCHD selected Bangs Lake as one of the county's seven sentinel lakes. Bangs Lake has outstanding water quality, with many parameters below the median values for all 160+ lakes monitored by the LCHD county-wide. The lake's low nutrient and solids concentrations are reflected in its water clarity. Between 2005 and 2012, Secchi transparency averaged between 10 and 14 feet annually, total suspended solids averaged about 2.0 mg/L each year, and total phosphorus averaged between 0.017 and 0.026 mg/L annually (well below Illinois general use water quality standard of 0.050 mg/L). The lake's $TSI_{(phosphorus)}$ in the mid- to upper 40s places it in the mesotrophic category. Annual water quality parameter averages for both epilimnetic (near-surface) and hypolimnetic (near bottom) samples collected by LCHD at the monitoring site in the 32-foot deepest area of the lake (Figure 70) are provided in Table 60. Unlike the other nine lakes featured in this plan, Bangs Lake is not on Illinois EPA's list of impaired waters.

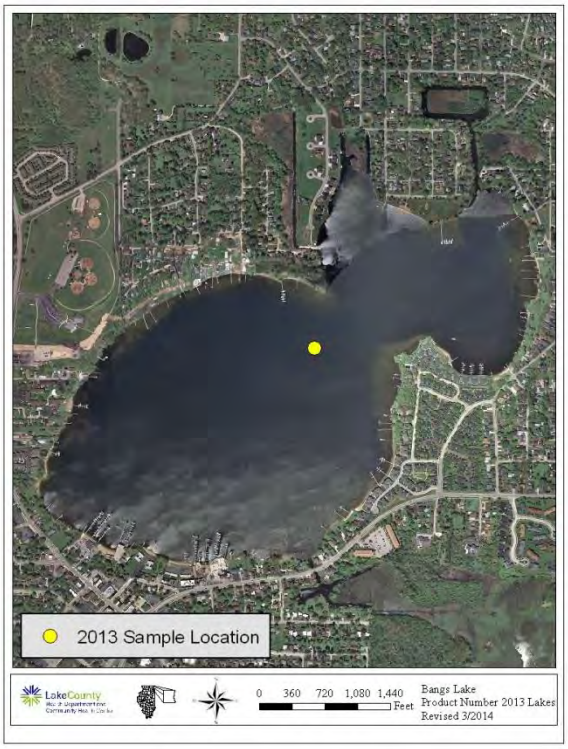
Table 60. Average annual water quality characteristics for Bangs Lake.

Epilimnetic													
	Alk	**TKN**	**NH_3**	**NO_3**	**TP**	**SRP**	**CL**	**TSS**	**TS**	**TVS**	**Cond**	**pH**	**Secchi**
Year	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µs/cm	units	ft
2005	136	0.827	0.00	0.000	0.020	0.000	99	2.0	359	89	606	8.24	13.76
2006	132	0.890	0.00	0.008	0.022	0.001	107	2.3	361	83	620	8.49	12.76
2007	143	0.849	0.00	0.000	0.022	0.000	102	1.8	366	83	620	8.32	14.12
2008	137	0.703	0.00	0.011	0.017	0.000	102	1.5	354	74	614	8.47	14.09
2009	145	0.738	0.00	0.000	0.024	0.000	94	1.5	348	76	600	8.26	13.99
2010	143	0.679	0.00	0.013	0.025	0.000	87	2.0	330	77	571	8.44	11.15
2011	143	0.721	0.05	0.000	0.026	0.000	87	2.3	332	73	542	8.42	10.14
2012	137	0.720	0.00	0.000	0.023	0.000	95	2.0	342	75	553	8.49	10.95
Mean	**139**	**0.766**	**0.01**	**0.004**	**0.022**	**0.000**	**97**	**1.9**	**349**	**79**	**591**	**8.39**	**12.62**
Hypolimnetic													
	Alk	**TKN**	**NH_3**	**NO_3**	**TP**	**SRP**	**CL**	**TSS**	**TS**	**TVS**	**Cond**	**pH**	
Year	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µs/cm	units	
2005	154	1.093	0.185	0.000	0.121	0.032	97	6.2	364	82	628	7.66	
2006	143	0.900	0.060	0.008	0.043	0.010	107	3.2	369	83	641	8.01	
2007	160	1.074	0.254	0.007	0.169	0.044	102	5.7	380	84	648	7.82	
2008	150	0.855	0.168	0.010	0.131	0.041	101	4.0	363	74	632	8.07	
2009	150	0.812	0.092	0.000	0.099	0.041	94	3.4	353	75	610	7.76	
2010	159	0.938	0.214	0.147	0.172	0.033	88	6.5	350	82	602	7.97	
2011	156	1.161	0.284	0.080	0.221	0.010	87	3.7	351	73	560	7.83	
2012	154	1.119	0.254	0.000	0.167	0.005	93	7.5	354	73	571	7.68	
Mean	**153**	**0.994**	**0.19**	**0.032**	**0.141**	**0.027**	**96**	**5.0**	**361**	**78**	**612**	**7.85**	

A diverse aquatic plant population is present in Bangs Lake, with more than 15 native species documented by LCHD staff over the years, including several pondplant (*Potamogeton*) species, water stargrass (*Heteranthera dubia*), eel grass (*Vallisneria americana*), and bladderwort (*Utricularia* spp.). The invasive, exotic species Eurasian watermilfoil (*Myriophyllum spicatum*) and curlyleaf pondweed (*Potamogeton crispus*) are common as well, managed by the Village of Wauconda via regular mechanical harvesting during the summer recreational season.

LCHD's Bangs Lake summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx).

Figure 70. Water quality monitoring site location in Bangs Lake.



Shoreline Erosion Condition

LCHD's latest assessment of shoreline erosion conditions at Bangs Lake in 2009 indicated that approximately 25 percent had some degree of erosion. About 23 percent of the shoreline exhibited slight, three percent moderate, and less than one percent high erosion (Table 61, Figure 71).

Table 61. Bangs Lake 2009 shoreline erosion condition assessment summary.

Lake Name	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Bangs Lake	29,907	22,303	74.6	6,795	22.7	743	2.5	67	0.2
from Lake Co. Health Department's Island Lake shoreline erosion assessment GIS data (2009)									

Figure 71. Bangs Lake 2009 shoreline erosion condition.

Figure provided by Lake County Health Dept. (2014)

Land Use

Land use in the Bangs Lake subunit is predominantly Open Space (Table 62), classified primarily as conservation land. This type of land use dominates the eastern half of the area. Residential land use is considerable too and concentrated around Bangs Lake (Figure 72).

Figure 72. Land use within Bangs Lake subunit.

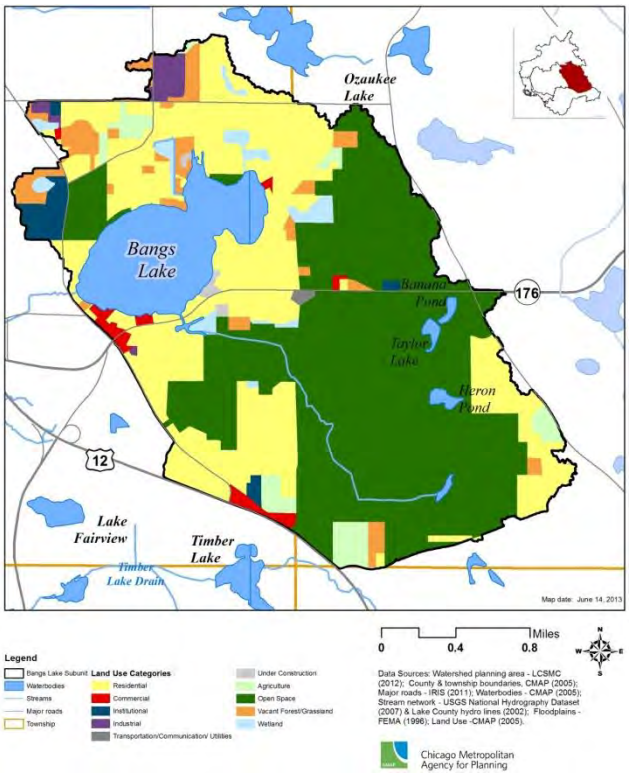


Table 62. 2005 Land use distribution within Bangs Lake subunit.

Land Use Category	*Area (acres)*	*Area (Sq.mi.)*	*Percent of Subunit*
Residential	969.2	1.5	30.6
Commercial	37.4	0.06	1.2
Institutional	51.8	0.08	1.6
Industrial	35.6	0.06	1.1
Transportation/ Communication/ Utilities	4.7	0.01	0.1
Under Construction	10.7	0.02	0.3
Agriculture	91.4	0.1	2.9
Open Space	1,439.9	2.2	45.6
Vacant Forest/Grassland	138.0	0.2	4.3
Wetland	63.3	0.1	2.0
Water	39.9	0.06	1.3
Bangs Lake	282.1	0.4	8.9
Totals	3,164.8	4.9	100.0

Soils

The soils in the Bangs Lake subunit are predominantly "Not Hydric" (Table 63). "All Hydric" soils make up 19.4 percent of the subunit and are spatially dispersed throughout the area (Figure 73). Lake bottoms are classified as "unknown"; this category characterizes 13 percent of the subunit.

Figure 73. Hydric soils within Bangs Lake subunit.

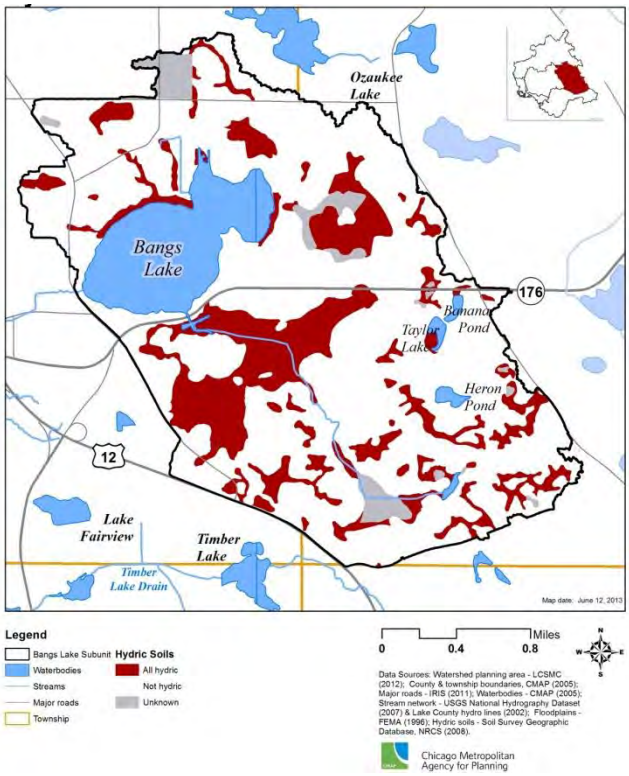


Table 63. Hydric soil acreage within Bangs Lake subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	613.7	19.4
Not hydric	2125.6	67.2
Unknown	425.5	13.4

The dominant hydrologic soil group is Group C which characterizes up to 67.6 percent of the soils (Table 64). Group C soils are evenly dispersed throughout the area, and Group D soils are concentrated in the center of the subunit, below Bangs Lake (Figure 74). Other soil groups are present in minimal areas within the subunit.

Figure 74. Hydrologic soil groups within Bangs Lake subunit.

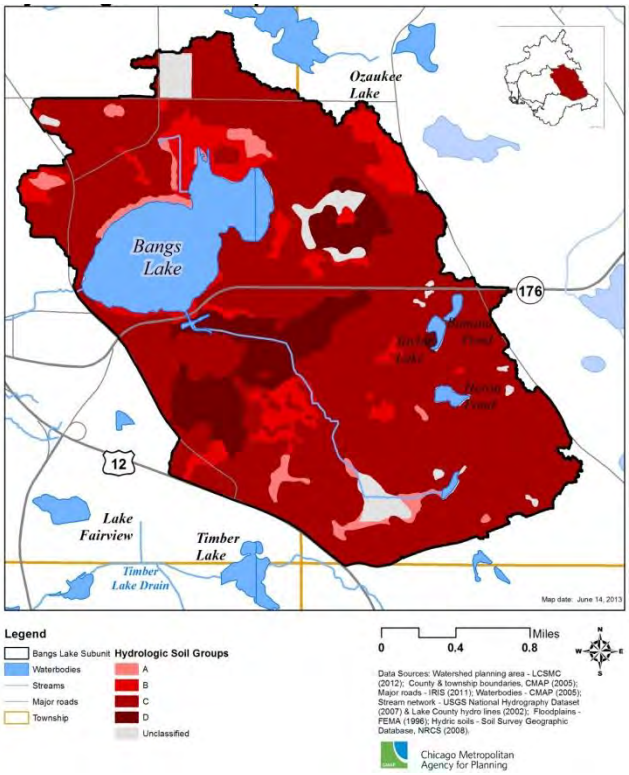


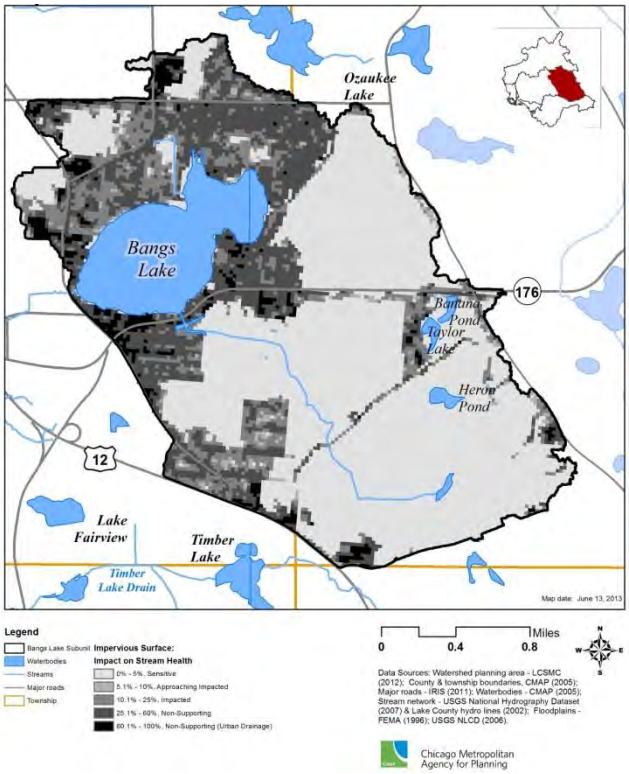
Table 64. Hydrologic soil groups within Bangs Lake subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	79.7	2.5
B	249.1	7.9
C	2139.7	67.6
D	278.6	8.8
Unclassified	417.7	13.2

Impervious Cover

The Bangs Lake subunit is comprised of 12.4 percent impervious surfaces, based on calculations derived from National Land Cover Dataset. As the percent impervious area in a watershed increases, stream quality decreases (Figure 75). This quantity of impervious cover suggests the stream health in the watershed is classified as "Impacted." Impervious surface projections estimate that the Bangs Lake subunit will reach 13.6 percent by the year 2040. This small increase implies that the stream health of the subunit will remain in the "Impacted" category.

Figure 75. Impervious surfaces within Bangs Lake subunit.



Pollutant Loads

Pollutant loads were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for the Bangs Lake subunit are found in Table 65.

Table 65. Bangs Lake subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chloride (lbs/yr)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos-phor. (lbs /yr)*	*P (lbs /ac)*	*Bac. (bill col /yr)*	*Bac (bil col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	896.1	791.5	153042.4	170.8	3951.2	4.4	413.9	0.5	4425.1	4.9	247961.5	276.7
1120 RES/ FARM	21.4	21.3	6334.0	295.7	147.3	6.9	13.8	0.6	171.5	8.0	10378.7	484.5
1130 RES/MF	28.3	30.8	9789.6	345.3	211.7	7.5	19.8	0.7	228.7	8.1	15398.8	543.2
1231 URB MX W/PRKG	38.1	56.0	13907.8	365.1	265.9	7.0	32.9	0.9	93.4	2.5	15486.6	406.6
1240 CULT/ ENTERTAIN	1.9	2.9	917.6	470.9	13.4	6.9	1.8	0.9	6.2	3.2	758.9	389.4
1320 EDUCATIN	18.2	27.0	12273.5	672.6	265.4	14.5	34.8	1.9	82.4	4.5	10150.5	556.3
1330 GOVT	13.9	20.6	4325.4	310.7	93.5	6.7	12.3	0.9	29.0	2.1	3577.2	256.9
1350 RELIGOUS	9.6	14.3	3077.3	320.0	66.5	6.9	8.7	0.9	20.7	2.1	2545.0	264.6
1360 CEMETERY	3.1	1.9	459.1	148.3	9.6	3.1	1.4	0.5	1.7	0.6	379.7	122.6
1410 MINRL EXTRACT	27.2	32.5	15457.2	568.1	186.9	6.9	32.4	1.2	103.8	3.8	7845.6	288.3
1430 WARE/ DIS/WHOL	1.1	1.7	213.8	186.3	3.8	3.3	0.4	0.4	1.4	1.3	238.1	207.5
1440 INDUS PARK	6.7	9.9	3097.4	463.6	54.4	8.1	6.5	1.0	20.8	3.1	3850.8	576.4
1512 OTHR ROADWY	29.7	63.0	16561.2	557.2	257.4	8.7	38.0	1.3	75.6	2.5	34912.8	1174.6
1560 UTILI/ WASTE/WA	1.7	2.1	305.6	177.9	4.3	2.5	0.7	0.4	1.1	0.7	252.8	147.1
2100 CROP/ GRAIN/ GRAZING	11.4	11.3	20.2	1.8	157.4	13.8	13.3	1.2	22.9	2.0	21587.0	1897.6
2200 NRSY/ GRHS/ORC	13.6	6.2	16.8	1.2	66.6	4.9	7.4	0.5	19.1	1.4	3550.5	261.4
2400 EQUESTRI	31.6	22.3	52.2	1.7	407.0	12.9	30.4	1.0	205.1	6.5	11006.5	348.6
3100 OPEN SPA/RECRE	65.5	35.9	78.8	1.2	108.2	1.7	26.0	0.4	89.5	1.4	4501.0	68.7
3300 OPEN SPA/CONS	1350.2	609.8	1507.2	1.1	1159.4	0.9	248.4	0.2	855.9	0.6	39751.6	29.4

3400 OPEN SPA/PRIVA	56.2	22.6	41.9	0.7	32.2	0.6	6.9	0.1	23.8	0.4	1105.1	19.7
3500 OPEN SPA/CORR	3.6	1.6	2.1	0.6	1.6	0.4	0.3	0.1	1.2	0.3	54.6	15.0
4110 VAC FOR/GRASS	125.1	57.7	119.4	1.0	183.8	1.5	17.1	0.1	67.8	0.5	6300.7	50.4
4120 WETLAND	67.8	56.7	143.9	2.1	110.7	1.6	1.6	0.0	31.4	0.5	126.5	1.9
5200 LAKE/ RES/LAGO	342.5	726.0	234957.4	686.0	734.2	2.1	48.9	0.1	389.1	1.1	2349.6	6.9
Grand Totals	**3164.8**	**2625.5**	**476702.1**	**150.6**	**8492.5**	**2.7**	**1017.9**	**0.3**	**6967.4**	**2.2**	**444070.2**	**140.3**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

2.6.3.7 Subunit #7 - Slocum Lake

Lake Location, Ownership, Use, and Morphometric Information

This natural pothole slough of glacial origin is located in the eastern portion of the Slocum Lake Drain/Fiddle Creek Watershed in unincorporated Wauconda Township near the border of Lake and McHenry Counties. Slocum Creek (also known as Bangs Lake Drain) enters the lake along the eastern shore and exits as Slocum Lake Drain over a dam spillway (built in the early 1900s) along the southern shore. Slocum Lake Drain flows approximately ¾ miles to its confluence with Fiddle Creek which then continues about ¼ mile to the Fox River.

Lake bottom ownership is a mix of organizations (Mylith Park Association, Williams Park Improvement Association, and Water's Edge Homeowners Association) and numerous private individuals. The lake is used recreationally for fishing, swimming, and boating by the members of the various associations and private homeowners around the lake. Slocum Lake's morphometric information is provided below (Table 66).

Table 66. Slocum Lake morphometric information.

Illinois EPA lake code	IL_RTPI
Surface Area[a]	216.9 ac
Maximum Depth[a]	7.02 ft
Average Depth[a]	3.77 ft
Volume[a]	817.64 ac-ft
Shoreline Length[a]	3.79 mi
Lake Elevation[a]	736.32 ft above MSL
Watershed Area[b]	5,383.5 ac
Watershed to lake ratio	25:1
Average Water Residence Time / Flushing Time	0.17 yr (60 days) / 6.05 times per yr

a From Slocum Lake bathymetric map, LCHD (2010). b Determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area.

From the early 1900s until the late 1990s, the Wauconda Wastewater Treatment Plant discharged treated effluent into Slocum Creek. Additionally, at times when sewage inflows exceeded the plant's capacity, raw effluent was discharged to Slocum Creek.[90] While Slocum Lake probably always has been turbid due to its shallow nature and slough origin, the long-term addition of wastewater effluent, both treated and untreated, has accelerated Slocum Lake's eutrophication and contributed to its high nutrient levels. Since the late 1990s, the wastewater treatment plant has discharged to Fiddle Creek, thus bypassing Slocum Lake. Still, the impacts

[90] LCHD. *2001 Summary Report of Slocum Lake,* by Brant, Christina, M. Adam, M. Colwell, J. Marencik, M. Pfister. Waukegan, IL: LCHD 2002 http://health.lakecountyil.gov/Population/LMU/Lakes/slocumlake.pdf.

of these discharges are reflected in the lake's water quality and will continue to be for many years.

Water Quality Conditions

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[91] is based on water sampling conducted by the LCHD—Lakes Management Unit in 2001 and 2005 at one mid-lake monitoring site (Figure 76). The lake exhibited poor water quality with low Secchi transparency (average of about 1 foot water clarity) and high total phosphorus, total suspended solids, total solids, and total volatile solids concentrations (two-year average of 0.166, 46.4, 623, and 175, respectively; Table 67). Slocum Lake is a hypereutrophic system as indicated by its mid- to upper 70s trophic state index ($TSI_{phosphorus}$) (76.4 in 2005 and 79.2 in 2001).[92]

Table 67. Average annual water quality characteristics for Slocum Lake.

IEPA lake code		IL_RTP	
Year		2001	2005
Parameter	*Units*	*Average*	
Secchi transparency	feet	0.93	1.03
	inches	11	12
Total Phosphorus (TP)	mg/L	0.182	0.150
Soluble Reactive Phosphorus (SRP)	mg/L	0.007[k]	0.007[k]
Dissolved Phosphorus (DP)	mg/L	---	---
Total Kjeldahl Nitrogen (TKN)	mg/L	2.26	2.90
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	---
Nitrate Nitrogen (NO_3)	mg/L	0.057[k]	0.050[k]
Ammonia Nitrogen (NH_3)	mg/L	0.100[k]	0.100[k]
Total Suspended Solids (TSS)	mg/L	39.2	53.6
Volatile Suspended Solids (VSS)	mg/L	---	---
Total Solids (TS)	mg/L	543	703
Total Volatile Solids (TVS)	mg/L	166	183
Chloride (Cl)	mg/L	---	257
Conductivity	µS/cm	812	1,119
pH	units	8.43	9.16
Alkalinity	mg/L	147	125
Chlorophyll *a* (corrected)	µg/L	---	---

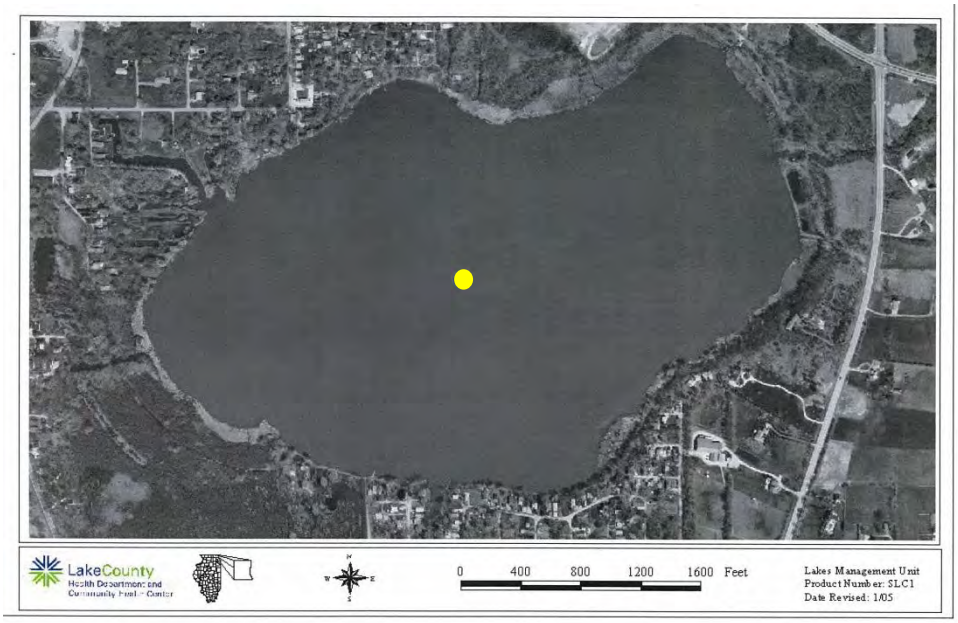
k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

[91] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012

[92] LCHD. *2005 Summary Report of Slocum Lake,* by Davis, Adrienne, M. Adam, L. Dane, S. Keseley. Waukegan, IL: LCHD undated. http://health.lakecountyil.gov/Population/LMU/Lakes/Slocum05.pdf

Daytime dissolved oxygen levels remained adequate for the support of aquatic life throughout the water column (above 5 mg/L) as measured at the monitoring site except on two dates in the bottom one to three feet of the lake during June and July 2001.

Figure 76. Water quality monitoring site location in Slocum Lake.



Aquatic plants were present in relatively small amounts during the monitoring season, with the invasive exotic Eurasian watermilfoil (*Myriophyllum spicatum;* EWM) and the native coontail (*Ceratophyllum demersum*) dominating the population. Other plant species observed were the invasive exotic curlyleaf pondweed (*Potamogeton crispus*, CLP) and the native sago pondplant (*Stukenia pectinata*).

Conductivity measurements averaged 966 µS/cm over the two sampling seasons. Chloride concentrations averaged 257 mg/L in 2005. Water quality parameter averages based on LCHD data[93] are provided in Table 67.

LCHD's 2001 and 2005 Slocum Lake summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). It is expected that LCHD's 2013 Slocum Lake summary report will be added to this website in 2014.

Lakeshore Buffer Condition

For Slocum Lake, full details for each segment are featured in Appendix A. Here, a summary is provided in Table 68 and Figure 77.

[93] Mike Adam, Sr. Biologist, Lake County Health Dept. (LCHD), e-mail message with attached data to the author(s), February 2013.

Table 68. Slocum Lake 2013 lakeshore buffer condition assessment summary

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Slocum Lake	15	18,030	11,255	62.5	2,255	12.5	4,520	25.0
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 77. Slocum Lake 2013 lakeshore buffer condition.

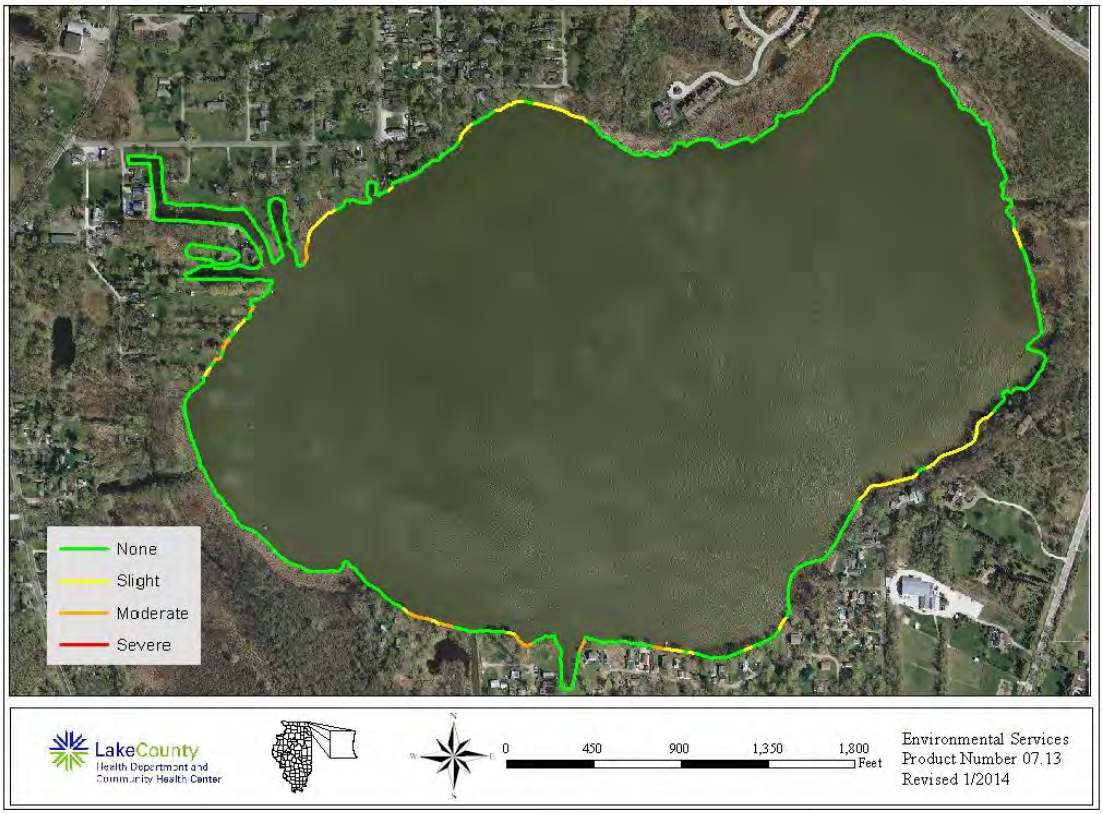
Shoreline Erosion Condition

LCHD's 2013 assessment of shoreline erosion conditions indicated that about 16 percent had some degree of erosion: 12 percent slight and four percent moderate erosion (Table 69, Figure 78). The 2013 numbers indicate about a 20 percent decrease in overall erosion, apparently associated with an increase in the extent of cattails along the southern and southeastern shorelines. While the extent of moderately eroding shoreline decreased about 25% between 2001 and 2013, the extent with slight erosion increased about five percent.

Table 69. Slocum Lake 2013 shoreline erosion assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Slocum Lake	50	18,153	15,167	83.6	2,238	12.3	748	4.1	0	0
from Lake Co. Health Department lake shoreline erosion assessment GIS data (2014)										

Figure 78. Slocum Lake 2013 shoreline erosion condition.



Land Use

Land use within the 2,433 acre Slocum Lake subunit is dominated by residential use, which makes up over 42 percent of the area (Table 70). Residential use is interspersed with lesser amounts of industrial, commercial, and institutional land use. The second largest land use category, agricultural land, makes up 13.6 percent of the area and is principally located in the central portion of the subunit (Figure 79).

Figure 79. Land use within Slocum Lake subunit.

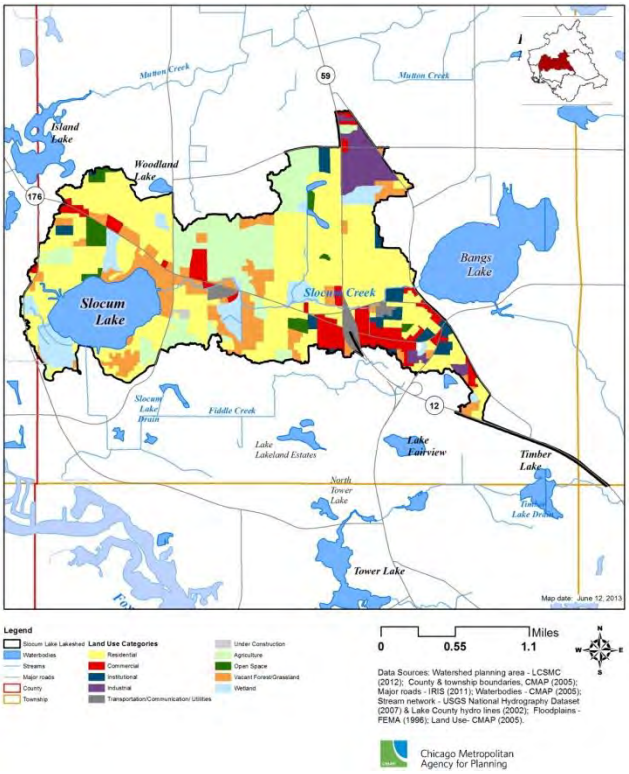


Table 70. 2005 Land use distribution within Slocum Lake subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	1029.0	1.6	42.3
Commercial	165.2	0.3	6.8
Institutional	66.6	0.1	2.8
Industrial	95.1	0.1	3.9
Transportation/ Communication/ Utilities	37.4	0.06	1.5
Under Construction	4.6	<0.01	0.1
Agriculture	330.1	0.5	13.6
Open Space	49.2	0.08	2.0
Vacant Forest/Grassland	280.7	0.4	1.5
Wetland	152.8	0.2	6.3
Water	222.6	0.3	9.2
Totals	2433.3	3.8	100.0

Soils

Soils within the Slocum Lake subunit are primarily "Not Hydric." "All Hydric" soils make up 22.8 percent of the subunit and are spatially interspersed throughout the area (Table 71, Figure 80).

Figure 80. Hydric soils within Slocum Lake subunit.

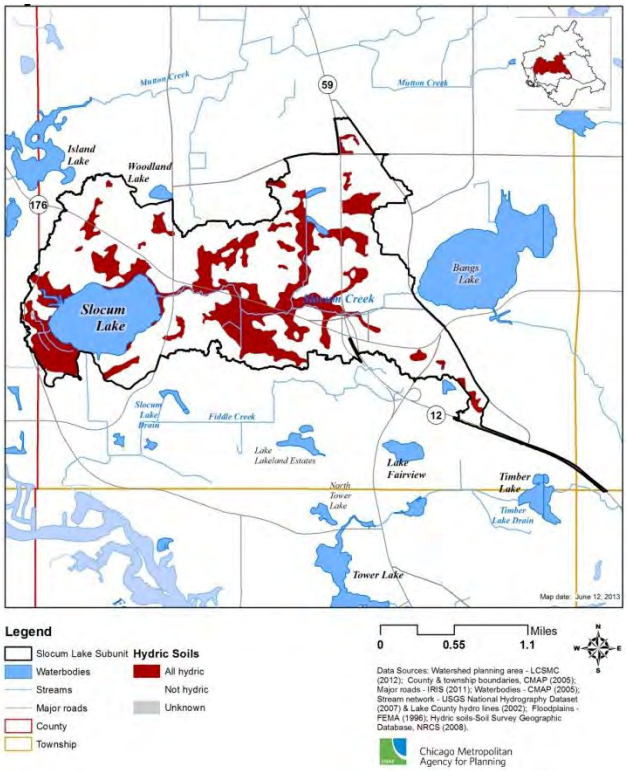


Table 71. Hydric soil acreage within Slocum Lake subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	555.5	22.8
Not hydric	1659.2	68.2
Unknown	218.5	9.0

The dominant hydrologic soil group in the Slocum Lake subunit is Group C (48.6 percent), followed by Group B (34.4 percent). Other soil types are present, though minimal (Table 72, Figure 81).

Figure 81. Hydrologic soil groups within Slocum Lake subunit.

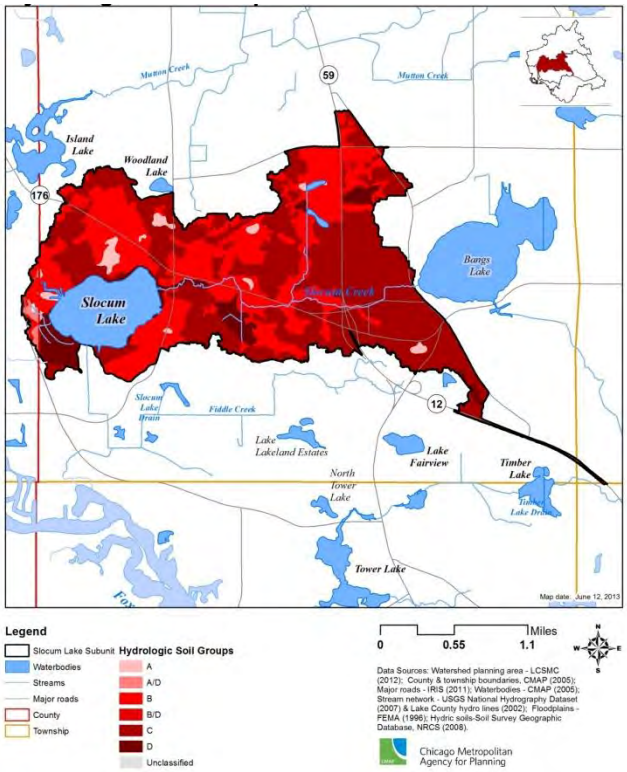
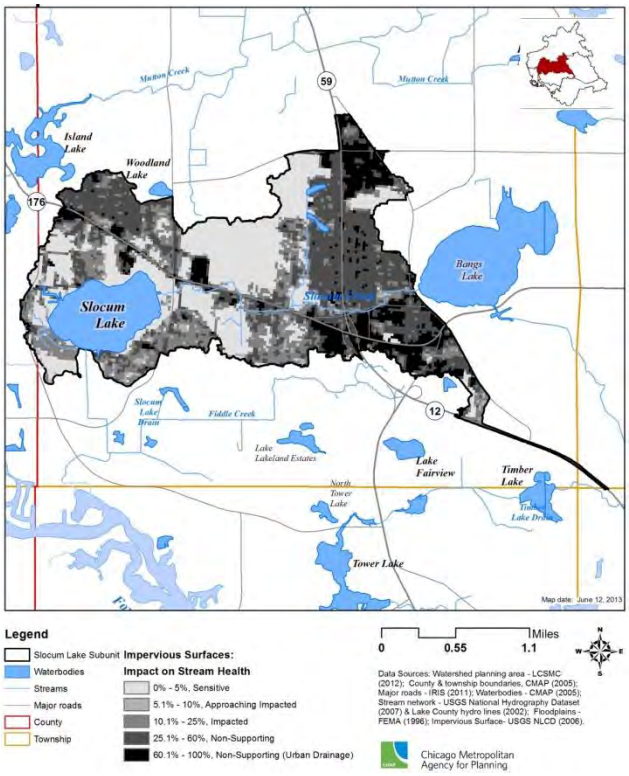


Table 72. Hydrologic soil groups within Slocum Lake subunit.

Hydrologic Soil Group	*Area (Acres)*	*Percent of Subunit*
A	42.4	1.7
A/D	13.1	0.5
B	836.4	34.4
B/D	3.1	0.1
C	1181.2	48.6
D	138.6	5.7
Unclassified	218.6	9.0

Figure 82. Impervious cover within Slocum Lake subunit.



Impervious Cover

The impervious surface coverage in the Slocum Lake subunit is 25.2 percent, which is highest in the 9 Lakes Planning Area (Figure 82). Imperviousness is greater in the vicinity of Slocum Creek, north of Slocum Lake. This quantity of impervious surfaces throughout the subunit translates to a stream health classification of "Non-Supporting" (Table 5). Impervious surface projections to the year 2040 suggest that Slocum Lake subunit will reach an impervious surface coverage of 29.2 percent. This is a relatively significant increase and will maintain the subunit's status of highest imperviousness. The stream health classification for the Slocum Lake subunit will remain "Non-Supporting."

Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for the Slocum Lake subunit are found in Table 73.

Table 73. Slocum Lake subunit pollutant loads.

Land Use	*Acre*	*Run off (ac-ft)*	*Chloride (lbs/yr)*	*CL (lbs /ac)*	*Nitro gen (lbs /yr)*	*N (lbs /ac)*	*Phos phor (lbs /yr)*	*P (lbs /ac)*	*Bact. (bill col /yr)*	*Bac (bilcol /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	898.6	726.7	136704.8	152.1	3517.5	3.9	367.9	0.4	3928.1	4.4	221131.7	246.1
1120 RES/ FARM	25.7	15.9	1536.0	59.8	54.4	2.1	6.6	0.3	67.2	2.6	2749.2	106.9
1130 RES/MF	13.0	13.9	2886.8	221.8	62.4	4.8	5.9	0.4	67.5	5.2	4540.8	348.9
1140 RES/ MOBI HM	13.8	15.5	6150.3	445.6	133.0	9.6	12.5	0.9	143.7	10.4	9674.3	700.9
1212 RETA CNTR	9.8	14.1	4416.2	448.5	95.5	9.7	14.6	1.5	29.7	3.0	4917.5	499.4
1231 URB MX W/PRK	154.0	218.4	71769.6	466.0	1372.4	8.9	169.7	1.1	481.9	3.1	79916.4	518.9
1310 MEDICAL	4.6	6.8	2833.5	618.5	61.3	13.4	8.0	1.8	19.0	4.2	2343.4	511.5
1320 EDUCATI	17.5	24.7	6606.7	377.8	142.8	8.2	18.7	1.1	44.4	2.5	5463.9	312.5
1330 GOVT	3.9	5.8	803.0	206.1	17.4	4.5	2.3	0.6	5.4	1.4	664.1	170.5
1350 RELIGOUS	11.3	16.6	4915.5	436.8	106.3	9.4	13.9	1.2	33.0	2.9	4065.3	361.2
1360 CEMETRY	7.2	4.5	687.1	95.3	14.4	2.0	2.1	0.3	2.6	0.4	568.3	78.8
1370 INST/ OTHER	0.9	1.1	156.6	168.9	2.5	2.7	0.3	0.3	1.1	1.1	60.9	65.7
1420 MAN/ PROC	2.8	3.4	549.7	194.2	9.7	3.4	1.2	0.4	3.7	1.3	683.4	241.5
1430 WAR /DIS/WHO	20.6	28.3	10457.0	508.6	183.7	8.9	21.9	1.1	70.2	3.4	11644.0	566.4
1440 INDU PARK	77.9	106.9	38765.5	497.4	681.0	8.7	81.2	1.0	260.3	3.3	48194.9	618.4
1512 OTHR ROADWY	36.8	77.5	25279.8	686.6	392.9	10.7	58.1	1.6	115.4	3.1	53292.6	1447.5
1520 OTHR TRA CORR	2.6	5.5	981.2	381.2	15.2	5.9	2.3	0.9	4.5	1.7	2068.6	803.7
1560 UTIL/ WAST/WA	4.8	5.7	2659.7	554.2	37.7	7.9	6.1	1.3	10.0	2.1	2199.6	458.3
2100 CROP /GRAIN/ GRAZING	236.5	203.2	446.3	1.9	3482.2	14.7	294.2	1.2	508.9	2.2	652149.4	2758.0
2200 NSRY /GRN/ORC	11.6	3.9	9.1	0.8	35.9	3.1	4.0	0.3	10.3	0.9	1915.6	164.6
2400	42.0	28.2	40.4	1.0	315.4	7.5	23.5	0.6	158.9	3.8	8528.1	203.1

EQUESTRI												
3100 OPEN SPA/RECR	45.1	23.3	57.3	1.3	78.7	1.7	18.9	0.4	65.1	1.4	3274.7	72.5
3300 OPEN SPA/CONS	2.0	0.9	1.1	0.6	0.8	0.4	0.2	0.1	0.6	0.3	28.6	14.5
3400 OPEN SPA/PRIVT	118.7	41.8	74.5	0.6	57.3	0.5	12.3	0.1	42.3	0.4	1965.1	16.6
3500 OPEN SPA/CORR	7.4	2.5	4.7	0.6	3.6	0.5	0.8	0.1	2.6	0.4	122.9	16.6
3600 OPEN SPA/OTHR	4.2	1.1	3.4	0.8	2.7	0.6	0.6	0.1	2.0	0.5	90.9	21.5
4110 VAC FOR/GRAS	278.3	117.2	228.6	0.8	351.7	1.3	32.7	0.1	129.8	0.5	12058.0	43.3
4120 WETLAND	152.2	127.2	336.9	2.2	259.1	1.7	3.7	0.0	73.6	0.5	296.2	1.9
4300 OTHR VACANT	1.6	0.4	1.1	0.7	1.7	1.0	0.2	0.1	0.6	0.4	56.6	36.0
5200 LAK/ RES/LAGO	228.0	483.2	144482.1	633.8	451.5	2.0	30.1	0.1	239.3	1.0	1444.8	6.3
Grand Totals	**2433.3**	**2324.1**	**463844.6**	**190.6**	**11940.6**	**4.9**	**1214.4**	**0.5**	**6521.5**	**2.7**	**1136109.8**	**466.9**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Slocum Lake's epilimnion[94] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[95] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 1,245 lbs/yr P from average annual land runoff (Table 73 + estimated P export of 31 lbs/yr from upstream Bangs Lake).[96]

Together with other model parameters set for Slocum Lake – mean depth: 1.15 m; lake retention or residence time: 0.17 yr.[97]; surface area: 214.6 ac – the CB model predicted an average annual

[94] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[95] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[96] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[97] Lake residence time is lake volume divided by avg. annual inflow. For Slocum Lake: 817.64 ac ft / 4,950 ac ft per yr = 0.1652 yr. The reciprocal equation is "lake flushing time" or 6.05 times per year which is the value used in the CB model.

epilimnetic TP of 0.046 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that meets the applicable water quality standard.

Data available from samples taken from Slocum Lake reveal TP concentrations with an average of 0.166 mg/L over two growing seasons (2001, 2005).[98] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield the observed average TP concentration of 0.166 mg/L. This exercise resulted in an average influx of 7,442 lbs/yr, of which land runoff explains only about 17 percent (1,245 / 7,442) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 1,292 lbs/yr. When compared to the estimated total influx of 7,442 lbs/yr, an 83 percent reduction in annual TP influxes (6,150 lbs/yr) will be needed. Because only 1,245 lbs/yr is potentially contributed by land runoff, in-lake management practices will likely be required in addition to any on-the-ground BMPs implemented within the lake's watershed.

2.6.3.8 Subunit #8 - Slocum Lake Drain / Fiddle Creek

The following information summarizes the land use, soil classifications and impervious surface cover within the Slocum Lake Drain / Fiddle Creek subunit. This subunit consists of 1,606 acres within the 9 Lakes Planning Area. The study area encompasses the Slocum Lake Drain below Slocum Lake and the Fiddle Creek subwatershed.

[98] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

Land Use

Land Use in the Slocum Lake Drain / Fiddle Creek subunit is diverse, yet predominantly residential (37 percent; Table 74). Residential use is concentrated in eastern and western portions of the area, with open an expanse of open space, agriculture and vacant forest/ grassland in the central portion of the subunit (Figure 83).

Figure 83. Land use distribution within Slocum Lake Drain/Fiddle Creek subunit.

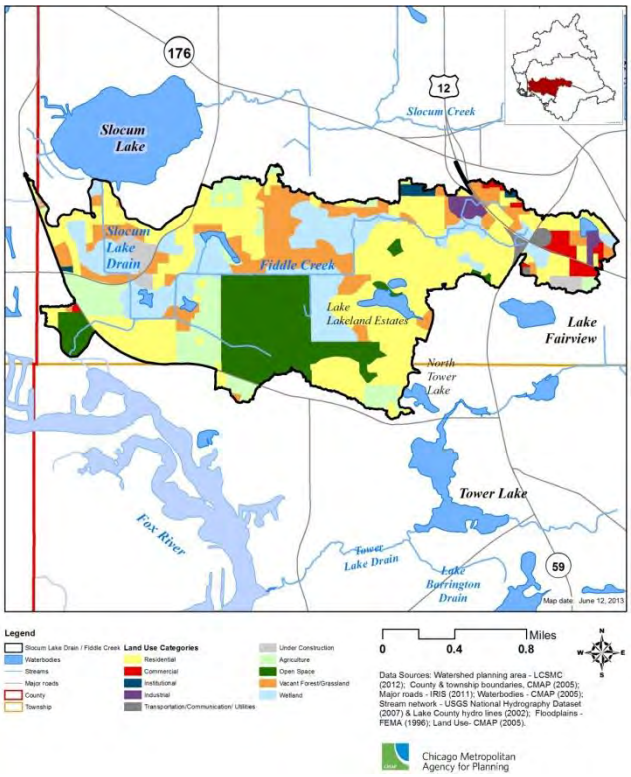


Table 74. 2005 Land use distribution within Slocum Lake Drain / Fiddle Creek subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	594.7	0.9	37.0
Commercial	29.1	0.05	1.8
Institutional	10.1	0.02	0.6
Industrial	19.8	0.03	1.2
Transportation/ Communication/ Utilities	14.8	0.02	0.9
Under Construction	28.9	0.05	1.8
Agriculture	151.4	0.2	9.4
Open Space	244.6	0.4	15.2
Vacant Forest/Grassland	221.3	0.4	13.9
Wetland	259.7	0.4	16.2
Water	31.5	0.05	2.0
Totals	1,606.0	2.5	100.0

Soils

The majority of soils in the Slocum Lake Drain/ Fiddle Creek subunit are classified as "Not Hydric" (63.7 percent; Table 75). "All Hydric" soils make up just over 34 percent of the subunit and are spatially interspersed throughout the subunit (Figure 84).

Figure 84. Hydric soils within Slocum Lake Drain / Fiddle Creek subunit.

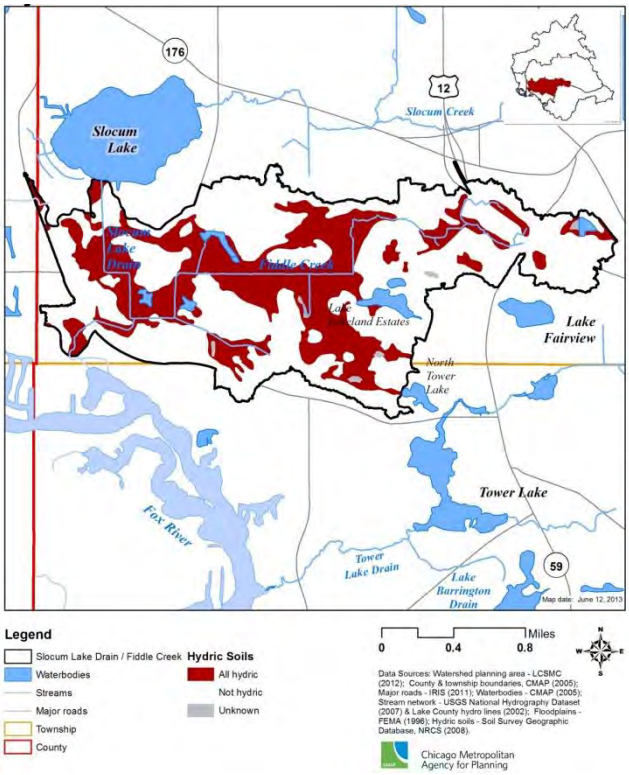


Table 75. Hydric soil acreage within Slocum Lake Drain / Fiddle Creek subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	548.4	34.1
Not hydric	1021.2	63.7
Unknown	36.4	2.2

The dominant Hydrologic Soil Group in the Slocum Lake Drain / Fiddle Creek subunit is "Group C" which makes up 48.8 percent of the area (Table 76). The "Group A" soil group makes up about a quarter of the subunit and is concentrated in the area adjacent to Fiddle Creek (Figure 85).

Figure 85. Hydrologic soil groups within Slocum Lake Drain / Fiddle Creek subunit.

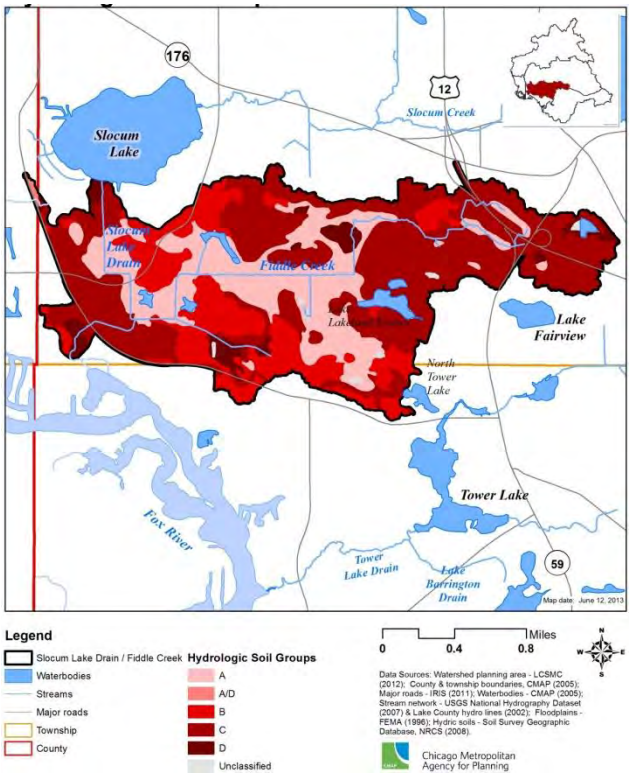


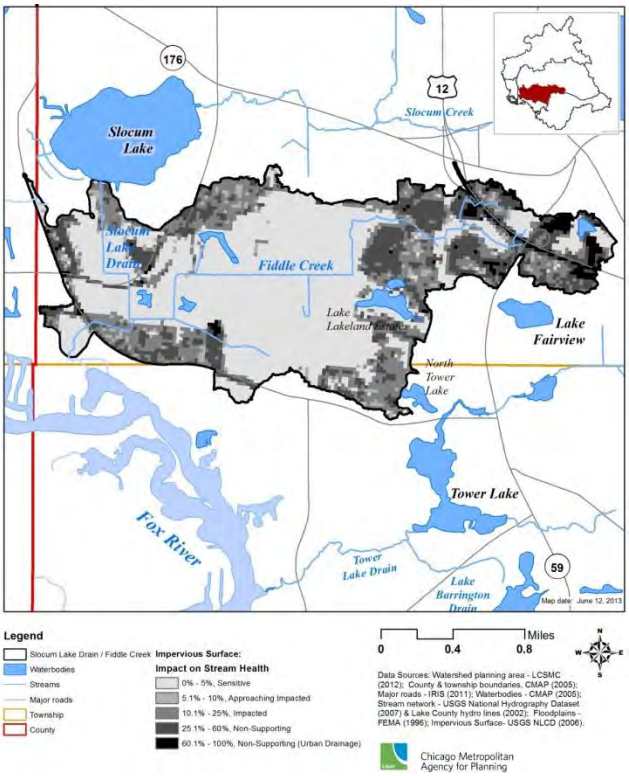
Table 76. Hydrologic soil groups within Slocum Lake Drain / Fiddle Creek subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	390.9	24.4
A/D	2.3	0.1
B	323.4	20.1
C	783.6	48.8
D	69.5	4.3
Unclassified	36.5	2.3

Impervious Cover

Impervious surfaces in the Slocum Lake Drain/ Fiddle Creek subunit cover approximately 13.4 percent of the area (Figure 86). This level of imperviousness translates to a stream health classification of "Impacted" (Table 5). The future degree of impervious surface in the subunit is estimated to reach 17.6 percent by 2040. This 31 percent increase is significant in and of itself, yet the stream health category will remain "Impacted."

Figure 86. Impervious surfaces within Slocum Lake Drain/ Fiddle Creek subunit.



Pollutant Loads

Pollutant loads were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for Slocum Lake Drain / Fiddle Creek subunit are found in Table 77.

Table 77. Pollutant loads within Slocum Lake Drain / Fiddle Creek subunit.

Land Use	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs/yr)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos phor (lbs /yr)*	*P (lbs /ac)*	*Bac. (bill col /yr)*	*Bac. (bill col /ac)*	*TSS (lbs/ yr)*	*TSS (lbs /ac)*
1110 RES/SF	531.6	361.3	52235.6	98.3	1785.1	3.4	211.9	0.4	2073.8	3.9	89197.6	167.8
1120 RES/FARM	29.8	13.2	839.8	28.2	49.1	1.6	6.9	0.2	64.0	2.1	1759.4	59.1
1140 RES/ MOB HM	15.2	17.4	5200.9	341.8	112.5	7.4	10.5	0.7	121.5	8.0	8180.9	537.7
1231 URB MX W/PRK	17.0	25.2	6788.7	400.2	129.8	7.7	16.1	0.9	45.6	2.7	7559.3	445.6
1250 HOTL /MOTEL	5.0	5.6	2310.2	465.6	33.7	6.8	3.6	0.7	15.5	3.1	1910.6	385.1
1310 MEDICAL	5.5	8.2	1930.6	348.8	41.7	7.5	5.5	1.0	13.0	2.3	1596.6	288.4
1330 GOVT	0.1	0.1	18.6	326.2	0.4	7.1	0.1	0.9	0.1	2.2	15.4	269.8
1350 RELIGOUS	1.2	1.8	344.2	280.9	7.4	6.1	1.0	0.8	2.3	1.9	284.6	232.3
1420 MAN/ PROC	0.0	0.0	0.7	194.8	0.0	3.4	0.0	0.4	0.0	1.3	0.9	242.2
1430 WAR/ DIST/WHO	24.5	36.2	12540.7	511.0	220.3	9.0	26.3	1.1	84.2	3.4	13964.2	569.0
1512 OTHR ROADWY	16.2	34.3	12875.7	795.6	200.1	12.4	29.6	1.8	58.8	3.6	27143.3	1677.2
1560 UTIL/ WAST/WA	1.1	1.4	223.1	195.8	3.2	2.8	0.5	0.4	0.8	0.7	184.5	161.9
2100 CROP /GRAIN/ GRAZING	47.3	43.5	62.9	1.3	490.8	10.4	40.5	0.9	120.3	2.5	72455.7	1533.1
2200 NRSY/ GRN/ORC	8.4	2.9	7.2	0.9	28.4	3.4	3.2	0.4	8.2	1.0	1516.3	180.9
2400 EQUESTRI	38.9	27.2	47.3	1.2	369.1	9.5	27.6	0.7	186.0	4.8	9981.9	256.5
3100 OPEN SPA/RECR	9.8	4.9	11.7	1.2	16.1	1.6	3.9	0.4	13.3	1.4	669.8	68.4
3300 OPEN SPA/CONS	207.4	61.9	153.5	0.7	118.1	0.6	25.3	0.1	87.2	0.4	4049.5	19.5
3400 OPEN SPA/PRIV	93.6	30.0	54.0	0.6	41.6	0.4	8.9	0.1	30.7	0.3	1425.5	15.2
3500 OPEN SPA/CORR	1.3	0.6	0.5	0.4	0.4	0.3	0.1	0.1	0.3	0.2	12.6	9.6
4110 VAC FOR/GRAS	247.9	91.9	152.5	0.6	234.6	0.9	21.8	0.1	86.6	0.3	8044.4	32.4
4120	257.7	215.5	588.2	2.3	452.4	1.8	6.5	0.0	128.5	0.5	517.1	2.0

WETLAND												
5200 LAKE /RES/LAG	46.4	98.3	35161.7	758.2	109.9	2.4	7.3	0.2	58.2	1.3	351.6	7.6
Grand Totals	**1606.0**	**1081.3**	**131548.3**	**81.9**	**4444.7**	**2.8**	**456.8**	**0.3**	**3198.8**	**2.0**	**250821.7**	**156.2**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Tower Lake Drain Watershed

2.6.3.9 Subunit #9 - Timber Lake

Lake Location, Ownership, Use, and Morphometry

This impoundment lake, created in 1949 by the damming of a stream and dredging of adjacent wetlands,[99] sits in the east-central portion of the Tower Lake Drain Watershed in unincorporated Lake County. The lake itself straddles the Wauconda-Cuba Township line; its drainage area extends into Ela and Fremont Townships. Most of the lake bottom is privately owned by the landowners around the lakeshore; a portion adjacent to the community park and beach is organizationally owned by the Timberlake Civic Association. The lake is used recreationally for fishing, swimming, non-power boating, and aesthetic enjoyment. Access is open to Timberlake Civic Association members and their guests. Water flows from the lake over a spillway dropbox at its western shore, flowing via Timber Lake Drain to Tower Lake approximately 1.5 river miles downstream. Timber Lake's morphometric data is presented in Table 78.

Table 78. Timber Lake morphometric information.

Illinois EPA lake code	IL_RTZQ
Surface Area[a]	32.4 ac
Maximum Depth[a]	14.0 ft
Average Depth (estimated)[a]	7.6 ft
Volume (estimated)[a]	244.0 ac-ft
Shoreline Length[a]	1.5 mi
Lake Elevation[a]	774.0 ft above MSL
Watershed Area[b]	1,141.3 ac
Watershed to lake ratio	35:1
Average Water Residence Time / Flushing Time	0.27 yr (100 days) / 3.65 times per yr

a From 2007 Summary Report of Timber Lake, LCHD (undated).
b Determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area.

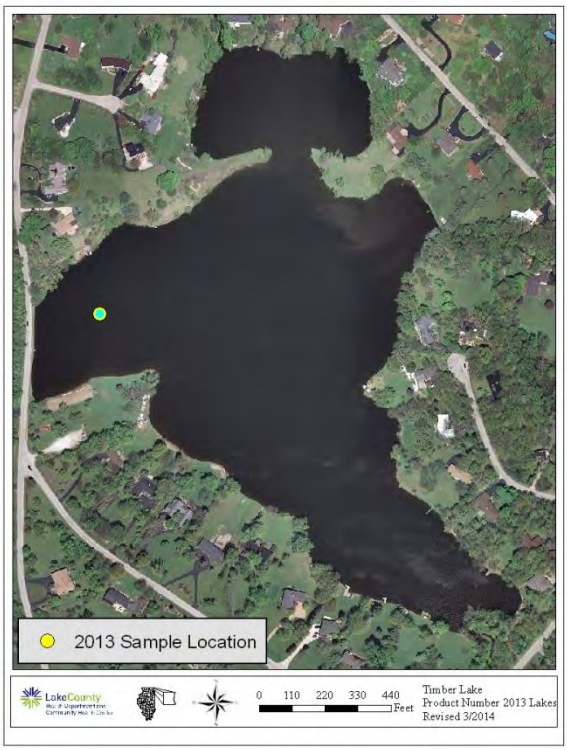
[99] Lake Co. Health Dept., Lakes Management Unit. *2000 Summary Report of Timber Lake,* by Marencik, Joseph, M. Adam, M. Colwell, M. Pfister. Waukegan, IL: LCHD, 2001. http://health.lakecountyil.gov/Population/LMU/Lakes/timber2.pdf

Water Quality Conditions

Timber Lake has suffered from a variety of lake quality issues since at least the late 1950s, a decade after its creation. Challenges have included overabundant aquatic plants, unbalanced fishery, severe algal blooms, and nutrient enrichment. Various management activities have been implemented over the years, including partial fishery rehabilitations (late 1950s into late 1960s), as needed aquatic herbicide and algicide applications since at least the late 1950s to present, stocking of triploid grass carp in the late 1980s, aeration from the late 1980s into the 2000s, and weed harvesting and milfoil weevil stocking in the mid-2000s [100,101] —all with varying levels and time periods of effectiveness.

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[102] is based on monitoring conducted at Timber Lake by the LCHD Lakes Management Unit in 2000 and 2007. The sampling site is located in the lake's deepest area in the central portion of the western bay Figure 87.

Figure 87. Water quality monitoring site location in Timber Lake.



Timber Lake exhibited Secchi transparencies ranging from less than 1.5 feet to nearly 5.75 feet over the two monitoring seasons, averaging 2.4 feet in 2000 and 3.5 feet in 2007. The two-year average for total phosphorus was 0.099 mg/L. Total suspended solids, total solids, and total volatile solids concentration two-year averages of 14.7, 545, and 133 mg/L, respectively, indicate turbid water conditions. A trophic state index ($TSI_{phosphorus}$) of 72.0 in 2000 [103] and 68.2 in 2007 [104] places Timber Lake into the eutrophic to hypereutrophic category.

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[100] Illinois DNR, Div. of Fisheries. *Lake County Surface Water Resources* by Tichacek, Gregg and H. Wight. Springfield, IL: IDNR, 1972.

[101] Notes recorded by VLMP participants at Timber Lake on Secchi monitoring forms, 1987 – 2006, on file at CMAP, Chicago, IL.

[102] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA, 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012

[103] Lake Co. Health Dept., Lakes Management Unit. *2000 Summary Report of Timber Lake,* by Marencik, Joseph, M. Adam, M. Colwell, M. Pfister. Waukegan, IL: LCHD, 2001. http://health.lakecountyil.gov/Population/LMU/Lakes/timber2.pdf

[104] Lake Co. Health Dept., Lakes Management Unit. *2007 Summary Report of Timber Lake,* by Keseley, Shaina, M. Adam, L. Dane, A. Orr. Waukegan, IL: LCHD, undated. http://health.lakecountyil.gov/Population/LMU/Lakes/Copy%20of%202007Timber(S).pdf

Dissolved oxygen/temperature profiles indicated stratification was in place on all but one monitoring date over the two monitoring seasons. Dissolved oxygen levels remained adequate for aquatic life (above 5 mg/L) in the epilimnion but fell below 5 mg/L in the hypolimnion (as would be expected under stratified conditions).

Conductivity measurements averaged 778 µS/cm in 2000 and 961 µS/cm in 2007. Chloride concentrations (which are one of the factors influencing conductivity readings) were measured in 2007 and averaged 159 mg/L. Water quality parameter averages based on LCHD data[105] are provided in Table 79.

Table 79. Timber Lake average annual water quality conditions.

IEPA lake code		IL_RTZQ	
Year		2000	2007
Parameter	*Units*	*Average*	
Secchi transparency	feet	2.37	3.51
	inches	28	42
Total Phosphorus (TP)	mg/L	0.110	0.085
Soluble Reactive Phosphorus (SRP)	mg/L	0.027[k]	0.021[k]
Dissolved Phosphorus (DP)	mg/L	---	---
Total Kjeldahl Nitrogen (TKN)	mg/L	1.63	1.28
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	0.088[k]
Nitrate Nitrogen (NO_3)	mg/L	0..477[k]	---
Ammonia Nitrogen (NH_3)	mg/L	0.130[k]	0.144[k]
Total Suspended Solids (TSS)	mg/L	15.0	14.5
Volatile Suspended Solids (VSS)	mg/L	---	---
Total Solids (TS)	mg/L	522	569
Total Volatile Solids (TVS)	mg/L	143	122
Chloride (Cl)	mg/L	---	159
Conductivity	µS/cm	778	961
pH	units	8.40	8.57
Alkalinity	mg/L	186	192
Chlorophyll *a* (corrected)	µg/L	---	---

k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

An aquatic plant survey conducted in July 2007 revealed low species diversity and abundance. Eight species were found, with the invasive exotic Eurasian water milfoil (*Myriophyllum spicatum*) the most abundant at nine percent of the 149 plant sampling sites. The next most

[105] Mike Adam, Sr. Biologist, Lake County Health Dept. (LCHD), e-mail message with data attachment to author(s), February 2013.

abundant species were the native sago pondplant (*Stukenia pectinata*) and the exotic invasive curlyleaf pondweed (*Potamogeton crispus*) at two percent of the sampling sites.

LCHD's full 2000 and 2007 Timber Lake summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). It is expected that LCHD's 2013 Timber Lake summary report will be added to this website in 2014.

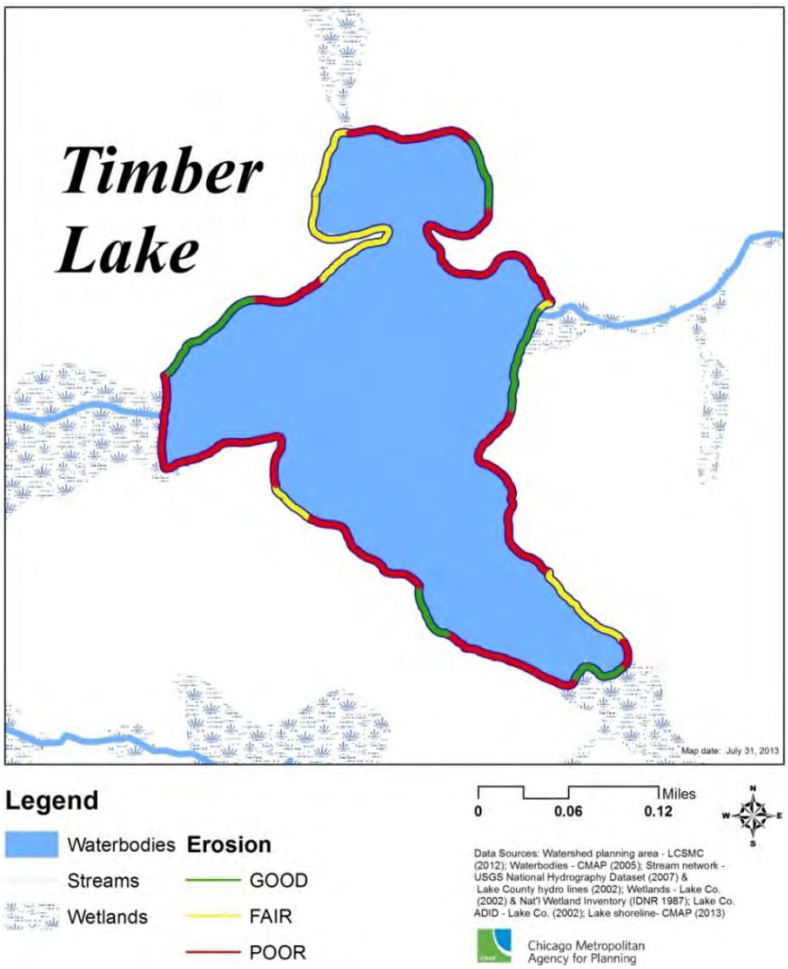
Lakeshore Buffer Condition

An explanation of the lakeshore buffer condition assessment methodology is provided under the Ozaukee Lake section. For Timber Lake, full details for each segment are featured in Appendix A. Here, a summary is provided in Table 80 and Figure 88.

Table 80. Timber Lake 2013 lakeshore buffer condition assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Timber Lake	33	7,515	2,565	34.1	1,290	17.2	3,660	48.7
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 88. Timber Lake 2013 lakeshore buffer condition.



Shoreline Erosion Condition

LCHD's 2013 assessment of shoreline erosion conditions at Timber Lake indicated that 61 percent of the shoreline had some degree of erosion, about a six percent increase since LCHD's 2007 assessment. In 2013, approximately 39 percent of the shoreline exhibited slight, 16 percent moderate, and six percent severe erosion (Table 81, Figure 89).

Table 81. Timber Lake 2013 shoreline erosion assessment summary.

Lake Name	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Timber Lake	7,433	2,932	39.4	2,866	38.6	1,205	16.2	429	5.8
From Lake Co. Health Department Timber Lake shoreline erosion assessment GIS data (2013).									

Figure 89. Timber Lake 2013 shoreline erosion.

Figure provided by Lake County Health Dept. (2014)

The following information summarizes the land use, soil classifications and impervious surface cover within the Timber Lake subunit. This subunit consists of 1,174 acres within the eastern portion of the 9 Lakes Planning Area (Figure 37).

Land Use

Land use in the Timber Lake subunit is primarily residential (58.7 percent; Table 82). Agricultural land makes up 19 percent of the subunit and is concentrated in the eastern portion of the area. Agricultural land is interspersed with wetland and other land use types with minimal extent (Figure 90).

Figure 90. Land use distribution within Timber Lake subunit.

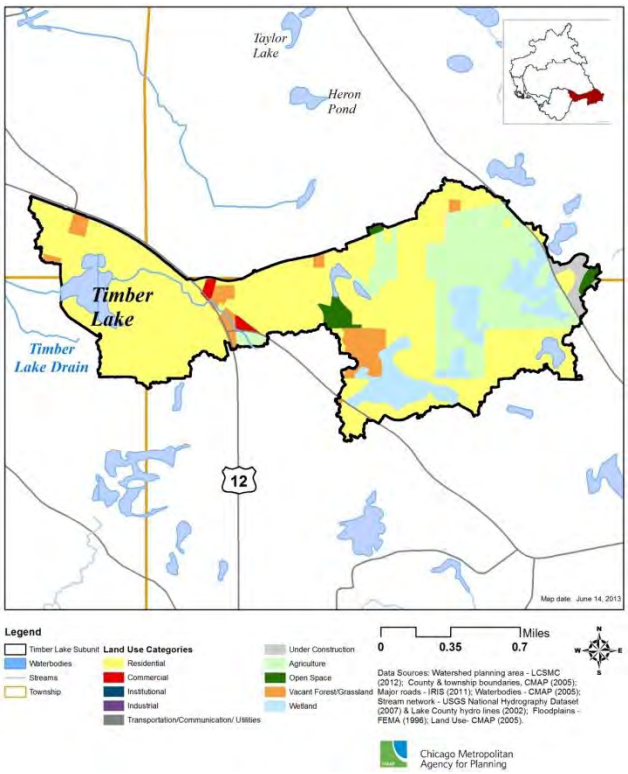


Table 82. 2005 Land use distribution within Timber Lake subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	689.4	1.1	58.7
Commercial	6.5	0.01	0.5
Under Construction	15.4	0.02	1.3
Agriculture	223.6	0.3	19.1
Open Space	19.6	0.03	1.7
Vacant Forest/ Grassland	53.7	0.08	4.6
Wetland	120.2	0.2	10.2
Water	34.6	0.05	2.9
Timber Lake	10.6	0.02	0.9
Totals	1,173.7	1.8	100.0

Soils

Soils within the Timber Lake subunit are predominantly "Not Hydric" (Table 83). "All Hydric" soils are evenly interspersed throughout the study area and represent nearly 25 percent of the subunit (Figure 91).

Figure 91. Hydric soils within Timber Lake subunit.

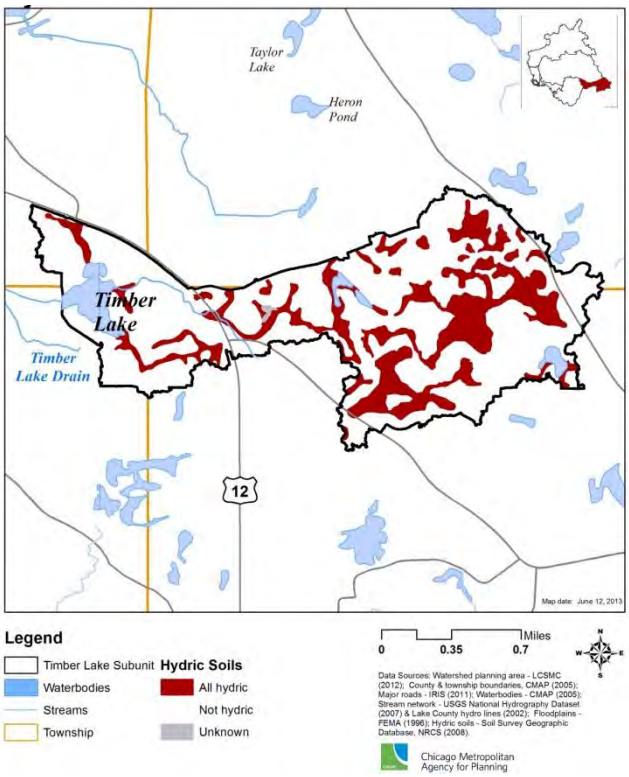


Table 83. Hydric soil acreage within Timber Lake subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	288.3	24.6
Not hydric	837.7	71.4
Unknown	47.8	4.0

There are four major hydrologic soil groups represented in the subunit, the majority of which are classified as "Group C" and cover 82.5 percent of the subunit area (Table 84, Figure 92).

Figure 92. Hydrologic soil groups within Timber Lake subunit.

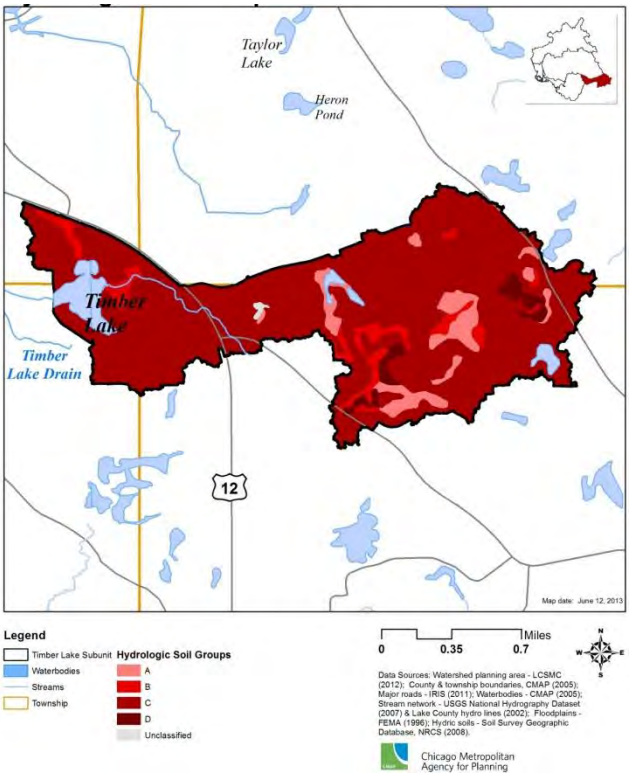


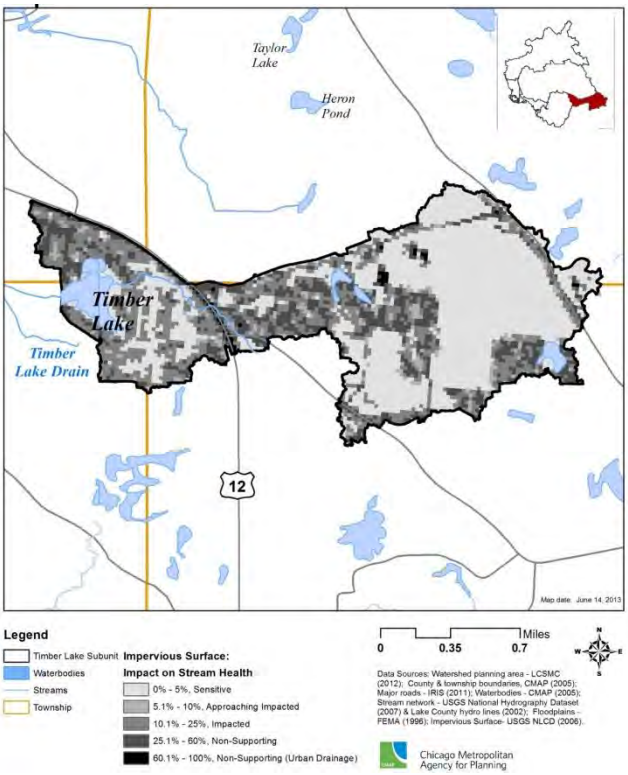
Table 84. Hydrologic soil groups within Timber Lake subunit.

Hydrologic Soil Group	*Area (scres)*	*Percent of Subunit*
A	68.4	5.8
B	58.9	5.0
C	968.5	82.5
D	30.1	2.6
Unclassified	47.8	4.1

Impervious Cover

The Timber Lake subunit includes 11.8 percent impervious surface area (Figure 93). This imperviousness is concentrated in the western half of the subunit and results in a stream health classification of "Impacted" (Table 5). Based on an estimate of future land use, impervious surface will grow to 15.9 percent of the subunit area; an increase of 35 percent. The stream health classification for the subunit will remain "Impacted."

Figure 93. Impervious cover within Timber Lake subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for the Timber Lake subunit are found in Table 85.

Table 85. Timber Lake subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs./yr.)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos phor (lbs /yr)*	*P (lbs /ac)*	*Bac. (bill col /yr)*	*Bac (bil col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	651.0	417.2	43373.3	66.6	2194.4	3.4	291.1	0.4	2651.9	4.1	81785.9	125.6
1120 RES/ FARM	17.3	16.3	3302.8	190.9	81.2	4.7	8.0	0.5	94.8	5.5	5453.4	315.1
1231 URB MX W/PRK	5.2	7.8	3507.3	669.7	67.1	12.8	8.3	1.6	23.5	4.5	3905.5	745.7
1512 OTHR ROADWY	3.4	7.3	1686.1	489.3	26.2	7.6	3.9	1.1	7.7	2.2	3554.6	1031.6
2100 CROP/ GRAIN/ GRAZING	163.6	156.0	389.4	2.4	3038.2	18.6	256.4	1.6	461.2	2.8	450902.1	2755.7
2400 EQUESTRI	14.9	12.4	28.1	1.9	219.2	14.7	16.4	1.1	110.5	7.4	5928.9	397.6
3100 OPEN SPA/RECR	12.4	5.2	9.6	0.8	13.2	1.1	3.2	0.3	10.9	0.9	547.2	44.3
3200 GOLF COURSE	4.8	2.4	6.0	1.2	23.7	4.9	4.0	0.8	6.8	1.4	443.0	91.8
3300 OPEN SPA/CONS	1.7	0.8	2.0	1.2	1.6	0.9	0.3	0.2	1.2	0.7	53.8	31.5
3400 OPEN SPA/PRIVA	62.8	26.3	52.1	0.8	40.1	0.6	8.6	0.1	29.6	0.5	1374.4	21.9
4110 VAC FOR/GRAS	62.2	28.8	53.8	0.9	82.8	1.3	7.7	0.1	30.6	0.5	2840.2	45.7
4120 WETLAND	124.2	103.8	258.5	2.1	198.8	1.6	2.8	0.0	56.5	0.5	227.3	1.8
5200 LAKE /RES/LAGO	50.3	106.6	37204.1	740.1	116.3	2.3	7.8	0.2	61.6	1.2	372.0	7.4
Grand Totals	**1173.8**	**890.8**	**89873.2**	**76.6**	**6102.8**	**5.2**	**618.3**	**0.5**	**3546.7**	**3.0**	**557388.2**	**474.9**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Timber Lake's epilimnion[106] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[107] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 618 lbs/yr P from average annual land runoff (Table 85).[108]

Together with other model parameters set for Timber Lake—mean depth: 7.6 ft (2.32 m); lake retention or residence time: 0.27 yr.[109]; surface area: 32.4 ac—the CB model predicted an average annual epilimnetic TP of 0.088 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that exceeds the applicable water quality standard.

Data available from samples taken from Timber Lake reveal TP concentrations with an average of 0.099 mg/L over two growing seasons (2000, 2007).[110] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield the observed average TP concentration of 0.099 mg/L. This exercise resulted in an average influx of 706 lbs/yr, of which land runoff explains about 88 percent (618 / 706) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 261 lbs/yr. When compared to the estimated total influx of 7062 lbs/yr, a 63 percent reduction in annual TP influxes (445 lbs/yr) will be needed. Because 618 lbs/yr is potentially contributed by land runoff, it is theoretically possible that the necessary P reduction could be achieved by on-the -ground BMPs implemented throughout the lake's watershed.

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[106] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[107] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[108] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[109] Lake residence time is lake volume divided by avg. annual inflow. For Timber Lake: 244 ac-ft / 891 ac-ft per yr = 0.274 yr. The reciprocal equation is "lake flushing time" or 3.65 times per year which is the value used in the CB model.

[110] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.10 Subunit #10 - Lake Fairview

Lake Location, Ownership, Use, and Morphometry

Lake Fairview lies in the north-central portion of the Tower Lake Drain Watershed in unincorporated Lake County in Cuba Township. This impoundment lake was created in 1969 under the supervision of the USDA Soil Conservation Service by the construction of an earthen mound that dammed a wetland.[111] The entire lake bottom is privately owned by the landowners around the lakeshore; there is no public access. The lake is used recreationally for fishing, swimming, non-power boating, and aesthetic enjoyment. Water flows from the lake through a corrugated metal pipe at its southeastern shore, flowing through wetlands to the Timber Lake Drain approximately half-mile downstream. Lake Fairview's morphometric data is presented in Table 86.

Table 86. Lake Fairview morphometric information.

Illinois EPA lake code	IL_STK
Surface Area[a]	20.5 ac
Maximum Depth[a]	10.0 ft
Average Depth (estimated)[a]	5.0 ft
Volume (estimated)[a]	102.3 ac-ft
Shoreline Length[a]	0.8 mi
Lake Elevation[a]	766.0 ft above MSL
Watershed Area[b]	52.4 ac
Watershed to lake ratio	3:1
Average Water Residence Time / Flushing Time	1.28 yr (467 days) / 0.78 times per yr

a) from 2007 Summary Report of Lake Fairview, Lake Co. Health Dept. (undated)
b) determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area

Water Quality Conditions

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[112] is based on monitoring conducted at Lake Fairview by the LCHD Lakes Management Unit in 2000 and 2007. The sampling site is located in the lake's deepest area slightly northeast of the lake's center (Figure 94).

[111] Lake Co. Health Dept., Lakes Management Unit. *2000 Summary Report of Lake Fairview*, by Adam, Michael D., M. Colwell, J. Marencik, M. Pfister. Waukegan, IL: LCHD, 2001 http://health.lakecountyil.gov/Population/LMU/Lakes/fairview.pdf.

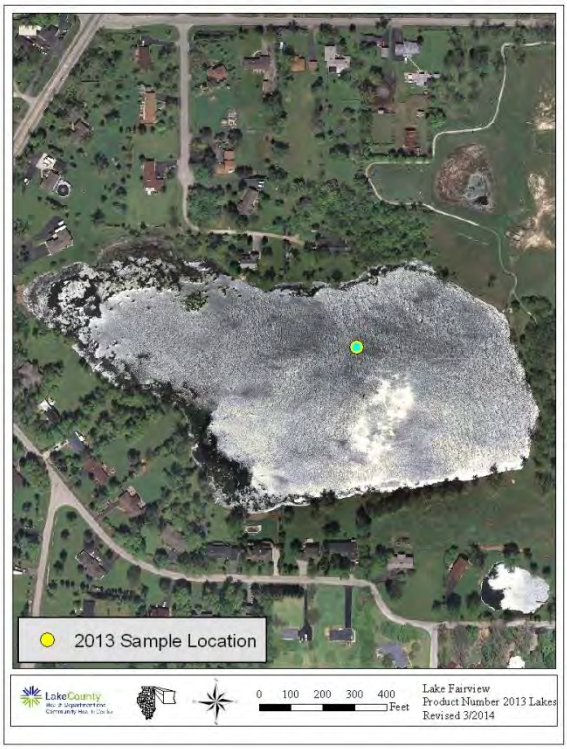
[112] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: Illinois EPA, 2012 http://www.epa.state.il.us/water/tmdl/303d-list.html#2012.

Lake Fairview exhibited Secchi transparencies ranging from about 3 feet to more than 9 feet, averaging about 5.5 feet each of the two monitoring seasons. The two-year average for total phosphorus was 0.069 mg/L, with a range of 0.015 – 0.089 mg/L. Total suspended solids, total solids, and total volatile solids concentration 2-year averages were 5.1, 493, and 119 mg/L, respectively. A trophic state index ($TSI_{phosphorus}$) of 65.9 in 2000 [113] and 64.3 in 2007 [114] places Lake Fairview into the eutrophic category.

Dissolved oxygen/temperature profiles indicated temperature stratification did not occur during 2000 but did during summer 2007. However, low D.O. levels were common during the summer months. Hypoxic D.O. concentrations (below 5.0 mg/L) were recorded throughout the water column in July and August 2000 and September 2007. Anoxic conditions (D.O. less than 1.0 mg/L) were typical in the bottom 3-5 feet during August 2000 and June, July, and August 2007.

Conductivity measurements averaged 935 µS/cm in 2000 and 784 µS/cm in 2007. Chloride concentrations (which are one of the factors influencing conductivity readings) were measured in 2007 and averaged 200 mg/L. Water quality parameter averages based on LCHD data[115] are provided in Table 87.

Figure 94. Water quality monitoring site location in Lake Fairview.



[113] Lake Co. Health Dept., Lakes Management Unit. *2000 Summary Report of Timber Lake,* by Marencik, Joseph, M. Adam, M. Colwell, M. Pfister. Waukegan, IL: LCHD, 2001 http://health.lakecountyil.gov/Population/LMU/Lakes/timber2.pdf.

[114] Lake Co. Health Dept., Lakes Management Unit. *2007 Summary Report of Lake Fairview,* by Keseley, Shaina, M. Adam, L. Dane, A. Orr. Waukegan, IL: LCHD, undated http://health.lakecountyil.gov/Population/LMU/Lakes/2007Fairview.pdf.

[115] Mike Adam, Sr. Biologist, Lake County Health Dept. (LCHD), e-mail message with data attachment to author(s), February 2013.

Table 87. Lake Fairview average annual water quality conditions.

Illinois EPA lake code		IL_STK	
Year		2000	2007
Parameter	*Units*	*Average*	
Secchi transparency	feet	5.43	5.59
	inches	65	67
Total Phosphorus (TP)	mg/L	0.072	0.065
Soluble Reactive Phosphorus (SRP)	mg/L	0.009[k]	0.009[k]
Dissolved Phosphorus (DP)	mg/L	---	---
Total Kjeldahl Nitrogen (TKN)	mg/L	1.47	1.18
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	0.050[k]
Nitrate Nitrogen (NO_3)	mg/L	0.051[k]	---
Ammonia Nitrogen (NH_3)	mg/L	0.177[k]	0.136[k]
Total Suspended Solids (TSS)	mg/L	4.9	5.3
Volatile Suspended Solids (VSS)	mg/L	---	---
Total Solids (TS)	mg/L	469	517
Total Volatile Solids (TVS)	mg/L	126	111
Chloride (Cl)	mg/L	---	200
Conductivity	µS/cm	784	935
pH	units	8.57	8.62
Alkalinity	mg/L	126	126
Chlorophyll *a* (corrected)	µg/L	;---	---

k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

An aquatic plant survey conducted in July 2007 revealed low species diversity and moderately high abundance with plants present at 59 percent of the 64 aquatic plant sampling locations. Nine species were found, with coontail (*Ceratophyllum demersum*) the most abundant, collected at 56 percent of the sampling sites. The next most abundant species were white water lily (*Nymphaea odorata*) at 31 percent and small pondweed (*Potamogeton pusillus*) at 23 percent occurrence. The invasive exotic curlyleaf pondweed (*Potamogeton crispus*) also was present. Its low two percent occurrence in July reflects its life cycle since this species is most abundant in the spring before dying back in early summer. In fact, curlyleaf pondweed was observed to cover nearly 100 percent of the lake surface in May. Another exotic invasive species, Eurasian water milfoil (*Myriophyllum spicatum*), was documented by LCHD staff in 2000 but not in 2007, as was the native northern water milfoil (*Myriophyllum sibericum*).

LCHD's complete Lake Fairview 2000 and 2007 summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). It is expected that LCHD's 2013 Lake Fairview summary report will be added to this website in 2014.

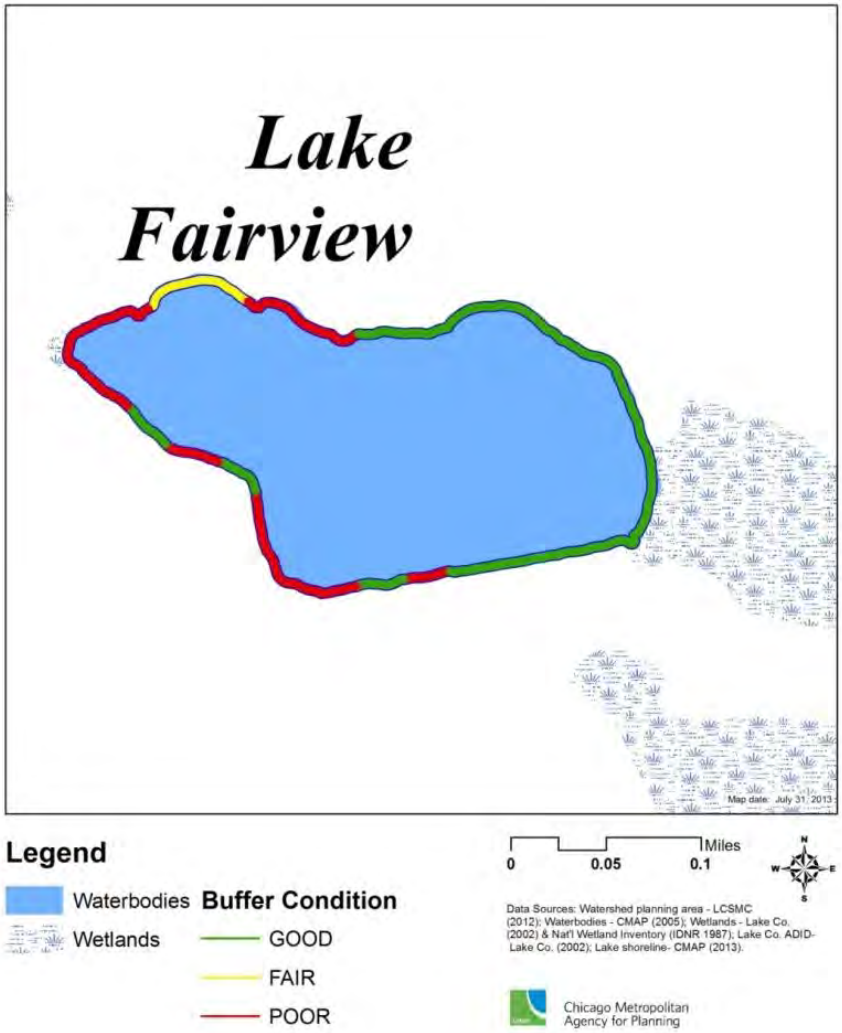
Lakeshore Buffer Condition

An explanation of the lakeshore buffer condition assessment methodology is provided under the Ozaukee Lake section. For Lake Fairview, full details for each segment are featured in Appendix A. Here, a summary is provided in Table 88 and Figure 95.

Table 88. Lake Fairview 2013 lakeshore buffer condition assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Lake Fairview	16	4,260	2,495	58.5	475	11.2	1290	30.3
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 95. Lake Fairview 2013 lakeshore buffer condition.



Shoreline Erosion Condition

LCHD's 2013 assessment of shoreline erosion conditions at Lake Fairview indicated that about 43 percent of the shoreline had some degree of erosion, an increase of nearly 30 percent since their previous assessment in 2007. In 2013, about six percent exhibited severe, 18 percent moderate, and 19 percent slight erosion (Table 89, Figure 96).

Table 89. Lake Fairview 2013 shoreline erosion assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Lake Fairview	45	3,213	1,827	56.9	604	18.8	585	18.2	197	6.1
From Lake Co. Health Department lake shoreline erosion assessment GIS data (2013).										

Figure 96. Lake Fairview 2013 shoreline erosion condition.

Figure provided by Lake County Health Dept. (2014)

The following information summarizes the land use, soil classifications and impervious surface cover within the Lake Fairview subunit. This subunit consists of 72.9 acres within the 9 Lakes Planning Area (Figure 37).

Land Use

The majority of land use in the Lake Fairview subunit is residential at 60.9 percent. Other land use types are minimal with the lake itself covering the majority of the balance (Table 90, Figure 97).

Figure 97. Land use distribution within Lake Fairview subunit.

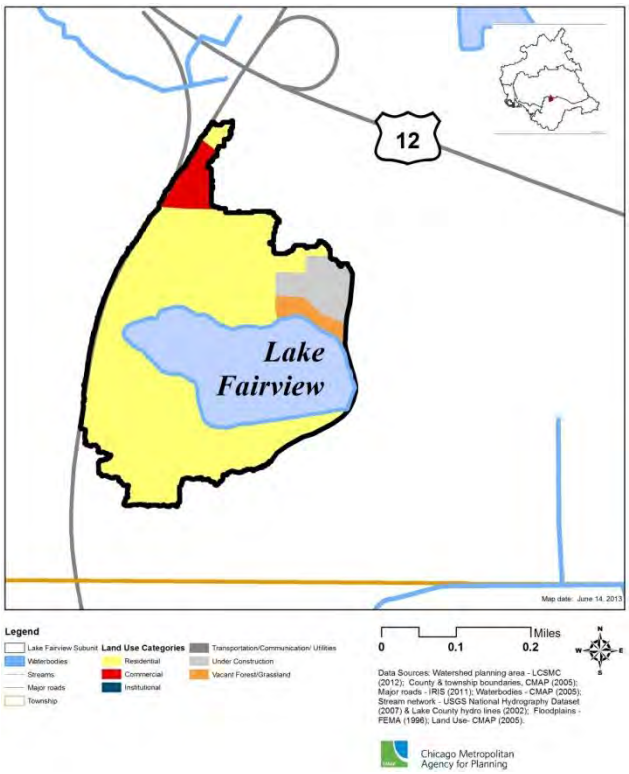


Table 90. 2005 Land use distribution within Lake Fairview subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	44.4	0.07	60.9
Commercial	2.6	<0.01	3.6
Institutional	0.03	<0.01	0.04
Transportation/ Communication/ Utilities	0.007	<0.01	<0.01
Under Construction	3.7	<0.01	5.1
Vacant Forest/Grassland	1.8	<0.01	2.5
Lake Fairview	20.3	0.03	27.8
Totals	72.9	0.1	100.0

Soils

"Not Hydric" soils dominate the subunit while "All Hydric" soils account for less than one percent of the area (Table 91, Figure 98).

Figure 98. Hydric soils within Lake Fairview subunit.

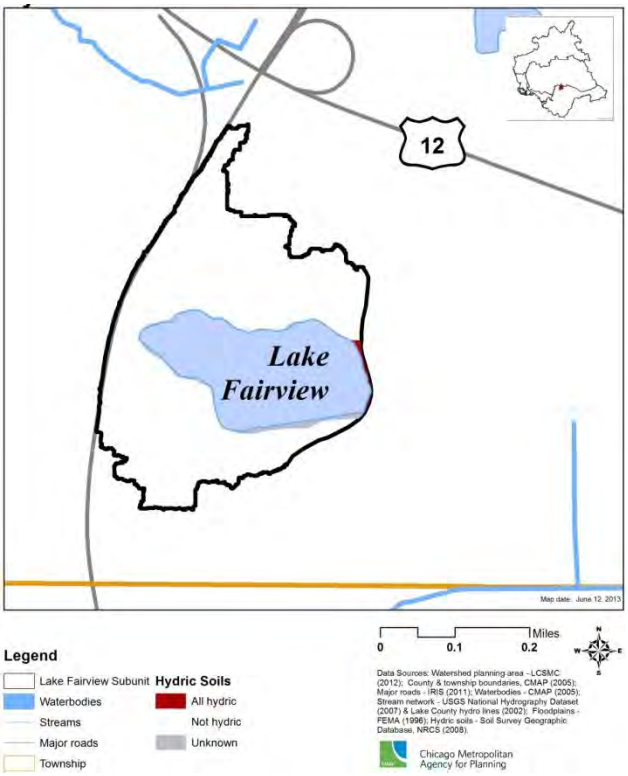


Table 91. Hydric soil acreage within Lake Fairview subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	.4	.5
Not hydric	51.8	71.0
Unknown	20.8	28.5

"Group C" soils make up 71 percent of the Lake Fairview subunit, with a low quantity of "Group D" and "Unclassified" soils characterizing the rest of the area (Table 92, Figure 99).

Figure 99. Hydrologic soil groups within Lake Fairview subunit.

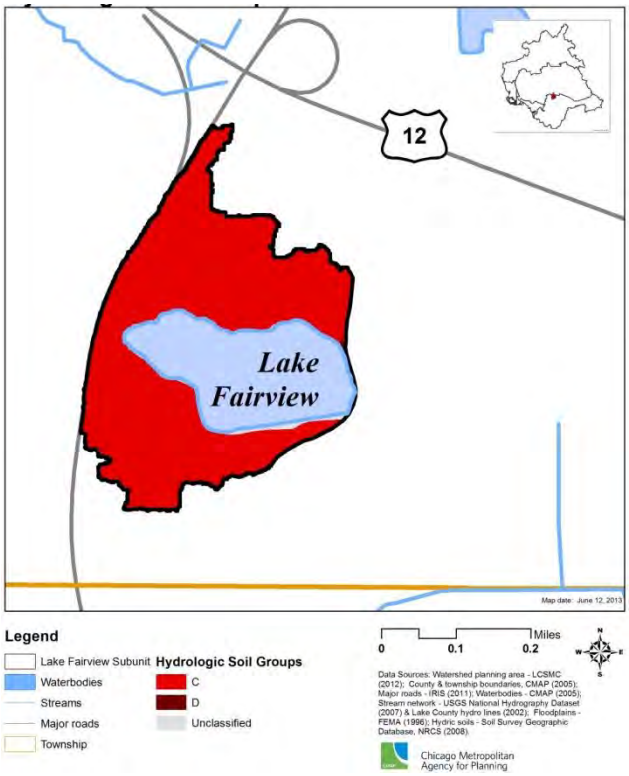


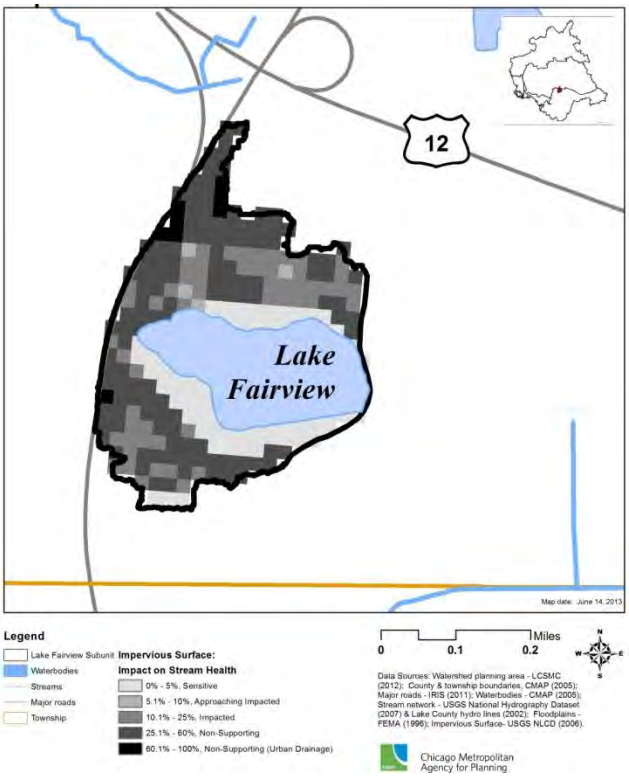
Table 92. Hydrologic soil groups within Lake Fairview subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
C	51.8	71.1
D	0.35	0.5
Unclassified	20.8	28.5

Impervious Cover

Impervious surfaces cover 17.9 percent of the Lake Fairview subunit (Figure 100). The subunit's overall stream health is categorized as "Impacted." Future impervious surfaces within the subunit are estimated to reach 19.2 percent by the year 2040. This quantity suggests that the stream health category will remain "Impacted."

Figure 100. Impervious surfaces within Lake Fairview subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads to Lake Fairview are found in Table 93.

Table 93. Lake Fairview pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chloride (lbs/yr)*	*CL (lbs /ac)*	*Nitro Gen (lbs /yr)*	*N (lbs /ac)*	*Phos phor (lbs /yr)*	*P (lbs /ac)*	*Bact (bill col /yr)*	*Bact (bill col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	44.8	30.4	4029.1	90.0	177.3	4.0	22.9	0.5	198.6	4.4	6974.6	155.8
1231 URB MX W/PRK	2.6	3.9	613.6	234.6	11.7	4.5	1.5	0.6	4.1	1.6	683.3	261.3
1350 RELIGOUS	0.0	0.0	5.7	227.8	0.1	4.9	0.0	0.6	0.0	1.5	4.7	188.4
1560 UTIL/ WAST/WA	0.0	0.0	1.2	184.4	0.0	2.6	0.0	0.4	0.0	0.7	1.0	152.5
3400 OPEN SPA/PRIV	3.4	1.5	4.1	1.2	3.1	0.9	0.7	0.2	2.3	0.7	107.0	31.9
4110 VAC FOR/GRAS	1.8	0.9	2.9	1.6	4.4	2.4	0.4	0.2	1.6	0.9	152.5	83.2
5200 LAKE /RES/LAG	20.3	43.1	17135.4	842.7	53.5	2.6	3.6	0.2	28.4	1.4	171.4	8.4

Grand Totals	**72.9**	**79.9**	**21792.0**	**298.8**	**250.3**	**3.4**	**29.0**	**0.4**	**235.0**	**3.2**	**8094.4**	**111.0**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Lake Fairview's epilimnion[116] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[117] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 29 lbs/yr P from average annual land runoff (Table 93).[118]

Together with other model parameters set for Lake Fairview— mean depth: 5 ft (1.52 m); lake retention or residence time: 1.28 yr.[119]; surface area: 20.5 ac—the CB model predicted an average annual epilimnetic TP of 0.043 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that meets the applicable water quality standard.

Data available from samples taken from Lake Fairview reveal TP concentrations with an average of 0.069 mg/L over two growing seasons (2000, 2007).[120] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield the observed average TP concentration of 0.069 mg/L. This exercise resulted in an average influx of 62 lbs/yr, of which land runoff explains about 47 percent (29 / 62) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 36 lbs/yr When compared to the estimated total influx of 62 lbs/yr, a 43 percent reduction in annual TP influxes (26 lbs/yr) will be needed. Because 29 lbs/yr is potentially contributed by land runoff, it is theoretically possible that the necessary P reduction could largely be achieved by on-the -ground BMPs implemented throughout the lake's watershed.

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[116] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[117] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[118] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[119] Lake residence time is lake volume divided by avg. annual inflow. For Lake Fairview: 102.3 ac-ft / 80 ac-ft per yr = 1.279 yr. The reciprocal equation is "lake flushing time" or 0.78 times per year which is the value used in the CB model.

[120] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.11 Subunit #11 - Tower Lake

Lake Location, Ownership, Use, and Morphometry

Tower Lake is located in the western portion of the Tower Lake Drain Watershed within the Village of Tower Lakes. The lake was created by damming and dredging a slough pothole in the early 1900s. Differing accounts place the year of construction as 1915 [121] or 1923.[122] The original dam was located where the suspension bridge is now. Tower Lake was expanded in 1927 when the dam was moved southwest to its current position. The lake was enlarged further during the 1940s when the southeastern bay was dredged, bringing Tower Lake to its current size.[123] Tower Lake's morphometric data is presented in Table 94.

Timber Lake Drain (a.k.a. Mud Creek) enters at the lake's north end at Roberts Road and exits to Tower Lake Drain over the spillway at the southwestern corner of the lake. Tower Lake Drain then flows about one mile to the Fox River. The lake is surrounded by residential homes and the entire lake bottom is owned by the Tower Lakes Improvement Association (TLIA), which has overseen the management of both Tower Lake and North Tower Lake since 1931.[124] Tower Lake is used recreationally by TLIA members and their guests for fishing, swimming, non-power boating, and aesthetic enjoyment.

Table 94. Tower Lake morphometric information.

Illinois EPA lake code	IL_RTZF
Surface Area[a]	69.2 ac
Maximum Depth[a]	7.5 ft
Average Depth (estimated)[a]	4.5 ft
Volume (estimated)[a]	233.5 ac-ft
Shoreline Length[a]	3.3 mi
Lake Elevation[a]	746.0 ft above MSL
Watershed Area[b]	2,559.1 ac
Watershed to lake ratio	37:1
Average Water Residence Time / Flushing Time	0.12 yr (42 days) / 8.68 times per yr

a) from 2007 Summary Report of Tower Lake, Lake Co. Health Dept. (undated)
b) determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area

[121] IDNR. *Lake County Surface Water Resources*, by Tichacek, Gregg and H. Wight. Springfield, IL: IDNR, 1972.

[122] Lake Co. Health Dept., Lakes Management Unit. *2001 Summary Report of Tower Lake*, by Marencik, Joseph, M. Adam, C. Brant, M. Colwell, M. Pfister. Waukegan, IL: LCHD 2002.

[123] Ibid.

[124] Ibid.

Water Quality Conditions

Timber Lake has suffered from a variety of lake quality issues since its creation. Carp invaded the lake soon after its construction, and in 1950, the earliest recorded fish winterkill occurred.[125] Challenges have included not only winterkills which contribute to an unbalanced fishery but also overabundant aquatic plants, severe algal blooms, turbidity, and nutrient enrichment. Various management activities have been implemented over the years, including fishery rehabilitations and partial lake dredging in the 1960s, and as-needed aquatic herbicide and algicide applications.

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[126] is based on monitoring conducted at Tower Lake by the LCHD Lakes Management Unit in 2001 and 2007. The sampling site is located in the lake's deepest area in the east central portion of the lake's northern basin (Figure 101).

Figure 101. Water quality monitoring site location in Tower Lake.

Tower Lake exhibited Secchi transparencies ranging from about 1 foot to 6.5 feet, averaging 2.3 feet in 2001 and 4.3 feet in 2007. The two-year average for total phosphorus was 0.083 mg/L, with a range of 0.028–0.162 mg/L. Total suspended solids, total solids, and total volatile solids concentration two-year averages were 11.1, 636, and 163 mg/L, respectively. A trophic state index ($TSI_{phosphorus}$) of 66.8 in 2001 [127] and 64.6 in 2007 [128] places Tower Lake into the eutrophic category.

Dissolved oxygen levels recorded in 2007 remained above 5.0 mg/L throughout the water column on all but the August sampling

[125] IDNR. *Lake County Surface Water Resources*, by Tichacek, Gregg and H. Wight. Springfield, IL: IDNR, 1972.

[126] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA, 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012

[127] Lake Co. Health Dept., Lakes Management Unit. *2001 Summary Report of Tower Lake,* by Marencik, Joseph, M. Adam, C. Brant, M. Colwell, M. Pfister. Waukegan, IL: LCHD, 2002. http://health.lakecountyil.gov/Population/LMU/Lakes/towerlake.pdf

[128] Lake Co. Health Dept., Lakes Management Unit. *2007 Summary Report of Tower Lake,* by Orr, Adrienne, M. Adam, L. Dane, S. Keseley. Waukegan, IL: LCHD, undated. http://health.lakecountyil.gov/Population/LMU/Lakes/Copy%20of%202007Tower.pdf

date when the lake was thermally stratified and anoxic conditions (less than 1.0 mg/L) occurred in the near-bottom waters. In 2001, summer stratification was more prolonged with anoxia occurring in the near-bottom waters between late June and late August.

Conductivity measurements averaged 1,054 µS/cm in 2000 and 1,025 µS/cm in 2007. Chloride concentrations (which are one of the factors influencing conductivity readings) were measured in 2007 and averaged 174 mg/L. Water quality parameter averages based on LCHD data[129] are provided in Table 95.

Table 95. Tower Lake average annual water quality conditions.

Illinois EPA lake code		IL_RTZF	
Year		2001	2007
Parameter	*Units*	*Average*	
Secchi transparency	feet	2.31	4.31
	inches	28	52
Total Phosphorus (TP)	mg/L	0.100	0.066
Soluble Reactive Phosphorus (SRP)	mg/L	0.010[k]	0.006[k]
Dissolved Phosphorus (DP)	mg/L	---	---
Total Kjeldahl Nitrogen (TKN)	mg/L	1.47	1.18
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	0.050[k]
Nitrate Nitrogen (NO_3)	mg/L	0.050[k]	---
Ammonia Nitrogen (NH_3)	mg/L	0.127[k]	0.100[k]
Total Suspended Solids (TSS)	mg/L	15.0	7.1
Volatile Suspended Solids (VSS)	mg/L	---	---
Total Solids (TS)	mg/L	676	597
Total Volatile Solids (TVS)	mg/L	200	125
Chloride (Cl)	mg/L	---	174
Conductivity	µS/cm	1,054	1,025
pH	units	8.11	8.71
Alkalinity	mg/L	210	218
Chlorophyll *a* (corrected)	µg/L	---	---

k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit

An aquatic plant survey conducted in July 2007 revealed low species diversity and moderately low abundance with plants present at 38 percent of the 71 aquatic plant sampling locations. Five species were found, a decrease from the nine species observed in 2001. In the 2007 survey, coontail (*Ceratophyllum demersum*) was the most abundant, collected at 23 percent of the

[129] Mike Adam, Sr. Biologist, Lake County Health Dept. (LCHD), e-mail message with data attachment to author(s), February 2013.

sampling sites. The next most abundant species were white water lily (*Nymphaea odorata*) at 14 percent and Chara (*Chara* spp., a macro-algae) at a nine percent occurrence. Species seen in 2001 but not in 2007 were the natives bladderwort, horned pondweed, and small pondweed; and the exotic invasives curlyleaf pondweed and Eurasian water milfoil. LCHD staff noted that the loss in species abundance may be related in part to their change in survey methods. In 2007, a detailed plant survey was done only in July (after aquatic herbicide treatments had been conducted) unlike in 2001 when monthly May through September observations were made.

LCHD's complete Tower Lake 2001 and 2007 summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). It is expected that LCHD's 2013 Tower Lake summary report will be added to this website in 2014.

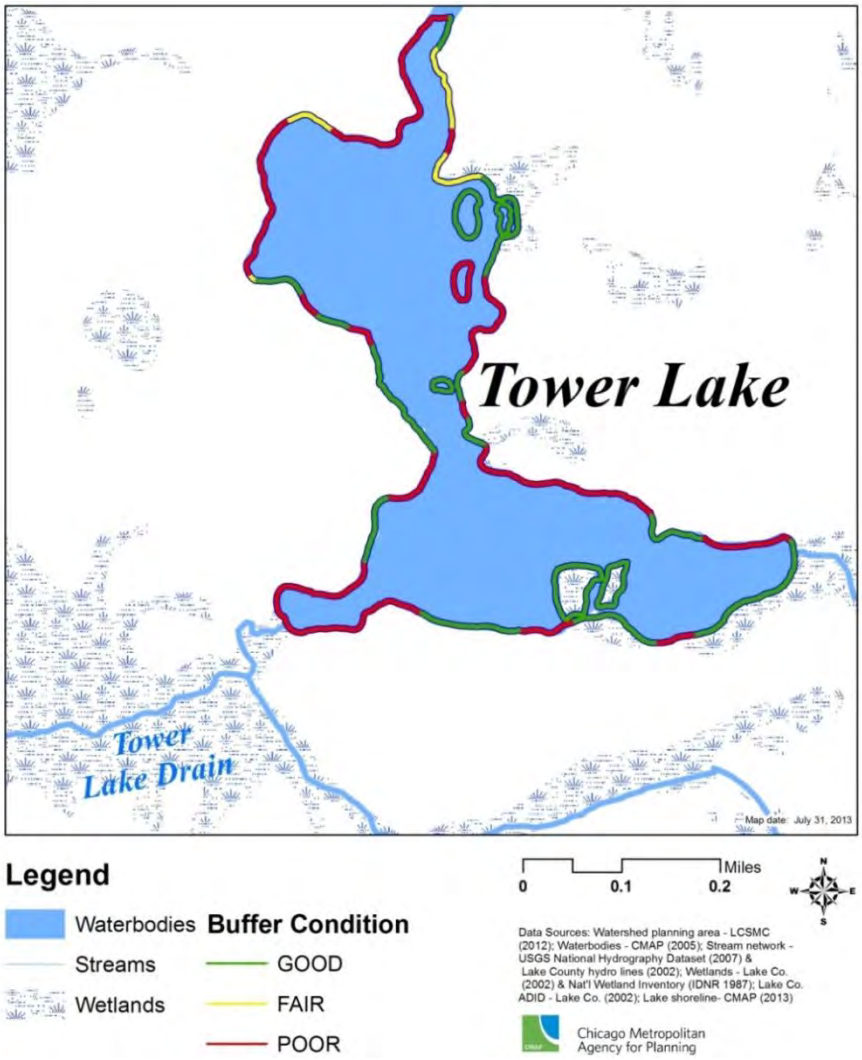
Lakeshore Buffer Condition

An explanation of the lakeshore buffer condition assessment methodology is provided under the Ozaukee Lake section. A summary of Tower Lake's lakeshore buffer condition assessment is provided here in Table 96 and Figure 102. Full details for each segment are provided in Appendix A.

Table 96. Tower Lake 2013 lakeshore buffer condition assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Tower Lake	48	17,380	9,105	52.4	1,715	9.9	6,560	37.7
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 102. Tower Lake 2013 lakeshore buffer condition assessment.



Shoreline Erosion Condition

LCHD's 2013 shoreline erosion assessment indicated that about 45 percent of the assessed shoreline had some degree of erosion: about 22 percent slight, 18 percent moderate, and 6 percent severe[130] (Table 97, Figure 103).

[130] Duck Island's 2013 erosion assessment data was missing from the GIS files provided to CMAP. However, its 279 feet of shoreline was assessed as moderately eroding in LCHD's 2007 assessment; thus, CMAP added this linear footage to the 2013 assessment data.

Table 97. Tower Lake 2013 shoreline erosion assessment summary.

Lake Name	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Tower Lake	17,278	9,444	54.7	3,819	22.1	3,072	17.8	943	5.5
From LCHD Tower Lake shoreline erosion assessment GIS data (2013).									

Figure 103. Tower Lake 2013 shoreline erosion condition.

Land Use

The 1,381 acre Tower Lake subunit is primarily residential land use (63.5 percent). Vacant Forest / Grassland make up 14.4 percent and wetlands make up 12.4 percent of the subunit. Other land use types are present, yet minimal in their extent (Table 98, Figure 104).

Figure 104. Land use distribution within Tower Lake subunit.

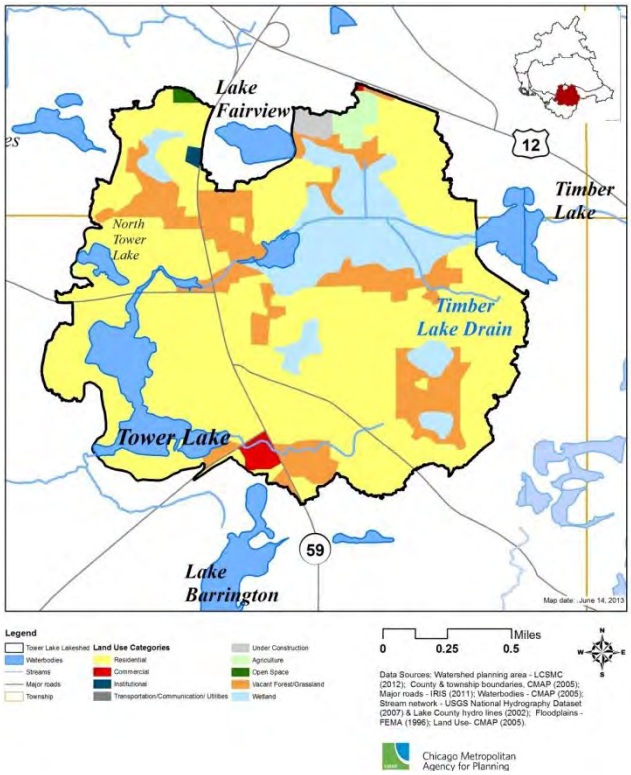


Table 98. 2005 Land use distribution within Tower Lake subunit.

Land Use Category	*Area (acres)*	*Area (Sq. mi.)*	*Percent of Subunit*
Residential	877.8	1.4	63.5
Commercial	10.9	0.02	0.8
Institutional	2.6	<0.01	0.2
Transportation/ Communication/ Utilities	0.07	<0.01	<0.01
Under Construction	9.7	0.02	.7
Agriculture	17.1	0.03	1.2
Open Space	3.0	<0.01	0.2
Vacant Forest/Grassland	199.0	0.3	14.4
Wetland	170.8	0.3	12.4
Water	90.7	0.1	6.6
Totals	1381.7	4.1	100.0

Soils

Soils within the Tower Lake subunit are mainly classified as "Not Hydric" and represent 67.5 percent of the subunit area. "All Hydric" soils comprise over 25 percent of the Tower Lake subunit (Table 99, Figure 105).

Figure 105. Hydric soils within Tower Lake subunit.

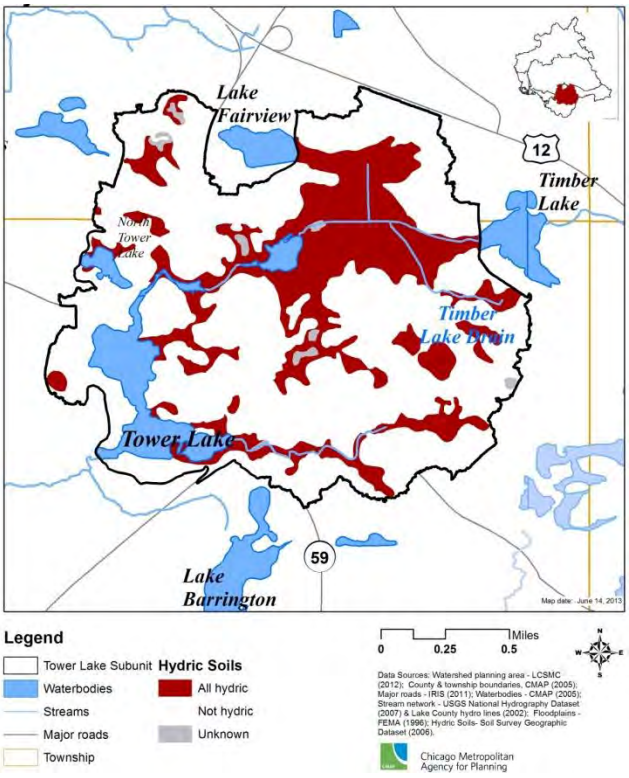


Table 99. Hydric soil acreage within Tower Lake subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	353.1	25.5
Not hydric	931.7	67.5
Unknown	96.8	7.0

The dominant hydrologic soil group within the subunit is Group C (71.6 percent, Table 100). A, B, and D soils are minimally interspersed throughout the subunit (Figure 106).

Figure 106. Hydrologic soil groups within Tower Lake subunit.

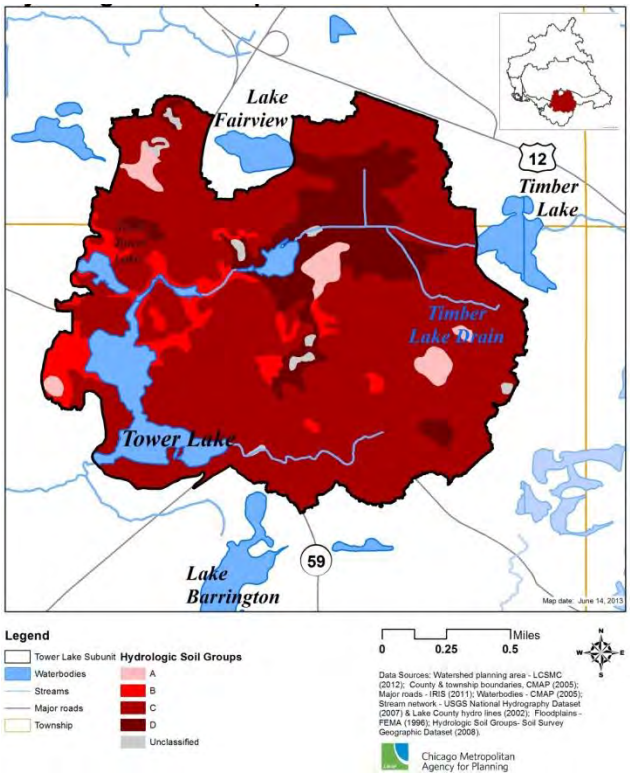


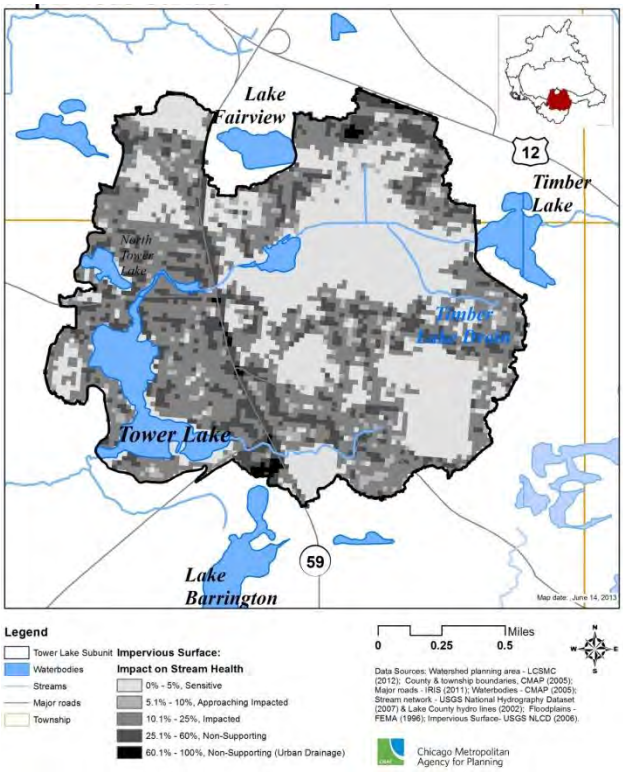
Table 100. Hydrologic soil groups within Tower Lake subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	36.1	2.5
B	85.1	6.2
C	989.1	71.6
D	174.8	12.7
Unclassified	96.8	7.0

Impervious Cover

The Tower Lake subunit features approximately 13.1 percent impervious surface and it is most prominent in the direct vicinity of Tower Lake (Figure 107). This level of imperviousness translates to a stream health classification of "Impacted" (Table 5). Impervious surface is estimated to grow 21 percent by 2040 to cover 15.8 percent of the area. This increase is moderate by comparison with the other subunits, and the stream health will remain "Impacted" as an outcome.

Figure 107. Impervious surfaces within Tower Lake subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads to Tower Lake are found in Table 101.

Table 101. Tower Lake subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs/yr)*	*CL (lbs /ac)*	*Nitr ogen (lbs /yr)*	*N (lbs /ac)*	*Phos phor (lbs /yr)*	*P (lbs /ac)*	*Bac. (bil col /yr)*	*Bac (bil col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	835.9	541.5	60690.5	72.6	2891.3	3.5	379.5	0.5	3385.5	4.0	110162.3	131.8
1120 RES/ FARM	2.1	1.9	308.8	148.9	7.5	3.6	0.7	0.3	8.8	4.3	510.9	246.3
1212 RETAIL CNTR	7.8	11.6	3361.8	430.2	72.7	9.3	11.1	1.4	22.6	2.9	3743.4	479.1
1231 URB MX W/PRK	0.5	0.8	364.4	678.6	7.0	13.0	0.9	1.6	2.4	4.6	405.8	755.6
1350 RELIGOUS	1.8	2.7	462.0	251.6	10.0	5.4	1.3	0.7	3.1	1.7	382.1	208.1
1512 OTHR ROADWY	6.6	14.0	4226.3	641.3	65.7	10.0	9.7	1.5	19.3	2.9	8909.6	1351.9
1560 UTILI/ WAST/WA	0.1	0.1	10.9	163.0	0.2	2.3	0.0	0.4	0.0	0.6	9.0	134.8
2200 NSRY/ GHS/ORC	16.1	7.4	18.1	1.1	71.6	4.4	8.0	0.5	20.6	1.3	3818.6	237.2
3100 OPEN SPA/RECR	3.0	2.0	5.9	2.0	8.2	2.8	2.0	0.7	6.7	2.3	339.6	114.8
3400 OPEN SPA/PRIV	44.7	19.4	45.3	1.0	34.9	0.8	7.5	0.2	25.7	0.6	1195.9	26.8
4110 VAC FOR/GRAS	190.0	95.0	208.7	1.1	321.0	1.7	29.8	0.2	118.5	0.6	11007.2	57.9
4120 WETLAND	170.8	142.8	396.5	2.3	305.0	1.8	4.4	0.0	86.6	0.5	348.6	2.0
5200 LAKE /RES/LAG	102.3	216.9	87813.5	858.3	274.4	2.7	18.3	0.2	145.4	1.4	878.1	8.6
Grand Totals	**1381.7**	**1056.0**	**157912.7**	**114.3**	**4069.4**	**2.9**	**473.1**	**0.3**	**3845.3**	**2.8**	**141711.0**	**102.6**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Tower Lake's epilimnion[131] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[132] was applied to estimate an average annual epilimnetic TP concentration. A key input to the CB model is provided by the SWAMM model: 505 lbs/yr P from average annual land runoff (Table 101 added to estimated P export of 32 lbs/yr from upstream Lakes Timber and Fairview).[133]

Together with other model parameters set for Tower Lake—mean depth: 4.5 ft (1.37 m); lake retention or residence time: 0.12 yr.[134]; surface area: 69.2 ac—the CB model predicted an average annual epilimnetic TP of 0.035 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that meets the applicable water quality standard.

Data available from samples taken from Tower Lake reveal TP concentrations with an average of 0.083 mg/L over two growing seasons (2001, 2007).[135] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield this observed average TP concentration of 0.083 mg/L. This exercise resulted in an average influx of 1,306 lbs/yr, of which land runoff explains about 39 percent (505 / 1,306) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 674 lbs/yr When compared to the estimated total influx of 1,306 lbs/yr, a 48 percent reduction in annual TP influxes (633 lbs/yr) will be needed. Because 505 lbs/yr is potentially contributed by land runoff, it appears that on-the-ground BMPs implemented in the lake's watershed could go a long way in reducing P influxes, although additional in-lake management practices may also be needed.

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[131] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[132] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

[133] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[134] Lake residence time is lake volume divided by avg. annual inflow. For Tower Lake: 233.5 ac-ft / 2,027 ac-ft per yr = 0.1152 yr. The reciprocal equation is "lake flushing time" or 8.68 times per year which is the value used in the CB model.

[135] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.12 Subunit #12 - Lake Barrington

Lake Location, Ownership, Use, and Morphometry

Lake Barrington is located in the southern portion of the Tower Lake Drain Watershed within the Village of Lake Barrington. The lake was created in 1925; development of the Lake Barrington Shores condominiums began in 1973 and continued through 1990.[136] The lake is owned and managed by the Lake Barrington Community Homeowners Association. Lake uses include fishing, swimming, boating (no gas motors), aesthetic enjoyment, and golf course irrigation. Access is restricted to association members and their guests.

Lake Barrington's morphometric data is presented in Table 102.

Table 102. Lake Barrington morphometric information.

Illinois EPA lake code	IL_RTZT
Surface Area[a]	91.1 ac
Maximum Depth[a]	13.0 ft
Average Depth[a]	7.8 ft
Volume[a]	701.4 ac-ft
Shoreline Length[a]	3.2 mi
Lake Elevation[a]	780.0 ft above MSL
Watershed Area[b]	394.3 ac
Watershed to lake ratio	4:1
Average Water Residence Time / Flushing Time	1.34 yr. (488 days) / 0.75 times per yr.

a) From 2007 Summary Report of Tower Lake, LCHD (undated)
b) Determined using CMAP's GIS system based on watershed boundaries delineated by LCSMC and LCHD (2012); does not include lake's surface area

Water Quality Conditions

Illinois EPA's lake assessment for their 2012-cycle integrated water quality report[137] is based on monitoring conducted at Lake Barrington by the LCHD Lakes Management Unit in 2001 and 2007. The sampling site is located in the deepest area in the lake's east central section (Figure 108).

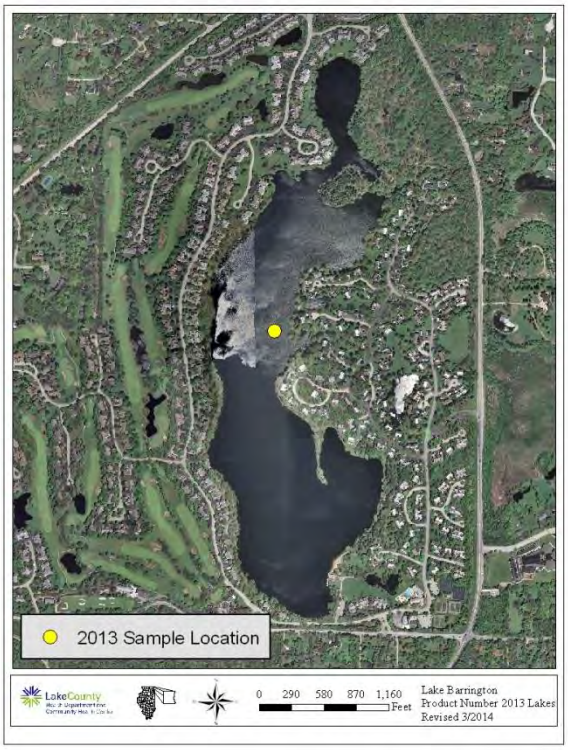
Lake Barrington exhibited Secchi transparencies ranging from about 1.5 feet to more than 12 feet (Secchi disk seen on the lake bottom), averaging about 6 feet in both 2001 and 2007. Total phosphorus (TP) averaged 0.096 mg/L in 2001 and something less than 0.067 mg/L in 2007 (TP

[136] Lake Co. Health Dept., Lakes Management Unit. *2007 Summary Report of Lake Barrington*, by Orr, Adrienne, M. Adam, L. Dane, S. Keseley. Waukegan, IL: LCHD, undated. http://health.lakecountyil.gov/Population/LMU/Lakes/2007Barrington.pdf

[137] Illinois EPA, Bureau of Water. *Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012.* Springfield, IL: IEPA, 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012

was below the 0.010 mg/L detection limit on two dates). Nitrate and nitrate+nitrite nitrogen concentrations were consistently below detection (less than 0.050 mg/L). Ammonia nitrogen was below detection (less than 0.100 mg/L) on all but two monitoring dates. Total suspended solids, total solids, and total volatile solids concentrationtwo-year averages were 8.2, 406, and 115 mg/L, respectively. A trophic state index ($TSI_{phosphorus}$) of 70.6 in 2001[138] and 71.3 in 2007 [139] places Tower Lake into the hypereutrophic category.

Figure 108. Water quality monitoring site location in Lake Barrington.



Dissolved oxygen (DO) concentrations recorded in 2001 remained above 5.0 mg/L throughout the water column. In 2007, concentrations fell below 5.0 mg/L in August below 2 feet and in September throughout the water column. Anoxic (less than 1.0 mg/L DO) conditions were seen in August below 4 feet.

Conductivity measurements averaged 600 µS/cm in 2001 and 752 µS/cm in 2007. Chloride concentrations (which are one of the factors influencing conductivity readings) were measured in 2007 and averaged 126 mg/L. Water quality parameter averages based on LCHD data[140] are provided in Table 103.

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[138] Lake Co. Health Dept., Lakes Management Unit. *2001 Summary Report of Lake Barrington*, by Brant, Christina, M. Adam, M. Colwell, J. Marencik, M. Pfister. Waukegan, IL: LCHD, 2002 http://health.lakecountyil.gov/Population/LMU/Lakes/barringtonlake.pdf.

[139] Lake Co. Health Dept., Lakes Management Unit. *2007 Summary Report of Lake Barrington*, by Orr, Adrienne, M. Adam, L. Dane, S. Keseley. Waukegan, IL: LCHD, undated http://health.lakecountyil.gov/Population/LMU/Lakes/2007Barrington.pdf .

[140] Mike Adam, Sr. Biologist, LCHD, e-mail message with data attachment to author(s), February 2013.

Table 103. Lake Barrington average annual water quality conditions.

IEPA lake code		IL_RTZT	
Year		2001	2007
Parameter	*Units*	*Average*	
Secchi transparency	feet	5.93[d]	6.00
	inches	71[d]	72
Total Phosphorus (TP)	mg/L	0.096	0.067[k]
Soluble Reactive Phosphorus (SRP)	mg/L	0.005[k]	0.007[k]
Dissolved Phosphorus (DP)	mg/L	---	---
Total Kjeldahl Nitrogen (TKN)	mg/L	1.55[k]	1.42
Nitrite + Nitrate Nitrogen (NO_2+NO_3)	mg/L	---	0.050[k]
Nitrate Nitrogen (NO_3)	mg/L	0.050[k]	---
Ammonia Nitrogen (NH_3)	mg/L	0.100[k]	0.169[k]
Total Suspended Solids (TSS)	mg/L	9.6	6.7
Volatile Suspended Solids (VSS)	mg/L	---	---
Total Solids (TS)	mg/L	368	444
Total Volatile Solids (TVS)	mg/L	110	120
Chloride (Cl)	mg/L	---	126
Conductivity	µS/cm	600	752
pH	units	8.29	8.43
Alkalinity	mg/L	157	147
Chlorophyll *a* (corrected)	µg/L	---	---

k = denotes that the actual value is known to be less than the value presented because of at least one measurement registering below the analysis equipment's detection limit
d = Secchi transparency limited by total depth at the monitoring site on at least one date

An aquatic plant survey conducted in July 2007 revealed low species diversity and moderate abundance with plants present at 57 percent of the 98 aquatic plant sampling locations. Ten species were found, with Chara (*Chara* spp., a macroalgae) the most abundant, collected at 33 percent of the sampling sites. The next most abundant species were the invasive exotic curlyleaf pondweed (*Potamogeton crispus*) at 28 percent and white water lily (*Nymphaea odorata*) at 15 percent occurrence.

LCHD's Lake Barrington 2001 and 2007 summary reports can be accessed on their website (http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx). It is expected that LCHD's 2013 summary report will be added to this website in 2014.

Lakeshore Buffer Condition

An explanation of the lakeshore buffer condition assessment methodology is provided under the Ozaukee Lake section. A summary of Lake Barrington's lakeshore buffer condition assessment is provided in Table 104 and
Figure 109. Full details for each segment are provided in Appendix A.

Table 104. Lake Barrington 2013 lakeshore buffer condition assessment summary.

Lake Name	*Reach Codes*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Lake Barrington	21	16,455	9,695	58.9	1,780	10.8	4,980	30.3
From CMAP lake shoreline assessment for buffer zone condition (2013).								

Figure 109. Lake Barrington 2013 lakeshore buffer zone condition.

Shoreline Erosion Condition

LCHD's 2013 erosion assessment revealed that about 32 percent of the shoreline had some degree of erosion, about a ten percent increase since LCHD's 2007 assessment. In 2013, approximately 13 percent of the shoreline was exhibiting slight, 15 percent moderate, and four percent severe erosion (Table 105 and Figure 110).

Table 105. Lake Barrington 2013 shoreline erosion assessment summary.

Lake Name	*Shore Length Assessed (ft.)*	*No Erosion (ft./percent)*		*Slight Erosion (ft./percent)*		*Moderate Erosion (ft./percent)*		*High Erosion (ft./percent)*	
Lake Barrington	16,767	11,406	68.0	2,067	12.3	2,578	15.4	716	4.3
From LCHD lake shoreline erosion assessment GIS data (2013).									

Figure 110. Lake Barrington 2013 shoreline erosion condition.

Land Use

Land use in the 485 acre Lake Barrington subunit is predominantly residential, covering 59.5 percent of the area (

Table 106). Open space, vacant forest/grassland and wetlands exist within the subunit as well. Commercial and institutional land use represents a minor portion of the subunit along Route 59 (Figure 111).

Figure 111. Land use distribution within Lake Barrington subunit.

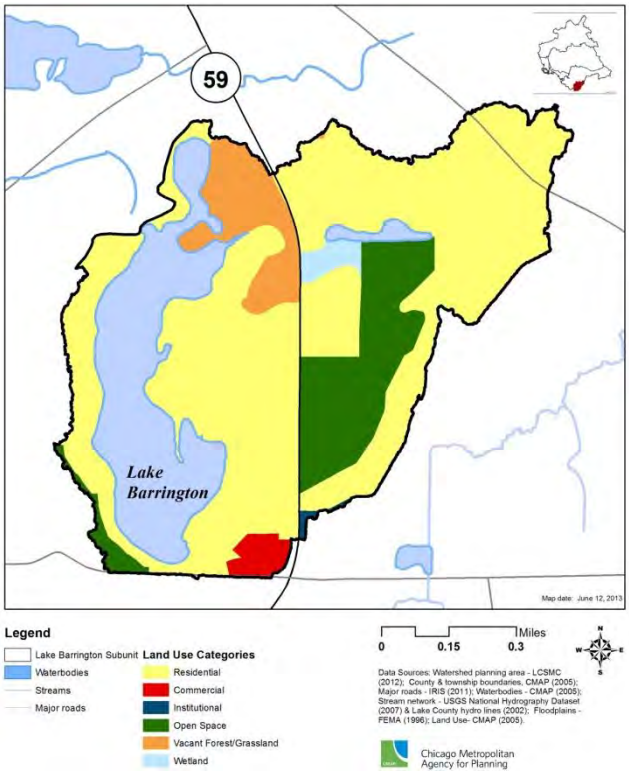


Table 106. 2005 Land use distribution within Lake Barrington subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	288.7	0.5	59.5
Commercial	6.9	0.01	1.4
Institutional	1.2	0.002	0.2
Open Space	58.7	0.1	12.1
Vacant Forest/ Grassland	31.0	0.05	6.4
Wetland	5.7	<0.01	1.2
Water	3.9	<0.01	0.8
Lake Barrington	89.3	0.1	18.4
Totals	485.4	0.8	100.0

Soils in the Lake Barrington subunit are primarily "Not Hydric" (61.4 percent) while 19 percent of the soils are considered "All Hydric" (Table 107, Figure 112).

Figure 112. Hydric soil within Lake Barrington subunit.

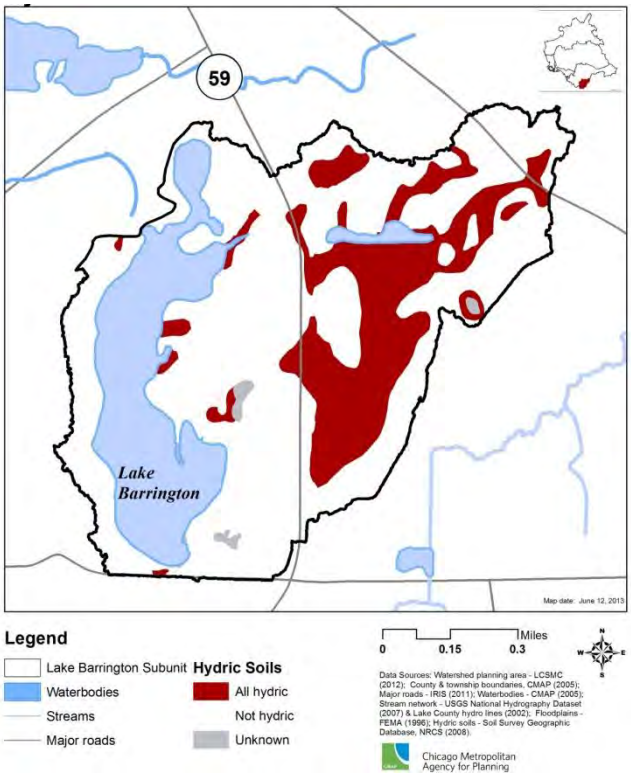


Table 107. Hydric soil acreage within Lake Barrington subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	92.7	19.1
Not hydric	298.2	61.4
Unknown	94.5	19.5

There are four hydrologic soil groups within the subunit. "Group C" comprises over 65 percent of the area and Group D soil groups compose over 13 percent the latter of which are found primarily to the east of Lake Barrington (Table 108, Figure 113).

Figure 113. Hydrologic soil groups within Lake Barrington subunit.

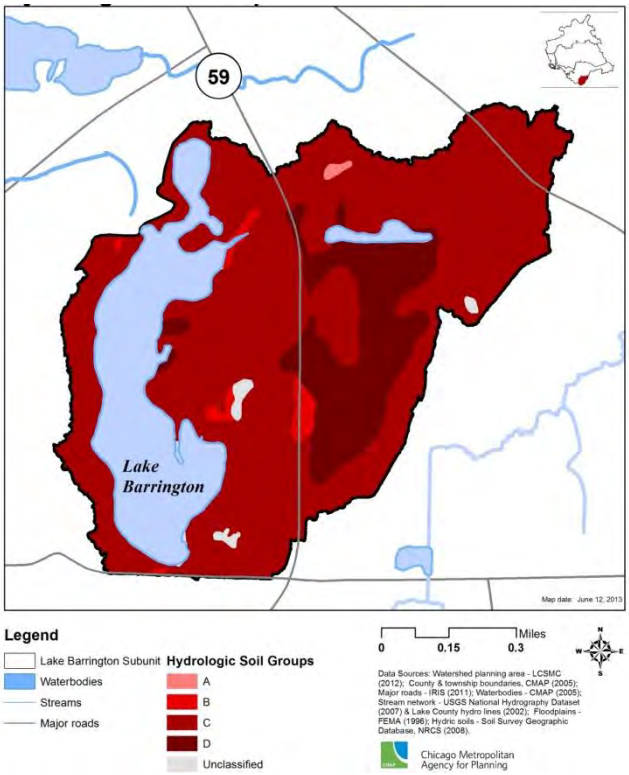


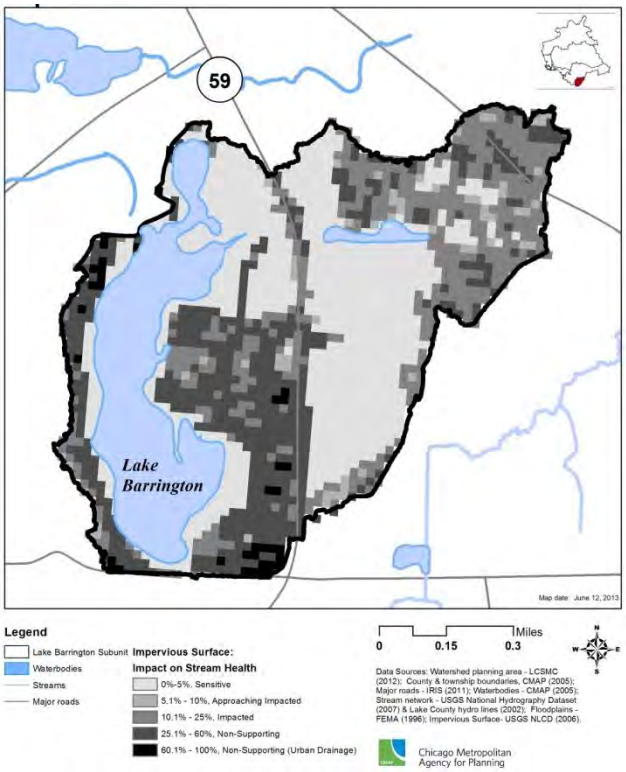
Table 108. Hydrologic soil groups within Lake Barrington subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	0.9	0.2
B	7.1	1.5
C	317.9	65.4
D	64.9	13.4
Unclassified	94.6	19.5

Impervious Cover

Impervious surface covers approximately 13.1 percent of the Lake Barrington subunit and results in a stream health class that is "Impacted" (Table 5). Impervious surfaces are more heavily concentrated west of State Rte. 59 and nearest the lake (Figure 114). Impervious surface is estimated to increase eight percent to cover 14.2 percent of the area by 2040 and thus, the subunit will maintain its "Impacted" relationship with water quality.

Figure 114. Impervious surfaces within Lake Barrington subunit.



Pollutant Loads

Pollutant loads to the nine lakes were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads to Lake Barrington are found in Table 109.

Table 109. Lake Barrington subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chloride (lbs/yr)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos phor (lbs /yr)*	*P (lbs /ac)*	*Bac. (bil col /yr)*	*Bac (bil col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	265.6	235.6	67458.5	253.9	1739.7	6.5	182.1	0.7	1952.9	7.4	109401.8	411.8
1231 URB MX W/PRK	1.3	2.0	381.8	288.7	7.3	5.5	0.9	0.7	2.6	1.9	425.1	321.5
1240 CULT /ENTERTA	6.9	10.3	2059.5	296.7	30.1	4.3	4.0	0.6	13.8	2.0	1703.2	245.4
1512 OTHR ROADWY	2.7	5.8	1409.7	515.7	21.9	8.0	3.2	1.2	6.4	2.4	2971.7	1087.2
3200 GOLF COURSE	1.1	0.5	0.6	0.5	2.3	2.1	0.4	0.4	0.7	0.6	42.6	39.9
3300 OPEN SPA/CONS	53.5	30.4	73.4	1.4	56.5	1.1	12.1	0.2	41.7	0.8	1936.2	36.2
3400 OPEN SPA/PRIV	18.2	8.4	14.9	0.8	11.5	0.6	2.5	0.1	8.5	0.5	393.3	21.6
3500 OPEN SPA/CORR	0.6	0.3	0.2	0.4	0.2	0.3	0.0	0.1	0.1	0.2	6.3	9.9
4110 VAC FOR/GRAS	29.7	14.6	32.2	1.1	49.6	1.7	4.6	0.2	18.3	0.6	1699.3	57.2
4120 WETLAND	5.7	4.7	13.8	2.4	10.7	1.9	0.2	0.0	3.0	0.5	12.2	2.1
5200 LAKE /RES/LAG	100.0	212.0	86115.7	861.1	269.1	2.7	17.9	0.2	142.6	1.4	861.2	8.6
Grand Totals	**485.4**	**524.6**	**157560.3**	**324.6**	**2198.7**	**4.5**	**227.9**	**0.5**	**2190.6**	**4.5**	**119452.8**	**246.1**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Phosphorus Loads and Target Reductions

In order to estimate how much phosphorus Lake Barrington's epilimnion[141] can receive on an average annual basis and meet Illinois' General Use water quality standard for total phosphorus (TP) of 0.050 mg/L (50 µg/L), another modeling exercise was undertaken. The Canfield-Bachman (CB) artificial lake model[142] was applied to estimate an average annual epilimnetic TP

[141] The epilimnion is the upper and warmer layer of water in a temperature-stratified lake where a lower/colder layer of water known as the hypolimnion also forms. Stratification occurs in summer during which mixing occurs within, but not between, layers.

[142] Canfield, D.E. Jr. and R.W. Bachmann. 1981. Prediction of total phosphorus concentrations, chlorophyll a, and Secchi depths in natural and artificial lakes. Can. J. Fish. Aquat. Sci. 38:414-423.

concentration. A key input to the CB model is provided by the SWAMM model: 228 lbs/yr P from average annual land runoff (Table 109).[143]

Together with other model parameters set for Lake Barrington—mean depth: 7.8 ft (2.38 m); lake retention or residence time: 1.34 yr.[144]; surface area: 91.1 ac—the CB model predicted an average annual epilimnetic TP of 0.048 mg/L. Thus, annual TP loads from the land alone result in an estimated average lake concentration that meets the applicable water quality standard.

Data available from samples taken from Lake Barrington reveal TP concentrations with an average of 0.081 mg/L over two growing seasons (2001, 2007).[145] The CB artificial lake model was also used as a tool to determine what the total average annual TP influx might be in order to yield this observed average TP concentration of 0.081 mg/L. This exercise resulted in an average influx of 568 lbs/yr, of which land runoff explains about 40 percent (228 / 568) of the TP influxes that influence the average annual epilimnetic TP concentration.

Finally, the CB model was set up to predict what the total average annual TP influx would need to be in order to achieve the water quality standard of 0.050 mg/L. This resulted in an average annual influx of 241 lbs/yr. When compared to the estimated total influx of 568 lbs/yr, a 58 percent reduction in annual TP influxes (327 lbs/yr) will be needed. Because 228 lbs/yr is potentially contributed by land runoff, it appears that on-the-ground BMPs implemented in the lake's watershed along with in-lake management practices will be necessary.

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[143] It is important to note that no estimates of other potential TP influxes to the lake (e.g., groundwater infiltration, atmospheric deposition, waterfowl waste, internal regeneration) were made as inputs to the CB model.

[144] Lake residence time is lake volume divided by avg. annual inflow. For Lake Barrington: 701.4 ac-ft / 525 ac-ft per yr = 1.336 yr. The reciprocal equation is "lake flushing time" or 0.75 times per year which is the value used in the CB model.

[145] Samples taken over just the growing season as opposed to those taken from throughout the year may result in a higher average concentration which will exaggerate the amount of estimated load reduction needed to meet water quality standards.

2.6.3.13 Subunit #13 - Tower Lake Drain

Land Use

The major land use in the 638 acre Tower Lake Drain subunit is residential, making up over half of the area. Open space represents a large portion of the subunit as well (36.8 percent) and other land uses are represented in lesser degrees (Table 110, Figure 115).

Figure 115. Land use distribution within Tower Lake Drain subunit.

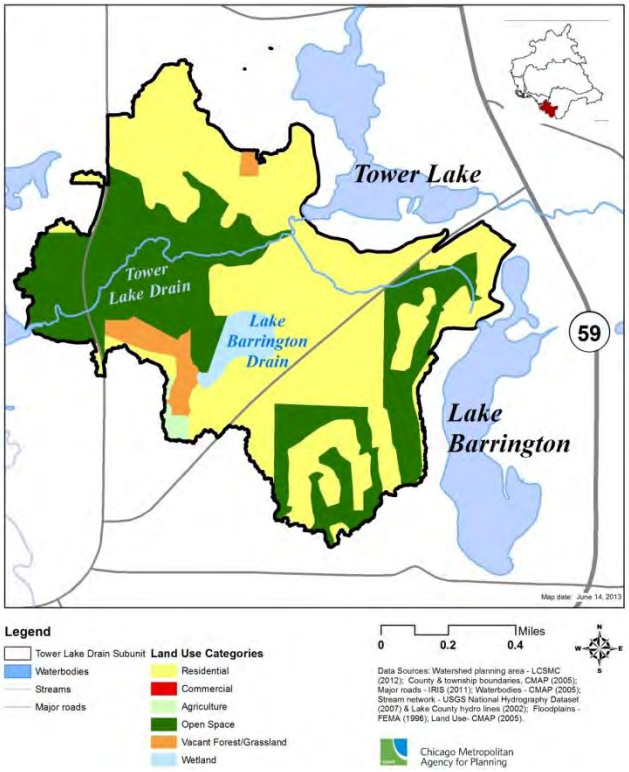
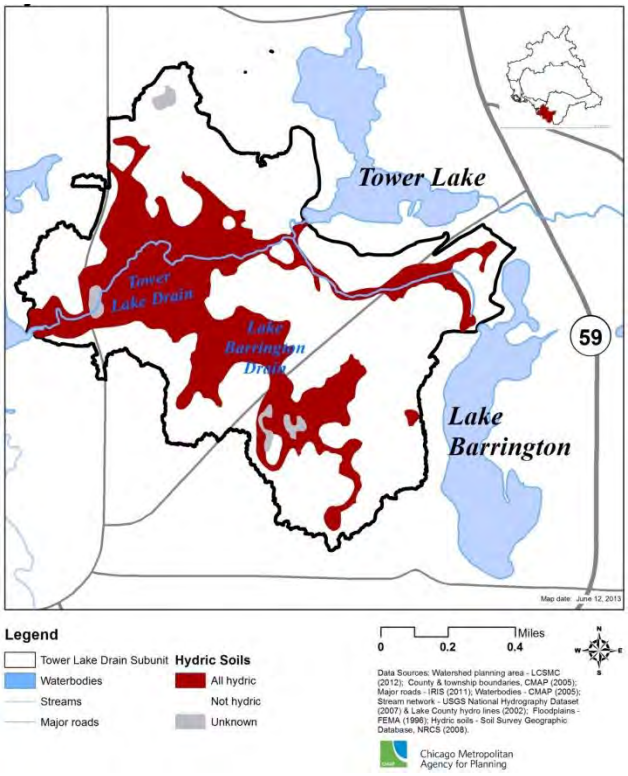


Table 110. 2005 Land use distribution within Tower Lake Drain subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	360.5	0.6	56.6
Commercial	0.03	<0.01	<0.01
Agriculture	4.8	<0.01	0.7
Open Space	234.4	0.4	36.8
Vacant Forest/ Grassland	20.6	0.03	3.2
Wetland	16.7	0.03	2.6
Water	0.3	<0.01	0.05
Totals	637.3	1.0	100.0

Figure 116. Hydric soil within Tower Lake Drain subunit.



Soils

Soils within the Tower Lake Drain subunit are predominantly "Not Hydric" (66 percent; Table 111). "All Hydric" soils make up 25 percent of the subunit and are spatially interspersed throughout the area with the greatest concentration in the southwestern half of the subunit area (Figure 116).

Table 111. Hydric soil acreage within Tower Lake Drain subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	207.1	32.5
Not hydric	422.3	66.3
Unknown	7.9	1.2

The dominant hydrologic soil groups are Group B (37 percent) and Group C (36 percent; Table 112). Group B soils, are concentrated in the northwestern portion, and Group C soils are found mostly in the southeastern portion of the subunit (Figure 117).

Figure 117. Hydrologic soil groups within Tower Lake Drain subunit.

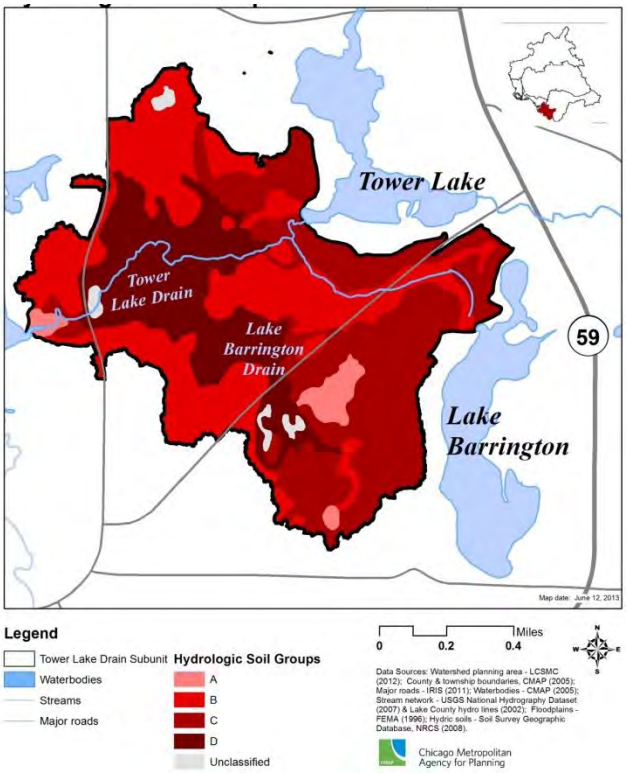
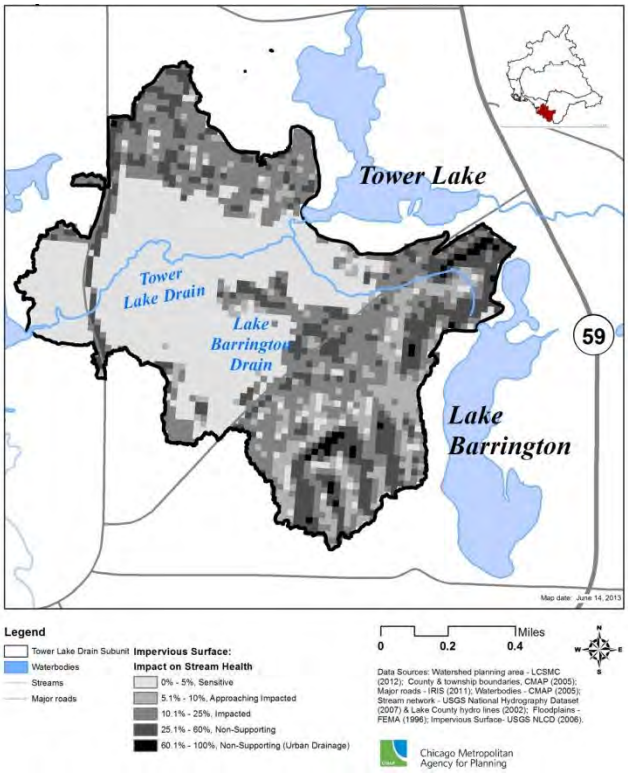


Table 112. Hydrologic soil groups within Tower Lake Drain subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	19.4	3.0
B	235.9	37.0
C	229.2	36.0
D	144.8	22.7
Unclassified	7.9	1.3

The Tower Lake Drain subunit includes 12.9 percent impervious surface area (Figure 118). Due to the correlation between imperviousness and stream health, the overall stream health in the subunit is considered "Impacted" (Table 5). Projections for future impervious surfaces suggest the Tower Lake Drain subunit will reach 13.5 percent by the year 2040. This relatively slight increase, five percent, will keep the area in the "Impacted" stream health category.

Figure 118. Impervious surfaces within Tower Lake Drain subunit.



Pollutant Loads

Pollutant loads were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads for the Tower Lake Drain subunit are found in Table 113.

Table 113. Tower Lake Drain subunit pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs/yr)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos phor. (lbs /yr)*	*P (lbs /ac)*	*Bac. (bil col /yr)*	*Bac (bil col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	306.6	207.1	37849.1	123.4	1131.7	3.7	127.7	0.4	1264.7	4.1	62192.7	202.8
1212 RETA CNTR	0.0	0.1	10.4	299.7	0.2	6.5	0.0	1.0	0.1	2.0	11.6	333.7
1512 OTHR ROADWY	4.0	8.4	2193.9	554.0	34.1	8.6	5.0	1.3	10.0	2.5	4625.0	1168.0
3200 GOLF COURSE	77.8	36.4	93.3	1.2	369.0	4.7	61.5	0.8	105.9	1.4	6887.8	88.6
3300 OPEN SPA/ CON	147.3	72.9	199.0	1.4	153.1	1.0	32.8	0.2	113.0	0.8	5248.3	35.6
3400 OPEN SPA/ PRIV	35.5	11.6	23.2	0.7	17.9	0.5	3.8	0.1	13.2	0.4	613.1	17.3
4110 VAC FOR/GRAS	24.2	7.7	14.5	0.6	22.2	0.9	2.1	0.1	8.2	0.3	762.5	31.5
4120 WETLAND	29.3	24.5	63.5	2.2	48.9	1.7	0.7	0.0	13.9	0.5	55.8	1.9
5100 RIVRS /CANALS	0.3	0.6	134.0	497.6	2.4	8.9	0.2	0.8	0.4	1.4	4.7	17.6
5200 LAKE /RES/LAG	12.3	26.0	10329.9	842.1	32.3	2.6	2.2	0.2	17.1	1.4	103.3	8.4
Grand Totals	**637.3**	**395.1**	**50910.8**	**79.9**	**1811.8**	**2.8**	**236.1**	**0.4**	**1546.4**	**2.4**	**80504.9**	**126.3**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

Direct Drainage to the Fox River

2.6.3.14 Subunit #14 – Direct Drainage Area

Land Use

A plurality of land use within the 1,290 acre Direct Drainage Area is residential, covering 45.9 percent of the study area while open space characterizes about a third of the area (Table 114). Open space is interspersed with residential land use. Wetlands and other land use types are represented in the Direct Drainage Area as well (Figure 119).

Figure 119. Land use distribution within the Direct Drainage Area subunit.

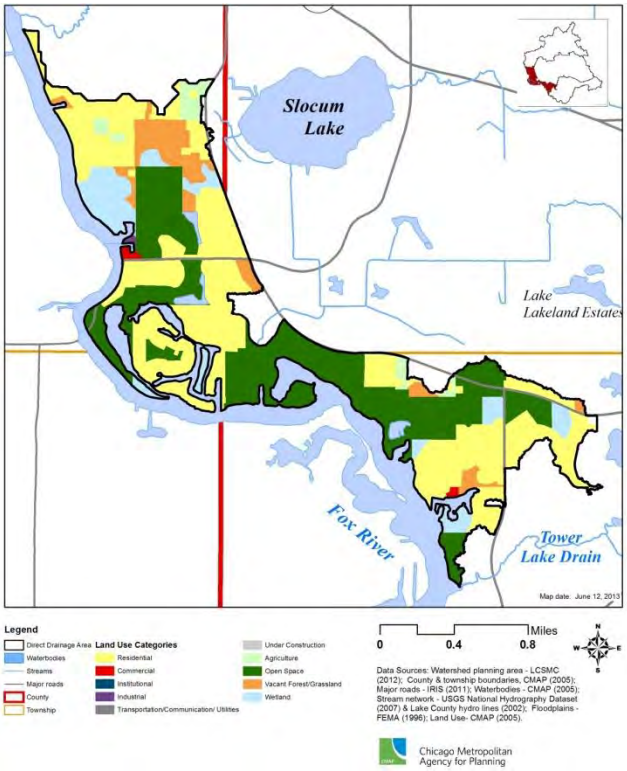


Table 114. 2005 Land use distribution within the Direct Drain Area subunit.

Land Use Category	*Area (acres)*	*Area (sq.mi.)*	*Percent of Subunit*
Residential	591.1	0.9	45.9
Commercial	5.6	0.01	0.4
Industrial	1.9	0.003	0.1
Transportation/ Communication/ Utilities	1.4	0.002	0.1
Agriculture	33.3	0.05	2.7
Open Space	438.9	0.7	34.0
Vacant Forest/Grassland	91.7	0.1	7.1
Wetland	112.6	0.2	8.7
Water	13.2	0.02	1.0
Totals	1289.8	2.0	100.0

The majority of the soils in the Direct Drainage Area are "Not Hydric," comprising close to two-thirds of soils in the area (Table 115). "All Hydric" soils are relatively abundant in comparison with other subunits and make up 36.2 percent of the area (Figure 120).

Figure 120. Hydric soils within the Direct Drainage Area subunit.

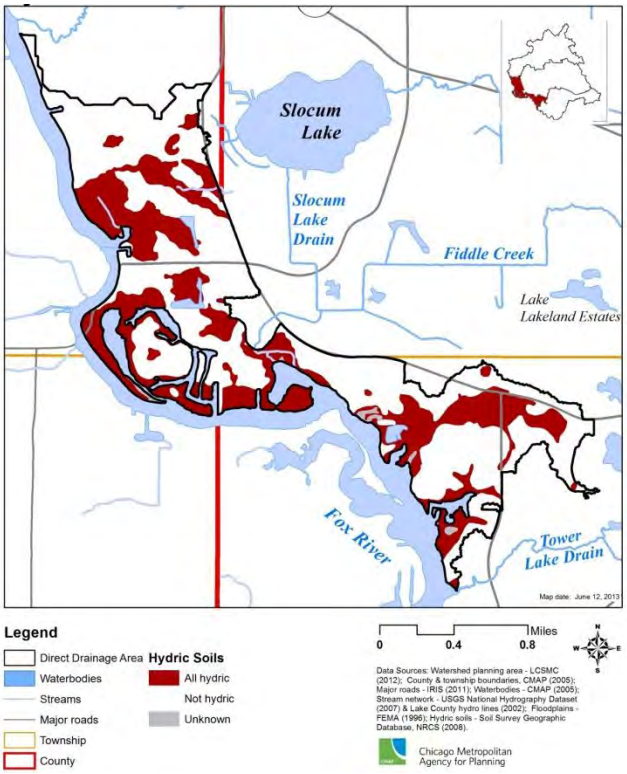


Table 115. Hydric soil acreage within the Direct Drainage Area subunit.

Hydric Soil Class	*Area (acres)*	*Percent of Subunit*
All hydric	467.1	36.2
Not hydric	803.4	62.3
Unknown	19.4	1.5

The dominant hydrologic soil group is Group B, accounting for 59.1 percent of the area (Table 116). These Group B soils are evenly interspersed throughout the area (Figure 121).

Figure 121. Hydrologic soil groups within Direct Drainage Area subunit.

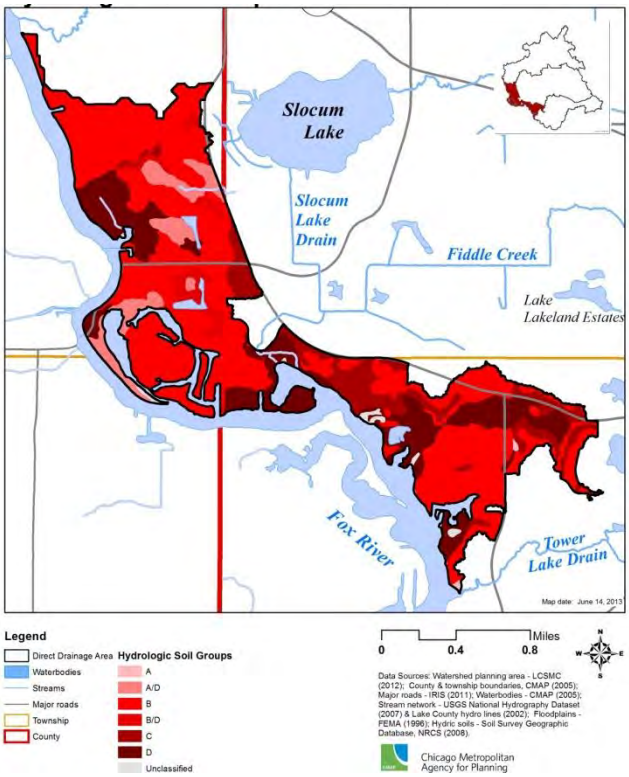
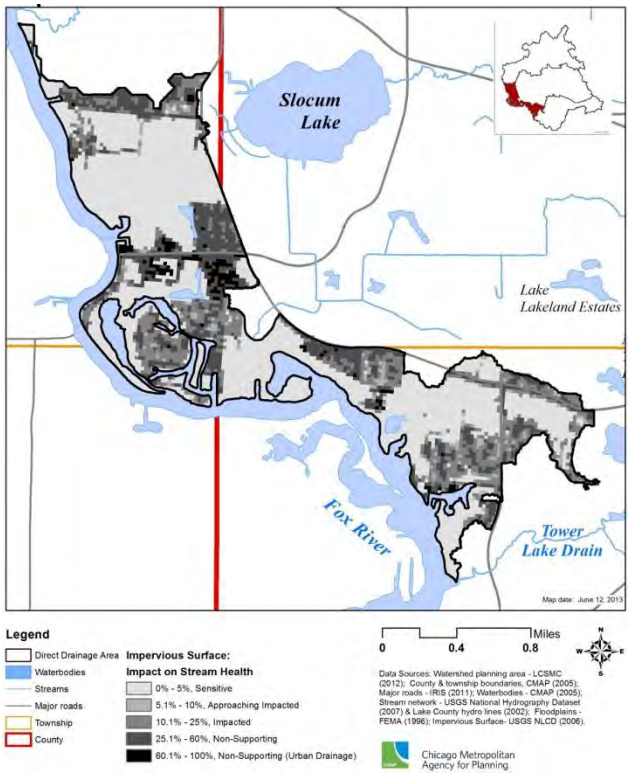


Table 116. Hydrologic soil groups within Direct Drainage Area subunit.

Hydrologic Soil Group	*Area (acres)*	*Percent of Subunit*
A	2.1	0.2
A/D	75.5	5.9
B	762.4	59.1
B/D	43.7	3.4
C	135.6	10.4
D	251.2	19.5
Unclassified	19.4	1.5

The Direct Drainage subunit includes 12.7 percent impervious surface and thus, features a stream health classification of "Impacted" (Table 5; Figure 122). Future impervious surfaces in the subunit are projected to grow to 14.3 percent of the area. This nearly 13 percent increase will maintain the current stream health classification.

Figure 122. Impervious surfaces within the Direct Drainage Area subunit.



<u>Pollutant Loads</u>

Pollutant loads were generated by applying the Spatial Watershed Assessment and Management Model (SWAMM) developed for the planning area by Northwater Consulting. Pollutant loads in the Direct Drainage Area subunit are found in Table 117.

Table 117. Direct Drainage Area pollutant loads.

Land Use	*Acres*	*Run off (ac-ft)*	*Chlor-ide (lbs/yr)*	*CL (lbs /ac)*	*Nitro-gen (lbs /yr)*	*N (lbs /ac)*	*Phos phor. (lbs /yr)*	*P (lbs /ac)*	*Bac. (bil col /yr)*	*Bac (bil col /ac)*	*TSS (lbs /yr)*	*TSS (lbs /ac)*
1110 RES/SF	562.9	326.8	47554.0	84.5	1393.6	2.5	155.9	0.3	1555.1	2.8	77913.8	138.4
1120 RES/ FARM	8.2	4.2	303.3	37.0	11.5	1.4	1.4	0.2	14.3	1.7	551.9	67.4
1240 CULT /ENTERTA	5.6	7.2	1503.0	266.8	21.9	3.9	2.9	0.5	10.1	1.8	1243.0	220.7
1330 GOVT	12.8	18.3	5723.8	448.6	123.8	9.7	16.2	1.3	38.4	3.0	4733.7	371.0
1430 WAR/ DIS/WHO	1.9	2.7	452.1	237.8	7.9	4.2	0.9	0.5	3.0	1.6	503.4	264.8
1512 OTHR ROADWY	5.6	11.8	3096.9	557.6	48.1	8.7	7.1	1.3	14.1	2.5	6528.7	1175.6
1560 UTIL/ WAST/WA	1.4	1.6	218.4	155.6	3.1	2.2	0.5	0.4	0.8	0.6	180.6	128.7
2100 CROP /GRAIN/ GRAZING	18.1	12.1	10.3	0.6	80.1	4.4	6.5	0.4	25.6	1.4	13389.0	740.6
2400 EQUESTRI	4.8	3.3	3.8	0.8	30.0	6.3	2.2	0.5	15.1	3.2	810.3	170.0
3100 OPEN SPA/RECR	21.4	8.7	12.8	0.6	17.5	0.8	4.2	0.2	14.5	0.7	728.6	34.0
3300 OPEN SPA/CONS	394.6	157.6	387.9	1.0	298.4	0.8	63.9	0.2	220.3	0.6	10230.0	25.9
3400 OPEN SPA/PRIV	28.7	10.7	15.8	0.6	12.2	0.4	2.6	0.1	9.0	0.3	417.2	14.5
4110 VAC FOR/GRAS	89.7	29.6	35.1	0.4	53.9	0.6	5.0	0.1	19.9	0.2	1848.9	20.6
4120 WETLAND	111.7	93.4	216.8	1.9	166.8	1.5	2.4	0.0	47.3	0.4	190.6	1.7
5200 LAKE /RES/LAG	22.5	47.6	10649.4	473.8	33.3	1.5	2.2	0.1	17.6	0.8	106.5	4.7
Grand Totals	**1289.8**	**735.7**	**72208.8**	**56.0**	**2302.0**	**1.8**	**274.2**	**0.2**	**2005.3**	**1.6**	**119376.2**	**92.6**

Runoff is an annual value; TSS = total suspended solids; bacteria counts expressed in billion colonies/unit

2.6.4 Other Waterbodies

Other waterbodies in the planning area for which Illinois EPA has assessed for one or more designated uses are featured in Table 118.[146]

Table 118. Specific assessment information for other waterbodies in planning area, 2012.

Waterbody/ID	*Surface Area (ac)*	*Impaired Designated Use(s)*	*Cause of Impairment(s)*	*Source of Impairment(s)*
Bangs Lake IL_RTG	309	Fish consumption	Mercury	Atmospheric deposition – toxics, Source unknown
Broberg Marsh IL_STN	77	Aesthetic Quality	Total phosphorus, total suspended solids, aquatic plants	Source unknown
Fox River DT-22	7.86 mi.	Aquatic Life	Alteration in stream-side or littoral vegetative covers, Chloride, Copper, Other flow regime alterations, Sedimenta-tion/siltation, Aquatic algae	Impacts from hydrostructure flow regula-tion/modification, Habitat modification – other than hydromodification, Highway/road/bridge runoff (non-construction related), Urban runoff/ storm sewers, Dam or impoundment, Source unknown
		Fish consumption	PCBs	Source unknown
Heron Pond IL_STY	8	Aesthetic Quality	Total phosphorus, aquatic plants	Agriculture, Urban runoff/storm sewers, Runoff from forest/grassland/parkland, Source unknown
Lakeland Estates IL_UTS	14	Aesthetic Quality	Total phosphorus, aquatic plants	Urban runoff/storm sewers, Runoff from forest/grassland, parkland, Source unknown
North Tower Lake IL_UTT	7	Aesthetic Quality	Total phosphorus, total suspended solids, aquatic plants	Source unknown
Slocum Lake Drain IL_DTR-W-C3	1.08 mi.	Aquatic Life	Dissolved oxygen, pH, total phosphorus, sedimentation/siltation, changes in stream depths and velocity patterns	Urban runoff/storm sewers, Municipal point source discharges, Channelization, Dam or impoundment, Source unknown

[146] Illinois EPA, Bureau of Water. Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012 http://www.epa.state.il.us/water/tmdl/303d-list.html#2012.

Waterbody/ID	*Surface Area (ac)*	*Impaired Designated Use(s)*	*Cause of Impairment(s)*	*Source of Impairment(s)*
Slocum Lake Drain IL_DTR-W-D1	0.92 mi.	Aquatic Life	Dissolved oxygen, pH, total phosphorus, sedimentation/siltation, changes in stream depths and velocity patterns	Urban runoff/storm sewers, Channelization, Dam or impoundment, Source unknown
		Aesthetic Quality	Bottom Deposits	Source unknown
Taylor Lake IL_VTZY	8.3	Aesthetic Quality	Total phosphorus, total suspended solids, aquatic plants	Urban runoff/storm sewers, Runoff from forest/grassland/parkland, Source unknown

2.6.5 NPDES and Facility Planning Areas

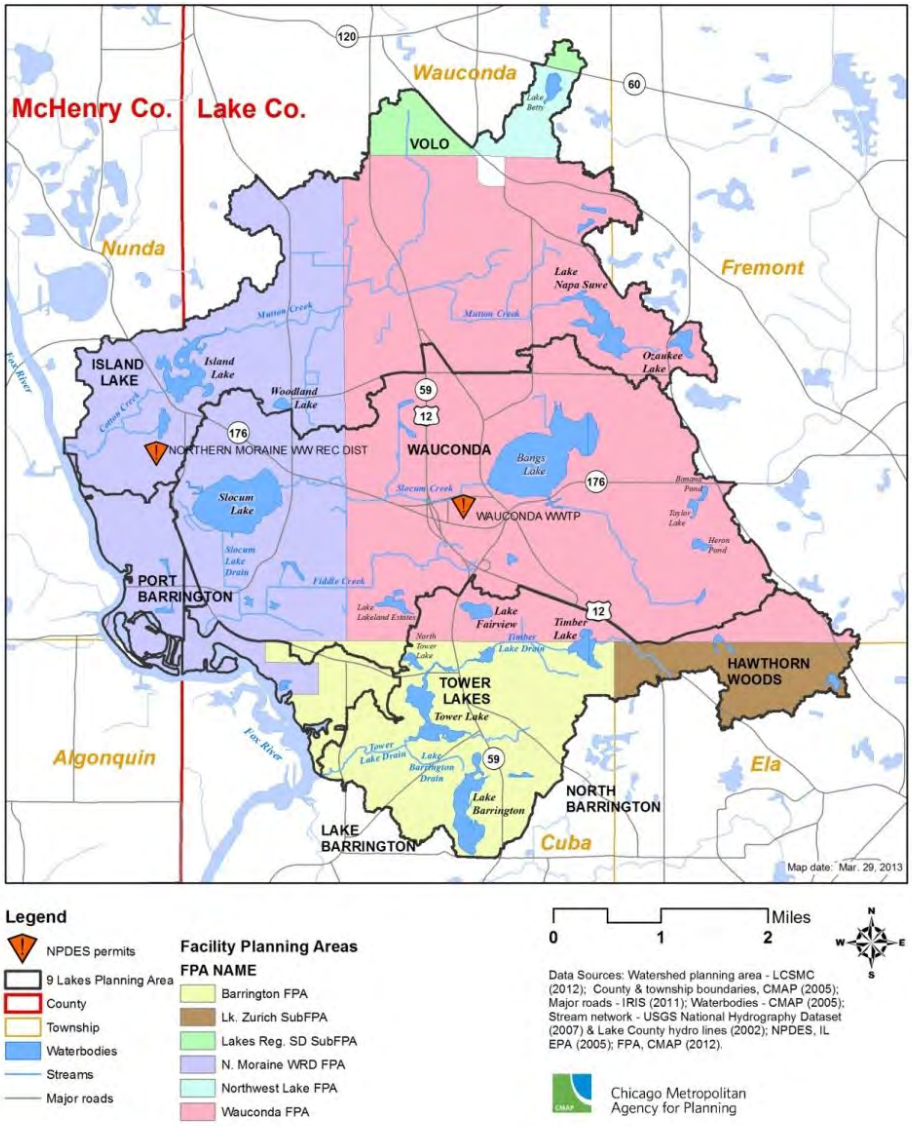
Authorized under amendments made to the Clean Water Act in 1987, the U.S. Environmental Protection Agency (U.S. EPA) uses permits issued through the NPDES to manage pollution to waterbodies from a variety of point sources. Illinois EPA issues the permits through delegation of authority by U.S. EPA. Point sources regulated through NPDES include wastewater treatment plants, industrial dischargers, concentrated animal feeding operations (CAFOs), combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), and urban stormwater runoff.[147] 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 specific pollutants including BOD, total suspended solids, ammonia nitrogen, fecal coliform, dissolved oxygen, and phosphorus.

There are two NPDES permits issued in the planning area, both for wastewater treatment plants (WWTP): Northern Moraine Wastewater Reclamation District (NMWRD; NPDES ID #IL0031933), and the Village of Wauconda (NPDES ID #IL0020109). Each permittee has a facility planning area (FPA)[148] that together are the two largest (i.e., greatest spatial extent) among six that are partially included in the 9 Lakes Planning Area (Figure 123). The Wauconda WWTP has two outfalls on Fiddle Creek and the NMWRD has two outfalls on the Fox River.

[147] "NPDES Permit Program Basics," U.S. EPA, last modified January 4, 2011, accessed October 12, 2011, http://cfpub.epa.gov/npdes/home.cfm? program_id=45.

148 A facility planning area (FPA) is the geography served by a wastewater treatment plant based on plant capacity, development plans, and other nearby FPAs. The FPA includes both the current sewer-service area as well as unsewered areas that are expected to be developed and served in the future.

Figure 123. Facility planning area and WWTP NPDES permittees.



NPDES Stormwater Program

The stormwater component of the NPDES Program was implemented in two phases. Phase I of this program was implemented in 1990 and applies to medium and large municipal storm sewer systems, as well as certain counties with populations of 100,000 or more. Phase II was implemented in 2003 and expands the scope of storm sewer systems which are subject to NPDES.[149] Phase II applies to small MS4s including smaller construction or industrial sites that

149 "NPDES Stormwater Program," U.S. EPA, last modified January 4, 2011, accessed October 13, 2011, http://cfpub.epa.gov/npdes/home.cfm? program_id=6.

are owned and operated in urbanized areas.[150] Industrial sites or construction activities that disturb one or more acres of land must obtain an NPDES permit before construction activities begin.[151]

Under the terms of Phase II permits, industrial, construction, and MS4 Phase II permittees are required to implement certain practices that control pollution in stormwater runoff. To prevent the contamination of stormwater runoff, industrial and construction permittees must develop a stormwater pollution prevention plan, while MS4 permittees must develop a similar stormwater management program. Stormwater runoff carrying pollutants from impervious surfaces can degrade water quality when discharged untreated into local rivers and streams, as is often the case. Programs like Phase II that encourage planning and implementation on a watershed basis are therefore vital for protecting water quality from stormwater runoff from both large and small separate stormwater sewer systems, as well as industrial and construction sites.

2.6.6 Leaking Underground Storage Tanks

Leaking underground storage tanks (LUST) are a source of environmental contamination and may pose a number of threats, groundwater contamination among them. While the Illinois Office of the State Fire Marshall regulates the daily operation and maintenance of underground storage tank systems, the Illinois EPA becomes involved once a release (i.e., leak) has been reported to the Illinois Emergency Management Agency (IEMA). Following a tank release report to IEMA, Illinois EPA's LUST section begins oversight of remedial operations.[152] While LUST sites are of concern anywhere they exist, they are particularly relevant in an area of groundwater-dependent communities and private-well owners. The 9 Lakes TMDL Planning Area includes 45 LUST sites (Figure 124). Table 119 offers information concerning the distribution of these sites by watershed and unit of government. Knowledge of LUST sites and their status can work in favor of developing wellhead protection plans for existing community water supply wells. Such plans can reduce the susceptibility of wells to other potential sources of contaminants. For information regarding the status of LUST sites, readers are referred to the LUST Incident Tracking database: http://epadata.epa.state.il.us/land/ust/.

An Underground Storage Tank (UST) Fund was established in 1989 to help tank owners and operators pay for cleaning up leaks from petroleum USTs. Illinois generates money for the UST Fund through a $0.003 per-gallon motor fuel tax and an $0.008 per-gallon environmental impact fee, both of which are due to expire in 2013.[153]

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150 "NPDES Stormwater Program," U.S. EPA, last modified January 4, 2011, accessed October 13, 2011, http://cfpub.epa.gov/npdes/home.cfm? program_id=6.

151 U.S. EPA. "Stormwater Phase II Final Rule: An Overview." EPA Report No. 833-F-00-001. Washington, D.C.: U.S. EPA, 2005. http://www.epa.gov/npdes/ pubs/fact2-0.pdf (accessed October 12, 2011).

152 For more information, visit Illinois EPA's website for this issue: http://www.epa.state.il.us/land/lust/introduction.html.

153 For more information, please visit: http://www.epa.state.il.us/land/lust/index.html.

Figure 124. Leaking underground storage tank (LUST) sites in 9 Lakes planning area.

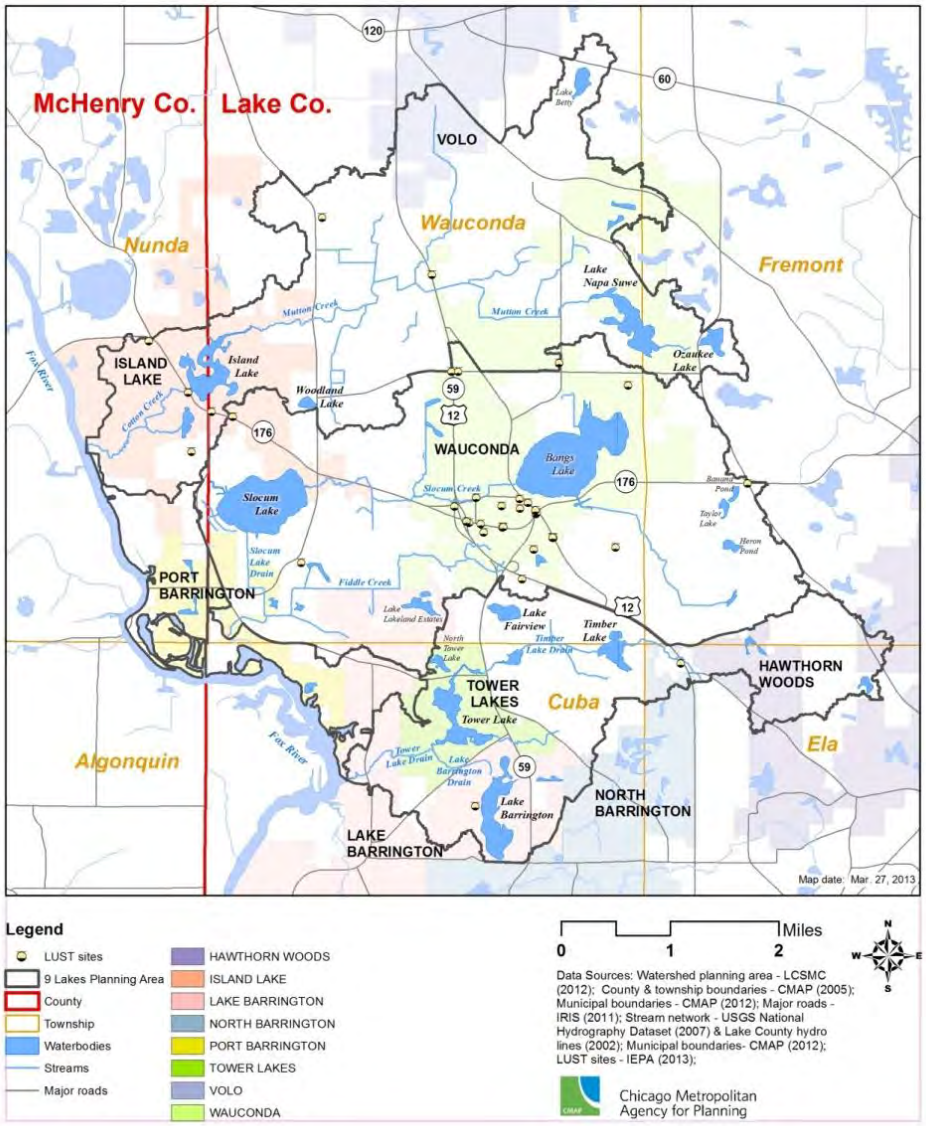


Table 119. Leaking underground storage tank sites by governmental jurisdiction and watershed.

City / County	*Township*	*Watershed*	*Number of sites*
Island Lake	Nunda (McHenry Co.)	Cotton-Mutton Creek	2
Island Lake	Wauconda	Cotton-Mutton Creek (1) Slocum Lake Drain (3)	4
Lake Barrington	Cuba	Tower Lake Drain	1
Wauconda	Wauconda	Cotton-Mutton Creek (1) Slocum Lake Drain (27)	28
Wauconda	Fremont	Slocum Lake Drain	1

Unincorporated	Nunda (McHenry Co.) Ela Fremont Wauconda	Cotton-Mutton Creek Tower Lake Drain Slocum Lake Drain Cotton-Mutton Creek (1) Slocum Lake Drain (5)	1 1 1 6

2.6.7 Community Water Systems

A community water system (CWS) means a public water supply system that serves at least 15 service connections used by residents or regularly serves at least 25 residents for at least 60 days per year.[154]

Presently, all of the municipalities within the planning area are served by groundwater that is pumped, treated, and distributed via municipal-run public water supply systems. Of the eight municipalities involved with this plan, five of them have CWS wells that are located within the planning area (Table 120).

Table 120. Number and type of community water supply wells.[155]

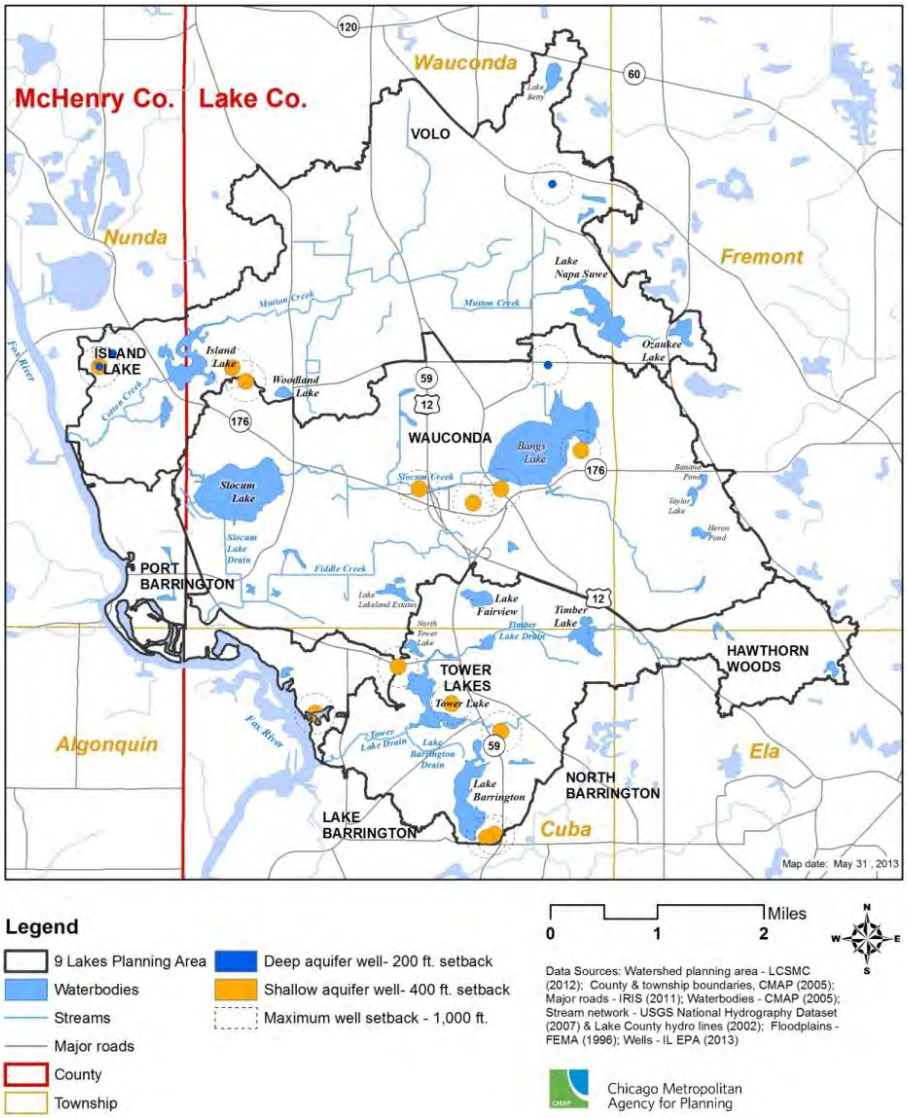
Municipality	*Number of shallow aquifer wells (400 ft. setback)*	*Number of deep aquifer wells (200 ft. setback)*
Island Lake	4	2
Lake Barrington Shores	2	0
Port Barrington	1	0
Tower Lakes	3	0
Wauconda	6	2

Community water systems are subject to the Illinois Groundwater Protection Act (IGPA; P.A. 85-0863). The IGPA requires that municipalities establish a geographic area, called a setback zone, for CWS wells in order to prevent contamination. The setback zone restricts certain land-use activities and is set at a minimum of either 200 (deep wells) or 400 feet radius (shallow wells) depending on the sensitivity of a well to possible contamination (Figure 125).

154 Illinois Groundwater Protection Act (415 ILCS 55/) http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=1595&ChapterID=36 For additional information, please visit: http://www.epa.state.il.us/water/groundwater/publications/primer.pdf.

155 Shallow wells draw from either sand and gravel deposits in the glacial drift or from limestone/dolomite aquifers generally less than 500 feet deep. Wells drilled into the deep-bedrock sandstone aquifer are generally over 500 feet deep.

Figure 125. Community water supply wells in 9 Lakes planning area.



Municipalities have the option of establishing by ordinance a maximum setback zone of 1,000 feet for community water supply wells. Such a decision will add an extra measure of protection from incompatible land-use activities yet offers flexibility to accommodate preexisting activities. No communities within the planning area have chosen to adopt a maximum setback zone. The IGPA also empowers municipalities to adopt other more stringent ordinances for enhanced groundwater protection. Wauconda has done so to prohibit the installation and use of new potable water supply wells in response to a limited area of groundwater contamination.[156]

156 For more information, please visit: http://epadata.epa.state.il.us/land/gwordinance/municipality.asp.

3. Water Quality and BMP Pollutant Load Reductions

3.1 Water Quality Standards

Methodologies used by Illinois EPA for assessing the level of support for designated uses are discussed in detail elsewhere.[157] Here, a brief overview of relevant water quality standards by designated use will serve as the basis upon which pollutant load reduction targets will be set.

3.1.1 Aquatic Life

Guidelines for identifying potential causes of impairment of the aquatic life designated use in Illinois streams and inland lakes are generally based on Illinois Water Quality Standards.[158] Table 121 lists the standards for pollutants that have either been identified as causes of impairment in the planning area or are expected to be addressed in this plan (i.e., total nitrogen).

Table 121. Applicable water quality standards.

Pollutant	*WQ Standard - Streams*	*WQ Standard - Lakes*
Total Phosphorus	None	0.05 mg/L in lakes >/= 20 acres (for smaller lakes, there is no standard)
Total Nitrogen	None	None
Total suspended solids (TSS)	None	None

Woodland Lake is the only lake of the nine where dissolved oxygen has been deemed a cause of impairment (designated use: aquatic life). Dissolved oxygen has also been identified as impairing aquatic life in Fiddle Creek. The standard for dissolved oxygen is more complex. Thus, text from 35 ILAC 302.206—Dissolved Oxygen—is recreated below:

General use waters must maintain dissolved oxygen concentrations at or above the values contained in subsections (a), (b) and (c) of this Section.

a. General use waters at all locations must maintain sufficient dissolved oxygen concentrations to prevent offensive conditions as required in Section 302.203 of this Part. Quiescent and isolated sectors of General Use waters including but not limited to wetlands, sloughs, backwaters and waters below the thermocline in lakes and reservoirs must be maintained at sufficient dissolved oxygen concentrations to support their natural ecological functions and resident aquatic communities.

40 Illinois EPA, Bureau of Water. Illinois Integrated Water Quality Report and Section 303(d) List – Volume I: Surface Water – 2012. http://www.epa.state.il.us/water/tmdl/303d-list.html#2012

41 General Use Water Quality Standards are outlined in 35 ILAC 302, Subpart B. http://www.ipcb.state.il.us/documents/dsweb/Get/Document-33354/

b. Except in those waters identified in Appendix D of this Part, the dissolved oxygen concentration in the main body of all streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs must not be less than the following:

1) During the period of March through July,
   A) 5.0 mg/L at any time; and
   B) 6.0 mg/L as a daily mean averaged over 7 days.
2) During the period of August through February,
   A) 3.5 mg/L at any time;
   B) 4.0 mg/L as a daily minimum averaged over 7 days; and
   C) 5.5 mg/L as a daily mean averaged over 30 days.

c. The dissolved oxygen concentration in all sectors within the main body of all streams identified in Appendix D of this Part must not be less than:

1) During the period of March through July,
   A) 5.0 mg/L at any time; and
   B) 6.25 mg/L as a daily mean averaged over 7 days.
2) During the period of August through February,
   A) 4.0 mg/L at any time;
   B) 4.5 mg/L as a daily minimum averaged over 7 days; and
   C) 6.0 mg/L as a daily mean averaged over 30 days.

d. Assessing attainment of dissolved oxygen mean and minimum values.
1) Daily mean is the arithmetic mean of dissolved oxygen concentrations in 24 consecutive hours.
2) Daily minimum is the minimum dissolved oxygen concentration in 24 consecutive hours.
3) The measurements of dissolved oxygen used to determine attainment or lack of attainment with any of the dissolved oxygen standards in this Section must assure daily minima and daily means that represent the true daily minima and daily means.
4) The dissolved oxygen concentrations used to determine a daily mean or daily minimum should not exceed the air-equilibrated concentration.
5) "Daily minimum averaged over 7 days" means the arithmetic mean of daily minimum dissolved oxygen concentrations in 7 consecutive 24-hour periods.
6) "Daily mean averaged over 7 days" means the arithmetic mean of daily mean dissolved oxygen concentrations in 7 consecutive 24-hour periods.
7) "Daily mean averaged over 30 days" means the arithmetic mean of daily mean dissolved oxygen concentrations in 30 consecutive 24-hour periods.

3.1.2 Primary Contact Recreation

To assess the primary contact use in both streams and inland lakes, Illinois EPA uses all fecal coliform bacteria from water samples collected in May through October, over the most recent five-year period (i.e., 2006 through 2010 for the 2012 Integrated Report). From these water samples, geometric means and individual measurements of fecal coliform bacteria are compared to the concentration thresholds in Table 122 and Table 123. To apply the guidelines, the geometric mean of fecal coliform bacteria concentration is calculated from the entire set of May through October water samples, across the five years. No more than 10 percent of all the samples may exceed 400/100 ml for a water body to be considered Fully Supporting.

Table 122. Guidelines for assessing primary contact use in Illinois streams and inland lakes.

Degree of Use Support	*Guidelines*
Fully Supporting (Good)	No exceedance of the fecal coliform bacteria standard in the last five years and the geometric mean of all fecal coliform bacteria observations <200/100 ml, and <10% of all observations exceed 400/100 ml.
Not Supporting (Fair)	One exceedance of the fecal coliform bacteria standard in the last five years (when sufficient data is available to assess the standard) or The geometric mean of all fecal coliform bacteria observations in the last five years <200/100 ml, and >10% of all observations in the last five years exceed 400/100 ml or The geometric mean of all fecal coliform bacteria observations in the last five years >200/100 ml, and <25% of all observations in the last five years exceed 400/100 ml.
Not Supporting (Poor)	More than one exceedance of the fecal coliform bacteria standard in the last five years (when sufficient data is available to assess the standard) or The geometric mean of all fecal coliform bacteria observations in the last five years >200/100 ml, and >25% of all observations in the last five years exceed 400/100

Table 123. Guidelines for identifying potential causes of impairment of primary contact use in Illinois streams and inland lakes.

Potential Cause	*Basis for Identifying Cause - Numeric Standard*[159]
Fecal Coliform	Geometric mean of at least five fecal coliform bacteria observations collected over not more than 30 days during May through October >200/100 ml or > 10% of all such fecal coliform bacteria observations exceed 400/100 ml or Geometric mean of all fecal coliform bacteria observations (minimum of five samples) collected during May through October >200/100 ml or > 10% of all fecal coliform bacteria observation exceed 400/100 ml.

3.1.3 Aesthetic Quality

Attainment of the aesthetic quality use is based on the attainment of the Offensive Conditions narrative standards in 35 ILAC 302.203 for streams covered under the General Use Standards which states, "Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth (aquatic macrophytes or algae), color or turbidity of other than natural origin. The allowed mixing provisions of Section 302.102 shall not be used to comply with the provisions of this Section." Whenever plant growth or algal growth is judged to cause nonattainment, total phosphorus is listed as a contributing cause. Such is the case with all of the nine lakes.

For inland lakes, the Aesthetic Quality Index (AQI) is the primary tool used to assess aesthetic quality. The AQI involves three evaluation factors: median Trophic Status Index (TSI), macrophyte coverage, and nonvolatile suspended solids concentrations. High AQI scores are indicative of lower quality water. The TSI is based on total phosphorus, chlorophyll a, and Secchi disk transparency. Thus, assessments of aesthetic quality are based on a combination of physical and chemical water quality data. For more details, the reader is referred to the Illinois Integrated Report.

Guidelines for identifying potential causes of impairment of aesthetic quality use are the same for streams and lakes except for total phosphorus where a standard exists for lakes with a surface area of 20 acres or larger (Table 124).

42 The applicable fecal coliform standard (35 Ill. Adm. Code, 302, Subpart B, Section 302.209) requires a minimum of five samples in not more than a 30-day period. However, because this number of samples is seldom available in this time frame, the criteria are also based on a minimum of five samples over the most recent five-year period.

Table 124. Guidelines for identifying potential causes of impairment of aesthetic quality use in Illinois streams and inland lakes.

	Basis for Identifying Causes[160]
Potential Cause	*Criteria based on Water Quality Standards*[161]
Sludge	The presence of sludge which violates the narrative standard[162]
Bottom Deposits	The presence of bottom deposits which violates the narrative standard
Floating Debris	The presence of floating debris which violates the narrative standard
Visible Oil	The presence of visible oil which violates the narrative standard
Odor	The presence of odor which violates the narrative standard
Specific Odor Causing Pollutant	If identified, the specific pollutant causing odor which violates the narrative standard
Aquatic Algae	The presence of aquatic algae which violates the narrative standard
Aquatic Plants (Macrophytes)	The presence of aquatic macrophytes which violates the narrative standard
Phosphorus (Total)	In lakes > 20 acres total phosphorus exceeds 0.05 mg/L[163], or In streams and lakes < 20 acres, when the narrative standard is not attained due in part to aquatic plant or algal growth, phosphorus (total) is listed as a contributing cause.
Color	The presence of color which violates the narrative standard
Turbidity	The presence of turbidity which violates the narrative standard

3.2 Best Management Practices

BMPS are subdivided into those that are site-specific (associated with a map number) and those that are "watershed-wide" (WW). As the name suggests, the former is a location specific practice that may or may not feature a SWAMM model-generated pollutant-load reduction. Those site-specific BMPs that feature pollutant load reductions are found in the Table 125, Table 126, Table 127, Table 128, Table 129, Table 130, Table 131, Table 132, Table 133, Table 134, Table 135, Table 136, Table 137, and Table 138 below for each of the 14 study units. Watershed-wide BMPs also have pollutant load reductions associated with them that are based on potential for

43 In general, a single exceedance of the criteria results in listing the parameter as a potential cause of impairment. Determination of causes is normally based on the most recent year of data from the Ambient Lake Monitoring Program (ALMP) or Illinois Clean Lakes Program (ICLP).

44 From Illinois General Use Water Quality Standards 35 Illinois Administrative Code, Part 302, Subpart B. Water Quality Standards are available at: http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp.

45 The Offensive Condition narrative standard in 35 Ill. Adm. Code 302.203.

46 The total phosphorus standard at 35 Ill. Adm. Code 302.205 applies to lakes of 20 acres or larger. In smaller lakes, phosphorus (total) is listed when the narrative standard in 35 Ill. Adm. Code 302.203 is not attained due to aquatic plant or algal growth.

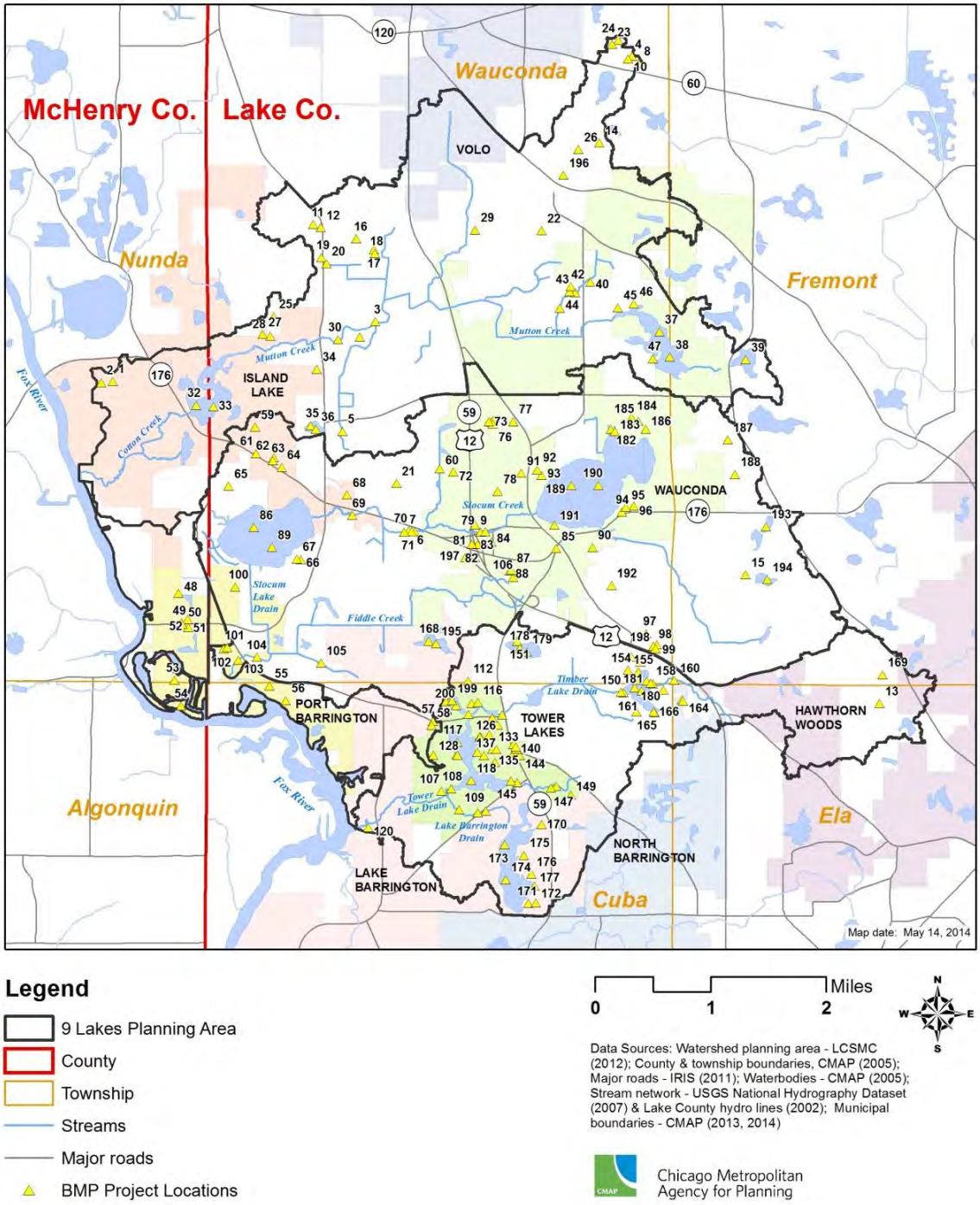
BMP application and at a certain threshold of implementation explained in section 3.2.2 below. Since load reduction estimates must be based on a strong sense of actual potential (location, amount, etc.) they are applied per each study unit much like the site-specific BMPs. Certain details associated with watershed-wide BMPs are summarized below in Table 139 and in a format that conforms with Illinois EPA requirements.

Another difference between site-specific and watershed-wide BMPs is that the SWAMM model generated output that is based on contributing areas delineated for each of the site-specific BMP. Other estimation methods are used for assigning the pollutant-load reductions to watershed-wide BMPs since contributing areas were not similarly delineated. These other methods were often informed by model output for similar BMPs that were site-specific. Lastly, shoreline stabilization BMPs are specific to each of the nine lakes.

3.2.1 BMP Recommendations and Pollutant-Load Reductions

Figure 126 illustrates the location of the full suite of site-specific BMPs recommended throughout the planning area. While many of the BMPs are found in the pollutant-load reduction tables that follow, Appendix B provides a complete listing of all the site-specific BMPs identified in Figure 126, including additional details on BMPs for which load reductions were not modeled or possible. The following tables feature site-specific and watershed-wide BMPs with expected pollutant-load reductions by each of the 14 study units. Cumulative pollutant-load reductions are featured at the bottom of each table where they are also expressed as a percentage of incoming pollution loads, found tabulated in the resource inventory for each study unit. The priory for implementation column features a binary scheme: 1 = high priority or short term, within five years; 2 = lower priority or longer term, within 10 years. Priority 1 BMPs were recommendations from local stakeholders. Priority 2 BMPs were the product of CMAP staff reconnaissance and best professional judgment. Immediately following the study unit, BMP, and other pollutant-load tables is section 3.2.2 that states assumptions made during development of cost estimates, load reduction estimates, or other aspects of the suite of BMPs presented.

Figure 126. BMP locations within 9 Lakes planning area.



Legend

- 9 Lakes Planning Area
- County
- Township
- Streams
- Major roads
- BMP Project Locations

0 1 2 Miles

Data Sources: Watershed planning area - LCSMC (2012); County & township boundaries, CMAP (2005); Major roads - IRIS (2011); Waterbodies - CMAP (2005); Stream network - USGS National Hydrography Dataset (2007) & Lake County hydro lines (2002); Municipal boundaries - CMAP (2013, 2014)

Chicago Metropolitan Agency for Planning

3.2.1.1 Subunit #1 - Ozaukee Lake

Table 125. Pollutant-load reductions available from BMPs if implemented for Ozaukee Lake subunit.

Map No.	*BMP Name*	*A-mount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Prior-ity*	*Responsible Entity*
					N	*P*	*Bac-teria*	*Cl*	*TSS*	*Sedi-ment*		
39	Shoreline stabilization	3,831	feet	574,650	11	6	---	---	---	6	2	Lake Co. FPD
WW	Bioswale	137	feet	5,754	5	1	6	5	321	---	2	Road maintenance agencies
	Total load reductions	---	---	---	16	7	6	5	321	6	---	---
	Percent load reductions	**---**	**---**	**---**	**13**	**41**	**8**	**0**	**13**	**---**	**---**	**---**

3.2.1.2 Subunit #2 - Lake Napa Suwe

Table 126. Pollutant-load reductions available from BMPs if implemented for Lake Napa Suwe subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
45	Bioswale	290	feet	12,180	79	1	7	7	382	---	2	Lake Napa Suwe Assoc.
46	Bioswale	310	feet	13,020	4	1	5	4	175	---	2	Lake Napa Suwe Assoc.
47	Bioswale	90	feet	3,780	19	2	24	19	788	---	1	Wauconda Twnshp.
37	Shoreline stabilization	4,229	feet	634,350	21	10	---	---	---	10	2	LNSA, private prop. owners
	subtotals	---	---	---	123	14	36	30	1,345	10	---	---
WW	Streambank stabilization	4,220	feet	675,200	4	4	---	---	---	4	2	Private landowners
WW	Bioswale	4,303	feet	180,726	151	30	181	164	10,069	---	2	Road maintenance agencies
	WW subtotals	---	---	---	155	34	181	164	10,069	4	---	---
	Total load reductions	---	---	---	278	48	217	194	11,414	14	---	---
	Percent load reductions	**---**	**---**	**---**	**17**	**29**	**14**	**0**	**15**	**---**	**---**	**---**

3.2.1.3 Subunit #3 - Woodland Lake

Table 127. Pollutant-load reductions available from BMPs if implemented for Woodland Lake subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
35	Shoreline stabilization	266	feet	39,900	2	2	---	---	---	2	2	Private prop. owners
WW	Bioswale	1,350	feet	56,700	47	9	57	51	3,158	---	2	Road maintenance agencies
	Total load reductions	---	---	---	49	11	57	51	3,158	2	---	---
	Percent load reductions	**---**	**---**	**---**	**24**	**48**	**27**	**0**	**35**	**---**	**---**	**---**

3.2.1.4 Subunit #4 - Island Lake

Table 128. Pollutant-load reductions available from BMPs if implemented for Island Lake subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
3	Ag filter strip	1.1	acre	121	27	3	8	10	1,950	---	1	Private landowner
20	Ag filter strip	0.5	acre	55	51	5	8	19	5,436	---	1	Private landowner
44	Ag filter strip	3.7	acre	407	122	10	25	45	39,525	---	1	Private landowner
22	CRP enrollment	2.3	acre	1,472	104	9	17	39	32,608	---	1	Private landowner
25	CRP enrollment	2.8	acre	1,792	128	12	22	47	52,480	---	1	Private landowner
8	Dry detention basin retrofit	1	number		7	1	3	4	599	---	2	Private prop. owner
27	Dry detention basin retrofit	1	number		18	2	6	11	9,234	---	2	Private prop. owner or VIsLk
43	Forage/biomass plant; prescribed grazing	3.34	acre	1,406	32	3	28	53	1301	---	1	Private landowner
5	Grassed waterway	4.9	acre	16,660	448	31	60	244	94,477	---	1	Private landowner
28	Oil/grit separator	1	number	16,000	0	1	6	2	479	---	2	Wauc. Twn. or VIsLk
14	Permanent vegetation	14	acre	5,600	8	2	6	3	344	---	1	Lake Co. FPD
12	Wetland restoration	0.2	acre	2,881	8	1	6	6	2821	---	2	Priv. land. or road ag.
18	Wetland restoration	0.5	acre	7,203	5	1	8	4	1168	---	2	Private landowner
19	Wetland restoration	6.1	acre	87,871	136	21	67	102	68,200	---	2	Private landowner or road maintenance agency
32	Shoreline stabilization	3,968	feet	595,200	35	18	---	---	---	21	2	VIsLk, pri. prop. own.
	subtotals	---	---	---	1129	120	270	589	310,622	21	---	---

WW	Streambank stabilization	12,120	feet	1,939,200	144	82	---	---	---	72	2	Private landowners
WW	Green roofs	21.56	acre	14,087,304	161	3	---	3	6,748	---	2	Private property owners
WW	Ag field borders	32.2	acre	2,737	171	16	32	64	25,039	---	1	Private landowners
WW	Bioswale	14,177	feet	595,434	496	99	595	539	33,174	---	2	Road maintenance agencies
	WW subtotals	---	---	---	972	200	627	606	65,033	72	---	---
	Total load reductions	---	---	---	2,101	320	897	1,195	375,655	93	---	---
	Percent load reductions	**---**	**---**	**---**	**7**	**12**	**9**	**0**	**9**	**---**	**---**	**---**

3.2.1.5 Subunit #5 - Cotton Creek

Table 129. Pollutant-load reductions available from BMPs if implemented for Cotton Creek subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
1	Dry det. basin retrofit	1	number		9	1	12	5	1,466	---	2	Vill. of Isl. Lk. or HOA
2	Dry det. basin retrofit	1	number		9	1	12	5	1,485	---	2	Vill. of Isl. Lk. or HOA
	subtotals	---	---	---	18	2	24	10	2,951	---	---	---
WW	Streambank stabilization	22160	feet	3,545,600	4	4	---	---	---	4	2	Private landowners
WW	Green roofs	1.02	acre	666,468	8	0	---	0	319	---	2	Private property owners
WW	Bioswale	4,527	feet	190,134	158	32	190	172	10,593	---	2	Road maintenance agencies
	WW subtotals	---	---	---	170	36	190	172	10,912	4	---	---
	Total load reductions	---	---	---	188	38	214	182	13,863	4	---	---
	Percent load reductions	**---**	**---**	**---**	**13**	**20**	**20**	**0**	**17**	**---**	**---**	**---**

3.2.1.6 Subunit #6 - Bangs Lake

Table 130. Pollutant-load reductions available from BMPs if implemented for Bangs Lake subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
90	Bioswale	180	feet	7,560	25	2	30	25	1925	---	2	HOA or Vill. of Wauconda
92	Bioswale	350	feet	14,700	53	6	43	53	5185	---	2	Wauconda Park Dist.
15	CRP enrollment	0.9	acre	640	3	1	3	1	160	---	1	Private landowner
94	Dry detention basin retrofit	1	number		37	12	16	8	2096	---	2	Vill. of Wauconda or HOA
96	Dry detention basin retrofit	1	number		14	1	18	8	2326	---	2	Vill. of Wauconda or HOA
98	Forage/biomass plant; prescribed grazing	2.5	acre	1,053	26	3	28	43	1339	---	1	Private landowner
93	Wetland restoration	11.2	acre	161,336	120	29	167	90	17476	---	2	Wauconda Park Dist.
99	Wetland restoration	4.9	acre	70,585	25	5	46	19	2253	---	2	Private landowner
	subtotals	---	---	---	303	59	350	247	32,759	---	---	---
WW	Streambank stabilization	25140	feet	4,022,400	38	24	---	---	---	22	2	Private landowners
WW	Ag field borders	1.4	acre	119	7	1	1	3	1089	---	1	Private landowners
WW	Green roofs	4.79	acre	3,129,786	36	1	---	1	1498	---	2	Wauconda H.S. and Park Dist.
WW	Bioswale	21874	feet	918,708	766	153	919	831	51,185	---	2	Road maintenance agencies
	WW subtotals	---	---	---	847	179	920	835	53,772	22	---	---
	Total load reductions	---	---	---	1,150	238	1,270	1,082	86,531	22	---	---
	Percent load reduction	**---**	**---**	**---**	**14**	**23**	**18**	**0**	**19**	**---**	**---**	**---**

3.2.1.7 Subunit #7 - Slocum Lake

Table 131. Pollutant-load reductions available from BMPs if implemented for Slocum Lake subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
81	Bioretention for infiltration	1	number	48,503	2	0	0	1	2831	---	2	IDOT
21	CRP enrollment	4.9	acre	3,136	450	40	73	167	151,069	---	1	Private landowner
77	Dry detention basin retrofit	1	number		14	2	9	9	2,304	---	2	VW or priv. prop. owner
65	Forage/biomass planting; prescribed grazing	9	acre	3,789	81	8	70	135	3,442	---	1	Private landowner
75	Green roof	1	acre	653,400	4	0	1	1	354	---	2	Private building owner
76	Green roof	1	acre	653,400	5	1	1	1	469	---	2	Private building owner
82	Infiltration trench	1	number	61,200	9	2	3	15	1,878	---	2	IDOT
74	Porous pavement	1.3	acre	169,884	16	2	7	24	2,656	---	2	Private prop. owner
84	Porous pavement	6	acre	784,080	29	5	10	41	3,453	---	2	Private prop. owner
7	Urban filter strip	0.35	acre		3	0	4	1	161	---	2	Private prop. owner
83	Urban stormwater wetland	5	acre	72,025	4	1	4	3	1,088	---	2	IDOT
9	Wetland restoration	0.6	acre	8,643	8	1	22	6	1,369	---	2	Village of Wauconda
61	Wetland restoration	6.5	acre	93,633	58	10	153	44	9,920	---	2	Village of Island Lake
86	Shoreline stabilization	6598	feet	989,700	20	10	---	---	---	10	2	Multiple private property owners and HOAs
	subtotals	---	---	---	703	82	357	448	180,994	10	---	---
WW	Streambank stabilization	42300	feet	6,768,000	600	302	---	---	---	302	2	Private landowners

WW	Ag field borders	5.5	acre	468	29	3	6	11	4,277	---	1	Private landowners
WW	Green roofs	16.92	acre	11,055,528	126	2	---	2	5,295	---	2	Private property owners
WW	Bioswale	21208	feet	890,736	742	148	891	806	49,627	---	2	Road maintenance. agencies
	WW subtotals	---	---	---	1,497	455	897	819	59,199	302	---	---
	Total load reductions	---	---	---	2,200	537	1,254	1,267	240,193	312	---	---
	Percent load reduction	**---**	**---**	**---**	**18**	**44**	**19**	**0**	**21**	**---**	**---**	**---**

3.2.1.8 Subunit #8 - Slocum Lake Drain / Fiddle Creek

Table 132. Pollutant-load reductions available from BMPs if implemented for Slocum-Lake Drain / Fiddle Creek subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions (lbs/yr, bcol/yr)*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
101	Bioswale	650	feet	27,300	9	1	9	9	628	---	1	Village of Port Barrington
102	Bioswale	770	feet	32,340	2	0	2	2	101	---	1	Village of Port Barrington
106	Dry detention basin retrofit	1	number		5	1	3	3	440	---	2	Vill. of Wauconda or priv. property owner
104	Urban filter strip	1	acre		47	5	14	17	12,695	---	2	Private property owner
100	Wet detention basin retrofit	1	number		5	1	10	3	740	---	2	HOA or Vill. of Port Barrington
	Subtotals	---	---	---	67	7	38	34	14,604	---	---	---
WW	Streambank stabilization	62840	feet	10,054,400	160	90	---	---	---	76	2	Private landowners
WW	Ag field borders	2.3	acre	196	12	1	2	5	1,789	---	1	Private landowners
WW	Green roofs	1.0	acre	653,400	7	0	---	0	313	---	2	Multiple property owners
WW	Bioswale	10674	feet	448,308	374	75	448	406	24,977	---	2	Road maintenance agencies
	WW subtotals	---	---	---	553	166	450	411	27,079	76	---	---
	Total load reductions	---	---	---	620	173	488	445	41,683	76	---	---
	Percent load reduction	**---**	**---**	**---**	**14**	**38**	**15**	**0**	**17**	**---**	**---**	**---**

3.2.1.9 Subunit #9 - Timber Lake

Table 133. Pollutant-load reductions available from BMPs if implemented for Timber Lake subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
153	Bioswale	1300	feet	926	2	0	2	2	58	---	1	Wauconda Twnshp.
162	Bioswale	1300	feet	926	1	0	1	1	28	---	1	Cuba Twnshp.
163	Bioswale	950	feet	677	1	0	2	1	24	---	1	Cuba Twnshp.
164	Bioswale	1000	feet	712	2	0	3	2	44	---	1	Cuba Twnshp.
165	Bioswale	1600	feet	1140	2	0	4	2	64	---	1	Cuba Twnshp.
13	CRP enrollment	2.8	acre	1,792	288	267	47	107	63,003	---	1	Private landowner
169	Grassed waterway	3.5	acre	11,900	378	26	52	206	67,001	---	1	Private landowner
154	Rain gardens	55	number	82,500	100	12	95	30	5,217	---	1	Private prop. owners
159	Sediment forebay	1	number		140	30	125	93	32,836	---	1	Timber Lk. Civic Assoc.
167	Sediment forebay	1	number		86	21	128	58	8,331	---	1	Timber Lk. Civic Assoc.
152	Wetland restoration	0.6	acre	8,643	1	0	2	1	119	---	1	Private landowners
180	Shoreline stabilization	4,501	feet	675,150	28	15	---	---	---	15	2	TLCA and private property owners
	Subtotals	---	---	---	1029	371	461	503	176,725	15	---	---
WW	Streambank stabilization	8,580	feet	1,372,800	242	122	---	---	---	122	2	Private landowners
WW	Ag field borders	3.7	acre	315	20	2	4	7	2,877	---	1	Private landowners
WW	Green roofs	0.13	acre	84,942	1	0	---	0	41	---	2	Multiple property owners
WW	Bioswale	4,274	feet	179,508	150	30	180	162	10,001	---	2	Road maintenance agencies
	WW subtotals	---	---	---	413	154	184	169	12,919	122	---	---
	Total load reductions	---	---	---	1,442	525	645	672	189,644	137	---	---
	Percent load reduction	**---**	**---**	**---**	**24**	**85**	**18**	**0**	**34**	**---**	**---**	**---**

3.2.1.10 Subunit #10 - Lake Fairview

Table 134. Pollutant-load reductions available from BMPs if implemented for Lake Fairview subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	TSS	*Sediment*		
151	Bioswale	70	feet	2,940	9	1	10	9	426	---	1	Private landowner and/or Wauconda Township
178	Shoreline stabilization	1,788	feet	268,200	1	1	---	---	---	1	2	Private property owners
	subtotals	---	---	---	10	2	10	9	426	1	---	---
WW	Green roofs	0.03	acre	19,602	0	0	---	0	9	---	2	Private prop. owner
WW	Bioswale	2,070	feet	86,940	72	14	87	79	4,843	---	2	Road maintenance agencies
	WW subtotals	---	---	---	72	14	87	79	4,852	---	---	---
	Total load reductions	---	---	---	82	16	97	88	5,278	1	---	---
	Percent load reduction	**---**	**---**	**---**	**33**	**55**	**41**	**0**	**65**	**---**	**---**	**---**

3.2.1.11 Subunit #11 - Tower Lake

Table 135. Pollutant-load reductions available from BMPs if implemented for Tower Lake subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
126	Bioretention for infiltration	1	number	48,503	18	2	16	6	981	---	1	Village of Tower Lakes
139	Bioretention for infiltration	1	number	48,503	3	0	2	1	379	---	1	Village of Tower Lakes
113	Bioswale	100	feet	4,200	2	0	3	2	95	---	1	Village of Tower Lakes and/or TLIA
119	Bioswale	410	feet	17,220	5	1	6	5	193	---	1	Village of Tower Lakes and/or TLIA
121	Bioswale	625	feet	26,250	3	0	4	3	134	---	1	Village of Tower Lakes
141	Bioswale	470	feet	19,740	4	0	5	4	156	---	1	Village of Tower Lakes and/or IDOT
142	Bioswale	660	feet	27,720	1	0	1	1	75	---	1	Village of Tower Lakes
143	Bioswale	450	feet	18,900	1	0	1	1	26	---	1	Village of Tower Lakes
135	Brush management	1	acre	82	1	0	1	0	39	---	1	IDOT
144	Brush management	2.5	acre	205	1	0	1	0	81	---	1	Village of Tower Lakes
131	Infiltration trench	1	number	61,200	4	1	4	7	344	---	1	TLIA
132	Infiltration trench	1	number	61,200	21	4	22	35	1,850	---	1	TLIA
129	Urban filter strip	0.1	acre		3	0	3	1	147	---	1	TLIA
137	Rain gardens	88	number	132,000	71	8	63	21	3,896	---	1	Private property owners
112	Wetland restoration	2.7	acre	38,894	13	3	30	10	1,161	---	1	Private landowner
114	Wetland restoration	0.4	acre	5,762	3	1	8	2	244	---	2	TLIA
116	Wetland restoration	1.2	acre	17,286	8	2	25	6	788	---	1	Private landowner
128	Wetland restoration	0.9	acre	12,965	1	0	4	1	86	---	2	TLIA

134	Wetland restoration	1	acre	14,405	1	0	2	1	61	---	1	IDOT
147	Wetland restoration	8	acre	115,240	93	20	271	70	8,218	---	1	Village of Tower Lakes
117	Shoreline stabilization	7,835	feet	1,175,250	42	22	---	---	---	22	2	TLIA and private prop. owners
	subtotals	---	---	---	299	64	472	177	18,954	22	---	---
WW	Streambank stabilization	31920	feet	5,107,200	66	36	---	---	---	36	2	Private landowners
WW	Ag field borders	0.5	acre	43	3	0	1	1	389	---	1	Private landowners
WW	Green roofs	0.04	acre	26,136	0	0	---	0	13	---	2	Multiple prop. own.
WW	Bioswale	13202	feet	554,484	462	92	554	502	30,892	---	2	Road maintenance agencies
	WW subtotals	---	---	---	531	128	555	503	31,294	58	---	---
	Total load reductions	---	---	---	830	192	1,027	680	50,248	58	---	---
	Percent load reduction	**---**	**---**	**---**	**20**	**41**	**27**	**0**	**35**	**---**	**---**	**---**

3.2.1.12 Subunit #12 - Lake Barrington

Table 136. Pollutant-load reductions available from BMPs if implemented for Lake Barrington subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
172	Urban filter strip	0.1	acre		36	4	43	13	3,579	---	1	Lk. Barrington Shores HOA
173	Shoreline stabilization	3,784	feet	567,600	7	5	---	---	---	5	2	Lk. Barrington Shores HOA
	subtotals	---	---	---	43	9	43	13	3,579	5	---	---
WW	Streambank stabilization	2,760	feet	441,600	52	30	---	---	---	30	2	Private landowners
WW	Bioswale	4,031	feet	169,302	141	28	169	153	9,433	---	2	Road maintenance agencies
	WW subtotals	---	---	---	193	58	169	153	9,433	30	---	---
	Total load reductions	---	---	---	236	67	212	166	13,012	35	---	---
	Percent load reduction	**---**	**---**	**---**	**11**	**29**	**10**	**0**	**11**	**---**	**---**	**---**

3.2.1.13 Subunit #13 - Tower Lake Drain

Table 137. Pollutant-load reductions available from BMPs if implemented for Tower Lake subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions lbs/yr, bcol/yr, tons/yr*						*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*	*Sediment*		
107	Wetland restoration	1.4	acre	20,167	7	2	21	5	614	---	1	TLIA
109	Wetland restoration	4.0	acre	57,620	15	4	43	11	1,565	---	1	Village of Tower Lakes
111	Wetland restoration	5.4	acre	77,787	75	14	183	56	11,062	---	2	Lk. Barrington Shores HOA
	subtotals	---	---	---	96	20	247	72	13,242	---	---	---
WW	Streambank stabilization	10720	feet	1,715,200	62	34	---	---	---	34		Private landowners
WW	Bioswale	3075	feet	129,150	108	22	129	117	7,194	---	2	Road maintenance agencies
	WW subtotals	---	---	---	170	56	129	117	7,194	34	---	---
	Total load reductions	---	---	---	266	76	376	189	20,436	34	---	---
	Percent load reduction	**---**	**---**	**---**	**15**	**32**	**24**	**0**	**25**	**---**	**---**	**---**

3.2.1.14 Subunit #14 – Direct Drainage Area

Table 138. Pollutant-load reductions available from BMPs if implemented for Direct Drainage Area subunit.

Map No.	*BMP Name*	*Amount*	*Unit*	*Cost ($)*	*Pollutant-load Reductions (lbs/yr, bcol/yr)*					*Priority*	*Responsible Entity*
					N	*P*	*Bacteria*	*Cl*	*TSS*		
54	Bioretention for infiltration	1	number	48,503	2	0	1	1	84	1	Village of Port Barrington
48	Bioswale	405	feet	289	1	0	1	1	39	1	Village of Port Barrington
56	Porous pavement	2.5	acre	326,700	14	2	5	20	1,213	1	Lake Co. FPD
58	Wetland restoration	0.7	acre	10,084	1	0	2	1	127	1	Village of Tower Lakes
	subtotals	---	---	---	17	3	10	22	1,462	---	---
WW	Ag field borders	0.5	acre	43	3	0	1	1	389	1	Private landowners
WW	Bioswale	12,957	feet	554,194	453	91	544	492	30,320	2	Road maintenance agencies
	WW subtotals	---	---	---	456	91	545	493	30,709	---	---
	Total load reductions	---	---	---	473	94	554	515	32,171	---	---
	Percent load reduction	---	---	---	21	34	28	1	27	---	---

A summary of watershed-wide BMPs that are recommended for implementation are presented in Table 139.

Table 139. Summary of pollutant-load reductions associated with Watershed-Wide BMPs recommended for implementation.

BMP Name	*Amount*	*Unit*	*Cost ($)*	*Sediment (tons/yr)*	*TSS (lbs/yr)*	*Phosphorus (lbs/yr)*	*Nitrogen (lbs/yr)*
Ag field borders	46.1	acre	7,842	---	35,849	23	245
Bioswales	117,859	feet	4,950,078	---	275,787	824	4125
Green roofs	45.4	acre	29,664,360	---	14,236	6	339
Streambank stabilization	222,760	feet	35,641,600	702	---	728	1372

Table 140 summarizes the pollutant-load reductions for all BMPs (i.e., both site-specific and watershed-wide (WW)) at the scale of the entire 9 Lakes planning area.

Table 140. Pollutant-load reductions from BMPs as a function of incoming loads for entire 9 Lakes planning area.

	N (lbs/yr)	*P (lbs/yr)*	*Bacteria (Bcol/yr)*	*TSS (lbs/yr)*	*Sediment (tons/yr)*	*Cl (lbs/yr)*
Baseline loads	74,865	7,685	43,353	7,063,987	---	2,235,810
BMP load reductions	9,931	2,342	7,314	1,083,683	794	6,731
Percent reductions from all BMPs	13.3	30.5	16.9	15.3	---	0.3

Table 140 suggests a number of things. First, nonpoint-source pollution will be difficult, if not impossible, to mitigate entirely. Secondly, of all the pollutants impacting the lakes, plan recommendations have the potential to impact phosphorus loads the most. This is encouraging given that the primary motivation for developing the plan was to address phosphorus in the nine lakes. Thirdly, chloride is a particularly vexing pollutant to mitigate. In order to reduce chloride loads, the most effective if not only practice available is to reduce the amount applied to roads (i.e., source control).

Given the emphasis on total phosphorus (P) related lake impairments and CMAP's charge to determine load reductions required in order for the lakes to attain the P water quality standard, the Canfield-Bachman (CB) artificial lake model was employed. The CB model estimates what the total average annual P influx would need to be in order to achieve the water quality standard of 0.05 mg/L. The CB model also determines what the influx is that corresponds with water quality data available from samples taken from the lakes. When combined with SWAMM output that estimates land-based inputs of P to the lakes, stakeholders can understand how well the plan recommendations perform relative to reducing land-based phosphorus and relative to the total influx that the lakes are receiving (Table 141).

Table 141 offers stakeholders a mix of potential observations. Phosphorus control from implementation of plan recommendations will have variable impact on the nine lakes of special concern. Timber Lake stands to benefit the most from site-specific and watershed-wide plan recommendations with an estimate of as much as an 85 percent reduction of land-based phosphorus loads. Island Lake is at the other end of the spectrum with a 12 percent load reduction estimated from plan implementation. While in-lake management measures are appropriate for all of the lakes, they appear to be most critical for improving Island Lake water quality (i.e., P).

Table 141. Phosphorus reduction potential of BMPs compared to surface inputs and total reductions needed for the 9 Lakes.

Lake name	*P (lbs/yr) from surface runoff*	*Reduction (lbs/yr) from full implementation of BMPs*	*Max. % reduction from land-based BMPs compared to inputs from surface runoff*	*Total P (lbs/yr) reduction needed from all sources to attain WQ standard*	*% of reduction possible from BMPs relative to WQ standard*
Ozaukee Lake	17	7	41	201	3
Lake Napa Suwe	164	48	29	602	8
Woodland Lake	23	11	48	33	33
Island Lake	2,759	320	12	2,258	14
Slocum Lake	1,245	537	43	6,150	9
Timber Lake	618	525	85	445	118
Lake Fairview	29	16	55	26	62
Tower Lake	505	192	38	633	30
Lake Barrington	228	67	29	327	20

When considering the total influx of phosphorus including in-lake recycling, the efficacy of BMPs to remediate the problem is less optimistic for most of the lakes. Timber Lake could potentially achieve water quality standards with full implementation of plan recommendations. Lake Fairview offers the next best chance of achieving a phosphorus standard in response to plan implementation, but this lake and others except Timber Lake will require in-lake management strategies to solve the phosphorus problem.

In-lake management practices to be considered are numerous including: phosphorus inactivation via alum application, sediment oxidation, artificial circulation, hypolimnetic aeration and oxygenation, dilution/flushing, hypoimnetic/selective withdrawal, biomanipulation, aquatic plant community rehabilitation, pollutant capture (basins within lake), water level drawdown, and accumulated sediment removal. An Illinois Clean Lake Program type diagnostic/feasibility study is recommended for each lake to more thoroughly diagnose each lake's condition (including hydrologic and nutrient budgets) and evaluate the feasibility of rehabilitation alternatives.

3.2.2 Notes on BMP Assumptions

Several assumptions were made during the calculations of various BMP load reduction potential and cost estimates. Here, pertinent details are concisely provided.

1. Green roofs—The pollutant-removal efficiencies of green roofs was set to be the same as bioswales according to literature reviewed. A cost estimate of $15/sq. ft. was applied. To determine the total potential roof area for green roofs, aerial imagery (high resolution color imagery and Bing's bird's eye view) was used to identify flat or slightly pitched roofs in industrial, commercial, and institutional land uses. Corrugated metal roofs were not included since they likely do not have the necessary load-bearing capacity. Each candidate roof was then delineated in CMAP's GIS, its acreage determined, and organized by subunit. A 50 percent conversion to green roofs was assumed, and to this acreage, atmospheric deposition rates (lb/ac/yr) were applied (Table 142), resulting in an estimated pollutant load (lb/yr) to the suite of green roofs in each subunit. Pollutant removal rates were next applied (Table 143), resulting in an estimated pollutant removal total (lb/yr) for the suite of green roofs in each subunit.

Table 142. Atmospheric deposition rates.

Total Nitrogen *(lb/ac/yr)*			Total Phosphorus *(lb/ac/yr)*	Total Solids *(lb/ac/yr)*	Chloride *(lb/ac/yr)*
Wet	Dry	Sum	Wet + Dry	Wet + Dry	Wet
14.60[a]	6.71[b]	21.31	0.482[c]	447.1[c]	0.8[a]

a) from NAPD/NTN Monitoring location WI99, 1984-2012 mean (http://nadp.sws.uiuc.edu/ntn/)
b) from CASTNET Bondville, IL site, 1990-2012 mean (http://www.epa.gov/castnet/javaweb/site_pages/BVL130.html)
c) from Quon (1977)[1]

Table 143. Green roof pollutant removal rates.

Total Nitrogen *(percent)*	Total Phosphorus *(percent)*	Total Solids *(percent)*	Chloride *(percent)*
35	30	70	15

2. Bioswales, site-specific – Pollutant (p-load) reductions associated with bioswales were modeled based on the contributing area to the downhill point of the bioswale. Costs in the literature and those included in presentations posted on the web vary widely. Cost estimates presented here assume a $42/linear foot cost of installation multiplied by the length indicated in the p-load reduction tables. A 10-foot width is assumed.

3. Bioswales, watershed-wide – Same cost applied as site-specific bioswales above. To determine the potential extent for constructing roadside bioswales (or grass-lined

[1] Quon, J.E. 1977. The Potential Contributions of Air Contaminants to Water Pollution in the Six County Area of Northeastern Illinois. Staff Paper No. 23. Prepared for Northeastern Illinois Planning Commission, Chicago.

channel with permanent vegetation, depending on site conditions), the road miles within each subunit, categorized by jurisdictional responsibility (Illinois Division of Highways, county, municipalities, and township or road districts), were determined using CMAP's GIS and the Illinois Department of Transportation's Illinois Highway System File (http://gis.dot.illinois.gov/gist2/). An implementation rate of 20% was applied to those jurisdictions' where no curb and gutter is generally present (IDOH, county, township), while an implementation rate of one or five percent was applied to municipal roadways where curb and gutter is common, with the one percent applied to the more densely urbanized subunits and the five percent applied to the "less densely urbanized" subunits (i.e., Direct Drain, Timber Lake, Lake Barrington).

4. Field borders—An estimate of potential was arrived at by first setting a minimum size threshold for field eligibility (i.e., agricultural land-use polygons in ArcMap) of 500k square feet. The resulting total area of 113,153,122 square feet, divided by the 40 polygons that met the minimum size resulted in an average sized field whose square root is 1,682 ft. Assuming a 30 foot wide field border is placed on one side of each of the 40 fields, results in a total of 46 acres of field border that was then divided among study units in proportion to the amount of ag land present. Load reduction estimates are based on 100 percent of the implementation potential.

5. Streambank stabilization – Estimated pollutant load reductions were made using the "Bank Stabilization" worksheet in a Microsoft Excel spreadsheet tool (EstPollutLoadReduct_2IEPA.xls, date modified: 11/25/2008) provided by Illinois EPA (Ristau, personal correspondence to the author(s), 2011). Calculations were made for each coded stream reach based on their general overall level of bank erosion (see Section 2.6.1), the assumptions noted in the table below, and the soil textural class(es) associated which each stream segment.

Table 144. Streambank erosion assumptions

Stream Reach Erosion Level	Spreadsheet Erosion Category	Bank Height Assumption *(ft)*	Lateral Recession Rate Assumption *(ft/yr)*
None or Low	Slight	1	0.03
Moderate	Moderate	2	0.13
High	Severe	3	0.40

6. Shoreline stabilization -- Estimated pollutant load reductions were made using the "Bank Stabilization" worksheet in a Microsoft Excel spreadsheet tool provided by Illinois EPA (S. Ristau, personal correspondence). Calculations were made for each of the nine TMDL lakes as well as Bangs Lake based on the linear feet of low, moderate, and high bank erosion as assessed by LCHD (see Section 2.6.3), the assumptions noted in the table below, and the soil textural class(es) associated which each lake's shoreline.

Table 145. Lake shoreline erosion assumptions.

Shoreline Erosion Level	Spreadsheet Erosion Category	Bank Height Assumption *(ft)*	Lateral Recession Rate Assumption *(ft/yr)*
Slight	Slight	0.25	0.02
Moderate	Moderate	0.50	0.10
High	Severe	1.0	0.35
	Very Severe	2.0	0.50

7. Wetland restoration—Pollutant-load reductions were derived from the contributing area to the wetland. A 10:1 ratio, contributing area/restored wetland area, was applied to arrive at amount (acres) of restored wetland. Application of this BMP was limited to previously delineated wetlands.

8. Grassed waterways—Pollutant-load reductions were derived from the contributing area to the lowest point of a potential grassed waterway. A 10:1 ratio, contributing area/grassed waterway area, was applied to arrive at amount (acres) of ag land to be placed in a grassed waterway.

9. Filter strips—Pollutant-load reductions were derived from the contributing area to the filter strip. A 10:1 ratio, contributing area/filter strip area, was applied to arrive at amount (acres) of ag land to be placed in a filter strip.

10. Rain gardens—Two "site-specific" rain gardens were delineated and represented by two neighborhoods that could potentially meet declared goals for number of participating properties. Thus, a neighborhood of X number of contiguous homes/properties made for the contributing area used for calculating p-load reductions. Choosing a different set of contiguous homes (i.e., more dense or smaller lot versus less dense and larger lot) will likely result in different p-load reduction potential. Homes that implement a rain garden are not likely to be contiguous, but model generated reductions required contiguity. Costs are based on an average rain garden size of 10 x 10 feet (i.e., 100 sq. ft.) at $15/sq. ft.

11. Permanent vegetation—Cost of implementation assumes seeding with perennial grasses/legumes after any grading has been done, if necessary. Thus, cost of grading is not included. Planting of trees will be more costly.

12. Forage and Biomass Planting / Prescribed Grazing—Assumes native grass establishment or renovation with fertility; USDA NRCS Practice 512, Scenario #7. Cost listed does not include costs associated with a grazing specialist that might consult on USDA NRCS Practice 528, Prescribed Grazing.

13. Bioretention for Infiltration installation cost based on using the formula, $C = 7.3\ V^{0.99}$ where C = cost of design and construction, V = volume of stormwater treated. Volume calculated is based on one inch of runoff over two acres. Thus, V = 7,262 cubic feet of

water. (See http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=72.)

14. Porous asphalt pavement costs range from $0.50 - $6.00 / square foot. A cost estimate of $3.00 / sq. ft. is applied. Costs for other porous pavement options such as porous concrete or interlocking pavers are higher.

15. BMP costs do not include annual maintenance.

3.2.3 Green Infrastructure

Green infrastructure is an interconnected network of natural lands, working landscapes, and other open space that conserves ecosystem functions and thus, yields ecosystem services that are valued by society. Green infrastructure, therefore, provides benefits to people. Such benefits to society are often taken for granted or left out of the accounting of costs and benefits when development occurs and is without a means to capture the value of public benefits flowing from private undeveloped land.

The Green Infrastructure Vision (GIV 2.0) developed and refined by Chicago Wilderness[2] (CW), is a spatial-data product that identifies natural resources of ecological importance and natural area connectivity opportunities/needs in the region. As such, GIV 2.0 identifies 1.8 million acres in the CW region that can be restored, protected, or connected through conservation and/or sustainable development practices. The overarching GIV 2.0 goal is to establish an interconnected network of healthy ecosystems that contribute to economic vitality and quality of life for all the region's residents.

The purpose of identifying GIV 2.0 within the 9 Lakes Planning Area is to apply the regional vision to a more local mapping of watershed-scale opportunities for conservation of significant resources, open spaces, and corridors. While such a perspective can guide decisions as they pertain to local land use, the local expression of GIV 2.0 can also enable an enhanced understanding of how resource assets close to home matter within a larger context: the region and beyond.

Aligning the green infrastructure network with the 9 Lakes TMDL Planning Area identifies structural, if not functional, connections between protected natural areas and recognizes opportunity areas to conserve undeveloped land, restore degraded ecosystems through increased management, provide buffers for protected natural areas, improve water quality and aquatic habitat, preserve biodiversity, prevent flooding, and protect groundwater.

[2] http://www.chicagowilderness.org/

The core of the green infrastructure network was identified by combining several mapped natural resources characteristics for the watershed, including:

- Forest Land
- Floodplains
- Wetlands
- Prairie / Grassland / Savannah
- Streams and Lakes (with buffers)
- County Forest Preserves and Conservation District property
- Federal Lands
- Private Conservation Easements
- Private Nature Preserves
- State Department of Natural Resources Open Space Holdings

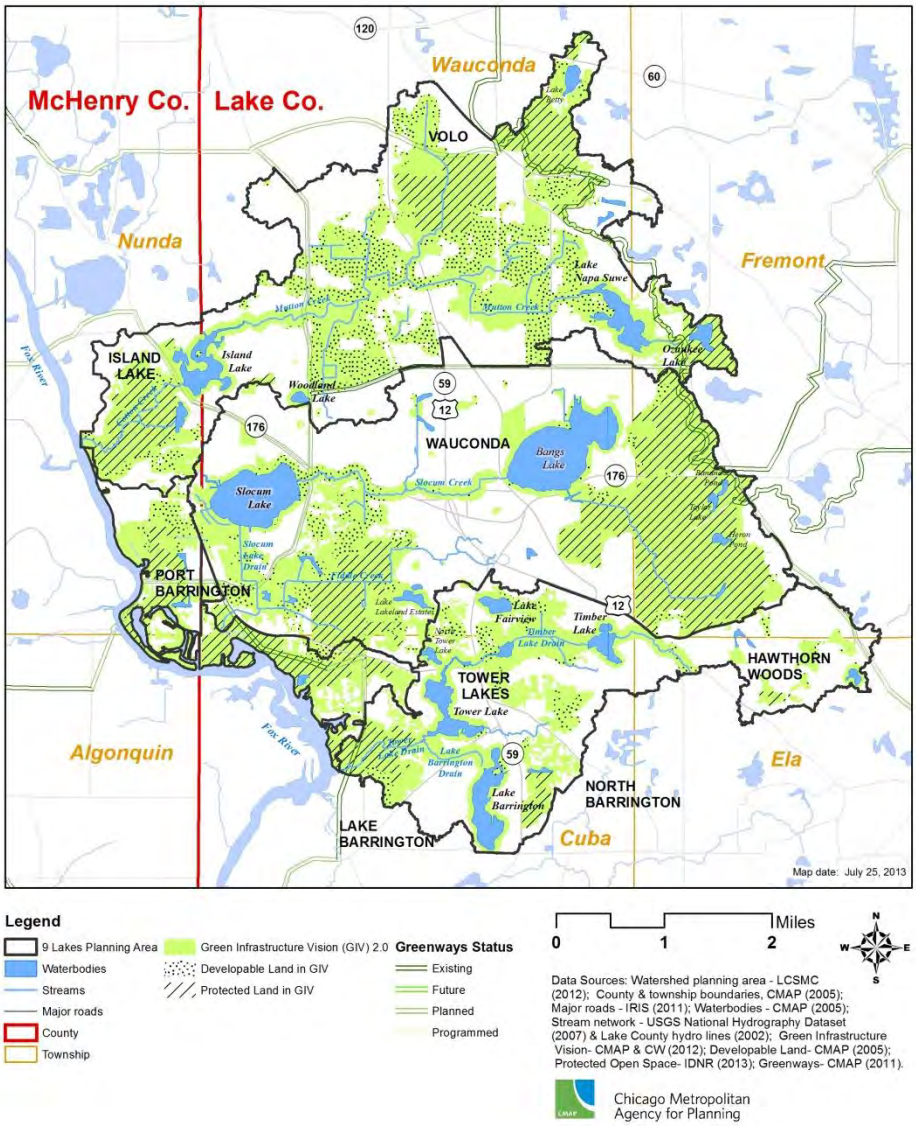
These resource areas and open spaces form an interconnected network of hubs and corridors. These hubs are composed of currently protected public and private open space, and proposed open space, which are connected by the stream network, greenways and trails. (Figure 127)

Within the 9 Lakes TMDL Planning Area, GIV 2.0 covers 10,217 acres or over half (54 percent) of the planning area. About two-thirds of this acreage (6,989 ac) is currently in some form of conservation land use and thus, "protected." Of the remaining 3,228 acres, approximately 1,000 acres have been developed and are either unavailable for conservation (e.g., converted to an incompatible land use) or are in diminished form (e.g., mowed turf grass/residential land use). What's left are over 2,200 acres that are considered developable[3] and, therefore, still available for providing conservation-related benefits to local residents and the region.

There are other sources of land conservation ideas, plans, and actions. For example, at the county level, Conserve Lake County (CLC) is an organization that has created a county-wide vision for land preservation. At more local levels, other organizations such as the Barrington Area Conservation Trust work towards ensuring that land conservation contributes to local and regional green infrastructure.

[3] Developable land includes such current land uses as agricultural land used for row crops, grains, and pasture, nurseries, green houses, orchards, tree and sod farms, equestrian facilities, hunting clubs, private campgrounds, vacant (i.e., private) forest and grassland, and unfinished residential areas under construction.

Figure 127. Green infrastructure within 9 Lakes planning area.



Green infrastructure can be conceived and implemented at multiple scales. At the watershed scale, conservation of green infrastructure can be achieved primarily through the efforts of land management agencies and acquisition of large land holdings and establishment of interconnected greenways and trails. Conservation easements can be added on private properties, should a landowner wish to do so, to complement public open space, provide connectivity, and achieve goals similar to those of land management agencies.

At the community scale, municipalities are encouraged to incorporate green infrastructure into their comprehensive plans and ordinances. Conservation design principles can be implemented

to affect many biodiversity-related benefits including those that are water-related.[4] The main principles are: 1) Develop flexible lot design standards, 2) Protect and create natural landscapes and drainage systems, 3) Reduce impervious surface areas, and 4) Implement sustainable stormwater management techniques. These principles are given form at the neighborhood scale which will reflect community ordinance and subdivision codes.

Communities can also establish important greenways/trails to connect larger protected sites. While the watershed-level green infrastructure map is a good starting point, individual municipalities are encouraged to tailor the plan to fit their own opportunities. In particular, communities are encouraged to engage local stakeholders, including municipal department representatives, park districts/departments, local residents, and conservation organizations to develop refinements.

At the site-scale, green infrastructure is a different yet related planning concept compared to regional or landscape/watershed scale green infrastructure. Best management practices can be implemented in parks, school grounds, residential lots, vacant lots, parking lots, and along streets to provide important water quality and/or habitat functions and can be implemented on newly developed sites, or retrofitted into existing sites. Implementation of practices such as rain gardens, bio-swales, permeable paving, bio-retention basins and green roofs, when considered cumulatively, can have demonstrable benefits to local and downstream waterbodies, and reduce pressure on existing infrastructure.

In summary, creating green infrastructure in the 9 Lakes Planning Area can include an array of integrated protection strategies including: conservation development, ecological restoration, greenway and trail connections, conservation easements, protective land use planning and zoning, stormwater retrofits, BMP implementation and retrofits. While this category of land will benefit people, natural plant communities and the wildlife they sustain, there are no particular pollutant load reductions promised or associated with this category of land. What is certain is that water quality will diminish should any of the developable land undergo land-use change in a manner that is at odds with or incompatible with the protection strategies listed above. Thus, 9 Lakes stakeholders must work diligently with land conservation organizations, agencies, and others to ensure that these strategies are implemented where appropriate and in a proactive-coordinated fashion.

[4] Northeastern Illinois Planning Commission and Chicago Wilderness. 2003. Conservation Design Resource Manual: Language and Guidelines for Updating Local Ordinances. Available at: http://www.chicagowilderness.org/files/1413/3087/0449/Conservation_Design_Resource_Manual.pdf.

4. Information and Education

The importance of education and public information about water quality protection and related conservation efforts cannot be overstated. The two-year planning process including several public meetings held throughout the planning area were instrumental in raising awareness of the issues and promoting a collective interest in solving water-quality problems. The post-plan process of raising awareness and promoting stewardship behavior is critical to the success of the watershed plan.

Among the many educational resources and programs available, the Conservation@Home program is particularly important as it is designed for property owners who all play a key role in initial stormwater management.[5] While this program's creator, The Conservation Foundation, is a source of support, there are other resources available within the 9 Lakes Planning Area. For example, the Barrington Area Conservation Trust (BACT) offers the Conservation@Home program throughout the Tower Lake Drain area.[6] BACT's goal is to visit a minimum of 100 properties in the Barrington area each year to promote the program and help with homeowner participation. This has the potential to impact approximately 300 acres of private land annually. Additional funding could support an even larger effort than the one underway and is needed to reach throughout the planning area.

Conserve Lake County (CLC) is another organization that promotes the Conservation@Home program as part of a more comprehensive stewardship mission that is complementary to the aim of the 9 Lakes Watershed-based Plan.[7] The Land Conservancy of McHenry County (TLC) is another nonprofit organization with resources and other programs that will benefit Island Lake and Port Barrington in particular given that these communities are uniquely bicounty among the 9 Lakes municipalities.[8]

All communities, in addition to unincorporated property owners, are encouraged to collaborate with organizations like BACT, CLC, and TLC to promote and implement water-quality friendly programs. The Village of Wauconda and Village of Island Lake are two of the larger municipalities in the planning area with some of the more dense neighborhoods. These and other local governments are encouraged to also collaborate with their forest/conservation, park, and library districts to promote the watershed plan and educational programs like Conservation@Home and others.

As noted in section 2.2.1, there are 16 units of local government in the planning area that are MS4 permittees. One of the six minimum control measures in the permit program is "public

[5] The Conservation Foundation, available at: http://www.theconservationfoundation.org/page.php?PageID=82.

[6] Barrington Area Conservation Trust, available at: http://www.bactrust.org/conservation.html.

[7] Conserve Lake County, available at: http://www.conservelakecounty.org/.

[8] The Land Conservancy of McHenry County, available at: http://www.conservemc.org/.

education and outreach on stormwater impacts." Local governments can tie the educational component of their MS4 program to this watershed plan and its implementation such that collaborative efforts might benefit from a consistent message and efficiencies to be gained from cooperation. Village newsletters and other means of communication, for example, can be used on behalf of both MS4 program permit requirements and the watershed plan to raise awareness and help promote widespread stewardship of shared water resources.

A neighborhood HOA offers an important gateway to collaboration between property owners and local governments. HOAs are often responsible for stormwater detention ponds, a task they are rarely aware of or equipped to perform. HOAs typically host regularly occurring meetings and are usually receptive to learning about water-related issues. The TLIA is a homeowner's association that emphasizes stewardship for their lake resources. Among other activities, TLIA hosts an annual event that draws attention to neighborhood participation in various water quality improvement activities. Local governments are encouraged to foster direct communications with HOAs within their jurisdictions about water stewardship needs and opportunities.

The Northwest Water Planning Alliance (NWPA), formed in 2010, is another potential collaborator for 9 Lakes stakeholders.[9] The NWPA includes five counties, and about 80 municipalities convened through Council of Governments that are predominantly groundwater dependent. NWPA geography roughly coincides with the Upper Fox River Basin and includes the entire 9 Lakes area. The NWPA mission: "The Northwest Water Planning Alliance, formed by intergovernmental agreement, seeks to collaboratively plan for and steward our shared river and ground water resources to ensure a sustainable water supply for the people, economy, environment, and future generations." Issues of water quality and water supply are intertwined and this "one water" concept, including the need for education and awareness, is reflected in NWPA goals and objectives.

All communities in the 9 Lakes area will benefit from following NWPA recommendations and activities as guided by their three-year strategic plan (2014-16). For example, the NWPA has issued guidance on lawn watering that was informed in part by CMAP's Model Water Use Conservation Ordinance.[10] The NWPA also recommends that members become WaterSense Partners. WaterSense is a U.S. EPA partnership program that provides free resources for raising awareness about water conservation and efficiency.[11] The program is free and benefits available easily exceed the transaction cost of application.

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[9] Northwest Water Planning Alliance. Available at: http://www.nwpa.us/.

[10] CMAP. Model Water Use Conservation Ordinance (2010). Available at: http://www.cmap.illinois.gov/livability/water/water-2050-implementation/resources.

[11] U.S. EPA, Office of Water. WaterSense: An EPA Partnership Program. Available at: http://www.epa.gov/watersense/index.html.

Closer to home the Fox River Ecosystem Partnership (FREP) is an umbrella organization and resource to communities and others with an interest in water resource conservation.[12] FREP provides educational resources and information that should be taken advantage of by all 9 Lakes residents, local governments, and others.

Policy and programmatic recommendations pertaining to education and public information are as follows:

1. Municipal governments should create a dialogue with neighborhood and/or homeowner's associations to raise awareness of stormwater management issues and responsibilities.
2. Municipal governments should collaborate with neighborhood and/or homeowner's associations to promote installation of rain barrels and other property-level green infrastructure practices.
3. Municipal governments should adopt a pet-waste pick-up ordinance and promote the importance of pet-waste removal to residents.
4. Local conservation-oriented organization should promote the 9 Lakes TMDL Implementation Plan and its recommendations in either special or regularly occurring communications with members and residents.
5. CMAP should issue a press release about the 9 Lakes Plan upon approval by Illinois EPA.
6. Municipal and other local government staff should participate in NWPA TAC meetings and related requests for data sharing and information.
7. Local governments and nongovernmental organizations alike should promote use of phosphorus-free lawn fertilizer by homeowners and other private individuals who maintain their lawns (i.e., noncommercial or non-for-hire applicators).

[12] FREP. Available at: http://foxriverecosystem.org/.

5. Monitoring Success

5.1 Interim Measurable Milestones

One requirement of a watershed-based plan is to establish interim measurable milestones for determining whether nonpoint source pollution management measures and other actions are being implemented. Table 146 identifies such milestones and ties them to goals and objectives that stakeholders established early in the planning process.

Stakeholders will evaluate progress towards measurable milestones on an annual basis and grade their efforts such that it will become clear where improvements and/or changes to an approach or the plan itself are needed. It is important, therefore, for a clear sense of progress to be documented.

Plan recommendations will require local commitments, resources, and collaboration for implementation success. While there are several sources of funding made available throughout the year, the Clean Water Act Section 319 grant program, administered by Illinois EPA is a particularly important one for local stakeholders to pursue.

Table 146. Interim measurable milestones for determining whether BMPs are being implemented.

Goal	*Indicator*	*Two-year milestone*	*Five-year milestone*	*Ten-year milestone*
Improve water quality	Lin. ft. bioswale	---	6,000	12,000 total
	Acres green roof	---	2.5	5 total
	Acres porous pavement	---	2	4 total
	No. of site-spec. ag. BMPs	---	3	6 total
	Lin. ft. streambank stabilization	---	11,000	22,000 total
	Lin. ft. shoreline stabilized	---	4,000	8,000 total
	No. of rain gardens	7 (5%)	29 total (20%)	72 total (50%)
	No. of wetlands restored	---	2	5 total
Strengthen local partnerships	Number of grant applications submitted	6	15 total	30 total
Protect groundwater	Number of communities becoming WaterSense partners as recommended by NWPA	5: Island Lk., Lake Barrington, Port Barrington, Village of Tower Lakes, Wauconda	3 (total 8): Volo, No. Barrington, Hawthorne Woods	---
	No. of communities adopting NWPA outdoor lawn watering ordinance	4	8 total	---
	No. of road maintenance departments participating in "sensible-salting" training	8	14 total including 6 townships	---
Support green infrastructure	No. of communities whose comprehensive plan updates feature support for local-regional green infrastructure	---	4	4
	# of acres places in permanent conservation status	---	110	220
Raise public awareness	Number of public meetings conducted	8	20	120

	with 9 Lakes Plan implementation theme			
	No. of Conservation @ Home installations	40	100 total	200 total
Enhance quality of recreation	*Same indicators as those associated with water quality improvement*	---	---	---

5.2 Criteria for Determining Progress

Gauging progress and success with the plan depends largely on how many of the plan recommendations are implemented. All BMPs that have been prioritized as #1 are expected to be implemented within the first five years following plan approval and priority #2 BMPs are expected to be implemented with 10 years. Progress made with implementing BMP recommendations should eventually translate to improved water quality and subsequent attainment of designated uses and/or water quality standards.

Monitoring pollutant-load reductions, particularly phosphorus loads in the nine lakes, will be the primary criterion by which progress can be judged. Table 147identifies criteria of determining progress within five and ten-year timeframes to reflect the fact that it will take time to see improvements manifest in response to plan implementation.

Table 147. Criteria for determining progress.

Criteria	*Within 5 years*	*Within 10 years*
Phosphorus-load reduction (percent)	20	30 total
No. of lake diagnostic feasibility studies	3	9 total

Another important criterion for determining progress will be delisting of a water body due to use attainment as documented in the biennial integrated water quality reports. Thus, improvements in water quality should result in greater use attainment and/or delisting (Section 303(d)) in the 2024 Integrated Report.

5.3 Monitoring Component for Evaluating Effectiveness

The nine lakes plus Fiddle Creek that were the focus of this watershed plan will require a robust water quality monitoring regime in order to evaluate the effectiveness of BMP implementation. Various models used to determine baseline or background pollution loads, load reduction estimates associated with BMP implementation, and those used to characterize total phosphorus loads that the lakes can assimilate while maintaining water quality standards (and thus, reductions needed from baseline inputs), were neither calibrated nor validated from water quality and land-use data collected from the planning area within the past couple of years. Of necessity, models were calibrated based on data from best available research conducted around the country over time (e.g., event-mean concentrations of pollutants, pollutant removal efficiencies, etc.).

Monitoring water quality to evaluate the effectiveness of the watershed plan will largely depend on the following three programs:

1) LCHD Lakes Management Unit – Continuation of the every-five years lake monitoring program with an emphasis on collecting samples for analysis of total phosphorus (P) concentrations and dissolved oxygen; tracking change/trends in P concentrations.
2) Volunteer Lake Monitoring Program (VLMP) – 9 Lakes stakeholders will strive for full VLMP participation and collect Tier 2 or 3 data on a three-year cycle; tracking change/trends in P concentrations.
3) Illinois EPA Lake Monitoring Program – Continuation of this data collection effort; tracking change/trends in P and dissolved oxygen concentrations.

Evaluation of plan effectiveness will require that a stakeholder (e.g., LCHD, CMAP) take the new data collected by the means enumerated above and compare changes, if any, in total phosphorus concentrations over time. It will be important to keep track of BMPs implemented in the study unit at issue as well as any in-lake management measures that may have been implemented to help explain any changes that occur or trends that may emerge.

Appendix A - Lakeshore assessment: condition of shoreline buffer zones.

Ozaukee Lake: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Ozaukee Lake	1	4945	4945	100	0	0	0	0
Totals	1	4945	4945	100	0	0	0	0

Lake Napa Suwe: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Lake Napa Suwe	1	110	40	35	0	0	70	65
Lake Napa Suwe	2	270	0	0	270	100	0	0
Lake Napa Suwe	3	460	140	30	0	0	320	70
Lake Napa Suwe	4	285	115	40	0	0	170	60
Lake Napa Suwe	5	70	30	40	0	0	40	60
Lake Napa Suwe	6	355	105	30	245	70	0	0
Lake Napa Suwe	7	250	175	70	75	30	0	0
Lake Napa Suwe	8	890	890	100	0	0	0	0
Lake Napa Suwe	9	1890	1895	100	0	0	0	0
Lake Napa Suwe	10	490	490	100	0	0	0	0
Lake Napa Suwe	11	610	610	100	0	0	0	0
Lake Napa Suwe	12	665	665	100	0	0	0	0
Lake Napa Suwe	13	395	315	80	80	20	0	0
Lake Napa Suwe	14	130	25	20	0	0	105	80
Lake Napa Suwe	15	165	165	100	0	0	0	0
Lake Napa Suwe	16	435	45	10	0	0	395	90
Lake Napa Suwe	17	40	0	0	0	0	40	100
Lake Napa Suwe	18	230	45	20	0	0	180	80
Lake Napa Suwe	19	695	695	100	0	0	0	0
Lake Napa Suwe	20	770	695	90	0	0	75	10
Lake Napa Suwe	21	1110	1110	100	0	0	0	0
Lake Napa Suwe	22	480	215	45	265	55	0	0
Lake Napa Suwe	23	465	465	100	0	0	0	0
Lake Napa Suwe	24	1390	1390	100	0	0	0	0
Lake Napa Suwe	25	610	610	100	0	0	0	0
Lake Napa Suwe	26	50	50	100	0	0	0	0
Lake Napa Suwe	27	50	50	100	0	0	0	0
Lake Napa Suwe	28	245	245	100	0	0	0	0
Lake Napa Suwe	29	875	790	90	90	10	0	0
Lake Napa Suwe	30	190	190	100	0	0	0	0

Lake Napa Suwe	31	160	70	45	85	55	0	0
Lake Napa Suwe	32	775	425	55	350	45	0	0
Lake Napa Suwe	33	175	45	25	0	0	130	75
Lake Napa Suwe	34	95	95	100	0	0	0	0
Lake Napa Suwe	35	120	95	80	25	20	0	0
Lake Napa Suwe	36	915	915	100	0	0	0	0
Lake Napa Suwe	37	280	240	85	40	15	0	0
Totals	37	17190	14140	82.4	1525	8.8	1525	8.8

Woodland Lake: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Woodland Lake	1	105	35	35	0	0	70	65
Woodland Lake	2	220	90	40	0	0	130	60
Woodland Lake	3	150	50	35	0	0	100	65
Woodland Lake	4	155	70	45	75	50	10	5
Woodland Lake	5	205	175	85	30	15	0	0
Woodland Lake	6	470	190	40	0	0	280	60
Woodland Lake	7	140	0	0	80	55	65	45
Woodland Lake	8	270	190	70	55	20	25	10
Woodland Lake	9	165	15	10	0	0	145	90
Woodland Lake	10	145	60	40	0	0	85	60
Woodland Lake	11	140	65	45	5	5	70	50
Woodland Lake	12	240	70	30	120	50	50	20
Totals	12	2405	1010	42.0	365	15.2	1030	42.8

Island Lake: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Island Lake	1	50	10	15	0	0	40	85
Island Lake	2	90	0	0	0	0	90	100
Island Lake	3	105	10	10	0	0	95	90
Island Lake	4	210	10	5	0	0	200	95
Island Lake	5	95	40	40	45	45	10	15
Island Lake	6	110	0	0	0	0	110	100
Island Lake	7	45	45	100	0	0	0	0
Island Lake	8	175	25	15	0	0	150	85
Island Lake	9	105	0	0	60	55	45	45
Island Lake	10	130	15	10	0	0	115	90
Island Lake	11	250	15	5	0	0	240	95
Island Lake	12	150	30	20	0	0	120	80
Island Lake	13	250	50	20	0	0	200	80
Island Lake	14	190	45	25	0	0	145	75

Island Lake	15	110	20	20	0	0	90	80
Island Lake	16	215	55	25	0	0	160	75
Island Lake	17	150	40	25	0	0	110	75
Island Lake	18	220	20	10	0	0	200	90
Island Lake	19	95	5	10	40	40	50	50
Island Lake	20	65	60	90	0	0	5	10
Island Lake	21	70	0	0	0	0	70	100
Island Lake	22	50	10	20	0	0	40	80
Island Lake	23	170	60	35	0	0	110	65
Island Lake	24	100	45	45	0	0	55	55
Island Lake	25	185	185	100	0	0	0	0
Island Lake	26	95	45	45	0	0	50	55
Island Lake	27	90	20	25	0	0	70	75
Island Lake	28	75	20	30	0	0	55	70
Island Lake	29	120	85	70	5	5	30	25
Island Lake	30	25	10	45	15	55	0	0
Island Lake	31	75	10	15	0	0	65	85
Island Lake	32	10	0	0	0	0	10	100
Island Lake	33	30	5	15	0	0	25	85
Island Lake	34	75	0	0	0	0	75	100
Island Lake	35	70	5	10	0	0	60	90
Island Lake	36	260	90	35	0	0	170	65
Island Lake	37	255	255	100	0	0	0	0
Island Lake	38	155	15	10	60	40	80	50
Island Lake	39	175	140	80	10	5	25	15
Island Lake	40	170	15	10	70	40	85	50
Island Lake	41	140	35	25	0	0	105	75
Island Lake	42	45	15	35	20	45	10	20
Island Lake	43	150	35	25	55	35	60	40
Island Lake	44	85	10	10	0	0	75	90
Island Lake	45	90	30	35	25	25	35	40
Island Lake	46	220	75	35	0	0	145	65
Island Lake	47	75	50	65	0	0	25	35
Island Lake	48	85	35	40	40	50	10	10
Island Lake	49	100	90	90	5	5	5	5
Island Lake	50	125	50	40	0	0	75	60
Island Lake	51	130	95	75	15	10	20	15
Island Lake	52	170	70	40	0	0	100	60
Island Lake	53	140	120	85	0	0	20	15
Island Lake	54	230	45	20	0	0	185	80
Island Lake	55	215	45	20	0	0	170	80
Island Lake	56	100	40	40	0	0	60	60
Island Lake	57	125	35	30	0	0	90	70
Island Lake	58	115	20	15	0	0	100	85
Island Lake	59	75	15	20	0	0	60	80
Island Lake	60	240	60	25	0	0	180	75

Island Lake	61	115	115	100	0	0	0	0
Island Lake	62	125	25	20	0	0	100	80
Island Lake	63	40	5	5	0	0	35	95
Island Lake	64	40	15	45	0	0	25	55
Island Lake	65	80	35	45	0	0	45	55
Island Lake	66	290	45	15	0	0	250	85
Island Lake	67	85	15	15	0	0	70	85
Island Lake	68	220	35	15	0	0	185	85
Island Lake	69	300	90	30	0	0	210	70
Island Lake	70	515	205	40	0	0	310	60
Island Lake	71	780	350	45	430	55	0	0
Island Lake	72	460	205	45	255	55	0	0
Island Lake	73	155	100	65	55	35	0	0
Island Lake	74	435	0	0	0	0	435	100
Island Lake	75	515	130	25	0	0	385	75
Island Lake	76	510	125	25	0	0	380	75
Island Lake	77	490	100	20	0	0	390	80
Island Lake	78	270	95	35	0	0	175	65
Island Lake	79	435	85	20	0	0	350	80
Island Lake	80	315	65	20	0	0	250	80
Island Lake	81	380	115	30	0	0	265	70
Island Lake	82	715	250	35	0	0	465	65
Island Lake	83	435	130	30	0	0	305	70
Island Lake	84	470	165	35	0	0	305	65
Island Lake	85	720	290	40	0	0	430	60
Island Lake	86	1090	490	45	600	55	0	0
Island Lake	87	310	125	40	155	50	30	10
Island Lake	88	530	240	45	0	0	290	55
Island Lake	89	595	210	35	0	0	385	65
Island Lake	90	410	145	35	0	0	265	65
Island Lake	91	105	105	100	0	0	0	0
Island Lake	92	290	75	25	0	0	215	75
Island Lake	93	175	10	5	0	0	165	95
Island Lake	94	710	285	40	0	0	425	60
Island Lake	95	385	95	25	0	0	290	75
Island Lake	96	445	200	45	245	55	0	0
Island Lake	97	310	140	45	0	0	170	55
Island Lake	98	555	165	30	0	0	390	70
Island Lake	99	455	160	35	0	0	295	65
Island Lake	100	355	105	30	0	0	250	70
Island Lake	101	315	125	40	0	0	190	60
Island Lake	102	455	135	30	185	40	135	30
Totals	102	24105	8075	33.5	2390	9.9	13640	56.6

Slocum Lake: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Slocum Lake	1	470	210	45	235	50	25	5
Slocum Lake	2	600	240	40	0	0	360	60
Slocum Lake	3	725	325	45	400	55	0	0
Slocum Lake	4	460	300	65	135	30	25	5
Slocum Lake	5	570	255	45	315	55	0	0
Slocum Lake	6	1650	1650	100	0	0	0	0
Slocum Lake	7	745	335	45	410	55	0	0
Slocum Lake	8	760	455	60	305	40	0	0
Slocum Lake	9	3040	455	15	455	15	2130	70
Slocum Lake	10	755	340	45	0	0	415	55
Slocum Lake	11	1220	550	45	0	0	670	55
Slocum Lake	12	3300	3300	100	0	0	0	0
Slocum Lake	13	2130	2130	100	0	0	0	0
Slocum Lake	14	975	585	60	0	0	390	40
Slocum Lake	15	630	125	20	0	0	505	80
Totals	15	18030	11255	62.5	2255	12.5	4520	25

Timber Lake: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Timber Lake	1	445	355	80	20	5	70	15
Timber Lake	2	245	60	25	35	15	150	60
Timber Lake	3	720	325	45	395	55	0	0
Timber Lake	4	275	165	60	70	25	40	15
Timber Lake	5	75	10	10	0	0	65	90
Timber Lake	6	135	15	10	0	0	120	90
Timber Lake	7	250	25	10	0	0	225	90
Timber Lake	8	255	165	65	75	30	15	5
Timber Lake	9	500	50	10	0	0	450	90
Timber Lake	10	300	15	5	0	0	285	95
Timber Lake	11	130	5	5	0	0	125	95
Timber Lake	12	55	20	35	35	60	0	0
Timber Lake	13	385	310	80	55	15	20	5
Timber Lake	14	340	100	30	0	0	235	70
Timber Lake	15	195	70	35	0	0	125	65
Timber Lake	16	200	30	15	0	0	170	85
Timber Lake	17	250	100	40	115	45	40	15
Timber Lake	18	125	45	35	80	65	0	0
Timber Lake	19.1	110	0	0	0	0	110	100
Timber Lake	19.2	215	215	100	0	0	0	0
Timber Lake	20	55	10	20	0	0	45	80
Timber Lake	21	185	10	5	0	0	175	95

Timber Lake	22	130	5	5	0	0	125	95
Timber Lake	23	125	15	10	0	0	115	90
Timber Lake	24	215	120	55	75	35	20	10
Timber Lake	25	165	50	30	0	0	115	70
Timber Lake	26	160	25	15	0	0	140	85
Timber Lake	27	165	40	25	55	35	65	40
Timber Lake	28	115	45	40	70	60	0	0
Timber Lake	29	55	5	10	30	50	25	40
Timber Lake	30	405	160	40	0	0	240	60
Timber Lake	31	205	0	0	80	40	120	60
Timber Lake	32	330	0	0	100	30	230	70
Totals	33	7515	2565	34.1	1290	17.2	3660	48.7

Lake Fairview: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Lake Fairview	1	550	440	80	55	10	55	10
Lake Fairview	2	130	15	10	0	0	120	90
Lake Fairview	3	140	120	85	20	15	0	0
Lake Fairview	4	130	40	30	15	10	75	60
Lake Fairview	5	220	65	30	0	0	155	70
Lake Fairview	6	130	25	20	0	0	105	80
Lake Fairview	7	140	140	100	0	0	0	0
Lake Fairview	8	160	50	30	0	0	110	70
Lake Fairview	9	150	150	100	0	0	0	0
Lake Fairview	10	170	50	30	0	0	120	70
Lake Fairview	11	370	110	30	0	0	260	70
Lake Fairview	12	320	145	45	175	55	0	0
Lake Fairview	13	360	70	20	0	0	290	80
Lake Fairview	14	250	235	95	15	5	0	0
Lake Fairview	15	470	330	70	140	30	0	0
Lake Fairview	16	570	515	90	55	10	0	0
Totals	16	4260	2495	58.5	475	11.2	1290	30.3

Tower Lake: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Tower Lake	1	270	150	55	0	0	120	45
Tower Lake	2	60	10	20	30	50	20	30
Tower Lake	3	340	100	30	0	0	240	70
Tower Lake	4	130	50	40	0	0	80	60
Tower Lake	5	345	140	40	0	0	205	60
Tower Lake	6	115	15	15	0	0	100	85

Tower Lake	7	275	125	45	150	55	0	0
Tower Lake	8	535	160	30	0	0	375	70
Tower Lake	9	270	25	10	0	0	245	90
Tower Lake	10	345	120	35	0	0	225	65
Tower Lake	11	125	0	0	0	0	125	100
Tower Lake	12	185	130	70	45	25	10	5
Tower Lake	13	480	215	45	240	50	25	5
Tower Lake	14	130	25	20	0	0	105	80
Tower Lake	15	415	185	45	210	50	20	5
Tower Lake	16	745	260	35	0	0	485	65
Tower Lake	17	410	225	55	185	45	0	0
Tower Lake	18	635	350	55	285	45	0	0
Tower Lake	19	495	100	20	0	0	395	80
Tower Lake	20	500	125	25	0	0	375	75
Tower Lake	21	195	50	25	0	0	145	75
Tower Lake	22	175	115	65	15	10	45	25
Tower Lake	23	280	280	100	0	0	0	0
Tower Lake	24	95	35	40	0	0	60	60
Tower Lake	25	230	185	80	35	15	10	5
Tower Lake	26	650	160	25	0	0	490	75
Tower Lake	27	450	135	30	0	0	315	70
Tower Lake	28	420	335	80	85	20	0	0
Tower Lake	29	490	170	35	0	0	320	65
Tower Lake	30	170	100	60	35	20	35	20
Tower Lake	31	665	665	100	0	0	0	0
Tower Lake	32	215	215	100	0	0	0	0
Tower Lake	33	505	455	90	50	10	0	0
Tower Lake	34	665	665	100	0	0	0	0
Tower Lake	35	910	910	100	0	0	0	0
Tower Lake	36	300	255	85	45	15	0	0
Tower Lake	37	560	335	60	170	30	55	10
Tower Lake	38	730	145	20	0	0	585	80
Tower Lake	39	240	25	10	0	0	215	90
Tower Lake	40	635	95	15	0	0	540	85
Tower Lake	41	240	240	100	0	0	0	0
Tower Lake	42	160	155	95	10	5	0	0
Tower Lake	43	395	60	15	0	0	335	85
Tower Lake	44	505	405	80	100	20	0	0
Tower Lake	45	195	155	80	30	15	10	5
Tower Lake	46	175	35	20	0	0	140	80
Tower Lake	47	185	185	100	0	0	0	0
Tower Lake	48	140	30	20	0	0	110	80
Totals	48	17380	9105	52.4	1715	9.9	6560	37.7

Lake Barrington: buffer zone assessment

Lake Name	*Reach Code*	*Shore Length Assessed (ft.)*	*Good Condition (ft./percent)*		*Fair Condition (ft./percent)*		*Poor Condition (ft./percent)*	
Lake Barrington	1	670	435	65	135	20	100	15
Lake Barrington	2	325	30	10	160	50	130	40
Lake Barrington	3	235	165	70	35	15	35	15
Lake Barrington	4	515	130	25	205	40	180	35
Lake Barrington	5	645	160	25	260	40	225	35
Lake Barrington	6	605	365	60	30	5	210	35
Lake Barrington	7	600	270	45	0	0	330	55
Lake Barrington	8	610	335	55	60	10	215	35
Lake Barrington	9	420	275	65	0	0	145	35
Lake Barrington	10	540	245	45	0	0	295	55
Lake Barrington	11	1190	355	30	0	0	835	70
Lake Barrington	12	880	265	30	0	0	615	70
Lake Barrington	13	2750	2750	100	0	0	0	0
Lake Barrington	14	1140	230	20	0	0	910	80
Lake Barrington	15	765	345	45	420	55	0	0
Lake Barrington	16	675	675	100	0	0	0	0
Lake Barrington	17	745	335	45	410	55	0	0
Lake Barrington	18	1240	1240	100	0	0	0	0
Lake Barrington	19	650	225	30	0	0	425	65
Lake Barrington	20	900	810	90	45	5	45	5
Lake Barrington	21	355	55	15	20	5	285	80
Totals	21	16455	9695	58.9	1780	10.8	4980	30.3

Appendix B - Site-Specific BMPs

9 Lakes Watershed-Based Plan: site-specific BMPs

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollutant load reduction calculation	Longitude	Latitude
1	Cotton Crk	Dry DB retrofit: Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Island Lake		yes	-88.21475	42.27927
2	Cotton Crk	Dry DB retrofit: Bioswale (or Grass-Lined Channel w/ Permanent Vegetation), Bioretention Facility	Urban	? (840, 880), 800	acres	Vlg of Island Lake		yes	-88.21672	42.27911
3	Island Lk	Ag Filter Strip	Agriculture	393	acres	private	USDA-NRCS, MLSWCD	yes	-88.170415	42.286689
4	Island Lk	Downspout Disconnections, Rain Gardens, rain barrels	Urban	37, 13, ?	#	private		no	-88.126883	42.3199
5	Island Lk	Grassed Waterway	Agriculture	412	acres	private	USDA-NRCS, MLSWCD	yes	-88.17601	42.27294
6	Slocum Lk	culvert needs replacement	Hydrologic		#	Wauconda Twp.		no	-88.164348	42.260328
7	Slocum Lk	Urban Filter Strip	Urban	835	acres	private		yes	-88.165625	42.260276
8	Island Lk	Infiltration Trench or Dry DB retrofit	Urban	847	acres	private		yes	-88.125798	42.319014
9	Slocum Lk	Wetland Restoration	Hydrologic	657	acres	Vlg of Wauconda		yes	-88.153627	42.261139
10	Island Lk	Parking lot retrofits: Porous Pavement, Bioswales, Bioretention Facilities, Infiltration Trenches	Urban	890, ? (840, 880), 800, 847	acres, feet	private		*no*	-88.12757	42.31956
11	Island Lk	Roof Runoff Structure	Livestock	558	#	private	USDA-NRCS, MLSWCD, U of I Extension	no	-88.18083	42.298888

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)										
Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
12	Island Lk	Wetland Restoration	Hydrologic	657	acres	private, Wauconda Twp. ROW?		yes	-88.17955	42.298506
13	Timber Lk	CRP federal program	Agriculture		acres	private	USDA-FSA	yes	-88.085354	42.238637
14	Island Lk	Permanent Vegetation	Agriculture	880	acres	Lake Co. FPD		yes	-88.132456	42.309067
15	Bangs Lk	Permanent Vegetation	Urban	880	acres	Lake Co. FPD		yes	-88.107919	42.254813
16	Island Lk	Wetland Restoration	Hydrologic	657	acres	private		no	-88.173596	42.297088
17	Island Lk	Roof Runoff Management	Livestock	558	#	private	USDA-NRCS, MLSWCD, U of I Extension	no	-88.170608	42.295703
18	Island Lk	Wetland Restoration	Hydrologic	657	acres	private		yes	-88.17044	42.295221
19	Island Lk	Wetland Restoration	Hydrologic	657	acres	private, Wauconda Twp. ROW?		yes	-88.179538	42.294738
20	Island Lk	Ag Filter Strip	Agriculture	393	acres	private	USDA-NRCS, MLSWCD	yes	-88.178632	42.293976
21	Slocum Lk	CRP federal program	Agriculture		acres	private	USDA-FSA	yes	-88.16688	42.266366
22	Island Lk	CRP federal program	Agriculture		acres	private	USDA-FSA	yes	-88.142245	42.298045
23	Island Lk	Wetland Restoration	Hydrologic	657	acres	Lake Co. FPD		*no*	-88.130298	42.321409
24	Island Lk	Permanent Vegetation	Urban	880	acres	Lake Co. FPD		*no*	-88.129237	42.321907

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)										
Map #	**Subunit**	**BMP Type**	**Category**	**BMP Code**	**Units**	**Landowner**	**Potential Partners**	**Pollut. load reduc. calc.**	**Longitude**	**Latitude**
25	Island Lk	CRP federal program	Agriculture		acres	private	USDA-FSA	yes	-88.18758	42.287342
26	Island Lk	Wetland Restoration	Hydrologic	657	acres	Lake Co. FPD		*no*	-88.13598	42.308218
27	Island Lk	Dry DB retrofit: Bioinfiltration Facility	Urban	800	acres	private, Wauconda Twp. or Vlg Island Lake ROW?		yes	-88.189432	42.28511
28	Island Lk	Oil & Grit Separator	Urban	10	#	private, Wauconda Twp. or Vlg Island Lake ROW?		yes	-88.188176	42.284867
29	Island Lk	Wetland Restoration	Hydrologic	657	acres	Lake Co. FPD		*no*	-88.153466	42.298147
30	Island Lk	Streambank Protection (stabilization)	Hydrologic	580	feet	private	USDA-NRCS, MLSWCD	iepa meth	-88.176698	42.284451
31	Island Lk	Wetland Restoration	Hydrologic	657	acres	private	USDA-NRCS, MLSWCD	*no*	-88.173016	42.284745
32	Island Lk	Shoreline Protection - Island Lk	Hydrologic	580	feet	private (multiple), Vlg of Island Lake		iepa meth	-88.200714	42.276237
33	Island Lk	Shorleline buffer zone (Urban Filter Strip) - Island Lk	Urban	835	acres	private (multiple), Vlg of Island Lake		no	-88.197797	42.276047
34	Island Lk	Parking lot retrofit: Porous and Permeable Pavements	Urban	890	sq feet	School Dist. 118		no	-88.180296	42.280731
35	Woodland Lk	Shoreline Protection - Woodland Lk	Hydrologic	580	feet	private (multiple)		iepa meth	-88.181381	42.273666
36	Woodland Lk	Shorleline buffer zone (Urban Filter Strip) - Woodland Lk	Urban	835	acres	private (multiple)		no	-88.1805	42.273206

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
37	Lk Napa Suwe	Shoreline Protection - Lk Napa Suwe	Hydrologic	580	feet	private (multiple), HOAs	Lake Napa Suwe Assoc.	iepa meth	-88.122398	42.285339
38	Lk Napa Suwe	Shorleline buffer zone (Urban Filter Strip) - Lk Napa Suwe	Urban	835	acres	private (multiple), HOAs	Lake Napa Suwe Assoc.	no	-88.120654	42.282161
39	Ozaukee Lk	Shoreline Protection - Ozaukee Lk	Hydrologic	580	feet	Lake Co. FPD		iepa meth	-88.107846	42.281805
40	Island Lk	Access Control / Fence (for livestock exclusion)	Livestock	472 / 382	acres / feet	private	USDA-NRCS, MLSWCD, U of I Extension	no	-88.134052	42.2916
41	Island Lk	Access Control / Fence (for livestock exclusion), riparian forest buffer	Livestock, Agriculture	472 / 382, 391	acres / feet, acres	private	USDA-NRCS, MLSWCD, U of I Extension	no	-88.136567	42.290269
42	Island Lk	Roof Runoff Structure, Waste Storage Facility	Livestock	558, 313	#	private	USDA-NRCS, MLSWCD, U of I Extension	no	-88.137358	42.291043
43	Island Lk	Forage and Biomass Planting, Prescribed Grazing	Livestock	512, 528	acres	private	USDA-NRCS, MLSWCD, U of I Extension	yes	-88.137526	42.290387
44	Island Lk	Ag Filter Strip, some riparian forest buffer, Access Control / Fence (for livestock exclusion)	Agriculture, Livestock	393, 391, 472 / 382	acres, feet	private	USDA-NRCS, MLSWCD, U of I Extension	yes	-88.139191	42.288312
45	Lk Napa Suwe	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	private	Lake Napa Suwe Assoc.	yes	-88.129375	42.288376
46	Lk Napa Suwe	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	private	Lake Napa Suwe Assoc.	yes	-88.126665	42.288847
47	Lk Napa Suwe	Bioinfiltration Facility, Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	800, ? (840, 880)	acres	Lake Napa Suwe Assoc.	Wauconda Twp.?	yes	-88.123502	42.28196

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
48	Direct Drainage	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Port Barrington		yes	-88.203717	42.25265
49	Direct Drainage	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Port Barrington?	Nunda Twp? McHenry Co. Div. of Transp.?	no	-88.203225	42.248945
50	Direct Drainage	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Port Barrington?	Nunda Twp? McHenry Co. Div. of Transp.?	no	-88.203051	42.248742
51	Direct Drainage	Wet DB retrofit: Shoreline Protection, Urban Stormwater Wetland, Urban Filter Strip	Hydrologic, Urban	580, 800, 835	feet, acres	Vlg of Port Barrington		no	-88.202183	42.249357
52	Direct Drainage	Wet DB retrofit: Shoreline Protection, Urban Filter Strip	Hydrologic, Urban	580, 835	feet, acres	Vlg of Port Barrington		no	-88.202102	42.248379
53	Direct Drainage	Parking lot retrofits: Permeable Pavement, Rain Garden, Education	Urban	890, 13, 1	acres, #	Vlg of Port Barrington		no	-88.204414	42.241745
54	Direct Drainage	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation), Bioretention Facility / Rain Garden	Urban	? (840, 880), 800 / 13	acres	Vlg of Port Barrington		yes	-88.203301	42.238523
55	Direct Drainage	Parking lot retrofits: Permeable Pavement, Bioswales, Bioretention Facilities, Infiltration Trenches	Urban	890, ? (840, 880), 800, 847	acres, feet	Lake Co. FPD		no	-88.188428	42.241
56	Direct Drainage	Parking lot retrofits: Permeable Pavement, Bioswales, Bioretention Facilities, Oil & Grit Separators	Urban	890, ? (840, 880), 800, 10	acres, #	Lake Co. FPD		yes	-88.185624	42.239161
57	Direct Drainage	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Tower Lakes		no	-88.160792	42.236528

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
58	Direct Drainage	Wetland Restoration, Brush Management	Hydrologic	657, 314	acres	Vlg of Tower Lakes		yes	-88.161048	42.236013
59	Slocum Lk	Wet DB retrofit: Urban Stormwater Wetland	Urban	800	acres	private	Vlg of Island Lake?	no	-88.19072	42.273485
60	Slocum Lk	Streambank Protection	Hydrologic	580	feet	private	Vlg of Wauconda, Wauconda Twp.	iepa meth	-88.159578	42.268219
61	Slocum Lk	Wetland Restoration	Hydrologic	657	acres	Vig of Island Lake		yes	-88.190619	42.270169
62	Slocum Lk	Downspout Disconnections, Infiltration Planters	Urban	37, 40	#	private		no	-88.187566	42.269623
63	Slocum Lk	Parking lot retrofits: Porous Pavement, Bioswales, Bioretention Facilities, Infiltration Trenches	Urban	890, ? (840, 880), 800, 847	acres, feet	private		no	-88.187751	42.269258
64	Slocum Lk	Detention basin retrofit: Bioretention Facility	Urban	800	acres?	private		no	-88.186275	42.268424
65	Slocum Lk	Forage and Biomass Planting, Prescribed Grazing, Brush Management	Livestock	512, 528	acres	private	USDA-NRCS, MLSWCD, U of I Extension	yes	-88.195218	42.266081
66	Slocum Lk	Roof Runoff Management	Livestock	558	#	private	USDA-NRCS, MLSWCD, U of I Extension	no	-88.183074	42.256832
67	Slocum Lk	Urban Filter Strip	Urban	835	#	private		yes	-88.183734	42.256916
68	Slocum Lk	Parking lot retrofits: Porous Pavement, Bioswales, Infiltration Trenches	Urban	890, ? (840, 880), 847	acres, feet	private		no	-88.175236	42.264934

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
69	Slocum Lk	Streambank Protection, Brush Management, Urban Filter Strip	Hydrologic, Urban	580, 314, 835	feet, acres	private (multiple), Wauconda Twp. ROW?		iepa meth	-88.174361	42.262381
70	Slocum Lk	Streambank Protection (stabilization) and/or two-stage ditch	Hydrologic, Agriculture	580, 608	feet	private, Wauconda Twp. ROW?	USDA-NRCS, MLSWCD, U of I Extension	iepa meth	-88.164812	42.260441
71	Slocum Lk	Streambank Protection, Urban Filter Strip	Hydrologic, Urban	580, 835	feet, acres	private, Wauconda Twp.		no	-88.16377	42.260315
72	Slocum Lk	Rain Gardens, rain barrels, Education	Urban, Other	13, ?, 1	#	private (multiple)	Vlg of Wauconda	no	-88.157225	42.267834
73	Slocum Lk	Channel Bed Stabilization, Grade Stabilization Structure	Hydrologic	584, 410	feet, #	private	Vlg of Wauconda	no	-88.151272	42.274079
74	Slocum Lk	Retrofits: Permeable Pavement, Infiltration Planters	Urban	890, 40	acres, #	private		yes	-88.150781	42.274059
75	Slocum Lk	Green Roof	Urban	11	acres	private	Vlg of Wauconda	yes	-88.150475	42.274249
76	Slocum Lk	Green Roof	Urban	11	acres	private	Vlg of Wauconda	yes	-88.150561	42.273834
77	Slocum Lk	Dry DB retrofit: Bioretention Facility	Urban	800	acres	private	Vlg of Wauconda?	yes	-88.1471	42.2741
78	Slocum Lk	Rain Gardens, Rain Barrels, Education	Urban, Other	13, ?, 1	#	private (multiple)	Vlg of Wauconda	no	-88.149746	42.26535
79	Slocum Lk	Streambank Protection	Hydrologic, Urban	580	feet	Vlg of Wauconda, private		iepa meth	-88.152706	42.260261
80	Slocum Lk	Streambank Protection	Hydrologic	580	feet	private, Vlg of Wauconda ROW?		iepa meth	-88.151917	42.260283
81	Slocum Lk	Bioretention Facility	Urban	800	acres	Illinois Dept. of Transportation?	Lake Co. Div. of Transportation?	yes	-88.154157	42.258724

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
82	Slocum Lk	Infiltration Trench	Urban	847	acres	Illinois Dept. of Transportation?	Lake Co. Div. of Transportation?	yes	-88.153136	42.258685
83	Slocum Lk	Bioretention Facility	Urban	800	acres	Illinois Dept. of Transportation?	Lake Co. Div. of Transportation?	yes	-88.153651	42.25708
84	Slocum Lk	Parking lot retrofits: Oil & Grit Separators, Bioretention Facilities	Urban	10, 800	#, acres	private		yes	-88.150868	42.259009
85	Slocum Lk	Rain Garden, Education	Urban	13, 1	#	Vlg of Wauconda		no	-88.139922	42.258156
86	Slocum Lk	Shoreline Protection - Slocum Lk	Hydrologic	580	feet	private (multiple), HOAs		iepa meth	-88.190972	42.260902
87	Slocum Lk	Downspout Disconnections, Infitration Planters	Urban	37, 40	#	private		no	-88.147491	42.25545
88	Slocum Lk	Rain Garden	Urban	13	#	private		no	-88.14777	42.255402
89	Slocum Lk	Shorleline buffer zone (Urban Filter Strip) - Slocum Lk	Urban	835	acres	private, HOAs		no	-88.18791	42.258392
90	Bangs Lk	Dry DB retrofit: Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	private	Vlg Wauconda	yes	-88.133801	42.258273
91	Bangs Lk	Infiltration Planters	Urban	40	#	School Dist. 118		no	-88.145794	42.267638
92	Bangs Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Wauconda Park District		yes	-88.143103	42.268029
93	Bangs Lk	Wetland Restoration	Hydrologic	657	acres	Wauconda Park District		yes	-88.142343	42.267334

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
94	Bangs Lk	Dry DB retrofit: Infiltration Trench, Bioretention Facility	Urban	847, 800	feet, acres	Sunset Ridge HOA?	Vlg of Wauconda?	yes	-88.128817	42.262717
95	Bangs Lk	Dry DB retrofit: Infiltration Trench, Bioretention Facility	Urban	847, 880	feet, acres	Sunset Ridge HOA?	Vlg of Wauconda?	(yes)	-88.128137	42.263323
96	Bangs Lk	Dry DB retrofit: Bioswale (or Grass-Lined Channel w/ Permanent Vegetation), Bioretention Facility	Urban	? (840, 880), 800	acres	Lakepointe HOA?	Vlg of Wauconda?	yes	-88.1268	42.2635
97	Bangs Lk	Downspout Disconnections, Rain Gardens, rain barrels	Urban	37, 13, ?	#	private		no	-88.124719	42.24747
98	Bangs Lk	Forage and Biomass Planting, Prescribed Grazing, Brush Management	Livestock	512, 528	acres	private	USDA-NRCS, MLSWCD, U of I Extension	yes	-88.123569	42.245878
99	Bangs Lk	Wetland Restoration, Access Control	Hydrologic, Livestock	657, 472	acres	private	USDA-NRCS, MLSWCD, U of I Extension	yes	-88.122971	42.24607
100	Slocum Lk Drain / Fiddle Crk	Wet DB retrofit: Urban Stormwater Wetland, Urban Filter Strip	Urban	800, 835	acres	Deer Grove HOA	Vlg of Port Barrington?	yes	-88.194135	42.253408
101	Slocum Lk Drain / Fiddle Crk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Port Barrington		yes	-88.195531	42.245825
102	Slocum Lk Drain / Fiddle Crk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Port Barrington		yes	-88.19614	42.24568
103	Slocum Lk Drain / Fiddle Crk	Streambank Protection	Hydrologic	580	feet	Lake Co. FPD		iepa meth	-88.193653	42.244208
104	Slocum Lk Drain / Fiddle Crk	Urban Filter Strip	Urban	835	acres	private		yes	-88.190527	42.244589

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
105	Slocum Lk Drain / Fiddle Crk	Access Control / Fence (for livestock exclusion), Filter Strip	Livestock, Agriculture	472 / 382, 393	feet, acres	private	USDA-NRCS, MLSWCD, U of I Extension	no	-88.179657	42.243856
106	Slocum Lk Drain / Fiddle Crk	Dry DB retrofit: Bioswale (or Grass-lined Channel w/ Permanent Vegetation), Bioretention Facility	Urban	? (840, 880), 800	acres	private	Vlg of Wauconda?	yes	-88.147183	42.254583
107	Tower Lk Drain	Streambank Protection, Brush Management, Urban Filter Strip	Hydrologic, Urban	580, 314, 835	feet, acres	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes, private landowner, CFC	yes	-88.159371	42.227751
108	Tower Lk Drain	Spillway Restoration - Tower Lk	Hydrologic	14	#	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes	no	-88.157773	42.228054
109	Tower Lk Drain	Wetland Restoration and/or Urban Filter Strip	Hydrologic, Urban	657, 835	acres	Vlg of Tower Lakes	Citizens for Conservation (CFC)	yes	-88.156398	42.2254
110	Tower Lk Drain	Streambank Protection	Hydrologic	580	feet	private (multiple)	Vlg of Tower Lakes	iepa meth	-88.15323	42.225008
111	Tower Lk Drain	Streambank Protection and/or Wetland Restoration and/or Urban Filter Strip	Hydrologic, Urban	580, 657, 835	feet, acres	Lake Barrington Shores HOA, private		yes	-88.151888	42.22522
112	Tower Lk	Wetland Restoration	Hydrologic	657	acres	private (multiple)	Vlg of Tower Lakes	yes	-88.15486	42.241581
113	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	TLIA, Vlg of Tower Lakes		yes	-88.15795	42.239907
114	Tower Lk	Shoreline stabilization, Brush Management, Wetland Restoration	Hydrologic	580, 314, 657	feet, acres	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes	yes	-88.158626	42.239027
115	Tower Lk	Brush Management, Outreach/Education	Urban	314, 1	acres, #	private		no	-88.154236	42.238784
116	Tower Lk	Brush Management, Wetland Restoration	Urban, Hydrologic	314, 657	acres	private	Vlg of Tower Lakes	yes	-88.153226	42.238874

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
117	Tower Lk	Shoreline Protection - Tower Lk	Hydrologic	580	feet	private, TLIA	Vlg of Tower Lakes	iepa meth	-88.156699	42.233892
118	Tower Lk	Shoreline buffer zone (Urban Filter Strip) - Tower Lk	Urban	835	acres	private, TLIA	Vlg of Tower Lakes	no	-88.154363	42.229079
119	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	TLIA, Vlg of Tower Lakes		yes	-88.154798	42.237382
120	Tower Lk Drain	Wetland Restoration	Hydrologic	657	acres	Lake Co. FPD		*no*	-88.171777	42.223238
121	Tower Lk	Permanent Vegetation, Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	880,? (880, 840)	acres	Vlg of Tower Lakes		yes	-88.150785	42.236918
122	Tower Lk	Stream Channel Stabilization, Wetland Restoration	Hydrologic	584, 657	feet, acres	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes	iepa meth	-88.149091	42.23734
123	Tower Lk	Shoreline Protection, Dredging	Hydrologic	580, 7	feet, #	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes	no	-88.149857	42.236033
124	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Tower Lakes		no	-88.152874	42.234652
125	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Tower Lakes		no	-88.152607	42.234411
126	Tower Lk	Bioretention Facility	Urban	800	acres / #	Vlg of Tower Lakes		yes	-88.15283	42.23447
127	Tower Lk	Bioretention Facility	Urban	800	acres / #	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes	no	-88.151261	42.234789
128	Tower Lk	Wetland Restoration	Hydrologic	657	acres	Tower Lakes Improvement Assoc.	Barrington Area Conservation Trust (BACT)	yes	-88.160756	42.232264

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)										
Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
129	Tower Lk	Urban Filter Strip, Shoreline Protection	Urban, Hydrologic	835, 580	acres, feet	Tower Lakes Improvement Assoc.		yes	-88.15675	42.2324
130	Tower Lk	Grade Stabilization Structures, Brush Management, Permanent Vegetation	Urban	410, 314, 880	#, acres	Tower Lakes Improvement Assoc.		no	-88.156681	42.232256
131	Tower Lk	Bioretention Facility	Urban	800	acres	Tower Lakes Improvement Assoc.		yes	-88.153277	42.232631
132	Tower Lk	Infiltration Trench / facility	Urban	847	feet / acres	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes	yes	-88.150799	42.233056
133	Tower Lk	Bioretention Facility	Urban	800	acres	Tower Lakes Improvement Assoc.	Vlg of Tower Lakes	(yes)	-88.150109	42.232996
134	Tower Lk	Wetland Restoration	Hydrologic	657	acres	Illinois Dept. of Transportation	Vlg of Tower Lakes	yes	-88.147224	42.233583
135	Tower Lk	Brush Management	Urban	314	acres	Illinois Dept. of Transportation		yes	-88.146818	42.233292
136	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Illinois Dept. of Transportation	Vlg of Tower Lakes	no	-88.146751	42.233013
137	Tower Lk	Rain Gardens, rain barrels, Education	Urban	13, ?, 1	#	private	TLIA, Vlg of Tower Lakes	yes	-88.152197	42.232211
138	Tower Lk	Bioinfiltration Facility / Rain Garden	Urban	800 / 13	acres / #	Vlg of Tower Lakes		no	-88.150312	42.231362
139	Tower Lk	Infiltration Trench and/or Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	847, ? (840, 880)	acres	Vlg of Tower Lakes		yes	-88.147372	42.232332

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
140	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation), Urban Filter Strip	Urban	? (840, 880), 835	feet, acres	Vlg of Tower Lakes, Illinois DOT		(yes)	-88.146879	42.232119
141	Tower Lk	Infiltration Trenches/Facility and/or Bioinfiltration Facility / Rain Garden	Urban	847, 800 / 13	acres / #	Vlg of Tower Lakes		yes	-88.146978	42.231754
142	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation), Urban Filter Strip	Urban	? (840, 880), 835	acres	Vlg of Tower Lakes, IDOT?		yes	-88.146801	42.232463
143	Tower Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of Tower Lakes		yes	-88.146542	42.23279
144	Tower Lk	Brush Management	Urban	314	acres	Vlg of Tower Lakes		yes	-88.146147	42.232181
145	Tower Lk	Stream Channel Restoration	Hydrologic	9	feet	Tower Lakes Improvement Assoc.	private landowner, Vlg of Tower Lks	no	-88.147617	42.22905
146	Tower Lk	Streambank Protection	Hydrologic	580	feet	private	TLIA, Vlg Tower Lks	iepa meth	-88.14655	42.2288
147	Tower Lk	Wetland Restoration, Brush Management, Urban Filter Strip	Hydrologic, Urban	657, 314, 835	acres	Vlg of Tower Lakes, Cuba Twp.	BACT, CFC	yes	-88.140883	42.2281
148	Tower Lk	Streambank Protection, Brush Management, Urban Filter Strip	Hydrologic, Urban	580, 314, 835	feet, acres	Vlg of Tower Lakes, private		iepa meth	-88.140017	42.228317
149	Tower Lk	Wetland Restoration	Hydrologic	657	acres	Vlg of Tower Lakes	TLIA, BACT	no	-88.137568	42.227239
150	Tower Lk	Streambank Protection	Hydrologic	580	feet	private, Cuba Twp.	Timberlake Civic Assoc.	iepa meth	-88.129038	42.240099

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
151	Lk Fairview	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	private	Wauconda Twp.?	yes	-88.14655	42.246574
152	Timber Lk	Wetland Restoration, Brush Management	Hydrologic	657, 314	acres	private (multiple)	Timberlake Civic Assoc.	yes	-88.127247	42.244527
153	Timber Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acre	Wauconda Twp.?	private landowners, Timberlake Civic Assoc.	yes	-88.125726	42.243903
154	Timber Lk	Rain Gardens, Rain Barrels, Education	Urban, Other	13, ?, 1	#	private (multiple)	Timberlake Civic Assoc., BACT, MLSWCD	yes	-88.127789	42.24288
155	Timber Lk	Emergent wetland filtration zone w/ deep pool sedimentation areas	Other?	?	acres	private (multiple)	Timberlake Civic Assoc.	no	-88.126132	42.242661
156	Timber Lk	Shoreline Protection - Timber Lk	Hydrologic	580	feet	private (multiple)	Timberlake Civic Assoc.	(iepa meth)	-88.126385	42.241611
157	Timber Lk	Shoreline Protection - Timber Lk	Hydrologic	580	feet	private (multiple)	Timberlake Civic Assoc.	(iepa meth)	-88.124698	42.241515
158	Timber Lk	Emergent wetland filtration zone w/ deep pool sedimentation areas	Other?	?	acres	private (multiple)	Timberlake Civic Assoc.	no	-88.124034	42.241237
159	Timber Lk	Sediment forebay - Timber Lk	Urban?	na	cubic yards	private	Timberlake Civic Assoc.	yes	-88.123633	42.241149
160	Timber Lk	Streambank Protection, Stream Channel Stabilization, Grade Stabilization Structures	Hydrologic, Urban	580, 584, 410	feet, #	private (multiple)	Timberlake Civic Assoc., Cuba Twp., Ela Twp.	iepa meth	-88.120007	42.241602
161	Timber Lk	Expanded drawdown structure at lake outlet	Other?	?	#	Timberlake Civic Assoc.	consultant	no	-88.128585	42.240072

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
162	Timber Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acre	Cuba Twp.?	private landowners, Timberlake Civic Assoc.	yes	-88.121836	42.240392
163	Timber Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of North Barrington?	private landowners	yes	-88.118685	42.239155
164	Timber Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Vlg of North Barrington?	private landowners	yes	-88.118513	42.238982
165	Timber Lk	Bioswale (or Grass-Lined Channel w/ Permanent Vegetation)	Urban	? (840, 880)	acres	Cuba Twp.?	private landowners, Timberlake Civic Assoc.	yes	-88.126402	42.237658
166	Timber Lk	Emergent wetland filtration zone w/ deep pool sedimentation areas	Other?	?	acres	private (multiple)	Timberlake Civic Assoc.	no	-88.123497	42.237685
167	Timber Lk	Sediment forebay - Timber Lk	Urban?	na	cubic yards	private	Timberlake Civic Assoc.	yes	-88.123315	42.237527
168	Slocum Lk Drain / Fiddle Crk	Shoreline Protection - Lk Lakeland Estates	Hydrologic	580	feet	private, Lakeland POA		no	-88.161546	42.246587
169	Timber Lk	Grassed Waterway	Agriculture	412	acres	private	USDA-NRCS, MLSWCD	yes	-88.084838	42.242228
170	Lk Barrington	Steambank Protection	Hydrologic	580	feet	Lake Barrington Community HOA		iepa meth	-88.142516	42.223563
171	Lk Barrington	Streambank Protection	Hydrologic	580	feet	Lake Barrington Community HOA		iepa meth	-88.144757	42.213637

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
172	Lk Barrington	Urban Filter Strip, Shoreline Protection	Urban	835, 580	acres, feet	Lake Barrington Community HOA		yes	-88.143489	42.213736
173	Lk Barrington	Shoreline Protection - Lk Barrington	Hydrologic	580	feet	Lake Barrington Community HOA		iepa meth	-88.148678	42.221005
174	Lk Barrington	Shoreline buffer zone (Urban Filter Strip) - Lk Barrington	Urban	835	acres	Lake Barrington Community HOA		no	-88.148591	42.216639
175	Lk Barrington	Downspout Disconnections, Rain Gardens, Rain Barrels, Infiltration Planters	Urban	37,13, ?, 40	#	Lake Barrington Community HOA		no	-88.145459	42.219691
176	Lk Barrington	Stream Channel Stabilization, culvert resizing	Hydrologic	584, ?	feet	Lake Barrington Community HOA		iepa meth	-88.14422	42.21732
177	Lk Barrington	Stream Channel Stabilization, Streambank Protection	Hydrologic	584, 580	feet	Lake Barrington Community HOA		*no*	-88.143731	42.215814
178	Lk Fairview	Shoreline Protection - Lk Fairview	Hydrologic	580	feet	private		iepa meth	-88.146116	42.245681
179	Lk Fairview	Shorleline buffer zone (Urban Filter Strip) - Lk Fairview	Urban	835	acres	private		no	-88.144922	42.245231
186	Bangs Lk	Wetland Restoration	Hydrologic	657	acres	Vlg of Wauconda		*no*	-88.124759	42.273095
187	Bangs Lk	Permanent Vegetation	Urban	880	acres	Lake Co. FPD		*no*	-88.110892	42.27174

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)

Map #	Subunit	BMP Type	Category	BMP Code	Units	Landowner	Potential Partners	Pollut. load reduc. calc.	Longitude	Latitude
188	Bangs Lk	Wetland Restoration	Hydrologic	657	acres	Lake Co. FPD		*no*	-88.109655	42.26741
189	Bangs Lk	Shoreline Protection - Bangs Lk	Hydrologic	580	feet	private (multiple), HOAs, Wauconda Pk Dist.	Vlg of Wauconda	no	-88.137353	42.266093
190	Bangs Lk	Shoreline buffer zone (Urban Filter Strip) - Bangs Lk	Urban	835	acres	private (multiple), HOAs, Wauconda Pk Dist.	Vlg of Wauconda	no	-88.132769	42.266058
191	Bangs Lk	Oil & Grit Separator	Urban	10	#	Wauconda Park Dist.		no	-88.140226	42.261113
192	Bangs Lk	Brush Management	Urban	314	acres	Lake Co. FPD		*no*	-88.130551	42.253518
193	Bangs Lk	Shoreline Protection - Banana Pond	Hydrologic	580	feet	Lake Co. FPD		no	-88.104455	42.260849
194	Bangs Lk	Shoreline Protection - Heron Pond	Hydrologic	580	feet	Lake Co. FPD		no	-88.104293	42.254187
195	Slocum Lk Drain / Fiddle Crk	Shoreline buffer zone (Urban Filter Strip) - Lk Lakeland Estates	Urban	835	acres	private (multiple), Lakeland POA		no	-88.160221	42.246258
196	Island Lk	Permanent Vegetation	Urban	880	acres	Lake Co. FPD		*no*	-88.138533	42.305012
197	Slocum Lk	Parking lot retrofits: Permeable Pavement, Bioretention Facilities, Oil & Grit Separators	Urban	890, 800, 10	acres, #	private		no	-88.155277	42.257069

9 Lakes Watershed-Based Plan: site-specific BMPs (cont.)										
Map #	**Subunit**	**BMP Type**	**Category**	**BMP Code**	**Units**	**Landowner**	**Potential Partners**	**Pollut. load reduc. calc.**	**Longitude**	**Latitude**
198	Bangs Lk	Access Control / Fence (for livestock exclusion), Grassed Waterway, Filter Strip	Livestock, Agriculture	472 / 382, 412, 393	feet, acres	private	USDA-NRCS, MLSWCD, U of I Extension	(yes)	-88.123185	42.245571
199	Tower Lk	Shoreline Protection - North Tower Lk	Hydrologic	580	feet	private, TLIA	Vlg of Tower Lakes	iepa meth	-88.157559	42.239089
200	Tower Lk	Shoreline buffer zone (Urban Filter Strip) - North Tower Lk	Urban	835	acres	private, TLIA	Vlg of Tower Lakes	no	-88.156919	42.238494

Appendix C - 9 Lakes Watershed Planning Participants

Name		Organization
Mike	Adam	Lake Co. Health Dept.
Loretta	Adams	Slocum Lake Management Assoc.
Beth	Adler	Barrington Area Conservation Trust volunteer
Rich	Bahr	Tower Lakes Improvement Assoc.
Paul	Berlin	Lake Barrington Shores
Steve	Burgoon	Tower Lakes - Lake Committee
Linda	Carlson	Vlg of Libertyville
Mary	Colwell	Integrated Lakes Management
David	Corrigan	Vlg of Port Barrington
Leonard	Dane	Deutschler Environmental
Barb	Day	Lake Barrington Shores
Kelly	Deem	Lake Co. Health Dept.
Paul	Dietzen	Timber Lake
Doreen	Dzialo	4 Lakes Initiative
Donna	Erfort	Vlg of Port Barrington
Norman	Fein	Lake Barrington Shores
Jim	Fischer	Lake Fairview
Nickie	Fischer	Lake Fairview
Bryan	Gainer	Northern Moraine Water Reclamation District
Al	Giertych	Lake Co. Department of Transportation
Gary	Glowacki	Lake Co. Forest Preserve District
Dustin	Good	Trillium Native Landscapes
Andy	Hay	Tower Lakes Improvement Assoc.
Rusty	Issleb	Vlg of Port Barrington
Frank	Jakubicek	Illinois DNR - Fisheries
Dolores	Jarchow	Slocum Lake Management Assoc.
Melanie	Kandler	4 Lakes Initiative; Villa Vaupel Lake Committee
Mike	Kacinski	EA Engineering, Science, and Technology, Inc.
Kathi	Keiran Mikenas	Lake Fairview
Jim	Kirby	Golden Oaks Farm
Mark	Knigge	Vlg of Wauconda
Tom	Kubala	Tower Lakes Improvement Assoc
Ken	Kulinski	
John	Lambert	Bangs Lake Advisory Committee

Name		Organization
Eric	Lecuyer	Northern Moraine Water Reclamation District
Kathleen	Leitner	Vlg of Tower Lakes
Ed	Lochmayer	Bangs Lake; Slocum Drainage District
Deanna	Loughran	Lake Barrington Community HOA / First Service Residential
Chris	Martin	Vlg of Lake Barrington
Nancy	McGranahan	Timber Lake
Alan	Merkle	Tower Lakes
Vern	Meyer	World Wide Farms
Chris	Miller	Vlg of Wauconda
Donna	Minkley	Lake Co. Health Dept.
Patsy	Mortimer	Citizens for Conservation; Flint Creek Watershed Partnership
Liz	Nelson	Island Lake Lake Management Cmte
Russ	Nelson	Northern Moraine Water Reclamation District
Mike	Novotney	Lake Co. Stormwater Management Commission
Kathleen	Paap	Lake Co. Health Dept.
Andy	Peterson	Northern Moraine Water Reclamation District
Kevin	Rische	Trillium Native Landscapes
Tony	Sahs	Northern Moraine Water Reclamation District
Joe	Sallak	Lake Napa Suwe
Nick	Sauer	Lake Co. Board candidate - Dist. 17
John	Schaller	Vlg of Lake Barrington
Donna	Schardt	Vlg of Tower Lakes
Nancy	Schumm	Village of Tower Lakes
Todd	Sheridan	Northern Moraine Water Reclamation District
Cindy	Skrukrud	Sierra Club
Jackie	Soccorso	Vlg of Wauconda
Chet	Stanley	Lake Fairview
Dick	Stranahan	Lake Barrington Shores
Mike	Szuba	Lake Napa Suwe
Bonnie	Thompson Carter	Lake Co. Board - Dist. 5
Gerard	Urbanozo	Lake Co. Health Dept.
Brian	Valleskey	4 Lakes Initiative; Manhard Consulting
Mike	Warner	Lake Co. Stormwater Management Commission
Patty	Werner	Lake Co. Stormwater Management Commission
Ken	Wick	Island Lake Lake Management Cmte
Lisa	Woolford	Barrington Area Conservation Trust
Steve	Wyland	Lake Barrington Community HOA / First Service Residential
Tracy	Yang	Sierra Club

Acronyms

ADID	ADvance IDentification of Disposal Areas
AQI	Aesthetic Quality Index
BACT	Barrington Area Conservation Trust
BMPs	Best Management Practices
CAFO	Confined Animal Feeding Operation
CB	Canfield-Bachman Artificial Lake Model
CFC	Citizens for Conservation
CLC	Conserve Lake County
CW	Chicago Wilderness
CWS	Community Water System
FRB	Fox River Basin
FREP	Fox River Ecosystem Partnership
HEL	Highly Erodible Land
HOA	Homeowner's Association
HSGs	Hydrologic Soil Groups
IDA	Illinois Department of Agriculture
IEMA	Illinois Emergency Management Agency
IFDA	Illinois Forestry Development Act
IGPA	Illinois Groundwater Protection Act
Illinois DNR	Illinois Department of Natural Resources
Illinois EPA	Illinois Environment Protection Agency
LCFPD	Lake County Forest Preserve District
LCHD	Lake County Health Department
LUST	Leaking Underground Storage Tanks
MLSWCD	McHenry and Lake County Soil and Water Conservation District
MS4s	Municipal Separate Storm Sewer Systems
MSL	Mean Sea Level
NLCD 2006	National Land Cover Database 2006
NOI	Notice of Intent
NMWRD	Northern Moraine Water Reclamation District
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
NWPA	Northwest Water Planning Alliance
p-load	Pollutant Load
SWAMM	Spatial Watershed Assessment and Management Model
TLIA	Tower Lakes Improvement Association
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
USDA	U.S. Department of Agriculture
U.S. EPA	U.S. Environmental Protection Agency

WW	Watershed Wide
WWTP	Wastewater Treatment Plants
VLMP	Volunteer Lake Monitoring Program

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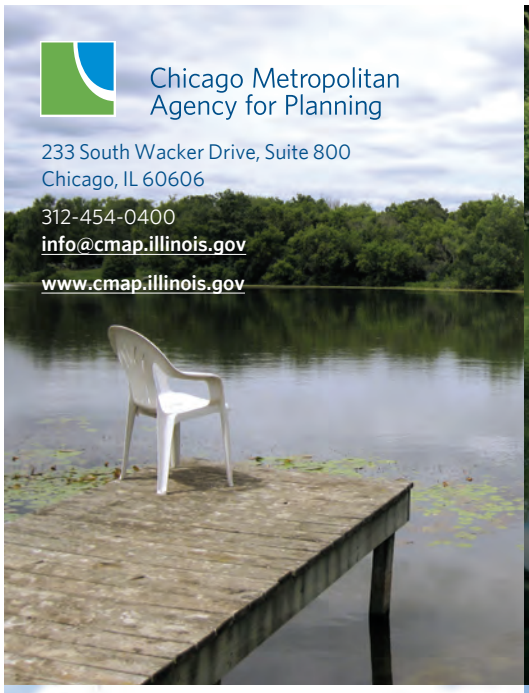

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Images by Chicago Metropolitan Agency for Planning staff.