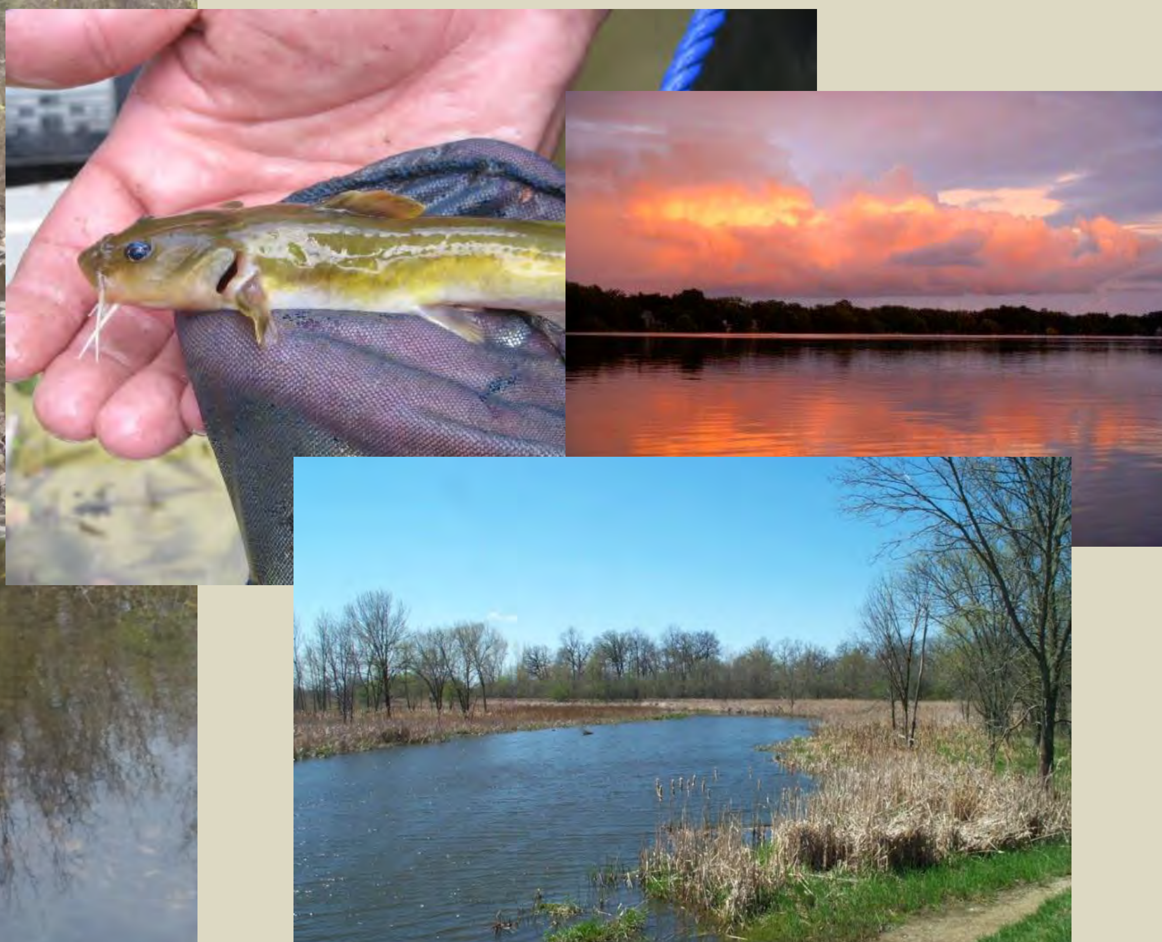
Mill Creek Watershed and Flood Mitigation Plan



LAKE COUNTY, ILLINOIS

LAKE COUNTY

STORMWATER MANAGEMENT COMMISSION

Mill Creek Watershed and Flood Mitigation Plan

4/8/2014

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Illinois Department of Commerce and Economic Opportunity
Community Development Block Grant (CDBG) Illinois "IKE" Disaster Recovery Planning Program
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ACKNOWLEDGEMENTS

The Mill Creek Watershed and Flood Mitigation Plan was largely funded by the Illinois Department of Commerce and Economic Opportunity with funds provided by the Community Development Block Grant Illinois "IKE" Disaster Recovery Planning Program. As one of the state's costliest natural disasters, Hurricane IKE in the spring of 2008 caused severe flood damage to several communities along the Mississippi, Fox and other rivers in Illinois, including the Des Plaines River in Lake County, resulting in the Federal Disaster Declaration 1771. Lake County applied for and received a $250,000 Community Development Block Grant (CDBG) from the U.S. Department of Housing and Urban Development administered by the Illinois Department of Commerce and Economic Opportunity (DCEO) for future planning purposes. The competitive IKE Grant funds comprehensive planning efforts for stormwater management, flood mitigation and management, and damage prevention, as well as other topics such as economic development, housing, and infrastructure.

The Lake County Stormwater Management Commission (SMC) also provided funds and services including project coordination and management, report authorship, geographical information systems (GIS) analysis and mapping, field inventories, consultant contract administration, education and outreach and stakeholder input coordination. Several agencies and organizations provided significant contributions to this plan including Mike Adam, Kathy Paap and staff of the Lake County Health Department provided lake assessments, and Jeff Boeckler and James Adamson of Northwater Consultants supported SMC with collecting and analyzing data, GIS modeling and writing sections of the plan report. The Illinois State Water Survey is completing the floodplain study and map update. The Illinois EPA and U.S. EPA provided timely review services to approve the final plan report as a watershed-based plan. Very importantly, the Villages of Grayslake and Third Lake, the Grayslake Public Library, the Grayslake Park District, the Wildwood Park District, Grandwood Park Park District, University of Illinois Extension Service, College of Lake County and Carillon North all graciously supported our watershed planning effort by providing us with comfortable places to meet throughout the planning period.

Contributions were also made by community planning partners and watershed stakeholders including the County of Lake; the Villages of Grayslake, Gurnee, Old Mill Creek, Third Lake, Lindenhurst, Wadsworth, Libertyville, Round Lake Beach, and Round Lake Park; the communities of Grandwood Park, Wildwood, Carillon North; the College of Lake County; and the Grayslake, Wildwood, Grandwood Park Park Districts, Lake County Forest Preserve District and Avon-Fremont Drainage District. Most of all we would like to recognize all of the watershed stakeholders whose interest in protecting, restoring, and enhancing the Mill Creek watershed has been critical to the success of this plan. They attended planning meetings representing municipal and county agencies, businesses, homeowner and lake associations, agricultural producers and interested groups and individuals from throughout the watershed. The following people participated in watershed planning meetings:

Mill Creek Watershed Planning Meeting Participants

Last Name	First Name	Organization
Adam	Mike	Lake County Health Department
Adamson	James	Northwater Consulting
Amidei	Moses	Village of Wadsworth
Anderson	Linda	Grandwood Park Park District
Anderson	James	Lake County Forest Preserve District
Anderson	Roy	Avon-Fremont Drainage District

Mill Creek Watershed Planning Meeting Participants		
Last Name	**First Name**	**Organization**
Baumann	Kurt	Baxter & Woodman
Beggan	Gary	Village of Third Lake
Beilfuss	Ed	Carillon North Wetland Committee
Berns	Leslie	Lake County Forest Preserve District
Bland	Jim	EPS Incorporated
Blaszczak	Kim	Integrated Lakes Management
Boeckler	Jeff	Northwater Consulting
Capaul	George	
Carlson	Nancy	Grandwood Park Park District
Carlson	Steve	Lake County Stormwater Management Commission
Cassidy	Leslie	Grandwood Park Park District
Chefalo	Tom	Lake County Planning Building and Development
Cline	Andrea	Lake County Stormwater Management Commission
Colwell	Mary	Integrated Lakes Management
Conint	Brian	Weston Solutions
Courser	Jerry	Grandwood Park Park District
Cunz	Cecily	Applied Ecological Services
DeGraff	Kara	Integrated Lakes Management
DeGrave	Chuck	Lake County Public Works
DeNomie	Jim	Avon Independents
Depke	Jennie	
Depke	Robert	
Drabicki	Scott	Village of Gurnee
Dreher	Dennis	Geosyntec
Elan	Donna	
Evans	Greg	College of Lake County
Evans	Kip	
Evans	Sue	
Flood	Rob	Gages Lake Conservation Committee
Gano	Chris	Grandwood Park Park District
Gentleman	Will	
Glunz	Joe	
Graft	Tony	Rollins North Wellness Committee
Gray	Bob	
Gray	Jean	
Gray	Keith	Integrated Lakes Management
Grinnell	Keith	Community Consolidated School District 46
Gutowski	Ken	Grayslake Lake Management
Gutowski	Lisa	Grayslake Lake Management
Halverson	Hillary	
Hanley	Marty	Land and Lakes
Hanlon	Theresa	Grandwood Park Park District
Hart	Sandy	Lake County Board
Heinz	Bill	Village of Grayslake
Hertel	Darcy	Lake County Stormwater Management Commission
Holloway	David	Volkert, Inc.

Mill Creek Watershed Planning Meeting Participants		
Last Name	**First Name**	**Organization**
Hubbard	Kurt	
Husemoller	David	Lake County Planning Building and Development
Husemoller	Tim	Prairie Crossing Charter School
Jekot	Maureen	Wildwood Park District
Jersey	Barb	Avon Township
Keller	Michele	Lake Properties Venture
Klees	Mary	Grayslake Environmental Commission
Klick	Rory	College of Lake County
Koch	Jill	
Kotulla	Wendy	Village of Third Lake
Kubillus	Sandy	Integrated Lakes Management
Kure	Patt	Village of Third Lake
Kwepfer	George	
LeClair	Diane	Grandwood Park Park District
Leffingwell	Larry	
Martin	Chuck	Gages Lake Conservation Committee
McCoy	Mike	
McCracken	Stephen	The Conservation Foundation
Miller	Christine	
Miller	Diane	
Morthost	Tom	Lakes Commission Third Lake
Nasatir	Mikki	
Nehila	Jeff	Grayslake Park District
Novotney	Mike	Lake County Stormwater Management Commission
Panther	Reed	Illinois Tollway
Pasternak	Tim	Round Lake Management Commission
Paulus	Carl "Max"	
Paulus	Tom	Grayslake Lake Management
Penny	Dan	Village of Third Lake
Petrovich	George	Elysian Fields Homeowners Association
Powel	Timothy	Avon-Fremont Drainage District
Prusila	Michael	Lake County Stormwater Management Commission
Rehlek	John	Gurnee Engineering Department
Reynolds	Del	
Rich	Karen	
Rich	Kathe	
Rieth	Lori	Mariner's Cove Community Association
Rogers	Jim	Village of Third Lake
Roskowski	John	Lake County Journal
Rusch	Lisa	Avon Township
Rybarczyk	R	
Salemi	Joe	
Scheddin	Bill	College of Lake County
Schultz	Walt	
Simpson	Howard	Tempel Farms
Smith	Rebecca	

Mill Creek Watershed Planning Meeting Participants		
Last Name	**First Name**	**Organization**
Smith	Tim	Village of Old Mill Creek
Starzec	Kathi	Grayslake Public Library
Surroz	Sarah	Conserve Lake County
Swiatowitz	Mike	Land and Lakes
Todd	Thomas	Prairie Crossing Charter School
Turf	Jeannie	Wildwood Park District
Urbanozo	Gerard	Lake County Health Department
Vancil	Susan	Lake County Stormwater Management Commission
Warner	Michael	Lake County Stormwater Management Commission
Wattleworth	Coleen	Grandwood Park Park District
Weber	Tom	Lake County Board
Welsh	Wesley	Village of Lindenhurst
Werner	Patricia	Lake County Stormwater Management Commission
Wildenberg	Jon	Round Lake Beach
Wilson	Don	
Wolterstorff	Greg	V3 Companies
Wylie	John	Candidate District 6 Lake County Board
Yamin	Yamin	James Anderson Company
Zachary	Dan	Carillon North HOA
Zachary	Rita	Carillon North HOA

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Common Acronyms/Abbreviations Used in Chapter 1

BMP – Best Management Practices
CMAP – Chicago Metropolitan Agency for Planning
DCEO – Department of Commerce and Economic Opportunity
IDNR – Illinois Department of Natural Resources
IDNR-OWR – Illinois Department of Natural Resources – Office of Water Resources
Illinois EPA – Illinois Environmental Protection Agency
ISWS – Illinois State Water Survey
LCDOT – Lake County Department of Transportation
LCPBD – Lake County Planning Building and Development
LCPW – Lake County Public Works
SMC – Lake County Stormwater Management Commission
SMU – Subwatershed Management Unit
TMDL – Total Maximum Daily Load
USEPA – United States Environmental Protection Agency

Watershed: Land area that drains to a given stream or river. The land area above a given point on a waterbody (river, stream, lake, wetland) that contributes runoff to that point is considered the watershed.
Drainage basin: land surface region drained by a length of stream channel; usually 1,000 to 10,000 square miles in size.
Subwatershed Management Unit (SMU): Small unit of a watershed or subwatershed that is used in watershed planning efforts. An example of an SMU would be the drainage area for an individual lake located in the watershed.
Subwatershed: A smaller basin within a larger drainage area that all drains to a central point of the larger watershed.
Best Management Practice (BMP): BMPs are non-structural practices such as site planning and design aimed to reduce stormwater runoff and avoid adverse development impacts - or structural practices that are designed to store or treat stormwater runoff to mitigate flood damage and reduce pollution. Some BMPs used in urban areas may include stormwater detention ponds, restored wetlands, vegetative filter strips, porous pavement, silt fences and biotechnical streambank stabilization.

1. INTRODUCTION

1.1 WHAT IS A WATERSHED?

A ***watershed*** is the area of land drained by a river, stream, or other body of water. Other common names given to watersheds include ***drainage basins*** (or ***Subwatershed Management Units (SMUs)***). As simple as the definition sounds, a watershed is actually a complex interaction between ground, climate, water, vegetation, and animals. In today's developed watersheds, other elements such as sewage, agricultural drainage, impervious surfaces, stormwater and erosion can all be detrimental to the health of the watershed.

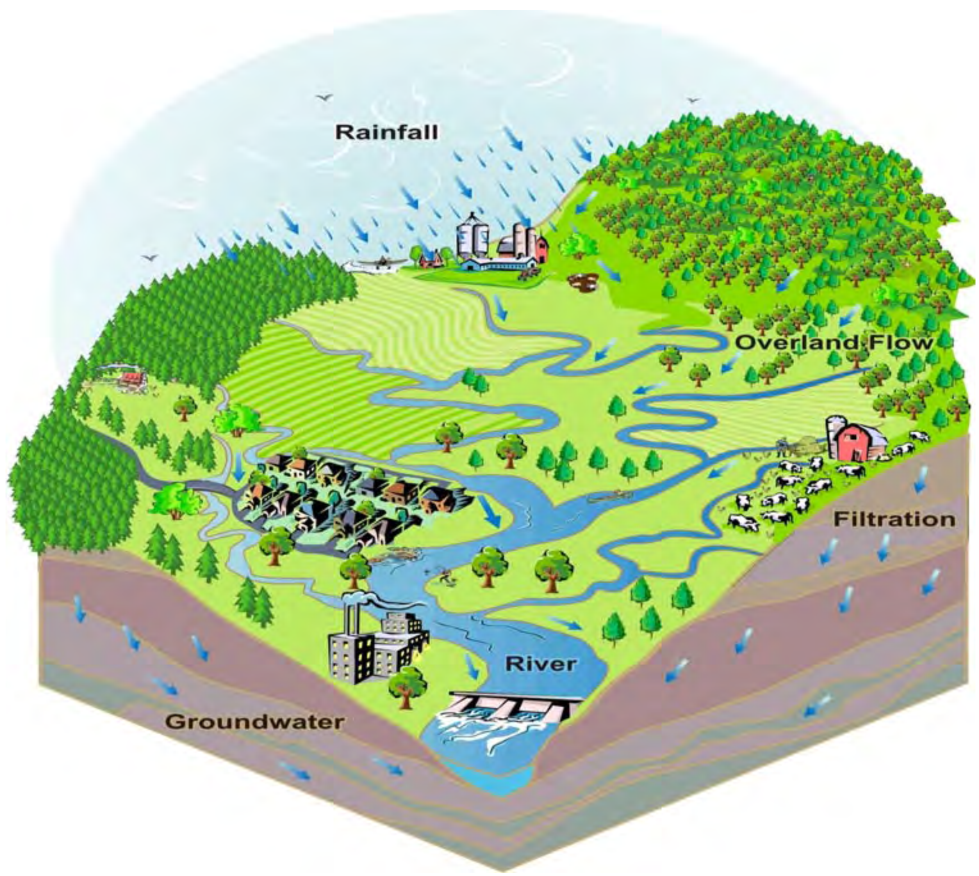


Figure 1-1: What is a watershed? A watershed is the area of land drained by a river, stream, or other body of water. Watershed diagram courtesy of Arkansas Watershed Advisory Group.

The Mill Creek watershed is a ***subwatershed*** of the larger Des Plaines River Basin and encompasses approximately 31 square miles (20,107 acres) in north central Lake County. The Mill Creek Watershed includes 38 miles of stream, more than 4,000 acres of wetland, and 23 named lakes encompassing over 1,100 acres. Smaller ponds and unnamed water bodies encompass approximately another 218.5 acres, bringing the open water total area in the watershed to over 2,500 acres. Mill Creek is a headwater tributary of the Mississippi River Basin. Mill Creek flows into the Des Plaines River and then the Illinois Rivers before reaching the Mississippi River and eventually the Gulf of Mexico a thousand miles away.

The Lake County Stormwater Management Commission (SMC) worked with local stakeholders, municipalities, park districts, residents, and others that are connected to the watershed, and hired Northwater Consulting to develop a watershed plan for the Mill Creek Watershed. This plan identifies ***Best Management Practices (BMPs)*** to remedy or mitigate water quality degradation, flood damage, and natural resource loss. The plan also makes recommendations for preventative actions to address potential future water quality and flood damage problems.

1.2 WATERSHED SETTING

The Mill Creek Watershed is located in northeast Illinois, in north central Lake County **Figure 1-3** and drains approximately 20,107 acres (31 square miles) from south to north through the Avon-Freemont Drainage Ditch, joining with North Mill Creek, and then flowing east to the Des Plaines River. The Des Plaines River then continues south through suburban Lake County, into a more urban Chicagoland, and eventually joins the Kankakee River near Morris, Illinois. The combined Des Plaines and Kankakee Rivers form the Illinois River. The Illinois River flows into the Mississippi River just north of St. Louis, Missouri. Mill Creek is a headwater tributary of the Mississippi River Basin, which covers 1,245,000 square miles of the continental U.S. Mill Creek flows into the Des Plaines and Illinois Rivers before reaching the Mississippi River and eventually the Gulf of Mexico, over a thousand miles away.

Land use in the watershed is typical of a combination of rural and suburban northwest Illinois. Residential and agricultural lands are the most abundant land use comprising 21% each. Open and partially open space comprises an additional 16% of the watershed. Municipalities cover 12,840 acres, 64% of the watershed, including Grayslake, Gurnee, Libertyville, Lindenhurst, Old Mill Creek, Round Lake Beach, Third Lake, and Wadsworth. Unincorporated areas, including Grandwood Park and Wildwood, cover 7,270 acres, 36% of the watershed.

1.2.1 GEOLOGY – THE WATERSHED STAGE

The geologic setting within the watershed was formed during the most recent glacial period known as the Pleistocene Era or “Ice Age” that began approximately 70,000 years ago and ended 10-14,000 years ago. During this time, 80% of Illinois was covered with one or more sheets of glacial ice (Neely and Heister 1987). Although the study area was most likely glaciated repeatedly during the Ice Age, the last glacial retreat, the Wisconsin Glacier, resulted in almost all of the geologic features present today (Fryxell 1927). Some of these features include ***loess, outwash*** gravels and sands, and ***till***. The Lake Michigan lobe of the Wisconsin glaciation extended as far south as Shelbyville, Illinois. As this lobe retreated, ground moraines, till plains, and recessional moraines formed. These formations presently appear as concentric belts around southern Lake Michigan and the Chicago region.

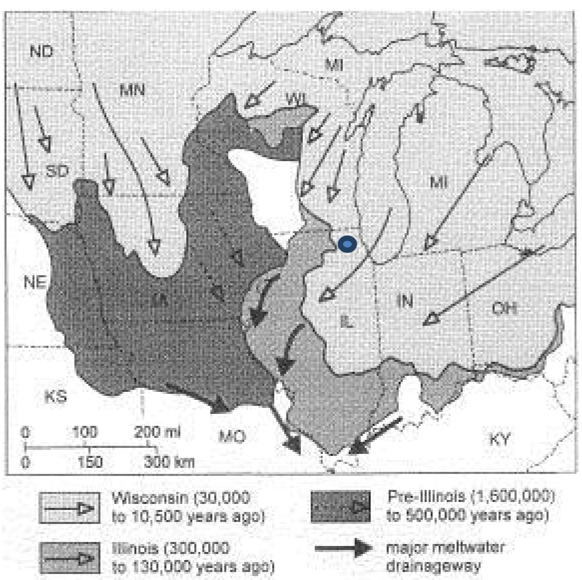


Figure 1-2: Geology of the Midwest. The blue circle represents the approximate location of the study area. This area has been affected by all three phases of glaciation; most recently the Wisconsin Period (Fryxell 1927).

The state of Illinois has 14 geographic or natural divisions. Each division is unique from other divisions by its geology and distribution of flora and fauna. The Mill Creek Watershed is located in the Northeastern Morainal Division (Neely and Heister 1987), a region that was covered by the Lake Michigan Lobe of the Wisconsin ice sheet (**Figure 1-2**).

Loess: Small sediment formed by the accumulation of wind-blown dust.
Outwash: Deposits of sand and gravel carried by running water from the melting ice of a glacier and laid down in stratified deposits.
Till: Unsorted glacial sediment.

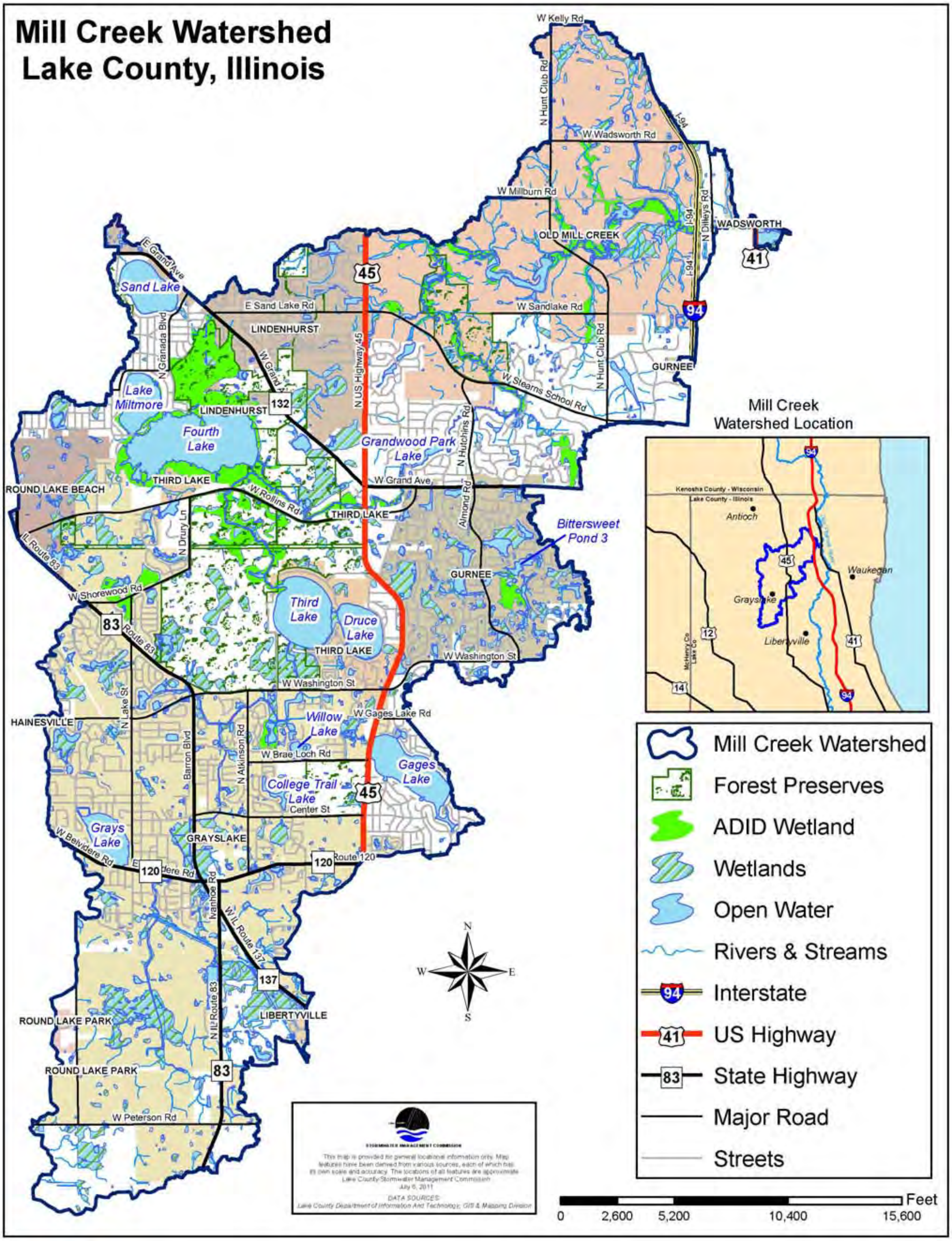


Figure 1-3: The Mill Creek Watershed water resources.

STORMWATER MANAGEMENT COMMISSION

When the Wisconsin ice sheet receded approximately 14,000 years ago, it deposited the Valparaiso and Lake Border moraines (**Figure 1-4**). As a result, the study area is characterized by rough, glacial landform topography. The study area is also unique in Illinois because the soils are derived from glacial drift that lead to the development of poorly drained soils and many natural lakes and stream systems.

The bedrock of the study area is composed primarily of dolomite, limestone, sandstone, shale, and coal. Fossils indicate that bedrock was formed during a geologic period known as the Silurian that began approximately 440 million years ago. Rock formed during this period is found at the surface only in the northern third of the state. Today, these rock formations are economically important because they yield limestone and other important minerals.

Natural Community: An assemblage of plants and animal interacting with one another in a particular ecosystem.
Prairie: A type of grassland characterized by low annual moisture and rich black soil.
Savanna: A type of woodland characterized by open spacing between trees and intervening grassland.
Wetland/marsh: Land that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of plants adopted for life in saturated soil conditions.

1.2.2 THE WATERSHED OVER TIME

In the early 1800's, pre-settlement ***natural community*** mapping in the Mill Creek Watershed indicated there were high-quality natural communities such as ***savannas***, ***wetlands/marsh***, ***prairie*** and woodland. Most of the watershed at that time was a landscape of scattered oak trees with the combined prairie and wetland understory typical of savannas. The predominant savanna was interspersed with marsh/wetland, oak woodlands, wet prairie and open water lakes. The northeastern watershed landscape was mostly prairie and very large complexes of wetland/marsh. These natural communities likely worked in unison to infiltrate and treat precipitation, which minimized surface stormwater runoff leaving the watershed with the large marsh/prairie complexes rather than defined stream channels.

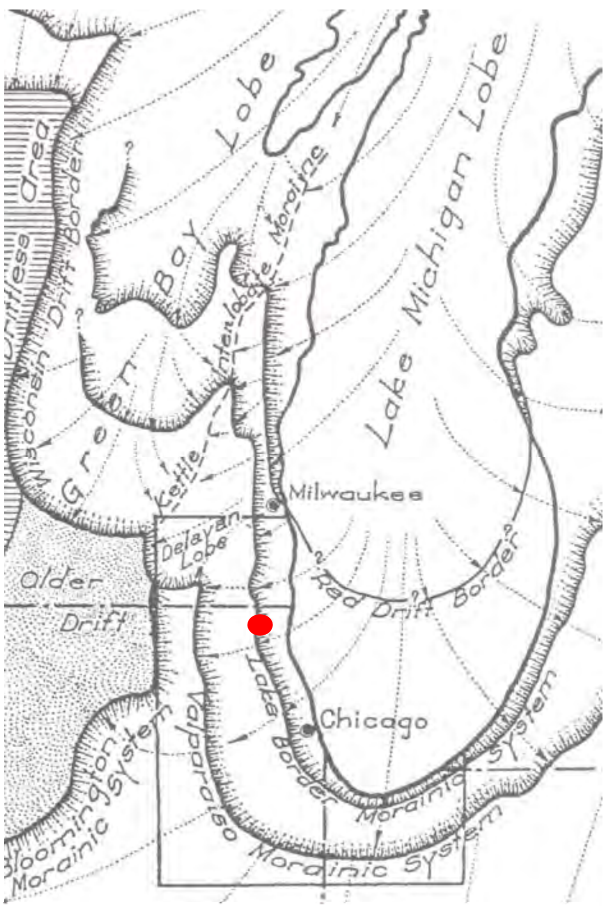


Figure 1-4: Moraine Deposits developed from advancing and retreating glaciers, the latest being the Wisconsin glacier (Fryxell 1927).

Noteworthy: Natural Communities

A natural community is made up of all living things in a particular ecosystem but is usually named by its dominant vegetation type. Prior to European settlement in the 1830's, when the Potawatomie were the last of several Native American tribes who called the area home, Lake County exhibited a mix of natural communities including prairies, savannas, oak woodlands, dune complexes, and wetlands.

European Settlement: A period in the early 1800's when European settlers moved across the United States in search of better lives. During this movement, natural plant communities were altered for farming and related development.
Channel: Any river, stream, creek, brook, ditch, gully, ravine, swale or wash, into which surface or groundwater flows, either perennially or intermittently.

According to pre-settlement natural community mapping, the watershed possessed high-quality open spaces such as prairies, savannas, and wetlands. These communities likely worked in unison to infiltrate and treat precipitation, which minimized surface stormwater runoff and provided excellent water quality conditions. Following ***European settlement*** in the early 1800's, most of the watershed was altered for agricultural purposes. This resulted in the clearing of woodlands and prairies and installation of drain tiles to convey water off the farmland and into stream ***channels.***

Rollins Savanna is likely the landscape that most closely resembles the wetland/marsh complexes that once existed in the northeast part of the watershed. Following European settlement, most of the watershed was altered for agricultural purposes. This resulted in the clear-cutting of savanna and woodlands, clearing of prairies, and installation of drain tiles and agricultural ditches to convey water from the marshes into stream channels to create farmland. The Avon-Fremont Drainage Ditch is actually a channel that was excavated to drain wetland for farmland, created through excavation in the early 20th century.

While almost a quarter of the watershed still remains in farms, suburban development of the watershed began with lakeside subdivisions. A rapid increase in suburban development began in the 1990s and carried through much of the 2000 decade, resulting in new suburban villages mixing with the older rural areas of the watershed. The watershed is comprised of portions of the Villages of Grayslake, Gurnee, Hainesville, Libertyville, Lindenhurst, Old Mill Creek, Round Lake Beach, Round Lake Park, Third Lake, and Wadsworth. These municipalities are interspersed with unincorporated areas of Avon, Lake Villa, Newport, and Warren Townships that make up the unincorporated portions of the watershed.

The watershed includes several high quality and remnant natural areas and is identified as a "Conservation Opportunity Area" in the Illinois Wildlife Action Plan. Natural areas of particular note include Fourth Lake Nature Preserve and Rollins Savanna which are owned by the Lake County Forest Preserve District.

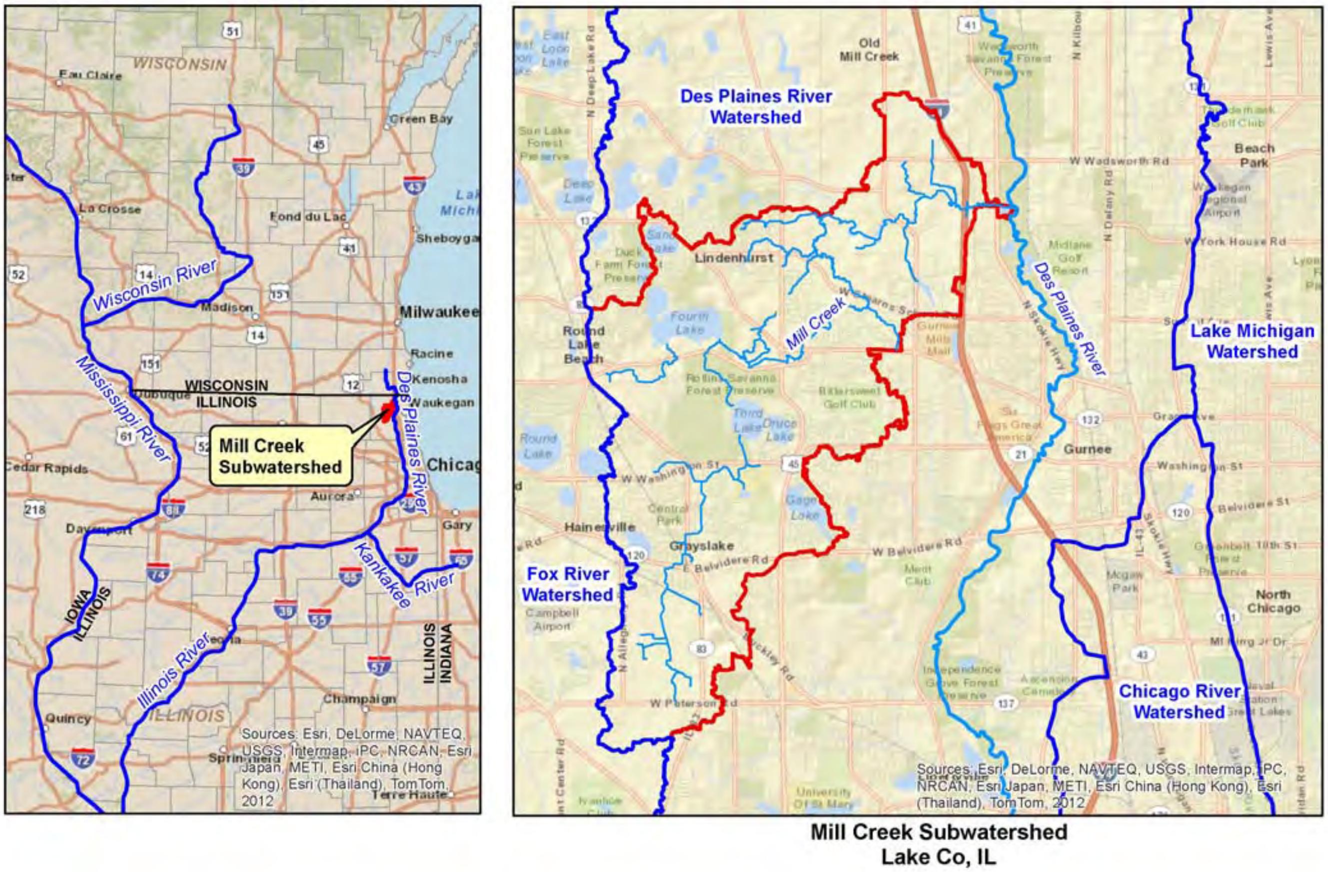


Figure 1-5: Mill Creek Watershed location. The Mill Creek is a subwatershed of the larger Des Plaines River Watershed.

1.3 WATERSHED PLAN PURPOSE AND FUNDING

SMC took the lead to develop this watershed plan for the Mill Creek Watershed. The purpose of this effort was to come up with a plan to restore watershed lakes, streams and wetlands to a healthy condition while reducing the impacts of water pollution and flood damage on watershed residents, and providing opportunities for watershed stakeholders to have a significant role in the process. This plan was developed with, and generally accepted and supported by, a broad representation of watershed stakeholders who participated in the planning process. A significant outcome of this planning effort and the implementation of the plan going forward is to return the nine watershed lakes that are presently listed as being "impaired" on the Illinois 303(d) list of impaired waters to conditions that fully support their designated uses.

This plan identifies BMPs to remedy or mitigate losses of natural resources, water quality degradation, and flood damages. The plan also makes recommendations for watershed stakeholders to implement to preserve, manage, and restore natural resources as well as prevent actions that will cause or exacerbate unintended water quality and flood damage problems. Watershed planning brings communities together to protect and improve the land and water resources they share and impact.

SMC took the lead in securing funding from the Illinois Department of Commerce and Economic Opportunity (DCEO) through an Illinois IKE Disaster Recovery Planning Program grant to fund the development of a flood mitigation and watershed-based plan for Mill Creek. Northwater Consultants and Water Resource Solutions provided planning support. The Illinois State Water Survey (ISWS) assisted in the development of the floodplain study. Staff of the Lake County Forest Preserves, the Villages of Grayslake, Gurnee, Hainesville, Libertyville, Lindenhurst, Old Mill Creek, Round Lake Beach, Round Lake Park, Third Lake, Wadsworth and Lake County Planning Building and Development (LCPBD), Lake County Public Works (LCPW), and Lake County Division of Transportation (LCDOT), Illinois Department of Natural Resources (IDNR), and the Illinois Environmental Protection Agency (Illinois EPA) provided data, information and planning support.

Noteworthy: Lake County Stormwater Management Commission's Watershed Planning Authority

SMC's authority for stormwater management for Lake County and development of this Watershed Plan is provided in 55 ILCS 5/5-1062. This state-level enabling legislation was enacted in response to the major flooding that occurred in October 1986 and August 1987 that caused widespread damages and dislocations across northeastern Illinois.

Lake County established the Lake County Stormwater Management Planning Committee in December 1987; a municipal/county partnership made up of six municipal members and six County Board members. In response to the enabling legislation at the state and county level, Lake County developed and adopted a Comprehensive Stormwater Management Plan in June 1990 and adopted an update of that plan in 2002. This watershed plan will be adopted as an amendment to the 2002 Comprehensive Plan.

SMC's authority for stormwater management enables it to:

• Enact and implement a countywide stormwater management plan that includes the management of natural and man-made drainageways and incorporates watershed plans

• Prescribe and enforce rules and regulations for watershed management, floodplains and control of stormwater runoff countywide

• Levy up to a 0.20% annual tax to implement the stormwater management plan

1.4 WATERSHED PLAN REQUIREMENTS, PROCESS, AND PLAN ORGANIZATION

The primary scope of this project is the development of a comprehensive watershed-based management plan for the 31 square mile Mill Creek watershed that identifies actions to improve water quality and reduce flood risks. The planning approach was designed to help stakeholders from multiple jurisdictions and with various interests to better understand and become engaged in the watershed, with a desired planning outcome to spur implementation of watershed improvement projects and programs that will accomplish the goals and objectives established by this plan.

One of the key programs supporting watershed improvement is the Clean Water Act Section 319 Nonpoint Source Pollution Prevention Program. This program targets voluntary activities that reduce non-point source pollution of the nation's waters. The Section 319 program supports a wide variety of voluntary watershed activities, and in Illinois provides funding for education, watershed planning, and best management practices and projects such as pollution prevention, stream restoration, and drainage system water quality retrofits. To be eligible for Section 319 funds however, watersheds are required to have a watershed-based plan or Total Maximum Daily Load (TMDL)

Noteworthy: USEPA's Nine Elements of a Watershed-Based Plan

1) Identification of the causes and sources or groups of similar sources of pollution that will need to be controlled to achieve the pollutant load reductions estimated in the watershed-based plan;

2) Estimate of the pollutant load reductions expected following implementation of the management measures described under number 3 below;

3) Description of the non-point source management measures that will need to be implemented to achieve the load reductions estimated under number 2 above and an identification of the critical areas in which those measures will be needed to implement the plan;

4) Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan;

5) Public information/education component that is designed to change social behavior;

6) Plan implementation schedule;

7) Description of interim, measurable milestones;

8) Set of criteria that can be used to determine whether pollutant loading reductions are being achieved over time;

9) Monitoring component to evaluate the effectiveness of the implementation efforts over time.

implementation plan. The Mill Creek Watershed and Flood Mitigation plan is designed to meet the nine minimum elements required by the U.S. Environmental Protection Agency (USEPA) for a watershed-based plan.

In addition to the USEPA requirements for watershed-based plans, this plan was subject to additional requirements due to the DCEO funding source. Any plan funded with Ike-Planning Program funds must at a minimum directly address the project area's disaster recovery needs. Specifically, the plan must:

1) Analyze the impact of the floods of 2008 on the area, paying special attention to the areas and groups that were most adversely affected, and the kinds of unmet "needs" that were created by the storm either directly or indirectly (e.g. infrastructure, housing, economic development, etc.).

2) Put forth principles/policies designed to best serve the affected populations and address the identified needs created by the disaster.

3) Outline strategies designed to mitigate or minimize future disaster damage.

The plan must consider each of the following subject areas: housing/community development, economic development, infrastructure, transportation, and environmental preservation – with a view toward their significance in the area's efforts to recover from the recent disaster. The plan must also address the sustainable planning principles.

Noteworthy: DCEO's Sustainable Planning Principles

1) Provide more transportation choices. Develop safe, reliable and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions and promote public health.

2) Promote equitable, affordable housing. Expand location – and energy-efficient housing choices for people of all ages, income, races and ethnicities to increase mobility and lower the combined cost of housing and transportation.

3) Enhance economic competitiveness. Improve economic competitiveness through reliable and timely access to employment centers, educational opportunities, services and other basic needs by workers as well as expanded business access to markets.

4) Support existing communities. Target funding toward existing communities – through such strategies as transit-oriented, mixed-use development and land recycling – to increase community revitalization, improves the efficiency of public works investments, and safeguard rural landscapes.

5) Coordinate policies and leverage investment. Align policies and funding to remove barriers to collaboration, leverage funding and increase the accountability and effectiveness of all levels of government to plan for future growth, including making smart energy choices such as locally generated renewable energy.

6) Value communities and neighborhoods. Enhance the unique characteristics of all communities by investing in healthy, safe, and walkable neighborhoods – rural, urban, or suburban.

Once completed and reviewed by SMC staff and the watershed planning committee, the SMC approved the start of an official 30-day public review and comment period for the draft watershed plan. The plan was also submitted to the Illinois Department of Natural Resources - Offices of Water Resources (IDNR-OWR) and the Chicago Metropolitan Agency for Planning (CMAP) for review and recommendations. Any subsequent amendments to the plan will also be submitted to IDNR and CMAP for review.

A public hearing was held at the county seat during the 30-day public comment period. Notice of the hearing was published in the Lake County News Sun (a newspaper of general circulation in the county) prior to the hearing. SMC will review and consider the comments received and may amend or approve the plan and recommend it to the county board for adoption. The county board may then enact the proposed plan by ordinance as an amendment to the Lake County Comprehensive Stormwater Management Plan.

1.5 PREVIOUS AND RELATED STUDIES AND PLANS

Several previous and concurrent studies of the watershed led to floodplain, biological, habitat, water quality, and demographic/geographic data. This information was collected. Analyzed and summarized, and supplemented with newly collected field data, which was then used to reach conclusions regarding the condition of the resources in the watershed. Field studies completed in association with this planning effort include: detailed stream and detention basin inventories performed by SMC; a biological and water quality monitoring of Mill Creek performed by the IDNR and the Illinois EPA, and a windshield tour and field verification of best management practice locations by Northwater Consulting. A list of previous reports and studies are included in Chapter 3. Summaries of collected field data and reports are included in the Appendices of this report.

1.6 USING THIS PLAN

1.6.1 WHO SHOULD USE THIS PLAN

This plan will be of limited use without the commitment of watershed stakeholders to improve, restore, manage and steward watershed resources. As the primary land use, development and infrastructure authorities in the watershed, municipal and county agencies and elected officials will have a significant amount of influence and responsibility for implementing this plan. These public agencies represent the interests of their constituents and are strongly influenced by every community resident or landowner. Therefore, every watershed stakeholder may influence the future of the watershed.

State and federal agencies and elected officials and private organizations such as lake associations, homeowner associations and private conservation organizations will also play an important role. State and federal agencies can support the implementation of this plan by approving projects in a timely fashion, supporting projects with funding, and providing technical information, tools and resources to assist local authorities and watershed organizations in their efforts. Private associations and organizations have the ear and influence of their members and can provide significant contributions to land and water protection. Individual watershed residents and landowners must also accept responsibility for managing their own land and water resources responsibly and for working with others to implement this plan. All jurisdictions, organizations and private landowners and residents will have to work together in order to successfully protect and restore the watershed. The power of water is immense, as anyone who has experienced flooding can attest. The flow of water also does not respect property lines or jurisdictional boundaries, therefore, everyone needs to share in the long-term stewardship responsibility, and share the costs and benefits of watershed improvements.

Plan implementation will also depend on a watershed organization to oversee, guide, coordinate and monitor watershed activities on behalf of all of the stakeholders. This organization typically forms as an outgrowth of those who participated in the watershed planning process with support coming from a variety of local and state agencies as well as local land use authorities and decision makers. This watershed organization will be the primary mechanism to engage the general public in watershed activities, to support the implementation of the watershed plan, and to voice their concerns and celebrate their successes in restoring watershed resources.

1.6.2 HOW TO USE THIS PLAN

For those unfamiliar with watershed planning, this document may appear overwhelming. There are pages of information with a lot of tables and maps that report on the condition of the watershed to navigate, and many costly recommendations that an individual could not possibly begin to implement. These recommendations are for public agencies to consider. But there are also a number of straightforward actions that each person in the watershed can take to improve the watershed. Every action, no matter how small, when undertaken by many, or key, landowners can have a positive impact on improving the watershed. To get a general understanding of what this plan is about – please read the Executive Summary, which also includes a list of top priority actions for each stakeholder group. For additional details, browse the table of contents and flip to the relevant section you are interested in.

To find out…

….what this plan is intended to accomplish, read about the watershed goals and objectives in Chapter 2.

….detailed information about watershed resources and condition, read the sections of interest in Chapter 3.

….what the problems are facing the watershed, Chapter 4 includes a summary and analysis of watershed problems that need to be addressed by the Action Plan.

….detailed information about flooding, including the flood events of 2008 and 2013, a flood problem inventory, and strategies for flood damage reduction, turn to Chapter 5.

….what kind of actions can be taken to improve the watershed, the Action Plan in Chapter 6 includes a watershed-wide programmatic action plan that includes general recommendations; and a site-specific action plan directed to critical areas of the watershed that identifies actions that can be taken to help fix problems in a specific area.

….what kind of funding may be available to provide cost share for implementing watershed improvement projects, refer to the Funding Sources in Chapter 7.

….what sort of outreach and education is needed so that watershed stakeholders understand the watershed problems, their role in the watershed, and have the capability to implement the Action Plan, refer to Chapter 8 the Watershed Education and Outreach Strategy.

References

Fryxell, F.M. 1927. The Physiography of the Region of Chicago. Augustana College, Department of Geology. The University of Chicago Press, Chicago, Illinois, 45pp.

Neely, R.D., and Heister, C.G., compilers, 1987. The Natural Resources of Illinois—Introduction and Guide: Illinois Natural History Survey Special Publication 6, 224pp.

Contents

Common Acronyms/Abbreviations Used in Chapter 2

BMP – Best Management Practice
DCEO – Department of Commerce and Economic Opportunity
DO – Dissolved Oxygen
Illinois EPA – Illinois Environmental Protection Agency
SMU – Subwatershed Management Unit
TSS – Total Suspended Solids

2. WATERSHED ISSUES, OPPORTUNITIES, GOALS AND OBJECTIVES

2.1 WATERSHED ISSUES

One of the first tasks undertaken by the Mill Creek Watershed Planning Committee was to identify watershed issues based on stakeholder input. Issues were first identified by meeting participants at the March 2013 planning meeting (see Appendix A for stakeholder meeting reports) and voted on at the April meeting to determine priorities.

The five highest priority issues as determined by committee vote are:

1) Sedimentation and its effect on water quality, particularly in lakes
2) Open land preservation
3) Population increase effects on the watershed – changes in land use, impacts from development
4) Invasive species
5) Public education

Issues were then grouped into categories by topic areas to begin categorizing them into goal areas:

1) Flooding
2) Water Quality
3) Stormwater Management and Drainage
4) Natural Resources
5) Education/Information/Input

Water quality was the topic area that was most important to watershed stakeholders.

2.2 WATERSHED OPPORTUNITIES

Following the identification of watershed issues, stakeholders provided input on what they think the watershed opportunities are. They considered what they really like about the watershed and identified these characteristics as opportunities for preserving for the future. The opportunities are listed below.

What do you like about the watershed? What needs to be protected?

- Protect natives/prevent invasive, fish habitat;
- Park land/open space;
- Stakeholder interaction/coordination, involvement, communication;
- Wetlands; and
- Recreational opportunities.

What do people need to know to address issues/take advantage of opportunities?

- Proper streambank, lake and riparian management practices;
- How to improve agricultural runoff;
- Condition of our waterways; and
- Funding and grant opportunities.

What are some steps that can be taken to capitalize on current opportunities?

- Phosphorous ban;
- Identification of stream restoration locations;
- Stakeholder interaction/coordination, involvement, communication;
- Green infrastructure;
- Land use planning;
- Public education and outreach opportunities; and
- Flood problem resolution.

The identification and prioritization of issues and opportunities at the outset of the planning process was the basis the planning team and stakeholders used for developing goals and objectives for the watershed plan and to guide the planning team's focus in completing the watershed assessment. The prioritization process did not limit watershed planning to only the five high priority issues/ opportunities, but rather allowed the watershed plan development team to focus their efforts and make sure that the highest priority issues are adequately addressed in the planning process and within this watershed plan report. The planning team also considered the results of the watershed assessment in developing the plan objectives.

2.3 GOALS AND OBJECTIVES

Five goals were established for the Mill Creek Watershed to address the issues and opportunities raised by the watershed planning committee. These goals led to the development of objectives and ultimately the action plan recommendations. The goals and objectives reflect watershed conditions, address stakeholder priority issues, consider expected future changes, and meet current and possible future funders' expectations (Department of Commerce and Economic Opportunity (DCEO) and Illinois Environmental Protection Agency (Illinois EPA), respectively).

Over the period of the planning year, "measurable" indicators were assigned to each goal to help measure future progress toward meeting each goal as the watershed action plan is implemented. The Action Plan contains recommended programmatic actions that address flooding; water quality; stormwater management and drainage; natural resources; and education, outreach, coordination and implementation goals; and site specific actions that recommend best management practices for specific problem locations identified during inventories and assessments. The goals and objectives are examined in more detail when evaluating the watershed plan's performance and progress by evaluating milestones related to measurable indicators for the goals and objectives.

1) FLOODING: Reduce flood damage to structures and infrastructure and prevent increased flood damage in the watershed.
   OUTCOME: Future floods have minimal adverse effect on structures and infrastructure.
   OBJECTIVES:
   a) Evaluate and improve riparian and depressional floodplain and wetlands. Preserve riparian and depressional floodplain and wetlands in open and undeveloped parcels to maximize flood storage and conveyance.
      Indicator: Number of wetland and floodplain parcels preserved.
   b) Mitigate flood damages through flood-proofing at-risk structures.
      Indicator: Number of structures flood proofed.
   c) Mitigate flood damages caused by sanitary sewer backups through remediation/correction of infiltration into pipes and cross connections with sanitary sewer systems.

Indicator: Number of cross connections fixed; linear feet of pipe replaced.

d) Mitigate local drainage capacity flood damage by providing additional flood storage and/or maintaining/improving local drainage systems.
Indicator: Amount of flood storage created; capacity added to existing systems.

e) Encourage communities and the county to enact ordinances and standards that require sump pump and downspout discharges to be directed to lawn or rain gardens and infiltrated.
Indicator: Number of communities with standards passed.

f) Remove excessive debris loads in channels following American Fisheries Society standards.
Indicator: Miles of channel maintained.

2) WATER QUALITY: Improve and protect water quality in streams, lakes, ponds and wetlands within the Mill Creek Watershed.
OUTCOME: Lakes are removed from the impaired list; prevent additional water resources from being added to the impaired list; and overall water quality is improved.
Pollutants of concern:

- Chloride
- Insufficient Dissolved Oxygen (DO)
- Fecal coliform
- Phosphorus
- Total Suspended Solids (TSS)
- Heavy metals

OBJECTIVES:

a) Reduce sediment accumulation in surface waters by reducing streambank, shoreline, and construction related erosion throughout the watershed.
Indicator: TSS levels, linear feet of streambank and shoreline restored.

b) Implement stormwater management practices that minimize runoff volumes, velocities and pollutants to the creek through infiltration of rainwater on-site using stormwater Best Management Practices (BMPs) such as rain gardens, bioretention, permeable pavement, and open swales.
Indicator: Number and area of Best Management Practices installed.

c) Improve agricultural practices, including drainage and tillage, to reduce sediment, chemical and nutrient transport to Mill Creek water bodies.
Indicator: Number and area of agricultural BMPs installed.

d) Retrofit and maintain existing stormwater management structures such as detention ponds to provide or enhance water quality improvement, including discouraging nuisance wildlife (Canada geese).
Indicator: Number of existing stormwater management structures retrofitted.

e) Reduce the quantity of road salt (sodium chloride) needed for safe and cost effective winter maintenance to reverse the current trend of rising chloride levels in water bodies.
Indicator: Amount of road salt used.

f) Offset the effect of future impervious cover to insure that additional impervious cover does not degrade subwatershed management units.
Indicator: Amount of future impervious cover that flows into a BMP.

g) Reduce phosphorus loads:

- by passing a municipal and county ordinance that bans the use of lawn fertilizer with phosphorus unless a soil test indicates it is needed;
- by removing phosphorus from wastewater discharges;
- by using agricultural BMPs to reduce nutrient loads from farmland; and
- by upgrading poorly functioning septic systems.

Indicator: Number of municipalities and the county that adopt a phosphorous ordinance, phosphorous discharges from wastewater treatment plants, number of agricultural BMPs targeting phosphorous implemented, number of septic systems upgraded.

h) Develop and implement a watershed monitoring program to collect and monitor water quality and biological data on a regular basis.
Indicator: Watershed monitoring program implemented, frequency of data collection.

3) STORMWATER MANAGEMENT AND DRAINAGE: Reduce and manage stormwater runoff through the use of BMPs, infiltration, detention and conveyance systems.
OUTCOME: Lower volume of stormwater runoff reaching natural resources and maintain an adequately functioning drainage system.
OBJECTIVES:

a) Reduce the rate and volume of stormwater runoff from areas that are already developed.
Indicator: Number of stormwater BMPs installed and area treated by a stormwater BMP.

b) Reduce the rates and volume of runoff from new development – maintain pre-development hydrology.
Indicator: Number of developments which maintain pre-development hydrology.

c) Where appropriate, remove or retrofit impoundments, dams and weirs to support fish passage and migration, natural baseflow conditions, and to improve dissolved oxygen levels.
Indicator: Number of dams and impoundments removed or retrofitted.

d) Clear, repair, or replace blocked, damaged and falling culverts, outfall pipes, stream channels, and other stormwater infrastructure to maintain conveyance and reduce erosion and other impacts of an impaired or blocked stormwater system.
Indicator:

e) Establish institutional stream maintenance programs and standards using the American Fisheries Society standards as guidelines.
Indicator: Number of communities with established stream maintenance programs.

f) Establish and preserve the annual hydrograph of Mill Creek to monitor and protect against drought conditions.
Indicator: Hydrograph established through monitoring program.

4) NATURAL RESOURCES: Protect and restore the natural resource components of the watershed, including wetlands, lakes, ponds, and streams and the upland components including prairies, savanna and woodland landscapes, developing a functioning green infrastructure system.
OUTCOME: Natural resources are protected, establishing a series of interconnected hubs and corridors that work to preserve the high quality natural areas and natural hydrology of the watershed.
OBJECTIVES:

a) Implement conservation design developments that cluster development to protect open space as green infrastructure, protecting important natural communities.

Indicator: Number of development using conservation design principles built.

b) Restore degraded natural communities, both terrestrial and aquatic (lakes, wetlands and streams), to ecological health with natural practices and native plants to improve habitat and functional value.
Indicator: Area of degraded natural communities restored.

c) Maintain and expand high quality native riparian buffers (non-native not to exceed 30%) and restore native riparian buffers along those stream reaches identified as having a high or medium level of need for improvement in the stream inventory.
Indicator: Area of riparian buffer restored.

d) Restore and create wetlands where feasible with a minimum target of 10% wetland per Subwatershed Management Unit (SMU).
Indicator: Number of wetlands created and/or restored.

e) Protect greater than 50% of the watershed as pervious open land by preserving open and partially open space.
Indicator: Area of open space preserved.

f) Identify and preserve open space in each SMU as green infrastructure or greenways to promote flood damage reduction, water quality improvement, natural resource protection, and wetland restoration.
Indicator: Amount of open space identified and preserved.

g) Identify, prioritize, and preserve open land with permeable soils, depressional storage, floodplain, wetlands, hydric soils, important natural communities, or significant cultural features within the watershed (i.e.: acquisition, conservation easements, etc.).
Indicator: Amount of open space preserved with permeable soils, depressional storage, floodplain, wetlands, hydric soils, important natural communities, or significant cultural features.

h) Identify and preserve open space that provides important trail or habitat corridor connections and provides passive recreational opportunities such as hiking fishing, biking, riding, canoeing, and environmental interpretations/education as part of the greenway.
Indicator: Area of open space identified and preserved that provide trail or habitat corridor connections.

i) Adopt and prioritize green infrastructure plan elements and support implementation of these elements through local land use plans, policies, and maps. Amend local and county zoning ordinances to encourage green infrastructure practices.
Indicator: Number of municipal and county ordinances amended to encourage green infrastructure practices.

j) Remediate detrimental stream channel conditions such as armoring, channelization, siltation, and lack of habitat characteristics with in-stream and channel-specific restoration enhancements such as remeandering, regrading, bioengineering approaches to stabilization, and habitat structures (pools and riffles, boulders, root wads, etc.).
Indicator: Linear feet of detrimental stream conditions restored.

k) Incorporate natural resource enhancement (wildlife crossings) as part of linear transportation projects.
Indicator: Number of wildlife crossings incorporated into linear transportation projects.

l) Identify potential north south migration corridors to help mitigate climate change affects.
Indicator: Potential migration corridors identified.

5) EDUCATION, OUTREACH, COORDINATION, AND IMPLEMENTATION: Provide watershed stakeholders with the knowledge, skills, resources, stewardship opportunities, and motivation to take action on implementing the watershed plan.
   OUTCOME: Stakeholders have adequate resources to implement the watershed plan.
   OBJECTIVES:
   a) Calculate/estimate the value of green infrastructure in the watershed and convey to watershed residents and jurisdictions.
      Indicator: Number of residents and watershed jurisdictions that receive information about the value of green infrastructure.
   b) Lake County and watershed municipalities will revise watershed development/subdivision ordinances to include requirement, credit or incentive for infiltration.
      Indicator: Number of municipalities and the county which revise ordinances to require, credit, or incentive for infiltration.
   c) Develop a pollution prevention campaign to reduce/eliminate pollution inputs associated with landscape maintenance and agricultural production.
      Indicator: Pollution prevention campaign established.
   d) Facilitate public training and engage students, lake associations and homeowner associations in volunteer lake and stream stewardship and maintenance.
      Indicator: Number of volunteers.
   e) Develop a technical resource, conduct an outreach campaign and provide training to landowners and government jurisdictions on riparian buffers and stream restoration and maintenance.
      Indicator: Number of people reached by outreach campaign.
   f) Provide technical assistance to watershed communities, the development community, residents and other stakeholders to help them implement watershed plan recommendations.
      Indicator: Hours of technical assistance provided.
   g) Promote the use of native plants and the removal of invasive plants by establishing demonstration sites and training.
      Indicator: Number of demonstration sites established and trainings held.
   h) Provide conservation and low impact development practice guidelines and case studies to educate municipalities and the development community about innovative or alternative development approaches.
      Indicator: Number of municipalities and developers which receive conservation and low impact development guidelines and case studies.
   i) Update watershed residents about the ecological health of the watershed by developing and disseminating a watershed report card in years 5 and 10 of plan implementation. Convey messages from the education plan with public relations, education, outreach and media vehicles to increase public awareness and understanding of watershed issues.
      Indicator: Number of watershed residents that receive watershed report card.

2.4 VISION

The Planning Committee also developed a vision for the watershed, identifying what they desire the watershed to look like over the next 20 years as development continues in the region. The vision serves to focus the aim of the group. While different groups implementing the plan may have different goals and objectives, the achievement of them should all fit under the overarching goal of the vision statement.

The vision for the Mill Creek Watershed is to reestablish and support clean water, accessible open space, and healthy natural areas through sustainable development and the involvement of an educated and engaged community that is safe from flooding and that recognizes the importance of, and works together to restore and maintain the balanced ecosystems, lakes, and streams that make up the watershed.

Contents

Tables and Figures

Common Acronyms/Abbreviations Used in Chapter 3

ACEC – American Council of Engineering Companies
ADID – Advanced Identification
ADT – Average Daily Traffic
BMP – Best Management Practice
BRAC – Blue Ribbon Advisory Committee
CAG – Community Advisory Group
CCS – Context Sensitive Solution
CDOT – Chicago Department of Transportation
CFU – Colony Forming Units
CMAP – Chicago Metropolitan Agency for Planning
CBDG – Community Block Development Grant
DEM – Digital Elevation Model
DO – Dissolved Oxygen
EOR – Element Occurrence Records
EWM – Eurasian Water Milfoil
fIBI – Fish Index of Biotic Integrity
FQI – Floristic Quality Inventory
GIS – Geographic Information System
GLCC – Gages Lake Conservation Committee
GPS – Global Positioning System
HOA – Homeowners Association
HQAR – High Quality Aquatic Resource
HUC – Hydrologic Unit Code
HUD – Housing and Urban Development
IDOT – Illinois Department of Transportation
IDNR – Illinois Department of Natural Resources
Illinois EPA – Illinois Environmental Protection Agency
I-LAST – Illinois Livable and Sustainable Transportation

INAI – Illinois Natural Area Inventory
INPC – Illinois Nature Preserve Commission
IP – Individual Permit
IPCB – Illinois Pollution Control Board
IRTBA – Illinois Road and Transportation Builders Association
ISGS – Illinois State Geologic Survey
IWLC – Isolated Waters of Lake County
LCDOT – Lake County Department of Transportation
LCFPD – Lake County Forest Preserve Department
LCHD-ES – Lake County Health Department - Ecological Services
LCPBD – Lake County Planning Building and Development
LCWI – Lake County Wetland Inventory
LMPOA – Lake Miltmore Property Owner's Association
MBI – Macroinvertebrate Biotic Index
MGD – Million Gallons per Day
mIBI – Macroinvertebrate Index of Biotic Integrity
NPDES – National Pollutant Discharge Elimination System
NRCS – National Resource Conservation Service
PCB – Polychlorinated biphenyl
PS&E – Plans, Specifications, and Estimate
RP – Regional Permit
SLPOA – Sand Lake Property Owners Association
SMC – Lake County Stormwater Management Commission
TDS – Total Dissolved Solids
TKN – Total Kjeldahl Nitrogen
TN – Total Nitrogen
TP – Total Phosphorous
TSI – Trophic State Index
TSS – Total Suspended Solids
VPD – Vehicles per Day
VVHA – Venetian Village Homeowners Association
USACE – United States Army Corps of Engineers
USDA – United States Department of Agriculture
USDOT – United States Department of Transportation
USEPA – United States Environmental Protection Agency
USGS – United States Geological Survey
WDO – Watershed Development Ordinance
WOUS – Waters of the U.S.
WRF – Water Reclamation Facility

3. WATERSHED CHARACTERISTICS ASSESSMENT

The watershed characteristic assessment is a compilation and analysis of data that describes the condition of the Mill Creek Watershed, considering such factors as climate, soils, demographics, land use, natural resources, water resource assessments, etc. This characterization of existing conditions is important so that the challenges and opportunities in the watershed can be more fully understood, and it is the basis for developing recommendations for the watershed action plan.

3.1 CLIMATE

Illinois is situated midway between the western Continental Divide and the Atlantic Ocean and is often underneath the polar jet-stream. The polar jet stream creates low pressure systems which bring clouds, wind and precipitation to the area. There are several other environmental factors that affect the climate of Illinois including solar energy, the proximity of Lake Michigan, and urban areas. The intensity of the sun's incoming energy is determined by Illinois' mid-latitude position. This position causes Illinois to experience warm summers and cold winters, since the regional solar energy input is three to four times greater in the summer than in the winter. The presence and density of buildings, roads, parking lots, and industrial activities also influence the climate in comparison to surrounding rural areas, often increasing the temperature (National Climatic Data Center, 2009).

Locally, Lake Michigan influences the climate of Illinois, including the Mill Creek Watershed. The Lake's large thermal mass moderates both the heat of the summer and the cold of the winter. Weather data also suggests that Lake Michigan increases general area cloudiness and decreases summer precipitation. During the winter, Lake Michigan enhances precipitation totals by adding lake-effect snow, which occurs when winds originate from the north or northeast (National Climatic Data Center, 2009).

Data collected in Antioch, Illinois best represents the overall climate and weather patterns experienced in the watershed. The winter months are cold, averaging 23°F (-5°C); winter lows average 15°F (-9°C). The coldest temperature on record is -29°F (-34°C) recorded on January 12, 1977. Summers are warm, averaging 70°F (21°C); summer highs average 80°F (27°C). The highest recorded temperature, 104°F (40°C) occurred on August 1, 1988.

The wide variety of climate conditions creates diverse watershed conditions. For example, during the winter months of December and January, Mill Creek Watershed does experience precipitation in the form of snow however; this precipitation minimally affects flooding within the watershed. Likewise, during the months of May and June, the watershed will usually experience a warming temperature and wet weather conditions. Snow melt in spring may result in stream and localized flooding. During the months of mid-September and October, the watershed will experience cooling temperatures, and precipitation frequency will decrease.

3.1.1 PRECIPITATION

Illinois exhibits a wide variability in annual precipitation. There have been prolonged wet periods, most recently during the 1970s and 1980s. There have also been major multi-year droughts in the 1930s and 1950s. January and February are normally the driest months, while May and June are typically the wettest months. Illinois has rainstorms producing 40 or more flash-floods annually, each with several inches of rainfall in a few hours, in localized areas. These flash floods can cause massive flooding within the Mill Creek Watershed, potentially resulting in water damage to buildings and infrastructure. Illinois' greatest recorded winter snowfall total was 105.1 inches at Antioch, Illinois in 1978-1979.

The Lake County Stormwater Management Commission (SMC) utilized rain gauge data located in the watershed to summarize the following statistics. From early 1999 to late 2013, an average of just over 27 inches of precipitation per year was recorded at a rain gauge station within the watershed at the Mill Creek Water Reclamation Facility (WRF) (42.4157, -87.9554). Most of this precipitation falls during the 2-year recurrence interval storm event. The 10 and 100-year recurrence interval rain events define peak flows for major flood events and potential flooding locations across the watershed. The most precipitation received in one year (37.20 inches) occurred in 2001. The least amount of precipitation received in one year (17.59 inches) occurred in 2005. The one-day maximum precipitation (3.59 inches) occurred on June 13, 1999. These unpredictable storm events can cause an increase in stream flow, velocity and flooding in surrounding areas.

3.2 TOPOGRAPHY

Generally, the watershed slopes from south to north and west to east, with the highest elevations in the southwestern end of the watershed and the lowest elevations in the northeast. Despite the glacial origin of the landscape, the highest point in the Mill Creek Watershed is the Countryside Landfill, a result of human agency, which rises to 891 feet above sea level, as shown in **Figure 3-1**. The lowest point in the watershed is the mouth of Mill Creek at the Des Plaines River, at 660 feet above sea level.

3.2.1 CATCHMENTS

Watersheds exist in a "nested hierarchy", that is, a given watershed may be comprised of many smaller watersheds and may also be a component of a much larger watershed. For instance, the Des Plaines River basin watershed is comprised of many smaller watersheds (e.g., Mill Creek, Indian Creek, Bull Creek, Buffalo Creek, etc.) and is also a component of the larger Illinois River Watershed. Similarly, the Illinois River Watershed is a nested component of the larger Mississippi River Watershed. USEPA and Illinois EPA often refer to watersheds, or hydrologic units, based on their Hydrologic Unit Code or HUC number. For Mill Creek the HUC number is 071200040202.

For the purposes of this plan, the Mill Creek Watershed has been divided into catchments, as shown in **Figure 3-2**. These are smaller watersheds, or "subwatersheds," within the Mill Creek Watershed and fall into the same nested hierarchy described above. These catchments drain to individual lakes or stream segments within the Mill Creek Watershed or are tributary areas with similar land use characteristics. The watershed is divided into catchments to facilitate pollutant load modeling, isolate critical areas, and achieve a more efficient and intelligible action and implementation plan.

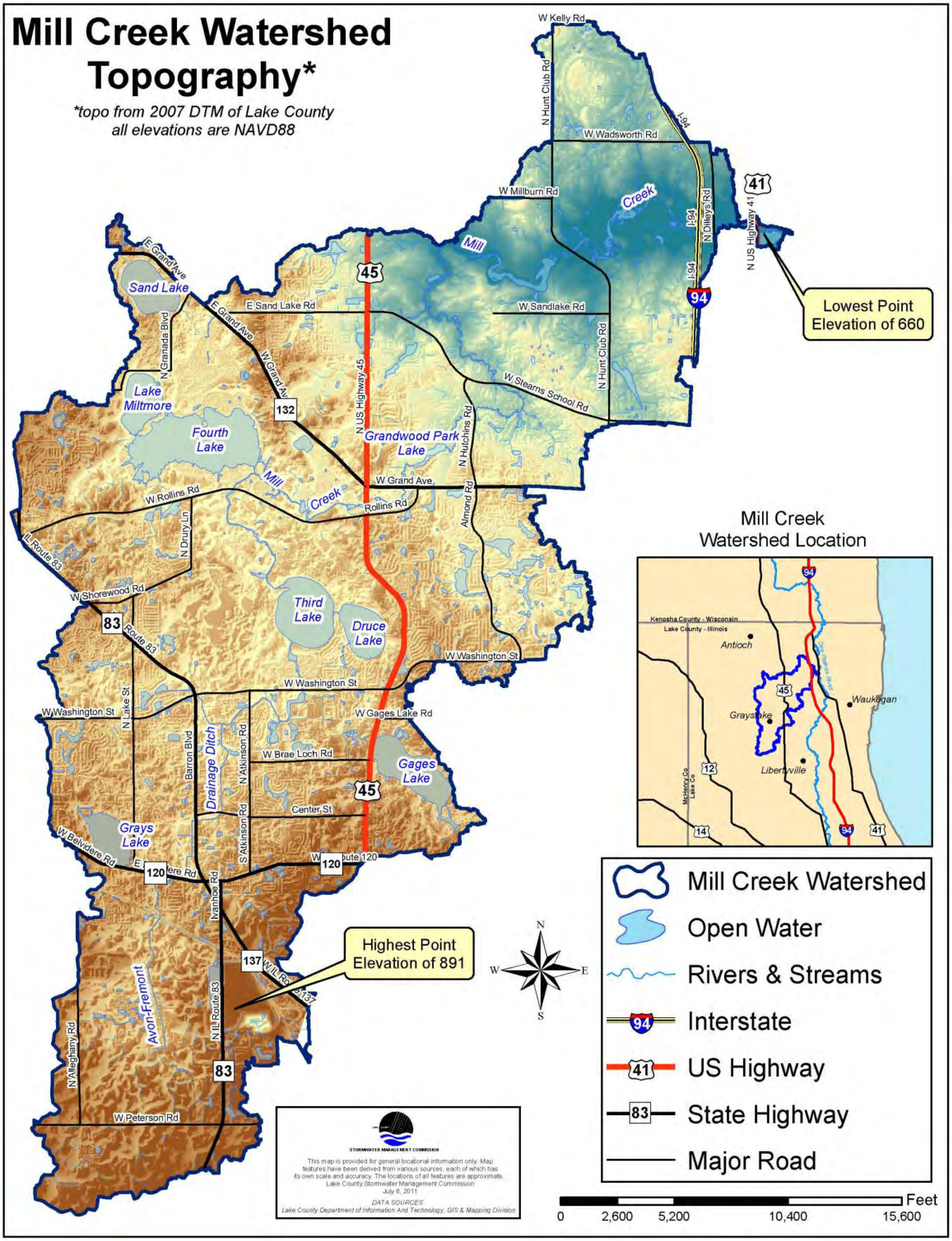


Figure 3-1: Digital elevation model of the Mill Creek Watershed.

STORMWATER MANAGEMENT COMMISSION

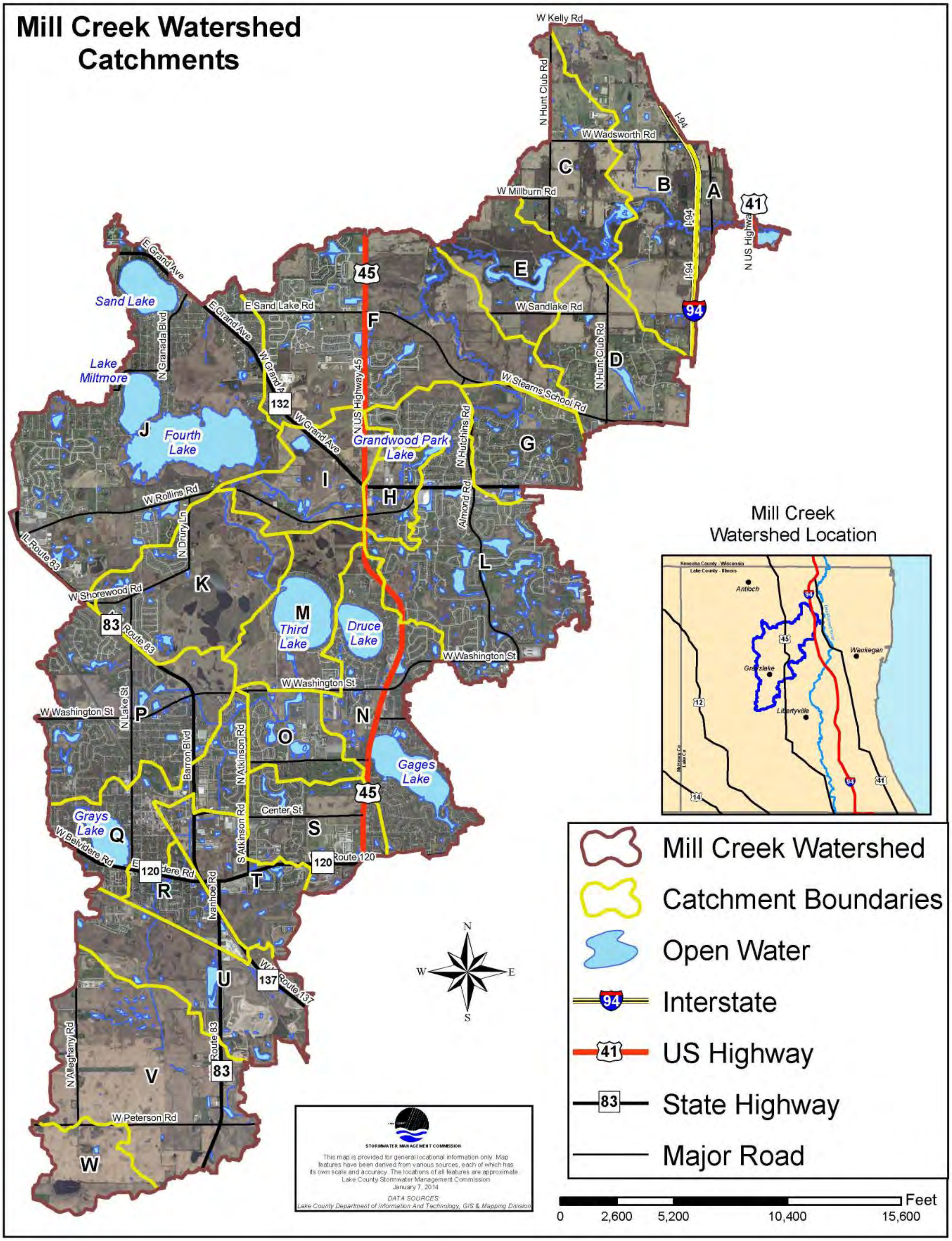


Figure 3-2: Mill Creek catchments.

3.3 SOILS

Soils are a significant factor in the runoff characteristics of a site and in large part determine the erosion and infiltration potential of land. Soil properties are used to identify wetlands and potential wetland restoration sites and have implications for various types of development as well as the implementation of stormwater best management practices.

Soil series: A group of soils that have profiles which are almost alike, except for differences in texture of the surface layer. All soils of a series have horizons that are similar in composition, thickness, and arrangement.
Soil phase: A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

The Natural Resources Conservation Service (NRCS) has produced a detailed soil survey for Lake County, Illinois, including the Mill Creek Watershed. The soil survey contains information regarding the physical and chemical properties as well as information regarding human use for each ***soil series*** and ***soil phase*** in Lake County. Importantly, the soil survey also maps soils throughout the entire county. **Table 3-1** includes the major soil series present in the Mill Creek Watershed and the amount of the watershed occupied by each. This data was used to map the extent of hydric soils, highly erodible soils, and hydrologic soil groups in the Mill Creek Watershed. These three soil characteristics indicate the manner in which soils in a particular area will interact with water in the environment, and therefore are useful in watershed planning. In particular, these soil characteristics can help to guide where restoration and best management practices are likely to be successful and where there may be constraints to project implementation.

Table 3-1: Major Soil Types in the Mill Creek Watershed.

Soil Series Name	Hydric (Y/N)	Hydrologic Soil Group	Total Area (Acres)	Percent of Watershed
Ashkum	Y	C	1,190.3	6.02%
Barrington and Varna	N	C	221.1	1.12%
Beecher	N	C	641.7	3.24%
Blount	N	C	290.3	1.47%
Dresden	N	B	98.9	0.50%
Elliott	N	C	723.6	3.66%
Grays	N	B	731.4	3.70%
Grays and Markham	N	C	1,646.2	8.32%
Houghton (drained)	Y	A	602.4	3.05%
Houghton, undrained/ponded	Y	D	853.8	4.32%
Landfills	N	C	255.5	1.29%
Markham	N	C	941.2	4.76%
Mundelein	N	B	428.2	2.16%
Mundelein and Elliott	N	C	657.7	3.32%
Orthents, clayey, undulating	N	C	97.4	0.49%
Orthents, loamy, undulating	N	B	131.2	0.66%
Ozaukee	N	C	3,369.8	17.03%
Pella	Y	B	1,261.1	6.37%
Peotone	Y	C	463.0	2.34%
Sawmill	Y	D	273.1	1.38%
Varna	N	C	641.6	3.24%

Soil Series Name	Hydric (Y/N)	Hydrologic Soil Group	Total Area (Acres)	Percent of Watershed
Water	Y	Impervious	1,326.4	6.70%
Wauconda	N	B	550.2	2.78%
Wauconda and Beecher	N	C	727.2	3.68%
Zurich	N	B	681.0	3.44%
Zurich and Ozaukee	N	C	491.3	2.48%
Other minor soils*	Varies	Varies	487.5	2.46%

*Minor soils include 16 additional series, each comprising less than 90 total acres within the Mill Creek Watershed

3.3.1 HYDRIC SOILS

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

Hydric soils form in areas of the landscape that are seasonally or permanently saturated. These conditions are conducive to the growth of hydrophytic vegetation, or plants that tolerate or require saturated soil or standing water. Therefore, the presence of hydric soils is indicative of present or historical wetland conditions or may indicate depressional areas. Areas with hydric soils and drained hydric soils that do not presently contain wetlands may be candidates for wetland restoration.

Figure 3-3 maps hydric soils in the Mill Creek Watershed, according to the NRCS 2004 Lake County Soil Survey. Hydric soils comprise 6,093 acres (31%) of the watershed, of which 1,326 acres are classified by NRCS as “water” (lakes, streams, and other perennially inundated areas). Hydric soils that have been drained for agriculture or other uses account for over one third of the total amount of hydric soils at 2,517 acres (13%). Most of the streams, lakes, and other surface waters in the watershed have hydric soils associated them. Additionally, smaller pockets of hydric soils are well-distributed throughout the watershed. Larger contiguous areas of hydric soils are located upstream and downstream of Fourth Lake and along the Avon-Fremont Drainage Ditch from Peterson Road north to Center Street.

Table 3-2: Hydric Soil Series and the area they cover.

Major Hydric Soil Series Name	Hydrologic Soil Group	Area (Acres)	Percent of Watershed
Ashkum	C	1,190.3	6.02%
Harpster	B	82.4	0.42%
Houghton Muck (drained)	A	602.4	3.05%
Houghton Muck (undrained/ponded)	D	853.8	4.32%
Kish loam	B	11.2	0.06%
Montgomery	D	21.9	0.11%
Pella	B	1,261.1	6.37%
Peotone (drained)	C	463.0	2.34%
Peotone (undrained)	D	7.0	0.04%
Sawmill	D	273.1	1.38%
Water	N/A	1,326.4	6.70%
TOTAL		**6,092.6**	**30.8%**

3.3.2 SOIL ERODIBILITY

Soil erodibility is largely determined by the tendency of soil particles to become detached and mobilized by water and the ground slope. Highly erodible soils in the watershed are highly susceptible to erosion by water due to a combination of slope, particle size, and cohesion, but are not prone to erosion by wind. Highly erodible soils are considered in the watershed plan because erosion from these soils can potentially end up in surface waters contributing to high amounts of total suspended solids in streams and lakes. This results in degradation of water quality due to silt and sediment deposition and pollution. The movement or removal of soil resulting from erosion may also cause damage to property as buildings and infrastructure are undermined.

In the Mill Creek Watershed, 2,211 acres (11%) are classified as having highly erodible soil. **Figure 3-3** maps the locations of highly erodible soils within the Mill Creek Watershed, while **Table 3-3** summarizes the highly erodible soils present in the watershed. These soils are well-distributed in the watershed north of Rollins Road and south of Illinois Route 120, but are less frequent in the central portion of the watershed. Highly erodible soils do not include any hydric soils and are represented by hydrologic soil groups "B" and "C", described as moderately poor to moderately well drained soils.

Erodible soils along lakeshores and stream channels and on disturbed land surfaces (e.g., active crop lands and construction sites) are most susceptible to erosion. Agricultural and construction best management practices can be employed to reduce the potential for water erosion on disturbed soils. Additionally, land developers are required to follow the National Pollutant Discharge Elimination System (NPDES) and Lake County Watershed Development Ordinance (WDO) regulations regarding soil erosion and sediment control during construction.

Table 3-3: Highly Erodible Soils.

Major Highly Erodible Soil Series Name	Area (Acres)	Percent of Watershed
Markham	515.9	2.61%
Ozaukee	986.1	4.98%
Varna	430.4	2.18%
Zurich	257.1	1.3%
Minor Series (Casco, Casco-Rodman, Fox)	21.3	0.11%
TOTAL	**2,210.8**	**11.18%**

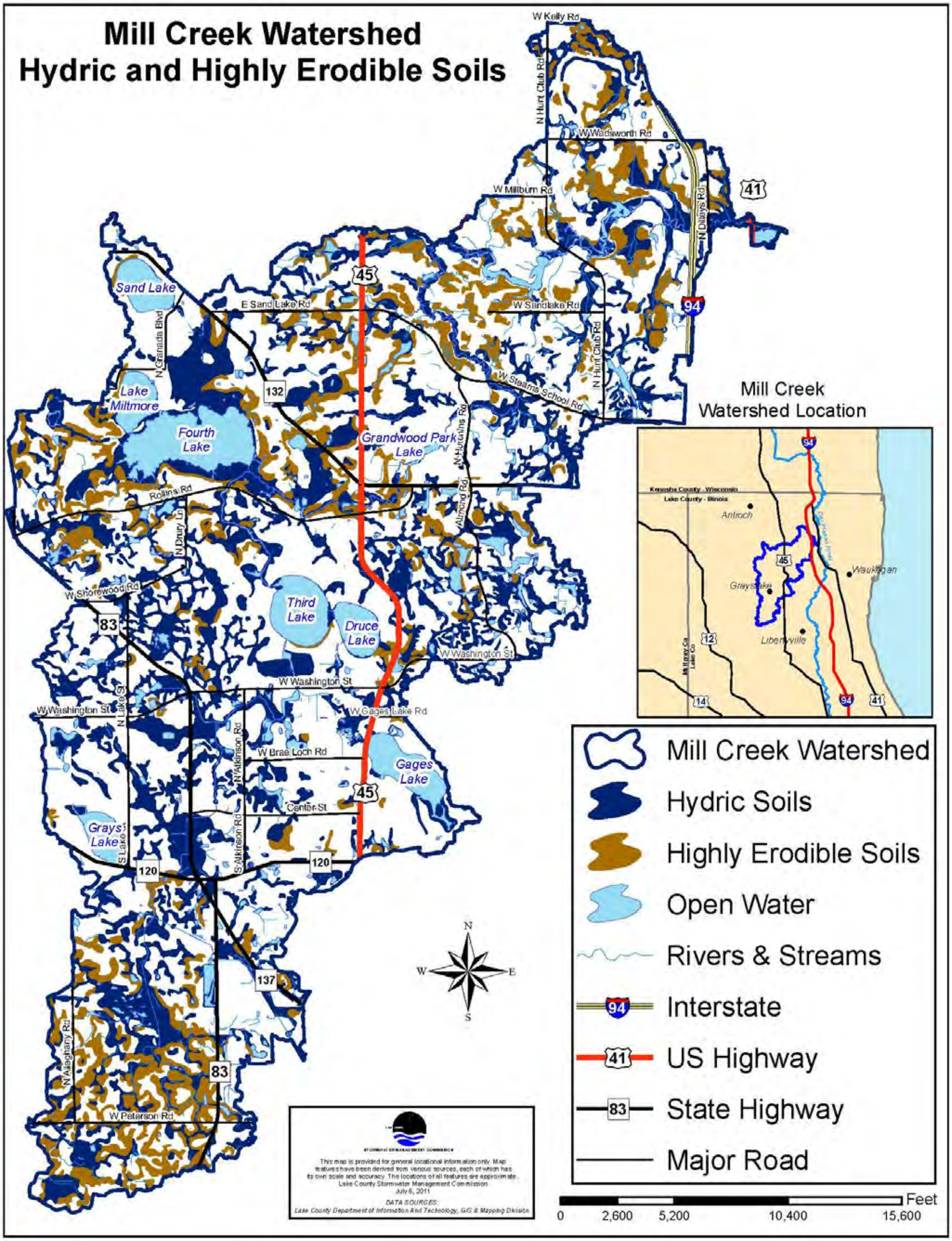


Figure 3-3: Highly erodible and hydric soils in the Mill Creek Watershed.

3.3.3 HYDROLOGIC SOIL GROUPS

Hydrologic Soil Groups: Groupings of soils according to their runoff potential. Soil properties that influence this potential are those that affect the minimum rate of infiltration on bare soil after prolonged wetting, including depth to seasonal high water table, infiltration rate and permeability after prolonged wetting, and depth to a low permeability layer. Slope and plant cover are not considered but are separate factors in determining runoff. Hydrologic Soil Groups are organized by the letters A, B, C, and D, with A having the lowest runoff potential (highest infiltration) and D have the highest runoff potential (lowest infiltration).A group of soils that have profiles which are almost alike, except for differences in texture of the surface layer. All soils of a series have horizons that are similar in composition, thickness, and arrangement.

Hydrologic soil groups are considered in the watershed plan because they broadly classify soils based on their drainage characteristics. In particular, the hydrologic soil group classification provides general information about infiltration rates and runoff potential that can be considered when identifying best farming practices and potential stormwater best management practice and retrofit opportunities. Overall, soils in the Mill Creek Watershed are not well drained, as shown in **Table 3-4**. The only soil classified in hydrologic soil group "A," or well-drained soils, is Houghton Muck and it comprises only 3% of the Mill Creek Watershed. Houghton Muck is a hydric wetland soil that must be drained (i.e., ditched) in order to achieve this classification (note that in its undrained state, the Houghton series is classified as a "D" , or very poorly drained, soil). Soils classified in hydrologic soil group "B" comprise 21.3% of the watershed, and are characterized as "moderately well drained" relative to other soil types. More than three quarters of the Mill Creek Watershed is covered by surface water or soils in hydrologic groups "C" and "D," which exhibit "slow" and "very slow" infiltration and transmission rates, relative to other soil types.

Table 3-4: Hydrologic Soil Groups.

Hydrologic Soil Group	Drainage Description	Runoff Potential	Infiltration and Transmission Rate	Major Soil Types in the Mill Creek Watershed	Area (Acres)	Percent of Watershed*
A	Deep, well drained to excessively drained sands or gravelly sands	Low to Moderate	High	Houghton (drained)	602	3%
B	Moderately deep or deep, moderately well drained or well drained soils that have moderately fine to moderately coarse texture	Moderate	Moderate	Pella; Grays; Wauconda; Zurich; Mundelein; Orthents, loamy, undulating; Dresden	4,220	21.3%
C	Soils having a layer that impedes the downward movement of water or soils of moderately fine or fine texture	High	Slow	Ozaukee; Grays and Markham; Ashkum; Markham; Wauconda and Beecher; Elliott; Mundelein and Elliott; Beecher; Varna; Zurich and Ozaukee; Peotone; Blount; Landfills; Barrington and Varna; Orthents	12,419	62.8%

Hydrologic Soil Group	Drainage Description	Runoff Potential	Infiltration and Transmission Rate	Major Soil Types in the Mill Creek Watershed	Area (Acres)	Percent of Watershed*
D	Clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material	High	Very Slow	Houghton (undrained/ponded); Sawmill	1,216	6.2%

*Does not add up to 100% because acreages do not include surface water

3.4 WATERSHED JURISDICTIONS

The Mill Creek Watershed has numerous political jurisdictions including municipal, township, and other local, state and federal elective and agency jurisdictions. The boundaries of these jurisdictions are seldom drawn to coincide with watershed boundaries. Therefore, watershed plans often require inter-jurisdictional coordination and cooperation for successful implementation.

The municipalities of Grayslake, Old Mill Creek, Gurnee, Lindenhurst, Third Lake, and Round Lake Beach all have greater than 400 acres of their corporate limits located within the Mill Creek Watershed, as shown in **Table 3-5**. Additionally, smaller portions (less than 80 acres) of Wadsworth, Libertyville, Round Lake Park and Hainesville are also located within the watershed. The Village of Grayslake occupies the most area of any municipality within the watershed, at nearly 5,900 acres, or almost 30% of the total watershed area, and the Village of Old Mill Creek occupies over 3,200 acres, or 16% of the watershed. Unincorporated areas of Lake County total more than 7,000 acres, over 35% of the Mill Creek Watershed.

Table 3-5: Watershed jurisdictions and the area they cover in the watershed.

Jurisdiction	Area (Acres)	Percent of Watershed
Unincorporated Lake County	7,082.8	35.8%
Grayslake	5,890.9	29.8%
Old Mill Creek	3,211.8	16.2%
Gurnee	1,375.1	7.0%
Lindenhurst	1,112.1	5.6%
Third Lake	551.0	2.8%
Round Lake Beach	406.2	2.1%
Wadsworth	56.9	0.3%
Libertyville	56.5	0.3%
Round Lake Park	37.3	0.2%
Hainesville	2.3	<0.1%

In addition to municipalities, local jurisdictions in the Mill Creek Watershed also include townships. Portions of Avon, Fremont, Lake Villa, Newport, and Warren Townships are all located within the watershed. Townships are often responsible for the maintenance of local roads and associated drainage features and therefore are often important partners when dealing with watershed issues and opportunities related to the transportation network.

Other local government units that own land or have jurisdiction pertinent to this watershed plan include the Lake County Forest Preserve District, the Avon-Fremont Drainage District, and the Grandwood Park, Grayslake Community, Gurnee, Lindenhurst, Round Lake Area, and Wildwood Park Districts.

The unincorporated communities of Grandwood Park, Wildwood, and Venetian Village are also located in the watershed. While not municipalities, these communities have a distinct geography and character which is commonly known and identified by the residents of those communities as well as nearby areas. In the case of Grandwood Park and Wildwood, park districts have been established to serve the residents of these communities. In all three instances, these communities contain significant water resources and will be important stakeholders and partners in the implementation of this watershed plan. Because Grandwood Park, Wildwood, and Venetian Village are not municipalities and are therefore located in unincorporated areas of Lake County, these communities are included in the "unincorporated" designation in other tabulations in this plan.

Due to the location of the Mill Creek Watershed near the geographic center of Lake County, the watershed includes portions of several local, state, and federal political districts. **Table 3-6** includes the political districts in the watershed.

Table 3-6: Political districts in the Mill Creek Watershed.

Political Body	Districts
Lake County Board	3rd, 4th, 6th, 7th, 10th, 13th, 15th, 16th, 21st
Illinois State House of Representatives	51st, 61st, 62nd, 64th
Illinois State Senate	26th, 31st, 32nd
United States House of Representatives	10th, 14th

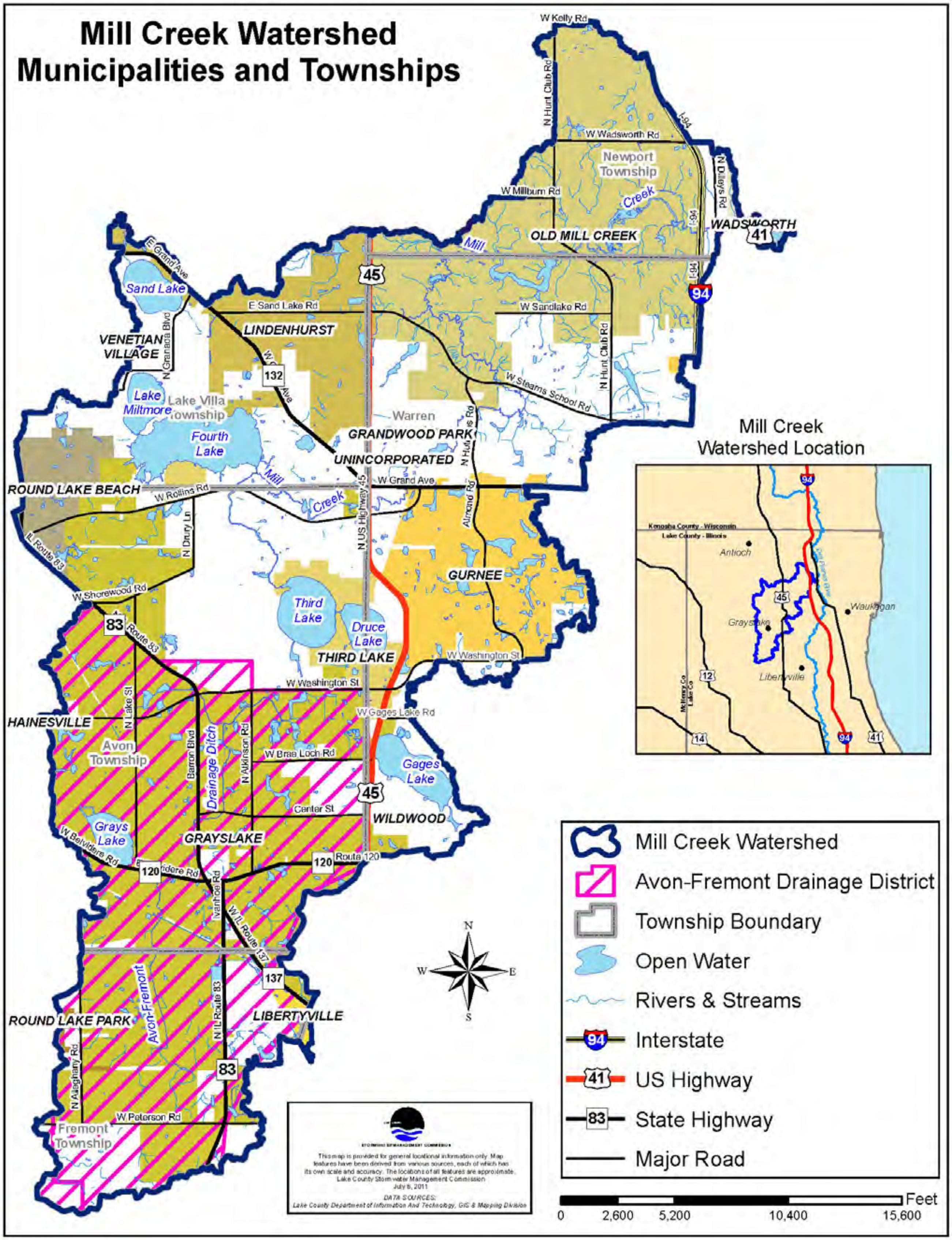


Figure 3-4: Mill Creek Jurisdictions.

3.5 DEMOGRAPHICS

The population of the Mill Creek Watershed is approximately 46,207 people, based on the 2010 decennial census. This is an increase of approximately 14% from the 2000 population. The Chicago Metropolitan Agency for Planning (CMAP) forecasts population to increase by an additional 31% by the year 2040; see **Figure 3-5**. On a decadal scale, this forecast growth is somewhat less (only about 10%-11% per decade) than the population increase experienced in the watershed from 2000 to 2010. As of 2010, there were approximately 16,500 jobs in the Mill Creek Watershed. CMAP forecasts employment to increase by 54% by the year 2040, a much larger ratio than the forecast for population growth. The CMAP population and employment forecast is based on a model that accounts for local future development and land use plans, as well as other land use, demographic, and economic variables and trends. Because the Mill Creek Watershed is a relatively small portion of the entire CMAP population forecast area, the results should be considered as an example or indicator of how the watershed could develop over the next few decades. This plan does not draw conclusions or recommendations from any single evaluation unit (square) in the forecast map. **Table 3-7** characterizes the demographics of the watershed in comparison to Lake County and the entire State of Illinois.

Table 3-7: Demographics within the Mill Creek Watershed in comparison to the County and State.

Demographic	Mill Creek Watershed	Lake County	Illinois
<18 years of age	29.6%	27.4%	24.4%
Age 65 & over	7.3%	10.4%	12.5%
Females	50.8%	50.1%	51.0%
Housing tenure-owner occupied units	79.8%	76.6%	67.5%

3.5.1 LOW AND MODERATE INCOME AREAS

The Mill Creek Watershed includes significant portions of four low and moderate income census tracts, as shown in **Figure 3-6**. Smaller portions of three additional low and moderate income census tracts are also located in the watershed. These areas cover 3,475 acres or 17.6% of the Mill Creek Watershed. In Lake County, 35.6% or more of the population of a census tract must meet the U.S. Department of Housing and Urban Development (HUD) definition of "low and moderate income" to be considered a Low and Moderate Income Area. The designation is based on 2000 U.S. Census data and is used to allocate funding through the Community Development Block Grant (CDBG) program.

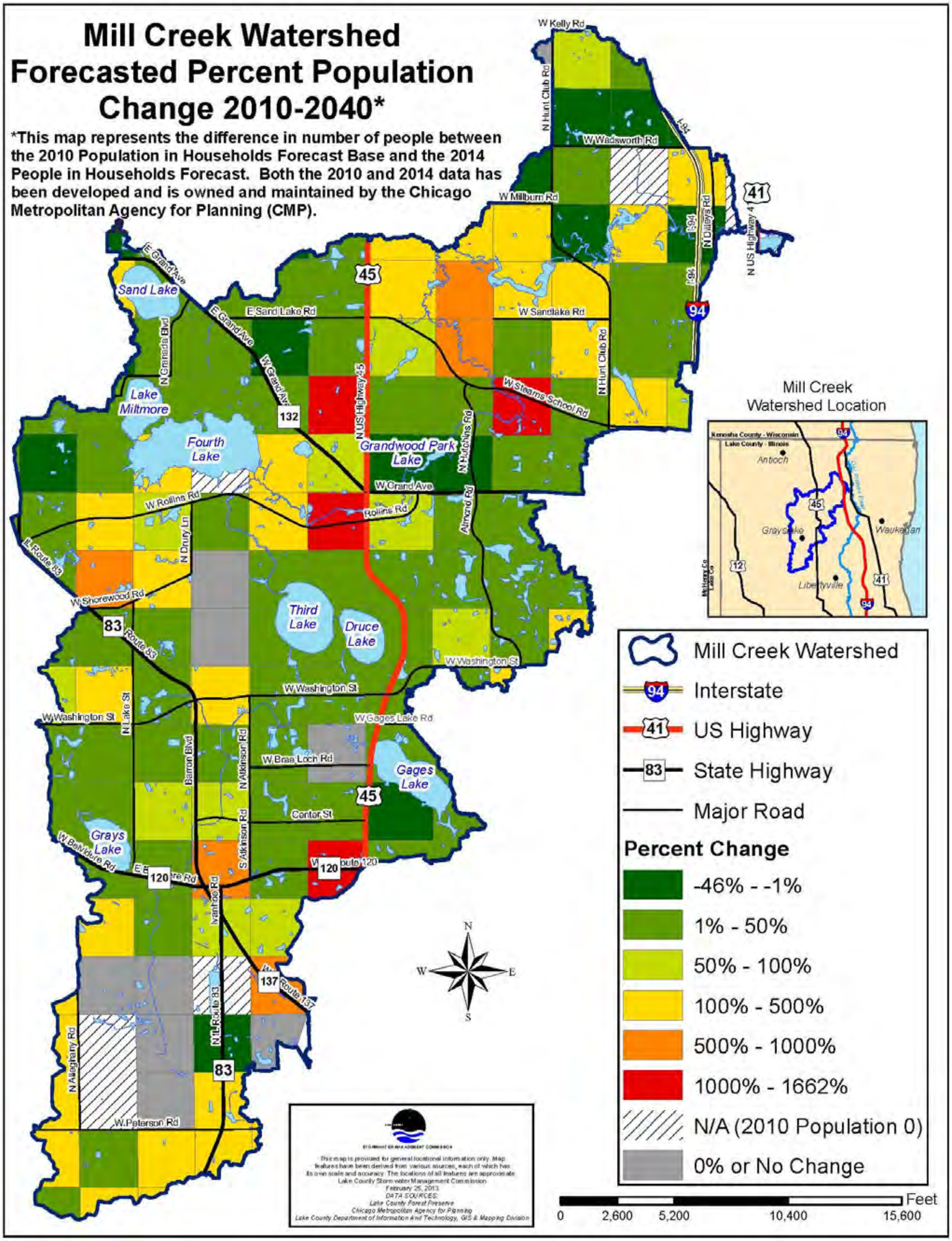


Figure 3-5: Forecasted percent population change in the Mill Creek Watershed.

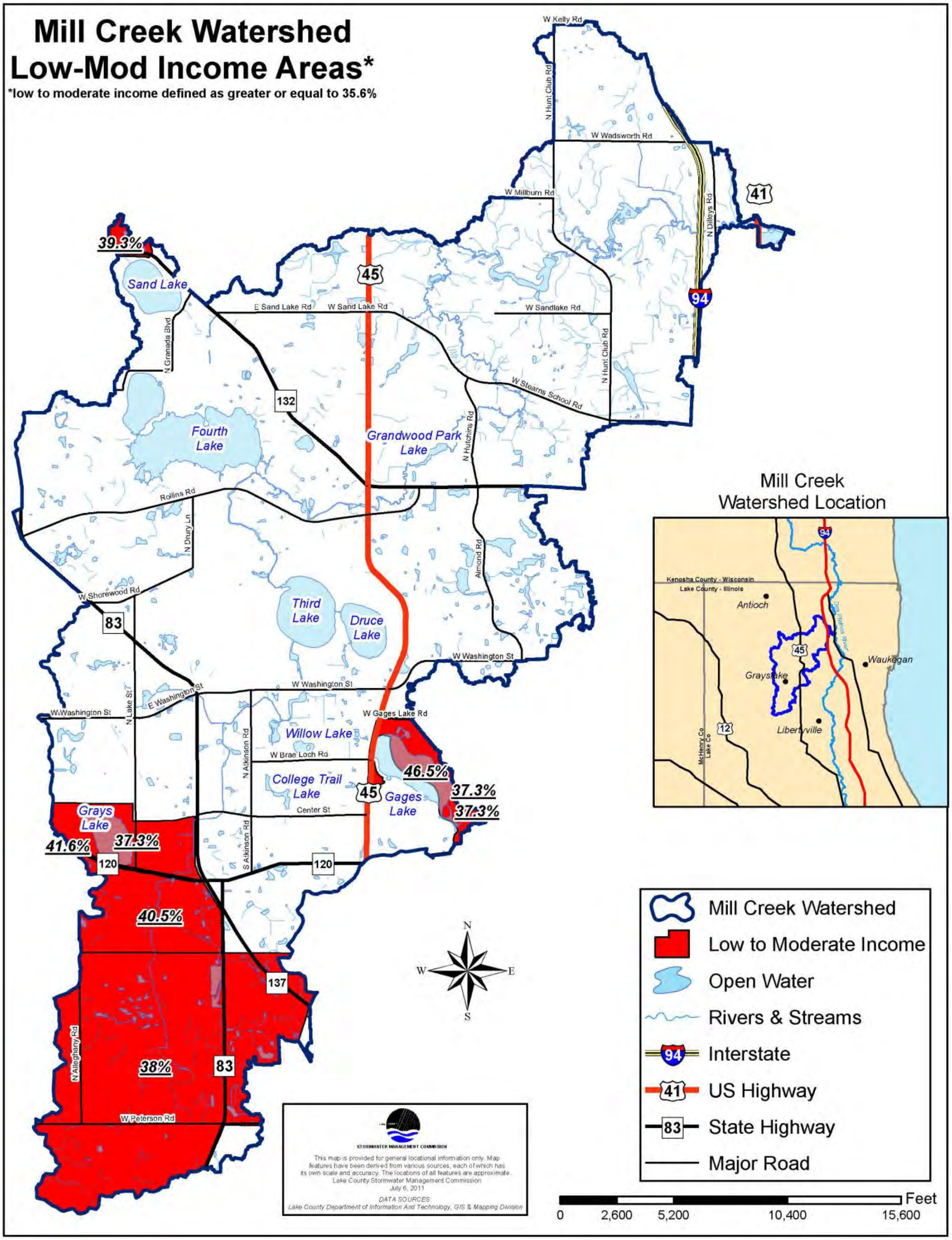


Figure 3-6: Low to moderate income areas within the Mill Creek Watershed.

3.6 LAND USE AND LAND COVER

3.6.1 HISTORIC LAND COVER

The historical government survey (1838-1840) of the pre-settlement natural communities in the Mill Creek Watershed include a network of oak woodlands, wet meadow/prairie, marsh, prairie, savanna, and upland forest. These communities are shown in **Figure 3-7**. Savanna covered just under half of the watershed. Prairies were the next dominant pre-settlement vegetation. Following European settlement, most of this land was converted to agricultural practices followed by residential and commercial land uses.

> *Noteworthy:* How we use land effects water quality
>
> Studies have shown that land use has a direct effect on water quality. The greater amount of impervious area, the greater the pollution load it generates. Pollutants from a variety of diverse and diffuse sources collect on impervious surfaces and are flushed into rivers and streams when it rains. Lawns, driveways, rooftops, parking lots and streets are the source areas of these pollutants, while the causes include: vehicles, road surface applications, direct atmospheric deposition, fertilizer/pesticides/herbicides, litter, pet waste, vegetative decay, and soil erosion. Urban runoff also carries pollutants such as oil and grease, metals, and pathogens such as fecal coliform bacteria. Runoff from impervious surfaces can be 10-12 degrees warmer than runoff from land in a natural state, which combined with reduced summer flows results in higher in-stream water temperatures.

The southern portion of the watershed once contained several large marshes surrounded by savanna and prairie. Avon-Fremont Drainage Ditch was created by excavating wetlands to drain the land for agricultural practices. Dams have been constructed to create existing lakes. Druce, Fourth, Gages, Grays, Miltmore, Sand, and Third are glacial lakes in the watershed, while Bittersweet, College Trail, Grandwood Park, and Willow are manmade. Much of the savanna and prairie communities are now developed as residential areas, except for Rollins Savanna and around Fourth Lake, where natural communities have been preserved and restored.

1939 aerials show the watershed as mainly agricultural, with Mill Creek winding more narrowly and sinuously throughout. The Avon-Fremont Drainage Ditch had been created to drain the large wetland complex in the south or headwater area of the watershed, although more wetlands remained in throughout the watershed 1939 than exist today. Drain tiles are evident throughout the watershed, but were especially prominent in the portion of the watershed served by the Avon-Fremont Drainage Ditch.

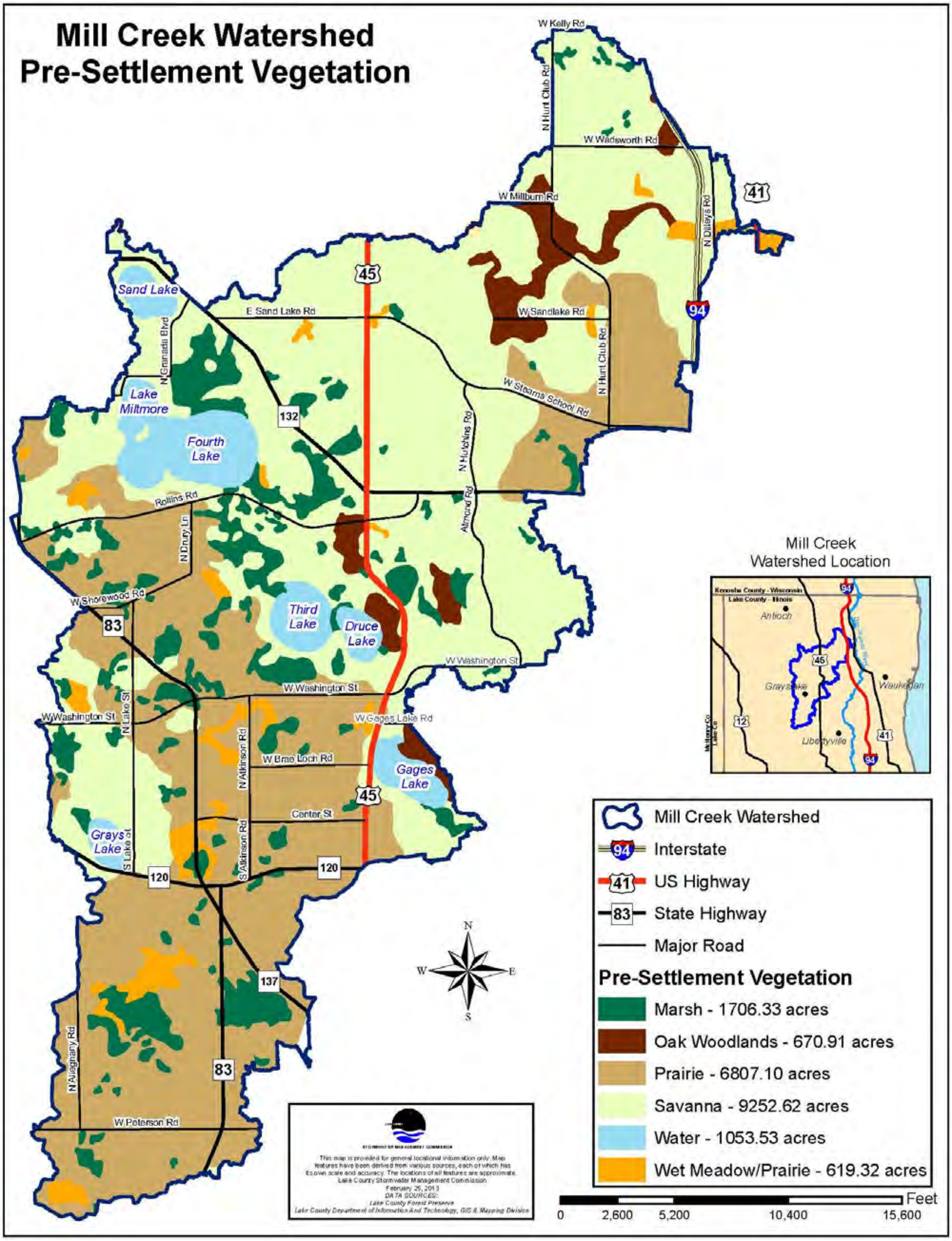


Figure 3-7: The map shows pre-settlement natural communities in the Mill Creek Watershed, including savanna, prairie, marsh, wet meadow/prairie, and oak woodlands.

3.6.2 EXISTING LAND USE

Land use and land cover in the Mill Creek Watershed was determined using a 2007 land use/cover layer developed by CMAP. To ensure land use and land cover represented the most recent watershed conditions, this CMAP layer was updated by interpreting 2012 aerial imagery. Adjustments were made if any discrepancies were observed between the imagery and the land use/cover layer. For example, where recent development has occurred or where errors were noted in land use/cover categories or boundaries. In addition, land use categories were simplified by grouping and re-naming similar land use codes and by extracting land cover designations from land use (i.e., cropland in a forest preserve was separated into row crops and open space conservation). **Table 3-8** includes Mill Creek land use/cover categories, including acreage and overall percentage, and **Figure 3-8** illustrates the land use in map format.

Residential and Open Space/Wetlands land use classes account for the greatest area of the watershed at 21% and 37%, respectively. Other substantial land uses include Agricultural at 18%. Row crops dominate the agricultural land use with 3,400 acres of the total 3,600 acres of agricultural land in row crops (corn 2,413 acres, soybeans 921 acres, wheat 114 acres) based on the U.S. Department of Agriculture (USDA) Agricultural Census 2011. Total open space, including all open land (agricultural, private/public open space wetlands, and water) comprises 12,482 acres or 63% of the watershed. This open space was indicated as valued by the stakeholders in the goal making process. Total developed land including residential, commercial/retail/mixed use, government/ institutional, industrial, office and research parks, transportation, and utilities accounts for 7,301 acres or 37% of the watershed.

Table 3-8: 2005 land use by category.

Land Use Class	Total Area (acres)	Percent of Watershed
Agricultural	3,639	18%
Residential	4,072	21%
Transportation	1,854	9%
Utility/Waste Facility	301	2%
Government/Institutional	389	2%
Industrial	184	1%
Office and Research Parks	69	0%
Retail/Commercial/Mixed Use	433	2%
Public/Private Open-Space/Wetlands	7,345	37%
Water	1,498	8%
Total	19,783	100%

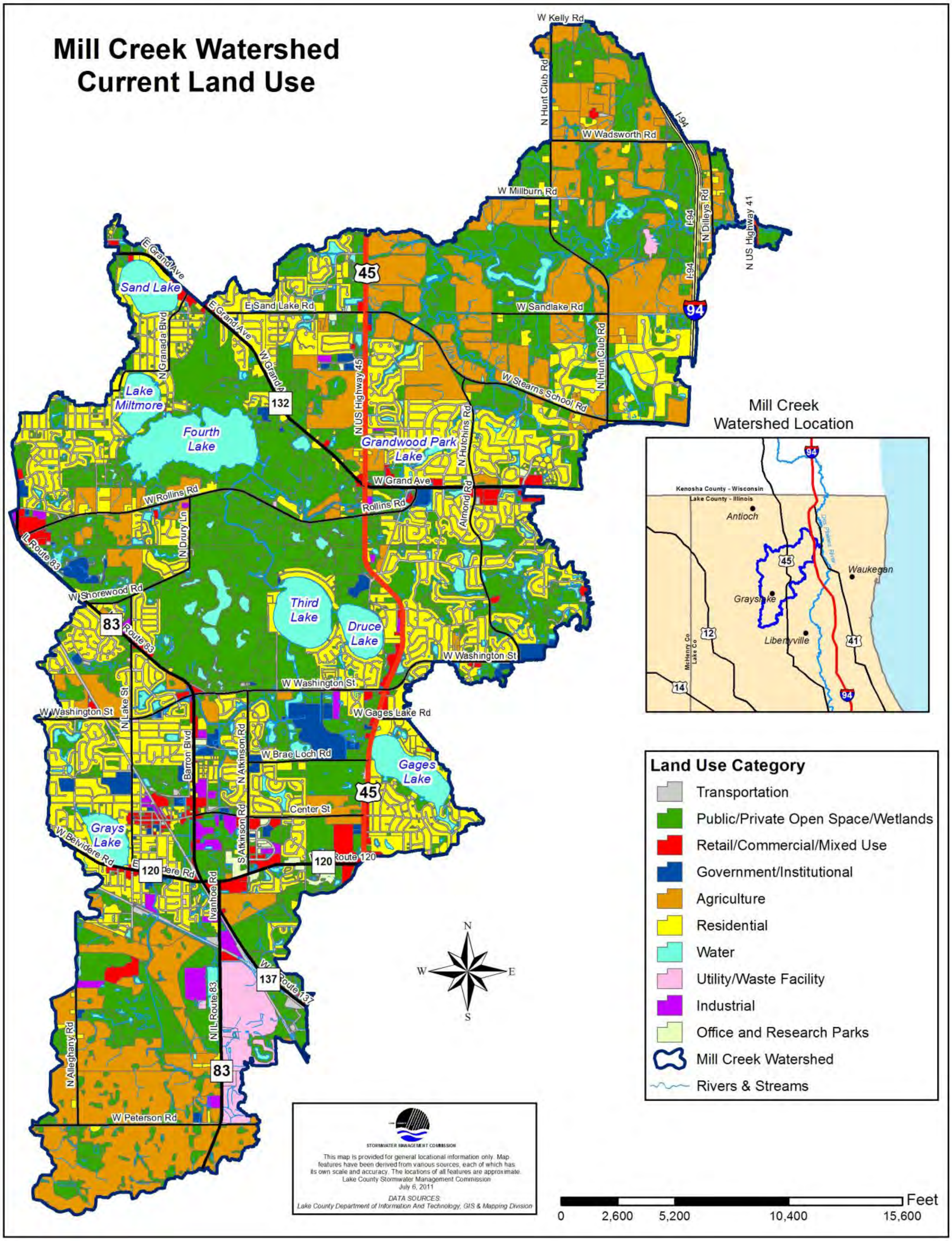


Figure 3-8: 2005 Land use in the watershed.

3.6.3 FUTURE LAND USE PROJECTIONS

Information on built-out future land use conditions within the watershed was obtained from the Lake County Planning, Building, and Development Department (LCPBD). The data was analyzed using a geographical information system (GIS). **Figure 3-9** shows future land use predicted on build-out conditions in the watershed.

The data indicates a substantial reduction in agricultural and open space/wetland land use classes, and substantial increases in residential, industrial, office and research and retail/commercial. With a total change of 5,941 acres (30%) from undeveloped land uses (agriculture, public open space and water) to developed land uses predicted.

Table 3-9: Area, percent, and change from current to future of land use by category.

Future Land Use Class	Area (acres)	Percent of Watershed	Percent Change Current to Future
Agricultural	939	5%	-288%
Residential	7,453	38%	45%
Transportation	2,056	10%	10%
Utility/Waste Facility	458	2%	34%
Government/Institutional	618	3%	37%
Industrial	922	5%	80%
Office and Research Parks	533	3%	87%
Retail/Commercial/Mixed Use	1,203	6%	64%
Public/Private Open Space/Wetlands	4,247	21%	-73%
Water	1,355	7%	-11%

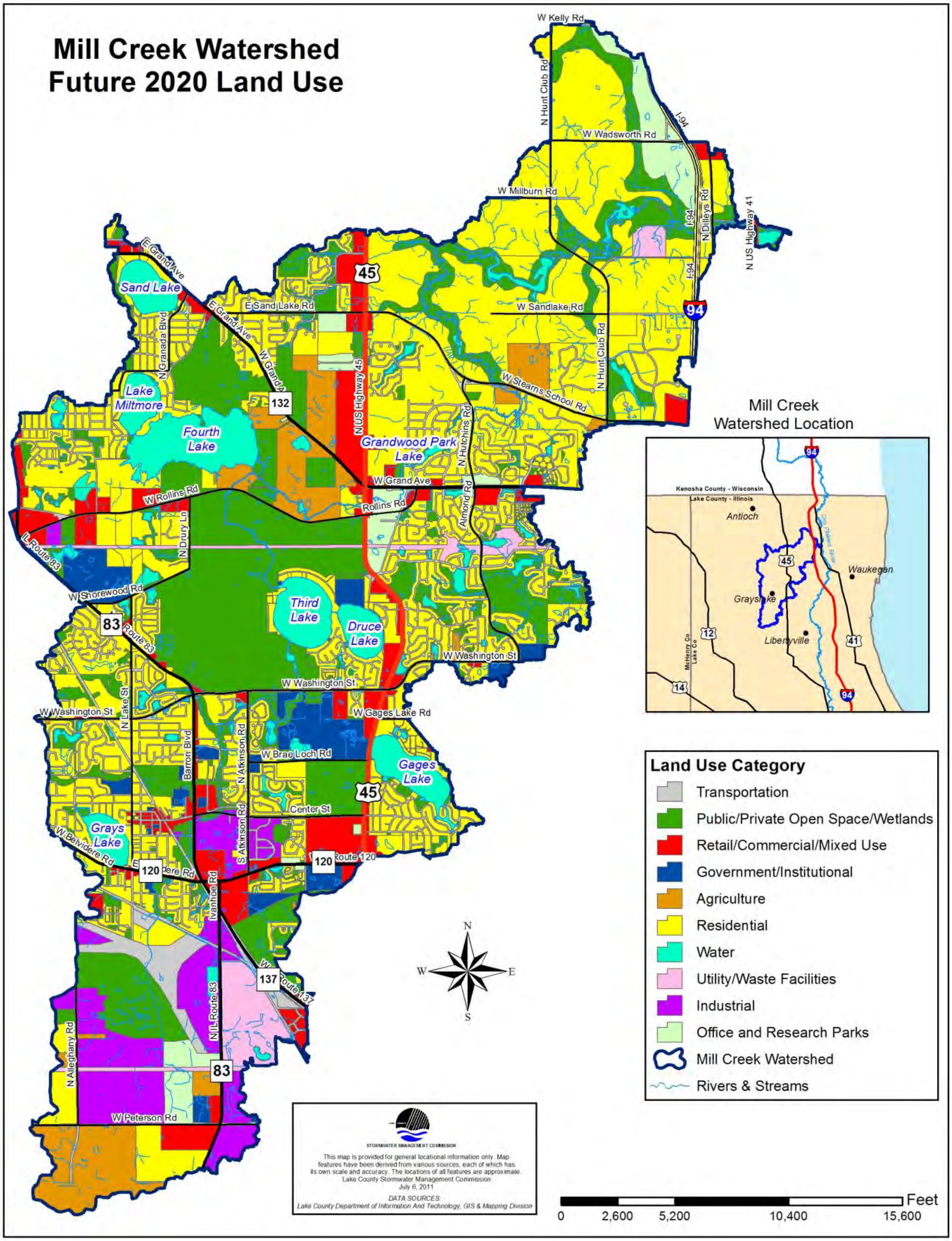


Figure 3-9: Future land use in the watershed.

Definitions for Each of the Watershed Land Use Types:

Transportation: Includes roadways and road right-of-ways, Interstates and tollways, bus facilities, air transportation centers, other non-residential or commercial parking lots.

Public/Private Open Space: Includes parks, golf courses, nature preserves, game preserves, abandoned right-of-ways, recreation trails (wider than 5ft), athletic fields when not associated with another land use, botanical gardens, forest preserves, set asides for stormwater management (wet and dry bottom detention basins), and wetlands that are larger than 0.25 acres. Also includes land that is currently under development but is less than 50% developed. Land that is past this threshold is coded under a specific land use.

Retail/Commercial/Mixed Use: Includes shopping malls and associated parking, single building offices, office parks, and a commercial mix, i.e. restaurants, auto repair shops, grocery stores, etc. Also includes zoos, museums, cultural centers, auto dealerships, and hotels/motels.

Government/Institutional: Includes military bases and associated living quarters, medical and healthcare facilities, educational facilities, government administration and services (fire, police, post offices, etc.), cemeteries, and prisons and correctional facilities.

Agricultural: Includes row crops, pasture, fallow lands, dairy and other livestock enterprises, equestrian lands, associated barns and out buildings, orchards, vineyards and nurseries.

Residential: Includes single and multiple family housing, townhomes, apartments, retirement communities, farmhouses (Larger than 1 acre), mobile homes, and income restricted housing, and associated parking. Excludes military bases and other group living quarters that are included under the Government/Institutional land use.

Water: Includes rivers, streams, canals (wider than 200ft), lakes, reservoirs, and lagoons.

Utilities, Waste Facilities: Includes utilities and waste water facilities, landfills, railroads and associated rail stations, also includes telephone poles and land associated with cell towers and other communications.

Industrial: Includes mineral extraction, manufacturing, warehousing/distribution centers, and industrial parks.

Office/Research Parks: Includes individual office buildings and office and research parks.

3.7 TRANSPORTATION

Transportation is identified as one of seven topic areas key to the County's sustainability in the draft Sustainability Chapter addendum to the Lake County Framework Plan. Private automobile transportation predominates in Lake County where County residents are driving more than the region's average resident. For example, the average County household drove almost 61 miles per day in 2007 compared to the approximate 48 miles per day of the average household in the region. In 2010, over 83% of County residents drove alone for their work commutes, compared with a regional average of 69.4%. County residents utilized transit for 3.8% of work trips, compared with an average of 4.4% across the region's collar counties. In addition, residents in Lake County spend, on average, about 21.7% of their income on transportation, while the regional average is 19.1%. Much of this increased travel time and cost is likely associated with County residents' accessibility to jobs in the region. Since Lake County has a somewhat limited ability to improve residents' access to regional jobs, reducing private vehicle use by providing a variety of viable

> ***"Lake County's transportation system is vital to its sustainability and continued economic prosperity****…While the County has many transportation assets, issues such as traffic congestion, pollution and emissions associated with the use of private automobiles and freight, and rising transportation costs pose potential obstacles to a sustainable and economically competitive future."*
>
> ***"Lake County has long recognized the importance of protecting its water resources.*** *Clean and plentiful water is a fundamental necessity for the health of Lake County residents and the natural environment."*
>
> Draft Lake County Sustainability Chapter, Regional Framework Plan Addendum December 13, 2013

transportation options is an even more critical component of a livable and sustainable County. Both the Illinois Department of Transportation (IDOT) and Lake County Division of Transportation (LCDOT) have been supporting the concept of multi-modal transportation in recent years. The LCDOT adopted a 'Non-Motorized Travel Policy' in 2010. The Policy "to provide appropriate accommodation for vehicles, pedestrians, bicyclists, transit users, and persons of all abilities" embodies a sustainable approach to transportation known as "complete streets", which focuses on the needs of all users – pedestrians, bicyclists, transit users, and automobile drivers – in designing transportation facilities *(Draft Sustainability Chapter Lake County Framework Plan Addendum,* December 2013*).*

Noteworthy: Streets and Non-Point Source Pollution

According to a Chesapeake Bay Commission study, residential, commercial and industrial streets were found to be the main contributor of non-point source pollution in an urban setting. "Not only did streets produce some of the highest concentrations of phosphorus and suspended solids, bacteria and several metals, but they also generated a disproportionate amount of the total runoff volume. Consequently, streets typically contributed four to eight times the pollutant load than would have been expected if all source areas contributed equally." (Chesapeake Bay Commission, 2003)

A number of factors contribute to high pollutant loading from streets. Streets are directly connected to the drainage system resulting in a high runoff coefficient. In addition, street curb and gutter systems tend to trap and retain fine particles that blow into them and are then flushed off by stormwater into pipes that empty to streams, rivers and lakes during a rain event or in snow melt.

3.7.1 TRANSPORTATION AND WATERSHED PLANNING

Transportation corridors in the Mill Creek Watershed connect residents within and to points outside of the watershed. "Car habitat", the combined area of roads, parking lots, driveways and garages, is significant in the watershed. Parking lots and roads are the largest components of car habitat. Combined they cover 1,342 acres of land in the watershed and can have a significant influence on stormwater runoff and water quality.

Studies have shown that streets are a major source of non-point source pollution in urban settings. A number of factors contribute to high pollutant loading from streets. Streets are typically connected to the drainage system and tend to be the collector of runoff and pollution from sidewalks, driveways, lawns and rooftops as well as from emissions and leaks from vehicles, atmospheric deposition and winter road maintenance practices. How transportation facilities and corridors are designed, constructed and maintained can play a significant role in determining whether the influence of transportation is positive or negative as it relates to watershed health and the wellbeing of watershed residents.

3.7.2 EXISTING TRANSPORTATION INFRASTRUCTURE NETWORK

The 31 square mile Mill Creek Watershed includes 227 miles of roads, 44 miles of trails and 10 miles of commuter rail lines that make up the existing network of transportation corridors in the watershed. Although not analyzed in detail in this section, other important components of the transportation network include the public bus transit system, parking lots, rail stations, and the public works and transportation maintenance yards that support the roads, trails and railroads in the watershed.

3.7.2.1 Railroads

The Metra commuter rail company operates on two rail lines transporting commuters on a general northwesterly route from the suburbs to the Chicago Loop and to numerous points in between. The North Central line has a stop that provides access to O'Hare Airport. The Metra Milwaukee District North rail line crosses the southern portion of the watershed to connect Chicago Union Station to the Village of Fox Lake. The Metra North Central Service rail line (extends northwestward through the watershed) connects Olgivie Station in Chicago to the Village of Antioch. Both the North Central and Milwaukee North rail lines that transect the watershed have experienced a slow but steady increase in ridership. In 2011 the North Central Line had a 6.1% increase in ridership while the Milwaukee North District line had a 1.8% increase in ridership. Metra has plans to expand rail service with double tracking improvements on both lines.

There are four Metra stations located in the watershed in the Villages of Libertyville and Grayslake. In addition, a fifth station resides on the watershed boundary in the Village of Round Lake Beach. See **Figure 3-10** for the location of the rail lines and stations and **Table 3-10** for the characterization of the Metra Stations.

Table 3-10: Characteristics of Metra Stations in the Watershed.

Metra Line	Station	Parking Capacity	Parking Utilization	Boarding 2006	% Change from 2002
Milwaukee Dist. North	Prairie Crossing	647	42%	344	n/a
Milwaukee Dist. North	Grayslake	670	54%	772	-12.8%
North Central Service	Prairie Crossing	647	42%	117	35%
North Central Service	Washington St. (Grayslake)	149	58%	109	n/a

*Data: Pg. 29 Draft Sustainability Chapter Lake County Framework Plan Addendum

3.7.2.2 Trails

There are currently 566 miles of mapped trails that include almost 500 miles of bicycle facilities in Lake County. Trails are in various forms ranging from mowed footpaths to divided concrete or asphalt construction, and are designed for single or multiple purpose users. Several jurisdictions develop and manage trails in the watershed including the Lake County Forest Preserve District (Forest Preserves), Park Districts, Municipalities (Village), Homeowner Associations (HOA), Township (very limited) and LCDOT. Several villages support trail systems along and across roadways within their jurisdiction. Park districts also provide and maintain a trail network to connect people to parks and other community centers. The Forest Preserves provides many miles of trails within and connecting forest preserves including the regional Millennium Trail and Greenway, which spans the watershed. HOAs provide neighborhood trails connecting to community trail systems, within the subdivision, and to neighborhood parks. Lastly, there are short segments of connector trails constructed and maintained by the LCDOT and Townships that are part of a large trunk system for bicyclists. See **Figure 3-10** for locating trails.

Forest Preserves:

Millennium Trail and Greenway: The watershed includes a large segment of the 35-mile Millennium Trail, which is a regional trail under development. The Millennium Trail when completed will connect central, western and northern Lake County communities and forest preserves. Approximately 21.5 miles of the overall 35 mile trail length is completed. A 3-mile segment of the Millennium Trail in the Mill Creek Watershed is largely complete and connects Rollins Savanna, Fourth Lake and McDonalds Woods Forest Preserves. A tunnel under Rollins Road is being constructed in 2014 that will complete the connection of Rollins Savanna to Fourth Lake Forest Preserve.

Rollins Savanna Trail: A 5.5-mile trail with bridges and boardwalks encircles the site. This multi-use trail is open for hiking, bicycling, cross-country skiing and nature and wildlife observation. Snowmobiles can parallel a small section of the trail as they pass through the preserve.

Fourth Lake Trail: Work is complete on the new Grand Avenue underpass, and a new 1.5-mile section of trail, stretching from just north of Rollins Road to the north side of Grand Avenue, is now open. Improvements also include boardwalks, overlooks and a 0.5-mile grass loop trail.

McDonald Woods: McDonald Woods is a perfect place to hike, bicycle and cross-country ski. A 3.5-mile trail includes several loops with an additional 0.9-mile wood-chip trail designed for hiking and cross-country skiing.

Community and Park District Trails:

Gurnee/Gurnee Park District has eight trail miles in the watershed. Grayslake/Grayslake Park District has 26 miles and Lindenhurst Park District has three trail miles in the watershed.

Planned Trail Improvements

LCDOT has an expanding bikeway and off-road trail network in Lake County. While no LCDOT trails are currently located in the Mill Creek Watershed, several trails are proposed by LCDOT for the watershed in the draft Lake County 2040 Transportation Plan. Proposed projects provide non-motorized connections to Metra stations, bus routes, communities, jobs, parks, schools, forest preserves, and other destinations.

LCDOT Plans:

1) Washington Street Bike Path: A 2-mile bike path is planned along south side of Washington St. from Atkinson Road east to Almond Road.
2) Hunt Club Bike Path: A bikeway/trail is planned for the length of Hunt Club Road from Washington Street to the Wisconsin state line. A 3-mile length of this trail between Stearn's School and Wadsworth Roads will be located in the Mill Creek Watershed.
3) Peterson Road Bike Path: The southern end of the watershed includes a 2-mile portion of a planned bike path along the recently expanded Peterson Road that will connect to planned trails along Fremont Center Road and Alleghany Roads.

Planned Trails by Other Jurisdictions:

In addition to the LCDOT trails, several trails and key trail connections are also planned to be constructed by other jurisdictions. Most notably, are proposed trails along Alleghany Road in Grayslake, Grand Avenue in Lindenhurst, and Wadsworth Road in Wadsworth.

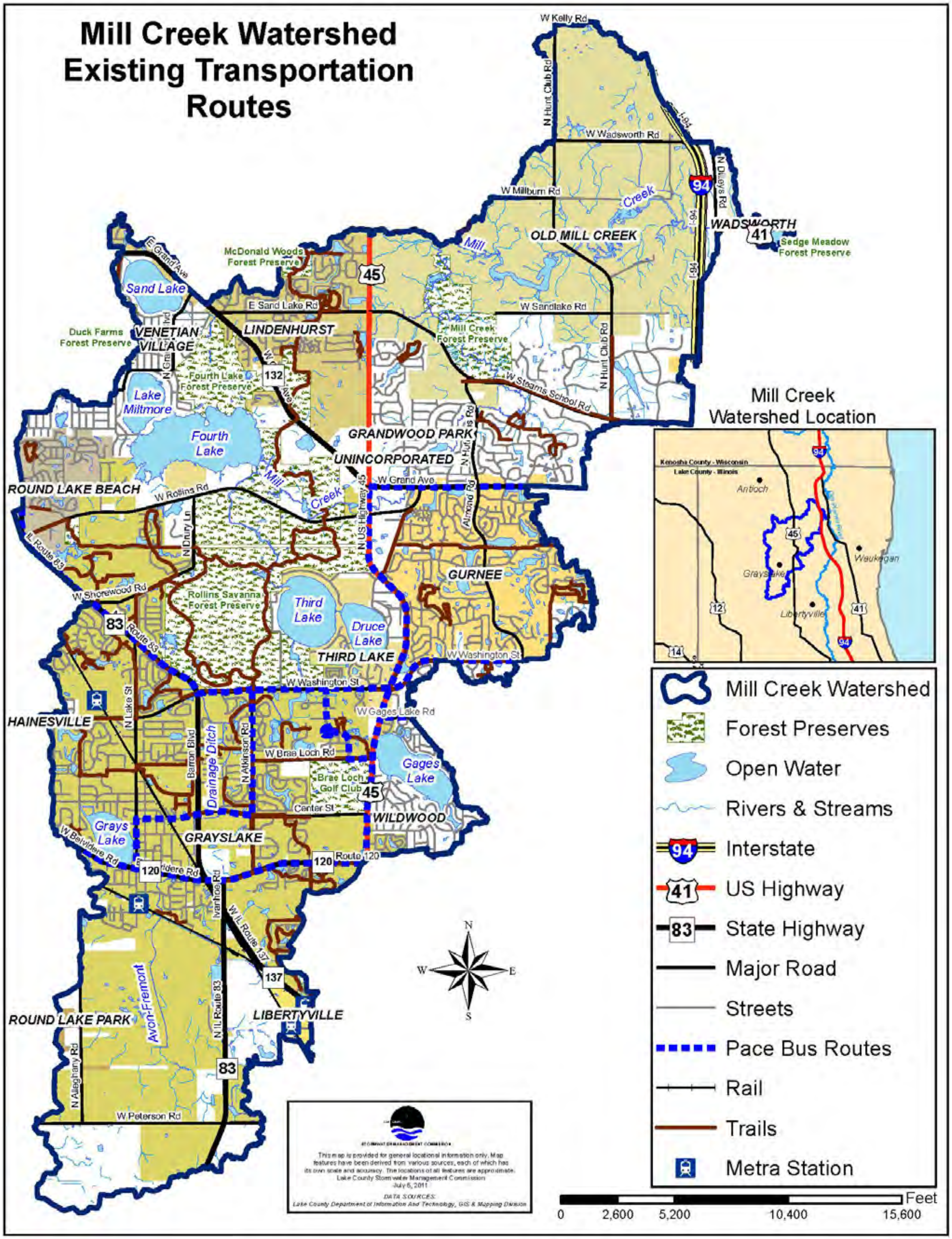


Figure 3-10: Existing Transportation Routes.

Connecting Low to Moderate Income Areas with Trails

According to the Lake County Draft Sustainability Plan, "Access to non-motorized transportation options, such as bicycling and walking, is a key feature of sustainable communities" (Draft Sustainability Chapter, page 34). Alternative transportation modes are particularly important for low to moderate income neighborhoods. The Mill Creek Watershed has three areas that are classified as low to moderate income based on 2000 census data. One of these areas is a neighborhood on the unincorporated north side of Gages Lake. A second area surrounds Grays Lake including older neighborhoods and extends south through the "Central Range Economic Development Initiative" area of the Village of Grayslake, which is proposed for future office, retail and light industrial development. A third very small area is located in the Village of Lindenhurst on the northwest boundary of the watershed. See **Figure 3-11** for the general locations of these low-moderate income areas with the current and proposed trails map. Neither the Grays Lake nor Gages Lake North neighborhood low to moderate income areas are presently connected to the community by trails.

Gages Lake North Neighborhood: Considering planned trail extensions in the watershed, it appears that a trail connection is not currently in the plans for the Gages Lake North neighborhood. A trail connection across US 45 to the College of Lake County and the Village of Grayslake trail system would probably be the best connection point for the Gages Lake neighborhood, but a safe crossing of US 45 will be needed to make this connection.

The Grayslake low-moderate income areas can be divided into two geographic areas from a trail service standpoint. The residential neighborhoods surrounding Grays Lake and on the north and south side of IL 120 may be considered as one service area, while the 900 acre Central Range Economic Development Initiative area located between Peterson, Alleghany Roads and IL 83 would be the second service area.

Grays Lake Neighborhoods: There is presently one short segment bike trail located in the Grays Lake neighborhood at West Trail Park. Although there are sidewalks along many of the streets, none of the other Grays Lake low to moderate income area neighborhoods have trail service to connect them to the surrounding neighborhoods or other parts of the community for biking in particular.

Central Range: The Route 53/120 corridor is proposed to intersect in the Central Range area. The Village has recommended a Route 53/120 design that connects the community along and across the road corridor (*Grayslake's Vision for a Low Profile Route 53/120*, March 2012). Trails are also planned for Alleghany and Peterson Roads within the 2040 timeframe, and trail extensions are proposed for the Central Range area as it is developed. Therefore, it appears that the Central Range area will have trail service in the future as it is developed and roadway transportation is improved.

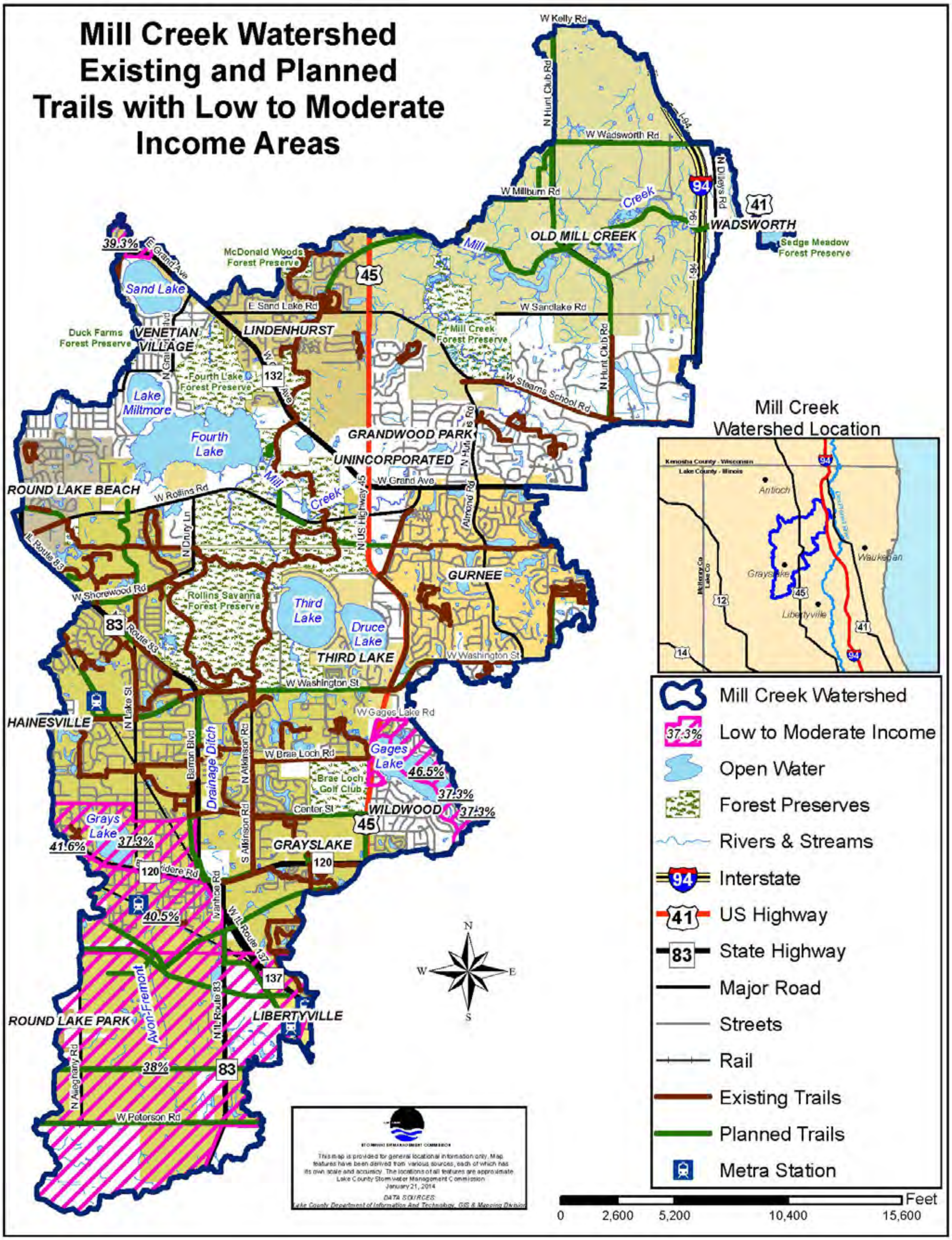


Figure 3-11: Trail Connections and Low to Moderate Income Areas

3.7.2.3 Roadways

Currently there are over 2,700 miles of roadways managed by the various jurisdictions in Lake County. The Lake County roadway network ranges from local roads, township roads, county roads, state highways, federal highways, and interstates. The roadways are maintained under a variety of jurisdictions. In Lake County and the Mill Creek Watershed, roads and roadway planning are the responsibility of one of five entities: Illinois Department of Transportation (IDOT), Illinois Tollway (Tollway), LCDOT, a township highway commissioner (Township), or a municipal public works department (Village). IDOT oversees 330 miles of state highways in Lake County, while LCDOT manages the County highway system, which is comprised of about 300 miles of arterial and collector roads. There are also over 430 miles of township roads and streets. While the State, County, and townships play a critical role in Lake County's road infrastructure, almost 60% of Lake County road mileage is constructed, maintained, and managed by its municipalities.

Roads in the watershed range from fairly narrow residential streets in areas such as the neighborhoods on the north side of Gages Lake to four lane major arterials and highways. IL 83 and US 45 are the major north-south routes through the watershed, while IL 120 and 132 are major east-west routes.

Within the watershed, State Roads: US 45, IL 83, IL 137, IL 132 make up the major arterials totaling 19 miles. LCDOT constructs and maintains 26 miles of minor arterial and collector roads in the watershed including portions of Winchester and Peterson Roads, Center Street, Washington Street, Granada Avenue, and Rollins, Stearns School, Sand Lake, Hunt Club and Wadsworth Roads totaling.

Portions of Avon, Fremont, Lake Villa, Newport, and Warren Townships are all located within the watershed. The townships collectively operate and maintain 52 miles of roadway in the watershed. Warren Township includes unincorporated Grandwood Park and Wildwood and has the largest area of township maintained roads. Ten municipalities are partially or largely located in the watershed. They operate and maintain a combined 124 miles of streets/roads in the watershed area. Three villages, Grayslake, Gurnee and Lindenhurst, have most of the village roads in the watershed, with Grayslake at 30% of the watershed area managing the most municipally owned road miles.

Planned Road Improvements

Information about planned roadway improvements in the watershed was gathered through local, regional and state transportation contacts and from available road planning reports. While the "future conditions" data gathering and research may not be exhaustive, especially as it relates to local streets that may be built to serve new commercial or residential developments in the watershed, the major county, regional and state roadway projects that are being planned for the watershed are described in this section and shown in **Figure 3-14**.

Illinois Department of Transportation Projects:

1) IL 83/IL137 Road Improvements:

IDOT is studying potential improvements to approximately 11 miles of Illinois 83 (Milwaukee Avenue/Barron Boulevard) and Illinois 137 (Buckley Road) in Lake County as shown in **Figure 3-12**. IL 83/IL 137 serves as a main north-south corridor servicing both local and regional traffic carrying traffic volumes of 15,000 to 23,000 vehicles per day. By 2040, the average daily traffic volumes

Figure 3-12: IL83/137 study area

along this route are projected to increase to 16,000 to 30,000 vehicles per day. A 5-mile segment of IL 83/IL 137 in the IDOT study area is within the Mill Creek Watershed located in the communities of Round Lake Beach, Grayslake and Libertyville.

IDOT is in the Phase I (preliminary engineering and environmental studies phase) of a three-phase study and construction process. Funding for preliminary engineering and environmental studies (Phase I) has been identified in the Department's Fiscal 2012- 2017 Proposed Highway Improvement Program. During Phase 1, IDOT studies a broad range of alternatives, including a "no build" option, to improve IL 83/IL 137 in the study area. IDOT also conducts an environmental analysis. The IDOT project team will collect information, analyze the alternatives and identify potential effects to study area resources.

IDOT is applying the Context Sensitive Solutions (CSS) process to the IL 83/IL 137 study. CSS is an interdisciplinary approach working with stakeholders to develop, build and maintain cost-effective transportation facilities that fit into a project's surroundings (its "context"). CSS stakeholder activities include meetings with the Community Advisory Group (CAG), special interest groups, and the public, which includes a public hearing. All input is evaluated and used to help shape viable solutions. The CSS process addresses various potential effects including those to:

- local businesses and industries
- schools and educational facilities
- historic properties
- cemeteries
- residential areas (relocation/right of way encroachment)
- agricultural land
- green space (preservation/protection interests)
- traffic and congestion
- water resources, including lakes, rivers and wetlands
- natural resources, including threatened and endangered species

Photo 3-1: IL 83/IL 137 Road Improvement Study Areas

2) Grand Avenue/IL 132 Deerpath Road to Munn Road:

IDOT recently received Design approval for their Phase 1 study for road widening improvements of IL 132/Grand Avenue in the Village of Lindenhurst. Road improvements will extend approximately 1 mile from Deerpath Road to Munn Road. The project is funded in the middle portion of IDOT's 2014 to 2019 Program pending plan readiness, right of way, funding, etc.

3) US 45 south of Milburn Bypass to IL 132/Grand Avenue:

Widening of approximately 3 miles of US 45 south of the Milburn Bypass to IL 132/Grand Avenue is under Phase I study. However, development of the plans, specifications and estimate (PS&E) and Construction is currently not Programmed.

4) US 45 from Washington Street – North of IL 132/Grand Avenue:

IDOT received Design Approval for widening approximately 2 miles of US 45 from Washington Street to north of IL 132/Grand Ave on C10/31/96. Development of the PS&E is underway. Construction for this project is currently not programmed. IDOT is targeting this project be let at the earliest after the Lake County project on Rollins Road at IL 83 is completed.

5) US 45 at IL 132/Grand Avenue and at Rollins Road:

IDOT received Design Approval on C10/31/96. Development of the PS&E is underway. Construction is currently not programmed for this improvement. IDOT is targeting this project be let at the earliest after the Lake County project on Rollins Road at IL 83 is completed.

6) IL 132/Grand Avenue Mill Creek Crossing:

IDOT will also be replacing the structure on IL 132/Grand Avenue over Mill Creek which is just east of US 45. It is not included in the above two projects, but is a standalone project to address the structure. This is a Phase I project to start soon. PS&E and Construction is currently not Programmed for this stream crossing structure replacement.

Illinois Tollway Project: IL Route 53/120:

New road construction to extend approximately 12.5 miles of Route 53 through central Lake County to connect with an approximate 12 miles of an improved Route 120 is being studied as shown in **Figure 3-13**. This would result in approximately 5 miles of new roadway in the watershed. While an Illinois Route 53 northern extension has been considered since the 1960s, it was not acceptable to various interests. The Illinois Tollway established the Illinois Route 53/120 Blue Ribbon Advisory Council (BRAC) in 2011 to develop regional consensus on whether the Tollway should move forward with the project. The BRAC outlined its findings in a June 7, 2012 Resolution and Summary Report, concluding that there is consensus for the Tollway to move forward with the project. The BRAC report provided the scope, configuration and design elements of the new roadway and identified potential methods for financing the project.

Figure 3-13: Potential Route 53/120 alignment

The BRAC defined a set of guiding principles to ensure that outcomes are clearly defined and the project fulfills its goals. The most important of these principles is to use innovative and environmentally beneficial design solutions to strike a balance between improving mobility and access while minimizing negative environmental and long-term developmental impacts.

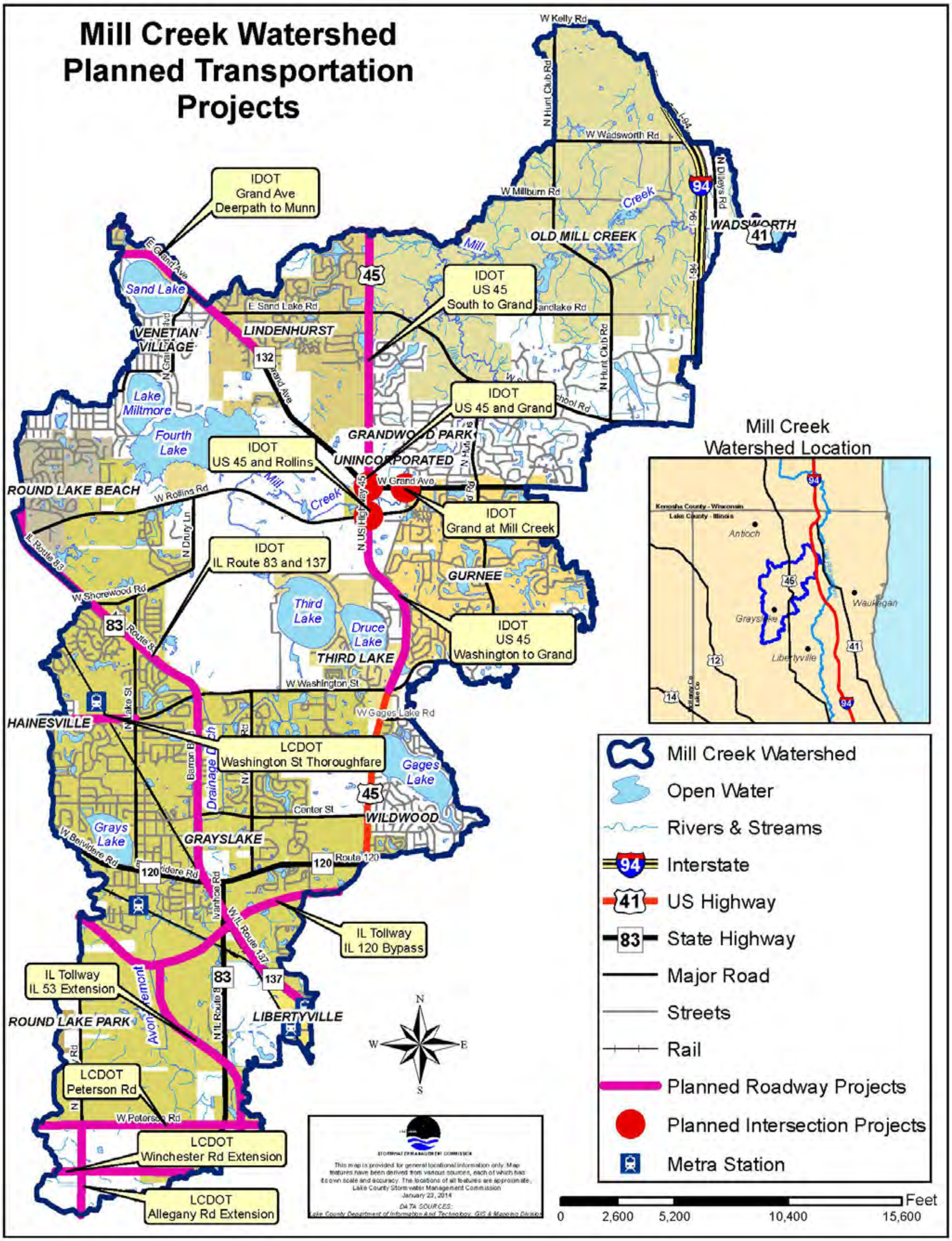


Figure 3-14: Planned Roadway Expansion/ Improvements.

The Illinois Route 53/120 Project is proposed to be a modern boulevard with a small footprint to protect the natural environment and preserve the character of Lake County.

The current proposal includes the following improvements:

Extension of Illinois Route 53 – four lanes at 45 mph
- From Lake Cook Road to just south of Illinois Route 120

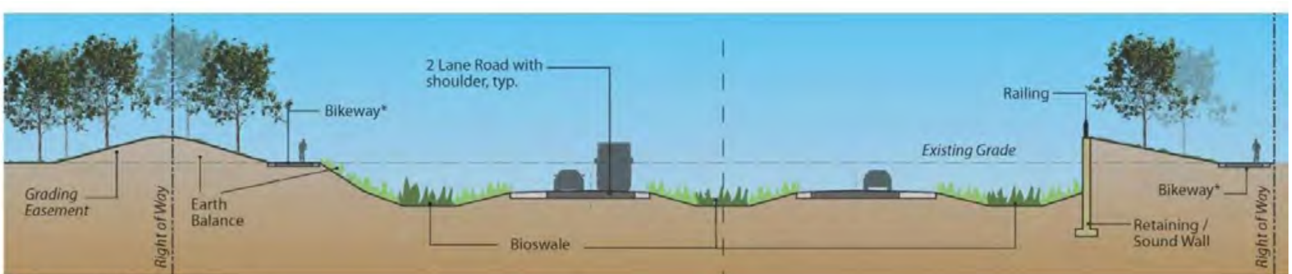
Upgrade of existing Illinois Route 120 (west end) – four lanes
- From U.S. Route 12 to west terminus of Illinois Route 120 Bypass

Illinois Route 120 Bypass – four lanes at 45 mph
- From east of Wilson Road to east of U.S. Route 45

Upgrade of existing Illinois Route 120 (east end) – four lanes
- From east terminus of Illinois Route 120 Bypass to the Tri-State Tollway (I-94)

Most of the proposed IL 53/120 roadway in the Mill Creek Watershed is located in the Village of Grayslake, and the Village has provided extensive recommendations to the BRAC including to:

- Preserve north/south bike path connection routes including Harris Road, Route 45, Route 83, Lake Street and Alleghany Road
- Use underpasses/pedestrian bridges to preserve corridors
- Provide access to wetland restoration area/overlook area
- Use Grayslake landscaping mix to include native landscaping on berms/detention basins
- Minimize impact on wetlands including those east of Route 45 and the Central Range wetland restoration area
- Use best management practices (BMP’s) in the final design
- Use recommended cross section as shown in **Figure 3-15**



* at recommended future bikeway locations

Roadway Cross Section

A low roadway profile is desired where practical along the corridor. A low profile offers the visual and acoustical benefits over an at-grade or above grade roadway and does not disrupt the connectivity of the local street system. Extensive use of natural landscaping and bio-swales is desired to maintain the character of the surrounding environment.

Figure 3-15: Potential roadway cross section for IL 53/120 proposed by the Village of Grayslake.

Noteworthy: Grayslake's Vision for a Low Profile Route 53/120

The Village's Route 53/120 design parameters fall under six broad categories:

1) Low Impact Design to Reduce Adverse Impacts - The Village seeks to minimize the area utilized for this project by constructing the roadway with a minimal footprint, and to protect wetlands and natural areas using design, construction and maintenance Best Management Practices (BMPs). Much of the Route 53/120 corridor is in or adjacent to environmentally sensitive wetlands and portions of the proposed Route 53/120 Interchange are within the 50-year or 100-year floodplain. The design of this corridor must protect these lands. The use of BMPs will greatly improve the quality of the rainwater discharged into the local streams. BMPs include:
    - Low Road Profile
    - Storm water cleansing through the use of bio-swales in the median and roadside
    - Operations (reduced salt usage)
2) Aesthetics - The landscape design goals include:
    - Using native materials where possible to increase sustainability and reduce maintenance
    - Enhance views through framing and buffering that emphasize Grayslake's unique natural environment; recognize visual and clear zone restrictions
    - Provide visual interest that blends with the natural design theme of the corridor
3) Community Connectivity – Vehicles: The Village must stay connected to and across the proposed Route 53/120 corridor. The corridor cannot be a barrier to the community; rather it must allow connectivity with cross corridor connections for the local collector and arterial street system including connections at Alleghany Road, Peterson Road, and U.S. Route 45 serving the west, south, and east sides of the Village.
4) Community Connectivity – Bicycles: The Route 53/120 project must maintain connections between Village's existing comprehensive trail network, provide connections to Alleghany Park, the Central Range Economic District, and existing local and regional path systems.
5) Mass Transit – The Village envisions a road corridor design that allows direct access from four existing Metra stations to places of employment.
6) Best Management Practices (BMPs) and Environmental Design Standards - Proposed BMPs include:
    - *Best Management Practices for Design* - The Illinois – Livable and Sustainable Transportation Rating System and Guide (I-LAST) includes a comprehensive list of practices that can bring sustainable results to highway projects. The full use of the I-LAST Guide book should be implemented for the Route 53/120 project, and set the bar for I-LAST scoring.
    - *Best Management Practices for Storm Water Control* - Bioswales are used to cleanse storm water before an outfall, permeable pavements are used to permit natural infiltration, and rainwater harvesting is used to capture and store storm water and to be later used for irrigation. The Route 53/120 project should make extensive use of storm water BMPs to maintain high water quality throughout Central Lake County.
    - *Best Management Practices for Construction and Maintenance* – BMPs should be developed for construction activities as well as operation and maintenance of the roadway once constructed.
    - *Awards* - While the purpose of building Route 53/120 has little to do with winning awards, meeting the criteria required to qualify for these awards represents a high level of accomplishment. Qualifying for awards would symbolize that the "best" practices in the industry were utilized as part of this project.

From: Grayslake's Vision for a Low Profile Route 53/120, March 2012

LCDOT Road Improvement Projects

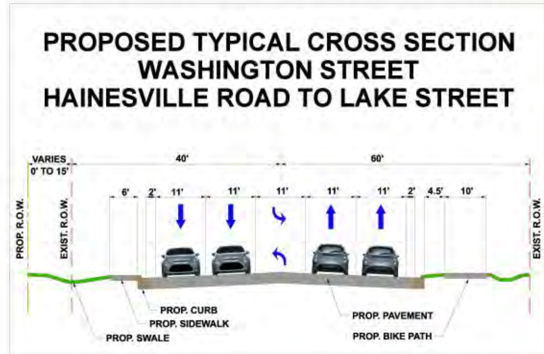


Figure 3-16: Washington Street Thoroughfare.

1) Washington Street Thoroughfare (west of N Lake Street):
LCDOT is planning to begin construction of the Washington Street improvement from Hainesville Road (west of the watershed) to Lake Street in Grayslake. The planned road widening extends 1.2 miles with construction beginning in late 2014 and extending into 2016. The existing roadway is mostly a rural cross-section with open ditch drainage. The improvement will include the widening of Washington Street in the project area to 5 lanes and is planned to address capacity, safety, and continuity issues due to changes in population in this area, as shown in **Figure 3-16**. A roadway underpass at the Canadian National rail line Metra crossing will eliminate vehicle backup. The portion of the project area in the Mill Creek Watershed is predominantly in the Village of Grayslake and includes the rail line underpass.

Washington Street is an east-west minor arterial that provides regional mobility for residents in Lake County. This roadway improvement is important because Washington Street is an integral component in the overall regional transportation system. Existing average daily traffic (ADT) volumes along Washington Street within the project limits range from 14,200 to 16,300 vehicles per day (VPD), and projected 2030 ADT volumes are estimated to be 17,000 VPD throughout the project limits. Based on the ADT and the intersection capacities, additional travel lanes are considered appropriate.

2) Peterson Road Widening:
At the southern end of the watershed, LCDOT has construction plans to expand Peterson Road from Route 45 to Route 83 from 2 to 5 lanes in 2013-2014. A bike path is also planned in this location.

3) Extension of Winchester and Allegany Roads:
The draft Lake County 2040 transportation Plan includes a Winchester Road route extension westward from Route 83 to Route 60. This extension will intersect with a planned southward extension of Alleghany Road from Peterson Road to Route 60.

Potential Impacts of Roadway Expansion Projects on the Watershed

As described earlier in this section, “car habitat” makes up a significant area of impervious cover in the watershed. As impervious surfaces such as roadways and parking lots increase, more water flows off and is delivered faster to receiving waters. The increased activity on these impervious surfaces means that more polluting material is available and likely to be flushed in stormwater runoff. Minimizing the mobilization of this material from streets and highways where pollutants tend to accumulate and collect is the goal of good roadway runoff management. **Table 3-11** includes a list of the types of constituents in highway runoff that are sources of pollution.

Table 3-11: Highway runoff constituents and their primary sources.

Constituents	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer application
Lead	Leaded gasoline (auto exhaust), tie wear (lead oxide filler material, lubricating oil and grease, bearing wear)
Zinc	Tire wear (filler material), motor oil (stabilizing additive), grease
Iron	Auto body rust, steel highway structures (guard rails etc.), moving engine parts
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides and insecticides
Cadmium	Tire wear (filler material), insecticide application
Chromium	Metal plating, moving engine parts, brake lining wear
Nickel	Diesel fuel and gasoline (exhaust), lubricating oil, metal plating, bushing wear, brake lining wear, asphalt paving
Manganese	Moving engine parts
Cyanide	Anti-cake compound (ferric ferrocyanide, sodium ferrocyanide, yellow prussiate of soda) used to keep deicing salt granular
Sodium, Calcium, Chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks or blow-by motor lubricants, antifreeze and hydraulic fluids, asphalt surface leachate
Polychlorinated Biphenyl (PCB)	Spraying of highway rights-of-way, background atmospheric deposition, PCB catalyst in synthetic tires

Source: USDOT, FHWA, Report No. FHWA/RD-84/057-060, June, 1987; USEPA 1993.

Based on the proposed transportation improvements described earlier in this section, it is estimated that an additional 21 miles of roadway will be developed in the Mill Creek Watershed, as detailed in **Table 3-12**.

Table 3-12: Planned major roadway expansion projects.

Project	Estimated Miles	Added Lanes	Estimated Area* (Ac)
IDOT: IL 83/137	5	2	21.2
IDOT: Grand Avenue/IL 132 Deerpath Road to Munn Rd.	2	2	8.5
IDOT: US 45 south of Milburn Bypass to IL 132/Grand Avenue	2	2	8.5
IDOT: US 45 from Washington St. to North of IL 132/Grand Ave.	2	2	8.5
IDOT: US 45 at IL 132/Grand Avenue and at Rollins Road			
IDOT: IL 132/Grand Avenue Mill Creek Crossing			
IL Tollway: IL 120/ Route 53	5	4	40
LCDOT: Washington Street Thoroughfare	1	2	4.2
LCDOT: Peterson Road	2	2	5.3
LCDOT: Extension of Winchester and Allegany Roads	2	2	5.3
Total	21		101.5

*Estimate based on the addition of 35 feet of impervious surface when expanding a roadway with 2 added driving lanes (2 lanes plus a turn lane and curb and gutter). IL 53/120 estimate based on 12’ lanes and 9’ shoulder width.

Noteworthy: The Illinois – Livable and Sustainable Transportation Rating System and Guide (I-LAST)

I-LAST is a metric system developed by the Joint Sustainability Group of IDOT, the American Council of Engineering Companies–Illinois (ACEC-Illinois) and the Illinois Road and Transportation Builders Association (IRTBA) to assess the sustainability performance of highway projects and address the associated effects highways have on the surrounding environment. I-LAST was designed to incorporate a broader range of issues into the development of state highway projects.

The Purpose of the I-LAST guide is to:

- Provide a comprehensive list of practices that have the potential to bring sustainable results to highway projects.
- Establish a simple and efficient method of evaluating transportation projects with respect to livability, sustainability, and effect on the natural environment.
- Record and recognize the use of sustainable practices in the transportation industry.

I-LAST goals to provide sustainable features in the design and construction of highway projects are:

- Minimize impacts to environmental resources
- Minimize consumption of material resources
- Minimize energy consumption
- Preserve or enhance the historic, scenic and aesthetic context of a highway project
- Integrate highway projects into the community in a way that helps to preserve and enhance community life
- Encourage community involvement in the transportation planning process
- Encourage integration of non-motorized means of transportation into a highway project
- Find a balance between what is important:
  - to the transportation function of the facility
  - to the community
  - to the natural environment
  - and is economically sound
- Encourage the use of new and innovative approaches in achieving these goals.

I-LAST includes a point system for evaluating the sustainable measures included in a project. The evaluation includes environmental and water quality metrics in addition to others and it consists of two steps:

1. At the beginning of the project, the project team can determine which elements are applicable to the project. Applicable items can be noted and considered in the development of the project.
2. At the end of the project, the team can determine which of the applicable items were included in the project plans. This evaluation can then be included in the project's file.

Note: I-LAST is purely advisory in nature, while it is intended to ascertain and document sustainable practices proposed for inclusion on state highway projects, use of I-LAST is purely voluntary on the part of the jurisdictional agency for which a project is being developed and completed.

From: *I-LAST™ Illinois - Livable and Sustainable Transportation Rating System and Guide,* 2009

The design of right-of-ways has a significant impact on the liveability of Lake County communities as well as the health, safety and welfare of residents. Roadway improvement projects are intended to benefit watershed and county residents and the local economy by providing better transportation access. While these are necessary goals, the fact that these projects also have the potential to have significant negative impacts on water quality and aquatic resources if not designed and maintained in ways that avoid and minimize these impacts cannot be overlooked.

Transportation agencies face several challenges in addressing the volume of runoff from roadways and the pollutants typical in roadway runoff. A transportation jurisdiction frequently has limited control of the pollutants entering its right of way (including pollutants generated from atmospheric deposition, vehicle operation, litter, organic debris, and surrounding land uses). In addition, highway projects are linear in nature and, as such, are faced with practical limitations in terms of locating and maintaining stormwater treatment facilities within the road right of way. As public agencies, transportation agencies must be accountable to taxpayers to provide cost-effective stormwater facilities, but they frequently lack funding mechanisms (such as stormwater utility fees). In addition, regional and state transportation agencies also lack the land use controls (zoning and land use ordinances) that are available to municipalities and the county.

3.7.3 SUSTAINABILITY

> *Water Resources: "Policy 6: Encourage or require innovative practices to reduce point and non-point sources of pollution of water resources."*
>
> Draft Lake County Sustainability Chapter

Even considering these challenges, transportation agencies have the authority to design and maintain roadways and public transportation facilities that deliver multiple benefits and include structural and non-structural best management practices that reduce stormwater runoff and pollutants from roadways. Since adjacent land uses influence the contribution of pollutants from roadways, the stormwater management features of the roadway need to be designed and maintained in consideration of adjacent land use. By using best management practices (BMPs), transportation jurisdictions can design and maintain roads to achieve the following objectives.

- Reduce the volume of polluted runoff reaching receiving waters
- Incorporate stream crossings that protect aquatic habitat
- Address the impacts of roadway proximity to sensitive lakes/wetlands
- Reduce chloride pollution resulting from road salt and winter maintenance practices
- Connect the green infrastructure network and include wildlife crossings
- Connect people and communities – incl. low/moderate income areas to the transportation network (bus lines, trails)

These objectives are consistent with several policies in the draft Sustainability Chapter of the Lake County Framework Plan. The transportation section of the Chapter includes 5 policies that recommend improving coordination among public transit services and extending public transit; implement non-motorized transportation/complete streets policies and encourage local agencies to support, adopt, and implement Complete Streets policies and practices; improving multi-modal transportation options; coordinating appropriate land uses and context sensitive street design to foster walkability; and active partnership in corridor planning processes, including the Route 53/120 corridor.

Watershed-healthy and sustainable transportation BMPs that may be implemented to move toward sustainability in the watershed include:

Design BMPS

- Use I-LAST Scoring System for all new roadway expansion and extension projects
- Practices that reduce runoff volume from roads and parking lots (reduce pavement extent, use porous pavement where appropriate, infiltrate runoff where appropriate)
- Practices that capture and treat runoff
- Route roadways to avoid waters and wetlands where possible
- Include environmentally friendly stream crossings that protect aquatic habitat
- Provide for safe, accessible and connected non-motorized transportation (including underserved and low to moderate income areas with alternative transportation options)
- Consider wildlife crossings

Construction BMPs

- Soil erosion and sediment control (install BMPs first, phase ground disturbance if possible, button up construction site daily, minimize length of time ground is bare and disturbed)
- Provide adequate construction oversight

Post construction BMPs

- Monitoring and maintaining BMPs post-construction
- Street sweeping and inlet cleaning
- Winter maintenance (develop a winter maintenance policy and use alternative products and practices such as liquids, anti-icing, calibrating trucks and equipment)

Personal communication and website research was conducted to identify what transportation policies and BMPs are being used by the largest roadway jurisdictions in the watershed (IDOT, LCDOT, the Villages of Grayslake, Gurnee and Lindenhurst and Warren Township). **Table 3-13** provides a quick summary of transportation policies and BMPs for these jurisdictions.

Table 3-13: Transportation policy and practices for largest roadway jurisdictions.*

Jurisdiction	Complete Streets Policy	Winter Maintenance Policy	Snow and Ice Removal Practices	Sustainable Street Policy/Initiatives
IDOT	IL 2007			I-Last (optional)
LCDOT	2010	Yes	Anti-icing and "Super Mix" (calcium chloride, salt brine, and Geo-Melt), plus rock salt Truck and equipment calibration	No specific policy - follows WDO requirements

Jurisdiction	Complete Streets Policy	Winter Maintenance Policy	Snow and Ice Removal Practices	Sustainable Street Policy/Initiatives
Village of Grayslake	No policy, although the Village supports complete streets with trails and sidewalks and will include trail connections in new developments	No	Beet juice/salt mixture, 35% reduction in road salt use, Trucks calibrated for each event	No specific policy - follows WDO requirements, recommended low impact design and BMP and environmental design standards for Route 53/120, Is looking at perennial plantings for medians
Village of Gurnee	No	Yes	Anti-icing and "Super Mix" (calcium chloride, salt brine, and Geo-Melt) Truck and equipment calibration	No specific policy, follows WDO requirements, will likely use bioswales for new parking lots when constructed
Village of Lindenhurst	No policy	Yes	Salt and liquid de-icer (salt brine, calcium chloride, agricultural by-product (beet juice)	No specific policy - follows WDO requirements, will likely use BMPs if Village Green development proceeds
Warren Township	No, (Township does not rebuild roads)	Yes	Beet juice/salt brine/calcium chloride mixture plus salt	No specific policy, but no rebuilds or new street construction

*Information derived from personal communications

Noteworthy: Sustainable Urban Infrastructure Policies and Guidelines

City of Chicago Department of Transportation (CDOT), 2013 Return on Sustainable Investment

"The philosophy of this document is that while there are cost implications to some of the requirements—such as increased staff time in review and documentation, modest design fee increases while consultants adjust to new standards, and potential modest construction fee increases as the entire industry adopts and adapts to revised practice—the value of the increased investment reflected in these costs justifies the expenditure. Furthermore, many of the requirements lead to cost savings. The use of recycled materials, recycling construction waste, using energy efficient lighting, and reducing "grey" or "pipe" stormwater solutions are just a few of the examples that have been shown to reduce both capital and long term costs…"

"This document took a particular look at the full cost and benefit of environmental best practices on CDOT pilot projects, which is often referred to as a sustainability valuation, sustainable return on investment, or calculation of the triple bottom line. In a fiscal reality where agencies must do more with less, investing in projects that deliver multiple benefits is the smartest approach. It is important to get the most out of every dollar invested. So when that dollar buys not just a physical project that enables mobility but also slows stormwater to reduce overflow events, improves air quality, reduces ambient temperatures for surrounding buildings, reduces energy use, and creates places where people want to live, we are making wise choices for the city's economy and future."

3.8 NATURAL RESOURCES

Threatened and ***endangered*** species and communities, rare habitats, and important natural areas, including natural area inventory sites, forest preserves, nature preserves and high quality ***advanced identification (ADID)*** wetlands make up the high quality natural resources in the watershed. No Federally endangered or threatened species have been observed in the watershed.

Endangered: An "endangered" species is one that is in danger of extinction throughout all or a significant portion of its range.
Threatened: A "threatened" species is one that is likely to become endangered in the foreseeable future.
Advanced Identification (ADID) Sites: Aquatic sites that have been determined to provide biological value by the USACE, Chicago District and the USEPA.

Noteworthy: Identifying High Quality Natural Resources

The Illinois Natural Heritage Database provides information on the presence of the state's threatened and endangered plants and animals, Illinois Natural Areas Inventory (INAI) sites, Illinois Nature Preserves, and Forest Preserve lands. The database's information was gathered from the INAI inventory (conducted in the mid 1970's), as well as by Illinois Department of Natural Resources (IDNR) biologists, resource managers, and volunteers. Lake County threatened and endangered species information was also assembled during Lake County Health Department-Ecological Service's water quality and plant sampling of the lakes, in addition to 20 years of threatened and endangered species data from the Lake County Forest Preserve District (LCFPD) queried through the IDNR Element Occurrence Records (EOR) reports.

3.8.1 THREATENED AND ENDANGERED SPECIES

As of 2011, there were 138 threatened and endangered species listed for Lake County with 22 species located in the Mill Creek Watershed. **Table 3-14** lists each threatened or endangered species and provides additional information, including status and source of data.

Table 3-14: Threatened and endangered species within the Mill Creek Watershed.

Common Name	Scientific Name	Type	Status
American Bittern	*Botaurus lentiginosus*	Bird	Endangered
Small Yellow Sedge	*Carex cryptolepis*	Vascular Plant	Endangered
Little Green Sedge	*Carex viridula*	Vascular Plant	Threatened
Black Tern	*Chlidonias niger*	Bird	Endangered
Northern Harrier	*Circus cyaneus*	Bird	Endangered
Downy Willow Herb	*Epilobium strictum*	Vascular Plant	Threatened
Iowa Darter	*Etheostoma exile*	Fish	Threatened
Peregrine Falcon	*Falco peregrinus*	Fish	Threatened
Banded Kill Fish	*Fundulus diaphanus*	Fish	Threatened
Common Moorhen	*Gallinula chloropus*	Bird	Endangered
Least Bittern	*Ixobrychus exilis*	Bird	Threatened
Water Marigold	*Megalodonta beckii*	Vascular Plant	Endangered
Blacknose Shiner	*Notropis heterodon*	Fish	Endangered
Black-crowned Night Heron	*Nycticorax nycticorax*	Bird	Endangered
Wilson's Phalarope	*Phalaropus tricolor*	Bird	Endangered
Pied-billed Grebe	*Podilymbus podiceps*	Bird	Threatened

Common Name	Scientific Name	Type	Status
Grass-leaved Pondweed	*Potamogeton gramineus*	Aquatic Plant	Threatened
King Rail	*Rallus elegans*	Bird	Endangered
Foster's Tern	*Sterna forsteri*	Bird	Endangered
Common Tern	*Sterna hirundo*	Bird	Endangered
Common Bog Arrow Grass	*Triglochin maritima*	Vascular Plant	Threatened
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Bird	Endangered

The majority of the threatened and endangered species were found around the Rollins Savanna and Fourth Lake areas, although threatened and endangered species can be found in Grays Lake, Druce Lake, Third Lake and in Mill Creek itself. The Lake County Health Department has noted the presence of sandhill cranes (*Grus canadensis*), pied-billed grebes (*Podilymbus podiceps*), and yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) in their lake summary reports.

Ecologically significant and protected areas in the Mill Creek Watershed provide habitat for threatened or endangered species and contain examples of high-quality natural communities. These areas include ADID (high quality) wetlands, one Illinois Natural Area Inventory site (Fourth Lake-Rollins Road Savanna), four forest preserves (Sedge Meadow, Fourth Lake, Rollins Savana, and McDonald Woods), and two Illinois Nature Preserves (Rollins Savanna Nature Preserve and Fourth Lake Fen Nature Preserve).

3.8.2 NATURE PRESERVES, FOREST PRESERVES, AND HIGH QUALITY NATURAL AREAS

Several dedicated Illinois Nature Preserves and Lake County Forest Preserves are located in the watershed. There are eight forest preserves (totaling 2,721 acres) in the watershed owned and maintained by the Lake County Forest Preserve District (**Figure 3-17**). The Illinois Nature Preserves are designated by the Illinois Nature Preserves Commission, but maintained by the property owner with oversight from the Commission and offer the highest level of protection for rare flora and fauna and high quality natural communities. There are two nature preserves in the watershed, and they are within forest preserves.

Noteworthy: Illinois Natural Area Inventory

The Illinois Natural Area Inventory (INAI) was established in the 1970's by the Illinois Nature Preserve Commission (INPC) to identify "high quality" examples of the natural features found in Illinois. Included in the INAI inventory is a system to classify natural communities, a grading scale related to the quality of natural areas, and the inventory itself.

The INAI was developed in order to generate detailed areas and natural resources that qualify for formal state protection. INAI sites contain one or more of the following attributes: high quality natural communities, specific suitable habitat for state-listed species, state dedicated Nature Preserves, outstanding geological features, species reintroductions and translocations, unusual concentrations of flora or fauna, and/or high quality streams (Kieninger, 2005).

3.8.2.1 Lake County Forest Preserves

Sedge Meadow

Sedge Meadow is an 808-acre preserve that is a living laboratory, designed to provide scientists the research opportunities to study the function of wetlands. Formerly part of the Des Plaines River Wetlands Demonstration Project, these controlled, experimental wetlands were constructed where abandoned farm fields and gravel pits once stood. The preserve has been restored to a natural condition with prairies, meadows and functioning wetlands that provide flood control, wildlife habitat and improved water quality for the adjacent Des Plaines River.

McDonald Woods

McDonald Woods is a 298-acre preserve that includes three lakes that were constructed by the previous landowner in the 1940s. The Lake County Forest Preserve District has restored these lakes to a wetland condition. The lakes receive runoff from Potomac, Waterford, and Spring Ledge Lakes in the Village of Lindenhurst. Millburn Creek, a small tributary to North Mill Creek mainstem, flows out of the east end of the lakes. A portion of this preserve is within the Mill Creek Watershed near the confluence with the Des Plaines River. However, the majority of the reserve is within the North Mill Creek Watershed.

The Bonner Heritage Farm is within the McDonald Woods Forest Preserve. Donated in 1995 by the Bonner family, the farm covers eight acres and contains two houses and several farm buildings.

Duck Farm

Duck Farm is named for the well-known duck farm once operated here. In 1911, the Weber family started a duck farm at this site. At the height of its operation, more than 50,000 ducks resided on the farm. The District acquired the property in 1989. The preserve features a 48- acre dog exercise area. Duck Farm offers a scenic countryside and a safe haven for a variety of waterfowl and wildlife. The preserve features gently sloping topography dotted with dense woodlands and expansive prairies. Slough Lake is tucked within the preserve. A section of the preserve also connects to neighboring Sand Lake.

Mill Creek

Mill Creek is named for the stream that runs through the entire 277 acre preserve, the latest Forest Preserve District property in the watershed. Acquired in 2010, the property contains old growth woodlands, rolling terrain, and allows for the protection of a large parcel of high quality land. The property contains a large manmade pond, Temple Smith Pond, has up to 30 foot slopes along the Mill Creek valley, and has excellent restoration potential for oak woodland, prairie, sedge meadow, and wetland communities.

Fourth Lake

Fourth Lake is named for the lake it borders. The 621 acre preserve contains a large natural wetland, a fen, and an expansive grove of pines and spruces. A thick group of mature oaks borders the lake and surrounding marsh. Acquisitions at Fourth Lake began in 1983. Some of the land was donated.

The land was originally slated as out lots for the Venetian Village subdivision, but was considered unsuitable for building because of the site's wetland. In addition, a wide drainage ditch ran through the middle of the land. Fourth Lake and its fen ecosystem are home to a variety of state threatened and endangered plant species and could provide habitat for the American bittern and various rails.

Considered a swale rather than a kettle ecosystem, the Fourth Lake fen is situated between two ridges of the Valparaiso Moraine. Fens are rare, often sloping, wetlands that occur where mineral rich alkaline groundwater comes to the surface. Unlike bogs, fens have higher nutrient and mineral levels and sustain a more diverse plant and animal community. Fens are often covered by grasses, sedges, reeds and wildflowers. The fen drains south into Fourth Lake, which drains eastward via Mill Creek to the Des Plaines River.

Rollins Savanna

Rollins Savanna is one of Lake County's largest forest preserves, covering 1,220 acres. The land was acquired in phases from 1988-1993 and has undergone extensive restoration from farmland to natural area dominated by grassland. A native plant nursery is located within the preserve. The preserve encompasses the south fork of Mill Creek, has frontage on Third Lake, and has many interior wetland complexes that were restored following the removal or breakage of farm drainage tiles. Rollins Savanna is named an Important Bird Area by the National Audubon Society due to the large number of endangered yellow-headed blackbirds that live there, and is noted as regionally significant grassland bird habitat.

Brae Loch

Brae Loch is a Certified Audubon Cooperative Sanctuary 18-hole golf course owned and operated by the Lake County Forest Preserve District. Brae Loch is recognized for its efforts in environmental stewardship by Audubon International.

> ***Noteworthy:*** **Audubon Cooperative Sanctuary Program for Golf**
>
> Audubon International, an international environmental education and sustainable natural resources management organization, hosts the award winning education and certification program that helps golf courses protect the environment. By helping people enhance the valuable natural areas and wildlife habitats that golf courses provide, improve efficiency, and minimize potentially harmful impacts of golf course operations, the program serves as a vital resource for golf courses. Audubon International has developed Standard Environmental Management Practices that are generally applicable to all golf courses. These standards form the basis for the Sanctuary Program for Golf certification guidelines.

Millennium Trail and Greenway

A portion of the Millennium Trail and Greenway runs through the Mill Creek Watershed. The Greenway will cover 35 miles when completed and currently covers approximately 25 miles, connecting local communities to forest preserves.

3.8.2.2 Illinois Nature Preserves

Rollins Savanna Nature Preserve

The largest nature preserve in the watershed, totaling 1,063 acres, is the Rollins Savanna Nature Preserve, located in Rollins Savanna Forest Preserve. Rollins Savanna is protected by the Illinois Nature Preserves Commission (INPC) as a natural area. The NPC report states that the preserve is home to several threatened and endangered species and is a mosaic of natural communities.

Fourth Lake Fen Nature Preserve

Fourth Lake Fen Nature Preserve is a large wetland complex with high quality calcareous floating mat, sedge meadow and marsh communities within the Fourth Lake Forest Preserve. The calcareous floating mat is considered high quality and is one of ten of its kind and quality in the state. The preserve is habitat for six threatened or endangered plant species and four animal species.

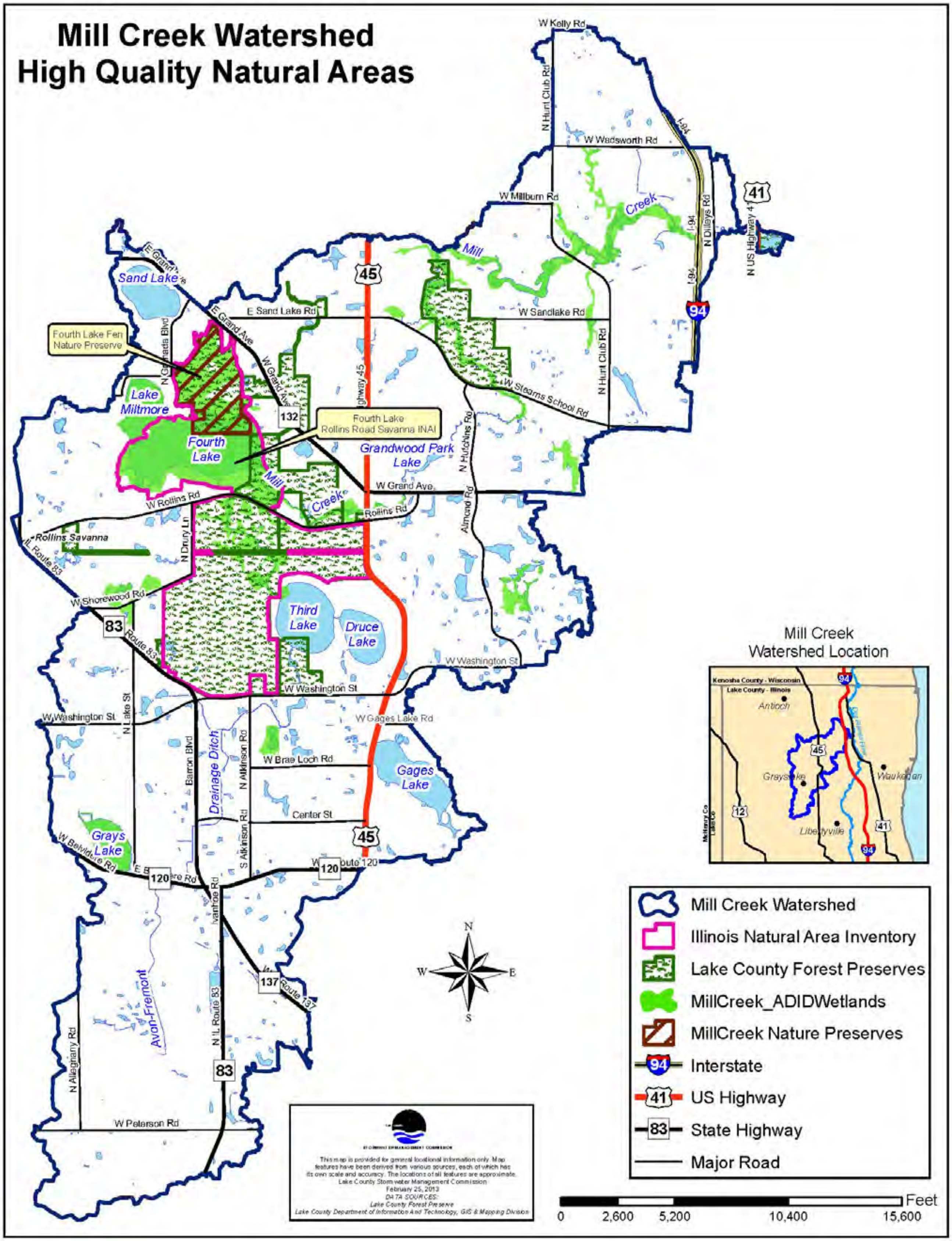


Figure 3-17: High Quality Natural Areas in the watershed including ADID wetlands, forest and nature preserves.

3.9 GREEN INFRASTRUCTURE INVENTORY

Greenway: A protected linear open space area that is either landscaped or left in its natural condition. It may follow a natural feature of the landscape such as a river or stream, or it may occur along an unused railway line or some other right of way. Greenways provide wildlife corridors and recreational trails.

The first step in assessing green infrastructure in the Mill Creek Watershed is to initiate an open space inventory. Aerial photographs, property parcels and assessor records were used in GIS to classify the open parcels, partially open parcels, and developed parcels. Open parcels, within the context of the green infrastructure planning effort are defined as parcels with no built structures or impervious cover (including open water). Partially open parcels, within the context of this planning effort include parcels with a structure (building, parking) on a relatively small part of the parcel, thus still offering potential for implementation of best management practices. They may also be private residences with acreage exceeding the surrounding minimum zoning in a subjective manner. Developed parcels, within the context of this planning effort include parcels which are mostly or completely occupied by structures and/or impervious surface. In calculating acreages, open and partially open parcels may include open water, such as lakes or rivers. Open and partially open parcels can be either protected or unprotected; unprotected areas may be developed in the future.

Noteworthy: Green Infrastructure

Green infrastructure is defined by SMC as site-specific BMPs (such as naturalized detention facilities, vegetated swales, porous pavements, rain gardens and green roofs) that are designed to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls, on the local, municipal or neighborhood scale. On the regional scale, green infrastructure consists of the interconnected network of open spaces and natural areas, such as forested areas, floodplains, wetlands, ***greenways***, parks and forest preserves. Green infrastructure is a type of stormwater management that is cost-effective, sustainable and environmentally friendly. Green infrastructure benefits include, increased land value, improved human health, improved air quality, increased wildlife habitat, recreational space, urban heat island mitigation, reduced energy demands, reduced stormwater pollution, reduced sewer overflow events, reduced and delayed stormwater runoff volumes, and increased carbon sequestration (Environmental Protection Agency, 2009).

3.9.1 INVENTORY FINDINGS

There are roughly 18,268 parcels in the watershed, covering 17,742 acres. The Mill Creek Watershed itself covers 19,783 acres but the parcel fabric contains gaps for transportation rights-of-ways; thus accounting for the 2,041 acre difference. The watershed contains a large amount of open space, which is well dispersed throughout the watershed, as indicated in **Figure 3-18**. Of the 18,268 parcels, 1,820 are open space, covering 8,886 acres, and 602 are partially open space parcels covering 4,156 acres. Calculating the areas based strictly on the parcel fabric alone, roughly 50% of the watershed is open space, 23% is partially open space and the other 27% is developed. The open and partially open parcels vary in size from less than 1/100th of an acre to over 337 acres. Open parcels are generally comprised of agricultural land, undeveloped land, common-ownership outlots and deed-restricted areas (such as detention basins and wetlands), public open space (such as parks and forest preserves) lakefront property, and open water. There are generally no occupied structures on open parcels, though there may be picnic shelters, utility sheds, and other similar types and sizes of buildings as well as roads or parking areas occupying less than 5% of the total parcel area. Partially open parcels contain some development (often residences, farmsteads and accessory buildings) but with acreage exceeding the surrounding minimum zoning. Partially open parcels also may include agricultural land, institutional sites, and deed-restricted areas or easements that contain stormwater detention or wetland areas.

3.9.1.1 Inventory Findings – Ownership Type

An ownership classification scheme was developed as part of the inventory process (**Figure 3-19**). Parcels were assigned to these categories by reviewing ownership tax records. The owner type with the highest percent of both open and partially open parcels in the watershed is private owners. Private owners account for 7,662 acres of open and partially open parcels (approximately 44%) in the watershed. The owner type with the second highest percent of both open and partially open parcels in the watershed is the Lake County Forest Preserve. Lake County Forest Preserve properties account for 2,375 acres of open and partially open parcels (approximately 13%) in the watershed.

The owner type with the third highest percent of both open and partially open parcels in the watershed is equally divided between Homeowners/Business Associations and Park Districts. Homeowners/Business Associations and Park Districts account for 617 acres (each or 1,234 together) of open and partially open parcels (approximately 3% each) in the watershed.

Table 3-15: Owner Type Summary for Open, Partially Open, and Developed Parcels.

Owner Type	Acres of Open Parcels	Percent of Open Parcels	Acres of Partially Open Parcels	Percent of Partially Open Parcels	Acres of Developed Parcels	Percent of Developed Parcels
Associations (Other)	4	<1%	19	<1%	0	0%
Cemetery Association	1	<1%	10	<1%	0	0%
CLCJAWA	0	0%	0	0%	1	<1%
Conservation Group	61	<1%	30	<1%	0	0%
County	53	<1%	48	<1%	11	<1%
Farm Bureau	3	<1%	1	<1%	4	<1%
Federal	0	0%	1	<1%	8	<1%
Fire Protection District	0	0%	0	0%	2	<1%
Forest Preserve	2195	12%	180	1%	10	<1%
Home Owner/Business Association	564	3%	53	<1%	71	<1%
Junior College District	27	<1%	178	1%	14	<1%
Landfill	17	<1%	103	1%	122	1%
Library District	0	0%	6	<1%	0	0%
Park District	278	2%	339	2%	5	<1%
Private	4911	28%	2751	16%	4239	24%
Religious Institution	145	1%	197	1%	30	<1%
School District	137	1%	142	1%	63	<1%
State	17	<1%	0	0%	28	<1%
Township	164	1%	<1	<1%	<1	<1%
Unknown	31	<1%	19	0%	69	<1%
Utility	60	<1%	50	0%	7	<1%
Village/Municipality	218	1%	29	0%	16	<1%
TOTAL	8886	50%	4156	23%	4700	27%

3.9.1.2 Inventory Findings– Public and Private Ownership

Public/private ownership was distilled from ownership type information presented above (**Figure 3-20** and **Table 3-15**). Some general observations are:

There is more acreage in Open Parcels than in Partially Open Parcels. There are 3,081 acres of open space and 920 acres of partially open space in public ownership, which cumulatively equals 4,001 acres (23%) of the watershed area.

Table 3-16: Public and Private Ownership.

Ownership	Acres of Open Parcels	Percent of Open Parcels	Acres of Partially Open Parcels	Percent of Partially Open Parcels	Acres of Developed Parcels	Percent of Developed Parcels
Public	3081	17%	920	5%	112	2%
Private	5774	33%	3216	18%	4519	25%
Unknown	31	0%	20	0%	69	0%
TOTAL	8886	50%	4156	23%	4700	27%

Noteworthy: Parcel Fabric

The parcel fabric consists of 18,268 individual parcels that fall completely or partially within the boundary of the Mill Creek Watershed. The total area of the parcel fabric covers 17,741 acres while the total area of the watershed covers 19,783 acres. Approximately 2,042 acres of the watershed (transportation rights-of-ways) are not covered by the parcel fabric; thus accounting for the difference.

Noteworthy: Open and Partially Open Space

Open space provides innumerable benefits to the watershed. The open space filters the air and water, reduces the volume and energy of surface water runoff, and provides wildlife habitat and recreation areas. These factors prove to be beneficial for social, economic, environmental and human health reasons. In addition much of the open land is in the form of wetlands that act like a sponge, absorbing rainwater and slowly releasing it into the aquifer, thus maintaining the groundwater level while decreasing flooding potential (Environmental Protection Agency, 2009). All of these positive factors are reduced and sometimes even irrevocably destroyed when urban and suburban development is mismanaged and poorly planned.

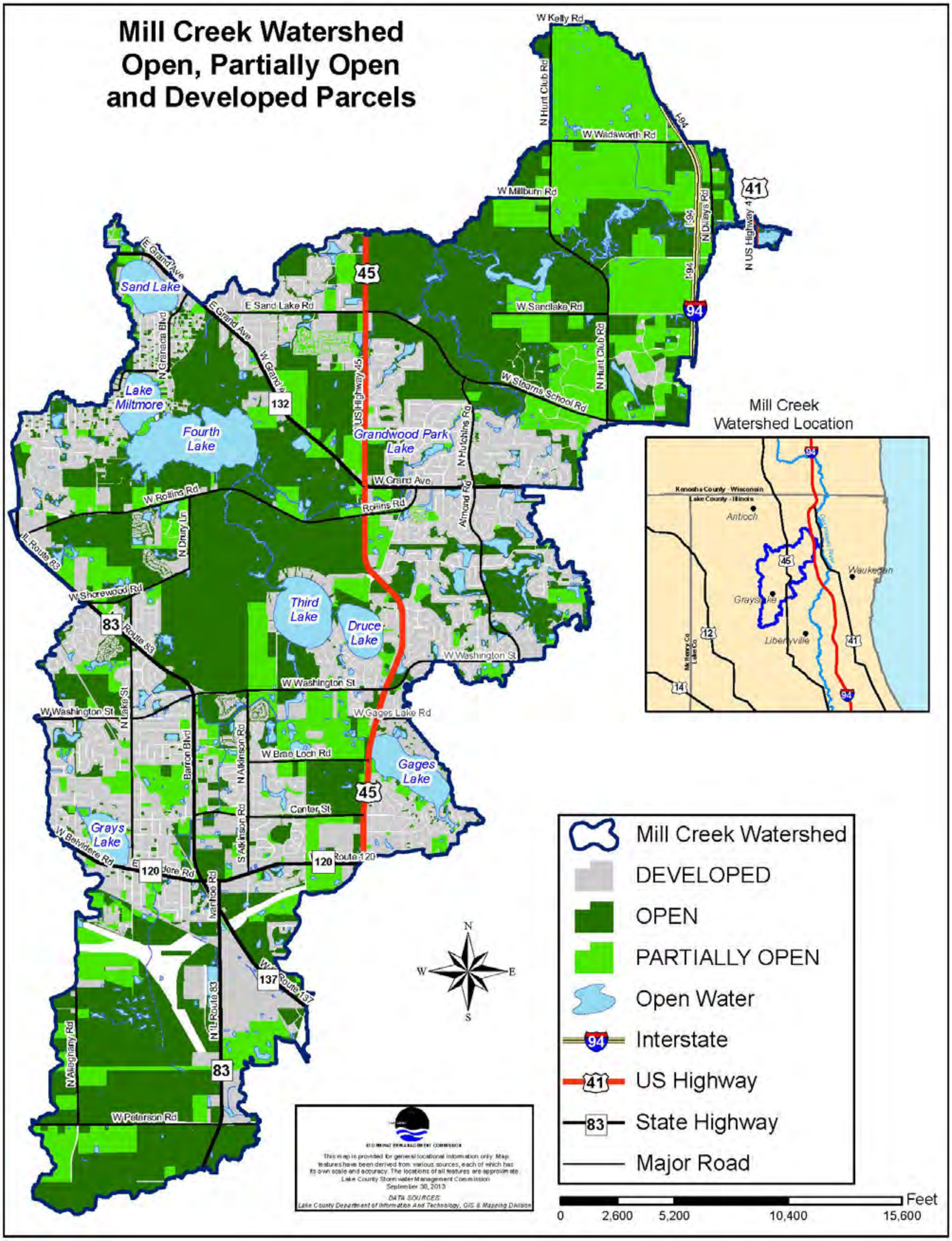


Figure 3-18: Open and Partially Open Developed Parcels.

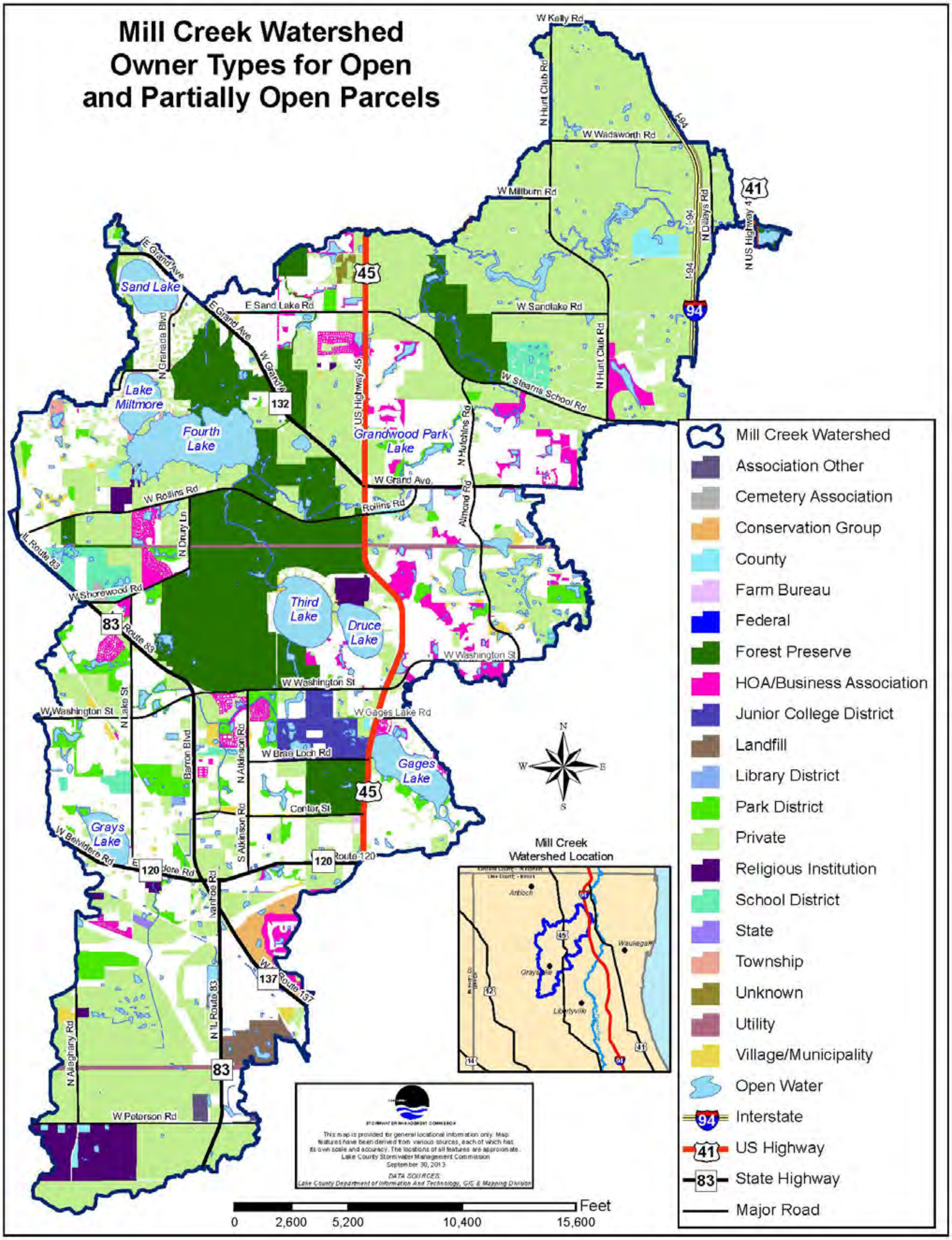


Figure 3-19: Owner Types for Open and Partially Open Parcels.

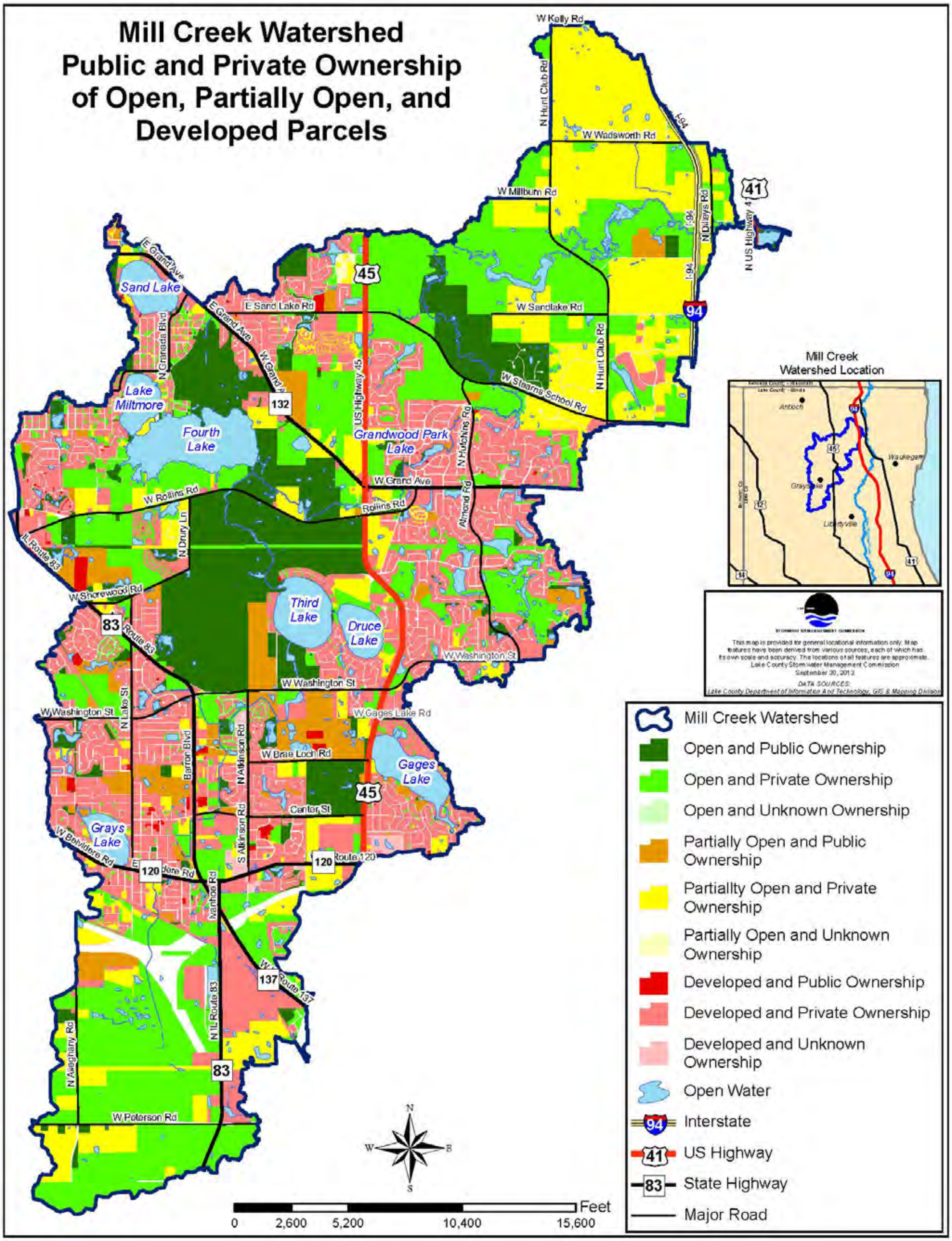


Figure 3-20: Public and Private Ownership of Open and Partially Open Parcels.

3.9.1.3 Inventory Findings – Protection Status

Protected open space differs from unprotected since it is permanently preserved by outright ownership of a private or public body because it is either chartered to permanently save land or is a permanent deed restriction such as a ***conservation easement***. Public protected areas include forest preserve districts, state nature preserves, and park districts. Privately protected areas include homeowners/business association-owned land with deed restrictions or conservation easements, and land owned by land trusts and other conservation organizations. The conversion of open space to other uses poses a threat to all watersheds. The conversion increases runoff, water quality degradation and loss of wildlife habitat, habitat connectivity and "sense of place" within the watershed.

Conservation easement: The transfer of land use rights without the transfer of land ownership. Conservation easements can be attractive to land owners that do not want to sell their land now, but would support perpetual protection from further development.
Headwaters: The upper reaches of a drainage basin. Headwaters are important to watersheds since they typically contain extensive wetland complexes that are important to overall stream health (Freeman et al., 2007).

The inventory identified that approximately 20% of the open and partially open parcels in the watershed are protected (**Table 3-17** and **Figure 3-21**). The majority of the open and partially open parcels, 53%, in the watershed are not protected.

Almost 89% of the unprotected open and partially open parcels are under private ownership. A high concentration of unprotected open and partially open parcels are in the southern and western portions of the watershed, which is where the ***headwaters*** are located.

As shown in **Table 3-17**, the watershed contains 9,305 acres of unprotected open and partially open parcels (52% of the total parcel fabric) of which approximately 89% are privately owned. Studies by Gomi, Sidle and Richardson (2002), indicated that the chance of obtaining a healthy stream or river is dramatically decreased when the headwaters are in poor condition. By protecting the headwaters, adverse physical, biological, and chemical pollution will decrease.

Table 3-17: Protection Status.

Protection Status	Acres of Open Parcels	Percent of Open Parcels	Acres of Partially Open Parcels	Percent of Partially Open Parcels	Acres of Developed Parcels	Percent of Developed Parcels
Protected	3085	17%	602	3%	88	<1%
Unprotected	5771	33%	3534	20%	4544	26%
Unknown	30	<1%	19	<1%	69	<1%
TOTAL	8886	50%	4154	24%	4701	26%

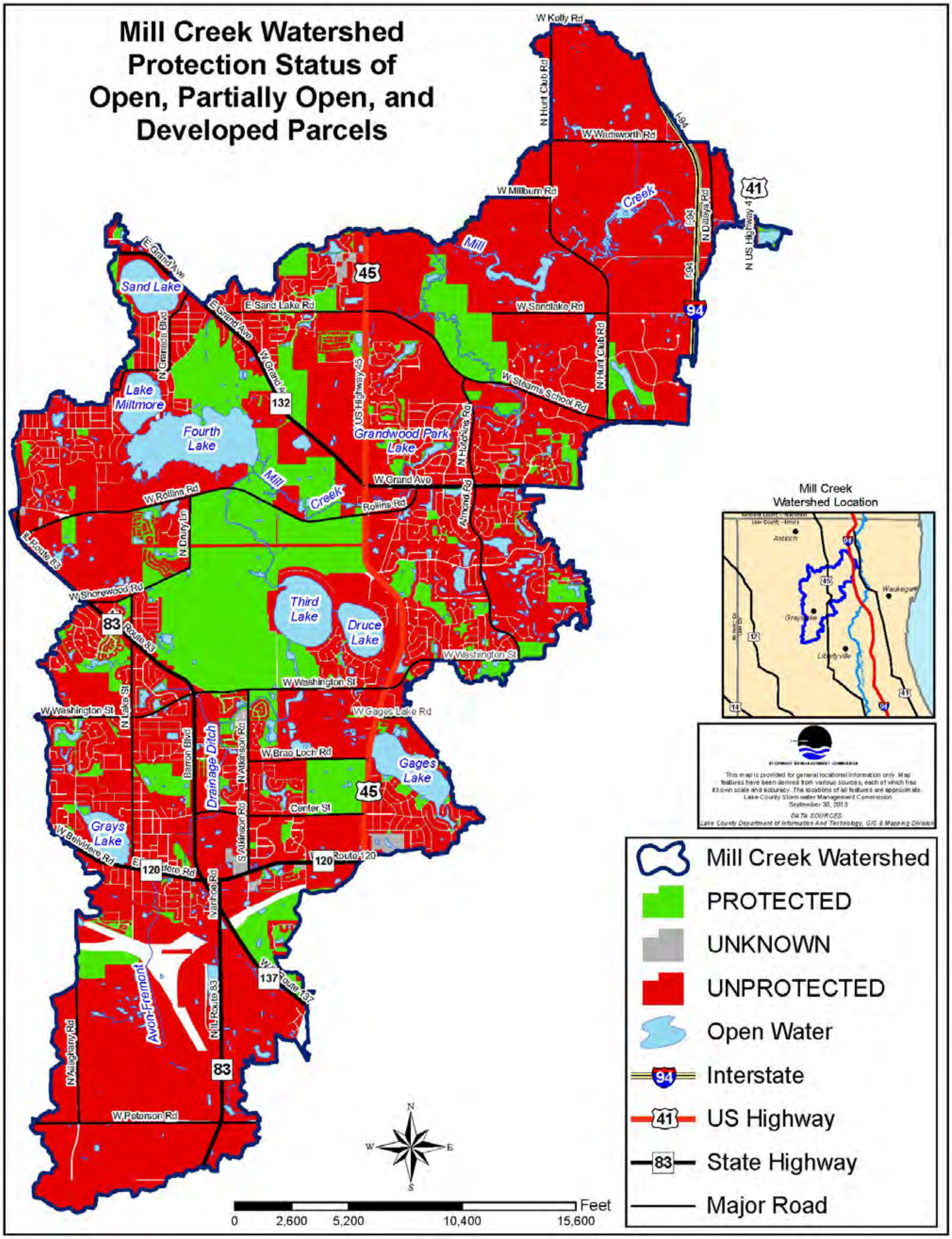


Figure 3-21: Protection Status of Open and Partially Open Parcels.

3.10 WATERSHED HYDROLOGY

Hydrology is the study of the occurrence, circulation, distribution, and properties (e.g., quality) of the earth's water. A central theme of the science is that the earth's water is constantly being cycled – between the ocean, the air, and the land – through different pathways and at different rates. The movement of the earth's water through these various pathways is called the hydrologic cycle.

Although the hydrologic cycle is inherently complex, one can gain a general understanding of how it works by envisioning the following process. Clouds form over the ocean due to the evaporation of water. Wind carries the clouds ashore where they produce rain. Excess rainfall (i.e., stormwater runoff) flows into lakes, rivers, and wetlands. Over time, water stored in the lakes, rivers, and wetlands, either evaporates back into the atmosphere or flows back into the ocean, beginning the cycle anew. As you might imagine, water typically changes state (e.g., surface water, water vapor, rain) numerous times as it passes through the cycle.

Primarily, hydrology involves studying the flow of water between its various states – or within a given state – through the various hydrologic pathways that can be found within a particular geographical region or area. These pathways connect every component of the landscape with every other and can generally be divided into two categories: surface water hydrologic pathways, which include all of the hydrologic pathways that can be found at or above the surface (e.g., precipitation, interception, evapotranspiration, surface water flow); and, ground water hydrologic pathways, which include all of the hydrologic pathways that can be found below the surface (e.g., infiltration, interflow, groundwater flow). The study of the surface water hydrologic pathways that connect the various parts of the landscape is known as surface water hydrology, while the study of the ground water hydrologic pathways that connect the various parts of the landscape is known as hydrogeology. Primary areas of study within the science include developing methods for directly measuring flows through the various hydrologic pathways and developing and/or applying models for estimating flows through the various hydrologic pathways, either for scientific knowledge or for making predictions.

Noteworthy: Hydrologic Cycle

The hydrologic cycle describes the continuous movement of water on, above, and below the surface of the earth. The total mass of water on earth remains fairly constant over time, but how much of that water is found in each of its three primary states: solid (i.e., ice), liquid (i.e., water), and gas (i.e., water vapor), is variable depending on a wide range of climate-related variables. Water moves from one state to another – and across the surface of the earth – through various hydrologic pathways, such as evaporation, transpiration, condensation, precipitation, infiltration, surface water flow, and interflow (i.e., shallow groundwater flow).

As water moves from one state to another, such as from water vapor to water (i.e., rain), energy is exchanged, which affects temperatures on the surface of the earth. For example, when water evaporates, energy is absorbed and the surface of the earth is cooled through the process of evaporative cooling. When it condenses, energy is released and the surface of the earth is warmed. These energy exchanges, which take place on a global scale, powered by solar energy, have a significant influence on the earth's climate, as does water, in its three primary states (e.g., water vapor is the most important greenhouse gas, absorbing and emitting energy back toward the surface of the earth, but, in the form of clouds, also works to reflect a significant amount of solar radiation back into space). Water and the hydrologic cycle are responsible for earth's mild climate and makes life possible for all creatures found upon, below, and above its surface.

When applied to a watershed, hydrology typically involves studying the flow of water between the surface water hydrologic pathways that connect the air, the land, and the lakes, rivers, and wetlands found within the watershed. Such investigations usually begin with a delineation of the watershed. As discussed in Section 3.2 (Topography), the Mill Creek Watershed boundary was delineated using a GIS based model (i.e., Arc Hydro), which uses available topographic data, in the form of a Digital Elevation Model (DEM), to delineate the watershed boundary.

A combination of desktop assessment and field reconnaissance work can then be performed to investigate the surface water hydrology of the watershed. Such investigations usually include identification of: surface water inputs to the watershed; surface water outputs from the watershed; and, surface water flow paths within the watershed.

Within the Mill Creek Watershed, major surface water inputs include inflow (i.e., North Mill Creek, which joins Mill Creek south of the intersection of Milburn Rd. and Crawford Rd.) and precipitation, and major surface water outputs include outflow (i.e., Mill Creek joins the Des Plaines River south of the intersection of Wadsworth Rd. and US 41) and evapotranspiration. Within the Mill Creek Watershed surface water generally flows from southwest to northeast and then from west to east across the watershed, with, as described in Section 3.2 (Topography), the highest elevations found in the southwest corner of the watershed, and the lowest found in the northeast. Along the way, surface water passes through various streams, lakes, and wetlands, which were further investigated and are described in more detail in the following sections.

3.11 STREAM INVENTORY

3.11.1 INTRODUCTION AND METHODS

SMC conducted a stream inventory of Mill Creek in the summer of 2013 to assess the current condition of the stream channel and riparian area. The stream inventory is a largely qualitative assessment of several easily observed parameters that can be analyzed individually or collectively to provide insight as to the present condition of the stream system. These data are also of use for documenting "baseline" conditions and prioritizing potential project need and location. For the purposes of the stream inventory, the entire stream network within the watershed is divided into reaches, which are smaller, geographically-defined segments of the stream for which data are aggregated. Typically, barriers such as dams or bridges and other road and railroad crossings are used to define the upstream and downstream limits of a reach. The average length of assessed reaches in the Mill Creek inventory is 2,181 feet (less than one half-mile). The Mill Creek stream network was divided into 65 reaches (26.7 miles), of which 28 reaches (11.4 miles) were assessed in the inventory, 28 reaches (11.7 miles) were inaccessible or could not be waded safely by the observer(s), and 9 reaches (3.6 miles) lacked a defined channel, or were not streams (i.e., lakes, ponds, wetlands or engineered stormwater systems).

The stream inventory is designed to assess the condition of streams flowing in channels and therefore data are collected only for reaches with a "defined" channel and that are safe to wade. Stream inventory data are not collected for open-water ponds, lakes and impoundments, wetland complexes with no defined channel, and areas where the depth of water and/or unstable substrate creates a hazard for the observer(s).

The following types of data were collected during the inventory and are discussed in detail in the following sections:

- Channel conditions (dimensions of the banks and bed)
- Channelization
- Pool-Riffle Development
- Bank Erosion

- Sediment Accumulation and Debris Loading
- Hydraulic Structures (bridges, culverts, dams, etc…)
- Discharge Points (stormsewers, pipes, and overland flow draining to the stream)
- Riparian Corridor (vegetated buffer along the stream)

Data are collected by a team of two observers walking the entire length of every assessment reach. At representative points within each reach, the observers measure the channel dimensions and relative velocity (at the surface) of the stream. The observers photograph areas of moderate to severe erosion, significant sediment deposition and debris jams, all hydraulic structures, all discharge points, and photos of the stream channel that are representative of the conditions through the reach. Because the observers use a camera that is equipped with a global positioning system (GPS), each photo is tagged with geographic coordinates that are translated into point locations in a GIS during post-processing. This manner of conversion allows for analysis and mapping of the collected data.

3.11.2 STREAM NETWORK DESCRIPTION

The Mill Creek Watershed contains approximately 23 miles of stream channels (of which 11.4 miles were assessed during the stream inventory), as shown in **Table 3-18**. The network of stream channels in the watershed includes natural meandering channels, channelized segments of natural streams, and wholly constructed channels or ditches that were created primarily to drain lands for agriculture in the early 20th century. In addition to the stream network, these channels are connected to an array of wetlands, lakes, and impoundments.

For the purposes of discussion in this section, the areas assessed during the stream inventory are divided into three geographic sections:

- Mill Creek: The stream channel downstream of Third Lake to the Des Plaines River
- Avon-Fremont Drainage Ditch: The largely constructed and channelized stream network upstream of Third Lake (south of Washington Street)
- Lambs Corners Creek: The small tributary that begins north of Grand Avenue (IL 132) and west of Hunt Club Road and runs generally northwest through residential developments, joining Mill Creek near the intersection of Stearns School Road and Mill Creek Drive.

Table 3-18: Stream Miles and Assessed Miles.

	Mill Creek	Avon-Fremont Drainage Ditch	Lambs Corners Creek	Watershed Total
Total Stream Channel Miles *	14.6	7.8	0.6	23.0
Assessed Miles	5.8	5.2	0.6	11.4

*Excludes lakes, wetlands, impoundments and stormwater systems.

The Avon-Fremont Drainage Ditch was constructed in the early 20th century to provide drainage for agricultural land in Avon and Fremont Townships. The channel begins north of Peterson Road and runs north through the Village of Grayslake to Washington Street, where water flows into a wetland complex and ultimately into Third Lake. Third Lake empties over a dam on the northwest shore into Mill Creek, which flows north to Rollins Road. North of Rollins Road, Mill Creek turns east, generally parallel to Rollins Road, to U.S. Route 45. Between Third Lake and U.S. Route 45, Mill Creek mostly flows through channelized wetlands. East of U.S. Route 45, Mill Creek flows north and east in a meandering channel to Grandwood Park Lake, an impoundment that was constructed in the mid-20th century. Below the Grandwood Park dam, Mill Creek flows northeast under Hutchins Road and north under Stearns School Road. North of Stearns School Road, the stream meanders to the north, where North Mill Creek, the largest tributary to Mill Creek, enters south of Millburn Road. Mill Creek generally flows east from the mouth of North Mill Creek, through two impoundments on private land, under Interstate 94 and U.S. Route 41, to the Des Plaines River. The mouth of Mill Creek is located immediately south of a footbridge over the Des Plaines River on the Lake County Forest Preserves' Des Plaines River Trail south of Wadsworth Road. Throughout the remainder of this section, numeric values refer only to the 28 reaches that were assessed during the stream inventory. The inaccessible areas for which there is no data are not considered.

3.11.2.1 Channel Conditions

Measurements of the physical dimensions of the stream channel reflect both the shape of the channel as well as the amount of water that it can transport under low and high flow conditions, as shown in **Table 3-19**. In the Mill Creek Watershed, the assessed reaches of Mill Creek downstream of Third Lake demonstrate a wide variety of channel dimensions. The assessed reaches of the Avon-Fremont Drainage Ditch have a narrower range of channel widths and greater bank heights than Mill Creek, which is likely due to its origin as a constructed drainage channel rather than a natural stream. Lambs Corner Creek has smaller values overall, indicative of the fact that it is a relatively small tributary to Mill Creek.

Table 3-19: Channel Conditions.

	Bank Height (ft.)		Channel Width, Top (ft.)		Channel Width, Bottom (ft.)	
	Min.	Max.	Min.	Max.	Min.	Max.
Mill Creek	0.5	5.3	18.75	57.4	10.45	25.5
Avon-Fremont Drainage Ditch	1.0	9.6	26.3	51.1	2.7	21.5
Lambs Corners Creek	0.5	0.9	3.7	14.0	3.7	10.8

3.11.2.2 Channelization

Channelization refers to the straightening of natural, meandering stream channels or the construction of channels for drainage or navigation, although no channels in the Mill Creek Watershed have been altered or constructed to improve navigation. In natural meandering streams, channelization has the effect of reducing the overall length of the stream and increasing the gradient of the channel. In both streams and constructed channels, channelization increases the speed at which runoff flows through the stream system. Because it is the nature of concentrated, flowing water to create meandering channels, channelized streams may be susceptible to bank instability and erosion.

Table 3-20 and **Figure 3-22** illustrate the degree of channelization of assessed reaches in the Mill Creek Watershed. The reaches of Mill Creek and Lambs Corner Creek downstream (east) of Hutchins Road are not channelized or have a low degree of channelization. The reaches of Mill Creek upstream (west) of Route 45 and the Avon-Fremont Drainage Ditch tend to be moderately or highly channelized. These trends are due to the fact that much of Mill Creek downstream of Hutchins Road flows through open space or agricultural land use and there has not been a historical need to channelize these reaches. Likewise, the Avon-Fremont Drainage Ditch is a constructed system of drainage channels and therefore is highly channelized. Downstream of the Third Lake dam and upstream of Route 45, Mill Creek flows through channelized wetlands, much of which is now within the Rollins Savanna and Fourth Lake Forest Preserves.

Table 3-20: Degree of Channelization.

Degree of Channelization	Mill Creek			Avon-Fremont Drainage Ditch			Lambs Corners Creek			Watershed Total		
	Reaches	Miles	% of Miles	Reaches	Miles	% of Miles	Reaches	Miles	% of Miles	Reaches	Miles	% of Miles
None	7	3.1	53%	0	0	0%	1	0.3	50%	8	3.4	29%
Low	1	0.7	12%	0	0	0%	1	0.3	50%	2	1.0	9%
Moderate	5	2.0	35%	1	0.5	10%	0	0	0%	6	2.5	22%
High	0	0	0%	12	4.7	90%	0	0	0%	12	4.7	41%

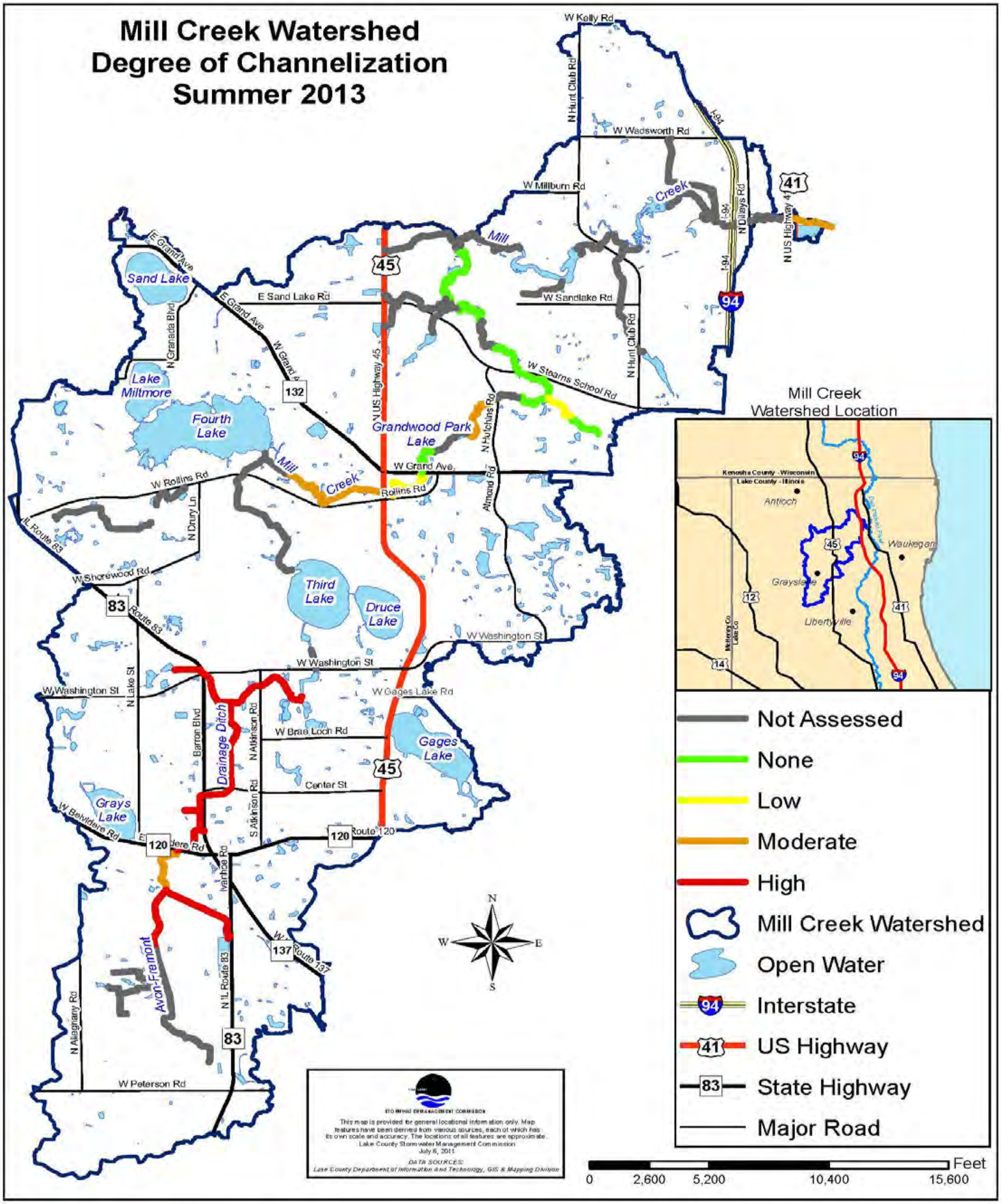


Figure 3-22: Degree of Channelization.

3.11.2.3 Pool-Riffle Development

Pool-riffle development refers to the degree to which naturally-undulating stream bed topography is present in a reach. Natural, meandering streams develop sequences of deeper bowl-shaped "holes," or pools, as well as steeper shallow areas, or riffles. Streams also develop relatively straight sections between pools and riffles called "runs". Pools, riffles, and runs all provide an array of ecosystem services in streams (aeration, refuge, spawning and nursery areas, foraging areas, etc.). Pool/riffle development may be low or absent in channelized or modified stream reaches.

The stream inventory noted a difference in pool-riffle development between Mill Creek and the Avon-Fremont Drainage Ditch, as shown in **Table 3-21**. As might be expected, Mill Creek, which contains significant portions of natural stream channel, has more pool-riffle development than the constructed and channelized Avon-Fremont Drainage Ditch. None of the assessed reaches were categorized has having a "high" degree of pool-riffle development. This may be due natural factors such as the stream bed and bank materials, human-related factors such as changes in watershed hydrology, or, most likely, a combination thereof.

Table 3-21: Pool-Riffle Development.

Degree of Pool/Riffle Development	Mill Creek		Avon-Fremont Drainage Ditch		Lambs Corners Creek		Watershed Total	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
None (<5%)	5	38	11	85	1	50	17	61
Low (5-33%)	4	31	2	15	1	50	7	25
Moderate (34-66%)	4	31	0	0	0	0	4	14
High (>67%)	0	0	0	0	0	0	0	0

3.11.2.4 Streambank Erosion

Streambank erosion is a function of the amount of water flowing along the bank, steepness of the bank, vegetative cover or armoring on the bank, and the material (earth) of which the bank itself is composed. Streambank erosion is a natural process and contributes to the sinuous, meandering form often associated with natural stream channels. In these relatively natural systems, there is typically an overall balance between the amount of material eroded from one streambank and the amount of sediment deposited on another. However, in watersheds with significant human development, streambank erosion rates are often exacerbated by changes in watershed hydrology, leading to several problems. Erosion can cause physical water quality problems such as increased or excessive turbidity (cloudiness) in the water and sedimentation, which can "choke" stream channels, reducing the volume that can be conveyed and covering streambed materials such as gravel, which are important for aquatic organisms. Additionally, erosion can lead to chemical water quality problems because nutrients, phosphorus in particular, are often bound to sediment particles and introduced to the aquatic environment by erosion. Excessive erosion can be problematic for property owners and land managers because it can lead to the loss of land, property, or structures.

The Mill Creek stream inventory assessed the degree of streambank erosion along the right and left bank (facing upstream) for each assessed reach, as shown in **Table 3-22**. Because all streambanks are assumed to have some degree of erosion, reaches were rated as having Slight, Moderate, or Severe erosion for each bank. The qualitative assessment criterion for each rating is given below. The results indicate that nearly all stream reaches are moderately or severely eroded, suggesting that the stream channel may be adjusting to overall changes in watershed hydrology. In channelized reaches, bank erosion would be expected to occur as flowing water naturally begins to erode a meandering channel.

The few reaches assessed as exhibiting "Slight" bank erosion tended to have large portions of the flow path consisting of wetlands.

> Slight - Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
>
> Moderate - Bank is predominantly bare with some rills and vegetative overhang.
>
> Severe - Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.

Table 3-22: Streambank Erosion.

Extent of Erosion	Mill Creek		Avon-Fremont Drainage Ditch		Lambs Corners Creek		Watershed Total	
	Left Bank Reaches	Right Bank Reaches	Left Bank Reaches	Right Bank Reaches	Left Bank Reaches	Right Bank Reaches	Left Bank Reaches	Right Bank Reaches
Slight	0	0	2	2	0	0	2	2
Moderate	6	7	7	7	2	2	15	16
Severe	7	6	4	4	0	0	11	10

3.11.2.5 Sediment Accumulation

As mentioned in the previous section, sediment transport is a natural process occurring in all streams, but the magnitude can be affected by human modifications to the watershed. Typically, streams suspend and transport sediment through high-gradient (steep) reaches and deposit sediment in low-gradient (flat) reaches or areas where velocity slows. These may be naturally occurring flat sections of the stream (such as areas where the stream enters a wetland complex), areas behind beaver dams or debris jams, or areas upstream of human impediments such as culverts or dams.

Most reaches in the watershed have low or moderate sediment accumulation; see **Table 3-23**. These reaches are distributed throughout the watershed and the amount of sediment accumulation does not obviously relate spatially to any other single geographic characteristic. High sedimentation was noted in Grandwood Park Lake, an impoundment of Mill Creek. Because sedimentation is typically a management issue for impoundments, the condition of Grandwood Park Lake is probably not extraordinary.

Table 3-23: Sediment Accumulation.

Sediment Accumulation	Mill Creek		Avon-Fremont Drainage Ditch		Lambs Corners Creek		Watershed Total	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
None (<5% of reach)	0	0	0	0	1	50	1	4
Low (5-33%)	4	31	4	31	1	50	9	32
Moderate (34-66%)	7	54	5	38	0	0	12	43
High (67-100%)	2	15	4	31	0	0	6	21

3.11.2.6 Debris Loading

In addition to sediment, most streams transport some amount of debris (organic material typically originating outside the stream itself, such as tree limbs, brush, and leaves). Because debris transport is a naturally-occurring stream process, some debris can provide habitat and contribute to a diverse instream environment. However, too much debris can be problematic and may result in large debris jams, causing backwater flooding and sediment deposition. Debris jams can also cause erosion of the stream banks which can lead to damage of riparian lands and property.

In the Mill Creek Watershed, reaches having a moderate or high debris load are considered to have the potential to be problematic. In some cases, these reaches may be in natural or open space areas and no action is needed or warranted. In other cases, moderate or high debris loads may be problematic and, for example, debris jams may warrant removal. **Table 3-24** summarizes the reaches that “failed” the debris load test, having moderate or high instream and/or overbank debris loads. These reaches exhibit multiple debris jams, beaver dams, or overhanging debris obstructions extending across all or significant portions of the channel and/or onto the banks. In Mill Creek, 11 reaches (85% of reaches assessed) failed the debris load test. While beaver activity contributed to the debris load in some of these reaches, it does not account for the moderate or high debris loads in all reaches. In addition to beaver activity, these reaches are downstream of a majority of the watershed and therefore receive debris transported from upstream reaches. Several reaches are also located in forested areas and therefore the debris loads from the adjacent riparian areas may be higher. Several of these reaches are located in open space areas and the debris loads are not affecting water levels on other properties. In such cases, it is up to the land manager or owner to determine if the debris loading constitutes a true “problem.” The Avon-Fremont Drainage Ditch had a total of five reaches that failed one or both of the debris loading tests. The lower debris loading in the Avon-Fremont Drainage Ditch is likely a result of two factors: first, there is less forested land along the stream channel, particularly in the upstream section; and second, the Avon-Fremont Drainage District actively clears debris jams in much of this portion of the stream system. Lambs Corner Creek primarily drains suburban or urban land uses and is not subject to high debris loads.

Table 3-24: Debris Loading.

Moderate or High Debris Load	Mill Creek		Avon-Fremont Drainage Ditch		Lambs Corners Creek		Watershed Total	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
Instream	11	85	5	38	0	0	15	56
Overbank	11	85	6	46	0	0	16	59
Both	11	85	4	31	0	0	15	56

3.11.2.7 Hydraulic Structures

Hydraulic structures are bridges, culverts, dams, weirs, or other structures spanning or crossing the stream channel. These structures modify or have the potential to modify the pattern or amount of flow in the creek and may act as constriction points under certain flow conditions (such as floods), leading to backwater flooding. Additionally, dams and weirs can impede the movement of fish and other aquatic organisms within the stream network. Culverts may create temporary or permanent barriers if scour causes the bottom of the culver to become elevated above the water level of the stream. Problem hydraulic structures include any obstructed bridges and culverts, culverts that are undermined or collapsed, bridges, culverts, dams and weirs that have been washed out, and beaver dams that are causing severe bank erosion or impounding a significant volume of water or length of stream channel. Structures are listed as “problem” structures to call attention to the need for further investigation but this designation is not a definitive determination that the structure is defective.

Table 3-25 contains a summary of hydraulic structures in the Mill Creek Watershed. The density of structures in the assessed reaches of Mill Creek and Avon-Fremont Drainage Ditch is similar, although several substantial beaver dams are included in the Mill Creek reaches. It should also be noted that because a number of reaches were not included in the inventory, a number of dams located on those reaches are not included. Common hydraulic structure problems noted in the Mill Creek inventory include several beaver dams creating substantial impoundments and multi-culvert road crossings in which one or more of the culverts was partially or completely obstructed by sediment and/or debris. Problem hydraulic structures are shown in **Figure 3-23**.

Table 3-25: Problem Hydraulic Structures.

Hydraulic Structures	Mill Creek	Avon-Fremont Drainage Ditch	Lambs Corners Creek	Watershed Total
Beaver Dam	8	1	0	9
Bridge	11*	5	0	16
Culvert	4	17	5	26
Dam^	1*	1	0	2
Total Hydraulic Structures	24*	24	5	53
Hydraulic Structures per stream mile	4.1	4.6	8.3	4.6
Problem Hydraulic Structures	9	4	0	13

*The dam at Grandwood Park Lake is spanned by a bridge, both are counted individually.
^The dam at Third Lake and several dams on private property are not included because the reaches were not assessed as part of the stream inventory.

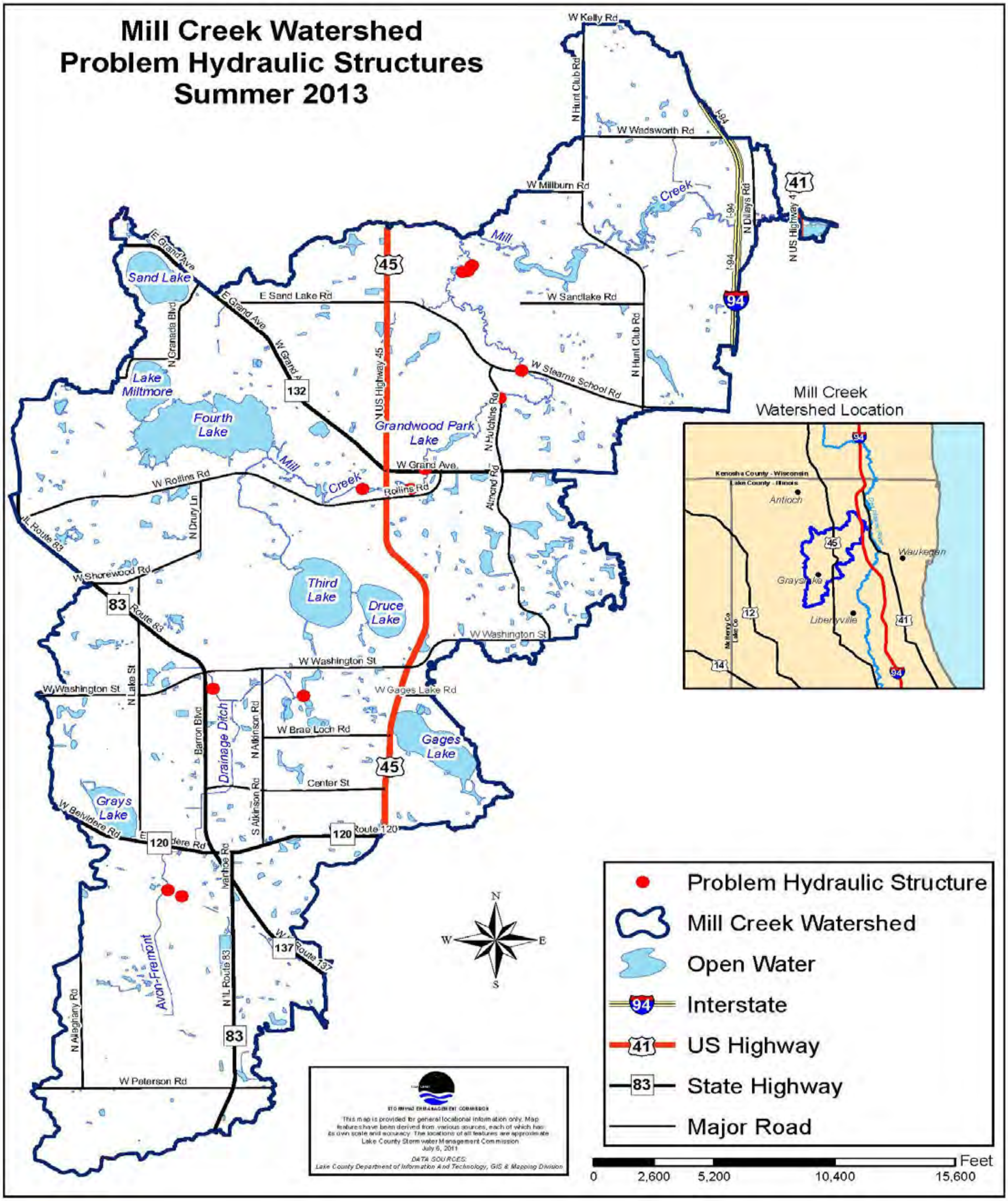


Figure 3-23: Problem Hydraulic Structures.

3.11.2.8 Discharge Points

Discharge points are identified as any outfalls into streams, and include "pipes" such as drain tile outlets, sump pump discharges, and storm sewers as well as "open channel" discharges such as drainage swales, gullies, and small tributaries. The stream inventory documented 164 discharge points into the stream network within the assessed reaches. Avon-Fremont Drainage Ditch contains the largest number of discharge points and the highest density of discharge points per stream mile. This is expected because a significant portion of Avon-Fremont Drainage Ditch runs through suburban and residential development. These land uses typically result in a greater frequency of discharge points along streams.

Problem discharge points in the Mill Creek Watershed contribute to streambank erosion and the transport of excess sediment and associated nutrients to the stream channel. The location of these points is shown in **Figure 3-24** and summarized in **Table 3-26**. Pipes commonly cause erosion below the end of the pipe, resulting in a positive feedback loop of bank erosion near the pipe, and may ultimately result in the failure of the pipe itself. End sections, aprons, and supporting structures sometimes fail as a result of this type of erosion. Gullies and other open channels can also result in bank erosion, as they deliver concentrated flow to the stream channel. In some cases, pipes appear to be in poor repair or flow may be discolored or appear to contain substances other than water. These cases are noted in the inventory as well.

Table 3-26: Discharge Points.

Discharge Points	Mill Creek	Avon-Fremont Drainage Ditch	Lambs Corners Creek	Watershed Total
Swales, gullies, and tributaries	34	15	1	50
Pipes, including storm sewers, culverts and drain tiles	26	87	1	114
Total Discharge points	60	102	2	164
Discharge points per stream mile	10.3	19.6	3.3	14.1
Problem discharge points	12	26	0	38

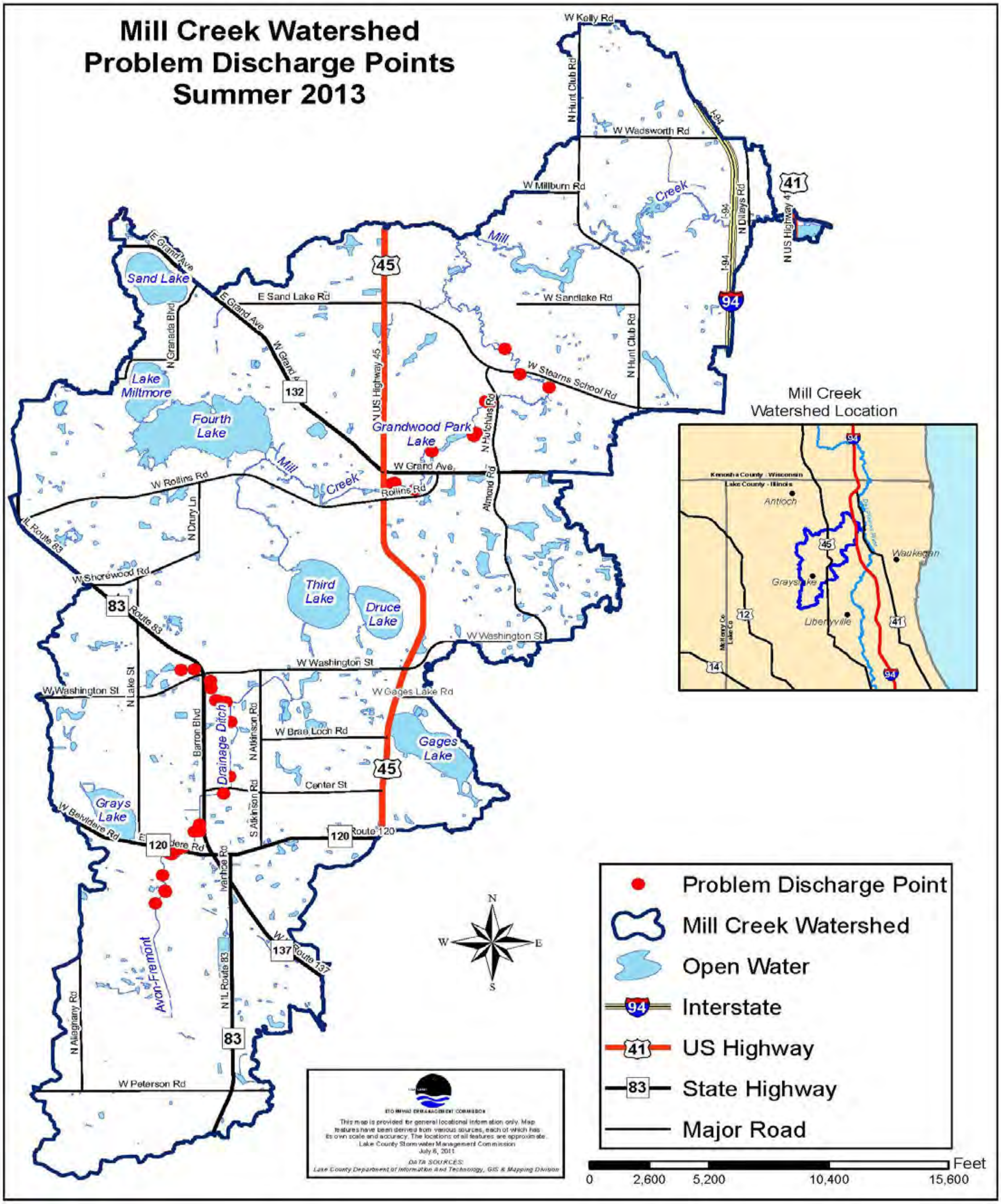


Figure 3-24: Problem Discharge Points.

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3.11.2.9 Riparian Buffers

The width and quality of vegetated riparian buffers were visually assessed while walking the stream channel throughout the inventory and checked with aerial photography of the watershed. Vegetated riparian buffers are of interest because riparian vegetation can make streambanks more resistant to erosion, buffers act as filters for runoff and pollutants, and riparian areas offer habitat for wildlife and can be important links in the watershed green infrastructure network. Using this combination of methods, the width of the vegetated riparian buffer was assessed for each reach, including several reaches that were not otherwise assessed in the inventory. **Table 3-27** summarizes the assessment criteria for buffer width, while **Figure 3-25** maps the observed vegetated riparian buffer quality in 2013. Throughout the watershed, riparian buffer width is related to riparian land use, with wide riparian buffers ("High" buffer width) in locations where the stream flows through open space areas and narrow buffers ("Low" buffer width) in locations where the stream flows through developed areas. Generally, the portion of the stream network known as Mill Creek (in the northern portion of the watershed) has wider riparian buffers and flows through more open space areas, with the exception of built-out neighborhoods such as Grandwood Park. The Avon-Fremont Drainage Ditch generally has narrower buffers, as it flows primarily through agricultural land and the Village of Grayslake. There are only a few reaches in the watershed in which there is no riparian buffer.

Table 3-27: Riparian Buffers.

Buffer Width Rating	NONE	LOW	MODERATE	HIGH
Description	Width of riparian zone <20 feet; little or no riparian vegetation due to human activities	Width of riparian zone 20-40 feet; human activities have impacted zone a great deal	Width of riparian zone 40-60 feet; human activities impacted zone minimally	Width of riparian zone >60 feet; human activities (parking lots, roadbeds, lawns, crops) have not impacted zone

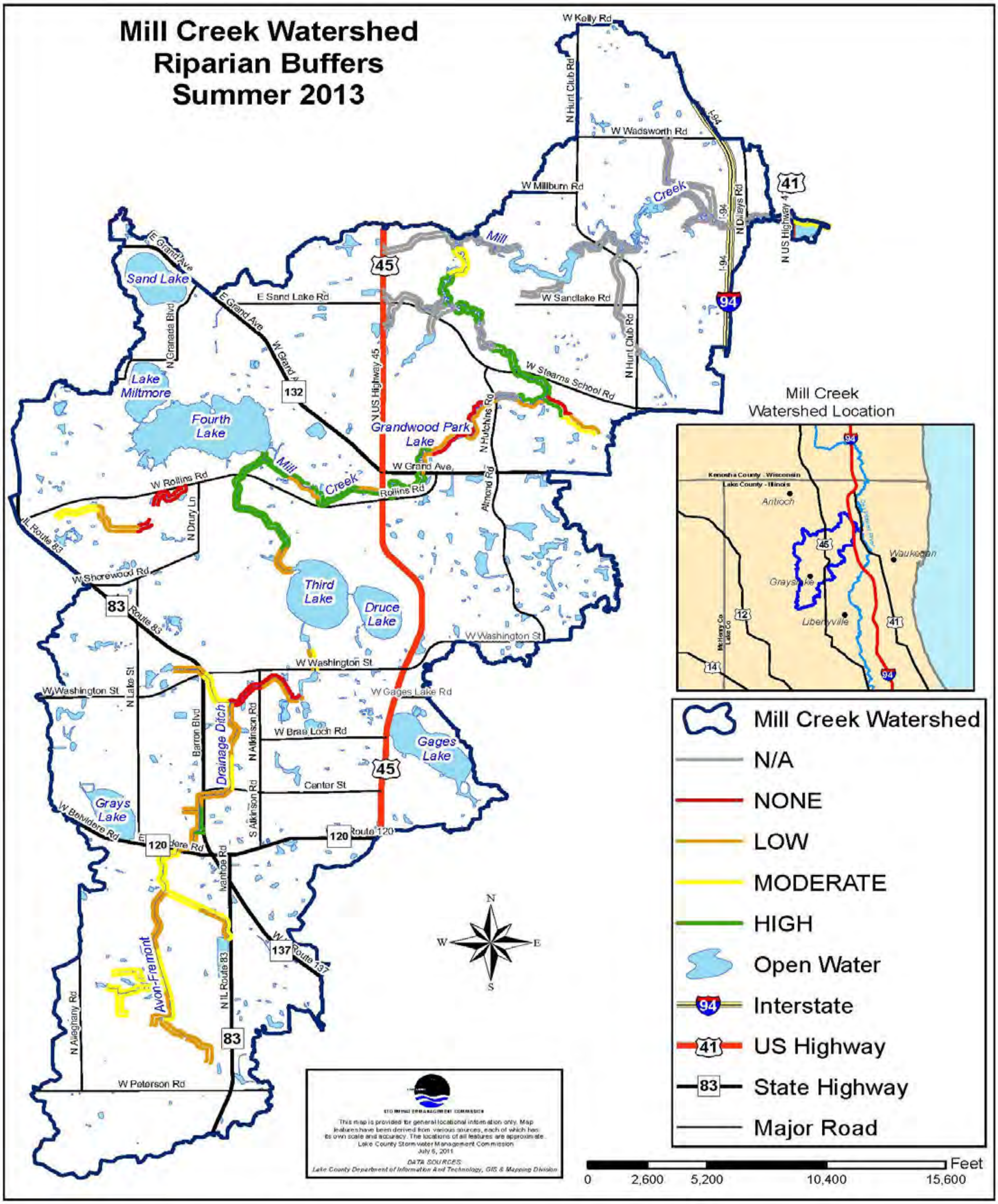


Figure 3-25: Riparian Buffers.

3.12 LAKE INVENTORY

The Mill Creek Watershed includes more than 1,485 acres of open water. Open water generally includes all lakes, ponds, streams, and wetlands with open water surfaces. In addition, there are numerous detention ponds and natural ponds in this watershed that have not been studied or listed to date. Eleven lakes in the watershed have been monitored by the Lake County Health Department – Ecological Services (LCHD-ES): Bittersweet, College Trail, Druce, Fourth, Gages, Grandwood Park, Grays, Sand, Miltmore, Third and Willow (**Figure 3-26**). Of the assessed lakes 2011 data is incorporated into this report except for Bittersweet Lake and College Trail Lake which were last assessed in 2004 and Willow Lake which was last assessed in 2003.

Reports completed by LCHD-ES indicate that a variety of conditions in the Mill Creek Watershed lakes. Several of the glacial lakes are in above average condition when compared to other County lakes. However, some of the man-made lake are in poor condition and are impaired for at least one water quality parameter. Median information is available based on the results obtained by the LCHD-ES from 2000 through 2011. Copies of detailed lake reports, including historical data on all of the lakes, can be obtained from http://health.lakecountyil.gov/Population/LMU/Pages/Lake-Reports.aspx.

Threats to the lakes can be described as coming from both external and internal sources. External sources include pollutant and nutrients draining into the lake from the watershed such as stormwater runoff, fertilizers, and erosion. Once in the lake, many of these pollutants and nutrients stay in the lake for long periods of time. Internal processes in the lake then recycle many of the pollutants, particularly nutrients such as nitrogen and phosphorus. Plants and algae take up the nutrients, but once they die and decompose, the nutrients are recycled back into the system. In addition, if a lake exhibits anoxic conditions (less than 1 mg/L dissolved oxygen) at the bottom of the lake, additional processes take place that make additional nutrients and metals available in the water column. Thus, lake management must consider both the external and internal issues and lake restoration objectives should be included in a watershed management plan.

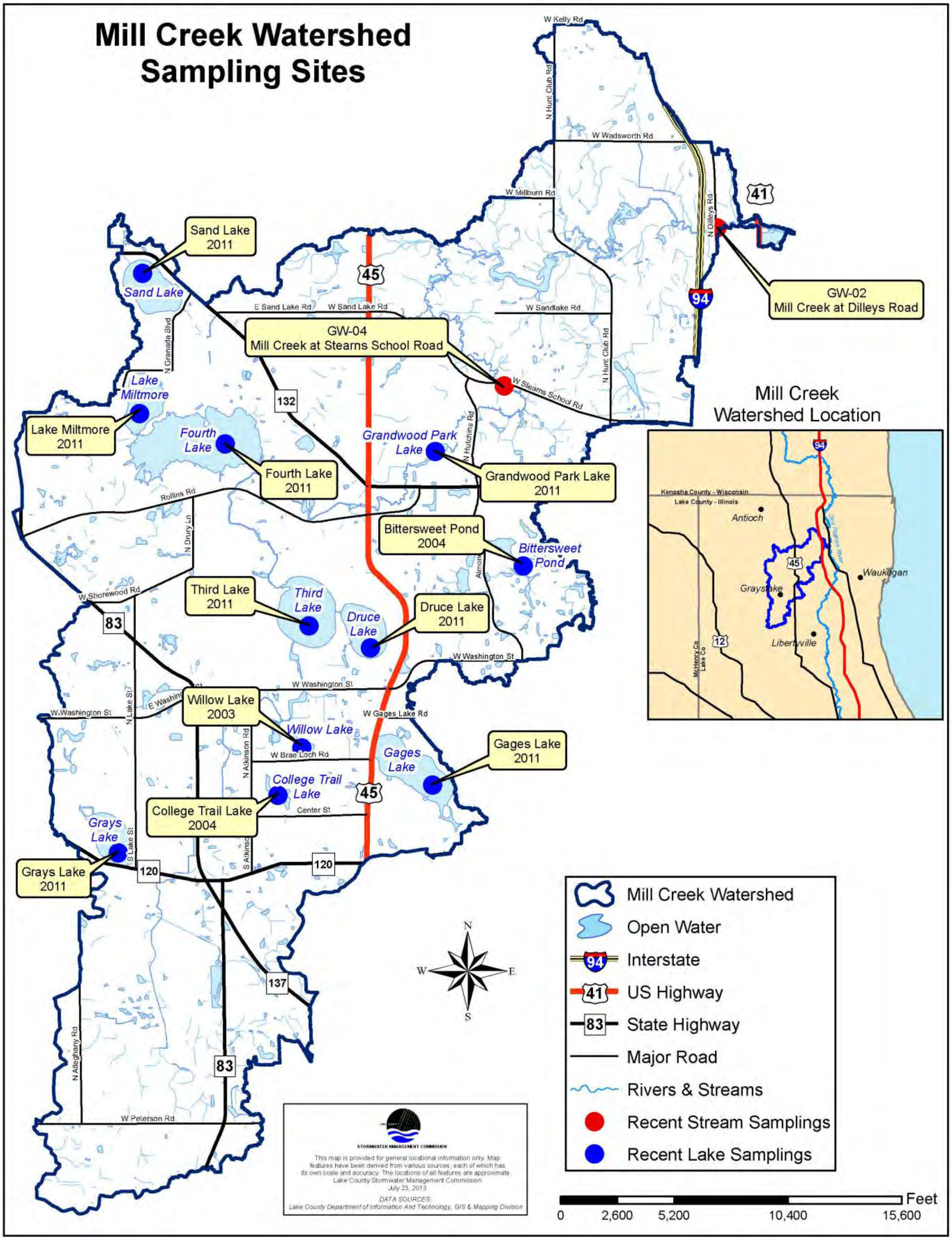


Figure 3-26: Lakes in the Mill Creek Watershed.

3.12.1 SHORELINE EROSION

According to the LCHD-ES, most lakes in the county have eroded shorelines with invasive plant species as shown in **Table 3-28** and depicted on **Figure 3-27**.

Table 3-28: Erosion of Lake Shorelines.

Lake	Year Assessed	% of Lake Developed	% of Lake with Erosion	% Slight	% Moderate	% Severe
Bittersweet Pond #3	2004	100%	0%	0%	0%	0%
College Trail Lake	2004	100%	93%	91%	2%	0%
Druce Lake	2011	62%	40%	27%	8%	5%
Fourth Lake	2011	NR	NR	NR	NR	NR
Gages Lake	2011	100%	18%	17%	1%	0%
Grandwood Park Lake	2011	100%	63%	0%	23%	40%
Grays Lake	2011	100%	19%	6%	6%	7%
Lake Miltmore	2011	100%	52%	44%	7%	1%
Sand Lake	2011	86%	44%	29%	3%	12%
Third Lake	2011	63.9%	32%	12%	12%	8%
Willow Lake	2003	100%	23%	23%	0%	0%

Noteworthy: Shoreline Erosion

Shoreline erosion usually increases as deep-rooted native vegetation is replaced by shallow-rooted non-native vegetation such as turf grass. Erosion not only results in loss of shoreline, but also negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. Additionally, turf grasses or constructed seawalls provide little habitat for wildlife and do not serve as a natural buffer to filter runoff. As suburban development increases in this area, it can be assumed that increased phosphorus loading and surface runoff will occur, resulting in increased algal blooms and decreased water quality (Novotny, 1995).

Noteworthy: Shoreline Assessment

A complete assessment of shoreline was completed on lakes monitored between 2000 and 2004. Other years, only degree of shoreline erosion was assessed. The degree of shoreline erosion was categorically defined as none, slight, moderate, or severe. Below are brief descriptions of each category.

None – Includes man-made erosion control such as beach, rip rap, and sea wall.

Slight – Minimal or no observable erosion; generally considered stable; no erosion control practices will be recommended with the possible exception of small problem areas noted within an area otherwise designated as "slight".

Moderate – Recession is characterized by past or recently eroded banks; area may exhibit some exposed roots, fallen vegetation or minor slumping of soil material; erosion control practices may be recommended although the section is not deemed to warrant immediate remedial action.

Severe – Recession is characterized by eroding of exposed soil on nearly vertical bans, exposed roots, fallen vegetation, or extensive slumping of bank material, undercutting, washouts, or fence posts exhibiting realignment; erosion control practices are recommended and immediate remedial action may be warranted.

Figure 3-27: Example of shoreline erosion on Gages Lake, 2011 (green = none, yellow = slight, orange = moderate, red = severe).

3.12.2 AQUATIC PLANTS

Aquatic plant diversity is an important part of a healthy ecosystem. The lakes in this study had relatively poor plant diversity. Several lakes had more than 10 species, while some had none. Nearly all had at least one non-native invasive species, either Curlyleaf Pondweed (*Potamogeton crispus*) or Eurasian Watermilfoil (*Myriophyllum spicatum*). Most of these lakes are glacial in origin, so it is assumed that historically the aquatic plant diversity was higher. Most of the lakes have been significantly altered by anthropogenic means. The introduction of carp and use of aquatic herbicides are the main causes of species decline. The management entities of these lakes include a diverse group including private owners, homeowner association, municipalities, townships, and government agencies (i.e., LCFPD, IDNR). All are trying to balance recreational uses with ecologic health. The management of the lakes for aquatic vegetation is critical to the future condition and potential uses of the lakes. The LCHD-ES lake surveys results are shown in **Table 3-29** and depicted on **Figure 3-28**.

Table 3-29: Aquatic vegetation density and percentage of exotic species.

Lake	Year Assessed	Rake Density	Percentage of Sampled Sites	Percentage of Sampled Sites
Bittersweet Pond #3	2004	NR	0.0%	0.0%
College Trail Lake	2004	NR	0.0%	0.0%
Druce Lake	2011	67.7%	3.0%	29.3%
Fourth Lake	2011	96.5%	9.2%	12.7%
Gages Lake	2011	72.5%	19.4%	39.4%
Grandwood Park Lake	2011	100%	18.6%	53.5%
Grays Lake	2011	47.3%	0%	0%
Lake Miltmore	2011	49.5%	2.2%	37.4%
Sand Lake	2011	66.7%	14.4%	49.5%
Third Lake	2011	48.1%	1.9%	30.2%
Willow Lake	2003	0.0%	0%	0%

Noteworthy: Plant Sampling

In order to randomly sample each lake, mapping software (ArcMap 9.3) overlaid a grid pattern onto an aerial photo of Lake County and placed points 60 or 30 meters apart, depending on lake size. Plants were sampled using a garden rake fitted with hardware cloth. The hardware cloth surrounded the rake tines and is tapered two feet up the handle. A rope was tied to the end of the handle for retrieval. At designated sampling sites, the rake was tossed into the water, and using the attached rope, was dragged across the bottom, toward the boat. After pulling the rake into the boat, plant coverage was assessed for overall abundance. Then plants were individually identified and placed in categories based on coverage. Plants that were not found on the rake but were seen in the immediate vicinity of the boat at the time of sampling were also recorded.

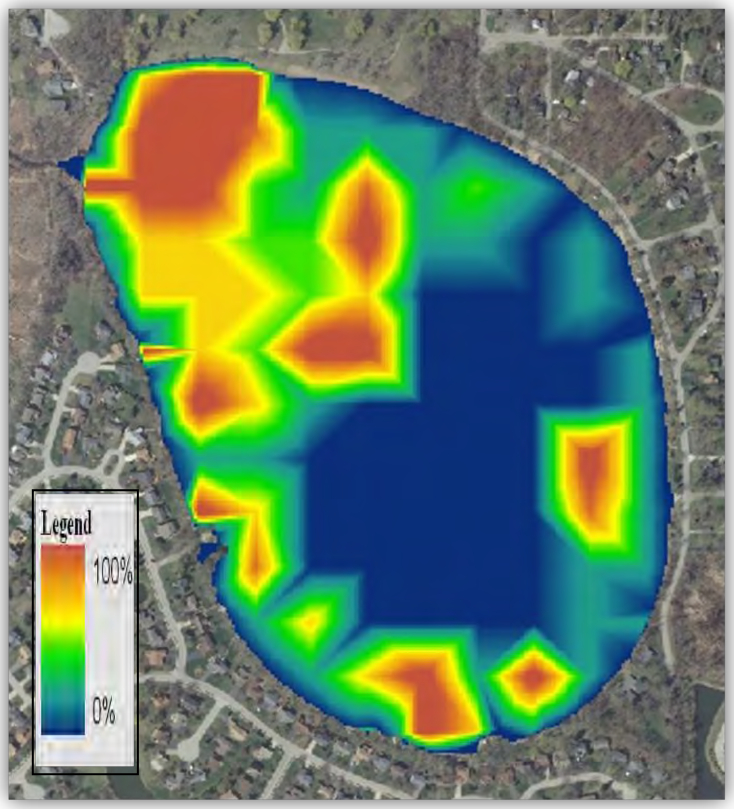


Figure 3-28: Example of aquatic plant density on Druce Lake, 2011.

Noteworthy: Floristic Quality Index

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and plant species found in a lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species or a good diversity of plants present in a lake. (LCHD-ES Reports).

3.12.3 FLORISTIC QUALITY INDEX

Floristic quality as measured by FQI is summarized in **Table 3-30** for all watershed lakes.

Table 3-30: Floristic Quality Index.

Lake	Year Assessed	FQI (all)	FQI (native)	FQI County Ranking (out of 154)
Lake County Median	2000- 2011	14.3	13.1	
Bittersweet Pond #3	2004	8.1	8.1	139
College Trail Lake	2004	10.0	10.0	120
Druce Lake	2011	19.1	21.8	27
Fourth Lake	2011	24.7	27.1	10
Gages Lake	2011	10.2	12.5	97
Grandwood Park Lake	2011	17.2	19	40
Grays Lake	2011	16.1	16.1	64
Lake Miltmore	2011	16.8	18.7	42
Sand Lake	2011	8	10.4	119
Third Lake	2011	21.4	24.0	28
Willow Lake	2003	0.0	0.0	154

3.12.4 INDIVIDUAL LAKE SUMMARIES

The majority of the following information is derived from lake summary reports prepared by the LCHD-ES.

Bittersweet Pond #13

Bittersweet Golf Course Lake #13 is a private lake located within the Bittersweet Golf Course in Gurnee (Warren Township). It was sampled by LCHD-ES in 2004.

> *Noteworthy:* Typical parameters assessed
>
> - Temperature
> - Dissolved Oxygen (DO)
> - Chlorides and Conductivity
> - pH
> - Nitrogen and Total Kjeldahl Nitrogen
> - Phosphorus, Total Nitrogen to Total Phosphorus ratios
> - Trophic State Index (TSI)
> - Total Suspended Solids (TSS)/Turbidity
> - Water Clarity / Secchi Depth (applicable in lakes only)
> - Fecal Coliform (*E. coli*)
> - Metals

Bittersweet Lake's watershed is approximately 604 acres, and has a watershed to lake ratio of 96:1. Bittersweet Lake encompasses approximately 6.3 acres and has a shoreline length of 0.52 miles. The current maximum depth was determined to be 17.4 feet, as measured in May 2004.

Water clarity, as measured by Secchi disk transparency readings, averaged 1.98 feet for the season, which is 36% below the 2004 county median (where 50% of the lakes are above and below this value) of 3.08 feet. The deepest reading was recorded in June (4.27 feet) and the shallowest recorded in September (1.05 feet). The decline in clarity over the season can be attributed primarily to the reduction in water volume in the lake that occurred after June. On August 12, 2004 the boundary of the shoreline was mapped and determined the surface area decline by 70%, going from 6.3 acres (May) to 1.9 acres (August).

Bittersweet Lake had high concentrations of total suspended solids, total phosphorus, and total Kjeldahl nitrogen. All of these parameters were well above county medians. These parameters increased in concentration as the water levels declined. The problems were exacerbated by the presence of carp, which resuspended bottom sediments.

Aquatic plants were scarce in Bittersweet Lake. Only three aquatic plant species and several emergent shoreline plants were found. The lack of plant is due to the poor clarity caused by carp activity.

The entire shoreline of Bittersweet Lake was classified as developed. Wetland habitat was the dominant shoreline type consisting of 73% of the shoreline. Buffer habitat was the next most common type at 23%. The remaining 4% consisted of riprap. Due to the shoreline types around the lake, there was no erosion noted.

Several exotics were found growing along the shoreline, including purple loosestrife and reed canary grass. Removal or control of these exotic species is recommended.

College Trail Lake

College Trail Lake is a private lake located within the College Trail Subdivision in Grayslake (Avon Township). College Trail Lake's watershed is approximately 784 acres, and has a watershed to lake ratio of 92:1. It was sampled by LCHD-ES in 2004.

Water clarity, as measured by Secchi disk transparency readings, averaged 2.18 feet for the season, which is 29% below the 2004 county median (where 50% of the lakes are above and below this value) of 3.08 feet. This was due primarily to the high total suspended solid concentrations (seasonal average of 12.4 mg/L) that were 57% higher than the 2004 county median of 7.9 mg/L. This is not surprising since the lake has a highly urbanized watershed and serves as the main stormwater detention for the subdivision. Stormwater usually contains sediment, nutrients, and pollutants from the surrounding residential area.

College Trail Lake also had high concentrations of total dissolved solids (TDS) and high conductivity readings. The 2004 epilimnetic average for TDS was 497 mg/L, which is 10% higher than the 2004 county median of 454 mg/L. The 2004 average conductivity reading in the epilimnion was 0.8878 milliSiemens/cm, which is 16% higher than the 2004 county median of 0.7652 milliSiemens/cm. The May sample had the highest values for the season (TDS=691 mg/L, conductivity=1.300 milliSiemens/cm) and probably due to the heavy spring rains. The most likely cause for these high TDS concentrations and conductivity readings is input from dissolved solids washed into the lake from storm events. One of the most common dissolved solids is road salt used in winter road deicing.

Aquatic plants in the lake were scarce. The limited aquatic vegetation in the lake is likely due to the hard substrate of the lake bottom, the steep slopes of the near shore areas, and the limited light penetration to the lake bottom.

The entire shoreline of College Trail Lake was classified as developed. Lawn habitat was the most common shoreline type consisting of 88% of the shoreline. Riprap shoreline was the next most common type at 7%. The shoreline was assessed for the degrees and types of shoreline erosion. Over 90% (4,767 feet) of the shoreline was classified as slightly eroding, but only 95 feet (1.8%) of the shoreline was classified as moderately eroding. There were no areas around the lake that were classified as severely eroding.

Druce Lake

Druce Lake, located partially in Avon Township and partially in Warren Township, is a glacial lake that was dammed in 1958. Approximately 2/3 of the lake is located within the Village of Third Lake. The lake is dominated by a residential shoreline and is managed by the Village of Third Lake.

Druce Lake has a surface area of 88.3 acres with a mean of 9.3 and maximum depths of 32.5 feet. It is used by residents for swimming, fishing, and aesthetics, with a boat launch on the south shore and many beaches around the perimeter of the lake. No gas motors are permitted on the lake.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature, water clarity were measured from May-September 2011. The plant community was assessed in July when most of the plants are likely to be present. There were some water quality parameter changes since 2001 which may have been caused by the introduction of zebra mussels in 2004.

Total phosphorus in Druce Lake averaged 0.014 mg/L which is a 41% decrease from the 2001 concentration of 0.024 mg/L and significantly lower than the Illinois Environmental Protection Agency (Illinois EPA) impairment rate of 0.050 mg/L.

Nitrogen is the other nutrient critical for algal growth. The average Total Kjeldahl nitrogen (TKN) concentration for Druce Lake was 0.60 mg/L, which was lower than the county median of 1.18 mg/L and the 2001 concentration by 39.4% (0.99 mg/L). A total nitrogen to total phosphorus (TN:TP) ratio of 49:1 indicates that phosphorus was the nutrient limiting aquatic plant and algae growth in Druce Lake.

By using phosphorous as an indicator, the trophic state index (TSIp) ranked Druce Lake as mesotrophic with a TSIp value of 42.41. This means that the lake is a moderately enriched system with good water quality. The 2011 average TSS concentration for Druce Lake was 1.7 mg/L, which was less than the county median and a 22.7% decrease from the 2001 average of 2.2 mg/L. Water clarity was measured by Secchi depth, with the lowest reading in May (6.5 ft.) and the highest was in June (18.80 ft.). The average Secchi depth for the season was 12.25 ft., which was deeper than the 2011 county median (2.95ft).

The conductivity of Druce Lake was 1.1650 mS/cm which is higher than the 2011 county median (0.7821 mS/cm). This was a 4% decrease from the 2001 average (1.2136mg/L). The chloride concentration in Druce Lake in 2011 was 276 mg/L which was higher the county median of 145 mg/L. Druce Lake has a large watershed that contributes to the high concentrations of chloride in the lake primarily from road salts. Conductivity was much higher than the county average and had increased dramatically since 1996.

Druce Lake has a diverse and healthy plant community, with 14 different aquatic plant species observed covering 68% of the lake. Curlyleaf pondweed and Eurasian Watermilfoil (EWM), which are both non-native plants, were also present. Zebra mussels were discovered in Druce Lake may have entered the lake via storm flow from Gages Lake or transferred by a boat and trailer. These are exotic and invasive species that tend to crowd out native species when left untreated.

Gages Lake

Gages Lake, located in Warren Township, is a glacial lake, created over 10,000 years ago by receding glaciers. The lake has a surface area of 143.4 acres and mean and maximum depths of 6.7 feet and 54 feet, respectively. It is located entirely in unincorporated Lake County and is predominantly managed by the Gages Lake Conservation Committee (GLCC) and the Wildwood Park District. It is used by residents for swimming, boating and fishing. There are a small number of beaches, parks and boat launches on the lake.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature, and water clarity were measured and the plant community was assessed each month from May-September 2011. Many water quality parameters have improved since the 2003 lake study. Total phosphorus in Gages Lake averaged 0.020 mg/L which is a 41% decrease from the 2006 concentration of 0.034 mg/L and significantly below the Illinois Environmental Protection Agency impairment rate of 0.050 mg/L. Nitrogen is the other nutrient critical for algal growth. The average Total Kjeldahl nitrogen concentration for Gages Lake was 0.97 mg/L, which was below the 2011 county median of 1.18 mg/L and lower than the 2006 concentration by 17% (1.17 mg/L). A total nitrogen to total phosphorus (TN:TP) ratio of 52:1 strongly indicates phosphorus was the nutrient limiting aquatic plant and algae growth in Gages Lake. Also using phosphorus as an indicator, the TSIp ranked Gages Lake as mesotrophic with a TSIp value of 47.2.

The 2011 average TSS concentration for Gages Lake was 4.8 mg/L, which was less than the county median and down from the 2006 average of 7.0 mg/L. Water clarity was measured by Secchi depth, with the lowest reading in August (3.00 feet) corresponding to the highest TSS concentration (9.4 mg/L). The average Secchi depth for the season was 5.45 feet, which was also higher than the county median (2.95 feet).

Conductivity concentrations, are correlated with chloride concentrations, the average conductivity reading for Gages Lake in 2011 was 1.0223 mS/cm, which was above the county median (0.7821 mS/cm). This was a 24% decrease from the 2006 average (1.3440 mg/L). The chloride concentration in Gages Lake in 2011 was 246 mg/L which was significantly above the county median of 145 mg/L.

Aquatic plant sampling was conducted on Gages Lake in July. Seven species of submerged aquatic plants and one macro-algae were present covering 73% of the lake bottom. Similar to 2006 EWM was the dominant species with plants present at 39% of the sites. Curlyleaf Pondweed was also found in the lake. EWM and Curlyleaf Pondweed are invasive, exotic species that tend to crowd out native species.

The shoreline of Gages Lake was assessed in 2011 for erosion. Approximately 31% of the shoreline had some degree of erosion. Overall, 69% of the shoreline had no erosion, 10% had slight erosion, 10% had moderate, and 11% had severe erosion.

In an effort to improve the sport fishery and overall water quality, a carp removal program has been implemented on Gages Lake. Carp are selectively removed by the IDNR through electrofishing or by the Gages Lake Improvement Association through carp angling events. These actions are a result of fishery surveys indicating that the carp population is predominant and negatively impacting other species of native fish.

Fourth Lake

Fourth Lake is one of the larger glacial lakes in Lake County, encompassing approximately 305 acres with a shoreline length of 5.4 miles. However, it is very shallow with a maximum depth of five feet and an average depth of 2.75 feet. It is primarily used for non-motorized recreation and duck hunting. LCHD-ES has sampled the lake in 1998, 2000, and 2011.

Due to its shallow nature, aquatic plant populations can be extensive. In 2011, 18 species of aquatic plants and one macro-algae were found, making it one of the most botanically diverse lakes in Lake County. However, both Curlyleaf Pondweed and EWM are present. EWM has played a significant role in the lake as it has dominated the plant community in the past. The milfoil weevil is present in the lake and is thought to alter the densities of EWM from time to time. While EMW was found in only 12.7% of the sample sites in June 2011, it was much more dominant in May (although not quantified). Some weevil damage was noticed, but it is unclear if this alone cause the decline in EWM from May to the late June sampling data. No known active plant management occurs on Fourth Lake.

Water quality is generally good, although dependent on aquatic plant coverage. During heavy plant coverage, parameter results from water clarity, total phosphorus and suspended solids indicate good water quality. However, when plant populations are depressed, the water quality declines. This is due to the long fetch of the lake, coupled with the shallow depths, which can resuspend bottom sediments during storm events Attached to these sediments can be nutrients such as phosphorus. In 2011, the average Total Phosphorus concentration in Fourth Lake was 0.036 mg/L.

Specific conductivity has increased in Fourth Lake. The 2011 average reading was 1.0348 mS/cm which is a 52% increase from the 2000 average (0.6810 mS/cm).

The fishery of Fourth Lake has been sampled twice in recent years, once in 2008 and again in 2013 following a documented fish kill in 2011. The fish kill was thought to be related to anoxic conditions that naturally and periodically occur in shallow, weedy lakes during winter (and not a result of catastrophic water pollution). Because of Fourth Lake's connection to Lake Miltmore and Mill Creek, the fishery is expected to recover some diversity beyond what might be expected of a smaller, isolated shallow, weedy lake. However, the 2013 survey suggested that populations of "sport" species such as largemouth bass and northern pike were still depressed as a result of the fish kill.

Grandwood Park Lake

Water enters Grandwood Park Lake from Mill Creek at the western end of the lake. Prior to entering the lake, Mill Creek flows through Third Lake and receives water from Fourth Lake. Mill Creek leaves Grandwood Park Lake through a spillway at the eastern end of the lake, eventually flowing into the Des Plaines River. At least two stormwater pipes enter the lake.

Grandwood Park Lake has a surface area of 8.5 acres with a mean depth of one foot and maximum depths of 3.5 feet. The residents of Grandwood Park use the lake primarily for aesthetics and fishing. The park adjacent to the lake has picnic facilities and a walking path.

There were some water quality parameter changes since 2000 which may have been caused by sedimentation of the lake. Total phosphorus in 2011 at Grandwood Park Lake averaged 0.072 mg/L at the inflow and 0.096 mg/L at the outflow which is a 30.5% decrease and 2.08% increase from the 2000 concentration of 0.094 mg/L at the inflow and 0.088 mg/L at the outflow. These are above the Illinois Environmental Protection Agency impairment rate of 0.050 mg/L.

Nitrogen is the other nutrient critical for algal growth. The average TKN concentration for Grandwood Park Lake inlet was 0.99 mg/L and 1.17 mg/L for the outlet, which is lower than the 2000 TKN of 1.21 mg/L for the inlet and 1.28 mg/L for the outlet. The 2011 figures are lower than the county median of 1.18 mg/L. A total nitrogen to total phosphorus (TN:TP) ratio of 16:1 indicates that phosphorus was the nutrient limiting aquatic plant and algae growth in Grandwood Park Lake.

By using phosphorous as an indicator, the TSIp ranked Grandwood Park Lake as eutrophic with a TSIp value of 66 at the inlet. This means that the lake is a moderately enriched system with poor water quality. The 2011 average TSS concentration for Grandwood Park Lake was 10.94 mg/L at the inlet and 10.70 mg/L at the outlet which was a decrease from the 2000 average of 15.4 mg/L at the inlet and 11.0 at the outlet. However, TSS was still higher than the county median of 8.6 mg/L.

The conductivity of Grandwood Park Lake was 0.9868 mS/cm which is higher than the 2011 county median (0.7821 mS/cm). This was a 29% increase from the 2000 average (0.7679 mg/L). The chloride concentration in Grandwood Park Lake in 2011 was 202 mg/L which was higher the county median of 145 mg/L. Grandwood Park Lake has a large watershed that contributes to the high concentrations of chloride in the lake primarily from road salts. Conductivity was much higher than the County average and had increased dramatically since 1996.

Grays Lake

Grays Lake is a natural glacial lake of approximately 80 acres with a shoreline length of two miles. It has a maximum depth of 17.3 feet. The 2011 average water clarity in Grays Lake was 4.08 feet; this was similar to the 1996 average (4.40 feet) and less than half the lake's 2002 average transparency of 8.46 feet. However the 2002 average was influenced by an unusual Secchi depth in June of 15.10 feet. This deeper Secchi depth might have been caused by the low concentrations of suspended solids, such as planktonic algae and sediment due to the extensive growth of curly leaf pondweed throughout the lake in May and June of that year. Aquatic plant populations have historically been actively managed in Grays Lake. In 2011, a fluridone treatment was made which kept plant populations low.

2011 TSS concentrations averaged 6.2 mg/L which was below the county median of 8.6 mg/L and a 53% increase from the 2002 average concentration of 2.9 mg/L. High TSS values are typically correlated with poor water clarity (Secchi disk depth) and can be detrimental to many aspects of the lake ecosystem including the plant and fish communities. Aquatic plant densities in 2011 were lower than in 2002.

In 2011, Grays Lake average conductivity was 0.7620 mS/cm. This parameter was below the county median of 0.7821 mS/cm and 13% decrease from the 2002 value 0.8738 mS/cm. One of the most common dissolved solids is road salt used in winter road deicing. Most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. Grays Lake 2011 average chloride concentration was 147 mg/L. Conductivity and chloride concentrations were the only parameters in 2011 that exceeded county medians. These values are influenced by the winter road maintenance of Route 120. However a key factor in Grays Lake lower chloride concentrations is the lake's small watershed.

Lake Miltmore

Lake Miltmore is an approximately 84.4 acre glacial lake located in Lake Villa Township. The land around the lake was settled in the 1830's and after construction of the Wisconsin Central Railway in 1877, summer cottages began to colonize the landscape surrounding the lake. The area began to be developed in earnest in the 1920's and continued throughout the 40's. In 1929 the Venetian Village Homeowners Association (VVHA) formed and remains active today. In 1980, the Lake Miltmore Property Owner's Association (LMPOA) formed and together with the VVHA and the Lake Villa Township participate in the decision making process regarding management of the lake.

Historically, Lake Miltmore had many beach closures; this was mainly due to failed septic systems from residences along the lake. In 2011, there was only one beach closure, this occurred after a rain event and is assumed to be related to that event. Most, if not all septic system failures occurring on lakefront properties were repaired. Lake Miltmore's watershed is primarily residential. The water quality of the lake has changed very little over the past sixteen years based upon monitoring of the lake during 1995, 1999, 2003 and in 2011. Variations in quality seem to be driven by wet and dry years, with exception of conductivity which has exhibited increased concentrations being reported during LCHD-ES monitoring years. Lake Miltmore discharges directly to Fourth Lake via a culvert.

Sand Lake

Sand Lake is a glacial lake, created over 10,000 years ago by receding glaciers, located partially in the Village of Lindenhurst and partially in unincorporated Lake Villa Township. The lake has a surface area of 100.0 acres and mean and maximum depths of 8.6 and 31.2 feet, respectively. Sand Lake is managed by the Sand Lake Property Owners Association (SLPOA) and Lake Villa Township. Access is open to residents of Lake Villa Township through the Lake Villa Township Beach, Park and Boat Launch (with the purchase of a key). The general public can access the lake through the Lake County Forest Preserve District parcel on the northwest side of the lake. The lake's main uses are boating, swimming and fishing.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature, and water clarity were measured and the plant community was assessed each month from May-September 2011. Most water quality parameters have slightly increased since the 2004 lake study. Total phosphorus in Sand Lake averaged 0.038 mg/L which is a 5% increase from the 2004 concentration of 0.032 mg/L and significantly below the Illinois Environmental Protection Agency impairment concentration of 0.050 mg/L. Nitrogen is the other nutrient critical for algal growth. The average Total Kjeldahl nitrogen concentration for Sand Lake was 1.23 mg/L, which was higher than the 2011 county median of 1.18 mg/L and the 2004 concentration by 24% (1.23 mg/L). A TN:TP ratio of 33:1 indicates phosphorus was the nutrient limiting aquatic plant and algae growth in Sand Lake. Also using phosphorus as an indicator, the TSIp ranked Sand Lake as eutrophic with a TSIp value of 56.5, ranking Sand Lake 40th out of 171 lakes in Lake County.

The 2011 average TSS concentration for Sand Lake was 5.0 mg/L, which was less than the county median (8.6 mg/L) and a 33% increase from the 2004 average of 3.3 mg/L. Water clarity was measured by Secchi depth, with the lowest reading in August (0.90 feet) corresponding to the highest TSS concentration (12 mg/L). The average Secchi depth for the season was 7.48 feet, which was also higher than the county median (2.95 feet).

Conductivity concentrations, are correlated with chloride concentrations, the average conductivity reading for Sand Lake in 2011 was 0.6652 mS/cm, which was below the county median (0.7821 mS/cm). This was a 6% increase from the 2004 average (0.6248 mg/L). The chloride concentration in Sand Lake in 2011 was 129 mg/L which was below the county median of 145 mg/L.

Aquatic plant sampling was conducted on Sand Lake in July. Five species of submerged aquatic plants and one macro-algae were present covering 67% of the lake bottom. There was a significant increase in Coontail since 2004. Both Coontail and Eurasian Watermilfoil were abundant. The two exotic species found in the lake were Eurasian Watermilfoil and Curlyleaf Pondweed; these species are invasive and tend to crowd out native species.

Third Lake

Third Lake is a natural glacial lake, encompassing approximately 155.5 acres and a shoreline length of 1.98 miles. It is the deepest lake in the county at 70 feet. It has been one of the most studied lakes in Lake County. LCHD-ES has monitored the lake in 1993, 1998-2000, and 2005-2011. Water clarity, as measured by Secchi disk transparency readings, averaged 5.73 feet for the season, which is the exact average for all years monitored. The clarity has remained relatively stable over the past 18 years.

TP concentrations have also remained relatively stable, with the 2011 average concentration (0.030 mg/L) which is close to the historic average (0.028 mg/L). In all years, TP was lowest early in the season (May) and highest in mid-summer (July-September).

Third Lake continues to have high concentrations of nitrate-nitrogen from May through July, in some cases more than ten times higher than the county epilimnetic median of 0.198 mg/L. The 2011 average concentration was (1.161 mg/L), slightly higher than the historic average (1.102 mg/L). The majority of the nitrate-nitrogen is thought to be entering the lake from the Avon-Fremont Drainage Ditch during spring and early summer runoff.

Conductivity readings in Third Lake continue to increase. The 2011 epilimnetic average for conductivity was 1.0467 milliSiemens/cm, which is higher than the county median of 0.7821 milliSiemens/cm, and a considerable increase from 1993 (0.6788 milliSiemens/cm). The seasonal average for chlorides in Third Lake in 2011 was 206 mg/L in the epilimnion and 236 mg/L in the hypolimnion. These numbers are down from the high of 318 mg/L in 2005 in the epilimnion and 451 mg/L in 2008 in the hypolimnion. The current concentrations of chlorides in Third Lake may be adversely affecting aquatic life in the lake.

In 2005, LCHD-ES reassessed the 2000 shoreline erosion survey and found some eroded areas had been remediated, but identified new areas of erosion around the lake. These eroded areas should be remediated to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls

The layered aeration system which was installed in 1999 has been an asset to the lake, increasing the oxic volume of the lake, but needs occasional modifications such as adjusting the air flow and position of the ports on the aerators. The dissolved oxygen concentrations are also influenced by climatic conditions such as precipitation in the watershed that leads to more inputs of nutrients, solids, and pollutants entering the lake.

Third Lake water quality is directly linked to precipitation events and the quality of the resulting runoff. This is due to the very large watershed (8,200 acres) that drains into Third Lake.

Willow Lake

Willow Lake, located in the Village of Grayslake, is a detention pond created in 1968 when the College of Lake County was being built. The lake is entirely contained on the grounds of the college and is surrounded by large upland and wetland buffer areas. The lake is not open to the public, but is used by members of the college for fishing and by several

Environmental Biology classes as a location for field work. Willow Lake has a surface area of 11.43 acres with mean and maximum depths of 6.0 and 11.9 feet, respectively. The lake receives water directly from two roof drains and the C-dock sump pump. Non-point sources of pollution include water from the golf course to the south, from soccer and baseball fields to the west, a fire station to the southeast and a residential neighborhood to the south.

Water quality parameters, such as nutrients, suspended solids, oxygen, temperature, and water clarity were measured and the plant community was assessed each month from May-September 2003. Willow Lake was mixed and stratified intermittently throughout the summer, and epilimnetic oxygen concentrations remained relatively high. The epilimnetic TP concentration was slightly lower than county median, but increased substantially throughout the summer. It appears that the TP concentrations are related to the amount of rainfall and subsequent lake level changes, as well as movement of phosphorus from bottom waters to surface waters. TSS levels were high all summer (over twice the county median value) and, as a result, Secchi depths (water clarity) were lower than the county median every month during the summer. Conductivity was much higher than the county median and is also thought to be related to the amount of rainfall and evaporation in the lake. Very little rain fell in the latter half of the summer, and lake levels decreased accordingly. This caused an increase in conductivity as dissolved solids were concentrated into a smaller volume of water. These elevated conductivity levels are cause for some concern, but there may not be much that lake managers can do to reduce them.

Aquatic plants were completely absent in Willow Lake, but a large number of emergent wetland plants and upland plant and shrub species were present along the shoreline. Buffer and prairie dominated the shoreline. Despite the high degree of beneficial shoreline type, 28% of the shoreline exhibited erosion. Most of the erosion was occurring along unmaintained buffer or shrubby shoreline. Buffer and shrub shorelines should be improved and maintained as much as possible. Invasive plant and tree species, including common buckthorn, purple loosestrife, honeysuckle, reed canary grass, bull thistle, and Queen Anne's lace were present along 59.3% of the shoreline. Steps should be taken to rid the lake of these plant species, as they do not provide quality wildlife habitat or erosion control.

3.13 DETENTION BASIN INVENTORY

In 2013, the SMC conducted a detention basin inventory on all areas that are being used for detention. These locations were identified using aerial image analysis and subsequently field verified to insure that these areas were man-made detention basins. Approximately 320 potential areas were identified and 194 were confirmed as detention basins. The location and year of construction (post or pre 1992) for each detention basin is illustrated in **Figure 3-29**. A summary of detention basin inventory can be found in Appendix C. The estimated storage volume of these detention basins is approximately 1319.28 acre-ft.

During the field verification process each basin was reviewed for the following information:

- Location (Latitude/Longitude)
- Size and drainage characteristics
- Design features
- Maintenance and design problems
- Potential safety problems
- Retrofit opportunities

The results of the inventory indicate that 172 of the 194 (88%) of the detentions basins would benefit from some type of improvement. The addition of rip rap, aerators, sediment control buffers, native vegetation, and the removal of woody vegetation and other debris would contribute to improving the overall water quality of these detention basins.

As demonstrated by Detention Basin Inventory, the majority of the detention basins (115/194) in the watershed were constructed post 1992 and fall under the jurisdiction of the WDO.

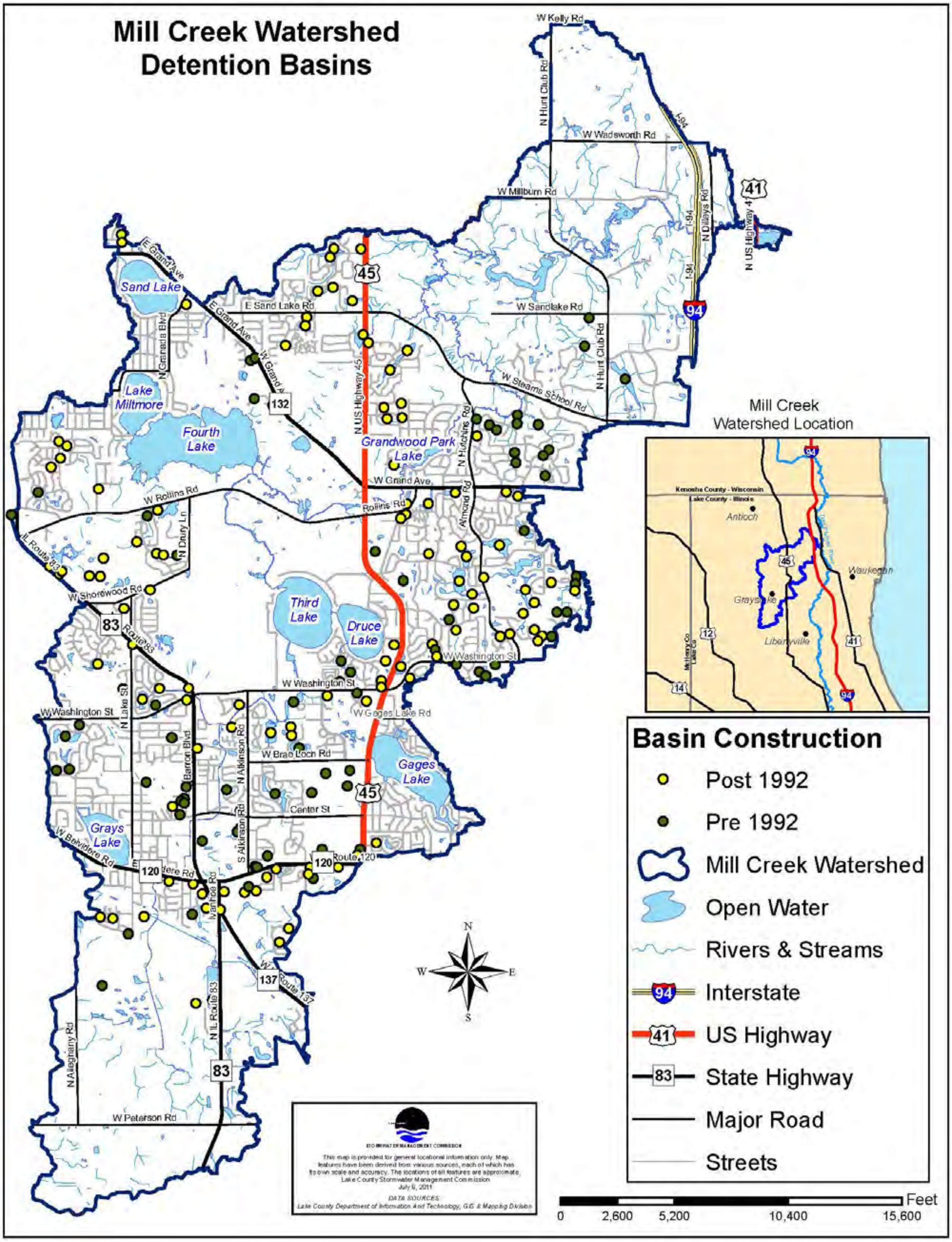


Figure 3-29: Detention Basins.

3.14 LAKE AND STREAM WATER QUALITY

Water quality refers to a waterbody's ability to support a variety of aquatic life and recreational uses such as swimming, fishing, boating, and drinking. Water quality assessments also incorporate the aesthetic value of the water body when determining its overall health. Water pollution reduces the health of aquatic ecosystems, including lakes and streams, and may be harmful to human health. Water quality is impacted by pollutants from a number of ***point*** and ***non-point sources***. During storms, pollutants on the landscape are washed from the ground and impervious surfaces into storm sewers, roadside drainage ditches, and natural drainageways and ultimately into the watershed's receiving streams and lakes.

Physical changes in the watershed, such as stream channelization and the loss of riparian vegetation and wetlands, reduce the ability of the natural drainage system to filter pollutants and infiltrate water into the ground, and contribute sediment and other pollutants to the stream and lakes, thereby reducing the quality of aquatic habitat. Water quality problems can be a result of many years of modification of the watershed landscape. These changes include modification of the stream channel, floodplain, wetlands, and other water resource-related landscape features.

Negative changes are also caused by an increase in watershed impervious cover (e.g., paving, concrete, rooftops) that has led to an increase in the volume and rate of runoff in the watershed. The increased quantity of runoff causes problems such as excessive stream bank erosion and the deepening of the stream channel due to in-stream erosion. In addition to increasing surface runoff, impervious surfaces reduce the amount of rainwater that infiltrates into the ground to recharge groundwater sources. This water quality summary includes information from water quality reports, data from stream inventories and recent water quality monitoring.

Non-Point Source Pollution (NPS): Pollutants that accumulate in waterbodies from a variety of diffuse sources including runoff from the land, impervious surfaces, the drainage system, and deposition of air pollutants.

Point Source Pollution: Discharges from a single source such as an outfall pipe conveying wastewater from an industrial plant or wastewater treatment facility.

Trophic State Index (TSI): A measure of the degree of plant material in a body of water. It is measured using several indices of biomass such as: Water Clarity (Secchi Depth), algal chlorophyll, and total phosphorus which are a measure of plant material in a water body.

Illinois Pollution Control Board (IPCB): An independent agency created in 1970 by the Environmental Protection Act. The Board is responsible for adopting Illinois' environmental regulations and deciding contested environmental cases.

Designated uses: The EPA requires that states and authorized Native-American Tribes specify appropriate water uses to be achieved and protected. These uses are determined by considering the values of the water body for public water supply, fisheries, recreational uses, industrial uses, navigational purposes, and the protection of fish and wildlife. The suitability of the body of water is determined by the chemical, physical biological characteristics exemplified by the water body. Characteristics necessary to support a use can be identified so that water bodies exhibiting similar characteristics can be grouped together in usage support categories.

Noteworthy: Water Quality Monitoring and Illinois Water Quality Standards

Water quality monitoring is conducted in lakes and streams, but differs depending on the parameters measured. Lakes are usually monitored for nutrients, suspended solids, water clarity, and dissolved oxygen. These measurements are used to analyze and develop ***Trophic State Indices (TSI)***. A TSI is an indicator of water quality for lakes and helps determine management strategies. Similar to lakes, streams are also monitored for nutrients, total suspended solids, and dissolved oxygen. However, flows are also monitored in order to assess the pollutant loading effects of various storm events.

Whether monitoring lakes or streams the overall objective is the same: To assess the existing conditions in order to restore or maintain the chemical, physical, and biological integrity of the body of water. The goal is met by monitoring for specific chemical, physical and biological parameters. Once collected, data for these parameters are compared to "General Use" water quality standards established by the ***Illinois Pollution Control Board (IPCB)***. These general use standards are designed to protect Illinois's water for aquatic life, wildlife, agricultural uses, secondary contact (swimming, drinking, etc.), and industrial uses. General Use standards are established to protect ***Designated Uses***. The Illinois State Water Quality Standards that apply to the pollutants identified as causing water quality impairments in the watershed are included in **Table 3-31**.

Table 3-31: Illinois State Water Quality Standards.

Parameter	Units	General Use
Dissolved Oxygen	Mg/L	March – July ≥5.0 minimum and ≥6.0 7-day mean August – February ≥3.5 minimum, ≥4.0 7-day mean and ≥5.5 30-day mean
Fecal Coliform	Count/100mL	May – October: 200, 400
Phosphorus	Mg/L	0.05
Total Suspended Solids		No standard

3.14.1 STUDIES AND SAMPLE LOCATIONS

Water quality studies have been completed by a few agencies within the Mill Creek waters. The sample site locations can be found in **Figure 3-30**. Water quality data gathering efforts on Mill Creek have been sporadic, both geographically and temporally, as summarized in **Table 3-32**. The most recent and most detailed data related to water quality regarding lakes has been collected by the Lake County Health Department – Ecological Services in relation to their lake studies. The most recent and most detailed data related to streams has been collected by the Lake County Department of Public Works in relation to its operation of the Mill Creek WRF. In addition to this work, monitoring data has historically been gathered by several agencies, including the USGS, IDNR, the Illinois EPA, and United States Army Corps of Engineers (USACE). The following is a list of recent monitoring efforts for Mill Creek.

Table 3-32: Summary of recent monitoring efforts in the Mill Creek watershed.

Year	Location(s)	Description	Source (Author)	Notes
1984*	Unknown	Fish	IDNR	No intolerant or threatened/endangered species collected
1990*	Dilleys Road	Water chemistry, fish and macroinvertebrates	IEPA/IDNR Basin Survey	No intolerant or threatened/endangered species collected
1995*	14 stations in Mill Creek and North Mill Creek Watersheds	Fish, macroinvertebrates and mussels	Hey & Associates/Western Illinois University for Lake County Public Works	Conducted prior to and in connection with construction of Mill Creek WRF
2000	Hunt Club Road	Contaminants in streambed sediments (48 parameters)	USGS	One-time grab samples, provisional data (not approved for official use)
2000-2001	Downstream of U.S. Route 41	Physical, chemical, microbiological parameters; fish and macroinvertebrates	USGS	One-time grab samples
2004	1 site above, 1 site below Third Lake Dam	Fish	USACE	Conducted in connection with the Des Plaines River Phase 2 Study
2007 and 2013	3 sites on Mill Creek	Water chemistry, fish, macroinvertebrates and mussels	Hey & Associates for Lake County Public Works	Conducted in connection with WRF expansion
2003, 2004, 2011	Lakes within the watershed	Lake surveys	LCHD-ES	Conducted on a five year rotating basis
2002-2013	Druce, Fourth, Gages, Grays, Miltmore, Sand, and Third Lakes	Fishery surveys	IDNR	Primarily conducted to assess quality of the sport fishery
2013	2 sites on Mill Creek	Fish	IDNR Basin Survey	Assess quality of stream fish community
1993, 2008, 2010,2011, 2013	Third and Gages Lakes	Samples	IEPA	Collected to determine level of contamination of fish for human consumption
*Data not available at time of publication, information and notes based on 2007 Hey & Associates report for Lake County Public Works.				

3.14.1.1 Water Quality Assessments

Various assessments of water quality in Mill Creek have been based on these and earlier studies. In its 1992-1993 Illinois Water Quality Report, the Illinois EPA characterized Mill Creek as partially supporting overall use and aquatic with minor impairments, while fully supporting fish consumption and swimming. At that time, causes of impairment described as "slight" were ammonia, chlorine, nutrients, and organic enrichment/dissolved oxygen. Causes listed as "moderate" were siltation and other habitat modifications. Municipal point sources, or wastewater treatment plants, were listed as a "moderate" cause of impairment, while agriculture, non-irrigated crop production, pasture land, construction, land development, urban runoff/storm sewers, hydrologic/habitat modification, and channelization were all listed as "slight" causes of impairment. The 1992-1993 assessment was based on data from 1976 and 1983, which Illinois EPA acknowledged was relatively old.

The next overall assessment of Mill Creek was in the Illinois EPA 1994-1995 Illinois Water Quality Report, using data collected in 1990. In this report, Illinois EPA characterized Mill Creek as fully supporting overall use, aquatic life, fish consumption, and swimming, thus indicating an improvement in water quality over the previous years. In subsequent assessments, Illinois EPA has not indicated any impairment for Mill Creek.

The only recent known sediment sampling of Mill Creek was performed in 2000 by USGS at the location of the present stream gauge station at Hunt Club Road. USGS analyzed sediment samples for 48 parameters (primarily metals), but considers the results "provisional" and subject to change. As of 2012, Illinois EPA does not use sediment chemistry guidelines for listing causes of aquatic life use impairment.

The largest amount of water quality data gathered since the mid-1990s has been related to the initial construction and the subsequent expansion of the Mill Creek WRF, operated by Lake County Public Works. It bears mentioning that this data gathering effort was designed with the operation of the WRF in mind, so the data should not be construed to be representative of conditions throughout the watershed. Because the WRF and all the water quality sampling locations are located (west) of Hunt Club Road near the downstream end of the watershed, the data does provide a characterization of the quality of water flowing from Mill Creek into the Des Plaines River.

Water samples were taken from two to three locations on Mill Creek and one location in the outfall channel of Mill Creek WRF on three separate occasions in 2007. These "grab samples" did not indicate any significant impairments to water quality. At the time the samples were taken, phosphorus levels were relatively high, particularly in the WRF outfall channel. Since that time, the WRF has been upgraded and now treats effluent for phosphorus. The only other water quality parameter noted as having an elevated value was conductivity. The data are summarized in **Table 3-33**, below.

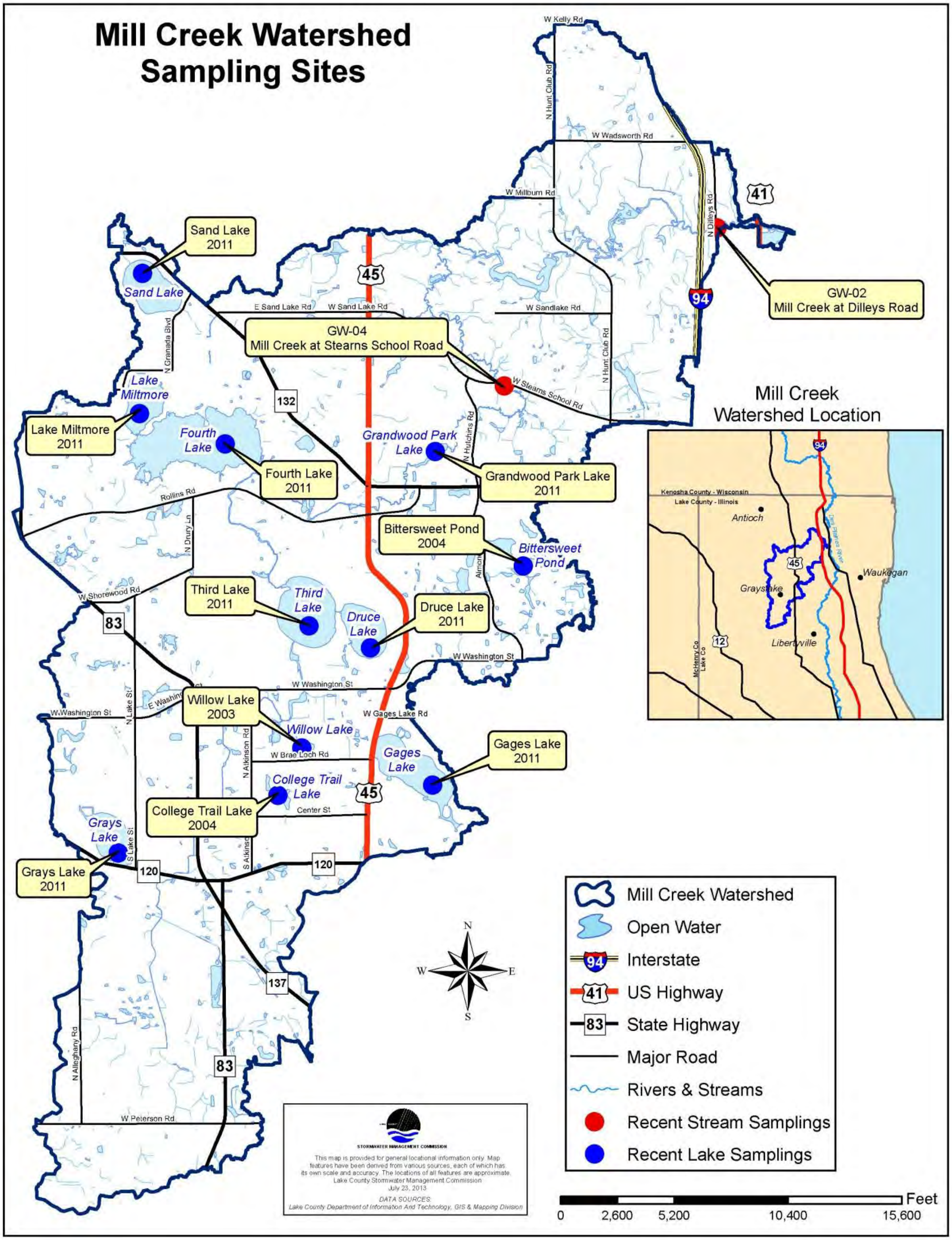


Figure 3-30: Sampling site locations in the Mill Creek Watershed.

Table 3-33: Mill Creek water chemistry sampling data, 2007 (from Hey & Associates, Inc., 2007).

Sample Date	29 May 2007				11 July 2007				18 September 2007			
Parameter	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
Total Phosphorus (mg/L)	0.189	4.28	--	0.358	0.275	4.24	0.268	0.468	0.202	2.73	0.209	0.22
Total Kjeldahl Nitrogen (mg/L)	1.91	<0.5	--	2.0	1.83	<0.5	1.79	1.85	1.32	<0.5	1.39	1.35
Ammonia-N (mg/L)	0.279	<0.1	--	0.248	0.365	<0.1	0.328	0.312	<0.1	<0.1	<0.1	<0.1
pH	8.12	7.92	--	8.11	8.11	7.85	8.09	8.11	No Data	7.56	8.12	8.12
Total Suspended Solids (mg/L)	51.2	2.9	--	58.0	65.8	8.0	62.0	74.4	51.8	3.7	47.2	46.4
Total Dissolved Solids (mg/L)	628	868	--	599	670	808	646	652	518	806	518	510
Temperature (°C)	21.1	19.1	--	22.2	28.2	22.2	27	26.1	18.5	19.1	18.6	18.7
*Dissolved Oxygen (mg/L)	6.86	10.7	--	6.93	6.78	8.4	6.75	6.43	8.83	6.65	7.64	7.68
Conductivity (µS/cm)	998	1,400	--	1,020	1,250	1,450	1,240	1,230	910	1,350	920	860
Chloride (mg/L)	159	211	--	162	206	189	206	207	114	162	115	117
Sulfate (mg/L)	57.4	139	--	61.0	55.3	129	54.0	54.9	37.7	124	36.8	36.5
Alkalinity (mg/L)	234	158	--	231	193	153	193	192	230	208	230	230
Hardness (mg/L)	322	344	--	322	288	315	286	286	277	347	297	297
Site 1: 300 ft. downstream of the dam impounding Mill Creek (Lake Elisabeth) and upstream of WRF												
Site 2: WRF outfall channel 120 ft. downstream from outfall structure and upstream of confluence with Mill Creek												
Site 3: 150 ft. below confluence of Mill Creek and outfall channel												
Site 4: Dilleys Road												
*All Dissolved Oxygen measurements are daytime field measurements												

In October 2013, follow-up monitoring was conducted, also by taking single-event "grab samples" at two locations on Mill Creek, one upstream of the Mill Creek WRF outfall channel at Hunt Club Road and the other 150 feet downstream of the WRF outfall channel. Results from the 2013 samples do not suggest any water quality impairments. The sample results are listed in **Table 3-34** below.

Table 3-34: Mill Creek water chemistry sampling data, October 2013 (from Hey & Associates, Inc. 2013).

Parameter	Site 1 (Upstream)	Site 2 (Downstream)
Total Phosphorus (mg/L)	0.20	0.14
Total Kjeldahl Nitrogen (mg/L)	2.2	1.8
Ammonia-N (mg/L)	<0.01	<0.01
pH	8.44	8.09
Total Suspended Solids (mg/L)	15	13
Temperature (°C)	19.4	19.4
Dissolved Oxygen (mg/L)	9.25	10.3
Conductivity (µS/cm)	998.9	1186
Chloride (mg/L)	149	135
Sulfate (mg/L)	39.6	123
Alkalinity (mg/L)	215	206
Hardness (mg/L)	252.0	280.0

Both data collecting efforts (2007 and 2013) included detection of total and dissolved heavy metals (copper, lead, mercury, etc.). None of the results from 2007 or 2013 suggest elevated levels of heavy metals. The complete results for all samples are included in Appendix D.

3.14.1.2 Overall Assessment Results

In general, waterbodies in the Mill Creek Watershed have poor water quality. Nine lakes in the watershed are classified as impaired by the Illinois EPA for at least one designated use, as shown in **Figure 3-31.** As previously discussed, the majority of the water quality assessment information provided in Section 3.14 is based on the detailed sampling efforts conducted by the LCHD-ES.

Mill Creek is not currently listed by Illinois EPA as an impaired water body (the 303(d) list). Detailed water chemistry data are limited to analysis of grab samples from sampling stations east of Hunt Club Road and no continuous water chemistry data for any time period or location are available. A more robust monitoring program is likely needed to provide sufficient data to determine if water quality is affecting aquatic life in Mill Creek or if impairments related to water quality exist. Based upon trends in lakes and other streams in Lake County, there is interest in monitoring chloride, phosphorus, and TSS to assess current levels and trends. Available data from biological surveys suggest that biotic integrity in the stream may be moderately impacted, but it is unclear whether this is related to water quality or habitat degradation.

Dissolved Oxygen

Dissolved oxygen (DO) is a basic requirement for a healthy aquatic ecosystem. Most fish and beneficial aquatic insects "breathe" oxygen dissolved in the water column. Some fish and aquatic organisms (such as carp and sludge worms) are adapted to low oxygen conditions, but most desirable fish species suffer if dissolved oxygen concentrations fall below state standards. Larval and juvenile fish are more sensitive and require even higher concentrations of dissolved oxygen. Many fish and other aquatic organisms can recover from short periods of low dissolved oxygen availability. Prolonged episodes of depressed dissolved oxygen concentrations of 2 mg/L or less can result in fish kills and "dead" waterbodies. Oxygen concentrations in the water column fluctuate under natural conditions, but severe depletion usually results from human activities that introduce large quantities of biodegradable organic materials into surface waters. In polluted waters, bacterial degradation of organic materials can result in a net decline in oxygen concentrations in the water. Oxygen depletion can also result from chemical reactions that place a chemical oxygen demand on receiving waters. Other factors (such as temperature and salinity) influence the amount of oxygen dissolved in water. Prolonged hot weather will depress oxygen concentrations and may cause fish kills even in clean waters because warm water cannot hold as much oxygen as cold water.

Algae and aquatic plants in the water elevate DO concentrations during the day (due to photosynthesis) and lower DO concentrations at night (due to respiration). Low DO conditions typically exist in mid to late summer when air and water temperatures are high and water levels are low. The current Illinois state standards for DO are based on the time of year and either a single event or a 7-day average:

March – July 5 mg/L or 6 mg/L (7-day average)

August - February 3.5 mg/L or 4 mg/L (7-day average)

Dissolved oxygen concentrations at Bittersweet Lake, monitored by the LCHD-ES, violated the Illinois state standard.

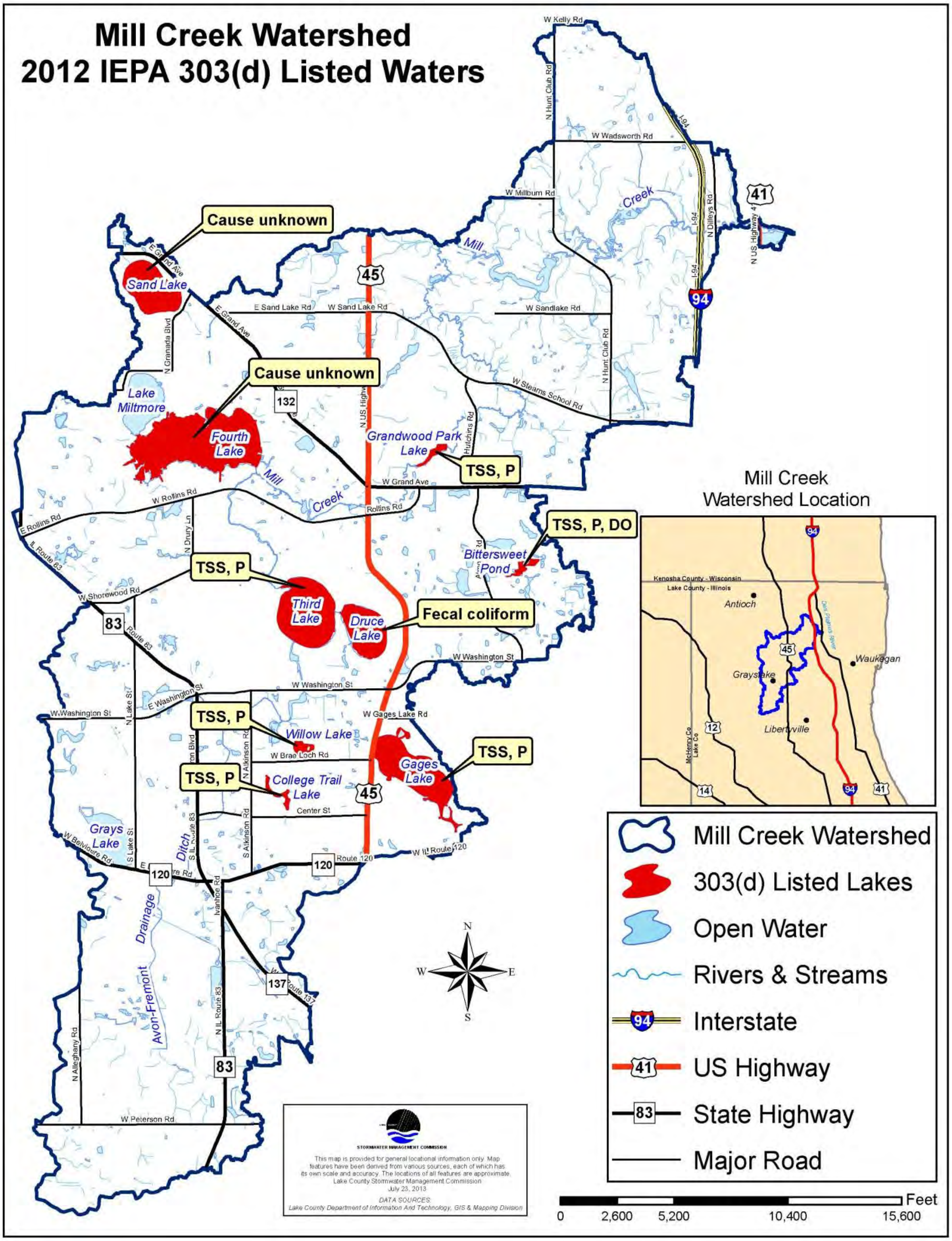


Figure 3-31: Impaired lakes in the Mill Creek Watershed. There are no stream segments identified as having impairments.

Chlorides and Conductivity

Specific ***conductivity*** indirectly measures the concentration of chemical ions or dissolved salts in the water, and is used an indicator of salt as a pollutant. The more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. Chloride concentration measurements are an indicator of how much salt is entering the waterbody, either through water runoff or natural leeching. Accordingly, conductivity and chloride concentrations are dependent on the watershed geology, the size of the watershed, the land uses within that watershed, evaporation and bacterial activity. In most surface waters, chloride concentrations are generally highest during the winter and spring months as a result of road de-icing activities, which generally consist of sodium chloride (rock salt). The leaching of effluent from a sanitary sewer line into a stream can also increase conductivity readings. Low water levels tend to increase concentrations of ions in the water column, while rain events tend to temporarily flush ions out of the stream system.

> *Noteworthy:* Conductivity of Water
>
> The conductivity of water refers to its ability to transmit electrical current. Conductivity changes also occur with depth fluctuations. For example, in stratified lakes the conductivity normally increases in the dense, bottom layer of water as bacterial decomposition converts organic materials to bicarbonate and carbonate ions, depending on the pH of the water. Conductivity is a good indicator of potential watershed or lake problems if an increasing trend is observed over a period of years. High levels of chlorides can negatively impact aquatic life and degrade drinking water. For these reasons, it is important to keep track of and manage any increases of conductivity and chlorides in the lakes within the watershed.

High chloride concentrations have negative impacts on aquatic life. In lakes, chloride concentrations over 250 mg/L (equivalent to ~1.2 mS conductivity) are a concern, and anything over 500 mg/L Cl (~2.0 mS) will lead to a waterbody being considered impaired by Illinois state standards. Groundwater chloride concentrations are usually below 50 mg/L in northeast Illinois.

According to the 2011 LCHD-ES Study, "Conductivity and chloride concentrations have declined in lakes sampled in 2011 compared to 2007. As expected, the highest average chloride concentrations came from lakes near roads. Considerable efforts have been made to reduce chloride entering our waterbodies and this should continue as chloride ions do not breakdown and will accumulate in a lake, settling toward the bottom. In addition to the negative impacts on aquatic life, chloride may influence the lake's energy flow patterns including thermal stratification, which may have long-term impacts on the lake."

The 2000-2010 county median chloride concentration and conductivity, for lakes, is 142 mg/L and 0.86 mS/cm. The lake concentrations in this watershed range from 129 mg/L (Sand Lake) to 276 mg/L (Druce Lake), as shown in **Figure 3-32**. Druce, Gages, and Willow Lakes have all exceeded the U.S. EPA standard for chloride, as shown by the data collected by the LCHD-ES. None of the lakes have exceeded the state standard for chloride.

> *Conductivity: The property or power of conducting heat, electricity, or sound.*

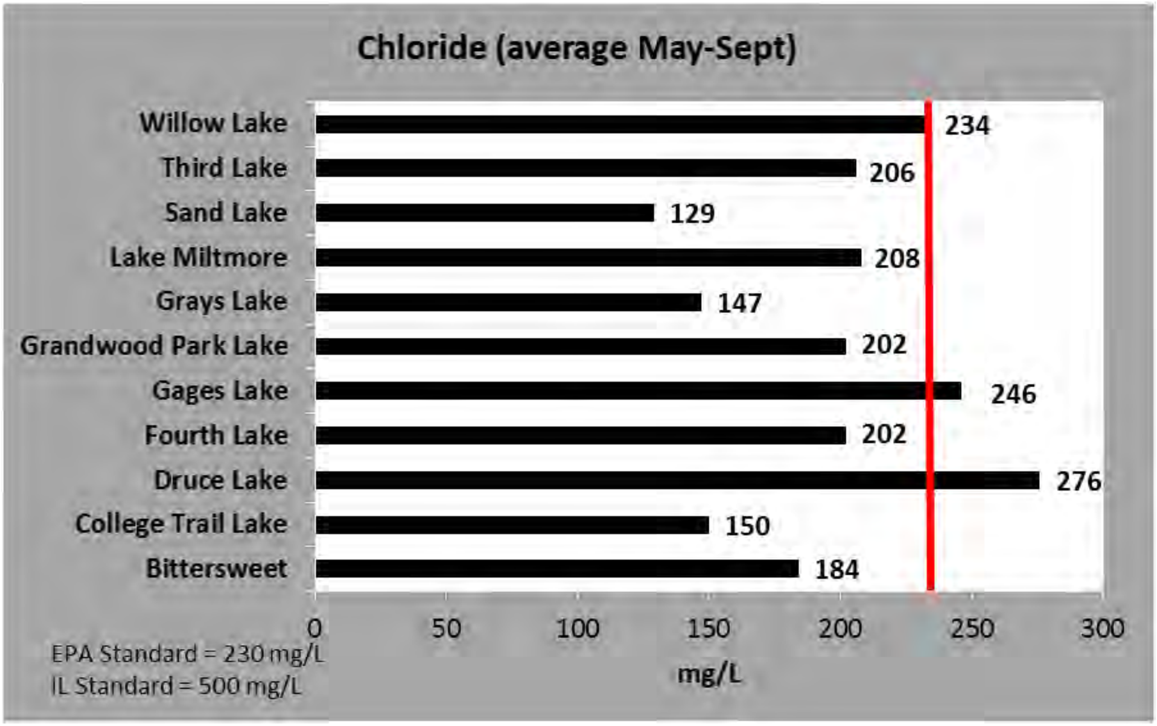


Figure 3-32: Chloride levels from 2011 in Mill Creek Watershed lakes.

Nutrients

All plants require nutrients for growth. In aquatic environments, nutrient availability usually limits plant growth. In freshwater lakes and streams, the “limiting nutrient” is usually nitrogen or phosphorus. Nitrogen and phosphorus generally are present at background or natural levels below 0.3 and 0.05 Mg/L, respectively.When a limiting nutrient is introduced into a water body, aquatic plant productivity may increase dramatically. Increased aquatic plant productivity creates increased organic material, which eventually dies and decays. The decaying organic matter produces unpleasant odors and depletes the oxygen supply required by fish and aquatic insects.

Phosphorus

Phosphorus is a necessary nutrient that helps determine plant and algal growth. In waters where phosphorus is the limiting nutrient increased phosphorus increases plant and algal growth and decreased phosphorus decreases plant and algal growth. TP concentrations are important to a lake’s productivity and health. TP concentrations greater than 0.03 mg/l can cause algal blooms. The State of Illinois General Use Standard for TP for lakes is 0.05 mg/L while the Lake County average is 0.066 mg/L. When TP levels exceed 0.05 mg/L lake wide algal blooms can occur. Increases in algal blooms lead to decreased water clarity, a decrease in light penetration, and increase in total suspended solids.

The Lake County median is 0.065 mg/L. According to 2011 LCHD-ES Study, six out of the eleven lakes sampled in Lake County portion of the Mill Creek Watershed exhibited elevated phosphorus levels, as shown in **Figure 3-33**. Bittersweet Lake exhibited the highest phosphorus levels in the watershed. This is most likely due to the nature of the lake. This lake is within a golf course, and is really more of a pond than a lake. While the chart below shows total phosphorus as an average over one sampling season, the state lists waterbodies for phosphorus for one exceedance.

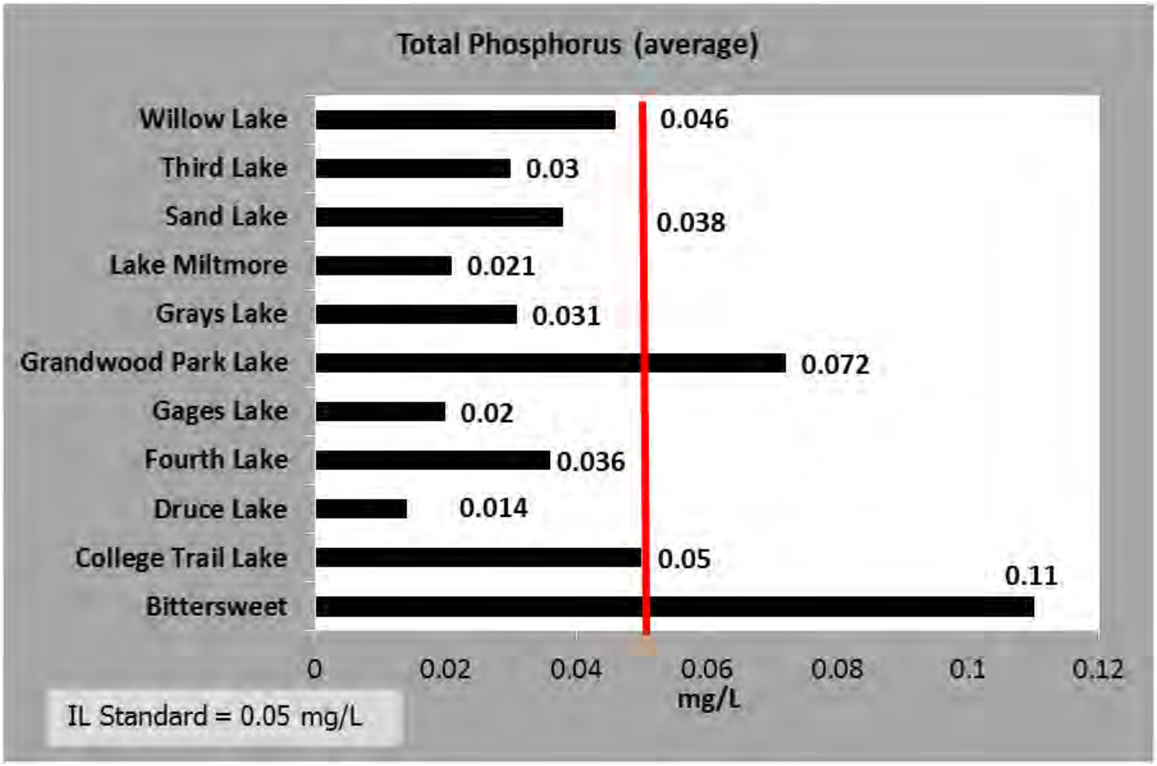


Figure 3-33: Total Phosphorus levels from 2011 in Mill Creek Watershed lakes.

Total Suspended Solids(TSS), Turbidity, and Water Clarity

Willow Lake had the highest average TSS concentration at 19.4 mg/L; Druce Lake had the lowest average TSS reading at 1.74 mg/L (**Figure 3-34**). The County 2000-2010 average TSS value is 8.1 mg/L.

Noteworthy: Total Suspended Solids

A TSS measurement quantifies all particles suspended and dissolved in water. Closely related to turbidity, this parameter quantifies sediment particles and other solid compounds typically found in water, including nonvolatile suspended solids such as non-organic clay or sediment materials, and volatile suspended solids such as algae and other organic matter. Watersheds experience a natural sediment load that is dependent upon its climate, geology, and vegetation. Sedimentation is considered a pollutant when it exceeds this natural level and has a detrimental effect on water quality. The Illinois EPA "General Use" standard for TSS is 750 ppm. Additional information provided by Waters (1995) indicates TSS measurements greater than 80 ppm has been found to be deleterious to aquatic life.

Rain washes silt and other soil particles off of plowed fields, construction sites and urban areas into waterbodies. Sedimentation and siltation can severely alter aquatic communities. Sediment may clog and abrade fish gills or suffocate eggs and aquatic insect larvae on the bottom. Suspended silt may interfere with recreational activities and aesthetic enjoyment of waterbodies by reducing water clarity. Nutrients and toxic chemicals may attach to sediment particles on land and ride the particles into surface waters where the pollutants may settle with the sediment or detach and become soluble in the water column.

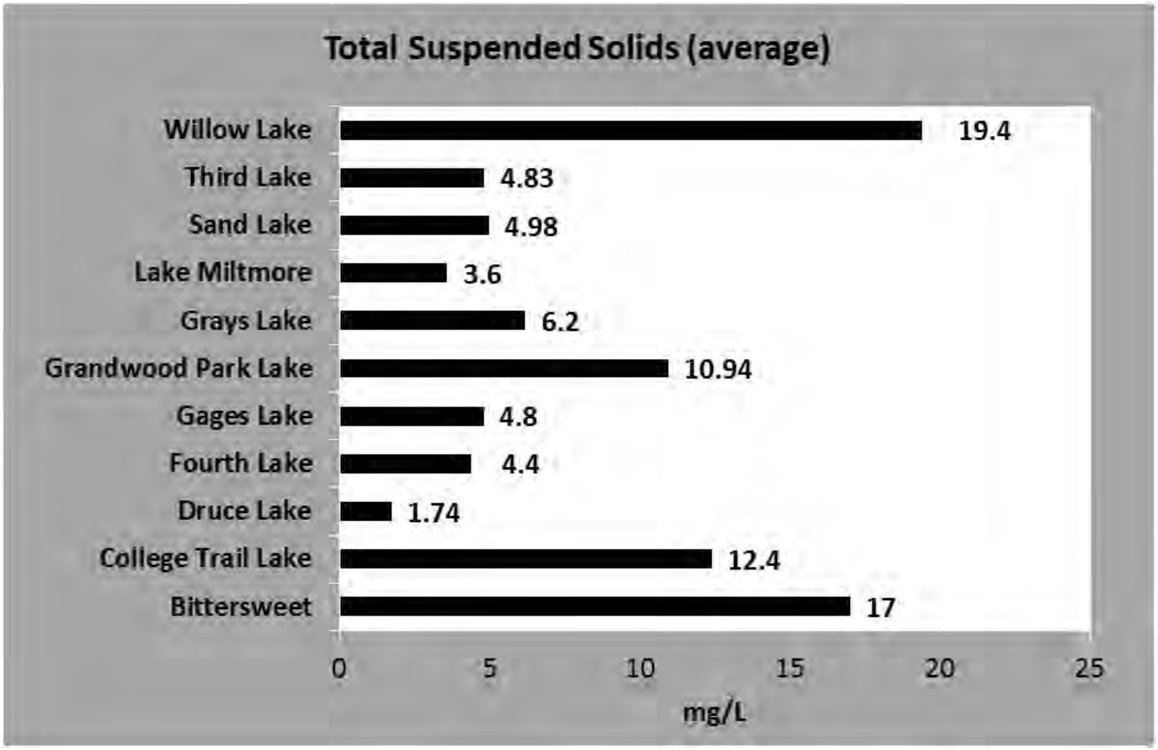


Figure 3-34: Average Total Suspended Solids from 2011 in Mill Creek Watershed lakes.

Secchi depth: A measure of the clarity of water, especially seawater. Secchi depth is measured using a circular plate, known as a Secchi disk, which is lowered into the water until it is no longer visible. High Secchi depths indicate clear water; whereas low Secchi depths indicate cloudy or turbid water.

Water Clarity (Secchi Depth)

The Lake County Secchi depth median is 2.95 feet. According to the LCHD-ES Study, lakes in the Mill Creek Watershed meet the general water quality Secchi depth standard, as shown in **Figure 3-35**. Third Lake, Sand Lake, Lake Miltmore, Grays Lake, Gages Lake, and Druce Lake met the standard for swimming. Grandwood Park Lake and Fourth Lake had readings of zero due to their shallowness.

Noteworthy: Water Clarity (Secchi Depth)

Water clarity is a direct result of the amount of TSS in the water column, and is usually the first thing people notice about a lake, as it visually typifies the overall lake quality. High TSS values, typically correlated with low Secchi readings, low water clarity, and poor water quality, can be detrimental to many aspects of the lake ecosystem, including the plant and fish communities.

Secchi depth readings are a simple method of visually measuring water clarity at various depths. A Secchi disk (a disk with alternating black and white patches) is lowered by a rope until the colors are no longer discernable. The depth point at which the disk becomes indistinct and unreadable is measured and recorded as the Secchi depth. High Secchi depths indicate clear water; whereas low Secchi depths indicate cloudy or turbid water. A lake must have a minimum Secchi depth of 1.5 feet to meet the state standard for water quality. It must have a measurement of at least 4.0 feet in order to meet the state standard for swimming.

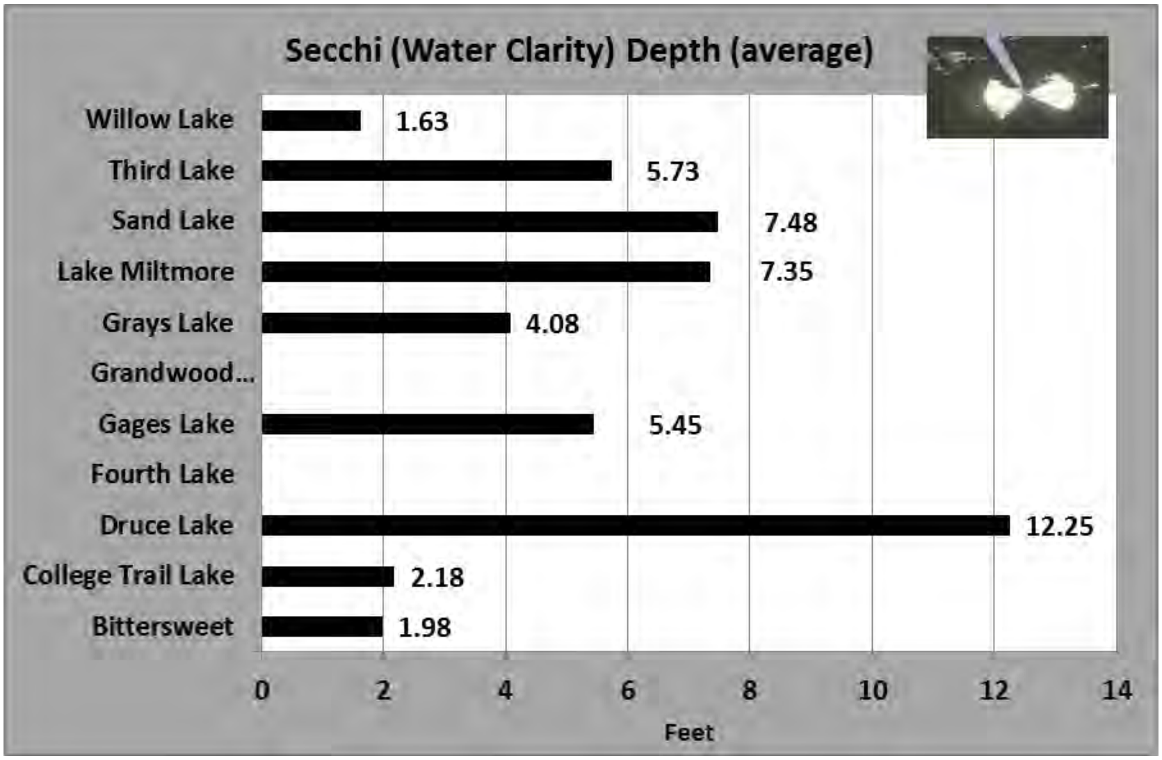


Figure 3-35: Average Secchi depth from 2011 in Mill Creek Watershed lakes.

Noteworthy: *E. coli* Bacteria

E. coli is one member of the fecal coliform bacteria group. Biologists use *E. coli* as an indicator organism to identify the potential for the presence of pathogenic organisms in a water sample. The Illinois "General Use" standard for *E. coli* states that during the months May – October, based on a minimum of five samples, taken over not more than a 30 day period, fecal coliform shall not exceed 200 colonies per 100 mL of water nor shall more than 10% of the samples during any 30 day period exceed 500 colonies per 100 mL.

Fecal coliform Bacteria

Fecal coliform can come from many rural and urban sources including failing septic systems. Sometimes heavy rain washes fecal material from the upstream areas into the stream. Pinpointing the exact source is often difficult. The Mill Creek WRF is required to monitor fecal coliform bacteria as part of their permit. Records indicate that during the course of this study, bacteria concentrations in the effluent did not exceed 15 colony forming units (cfu)/100mL. Fecal coliform readings were not taken for the lakes as part of the water quality assessment by the LCHD-ES. However, the Illinois EPA 303(d) report indicates that Druce Lake is impaired due to fecal coliform. The LCHD-ES does monitor fecal data at lake beaches.

Colony forming units: A measure of viable bacteria or fungal numbers.

3.14.2 BIOLOGICAL SURVEYS

Several biological surveys of the aquatic ecosystem of Mill Creek have been undertaken in recent years, examining the fish, mussel, and aquatic macroinvertebrate communities inhabiting the stream. Aquatic life is an important indicator of water quality but may also reflect habitat quality or availability in the stream. If impairments of the aquatic biological community are noted, care must be taken when determining if those communities are affected by water quality impairments, habitat limitations, or both. The integrity of the fish or macroinvertebrate community in a stream is assessed using an index value that is calculated based on the organisms in the sample collection. The indices are a tabulation of metrics representing the overall diversity of species in the sample (i.e., the total number of species present), the number of species or individuals that are known to be either tolerant or intolerant of water quality and habitat degradation, and the complexity of the ecosystem based on known ecological niches of the species present (i.e., species that eat only invertebrates or species that only reproduce in clean gravel streambeds). Each metric is assigned a value based on a “reference condition,” or the condition that would be expected or has been observed in a similar stream with limited impacts to water quality, habitat, and the aquatic ecosystem. The total value of all metrics is calculated to assign the index value. Ranges or “classes” of index values are then used to determine the level of impact to the biological community and formulate an assessment. Fish survey data are used to calculate the Fish Index of Biotic Integrity (fIBI). This index is used in concert with macroinvertebrate surveys, habitat assessments, and water chemistry data to determine if water quality impairments affecting aquatic life exist. Illinois EPA determines that no aquatic life impairment exists if the fIBI score is equal to or greater than 41 (maximum fIBI score is 60) and macroinvertebrate surveys and water chemistry data do not indicate impairment. Illinois EPA considers fIBI scores between 20 and 41 indicative of moderate impairment and scores of 20 and below indicative of severe impairment.

Since 2000, several fish surveys have been conducted on Mill Creek, with the resulting fIBI scores ranging from 18 to 39, indicating moderate to severe impairment of the fish community. Thirty-three species (32 native species) of fish are represented across all surveys. The lowest score (fIBI = 18) was from a sample taken below Grandwood Park Lake dam. All other samples for which fIBI scores were computed were taken at sites downstream of the first dam on Mill Creek, and ranged from 27 to 39. Among other Lake County streams in the Des Plaines River basin, the values for downstream samples are comparable to the results of recent fish surveys from sites in the Indian and Bull Creek Watersheds with uninterrupted connections to the Des Plaines River. Fish surveys conducted at three locations in the North Mill Creek Watershed, a tributary watershed to Mill Creek and separated from the Des Plaines River by one or more dams, had lower fIBI scores and were comparable to the value of the sample below Grandwood Park Lake dam on Mill Creek. In samples from Mill Creek, the greatest number of species encountered in any single sample was 26, from a site below the first dam upstream of the Des Plaines River. Nineteen species were encountered in each of the other recent samples taken downstream of the first dam on Mill Creek. Samples taken at three locations upstream of the first dam on Mill Creek yielded 15 or fewer species. The highest fIBI scores in the Mill Creek Watershed and from other similar Des Plaines River tributaries tend to come from sampling locations on downstream, barrier-free reaches where fish can migrate to and from the Des Plaines River. Other factors that may affect the decrease in species diversity in upstream reaches of the watershed are modification of habitat and degradation of water quality. At this time, more extensive study is required to assign causality for variation in species diversity to any of these factors within the Mill Creek Watershed.

Fish surveys have also been conducted on several of the lakes in the watershed. Illinois has not established an index of biotic integrity to evaluate the biodiversity of fish populations in lakes, primarily because it is more difficult to obtain a representative sample of the fish population from a lake than from a wadeable stream. Fish surveys from lakes tend to be focused on the sport fishery, although all species captured are noted. Species lists from recent IDNR surveys of Druce, Gages, Grays, Fourth, Miltmore, Sand, and Third Lakes are included in Appendix E. Of note is the high population of common carp in Gages Lake which may be having a deleterious effect on other fishes and for which the IDNR and Gages Lake Improvement Association have developed a carp removal program. Additionally, a winterkill event was documented on Fourth Lake in 2011 which was likely caused by hypoxia resulting from decomposition of organic material. Fish tissue samples were taken from black crappie and carp from Third Lake in 1993. Samples were collected again in 2010 from carp, largemouth bass, black crappie, and bluegill but have yet to be analyzed. Fish tissue samples were taken in 2008 and 2011 from bluegill, carp, largemouth bass, and walleye from Gages Lake. Carp samples indicated possible elevated levels of PCBs. Samples were therefore collected again in 2013, but have yet to be analyzed. Currently, there are no fish consumption advisories for any lakes in the Mill Creek Watershed.

Noteworthy: Fish Index of Biotic Integrity (fIBI)

The biotic integrity, or biodiversity and abundance of fish communities in Illinois streams, is measured using the Fish Index of Biotic Integrity, often abbreviated “IBI” or “fIBI”. The index was developed specifically for small and medium-sized Illinois streams (typically less than 150 feet wide) by the IDNR and Illinois EPA. The fIBI assigns a score of 0-6 to 10 different metrics that each represent an element of the fish community. The highest possible total fIBI score is 60 and the lowest possible score is 0. The computed fIBI score is assigned to one of five “biotic integrity classes,” numbered 1-5:

Class 1 (fIBI = 56-60): Streams with higher biotic integrity than would be expected in Illinois reference streams

Class 2 (fIBI = 46-55): Streams with biotic integrity similar to Illinois reference streams under current conditions

Class 3 (fIBI = 31-45): Streams with biotic integrity lower than Illinois reference streams due to loss of native species and a moderate imbalance in the trophic and reproductive functional structure (i.e., number of ecological niches represented)

Class 4 (fIBI = 16-30): Streams with biotic integrity much lower than reference streams due to further loss of native species and near complete loss of species intolerant of water quality and habitat degradation, imbalance in the fish community structure (i.e., number of genera represented), and moderate to extreme imbalance in the trophic and reproductive structure

Class 5 (fIBI = 0-15) Streams with biotic integrity much lower than reference streams due to further loss of native species and complete absence of intolerant species, an increased proportion of species tolerant of water quality and habitat degradation, and extreme imbalance in trophic and reproductive structure.

Macroinvertebrate surveys also generate data used to assess water quality. Like fish communities, aquatic macroinvertebrate communities can be affected by degradation of both water quality and habitat. There are two indices used to assess the integrity of the aquatic macroinvertebrate community, the Macroinvertebrate Index of Biotic Integrity (mIBI) and the Macroinvertebrate Biotic Index (MBI). Illinois EPA uses these index values in concert with fish surveys, habitat assessments, and water chemistry data to determine if water quality impairments affect aquatic life. While both indices provide insight related to potential impacts on aquatic life, the mIBI is the primary assessment method used by Illinois EPA while MBI is the secondary method. Illinois EPA determines that no aquatic life impairment exists if the mIBI score is equal to or greater than 41.8 (maximum mIBI score is 100) and fish surveys and water chemistry data do not indicate impairment. Illinois EPA considers mlBI scores between 20.9 and 41.8 indicative of moderate impairment and scores of 20.9 and below indicative of severe impairment. Conversely, MBI scores increase relative to the negative impact to aquatic life. Illinois EPA determines that no aquatic life impairment exist if the MBI score is 5.9 or less. MBI scores between 5.9 and 8.9 indicate moderate impairment and scores above 8.9 indicate severe impairment.

The only recent macroinvertebrate survey of Mill Creek was performed in 2007 prior to, and in conjunction with, the expansion of the Mill Creek WRF. Macroinvertebrates were sampled at three locations east of Hunt Club Road and downstream of the first dam on Mill Creek. Results from those samples were used to calculate the Stream Condition Index, a precursor to the mIBI, and to calculate MBI. Illinois EPA revised the Stream Condition Index and renamed it, resulting in the current method used to calculate mIBI. The 2007 Mill Creek survey reported Stream Condition Index values ranging from 37.4 to 41.2, ratings that fell into the narrative category of “fair”. Reported MBI values were 6.70, 5.86 and 5.47 (recall that lower scores indicate higher biotic integrity), indicating moderate impairment at one sample location and no impairment at the other two sites. If a macroinvertebrate survey is conducted in the future, mIBI values should be computed for all sample locations.

The Mill Creek WRF surveys also gathered information on the mussel communities at three sample locations. Four species were collected, with the giant floater and white heelsplitter significantly dominating the samples at each location. Other species present in the collections where the fatmucket and Lilliput, but with only one or two individuals represented per site. The total number of live mussels sampled at each location ranged from 80 to 103. In 2012, Third Lake and Mill Creek experienced a dramatic increase in the coverage of zebra mussel colonies. In 2013, rock substrates were still devoid of typical macroinvertebrate fauna (Bland, 2014). The present distribution and ecological effect of zebra mussels within the stream network is currently unknown.

3.14.3 POINT SOURCE POLLUTION

National Pollution Discharge Elimination System

Point sources of pollution are discharges from a single source such as a pipe conveying wastewater from an industrial process or a wastewater treatment facility into the stream. Point sources are regulated and monitored by the United States Environmental Protection Agency under the Clean Water Act of 1972. There is one active ***National Pollutant Discharge Elimination System (NPDES)*** municipal wastewater permit in the watershed. The Mill WRF is the only permitted wastewater discharge plant in the watershed. **Figure 3-36** shows the locations of the NPDES point source discharges in the watershed.

In the summer of 2013, SMC conducted a stream inventory for the Mill Creek Watershed. During this field study 12 problem discharge locations were identified. Problems range from broken or failed pipes to oily discharges.

National Pollutant Discharge Elimination System Phase II: A Clean Water Act law requiring smaller communities and public entities that own and operate a Municipal Separate Storm Sewer System (MS4) to apply and obtain a NPDES permit for stormwater discharges. Permittees at a minimum must develop, implement, and enforce a stormwater program designed to reduce the discharge of pollutants from the MS4 to the maximum extent practical. The stormwater management program must include these six minimum control measures: public education and outreach on stormwater impacts, public involvement/participation, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations.

Noteworthy: National Pollution Discharge Elimination System

The National Pollution Discharge Elimination System (NPDES) program regulates wastewater discharges of water to rivers and streams. In Illinois, the program is administered by the Illinois EPA under the federal Clean Water Act to reduce pollution to the nation's waters. Two types of wastewater discharges are controlled by NPDES permits including industrial process (point source) and stormwater (non-point source). A NPDES permit may be required at one business for either type of wastewater or for both. Wastewater includes almost any discharge of water that is generated from any process industry, manufacturing, trade, or business and can also include solids, liquid or gaseous waste, or substances where discharge would cause water pollution or a violation of the effluent or water quality standards of the State set forth by the IPCB.

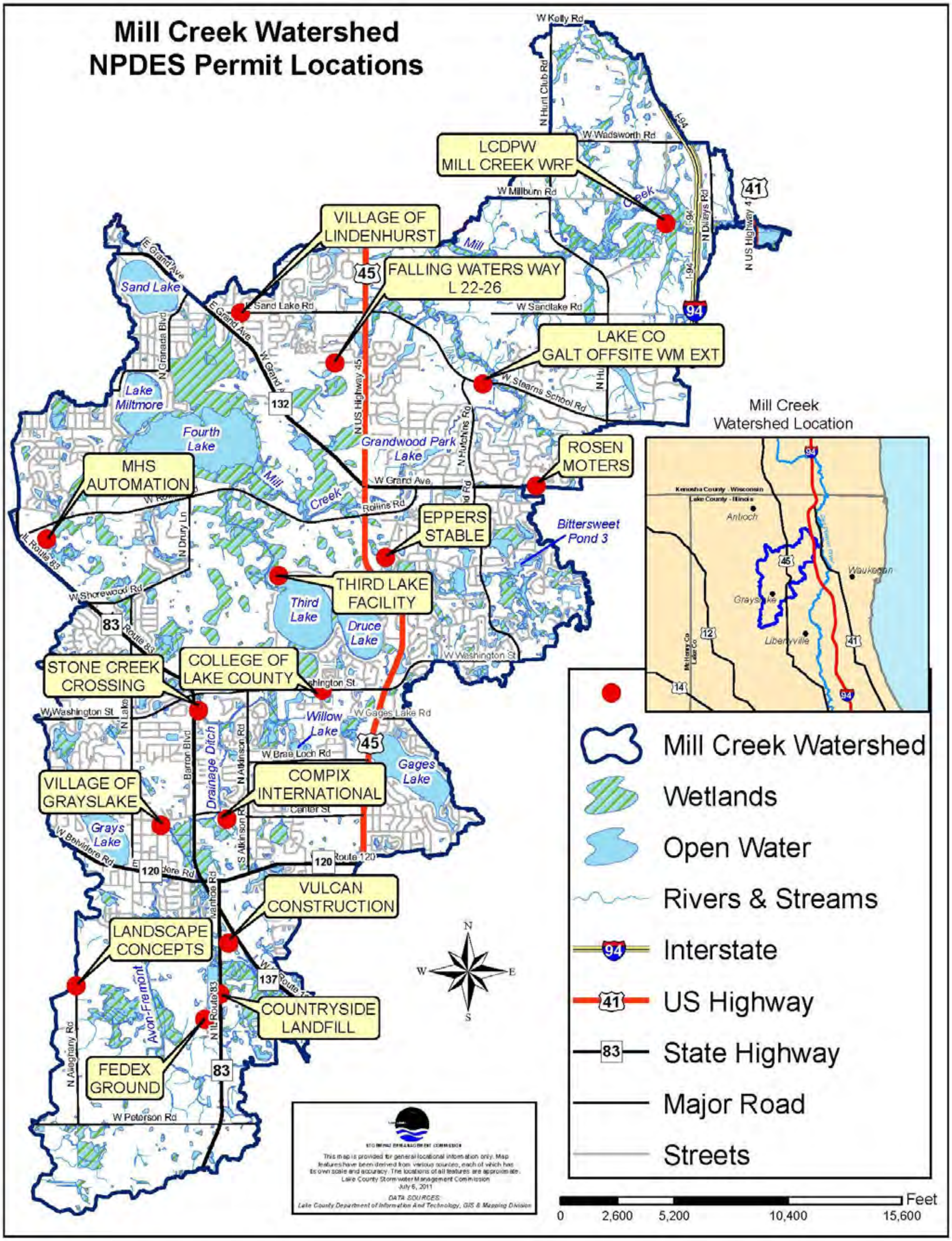


Figure 3-36: Watershed NPDES Permit Locations.

3.14.3.1 Mill Creek Water Reclamation Facility

The Lake County Department of Public Works operates the Mill Creek WRF which serves Lake County's Northeast Service Area, as shown in **Figure 3-37**. It is the only permitted wastewater treatment facility in the watershed. The service area includes the Village of Old Mill Creek, part of the Village of Antioch, and unincorporated areas. The facility can currently treat an average of 2.1 million gallons per day (MGD) and serves 21,000 people. It is constructed to support the expansion of up to 7.8 MGD in the future. The facility discharges to 001 STP Outfall on Mill Creek, which is the official receiving water body.

The facility incorporates the following treatment mechanisms:

- Septic receiving, screening, and grit removal;
- Parallel trains of aeration basins;
- Phosphorus removal selector basins;
- Clarifiers;
- Effluent sand filters;
- UV disinfection; and
- Biosolids are aerobically digested and belt filter pressed, then hauled from site for use as organic soil supplements.

Overall the facility employs state of the art nutrient reduction technologies, which were installed in the fall of 2011. The water quality analysis compared effluent flow, ammonia nitrogen, fecal coliform, TSS and phosphorus to NPDES permit limits for the water reclamation facility. Monthly averages for each data set have been plotted for the period between January 2012 and November 2013. The results of the analysis are shown in **Table 3-35** and **Figure 3-37**. The results show only a single permit limit exceedance since January 2012. The newly installed nutrient reduction technology has resulted in very low phosphorus concentrations in the effluent, well below the permit limit.

Table 3-35: Effluent Water Quality Summary, Mill Creek WRF: January 2012 – November 2013. Plant upgrades were conducted during 2012-2013.

Parameter	NPDES Permit Notes	Remarks
Flow	None	The NPDES permit does not directly limit flow. Flow is a reported value only.
Nitrogen as Ammonia	No Exceedances	The summer limit is 1.5 mg/L while the winter limit is 4.0 mg/L. The only time the monthly average exceeded 1.5 mg/L was during December 2012 when the monthly average was exactly 4.0 mg/L, still within the permit limits.
Fecal Coliform	May, 2012 Exceedance Due to temporary malfunction of UV disinfection unit.	There is no limit during winter months. The summer limit of 400/100 mL applies from May thru October.
Total Phosphorus	None	The limit is 1.0 mg/L. The reported monthly average exceeded 1.0 mg/l during 2012 plant construction activities and prior to permit being effective.
Total Suspended Sediment	None	None

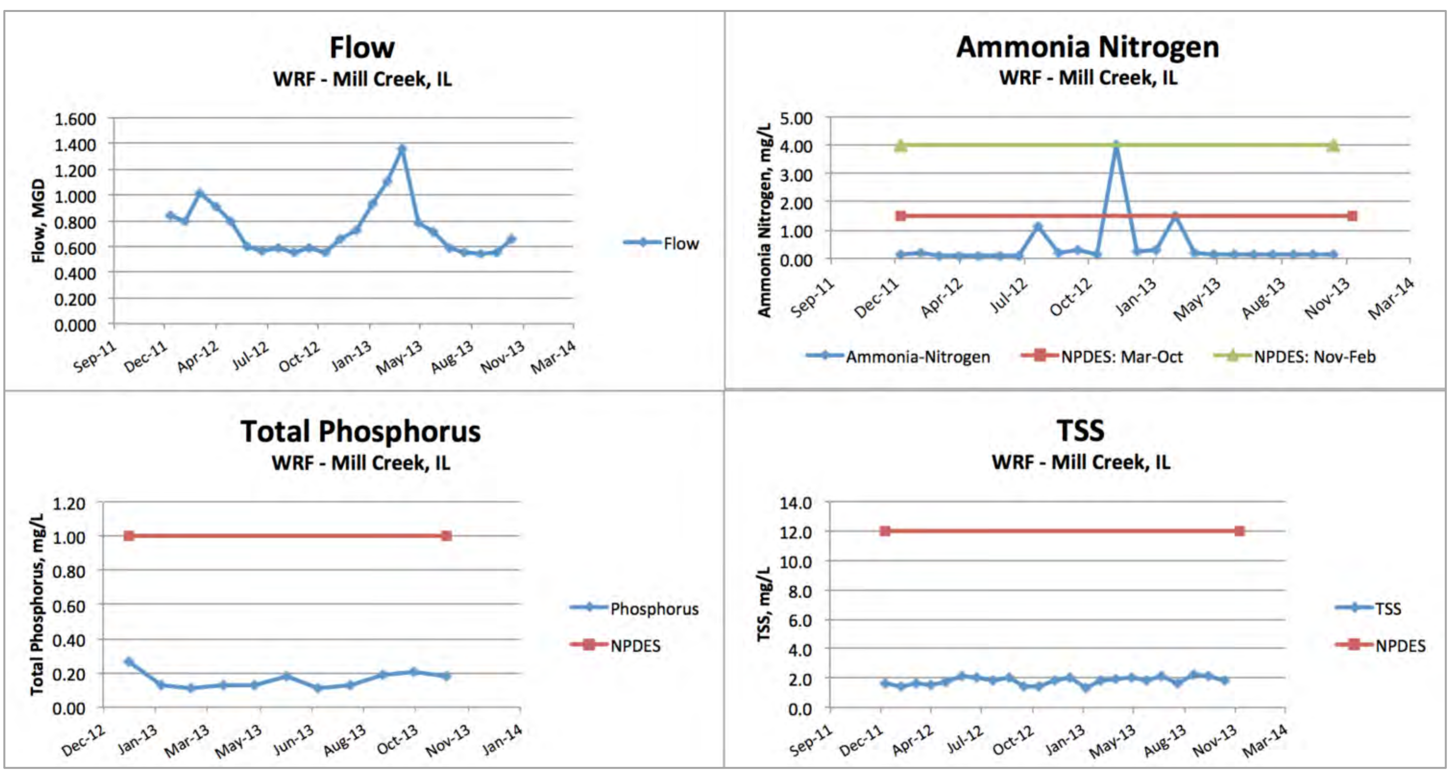


Figure 3-37: Effluent Water Quality Summary, Mill Creek WRF.

3.14.4 NON-POINT SOURCE POLLUTION

When rain flows across the landscape, pollutants such as oil and grease, road salt, eroding soil and sediment, metals, bacteria from pet wastes, and excess nutrients (nitrogen and phosphorus) from fertilizers are washed from streets, courses into the streams and lakes. This kind of pollution is called non-point source pollution, because it comes from the entire watershed rather than a single point, plant, or facility. These pollutants accumulate as the water flows downstream and eventually begin to degrade the quality of our streams and lakes by impacting aquatic life, as well as human uses such as fishing, swimming, and bird watching. In this way, every small bit of pollution adds up to a very large problem. The two land uses that contribute the most non-point source pollution are urban areas, where water runoff is not filtered through vegetation before entering a water body, and agricultural areas, where open ground and drain tiles allow water to carry sediments, fertilizers, and other contaminants into a body of water.

In addition to chemicals and other substances picked up from the landscape, non-point source pollution includes other parameters such as temperature, acidity, and the amount of oxygen in the water. Aquatic organisms, including fish and insects that are critical links in the food chain, need oxygen that is dissolved in the water to breathe. Low flows and non-point source pollution can cause the dissolved oxygen levels in the water to fall below healthy levels. When this happens, some plants and animals will die (in some cases causing large fish kills) and others capable of relocating will leave to try to find more habitable waters. Water temperature can also cause problems. Many fish and other aquatic animals require cool or cold flowing water to survive. As rainwater flows across urban surfaces and through the sewer system, these surfaces warm the water causing the overall temperature of the receiving stream to be too warm for many aquatic plants and animals. This water can also be either more acidic or more alkaline than is healthy for these organisms to survive.

As part of this watershed study, a non-point source model was created to identify those locations in the watershed that are likely to be contributing the greatest loads of non-point source pollutants. Chapter 4 includes a summary of the non-point source pollutant modeling results for Mill Creek.

3.15 WETLAND INVENTORY

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

European settlers to the region altered much of the Mill Creek Watershed's natural hydrology and wetland processes. Settlers drained wet areas, channelized streams, and cleared forests in order to farm the rich soils. Even after being cleared or drained, the underlying soil retains its characteristics. Hydric soils (soils that remain wet for an extended period of time) are a source used to identify pre-settlement wetlands. Based on hydric soils mapping, there were approximately 6,093 acres of wetlands in the watershed prior to European settlement.

According to the LCWI, 4,047 acres or 66% of the pre-settlement wetlands remain in the watershed. Of this, 3,996 acres are classified as wetlands (includes 1,380 acres of ADID wetlands) and 51 acres are farmed wetlands. Approximately 15 acres of artificial wetlands have also been created in the watershed, according to the LCWI. **Figure 3-38** depicts the location of the various wetland types, as documented in the LCWI.

Wetlands: areas with a high potential for exhibiting hydric soil, hydrophytic vegetation, and required hydrologic conditions.
ADID Wetlands: High functional wetlands identified by USEPA and others, based on biological, hydrological and water quality functions.
Farmed Wetlands: Agricultural cropped areas on hydric soil that have been cleared, partially drained, or filled.
Artificial Wetlands: Man-made water bodies on non-hydric soil.
Converted Wetlands: Areas that have been drained or filled and longer exhibit Wetland or Farmed Wetland characteristics

Noteworthy: Lake County Wetland Inventory

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

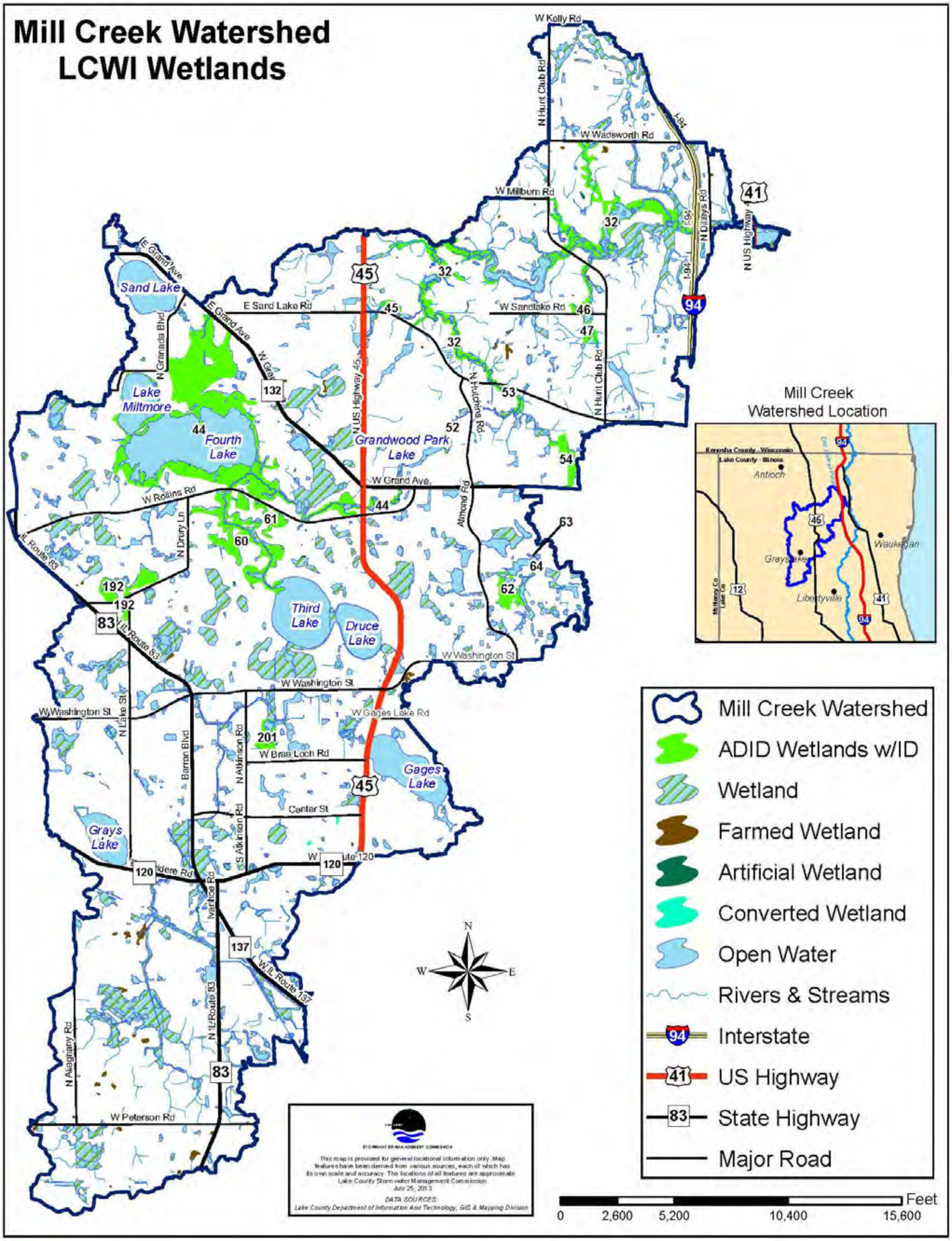


Figure 3-38: Mill Creek Watershed LCWI Wetlands.

Noteworthy: High Functionality (ADID) Wetlands

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

The ADID wetland process identified 15 wetlands in the Mill Creek Watershed comprising approximately 1,380 acres. **Figure 3-38** shows the location and ID number of these ADID wetlands. Data for each ADID wetland is summarized in **Table 3-36.** Two of the ADID wetlands comprise about 79% of the total ADID acreage: Unit 44 - Fourth Lake/Mill Creek Complex (776 acres) in the northwest area of the watershed, and Unit 32 – Mill Creek (309 acres) in the northeast area of the watershed. Both of these large ADID wetlands were identified as having significant biological and water quality/hydrology values, and Unit 44 was also identified as a designated Illinois Natural Area Inventory site (INAI).

Four ADID wetlands (# 54, #62, #63, and #201) have been altered by man-induced activities since the early 1990s. ADID #54 was partially filled for a road and residential lot at the Brookside Subdivision in Gurnee. ADID #62 was modified for development of the Bittersweet golf course in Gurnee, including conversion of some wetland areas to lakes and ponds. ADID #63 was partially filled for a residential lot at the Stonebrook Estates Subdivision and the remainder of the area was converted to a pond on the Bittersweet golf course in Gurnee. ADID #201 was partially filled for a road and residential lots at the College Trail Subdivision in Grayslake.

Table 3-36: ADID wetlands and attributes.

ADID ID #	Name	± Acres	ADID Attributes
32	Mill Creek	309*	High quality stream; State threatened or endangered fish species, shoreline/bank stabilization, sediment/toxicant retention, nutrient removal/transformation
44	Fourth Lake/Mill Creek Complex	776	Illinois Natural Area Inventory site, State threatened or endangered plant species, high quality plant community, shoreline/bank stabilization, sediment/toxicant retention, nutrient removal/transformation
45	Unnamed	8	Shoreline/bank stabilization, sediment/toxicant retention, nutrient removal/transformation
46	Trib. to Mill Creek	12	Stormwater storage, sediment/toxicant retention, nutrient removal/transformation

ADID ID #	Name	± Acres	ADID Attributes
47	Trib. to Mill Creek	10	Stormwater storage, sediment/toxicant retention, nutrient removal/transformation
52	Trib. to Mill Creek	0.4	High quality stream
53	Trib. to Mill Creek	11	High quality stream, shoreline/bank stabilization, sediment/toxicant retention, nutrient removal/transformation
54	Unnamed	25	High quality plant community (sedge meadow)
60	Rollins Savanna	110	High quality plant community (sedge meadow/emergent marsh complex), shoreline/bank stabilization, sediment/toxicant retention, nutrient removal/transformation
61	Rollins Savanna	14	High quality plant community (sedge meadow/emergent marsh complex), stormwater storage, sediment/toxicant retention
62	Unnamed	37	High quality plant community (sedge meadow), stormwater storage, sediment/toxicant retention
63	Unnamed	0.4	High quality plant community (sedge meadow), stormwater storage, sediment/toxicant retention
64	Unnamed	2	High quality plant community (sedge meadow), stormwater storage, sediment/toxicant retention
192	Unnamed	44	State threatened or endangered bird species, stormwater storage, sediment/toxicant retention
201	Unnamed	21	State threatened or endangered plant species, sediment/toxicant retention, nutrient removal/transformation
	Total	1379.8	
* ADID 32 extends approximately 32 acres beyond watershed boundary.			

Source: Lake County Wetland Inventory (LCWI, Updated 2002)

3.15.1 CURRENT MANAGEMENT ACTIVITIES

Limited current wetland management activities are occurring in the watershed, mainly by the LCFPD as follows:

Rollins Savanna Forest Preserve near Grayslake, Illinois: Approximately 110 acres of restored wetland and 270 acres of enhanced wetlands are being managed. The wetland creation and enhancement project was completed in the early 2000's by the LCFPD in partnership with Ducks Unlimited. Key elements of the project included nearly 13.3 miles of drain tile disablement to restore hydrology to historic wetlands that had been drained for agriculture and installation of over 200,000 wetland plants. Ongoing management of the restored and enhanced wetlands is focused on control of invasive species (e.g., purple loosestrife, reed canary grass, etc.) through selective herbicide applications and prescribed burning.

Fourth Lake Fen Forest Preserve near Lindenhurst, Illinois: Biological control of purple loosestrife is being implemented with the release of *Galerucella* beetles and rare plant monitoring is ongoing in the very rare calcareous floating mat portion of the marsh.

McDonald Woods Forest Preserve near Lindenhurst, Illinois: An adjustable water control structure is being used to create/maintain hemi-marsh conditions suitable for rare bird species.

Noteworthy: Wetlands Protection

Protection of wetlands is provided under existing regulatory programs, including federal and state floodplain development restrictions, the USACE's section 404 Clean Water Act wetland permit program, and WDO.

A permit/approval is required for any development that will impact wetlands in Lake County. The USACE-Chicago District issues permits for impacts to federal *Waters of the U.S.* (WOUS), while Lake County issues written approvals for impacts to *Isolated Waters of Lake County* (IWLC) that are not under federal jurisdiction. The USACE-Chicago District normally issues regional permits (RP) for impacts to less than 1.0 acre of non-high quality (non-ADID) WOUS and compensatory mitigation typically is required at a minimum 1.5:1 replacement ratio for impacts over 0.1 acre to these wetlands. An individual permit (IP) from the USACE is usually required for proposed impacts to federal ADID sites, since ADID sites are generally considered unsuitable for filling activities. The IP process requires permit applicants to conduct an analysis to identify practicable alternatives for avoiding and minimizing impacts to the federal ADID sites. In cases where an IP is issued for impacts to federal ADID sites, the USACE usually requires mitigation at a 3:1 or higher ratio.

Lake County issues written approvals for IWLC impacts as part of the Watershed Development Permit process, in accordance with the WDO regulations. Compensatory mitigation is required at a 1.5:1 ratio for impacts to 0.1 acre or more of non-high quality IWLC and 3:1 or higher for impacts to high quality IWLC.

The USACE-Chicago District's regulatory program and the WDO also require buffers of native vegetation around preserved wetlands to provide a natural transition between wetlands and developed upland areas and help treat stormwater runoff by filtering sediments and pollutants before the runoff reaches the wetlands. Required buffer widths vary, depending on the size, type (linear vs. water body), and quality of the wetlands. For *High Quality Aquatic Resources* (HQAR), which include ADID sites, a 100-foot buffer is required under both the USACE-Chicago District's regulatory program and WDO. A 30-50 foot wide buffer is required around all other wetland areas, depending on wetland size and type.

3.16 GROUND WATER

3.16.1 POTABLE GROUNDWATER SUPPLY

There are three primary categories of groundwater aquifers in the Mill Creek Watershed which include 1) Sand and Gravel, 2) Shallow Bedrock, and 3) Deep Bedrock. A thick blanket of glacial till covers the watershed and provides good aquifer protection from contamination; the glacial till also promotes very little recharge to reach the major aquifer systems from within the watershed. These three aquifer systems have historically served as the primary potable water supplies for this watershed and the Chicagoland area; however, large portions of the Chicagoland area, including the incorporated areas within the watershed, are now serviced by Lake Michigan water. **Table 3-37** outlines the 15 public wells that are currently located in the watershed. Public wells are defined as a well that provides at least 25 service connections or serves 25 persons with water for at least 60-days per year, and are regulated by the Illinois EPA. Based on records maintained by the Illinois State Geologic Survey (ISGS), there are over 1,500 private water wells in the watershed. **Figure 3-39** illustrates density of private-wells and the location of public wells. It is likely that a large portion of the wells in unincorporated areas are primary water supplies, the private wells within incorporated areas with water service are likely used for secondary purposes or not used.

The sand and gravel aquifer is prevalent throughout the watershed and is located within Quaternary-aged sand and gravels beneath a thick blanket of Wedron Group glacial tills. The aquifer is typically within 200-feet below the ground, 73% of the active public wells and a majority of the private wells are installed within this aquifer.

The shallow bedrock aquifer exists beneath the unconsolidated deposits within Silurian-aged dolomite and limestone bedrock. The depth to the Silurian system ranges from less than 100-feet to nearly 400-feet deep depending upon location in the watershed. Yields from the aquifer are variable due to the presence or absence of cracks and fractures that influence the porosity of the aquifer. There are no active public wells within this aquifer; it is believed that many private wells are installed in this aquifer system. The aquifer is recharged in the central portion of Illinois and Wisconsin where the bedrock is exposed near the surface.

The deep bedrock aquifer is present beneath the Ordovician-aged Maquoketa shale; groundwater is produced from the Galena and Plateville Group limestones and the Ancell Group sandstones. The deep bedrock aquifers produce more predictable yields due to uniform porosity of the geologic formations; this makes it a desirable drilling target for higher yielding wells. The depth to the aquifer is greater than 1,000-feet throughout the watershed, most of the known wells in the deep bedrock aquifer are between 1,020 and 1,333-feet deep. Four of the active public wells are installed in this aquifer; it is believed that very few private wells are installed in this system due to the depth and expense associated with drilling deeper versus shallower targets. This aquifer system is recharged in central and eastern Illinois, and Wisconsin.

Table 3-37: Public Wells in Watershed.

Owner	Depth (ft.)	Status	Aquifer	Illinois EPA Well ID
GRANDWOOD PARK SUBDIVISION	1020	Emergency	Deep Bedrock - Ordovician	826
GRANDWOOD PARK SUBDIVISION	143	Active	Sand & Gravel	825
GRANDWOOD PARK SUBDIVISION	135	Active	Sand & Gravel	1738
GRANDWOOD PARK SUBDIVISION	159	Active	Sand & Gravel	20015
GRANDWOOD PARK SUBDIVISION	122	Active	Sand & Gravel	324
GRANDWOOD PARK SUBDIVISION	137	Active	Sand & Gravel	1399
GRANDWOOD PARK SUBDIVISION	142	Active	Sand & Gravel	20016
GRANDWOOD PARK SUBDIVISION	121	Active	Sand & Gravel	1084
GRAYS LAKE	1354	Emergency	Deep Bedrock - Ordovician	20242
LINDENHURST	173	Active	Sand & Gravel	308
LINDENHURST	165	Active	Sand & Gravel	20268
ROUND LAKE BEACH	152	Emergency	Sand & Gravel	409
ROUND LAKE BEACH	1262	Emergency	Deep Bedrock - Ordovician	20318
WILDWOOD SUBDIVISION	173	Emergency	Sand & Gravel	21046
WILDWOOD SUBDIVISION	1333	Emergency	Deep Bedrock - Ordovician	261

3.16.2 PERCHED GROUNDWATER

Although not of major importance in terms of potable water supply, the Mill Creek Watershed has shallower perched groundwater systems that are sources of water for streams, lakes and wetlands. The perched groundwater systems typically exist within 15-meters depth within localized and discontinuous seams of soil with higher porosity. They are recharged locally from infiltration; and are often vulnerable to land use impacts that reduce infiltration. The perched systems are not continuous and interconnected in the watershed due to the clay matrix of the glacial tills that cover most of the watershed, however, 4,128-acres or 21% of the watershed exhibits geologic conditions that favor the presence of continuous perched groundwater.

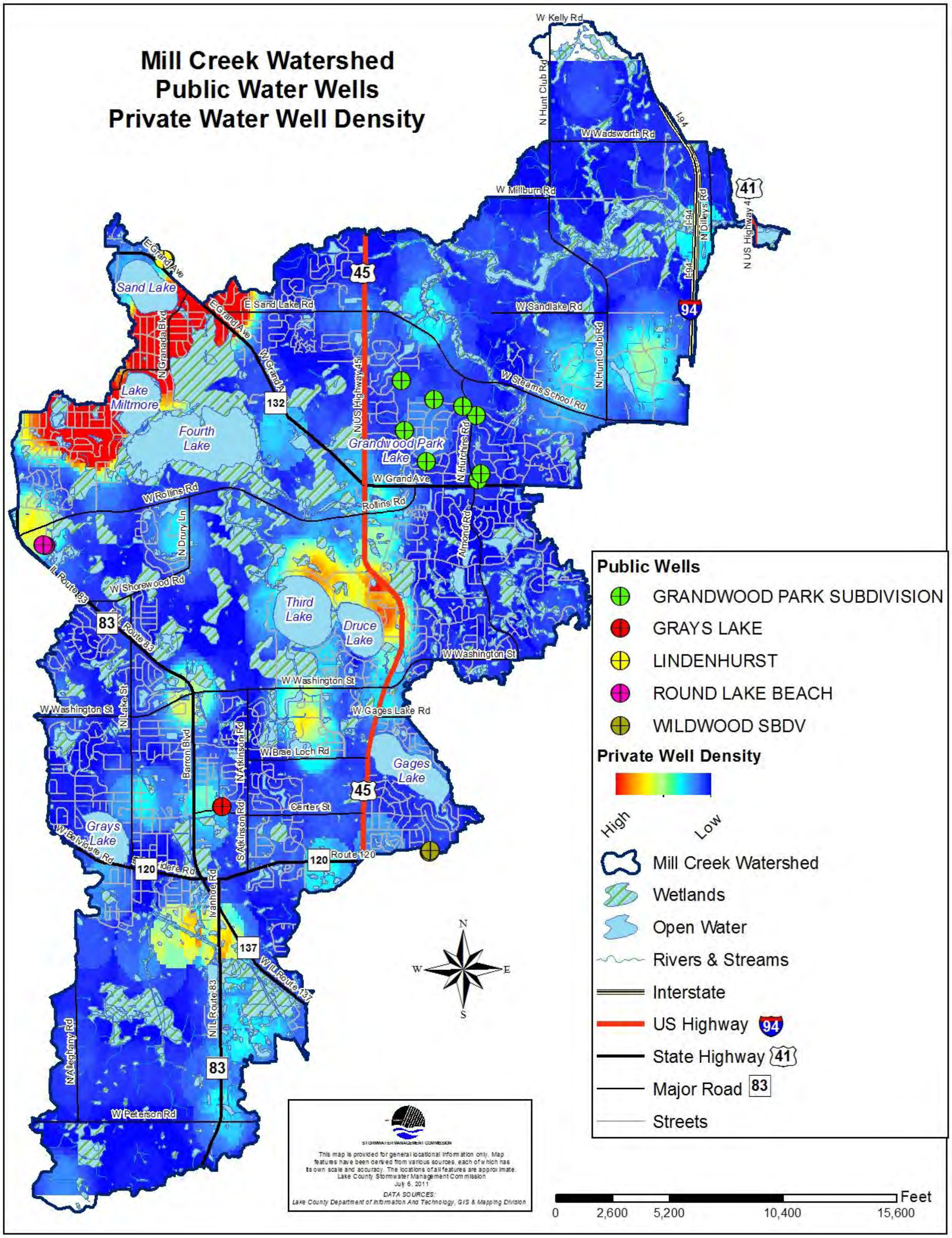


Figure 3-39: Public Water Wells and Private Well Density.

References

Bland, James. 2014. Personal communication.

City of Chicago Department of Transportation. July 2013. Sustainable Urban Infrastructure: Policies and Guidelines – Volume 1.

Chesapeake Bay Commission. 2003. Legislative. Using Federal Surface Transportation Programs.

Gomi , T., R.C. Sidle, and J.S. Richardson. October 2002. Understanding Processes and Downstream Linkages of Headwater Streams. BioScience, Vol. 52, No. 10 pg. 905-916.

Hey and Associates, Inc. 2007. Ecological Assessment of Mill Creek in Relation to Expansion of the Mill Creek Water Reclamation Facility (NPDES Permit No. IL0071366). Unpublished report prepared for Lake County Department of Public Works. Hey and Associates, Inc. Volo, Illinois.

Hey and Associates, Inc. 2013. Water Quality Sampling Update in Support of the Mill Creek Water Reclamation Facility (NPDES Permit No. IL0071366). Unpublished report prepared for Lake County Department of Public Works. Hey and Associates, Inc. Volo, Illinois.

Illinois Department of Transportation. Personal communication Rick Wojick, January 2014. Illinois 83/137 Study, http://www.dot.il.gov/IL83andIL137/index.html/. I-LAST™ Illinois - Livable and Sustainable Transportation Rating System and Guide, 2009.

Illinois Environmental Protection Agency. 1994. Illinois Water Quality Report 1992-1993. Illinois Environmental Protection Agency, Springfield, Illinois.

Illinois Environmental Protection Agency. 1996. Illinois Water Quality Report 1994-1995. Illinois Environmental Protection Agency, Springfield, Illinois.

Illinois Environmental Protection Agency. 2012. Illinois Integrated Water Quality Report and Section 303(d) List, 2012. Illinois Environmental Protection Agency, Springfield, Illinois.

Kieninger, T. 2005. Illinois Natural Areas Inventory (INAI) Data for Illinois. Illinois Natural Heritage Database Program, Illinois Department of Natural Resources.

Lake County Planning and Development Department and Chicago Metropolitan Agency for Planning. *Lake County Sustainability Chapter* (Draft), Regional Framework Plan Addendum, December 13, 2013.

Lake County Division of Transportation. Personal communications Emily Karry, Brendan Madden and Kevin Kerrigan August-October 2013, January 2014. Year 2020 Transportation Priority Plan Lake County, Illinois. Lake County Division of Transportation, adopted by Lake County Board June 2002. Excerpts from draft Lake County 2040 Transportation Plan, December 2013.

Lake County Forest Preserves. Personal communications Randy Seebach, August 2013. http://www.lcfpd.org/preserves/index.cfm?fuseaction=preserves.view .

Lindenhurst Park District and Village of Lindenhurst. Lindenhurst Community Pedestrian and Bicycle Comprehensive Plan, August 2008.

National Climatic Data Center. 2009. US Department of Commerce. www.ncdc.noaa.gov.

Natural Resource Conservation Service. 2004. Soil Survey of Lake County, Illinois.

Novotny, Vladimir, editor. 1995. Non-point Pollution and Urban Stormwater Management. Water Quality Management Library, Volume 9. Technomic Publishing Co, Inc, Lancaster PA.

Smogor, R. 2000 (draft, annotated 2006*). Draft manual for calculating Index of Biotic Integrity scores for streams in Illinois. Illinois Environmental Protection A*gency, Bureau of Water, Division of Water Pollution Control. Springfield, Illinois.

Smogor, R. 2005 (draft). Interpreting Illinois fish-IBI scores. Illinois Environmental Protection Agency, Bureau of Water, Division of Water Pollution Control. Springfield, Illinois

Swink and Wilhelm. 1994. Plants of the Chicago Region, 4th Edition.

Tetra Tech Inc. 2004. Illinois Benthic Macroinvertebrate Collection Method Comparison and Stream Condition Index Revision, 2004.

United States Department of Agriculture. 2011. Agricultural Census.

United States Geological Survey (Provisional). July 26, 2000. "Bottom material samples, Station USGS 05527950 Mill Creek at Old Mill Creek, IL." United States Geological Survey. Online. Accessed January 22, 2014.

United States Geological Survey. July 11, 2001. "Fish Survey, Station ID USGS 5527960 Mill Creek at Wadsworth, IL." United States Geological Survey. Online. Accessed January 20, 2014.

Veraldi, Francis M., Stephen M. Pescitelli, and Thomas M. Slawski, PhD. 2005. A Survey of Riverine Fish Assemblages and Habitat of the Upper Des Plaines River System. Unpublished Work In Progress. United States Army Corps of Engineers. Chicago, Illinois.

Village of Grayslake. Personal communications with Bill Heinz, Kirk Smith and Kurt Bauman, September 2013. Grayslake IL 53/120 Design Parameters (references design features in the Central Lake Thruway/Unified Vision), Correspondence from the Village of Grayslake to the IL Route 53/120 Blue Ribbon Advisory Council, December 2011. Grayslake's Vision for a Low Profile Route 53/120 (Grayslake best management practices (BMPs) recommended to be incorporated into design parameters). Village of Grayslake, March 2012.

Village of Gurnee. Personal communications Scott Drabicki and Eric Venden, August 2013. Village of Gurnee Public Works Snow and Ice Control Plan, Updated November 2012.

Village of Lindenhurst. Personal communications Matt Formica and John Briggs, September 2013. The Village of Lindenhurst Snow and Ice Control Manual, October 2010.

Warren Township. Personal communication Gerald Rudd, August 2013 and January 2014.

Contents

Tables and Figures

Common Acronyms/Abbreviations Used in Chapter 4

ADID – Advanced Identification
BMP – Best Management Practice
CLC – College of Lake County
CMAP – Chicago Metropolitan Area for Planning
CFU – Colony forming unit
DO – Dissolved Oxygen
EMC – Event Mean Concentration
FQI – Floristic Quality Index
GIS – Geographic Information System
ICM – Impervious Cover Model
IDOT – Illinois Department of Transportation
Illinois EPA – Illinois Environmental Protection Agency
INAI – Illinois Natural Areas Inventory
LCDOT – Lake County Department of Transportation
LCFPD – Lake County Forest Preserve District
LCHD-ES – Lake County Health Department-Ecological Services
LCPBD – Lake County Planning Building and Development

LID – Low Impact Development
NPDES – National Pollutant Discharge Elimination System
NRCS – Natural Resource Conservation Service
SMC – Lake County Stormwater Management Commission
SSURGO – Soil Survey Geographic Database
STEPL – Spreadsheet Tool for Estimating Pollutant Loads
SWAMM – Spatial Watershed Assessment and Management Model
TMDL – Total Maximum Daily Load
TSS – Total Suspended Solids
UDO – Unified Development Ordinance
USLE – Universal Soil Loss Equation
USACE – United States Army Corps of Engineers
USEPA – United States Environmental Protection Agency
WDO – Watershed Development Ordinance

4. WATERSHED PROBLEM ASSESSMENT

This section of the report is a more detailed assessment of the problems identified in the Watershed Characteristics Assessment (Chapter 3). The following subsections describe how further analysis was used to assess how land use conditions are affecting the water quality, natural resources, and flooding conditions in the Mill Creek Watershed. The watershed problems assessment section identifies several current and potential future problems in the watershed including:

- Impacts of land use change on aquatic resources
- Water resources problems assessment
- Jurisdictional coordination at the watershed level
- Green infrastructure assessment

4.1 LAND USE IMPACTS

Problem(s): As described in Chapter 3, many of the aquatic resources of the Mill Creek Watershed are showing signs of degradation. The watershed's stream network exhibits a high degree of channelization, and a number of stream reaches within the watershed are enlarging (e.g., downcutting and widening), experiencing moderate to severe streambank erosion, and showing signs of habitat degradation (e.g., minimal pool-riffle development) and decreased biological abundance and diversity (e.g., depressed fish index of biological integrity scores). In addition, a number of lakes within the watershed suffer from degraded water quality (e.g., elevated phosphorus and chloride concentrations), moderate to severe shoreline erosion, and decreased biological abundance and diversity (e.g., depressed floristic quality assessment scores). Nine of the watershed's lakes have been classified as impaired by the Illinois Environmental Protection Agency (Illinois EPA) for at least one designated use. Many of these issues can, at least in part, be traced back to changes in land use that have occurred in the watershed over the last two centuries.

Likely Cause(s): Changes in hydrology and stormwater runoff characteristics (i.e., increased stormwater runoff rates, volumes, and pollutant loads) resulting from land use changes within the watershed.

Assessment: Land use changes, including those that began occurring nearly 200 years ago in order to convert pre-settlement natural land (e.g., savanna, prairie) to agricultural land, significantly alter the landscape. In order to accommodate such land use changes, plowing, clearing, and tree removal are used to remove existing trees, shrubs, and other vegetation and create "useable" land. Grading, excavation, and filling are then used to shape and level the land and to increase the amount of "useable" land. To further expand the amount of "useable" land found on a site, drainage improvements, such as channelization, dredging, and artificial drainage systems (e.g., drain tile systems, storm sewer systems) are often constructed. All of these land disturbing activities, individually, and in combination with one another, can have significant impacts on the health of terrestrial and aquatic resources.

Historically, wetlands have been particularly vulnerable to land disturbing activities such as grading, filling, and draining. Since 1780, more than 53 percent of all of the wetlands that once existed in the contiguous U.S. have been lost as a direct result of land disturbing activities (Wright *et al.* 2006, Dahl 2006, Dahl 2000, Dahl and Johnson 1991,Dahl 1990). Although improved federal, state, and local regulations have helped slow the rate of wetland loss nationwide over the last few decades, land disturbing activities continue to pose a threat, both directly and indirectly, to the health of these and other important aquatic and terrestrial resources.

Any natural resources, and in particular any aquatic resources, that are not directly impacted by clearing, grading, and other land disturbing activities may still be significantly impacted by land use change. By altering the surface of the land, the land disturbing activities associated with land use change fundamentally alter watershed hydrology and the characteristics of stormwater runoff (e.g., increased stormwater runoff rates, volumes, and pollutant loads). These changes, and the negative impacts that they can have on the aquatic resources of the Mill Creek Watershed, are described in more detail below.

4.1.1 EFFECTS OF LAND USE CHANGE ON STORMWATER QUANTITY

Land disturbance associated with land use change has an immediate effect on stormwater quantity. When a site is disturbed, its hydrology is fundamentally altered. Plowing, clearing, and tree removal removes the trees, shrubs, and other vegetation that reduce stormwater runoff volumes through the hydrologic processes of interception, evaporation, and transpiration. Earthwork and grading disturb native soils and eliminate natural depressional areas that work to retain rainfall and stormwater runoff on site. Soil compaction resulting from the operation of heavy machinery over and across the site reduces the infiltration capacity of the underlying soils and increases the amount of rainfall that is converted to stormwater runoff. If the land use change is being completed in order to build a road or create residential, commercial, or other non-agricultural land, the addition of impervious surfaces, such as roads, parking lots, and rooftops, further increases stormwater runoff volumes. In the end, much of the rainfall that was once retained on the site through the hydrologic processes of interception, evapotranspiration, and infiltration is converted to stormwater runoff. The installation of drainage improvements (e.g., channelization, dredging, artificial drainage systems) further reduces a site's ability to retain rainfall, further increasing stormwater runoff volumes.

Previous studies (Pitt, 1994; Shueler, 1987) have shown that total stormwater runoff volumes can increase dramatically as a result of land use change. Because more rainfall is converted to stormwater runoff as a result of the land disturbing activities associated with land use change, and drainage improvements are installed to carry these increased stormwater runoff volumes more quickly and efficiently away, less rainfall becomes available to recharge groundwater aquifers and provide baseflow to aquatic resources, including streams and wetlands, during dry weather.

The land disturbing activities associated with land use change not only increase stormwater runoff volumes and decrease groundwater recharge, but also dramatically increase the rate at which stormwater runoff is carried off the land. Impervious surfaces, such as roads, parking lots, and rooftops, and compacted pervious surfaces, such as farm fields, lawns, parks, and athletic fields, increase stormwater runoff velocities and decrease the amount of time that it takes for stormwater runoff to reach both on-site and downstream aquatic resources. This effect is further exacerbated by the installation of drainage system improvements (e.g., ditches, drain tile systems, curbs and gutters, and storm sewer systems) that are designed to quickly and efficiently convey stormwater runoff away from "useable" land to downstream aquatic resources. These increased stormwater runoff velocities lead to increased peak discharge rates, which can be at least two to five times higher on a developed site than on an undeveloped site (ARC, 2001).

4.1.2 EFFECTS OF LAND USE CHANGE ON STORMWATER QUALITY

Land use change not only affects stormwater quantity, but also stormwater quality. Pollutants, including sediment, nutrients, trash, and debris from cleared, graded, and compacted sites can be picked up and washed into receiving streams and other aquatic resources during storm events. As land use changes proceed, roads, parking lots, rooftops and other impervious surfaces often replace the native soils and vegetation that once worked to reduce stormwater runoff volumes and pollutant loads on site through the processes of interception, evapotranspiration, filtration, and infiltration. Pollutants that accumulate on these impervious surfaces and on compacted pervious surfaces, such as farm fields, lawns, parks, and athletic fields, during dry weather are picked up and transported, typically by artificial drainage systems, into receiving waters during rainfall events. In the end, greater amounts of stormwater pollution are generated and transported into on-site and downstream aquatic resources as a result of land use change.

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

- Sediment: The sources of sediment found in stormwater runoff are typically land disturbing activities, atmospheric deposition, or surface or streambank erosion. Sediment particles can adsorb other stormwater pollutants, such as nutrients, metals, hydrocarbons, and pesticides, and transport them into receiving streams, wetlands, and other aquatic resources.

- Nutrients: The sources of nutrients found in stormwater runoff, which include nitrogen and phosphorus, are typically fertilizer use, pet and animal waste, leaves, grass clippings, sanitary sewer overflows, septic system discharges, and atmospheric deposition.

- Bacteria: The bacteria and other pathogenic organisms found in stormwater runoff, whose concentrations can exceed public health standards for contact recreation, are typically a result of pet and animal waste, sanitary sewer overflows, and septic system discharges.

- Organic Matter: The organic matter found in stormwater runoff is typically a result of leaves, grass clippings, pet and animal waste, sanitary sewer overflows, and septic system discharges. The decomposition of this organic matter in the water column can cause dissolved oxygen levels in the water to fall below those necessary to sustain plant and animal life.

- Metals: The heavy metals found in stormwater runoff (such as lead, zinc, copper, and cadmium) are typically a result of atmospheric deposition, vehicle wear, and use or handling at commercial, industrial, and hazardous waste sites.

- Hydrocarbons: The sources of hydrocarbons found in stormwater runoff are typically vehicle wear, chemical spills, restaurant grease traps, and improper handling and disposal of waste oil and grease.

- Pesticides: The sources of insecticides, herbicides, and other pesticides found in stormwater runoff are typically farming activities, lawn care and maintenance activities, chemical spills, and atmospheric deposition.

- Chlorides: The sources of chlorides found in stormwater runoff are primarily winter sidewalk, driveway, roadway, and parking lot anti-icing and de-icing activities, although septic system discharges, where ion-exchange water softeners are served by such systems, may also be a source of chlorides.

- Trash and Debris: Considerable quantities of trash and debris typically accumulate on impervious surfaces and compacted pervious surfaces and get picked up and transported into receiving waters by stormwater runoff. This trash and debris can accumulate in the stormwater conveyance system, potentially causing clogging and nuisance flooding.

As outlined below, these non-point source pollutants have been shown, by an extensive and ever-growing body of research, to have a number of negative impacts on streams, wetlands, and other aquatic resources, including reduced water quality, reduced dissolved oxygen levels, increased primary productivity (e.g., eutrophication, algal blooms), sediment contamination, degradation of habitat, and a general decline in the abundance and diversity of wildlife and aquatic animals.

4.1.3 EFFECTS OF LAND USE CHANGE ON STORMWATER TEMPERATURE

Land use change not only affects stormwater quantity and quality, but also affects stormwater temperature. The compacted pervious and impervious surfaces resulting from land use change tend to retain heat, especially when exposed to sunlight. The "heating" of these surfaces is exacerbated by the fact that plowing, clearing, and tree removal likely removed the trees, shrubs, and other vegetation that were once found on site and that could have helped shade and cool them. As a rainfall event begins, stormwater runoff moves over and across these "heated" surfaces and becomes "heated." When this "heated" stormwater runoff is conveyed into a stream, wetland, or other aquatic resource, typically through an artificial drainage system, it can increase the temperature of the receiving water as well as decrease the amount of dissolved oxygen contained within the water column, which reduces the amount of oxygen available to aquatic organisms.

4.1.4 IMPACTS ON AQUATIC RESOURCES

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

Streams

The changes in stormwater quantity, quality, and temperature resulting from changes in land use can have a number of negative impacts on freshwater streams. These impacts, which are well documented by an extensive and ever-growing body of research (CWP, 2003; CWP, 2009; Cruse *et al.*, 2012), include:

- <u>Increased Channel Forming Events</u>: The increased stormwater runoff rates and volumes resulting from land use changes cause an increase in the frequency and duration of channel forming bankfull and near-bankfull events. This in turn leads to changes in channel form, stream channel enlargement (e.g., stream down-cutting and widening), and streambank erosion.

- <u>Increased Flooding</u>: The increased stormwater runoff rates and volumes resulting from land use changes also cause an increase in the frequency, duration, and severity of overbank and extreme flooding events. These flooding events can cause property damage as well as endanger public health and safety.

- <u>Decreased Baseflow</u>: The increased stormwater runoff volumes resulting from land use changes reduce the amount of rainfall available to recharge shallow groundwater aquifers and feed freshwater streams during dry weather.

- <u>Stream Channel Enlargement</u>: Stream channels enlarge (e.g., downcut and widen) in order to accommodate the increased peak discharges resulting from land use changes. A stream channel may become much wider and deeper in order to accommodate the increased stormwater runoff rates and volumes resulting from land use changes.

- <u>Streambank Erosion</u>: As stream channels enlarge (e.g., downcut and widen) in order to accommodate an increased frequency and duration of channel forming events and the increased peak discharges resulting from land use changes, streambanks are gradually undercut, scoured, and eroded away.

- <u>Loss of Riparian Vegetation</u>: As stream channels enlarge and streambanks are gradually undercut, scoured, and eroded away, the roots of trees, shrubs, and other vegetation that are found along the stream corridor may become exposed. Consequently, a significant amount of riparian vegetation may be undercut, uprooted, and conveyed downstream during storm events.

- Degradation of Habitat: The increased stormwater runoff rates and volumes resulting from land use changes scour stream beds and wash away valuable aquatic habitat. The increased sediment loads that result from land use changes, as well as from surface and streambank erosion, can also degrade aquatic habitat, filling in streambeds and destroying the important pool-riffle structure found in many healthy freshwater streams.

- Increased Temperatures: The increased stormwater runoff temperatures resulting from land use changes can raise the temperature of the water found within freshwater streams. Since some aquatic organisms can survive only within a specific temperature range (e.g., trout, stoneflies), increased stream temperatures can lead to an overall decline in wildlife abundance and diversity.

- Degradation of Water Quality: The increased stormwater pollutant loads resulting from land use changes reduce the overall water quality of freshwater streams. This water quality degradation negatively impacts many of the ecological functions that these important natural resources provide.

- Reduced Dissolved Oxygen Levels: The increased amounts of organic matter found in urban stormwater runoff, and the increased stormwater runoff temperatures that result from land use changes, reduce the amount of dissolved oxygen found in freshwater streams. If the amount of dissolved oxygen found in the water column gets low enough, fish kills (and the loss of other aquatic organisms can result. Low dissolved oxygen levels can also force the release of harmful pollutants such as metals, nutrients, hydrocarbons, and pesticides that have accumulated within the sediments found at the bottom of freshwater streams.

- Decline in Wildlife Abundance and Diversity: When the increased stormwater runoff rates, volumes, and pollutant loads resulting from land use changes degrade habitat and water quality, the abundance and diversity of aquatic organisms found in freshwater streams may be significantly reduced. Sensitive “keystone” or “indicator” organisms that require high quality habitat may become stressed and be gradually replaced by organisms more tolerant of the degraded conditions.

- Reduced Recreational and Aesthetic Value: The increased trash, debris, and pollutant loads found in stormwater runoff can accumulate in freshwater streams and detract from their natural beauty and recreational value.

Wetlands

The changes in stormwater quantity and quality resulting from changes in land use can have a number of negative impacts on freshwater wetlands. These impacts, which have been well-documented by an extensive and ever-growing body of research (Wright *et al.*, 2006; Cruse *et al.*, 2012), include:

- Increased Ponding: The increased stormwater runoff rates and volumes resulting from land use changes can cause increased ponding within freshwater wetlands. This increased ponding can stress native wetland plant communities, particularly if the wetlands did not previously receive large inputs of stormwater runoff.

- Increased Water Level Fluctuations: The increased stormwater runoff rates and volumes resulting from land use changes can cause increased water level fluctuations in freshwater wetlands. These increased water level fluctuations can stress native wetland plant communities and lead to a decline in plant and wildlife abundance and diversity.

- Decreased Baseflow: The increased stormwater runoff volumes resulting from land use changes reduce the amount of rainfall available to recharge shallow groundwater aquifers and provide a steady supply of baseflow to freshwater wetlands, particularly during dry weather.

- Shoreline Erosion: The increased ponding and water level fluctuations and decreased baseflow resulting from land use changes can stress native wetland plant communities and leave portions of wetland shorelines unvegetated, making such shorelines vulnerable to undercutting, scour, and erosion.

- Degradation of Habitat: The increased ponding and water level fluctuations and decreased baseflow resulting from land use changes can stress native wetland plant communities and degrade the habitat value of freshwater wetlands. The increased sediment loads resulting from land use changes, as well as from surface and streambank erosion, can also degrade the habitat value of wetlands.

- Degradation of Water Quality: The increased stormwater pollutant loads resulting from land use changes reduce the overall water quality of freshwater wetlands. This water quality degradation negatively impacts many of the ecological functions that these important natural resources provide.

- Increased Primary Productivity: The increased nutrient loads found in stormwater runoff unnaturally increases the primary productivity of freshwater wetlands, promoting algal growth and forcing the native wetland plant community to compete for available nutrients. This competition can stress native wetland plant communities and lead to an overall decline in plant and wildlife abundance and diversity.

- Sediment Contamination: The metals, hydrocarbons, and pesticides found in stormwater runoff can become attached to the surface of sediment particles and accumulate within freshwater wetlands. This accumulation can cause sediment contamination and expose aquatic and terrestrial organisms alike to the harmful effects of these pollutants.

- Decline in Wildlife Abundance and Diversity: When the increased stormwater runoff rates, volumes, and pollutant loads resulting from land use changes degraded habitat and water quality, the abundance and diversity of plants, animals, and other organisms found in freshwater wetlands may be significantly reduced. In these situations, native wetland plant communities tend to be replaced by invasive species, and sensitive macroinvertebrate, amphibian, reptile, and bird populations become stressed and gradually replaced by populations that are more tolerant of the degraded conditions. This can result in the local extinction of native aquatic and terrestrial organisms.

- Reduced Aesthetic Value: The increased trash, debris, and pollutant loads found in stormwater runoff can accumulate in freshwater wetlands, detracting from their natural beauty and aesthetic value.

Lakes

The changes in stormwater quantity and quality resulting from changes in land use can have a number of negative impacts on lakes. The impacts on lakes are synonymous with those on wetlands described above. It is worth noting, however, that the water quality of lakes, particularly that of man-made lakes, is particularly sensitive to the increased stormwater pollutant loads resulting from land use changes. Since lakes function as "sinks" within the landscape, incoming sediment, nutrient, bacteria, metals, hydrocarbons, pesticides, chlorides, and trash and debris can remain in a lake for a long period of time. The accumulation of these various pollutants can reduce overall water quality, contaminate sediments, increase primary productivity (e.g., increase algal growth), and negatively impact many of the important ecological functions that lakes provide.

Conclusion: As documented above, land use changes can have a wide range of impacts on the health of terrestrial and aquatic resources. These impacts, which range from decreased water quality to shoreline erosion to a decline in wildlife abundance and diversity, have been well documented by an extensive and ever-growing body of research. Many of these same impacts have been observed within the aquatic resources of the Mill Creek Watershed, as described in Chapter 3. These impacts can, at least in part, be traced back to the changes in hydrology and stormwater runoff characteristics (i.e., increased stormwater runoff rates, volumes, and pollutant loads) resulting from land use changes that have occurred in the watershed over the last two centuries.

4.1.5 ASSESSING THE IMPACTS OF PREDICTED FUTURE LAND USE CHANGES

As described in Chapter 3, data obtained from the Lake County Planning, Building, and Development Department (LCPBD) on future land use conditions predict substantial reductions in agricultural and open space land uses, and substantial increases in residential, industrial, office and research and retail/commercial land uses. As summarized in **Table 4-1** below, future land use projections indicate that land use will change on 5,941 acres, or 30% of the watershed, by the year 2020. Most of this change will result in the conversion of agricultural land and open space to urban land uses (e.g., residential, transportation, retail/commercial/mixed use).

The predicted land use changes have the potential to further impact and degrade the aquatic resources of the Mill Creek Watershed. An understanding of the scope and extent of these potential impacts is useful in crafting watershed management strategies that will help control and minimize them. Since the future land use projections indicate that significant quantities of agricultural land and open space will be converted to urban land uses, additional investigation of the relationship between urban land use and aquatic resources is warranted.

Urban Land Use

As described above, the land disturbing activities associated with land use change fundamentally alter watershed hydrology and the characteristics of stormwater runoff (e.g., increased stormwater runoff rates, volumes, and pollutant loads). An extensive and ever-growing body of research indicates that these changes are particularly observable when land is converted to urban land uses. The key reason for this is the fundamental transformation of the surface of the landscape from ***pervious surfaces***, complete with soils and vegetation, which help to absorb and store rainfall, to ***impervious surfaces***, such as roads, parking lots, and rooftops, which eliminate the landscape's ability to retain rainfall. And, as more land becomes covered by rooftops, parking lots, roads, and other impervious surfaces, the less capable it becomes of absorbing and storing rainfall. Consequently, urban land uses typically produce much greater stormwater runoff rates, volumes, and pollutant loads than their open space or agricultural counterparts. These increased stormwater runoff rates, volumes, and pollutant loads can quickly degrade the aquatic resources found within a watershed.

> *Pervious Surfaces: Pervious surfaces include all surfaces that are "green." By nature, this term is used to describe a diverse mosaic of soil-plant communities, including forests, wetlands, meadows, lawns, landscaped areas, and agricultural lands, each of which has its own physical and hydrological characteristics.*
> *Impervious Surfaces: Impervious surfaces include roads, parking lots, sidewalks, rooftops, and other impermeable surfaces of the urban landscape. Impervious surfaces can be easily measured at all scales of development, as the percentage of land area that is not "green."*

Table 4-1: Predicted Land Use Change in the Mill Creek Watershed.

Land Use Class	2012 Total Area (acres)	Percent of Watershed	Projected 2020	Acre Change	Percent of Watershed	Percent Change Current to Future
Agricultural	3,639	18%	939	-2,700	5%	-288%
Residential	4,072	21%	7,453	3,381	38%	45%
Transportation	1,854	9%	2,056	202	10%	10%
Utility/Waste Facility	301	2%	458	157	2%	34%
Government/Institutional	389	2%	618	229	3%	37%
Industrial	184	1%	922	738	5%	80%
Office and Research Parks	69	0%	533	464	3%	87%
Retail/Commercial/Mixed Use	433	2%	1,203	770	6%	64%
Public/Private Open-Space/ Wetlands	7,345	37%	4,247	-3,098	21%	-73%
Water	1,498	8%	1,355	-143	7%	-11%
Total	19,783	100%	19,784			

Noteworthy: Urban Land Use and Water Quality

Studies have shown that urban land use has a direct effect on water quality. Generally, the higher the percent of connected impervious cover of an urban land use, the greater the pollution load it generates. Pollutants from a variety of diverse and diffuse sources collect on impervious surfaces and are flushed into rivers and streams when it rains. Urban lawns, driveways, rooftops, parking lots and streets are the source areas of these pollutants, while the causes include: vehicles, road surface applications, direct atmospheric deposition, fertilizer; pesticides/herbicides, general litter (including pet litter), vegetative decay; and soil erosion from construction sites. Urban runoff also carries pollutants such as oil and grease, metals, and pathogens such as fecal coliform bacteria. Runoff from impervious surfaces can be 10-12 degrees warmer than runoff from land in a natural state, which combined with reduced summer flows results in higher in-stream water temperatures. **Table 4-2** is a comparison of pollutant loads from a number of non-point sources representing different land uses based on extensive monitoring for a Wisconsin study.

Table 4-2: Geometric Mean Concentrations of Pollutants in Stormwater runoff from urban areas*.

Source Area	Total Phosphorous (mg/L)	Solids (mg/L)	E. coli (c/100mL)	Zinc (µL)	Cadmium (µL)	Copper (µL)
Residential feeder street	1.31	662	92,000	220	0.8	46
Residential collector street	1.07	326	56,000	339	1.4	56
Commercial arterial street	0.47	232	9,600	508	1.8	46
Industrial collector street	1.5	763	8,380	479	3.3	76
Industrial arterial street	0.94	690	4,600	575	2.5	74
Residential roofs	0.15	27	290	149	ND	15
Commercial roofs	0.2	15	1,117	330	ND	9
Industrial roofs	0.11	41	144	1,155	ND	6
Residential lawns	2.67	397	42,000	59	ND	13
Driveways	1.16	173	34,000	107	0.5	17
Commercial parking	0.19	58	1,758	178	0.6	15
Industrial parking	0.39	312	2,705	304	1	41

Adopted from Bannerman, R.T., D.W. Owens, R.B. Dodds, N.J. Horrewar, 1993

*Table 4-2 reproduced from Watershed Techniques Vol. 1, No. 1

The Importance of Imperviousness

Impervious cover represents the imprint of urban land uses on the landscape. It is comprised of two primary components: the rooftops under which we live, work, and shop; and, the transport system (e.g., roads, driveways, and parking lots) that we use to get from one rooftop to another. Research shows that it is a very useful indicator with which to predict the impacts of urban land use on aquatic resources.

Research generally indicates that certain levels of impervious cover within a watershed represent thresholds for stream health. For example, at around 10% impervious cover, most indicators of stream health consistently shift from good to fair, and, at around 25% impervious cover, most indicators of stream health consistently shift from fair to poor (e.g., degraded water quality, significant decline in wildlife abundance and diversity). Putting all of this research together, the Center for Watershed Protection (CWP, 1998A) has constructed a simple model, known as the Impervious Cover Model (ICM) that can be used to predict the health of streams and other aquatic resources based on the amount of impervious cover found within their watersheds. **Figure 4-1** illustrates this simple yet powerful model.

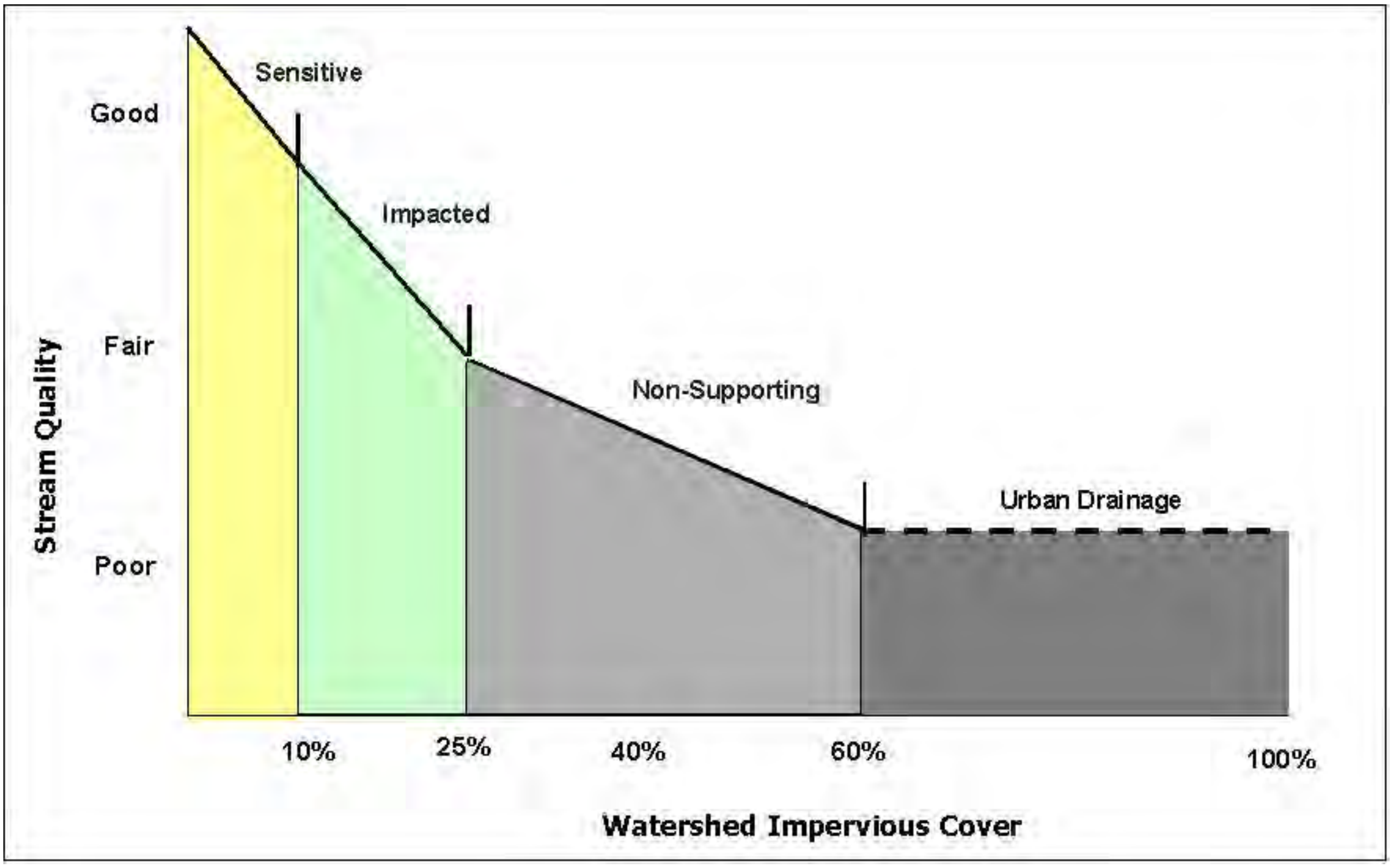


Figure 4-1: Impervious Cover Model (CWP, 1998A).

The ICM classifies streams into three distinct categories: sensitive, impacted, and non-supporting. Streams falling into these categories can be expected to have the following characteristics:

- <u>Sensitive Streams</u>. These streams typically have a watershed impervious cover of 0 to 10%. Consequently, they are typically of high quality, and typically have stable channels, excellent habitat, good to excellent water quality, and diverse communities of fish, insects, and other aquatic organisms. Since the amount of urban land use within their watersheds is so low, they are typically not exposed to the same "flashy" hydrology and other changes in stormwater runoff characteristics (e.g., increased stormwater runoff pollutant loads) that typically accompany watershed land use change. It should be noted that some streams with a watershed impervious cover of 0 to 10 located in agricultural areas may be impacted by farming practices and/or the installation of artificial drainage systems (e.g., drain tile systems) and, consequently, may not have all of the properties typically associated with a sensitive stream.

- Impacted Streams. Streams in this category typically have a watershed impervious cover ranging from 11 to 25%, and show clear signs of degradation due to watershed land use change. Increased stormwater runoff rates and volumes begin to alter stream geometry, leading to stream downcutting and widening. Streambank erosion is typically clearly evident. Streambanks become unstable, and habitat in the stream declines noticeably. As a result of increase stormwater runoff pollutant loads, stream water quality tends to shift into the fair category during both storm events and dry weather periods. Stream biodiversity tends to decline into the fair category, with the most sensitive fish, insects, and aquatic organisms disappearing from the stream.

- Non-Supporting Streams. Once watershed impervious cover exceeds 25%, stream health typically declines significantly. Streams in this category essentially become a conduit for conveying stormwater runoff and can no longer support a diverse community of fish, insects, and aquatic organisms. Stream channels become highly unstable, and many stream reaches experience severe downcutting, widening, and streambank erosion. The pool and riffle structure needed to sustain a diverse fish community is diminished or eliminated entirely, and the stream substrate no longer provides habitat for aquatic insects or spawning habitat for fish. Water quality is consistently fair to poor. The biological quality of non-supporting streams is generally considered poor, and they are dominated by pollutant-tolerant insects and fish.

The Mill Creek Watershed and the ICM

Based on 2011 planimetric data that measures the area of roads, parking lots and buildings in Lake County, Mill Creek Watershed has 917 acres of roads, 424 acres of parking lots, and 894 acres of structures. These 2,235 acres of impervious surfaces make up the bulk of the impervious cover found within the watershed (i.e., areas of driveways, sidewalks, and small structures that are less than 100 square feet in size are not included in this calculation of watershed impervious surface). A map of current watershed impervious cover, which measured at 11.2%, is included as **Figure 4-2**.

Based on the ICM, at 11.2%, aquatic resources found within the Mill Creek Watershed could be expected to fall into the impacted category, meaning that they would show clear signs of degradation due to watershed land use change. This classification is supported by the results of the watershed characteristics assessment, presented in Chapter 3, which indicates that many of the aquatic resources of the Mill Creek Watershed are showing clear signs of degradation. As described in Chapter 3, the watershed's stream network exhibits a high degree of channelization, and a number of stream reaches within the watershed are enlarging (e.g., downcutting and widening), experiencing moderate to severe streambank erosion, and showing signs of habitat degradation (e.g., minimal pool-riffle development) and decreased biological abundance and diversity (e.g., depressed fish index of biological integrity scores). In addition, a number of lakes within the watershed suffer from degraded water quality (e.g., elevated phosphorus and chloride concentrations), moderate to severe shoreline erosion, and decreased biological abundance and diversity (e.g., depressed floristic quality assessment scores).

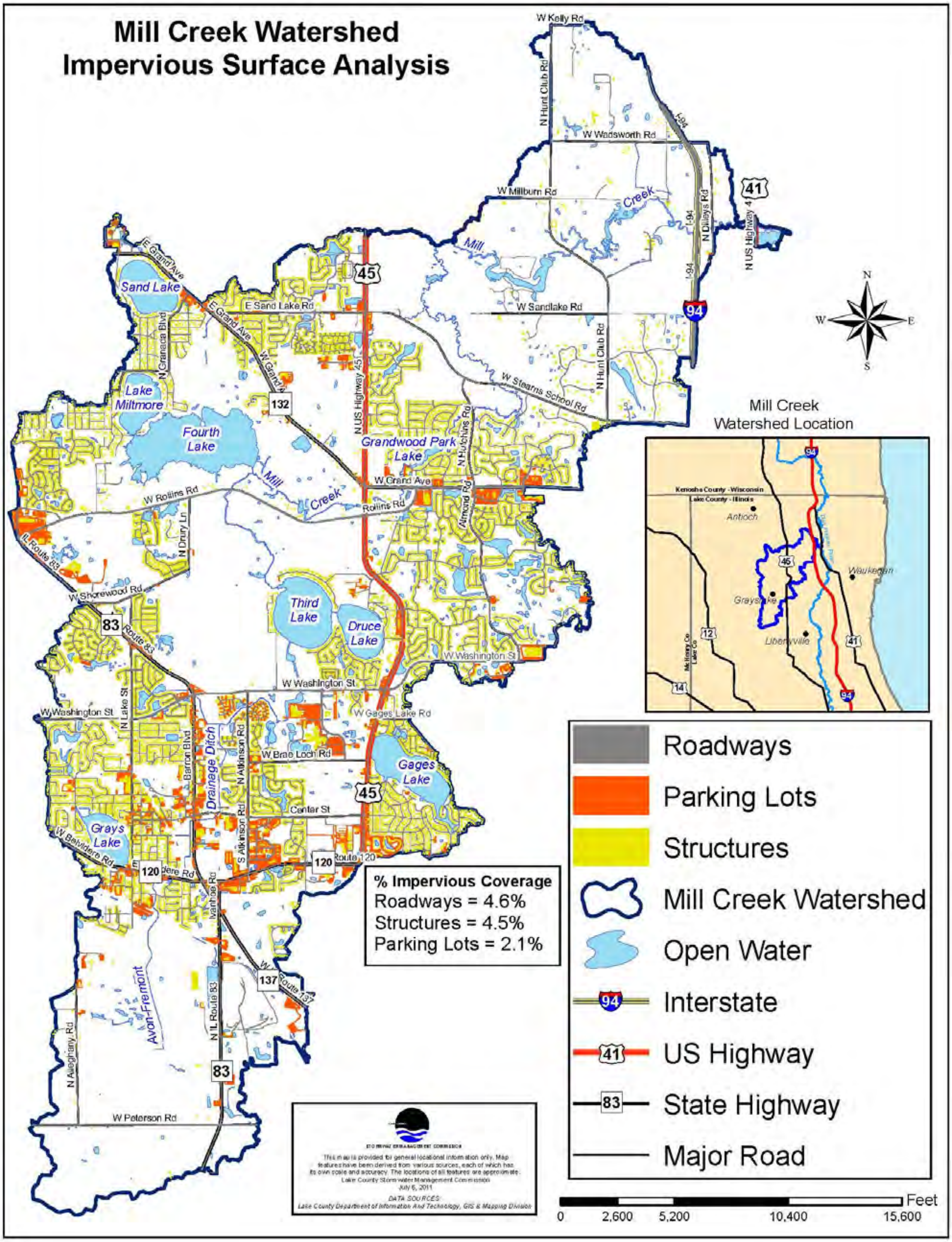


Figure 4-2: 2011 Watershed Impervious Cover Analysis.

The amount of impervious surface in the watershed is only expected to increase with the 5,941 acres of land use change that is predicted to occur in the coming years. More than half of the forecasted land use change is associated with new residential development (i.e., 3,380 acres), which typically consists of 20 to 30% impervious cover when it occurs on 1/2- to 1/4- acre lots (Cappiella and Brown, 2001). An additional 1,203 acres are predicted to be converted to retail/commercial/mixed-use development, which typically consists of about 70% impervious cover, and 922 acres are forecasted to be converted to industrial development, which typically consists of about 50% impervious cover (Cappiella and Brown, 2001). Although a relatively small percent of the total land use change, planned roadway expansion/ improvement projects of approximately 100 acres, as described in Chapter 3 and as summarized in Table 3-12, may nonetheless have a significant impact on the aquatic resources of the Mill Creek Watershed, as roadways tend to accumulate significant quantities of non-point source pollutants that are flushed into receiving waters (streams and lakes) during rainfall events.

Looking to the future of the Mill Creek Watershed, it is important that proper regulations and policies be identified and adopted in order to control and minimize the impacts of predicted future land uses and increases in watershed impervious cover.

4.1.6 REDUCING LAND USE IMPACTS THROUGH DEVELOPMENT REGULATIONS/POLICY

Among the primary goals of the Mill Creek Watershed and Flood Mitigation Plan are recommended actions for protecting and restoring natural resources, improving water quality, and reducing and preventing flood damage in the watershed. These actions include both remedial and preventative measures. One of the most significant and influential preventative measures are policies and regulatory programs. Changes to the Lake County Watershed Development Ordinance (WDO) and local municipal ordinances that benefit all watersheds in Lake County would consequently benefit the Mill Creek Watershed. But to maximize protection for the watershed, Lake County Stormwater Management Commission (SMC) and local municipalities should consider developing and administering watershed-specific regulation to meet goals and technical issues of concern in the watershed.

Frequently the appropriate measures of watershed protection are addressed most efficiently through non-degenerative practices rather than costly remediation after the problems become unavoidable. This watershed management plan does not include land use recommendations, because land use planning and development decisions are the right and responsibility of watershed municipalities and the County. But, this plan does consider the health of watershed lakes, streams and wetlands, which is a direct reflection of land use and management. Therefore, municipal and county consideration of land management and development impacts is necessary for effective watershed planning. Negative indicators in the Mill Creek Watershed show that land use and land management practices have impacted the physical, chemical and biological health of streams and lakes in the watershed and have created flood damage problems. Current water resource problems combined with projected future land use changes signal the need for review and modification of policies, standards and practices guiding how land is developed and managed in the watershed.

It is anticipated that stormwater runoff volume and pollution will continue to increase as development progresses and land use changes occur within the Mill Creek Watershed. Municipal and County review of relevant ordinances is needed to evaluate policies, standards and regulations for new and retrofitted development, and for land management as it pertains to stormwater runoff volume, detention, water quality, floodplains/floodways, and wetlands, to identify where opportunities for watershed-friendly development practices such as low impact development and green infrastructure may exist.

Two types of regulatory and policy programs need to be reviewed based on their potential to positively influence watershed health by preventing negative land development impacts. One type of program relates to watershed development regulations and policy focused on stormwater management; the second type is local ordinances and policy that direct development practices that influence impervious cover and drainage.

Stormwater Management

The WDO determines the minimum requirements for development as a consistent standard county-wide. Therefore, changes in development policy and regulation related to water resources fall in the hands of SMC and local enforcement officers for WDO ***Certified Communities*** in Lake County (see **Figure 4-3**). The SMC may determine there are conditions unique to the Mill Creek Watershed that warrant consideration for developing and administering watershed-specific stormwater management regulations to address the technical issues of concern in the watershed.

Certified Community: Community authorized by SMC to administer and enforce the majority of the provisions of the WDO. A community can be a fully certified community (delegated to review both standard (general stormwater provisions) and isolated waters (wetland) aspects of the WDO or partially certified community (delegated to review either standard or isolated wetland aspects of the WDO). SMC retains certain review authorities, primarily with respect to the floodplain and floodway provisions of the WDO in certified communities.

The primary technical issues of concern in Mill Creek Watershed related to stormwater management are:

- Hydrologic changes have resulted in stream channel changes. Deepening and widening of the creek in some locations has created excessive erosion and sedimentation, property loss, debris loads and blockages and aquatic habitat impairments.
- Significant increases in impervious surface and resulting hydrologic changes are projected for the southern headwaters area and the northeastern portion of the watershed;
- Non-point source pollution from urban land uses, transportation infrastructure and maintenance practices, and agricultural runoff has impaired watershed lakes.

Watershed development concerns that were identified during stakeholder meetings and the development of this plan include:

- The effects of increased runoff volume resulting from land use changes can be addressed in a variety of ways, examples include:
    - Instituting more effective and consistent runoff volume reduction practices; 5,941 acres or approximately 30% of undeveloped lands in the watershed (agricultural, open space and water) are projected to convert to developed land uses (residential, commercial/retail, transportation etc.) by 2020.
    - Review the detention volume/release rate requirements for the watershed and determine if unique conditions warrant adjustments or changes to storage and release regulations.
    - Ordinance and policy language can be reviewed and revised to ensure that the disconnection and minimization of impervious surfaces are allowed by right.
    - Low impact development practices and the use of green infrastructure best practices that maintain natural hydrology post-development could be expanded by municipal and County ordinances for all new development and significant redevelopment.
    - Unavoidable wetland loss should be mitigated within the watershed where the wetland impact/loss occurs.

- Water quality has been identified as a major watershed concern. Local community ordinances can be reviewed and revised to insure that development codes do not preclude, but rather encourage best management practices (BMPs) to protect and improve water quality such as:
    - The use of native vegetation in home and business landscaping.
    - Sustainable street designs (include alternative transportation opportunities (complete streets) and bio-swales or other vegetated conveyance systems for stormwater management instead of traditional curb and gutter).
    - Infiltration for a significant portion of increased runoff volume due to land development (the WDO was amended in 2013 to include runoff volume reduction requirements).
    - Preservation of natural retention and infiltration areas recognized as green infrastructure to reduce polluted runoff.
    - Rainwater harvesting.

- Significant lengths of Mill Creek and tributary streams in the watershed are eroded and degraded as a consequence of the volume of stormwater runoff that is being directed to them. There is also inadequate riparian management along many reaches. Stream issues to be addressed:
    - Stream corridor enhancements are not required as part of land development activities. Requirements or incentives for stream corridor buffering and restoration for stream reaches located on new development sites could provide both flood damage and water quality benefits.
    - Developing stream maintenance and restoration standards that can be applied throughout the watershed (by the Avon-Fremont Drainage District and other jurisdictions and private riparian landowners).

- Currently there are not any standardized long-term maintenance and monitoring protocols for naturalized stormwater drainage systems and natural areas. Development of standardized protocol for monitoring and maintenance plans for new developments, and requiring endowment funds for long-term implementation of the plans could be a significant benefit to the watershed.

Local Municipal and County Policies and Ordinances

Additional avenues for policy and regulatory change are the responsibility of the County planning and development department and local municipalities in their land use plans, local subdivision ordinances, etc. Local municipal ordinances can positively or negatively affect watershed response, and may be the best avenue for incorporating watershed-specific development standards and practices that prevent flood damage and protect water quality. Following the policy direction of elected officials, local community staff has a significant role in preserving watershed health, and could assist developers in the site review process by assessing each new development site for proper best management practice (BMP) selection, and implementation of stormwater management practices that best minimize runoff volumes and velocities.

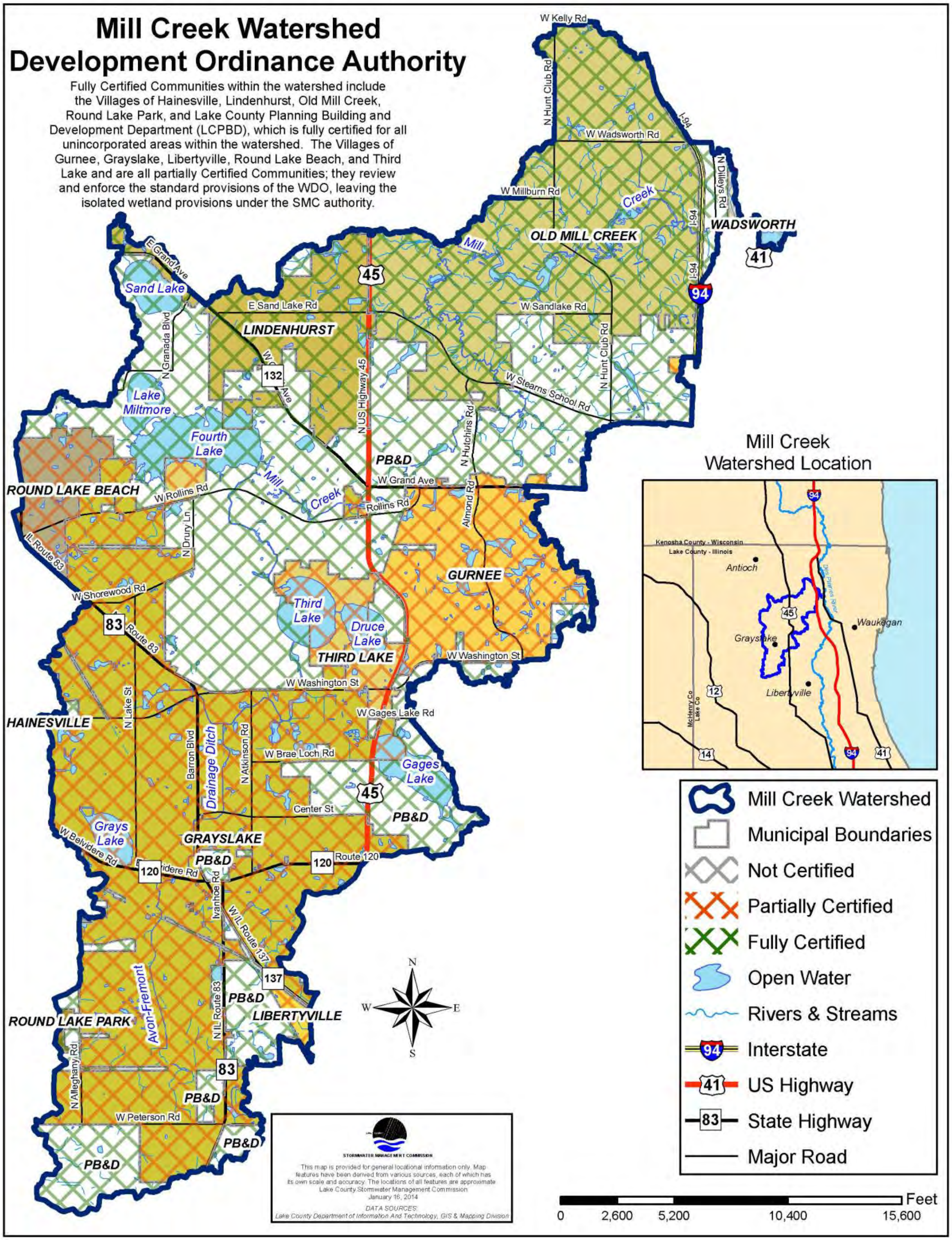


Figure 4-3: Jurisdictional Authority.

Noteworthy: Community Programs and Regulations Influence Watershed Health

There are many codes and ordinances that have an influence on the health and function of a watershed. **Table 4-3** includes typical types of codes and ordinances that can be evaluated and potentially changed or modified to help improve watershed conditions.

Table 4-3: Code or Ordinance Types with Ties to Watershed Health.

Code, Ordinance and Regulation Types With Ties To Watershed Health	
Erosion and Sediment Control Ordinances	Zoning Ordinance
Environmental Regulations (Buffers, Water Quality, Wetlands, Threatened/Endangered Species, etc.)	Subdivision Codes
Floodplain Regulations	Street Standards and Road Design
Stormwater Management & Drainage	Building and Fire Regulation Standards
Tree Protection and Landscaping	Public Fire Defense
Parking Requirements	Grading Ordinance

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

Conservation and low impact development (LID) are discussed in a following *Noteworthy*. An excellent source of information on model development principles and a sample code and ordinance review worksheet can be found in *Better Site Design: A Handbook for Changing Development Rules in Your Community* (Center for Watershed Protection, 1998). In addition, the Center for Watershed Protection and U.S. Environmental Protection Agency (USEPA) have self-appraisal checklists that watershed communities may use to evaluate their existing codes and ordinances to identify where regulatory changes and modifications can be made to improve the preservation and use of green infrastructure in the watershed. Adopting watershed-friendly codes and ordinances will elevate protection and enhancement of watershed resources. It is recommended that watershed communities perform this self-appraisal, and establish an action plan to revise ordinances and codes where needed.

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

Noteworthy: Conservation and Low Impact Development

County and local governments can work together to develop incentives for conservation and low impact development. Conservation development is the ideal compromise between economic development and water resource protection. Some ways to incorporate conservation development into developing communities and provide incentives for developers include:

- Allow conservation development "by-right" (does not require variances);
- Establish a joint review department/agency application process that reduces review time for conservation development;
- Reduce fees for conservation development application review;
- County and municipalities work together to locate appropriate parcels for future conservation development, and then zone those parcels as conservation development (parcels in the green infrastructure network that are proposed for development would be good candidates);
- Require all developments have a certain percentage of preserved open space;
- Develop native landscaping ordinances;
- Reduce setback requirements between lots and encourage multi-level and clustered residential development to reduce land consumption;
- Provide credit for combining natural buffers with recreational opportunities;
- Require native plantings in all detention basins
- Provide detention credit for green infrastructure best management practices.

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

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

4.2 WATER RESOURCE PROBLEMS ASSESSMENT

The problem: Lakes in the watershed have poor water quality. Nine of the eleven lakes in the watershed are classified as “impaired” by the Illinois Environmental Protection Agency (Illinois EPA). Of the streams, water quality is largely unknown because it has not been regularly monitored throughout the watershed, but is assumed to be impacted by the causes and sources of pollution discussed in Section 4.1.

Primary causes: Phosphorous and Total Suspended Solids (TSS) tend to be a cause of impairment for most lakes and streams throughout the watershed. Increased levels of phosphorous and TSS are attributed to wastewater effluent, agricultural production and suburban (including residential) sources. Chemical pollutant loads are causing impairments, as are physical alterations such as carp stirring up sediments and channel modifications to improve drainage or increase the area of usable land such as channelization. Modifying the stream channel causes erosion and sedimentation/siltation concerns with associated high TSS, which can be reasons for an impairment listing. Fecal coliform is listed as the cause of impairment for Druce Lake, and Dissolved Oxygen (DO) as a cause of impairment in Bittersweet Pond.

Changes to the watershed hydrology as a result of changing land use (impervious effects) and tile drainage impacts both lakes and streams. Hydrology changes in the watershed related to human land uses have resulted in lake sedimentation and stream erosion, increased flood damage (currently still limited), and non-point source pollution. There have also been substantial modifications to the stream system. Large segments of Mill Creek and the entire length of the Avon-Fremont Drainage Ditch have been modified by channelization and the construction of hydraulic structures. These hydrological and hydraulic changes further result in a decreased quantity of pool-riffle complexes, increased sediment accumulation, increased debris loads, habitat alteration and decreased biological productivity.

Noteworthy: Chemical, Physical, and Biological Assessments

Pollutants are inputs into water bodies that can be monitored by collecting chemical data for parameters such phosphorus, TSS, and fecal coliform bacteria. Physical modifications to the water bodies also play a significant role in degrading streams and water quality as they can impair aquatic habitat. Water quality monitoring has evolved to rely on chemical monitoring, toxicological and biological assessment data. Detailed chemical monitoring provides information on conditions as a snapshot in time when assessed using grab samples (reflects water chemistry at the time the sample is collected) that is restricted to the selected analyses and constrained by available methodology and detection limits. Other basic chemical and physical parameters can be collected continuously over a period of time using in-stream probes such as the data sondes. Biological data, a survey of macroinvertebrates and fish, can be used to assess stream health over time as water quality and aquatic habitat affect the makeup of the animal communities in the stream. Biological assessments improve the chances of detecting effects of episodic events (e.g., spills), toxic non-point source pollution (e.g., pesticides), and cumulative and chronic pollution. Biological assessment data can also reflect the effects of unknown or unregulated chemicals (such as pharmaceuticals), non-chemical impacts, and habitat alterations.

4.2.1 LAKE IMPAIRMENTS

Water Quality

Nine lakes in the watershed are listed as impaired by Illinois EPA. Of the lakes studied, six are listed as impaired for phosphorus and total suspended solids: Bittersweet, College Trail, Gages, Grandwood Park, Third, and Willow. Bittersweet is also listed as impaired for dissolved oxygen, in addition to phosphorus and total suspended solids. Druce Lake is impaired for fecal coliform. Most of the lakes remain in poor water quality condition, suffering from high nutrient and sediment concentrations, algae blooms, and invasive aquatic plant growth. These stressors have resulted from a variety of causes including rural (i.e., agriculture), urban (i.e., fertilizers, septic, road salts), and internal (i.e., carp, wind/wave action, invasive species) sources. Aquatic plant diversity, an important part of a healthy ecosystem, was relatively poor in the lakes studied. While some lakes had beneficial native species, most had one or two exotic invasive species present. Other lakes were nearly devoid of plants, due to human influences.

Biological Impairments

Lakes can also have impaired water quality as a result of internal sources (i.e., carp, wind/wave action, invasive species, and having excessive or being devoid of aquatic vegetation). Aquatic plant diversity, an important part of a healthy ecosystem, was relatively poor in the lakes studied. Some lakes were nearly devoid of plants, due to human influences. The Floristic Quality Indices (FQI) values on several lakes were some of the worst in the county (see Table 3-30).

The lakes suffered from algae blooms, and invasive aquatic plant growth. The decreased biological productivity and limited diversity of both fish and macroinvertebrate species are most likely a result of these impaired water quality and habitat alterations.

Shoreline Erosion

According to the Lake County Health Department – Ecological Services (LCHD-ES), most lakes in the county have eroded shorelines with invasive plant species as summarized in Table 3-28 and Table 3-29. This erosion will impact the water quality of the lakes, biological productivity, and loss of shoreline and property.

4.2.2 STREAM IMPAIRMENTS

Mill Creek is not currently listed by Illinois EPA as an impaired waterbody (the 303(d) list). Detailed water chemistry data are limited to analysis of grab samples from sampling stations east of Hunt Club Road and no continuous water chemistry data for any time period or location are available. A more robust monitoring program is likely needed to provide sufficient data to determine if water quality is affecting aquatic life in Mill Creek or if impairments related to water quality exist. Based upon trends in lakes and other streams in Lake County, there is interest in monitoring chloride, phosphorus, and TSS to assess current levels and trends. Available data from biological surveys suggest that biotic integrity in the stream may be moderately impacted, but it is unclear whether this is related to water quality or habitat degradation.

Hydrology

The hydrology of the Mill Creek Watershed has been significantly modified by humans. Upstream (south) of Washington Street, the stream network consists almost entirely of constructed drainage channels (the Avon-Fremont Drainage Ditch). These channels deliver runoff more rapidly to the northern half of the stream network than would have occurred prior to their construction, but this drainage infrastructure is also integral to the development of the communities surrounding it.

Watershed development (i.e., land use change) also contributes to the rapid delivery of runoff to the stream network. While much of the watershed downstream (north) of Stearns School Road is primarily open space or agriculture, the increase in impervious surfaces upstream and the construction of efficient land drainage systems for agriculture and urban development has changed the hydrology of Mill Creek. Since the adoption of the minimum standards for stormwater management in the WDO in 1992, hydrologic changes resulting from new development have been partly offset, but land use changes that occurred prior to 1992 and all agricultural land are not subject to these standards. Because impervious surfaces and drainage systems route precipitation runoff directly to detention ponds, lakes and streams, less water percolates into the ground. This reduces the groundwater available for baseflow in streams during dry periods of the year.

Changes to the hydrology of Mill Creek contribute to increased rates of streambank erosion and more frequent minor flooding ("bankfull" and "overbank" events). Due to increased erosion, debris loading may be increased in stream reaches with forested riparian areas as trees collapse into the stream channel. Decreased baseflow may impact aquatic life during dry periods of the year. Areas of moderate and severe streambank erosion are addressed in the Site-Specific Action Plan. Debris loading is discussed in the stream inventory section of Chapter 3.

Channelization

Mill Creek is an extensively channelized stream network (discussed and mapped in Chapter 3). Upstream (south) of Third Lake, virtually the entire network consists of drainage ditches that likely bear little or no resemblance to the natural drainage patterns that existed prior to their construction (the original township plats of Lake County from the Public Land Survey do not indicate any streams south of Third Lake). It is therefore difficult to assess the degree to which channelization has affected this portion of the drainage system, other than to say that the impact is significant and to note that the present mechanics of hydrology are altogether different from those that developed naturally.

Downstream of Third Lake, approximately 2 miles of the 5.8 miles of Mill Creek assessed in the stream inventory were "moderately" channelized. Additional wetland reaches in Rollins Savanna Forest Preserve that were not assessed in the stream inventory appear to have been moderately channelized as well (i.e., a clear straightened flow path was constructed within the wetland). There are several consequences of historic channelization of natural streams. In wetlands, often the intended result of channelization was to lower the surface water table, effectively draining the wetland in order to increase arable land area. In other areas, channelization simply straightened the stream and provided more area for agricultural or urban development and improved local drainage. The hydrologic effects of drainage improvement are discussed above.

Channelization of natural streams results in the loss of physical habitat in the stream system such as pools and riffles. If channelized streams are not maintained, they may become severely eroded as the stream moves from a constructed straight trapezoidal shape toward a natural meandering form over time. In the Mill Creek Watershed, this process is most evident downstream of Grandwood Park dam. Here the stream was moderately channelized (i.e., the meandering channel was "smoothed" rather than completely straightened) prior to construction of the residential neighborhood in the 1960s. Since that time, the stream has reassumed a meandering path, resulting in moderate to severe erosion of the streambanks that were constructed in the 1960s. This type of erosion is problematic and at times alarming for riparian property owners who have made considerable investments in—or derive aesthetic and other benefits from—their stream-side property.

Hydraulic Structures and Dams

Hydraulic structures such as bridges and culverts are necessary for stream crossings but may become problematic over time if they are compromised or not adequately maintained. The stream inventory noted 13 hydraulic structures throughout the 28 assessed reaches that may constitute a problem or impairment (discussed and mapped in Chapter 3). Noted issues include total or partial obstruction of culverts and bridges by sediment and debris, collapse or wash-out of culverts and bridges, and several of the noted issues are beaver dams. In general, beaver dams do not inherently constitute a problem or impairment, but can be problematic depending on the situation (i.e., a beaver dam is causing flooding of a road crossing upstream). In all 13 cases, this plan recommends that the responsible landowner, transportation or drainage district authority inspect the structure and determine whether remedial action is necessary.

There are several functioning dams on Mill Creek. Dams were historically constructed for any number of purposes including power, navigation, irrigation, drinking water, flood control, and recreation. The effect of dams on stream systems and watersheds is well-documented. The construction of dams may alter sediment loads, reduce the diversity and movement of fish and other aquatic organisms, result in drastic changes in water temperature, cause changes to riparian vegetation, and alter hydrology. This plan does not offer an opinion regarding the status or maintenance of any particular dam unless an action recommendation was specifically developed in consultation with the owner or manager.

4.2.3 POLLUTION LOADING AND NON-POINT SOURCES

Pollutant loading from a watershed is the sum of pollution from point sources and non-point sources. Non-point source pollution is a primary concern related to water quality in the Mill Creek Watershed. The Mill Creek Watershed stakeholders and planning committee have identified five priority non-point source pollution parameters to address in this plan: total phosphorus, total suspended sediment, chloride, fecal coliform bacteria and dissolved oxygen.

> *Universal Soil Loss Equation (USLE): USLE is a mathematical model used to describe soil erosion processes. It takes into account factors that include soil erodibility, land slope, slope length and the presence/absence of conservation practices on the land. The USLE (or one of its derivatives) is the main system used by United States government agencies to measure site-level erosion.*
> *Spreadsheet Tool for Estimation of Pollutant Load (STEPL): STEPL employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). STEPL development is supported and funded by the EPA.*

Point sources are also contributors to the overall watershed pollutant loads; however, the primary focus of this plan is to address non-point sources. Existing regulatory permit processes and enforcement largely handle point source pollution. The permitted point source facilities within the Mill Creek Watershed include one municipal wastewater reclamation facility, businesses, government, and landfills. All permitted facilities are subject to regulatory monitoring and reporting requirements, which are all public records.

4.2.3.1 Non-Point Source Pollution Model

For the Mill Creek Watershed, a custom geographic information system (GIS) model called the Spatial Watershed Assessment and Management Model (SWAMM™) was developed to estimate current and future non-point source pollutant loads for four parameters: total phosphorus, total suspended sediment, chloride and fecal coliform bacteria. Dissolved oxygen requires a different modeling approach, which was not performed for the development of this plan, however, the reduction of nutrients such as phosphorus is known to improve dissolved oxygen conditions in water bodies.

The model output illustrates and quantifies the spatial distribution of non-point source loading in the watershed. The non-point source loads are subtotaled by land use category and at the catchment scale.

SWAMM™ incorporates the land use described in Chapter 3 and Soil Survey Geographic Database (SSURGO) soils data for the watershed. Average annual and ***first flush runoff*** volumes were estimated for the basin using the land use, soil-types and climate statistics. ***Event Mean Concentrations (EMCs)*** were applied to the runoff volumes based on land use practices. The EMCs are established based on literature sources, water quality studies and professional experience, and are listed in Appendix G. In agricultural areas the model incorporates a Universal Soil Loss Equation (USLE) with a delivery ratio based on distance to the closest receiving water body (Appendix G). The USLE portion of the model allows for refined loading estimates based on soil types and topography. Formulas and selected variables incorporated into the model are largely derived from STEPL, Version 3 and Schueler's Simple Method (Appendix G).

First Flush Runoff: First flush is the storm-event runoff that occurs at the beginning of a rainstorm of a defined threshold. The first flush carries concentrations of pollutants that have accumulated on the ground during the period of drier weather between storms. Communities often struggle to adequately define what depth of rainfall constitutes a first flush, and how it is influenced by frequency and intensity of rainfall. First flush is a metric for gaining compliance with Phase II of the National Pollution Discharge Elimination System (NPDES) and meeting EPA's total maximum daily load (TMDL) regulations.
Event Mean Concentration (EMC): Method for characterizing pollutant concentrations in stormwater runoff. The pollutant concentrations are measured in studies and on-going research that collects and analyze s runoff from various land-use practices in different geographic and climatic regions. The values are determined by compositing (in proportion to flow rate) a set of samples, taken at various points in time during a runoff event, into a single sample for analysis.

It should be noted that all computation models have assumptions and limitations and that the model is designed as a planning tool. Therefore, the provided analytical results do not represent the exact pollution loads due to calibration and model limitations. The relative and spatially-presented results are intended to assist in identifying locations generating non-point source pollution that have the largest impact on water quality within the watershed. These areas can be targeted for BMP implementation that can provide the greatest water quality improvement benefit to the watershed.

4.2.3.2 Non-Point Source Loading

Figure 4-4 through **Figure 4-7** illustrate the spatial distribution of non-point source loading for total suspended sediment, total phosphorus, fecal coliform bacteria and chloride, respectively. The Figures represent measurements in pounds per acre of pollutant except for fecal coliform, which is measured by colony forming units (CFU). **Table 4-4** through **Table 4-6** display the total pollutant load results for the watershed, by land use category and catchment code.

Results show that transportation land uses and water (receiving bodies for much of the chloride) contribute the highest annual levels of chloride per acre. Agriculture generally contributes the highest phosphorus and sediment loads. Residential land uses contribute the highest fecal coliform loading. Open space ranks near the lowest contribution in all categories. **Table 4-7** shows the highest-ranked catchments in terms of pollutant loading per acre for each of the modeled parameters.

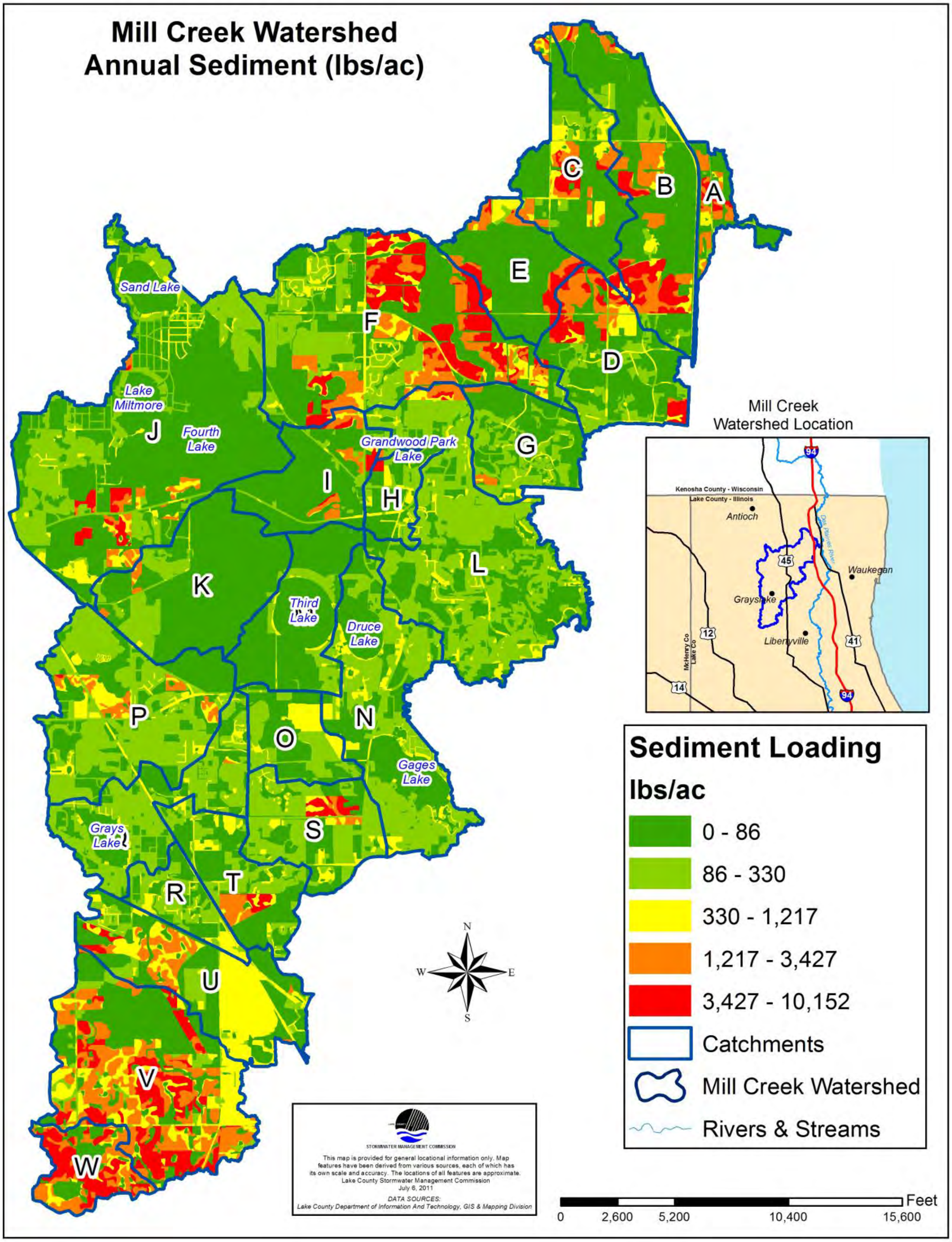


Figure 4-4: Annual Sediment Loading Model.

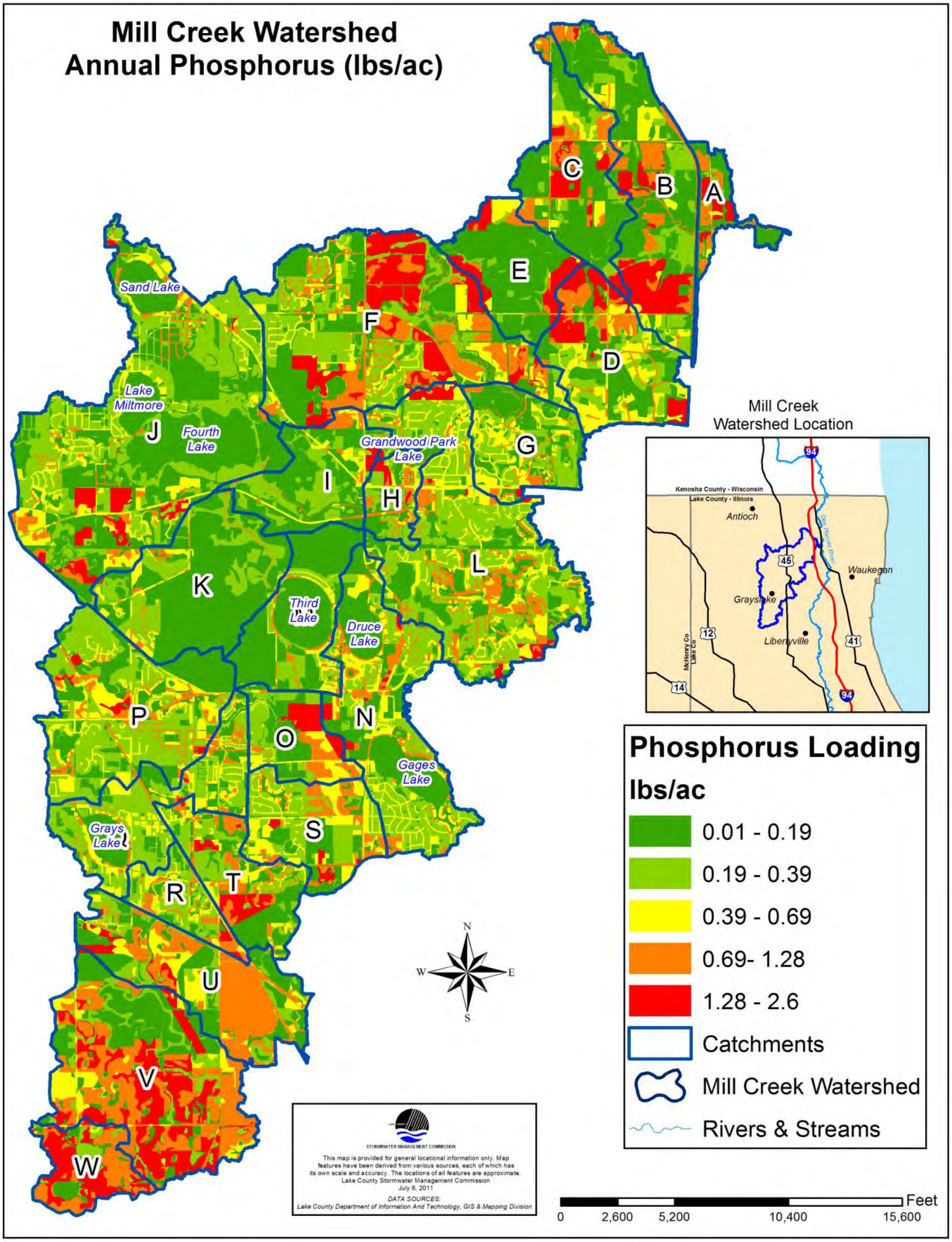


Figure 4-5: Annual Phosphorus Loading Model.

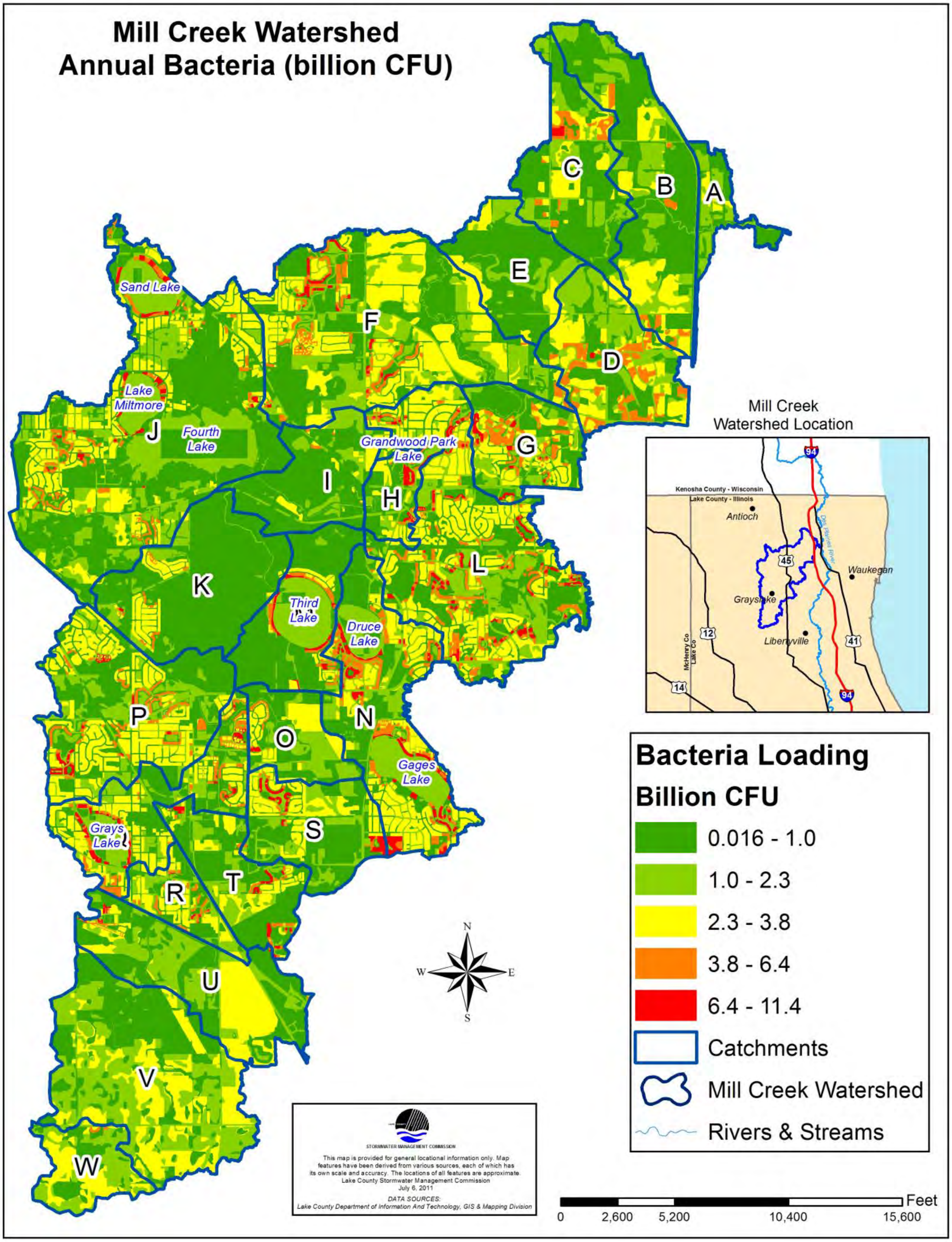


Figure 4-6: Annual Fecal Coliform Bacteria Loading Model.

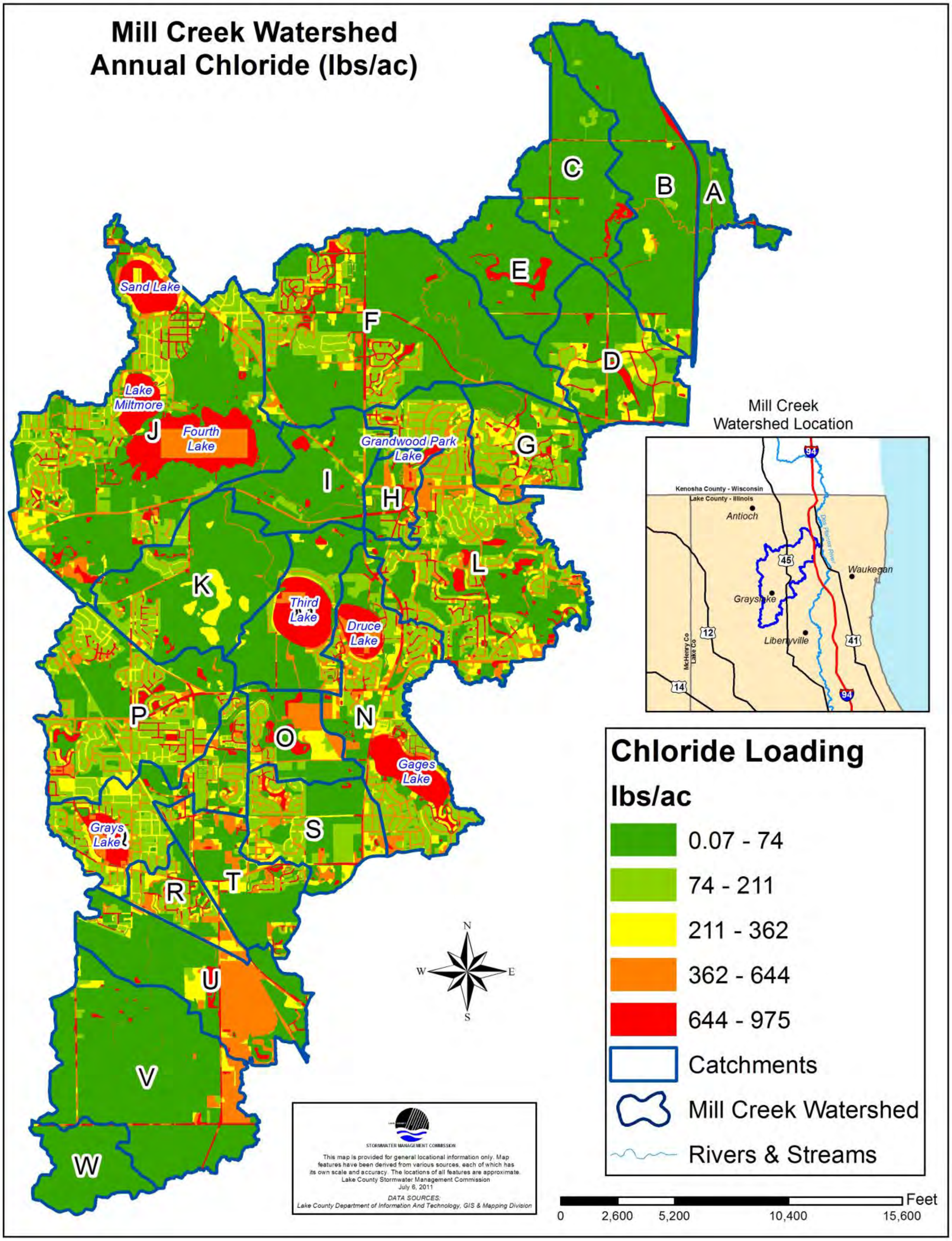


Figure 4-7: Annual Chloride Loading Model.

Table 4-4: Annual Non-Point Source Loading Results.

Parameter	Model Results	Avg. – Per Acre
Total Suspended Sediment – (tons/yr)	5,186	0.26
Total Phosphorus (lbs/yr)	9,280	0.47
Fecal Coliform (CFU in billions/yr)	31,783	1.61
Chloride (lbs/yr)	3,280,996	166
Total Annual Stormwater Runoff (ac-ft)	19,259	0.97

Table 4-5: Annual Non-Point Source Loading By Land Use.

Land Use	Total Acres	Phosphorus (lbs/ac)	Chloride (lbs/ac)	Fecal Coliform (B-cfu/ac)	TSS (tons/ac)
Agricultural	3,639	1.18	1.9	2.3	1.2
Residential	4,072	0.33	166	3.6	0.07
Transportation	1,854	0.61	558	1.3	0.12
Utility/Waste Facility	301	0.94	444	2.9	0.33
Government/Institutional	389	0.98	376	1.7	0.16
Industrial	184	0.66	302	1.8	0.15
Office and Research Parks	69	0.80	318	1.1	0.13
Retail/Commercial/Mixed Use	433	0.67	248	1.1	0.12
Public/Private Open Space/Wetlands	7,345	0.16	1.1	0.3	0.01
Water	1,498	0.17	728	1.2	0.004
Total	**19,783**	**0.47**	**166**	**1.6**	**0.26**

****Load results in this table are the result of the non-point source model and do not account for major gully and streambank erosion sources**

Table 4-6: Annual Non-Point Source Loading by Catchment.

Catchment Code	Total Acres	Phosphorus		Chloride		Fecal Coliform		Total Suspended Sediment	
		Total (lbs)	lbs/ac	Total (lbs)	lbs/ac	Total (cfu in billions)	per acre	Total (tons)	tons/acre
A	209	132	0.63	24,458	117	255	1.22	85	0.41
B	1,066	596	0.56	60,126	56	1,400	1.31	411	0.39
C	722	367	0.51	36,087	50	1,014	1.40	225	0.31
D	753	454	0.60	97,872	130	1,683	2.23	347	0.46
E	540	251	0.46	35,636	66	531	0.98	229	0.42
F	1,863	1,177	0.63	206,587	111	3,473	1.86	1,101	0.59
G	518	171	0.33	100,280	194	1,023	1.98	39	0.08
H	227	98	0.43	55,173	243	443	1.95	30	0.13
I	576	174	0.30	38,975	68	409	0.71	105	0.18
J	2,563	828	0.32	648,649	253	3,636	1.42	298	0.12
K	966	165	0.17	70,714	73	606	0.63	28	0.03
L	1,644	650	0.40	342,373	208	3,491	2.12	146	0.09

Catchment Code	Total Acres	Phosphorus		Chloride		Fecal Coliform		Total Suspended Sediment	
		Total (lbs)	lbs/ac	Total (lbs)	lbs/ac	Total (cfu in billions)	per acre	Total (tons)	tons/acre
M	629	117	0.19	162,252	258	667	1.06	13	0.02
N	1,112	391	0.35	384,405	346	2,432	2.19	70	0.06
O	379	221	0.58	90,348	238	559	1.47	32	0.08
P	1,185	402	0.34	219,348	185	2,096	1.77	120	0.10
Q	732	243	0.33	195,394	267	1,438	1.97	44	0.06
R	280	127	0.45	67,109	239	521	1.86	26	0.09
S	594	261	0.44	109,649	185	979	1.65	131	0.22
T	536	261	0.49	85,669	160	737	1.37	99	0.19
U	883	523	0.59	169,136	192	1,364	1.54	243	0.27
V	1,452	1,284	0.88	75,208	52	2,359	1.63	966	0.67
W	355	388	1.09	5,548	16	670	1.89	396	1.11

Table 4-7: Pollutant Loading Hotspot Catchments.

Parameter	Highest-Ranked Catchments
Total Suspended Sediment	W, F, V
Total Phosphorus	W, A, V
Fecal Coliform	D, L, N
Chloride	N, Q, M

4.2.3.3 First Flush Non-Point Source Loading

The SWAMM™ model includes a module to estimate loading from a first flush storm event. SMC selected the 90th percentile storm event equivalent to a 1.01-inch event to reflect a first flush storm. This section summarizes first flush loading of total phosphorus, chloride, sediment and fecal coliform bacteria. These results are useful for evaluating loading from single rainfall events or those relatively frequent events where runoff first occurs and can be easily detained or managed. In the Mill Creek Watershed, rainfall events of 1.01 inches or greater occur, on average, 23% of the time (84-days a year) and represent almost one-quarter of all precipitation events. As with annual estimates, those same land uses contribute the highest loading during a first flush event.

Table 4-8: First Flush Non-Point Source Loading.

Parameter	Model Results	Average – Per Acre
Total Suspended Sediment – (ton/yr)	56	0.003
Total Phosphorus (lb/yr)	211	0.01
Fecal Coliform (CFU in billions/yr)	706	0.04
Chloride (lbs/yr)	88,246	4.5
Total Annual Stormwater Runoff (ac-ft)	446	0.02

Table 4-9: First Flush Non-Point Source Loading By Land Use.

Land Use	Total Acres	Phosphorus (lbs/ac)	Chloride (lbs/ac)	Fecal Coliform (B-cfu/ac)	TSS (tons/ac)
Agricultural	3,639	0.03	0.04	0.05	0.01
Residential	4,072	0.01	4	0.08	0.002
Transportation	1,854	0.02	14	0.03	0.003
Utility/Waste Facility	301	0.02	11	0.07	0.008
Government/Institutional	389	0.03	11	0.05	0.005
Industrial	184	0.02	8	0.05	0.004
Office and Research Parks	69	0.02	9	0.03	0.004
Retail/Commercial/Mixed Use	433	0.02	7	0.03	0.003
Public/Private Open Space/Wetlands	7,345	0.002	0.01	0.003	0.0001
Water	1,498	0.01	23	0.04	0.0001
Total	**19,783**	**0.01**	**4.5**	**0.04**	**0.003**

Table 4-10: First Flush Non-Point Source Loading By Catchment.

Catchment Code	Total Acres	Phosphorus		Chloride		Fecal Coliform		Total Suspended Sediment	
		Total (lbs)	lbs/ac	Total (lbs)	lbs/ac	Total (cfu in billions)	per acre	Total (tons)	tons/acre
A	209	2.8	0.01	634	3.0	5.2	0.02	0.8	0.004
B	1,066	12	0.01	1,406	1.3	25	0.02	3.8	0.004
C	722	7.4	0.01	970	1.3	18	0.02	2.2	0.003
D	753	8.9	0.01	1,997	2.7	25	0.03	2.7	0.004
E	540	4.9	0.01	1,091	2.0	10	0.02	1.6	0.003
F	1,863	28	0.01	5,360	2.9	81	0.04	10	0.01
G	518	3.5	0.01	2,357	4.6	19	0.04	0.6	0.001
H	227	2.3	0.01	1,443	6.4	10	0.04	0.5	0.002

Catchment Code	Total Acres	Phosphorus		Chloride		Fecal Coliform		Total Suspended Sediment	
		Total (lbs)	lbs/ac	Total (lbs)	lbs/ac	Total (cfu in billions)	per acre	Total (tons)	tons/acre
I	576	3.2	0.01	1,031	1.8	7.3	0.01	0.7	0.001
J	2,563	18	0.01	18,729	7.3	84	0.03	3.4	0.001
K	966	3.2	0.00	1,911	2.0	12	0.01	0.4	0.0004
L	1,644	15	0.01	8,855	5.4	79	0.05	2.6	0.002
M	629	2.4	0.004	4,890	7.8	16	0.02	0.3	0.0005
N	1,112	9.5	0.01	10,820	10	58	0.05	1.7	0.002
O	379	5.1	0.01	2,561	6.8	13	0.03	0.8	0.002
P	1,185	10	0.01	5,603	4.7	49	0.04	1.9	0.002
Q	732	5.9	0.01	5,296	7.2	34	0.05	1.0	0.001
R	280	3.0	0.01	1,700	6.1	12	0.04	0.7	0.002
S	594	6.0	0.01	2,863	4.8	23	0.04	1.6	0.003
T	536	6.1	0.01	2,278	4.2	17	0.03	1.4	0.003
U	883	12.2	0.01	4,389	5.0	32	0.04	3.8	0.004
V	1,452	33	0.02	1,922	1.3	59	0.04	11	0.01
W	355	10	0.03	141	0.4	17	0.05	3.3	0.01

4.2.3.4 Future Non-Point Source Loading

A separate SWAMM™ model was built to simulate future 2020 conditions. Information on future land use projections within the watershed was obtained from LCPBD, which were incorporated into the model. Slight modifications were made to the layer by SMC to account for recent infrastructure planning in Lake County. Understanding the impacts of future development can inform planning and development decisions and can assist in mitigating water quality concerns before they arise. **Table 4-11** through **Table 4-13** present the results of the future conditions modeling analysis.

When comparing existing to future loading conditions, increases are estimated to occur in annual runoff (13%), chloride (58%), phosphorus (23%) and bacteria (71%) (**Table 4-11**). Due to the likely reduction in agricultural ground in the future, Mill Creek may experience a reduction in sediment loads by 2020. **Figure 4-8** shows the catchments where land use and non-point source water quality conditions are most likely to change.

Table 4-11: Future Annual Non-Point Source Loading.

Parameter	Future Model Results	Average Per Acre	Percent Change Compared to Existing Conditions
Total Suspended Sediment – (ton/yr)	3,342	0.17	-36%
Total Phosphorus (lb/yr)	11,416	0.6	23%
Fecal Coliform (CFU in billions/yr)	54,443	2.8	71%
Chloride (lbs/yr)	5,182,971	262	58%
Total Annual Stormwater Runoff (ac-ft)	21,781	1	13%

Table 4-12: Future Non-Point Source Loading By Land Use.

Land Use Class	Total Acres	Phosphorus (lbs/ac)	Chloride (lbs/ac)	Fecal Coliform (B-cfu/ac)	TSS (tons/ac)
Agricultural	939	0.7	1.1	1.3	1.5
Residential	7,453	0.5	240	5.3	0.12
Transportation	2,056	0.8	665	1.5	0.15
Utility/Waste Facility	458	0.7	307	1.1	0.15
Government/Institutional	618	1.4	426	1.6	0.20
Industrial	922	0.9	418	2.6	0.19
Office and Research Parks	533	1.2	419	2.8	0.20
Retail/Commercial/Mixed Use	1,203	1.1	337	1.2	0.19
Public/Private Open Space/Wetlands	4,247	0.2	1.2	0.5	0.01
Water	1,355	0.7	447	1.3	0.01
Total	**19,783**	**0.6**	**262**	**2.8**	**0.17**

Table 4-13: Future Non-Point Source Loading By Catchment.

Catchment Code	Total Acres	Phosphorus		Chloride		Fecal Coliform		Total Suspended Sediment	
		Total (lbs)	lbs/ac	Total (lbs)	lbs/ac	Total (cfu in billions)	per acre	Total (tons)	tons/ acre
A	209	149	0.7	85,439	409	796	3.8	32	0.2
B	1,066	760	0.7	333,943	313	4,414	4.1	152	0.1
C	722	409	0.6	201,315	279	3,977	5.5	89	0.1
D	753	513	0.7	239,701	318	4,142	5.5	166	0.2
E	540	327	0.6	156,127	289	3,130	5.8	70	0.1
F	1,863	1,129	0.6	461,895	248	7,384	4.0	542	0.3
G	518	277	0.5	148,968	288	2,067	4.0	91	0.2
H	227	192	0.8	86,072	379	710	3.1	37	0.2
I	576	356	0.6	69,344	120	877	1.5	364	0.6
J	2,563	1,310	0.5	637,701	249	5,252	2.0	247	0.1
K	966	274	0.3	79,425	82	845	0.9	32	0.03
L	1,644	745	0.5	395,012	240	4,310	2.6	149	0.1
M	629	230	0.4	108,725	173	762	1.2	18	0.03
N	1,112	714	0.6	364,795	328	2,626	2.4	104	0.1
O	379	295	0.8	102,663	271	571	1.5	42	0.1
P	1,185	401	0.3	240,120	203	2,543	2.1	69	0.1
Q	732	322	0.4	191,120	261	1,566	2.1	48	0.1
R	280	158	0.6	93,977	335	687	2.5	31	0.1
S	594	396	0.7	167,573	282	1,060	1.8	69	0.1
T	536	418	0.8	172,902	323	999	1.9	76	0.1
U	883	652	0.7	367,706	416	1,798	2.0	138	0.2
V	1,452	1,122	0.8	465,349	321	3,446	2.4	310	0.2
W	355	268	0.8	13,098	37	482	1.4	468	1.3

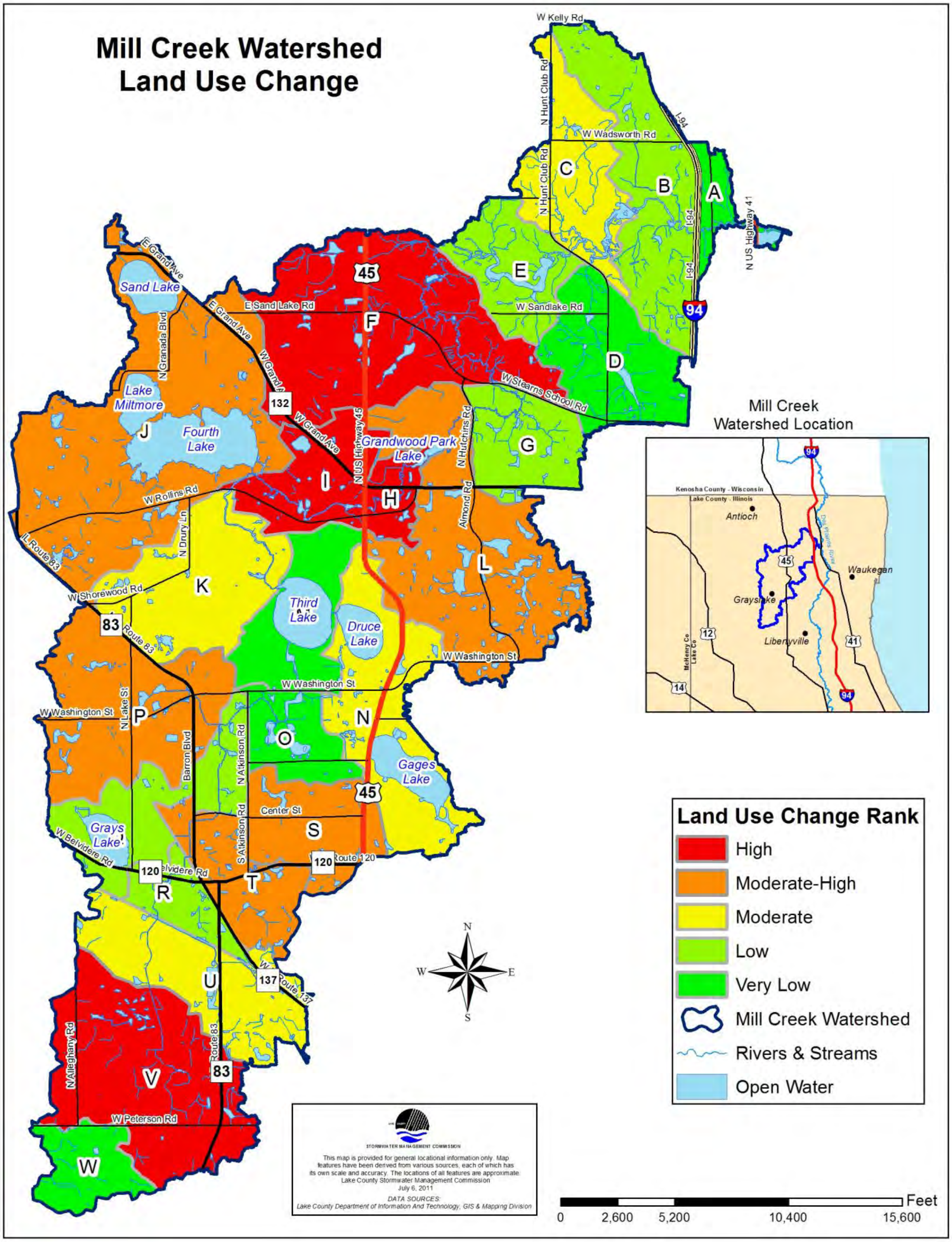


Figure 4-8: Projected Magnitude of Future Land Use Change.

4.2.3.5 Sediment Source Analysis

The SWAMM™ model does not directly account for significant sources of streambank and ***gully erosion***. Estimates for significant gully and streambank erosion were made based on a watershed-wide windshield survey that was conducted in the spring of 2013 and stream inventory data collected by SMC. **Table 4-14** summarizes the streambank and gully load estimates.

It is estimated that at least 3,017 tons of sediment are delivered annually as the result of numerous low and several severe streambank erosion sources in the watershed. Although streambank erosion is a large source of sediment loading in the watershed, it is not as significant as sheet and rill erosion.

Gully Erosion: The removal of soil along drainage lines by surface water runoff. Once started, gullies will continue to move by headward erosion or by slumping of the side walls unless steps are taken to stabilize the disturbance. Gully erosion occurs when water is channeled across unprotected land and washes away the soil along the drainage lines. Under natural conditions, run-off is moderated by vegetation which generally holds the soil together, protecting it from excessive run-off and direct rainfall. To repair gullies, the object is to divert and modify the flow of water moving into and through the gully so that scouring is reduced, sediment accumulates and revegetation can proceed.

Areas of significant gully erosion in the Mill Creek Watershed were identified during the 2013 windshield survey. Gullies evaluated only included those visible from the road right-of-ways or during assessments of land parcels with granted landowner permission. A total of 12 large eroding gullies were assessed and the load estimates were calculated using USEPA methodologies that are further detailed in Appendix G. The analysis concludes that gully erosion is a nominal source of sediment loading in the watershed.

Table 4-14: Streambank and Gully Pollutant Loading Estimates.

Sediment Source	Sediment (tons/yr)	Phosphorus (lbs/yr)
Streambank	3,017	3,017
Gully	334	395

4.2.3.6 Septic System Analysis

Based on an analysis of known septic systems provided by LCHD-ES, the Mill Creek Watershed contains an estimated 703 septic systems, 88 of these are in unsewered areas (**Figure 4-9**). Assuming a conservative failure rate of 2%, approximately 14 systems are likely to be failing at any given time within the watershed.

Table 4-15 summarizes pollutant loading from failing septic systems for the entire watershed. Septic system loading for phosphorus was calculated using STEPL, Version 3 and methodology outlined by Lowe *et al.* (2007). Assuming 2.43 people per system and an average of 0.15 billion CFU/person/day, it is estimated that failing septic systems may contribute an annual load of 171 pounds of phosphorus and a fecal coliform bacteria load of 1,870 billion CFU/yr (**Table 4-15**).

Table 4-15: Septic System Analysis and Pollution Loading.

Estimated Number Failing Systems	Population per system	Phosphorus Load (lbs/yr)	Bacteria Load (billion CFU/yr)
14	2.43	171	1,870

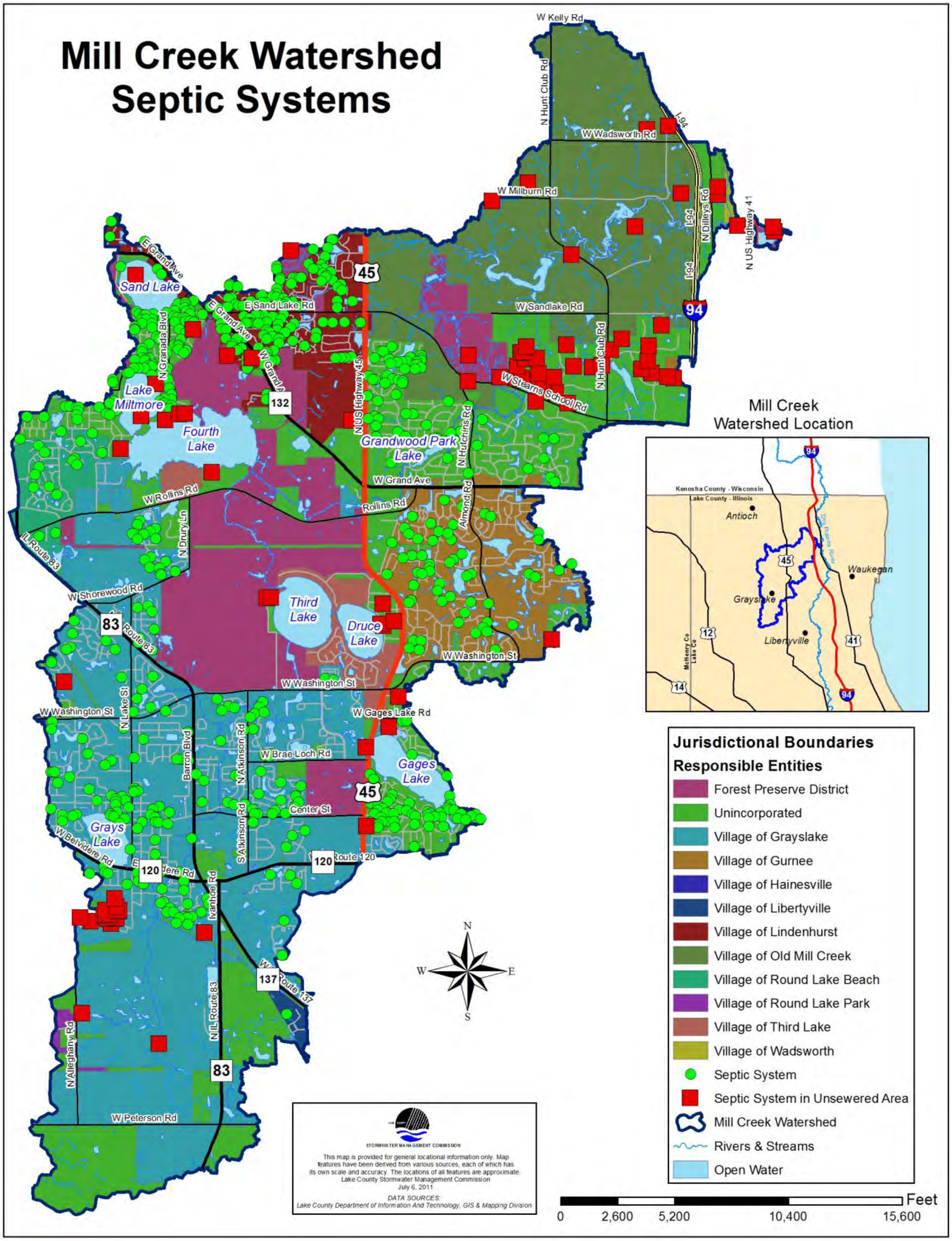


Figure 4-9: Septic Systems.

4.2.4 CRITICAL CATCHMENTS

Critical areas are identified by catchment in the watershed. These critical catchments are the areas best suited to focus implementation efforts to help achieve the non-point source pollutant reduction goals and objectives of the watershed plan. Critical areas represent catchments that likely contribute to water quality problems in the watershed, and present opportunities where project implementation would provide the greatest value and benefit. The following criteria were used to identify critical areas catchments, which are further detailed in **Table 4-12**:

1) Agricultural highly erodible soils
2) Areas of greatest landuse change (2013-2020)
3) Highest amount of streambank and lake bank erosion
4) Pollution loading hot spots; areas of highest cumulative pollution loading
5) Number of water quality impairments

The top four critical catchments were identified as W, H, A and U. Each catchment met some or all of the listed criteria, however only the top four catchments were selected as priority critical areas. **Table 4-17** and **Figure 4-10** show the final critical areas catchment rankings. Chapter 6 outlines recommended actions for the critical area catchments.

Noteworthy: Critical Area Analysis

Each catchment was ranked for five criteria, after which the catchments were normalized statistically on a scale of 0 – 100. The normalized ranking of each critical area criteria was summed for each catchment, after which the data was re-normalized on a scale of 0 – 100. The statistical process identifies priority catchments based on a combined score of all criteria, with the highest ranked catchment receiving 96 out of 100 and the lowest receiving 1 out of 100.

Table 4-16: Critical Area Analysis.

Critical Area Criteria	Description
Highly Erodible Soils	Chapter 3 identifies the highly erodible soils in the watershed. Erodible soils on agricultural lands are extremely susceptible to erosion. Concentrated flow areas on these highly erodible soils provide pollutant transport pathways to a stream or lake. Highly erodible soil areas that are within agricultural and equestrian pasture areas are considered in the critical areas analysis.
Area of Greatest Landuse Change	Mitigating future development impacts is an important proactive strategy to address water quality and hydrologic issues before they become a problem. Understanding future development trends can assist stakeholders in making informed decisions related to land development and economic growth. Lake County developed a 2020 future land use analysis that identified areas within the watershed most likely to experience future land use changes. This data was spatially analyzed by density for each catchment to identify the critical areas that may experience the greatest change.
Stream and Lake Bank Erosion	A survey conducted by SMC assessed and quantified streambank erosion; the LCHD-ES assessed the degree of erosion severity for nine local lakes. Eroding stream and lake banks deliver sediment and nutrients directly to waterways. Focusing stabilization measures to these areas can offer great opportunities for reducing sediment and nutrient loading while stabilizing aquatic habitat. The erosion assessment was spatially analyzed based on catchment; the catchments with the most severe erosion rates and density received the highest score.

Critical Area Criteria	Description
Number of Water Quality Impairments	The Illinois EPA and the LCHD-ES assess lakes in the watershed to determine whether water quality is achieving state standards, the waterbodies are designated as impaired when state standards are not met. The total number of 2012 listed lake impairments was totaled for each catchment. Causes of impairments include phosphorus, TSS, DO, fecal coliform and "cause unknown."
Pollution Loading Hotspots	Catchments with the highest percentile of non-point source pollutant loading for phosphorus, sediment, chloride and fecal coliform bacteria.

Table 4-17: Critical Area Catchment Rankings.

Catchment Code	RANK (1-23)	Final Score (0 – 100)
W	**1**	**96.12**
H	**2**	**93.56**
A	**3**	**83.69**
U	**4**	**83.55**
F	5	78.39
B	6	68.55
J	7	66.33
D	8	64.94
E	9	64.20
R	10	63.60
S	11	61.15
T	12	57.94
O	13	53.98
L	14	49.03
V	15	41.54
M	16	39.04
Q	17	35.37
C	18	24.58
P	19	21.70
N	20	20.75
G	21	16.84
I	22	2.56
K	23	0.58
Ranking: 1 highest critical priority, 23 lowest critical priority		

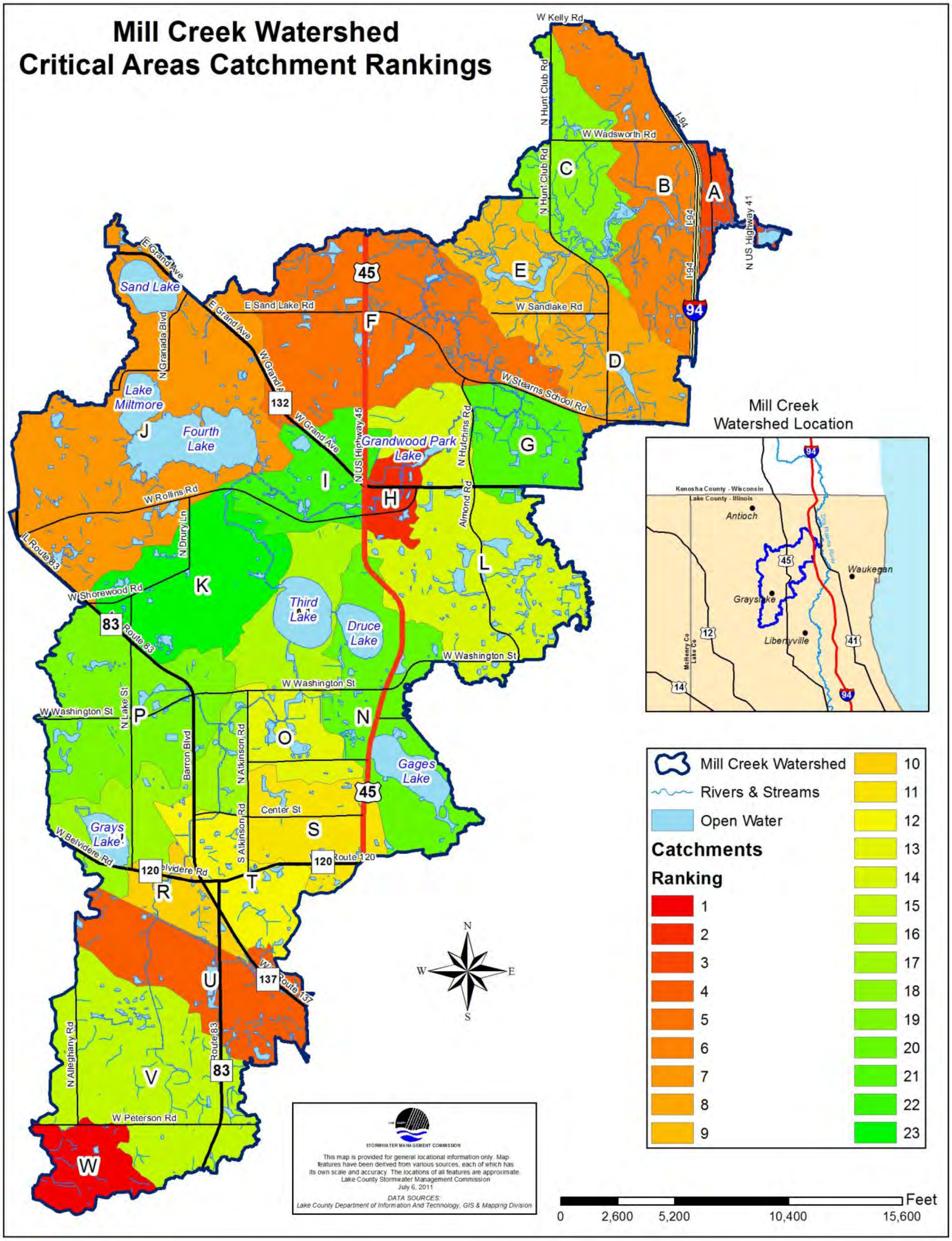


Figure 4-10: Critical Area Catchment Rankings.

4.3 WATERSHED JURISDICTIONAL COORDINATION

The problem: Watershed protection is a shared responsibility of multiple jurisdictions in the watershed that operate with different policies, practices and regulations. There has not been a coordinated effort and consistent management of the watershed due to the multiple authorities and jurisdictions and their divergent management practices and development requirements related to land and water resources. Requirements for, and application of, best management practices also vary based on county, municipal, township, drainage, park, forest preserve and school district policies, standards, requirements and incentives.

While public policies and regulations can significantly influence the prevention of further watershed degradation, private efforts will need to be combined with public initiatives to address current watershed issues such as the poor water quality in lakes and degraded stream conditions prevalent throughout the watershed. Private landowners (farmers and suburban) and homeowner groups should voluntarily incorporate BMPs in the landscapes that they manage to resolve the existing watershed problems and improve conditions. Education and outreach can significantly influence voluntary participation in watershed improvement activities.

Primary cause: With multiple jurisdictions in the watershed, coordination is a limiting factor in adopting consistent preventative practices, and presents challenges in completing BMP projects and providing ongoing monitoring and maintenance that may provide broad watershed benefits. There presently is not a watershed-wide stakeholder engagement effort that supports education and outreach and voluntary implementation of BMPs. The following section describes watershed jurisdictional coordination roles and responsibilities.

4.3.1 ISSUES TO BE ADDRESSED BY A COORDINATED EFFORT OF WATERSHED JURISDICTIONS

The watershed planning process identified a number of issues that would be most effectively addressed at the watershed level. Issues that would be best advanced through a coordinated effort of watershed jurisdictions with the support of private stakeholders include:

- The increased volume of stormwater runoff
- Phosphorus pollution in lakes
- Rising chloride pollution from winter maintenance practices
- Lack of water quality data to adequately assess causes and sources of pollution impairments
- Invasive plants and animals
- Barriers to alternative transportation - connecting routes and modes
- Barriers to low impact development and green infrastructure practices
- Preservation of green infrastructure and greenway corridor connections
- Poor stream condition
- Flood damage/ regional flood storage

4.3.2 WATERSHED ROLES AND RESPONSIBILITIES

This section describes watershed management and discusses ways to improve jurisdictional coordination among the primary responsible parties. Watershed management in the Mill Creek Watershed is a shared responsibility of both public and private interests. Watershed protection provided by jurisdictional entities and private stakeholders comes in several forms: policy, regulation; planning; zoning; development and land and water management standards and incentives; education and outreach; and in-the-ground BMP projects.

Municipal and county government shares the greatest responsibility for watershed protection because they play a significant role in influencing and overseeing development impacts to the watershed through land use planning, land management and development policies and regulatory oversight. The Avon-Freemont Drainage District is a significant watershed stakeholder in stream management with authority to maintain the conveyance function of the 6.5 miles of the upper reaches of Mill Creek referred to as the Avon-Fremont Drainage Ditch. Transportation agencies are also influential. While transportation infrastructure improvements are necessary to accommodate a growing population and expanding business employment, roadway construction and post-construction operation and maintenance can have a significant influence on water resources. Roadway projects are not only initiated and maintained by municipalities and the County in the watershed, but also by townships and the Illinois Department of Transportation. In addition, the Illinois Tollway Authority is a fairly recent watershed stakeholder with the development of the Route 53/120 corridor.

Other agencies and private entities with watershed or technical advisory roles include the Lake County Forest Preserve District, park districts (Grayslake, Gurnee, Lindenhurst, Grandwood Park and Wildwood), the College of Lake County, University of Illinois Extension Service, and the Lake County Soil and Water Conservation District. The forest preserve district and municipal park districts not only provide important recreation and educational opportunities, but also play a critical role in natural resource protection, particularly for rare or high quality habitat and threatened and endangered species. They protect and manage land that often contains wetlands, lakes, ponds, and streams. The McHenry/Lake County Soil and Water Conservation District provides technical resource assistance to the public and other regulatory agencies including soil erosion and sediment control inspections. The University of Illinois Extension Service and the College of Lake County are well-situated to be demonstration sites and provide technical assistance and educational outreach programs to watershed stakeholders.

4.3.3 WATERSHED DEVELOPMENT

Development practices that affect water resources (rivers, streams, lakes, isolated wetlands, and floodplains) are largely regulated by the WDO along with county and municipal ordinances and land use plans. In addition to local regulations, the U.S. Army Corps of Engineers (USACE) regulates the fill of waters of the United States (including adjacent and connected wetlands), and the Illinois Department of Natural Resources has floodplain/floodway regulatory and oversight authority. The Illinois Department of Transportation designs and constructs roadways in the watershed (state and federal projects are not required to meet local regulatory requirements but are governed by state and federal policies and regulations).

Watershed Development and Stormwater Management

Development affecting water resources (streams, lakes, isolated wetlands, and floodplains) in the Mill Creek Watershed is most significantly regulated by the WDO. The WDO is administered and enforced by SMC or a Certified Community. A community can be fully certified with authority to review and enforce both the standard stormwater and the isolated wetland provisions of the WDO, or may be a partially certified community with delegation to review and enforce one aspect of the WDO (either the standard or isolated wetland provisions). SMC retains certain review authorities, primarily for several specific floodplain and floodway provisions of the WDO for all communities. Fully Certified Communities within the watershed include the Villages of Hainesville, Lindenhurst, Old Mill Creek, Round Lake Park, and LCPBD, which is fully certified for all unincorporated areas within the watershed. The Villages of Gurnee, Grayslake, Libertyville, Round Lake Beach and Third Lake are all partially Certified Communities; they review and enforce the standard provisions of the WDO, leaving the isolated wetland provisions under SMC authority. SMC administers the WDO for the Village of Wadsworth as the Village has chosen to not apply for community certification.

Planning and Development in Unincorporated Lake County

Development practices within unincorporated areas are guided by the Lake County Framework Plan and must meet the requirements of the Unified Development Ordinance (UDO). The LCPBD administers the UDO on unincorporated parcels. The LCPBD operates under direction from the Regional Planning Commission, the Zoning Board of Appeals, the Planning Building and Zoning Committee of the Lake County Board, and the full County Board. The County Board oversees decisions made by county government and therefore has the power to override or alter policies and regulations for unincorporated Lake County (36% of the watershed). Unincorporated areas are located in Fremont, Warren, Avon, Lake Villa and Newport Townships. Warren Township includes the largest unincorporated communities of Grandwood Park and Wildwood. Development affecting water resources in the unincorporated areas of the townships must be reviewed by LCPBD, or in the case of publicly funded projects in the floodway, by SMC. LCPBD reviews may involve coordination with SMC on issues such as base (100-year) flood elevation determinations.

Planning and Development in Municipalities

For areas of the watershed that are located in one of the ten watershed municipalities, development and many land management practices are regulated by each municipality. Development is regulated via municipal administration of the WDO, which provides minimum county-wide standards, and by local municipal policies and ordinances. Local policies and ordinance provisions vary among the municipalities.

Other Agencies and Jurisdictions

Water resource protection even at the county and municipal level still involves close coordination with state agencies and the federal government. Cultural resources, threatened and endangered species, rare habitats, navigable and scenic waterways, and federal jurisdiction wetlands are all regulated by state or federal agencies.

4.3.4 IN-THE-GROUND PROJECTS

In-the-ground projects are encouraged and incentivized through county-wide adoption of a watershed management plan by local units of government. Plan adoption should be followed by close coordination, and development of funding mechanisms, timelines, and shared responsibilities for implementing the projects prioritized by watershed planning efforts. Of particular importance for implementing projects identified in the watershed plan is the development of partnerships – stakeholder groups (homeowners associations, non-profit organizations, businesses, etc.), schools, community agencies and the like – to coordinate, fundraise, secure grants, and ultimately oversee project implementation. The experience and success that partnerships often gain from working together on a watershed project can influence regulatory changes and further cooperation among policy-makers.

The watershed action plan will identify lead and support roles for multiple units of government to assist private landowners and watershed groups. Specific types of aid that governments can provide to private landowners can include BMP project cost-share funding or technical assistance especially for studies/plans. Private entities as partners can also provide cost share for design, consulting, and construction work for projects, and/or in-kind BMP services such as seeding, planting, restoration work, trail construction, and interpretive education.

Nearly all watershed projects, including those developed through coordinated planning efforts, benefit from partnerships that share design, permitting, material, and labor costs. In some instances, project costs can be covered by cost-share grants, while on-going maintenance may be completed in partnership with a local jurisdiction. Partnerships involving one or more municipalities, townships, drainage districts, homeowner associations, developers, county agencies, lakes management groups, landowners, and local, state and federal agencies are possible. Public/private partnerships are also important for securing state or federal funding for in-the-ground projects. Projects with shared costs and benefits often result in more successful project outcomes because of relationship building among partners who share a vested interest in how well their projects perform. Partnership on a first project may result in the establishment of an institutional relationship that results in implementing projects into the future.

Post-Construction Monitoring and Maintenance

Opportunities for establishing partnerships to improve monitoring and maintenance effectiveness and efficiency should also be explored. Some examples of shared maintenance activities for consideration include stream monitoring and maintenance, stormwater monitoring, road and parking lot deicing, detention basin monitoring and maintenance and invasive plant management. Partnerships may be established to share technical expertise; develop maintenance guidelines or standards; share services, equipment or storage locations; or combine contracts with neighboring jurisdictions for similar activities such as winter road maintenance and invasive plant management.

The Mill Creek stream assessment conducted for this watershed planning effort along with input from the watershed planning stakeholder group points out a strong need for better stream monitoring and maintenance for Mill Creek. Stream maintenance responsibility is shared by the Avon Freemont Drainage District (6.5 miles) and the property owners outside of the 6,163 acre drainage district area who have portions of Mill Creek flowing through their land. In some instances, individual lot owners will have responsibility for 50-100 feet of creek on their home or business lots, while in other locations the Forest Preserve District or large farm owners may have thousands of linear feet of stream running through their properties. Because of the length of stream under the Drain District's authority, the District is considered to have a lead responsibility in working cooperatively with water resource experts and other stakeholder jurisdictions and homeowner to develop and implement a set of guidelines or standards for stream maintenance in the watershed.

Communication among relevant watershed jurisdictions is crucial to the successful sharing of services and responsibilities. This may include communication amongst transportation agencies, between the drainage district and municipalities or private landowners, and among municipalities, townships and the county. With the availability of the internet, the first order of communication should be to provide transparency by making the information on the work activities of each organization/jurisdiction available to all watershed partners and residents. While inter-jurisdictional coordination may entail doing business in a new or different way, the ultimate outcome should be more efficient, effective and sustainable achievement of watershed goals within a reasonable timeframe and at a reasonable cost.

Table 4-18 includes a summary of the issues identified in the watershed planning process that would be best addressed through coordinated partnership efforts.

Table 4-18: Issues to be addressed with watershed-level coordination.

Issue	Strategies to address issue	Potential actions	Responsibility
Volume of stormwater runoff	• Review adequacy of runoff volume reduction requirements for Mill Creek Watershed	Review regulations and update as needed	Municipalities County SMC
	• Porous pavement	Promote through public/private BMP programs	Municipalities County

Issue	Strategies to address issue	Potential actions	Responsibility
	• Installing neighborhood and site scale green infrastructure · Native landscaping · Downspout disconnection · Rain garden program	Review ordinances and land management standards to allow by right and set up voluntary incentive programs	Municipalities County CLC Park districts
	• Wetland mitigation in the watershed	Future potential watershed-specific policy.	SMC, USACE, Certified Communities
	• Preserving landscape scale green infrastructure · Wildlife and floodplain connections with greenway corridors	Incorporate green infrastructure network in land use plans. Set up partnership to fund and implement.	Municipalities County FPD Park Districts
	• Road improvement/retrofit projects/designs	Incorporate stormwater BMPs. Score all projects with I-Last or similar tool.	IDOT, LCDOT, Municipalities, Township
Excess phosphorus pollution in lakes	• Phosphorus ban	Adopt ban(s)	Municipalities, County
	• Pollution prevention education	Coordinate with NPDES II program outreach	CLC, Municipalities, County
	• Nutrient management plans and agricultural BMPs	Provide cost-share or as a free technical service to agricultural producers with grant or farm program support	Farm Bureau, Municipalities, County, NRCS
Rising chloride pollution from winter snow and ice maintenance	• Reduce sodium chloride application with alternative practices and chemicals	Form buying consortium to share equipment and reduce cost of alternative products	Municipalities, LCDOT, Township
	• Calibrate equipment	Document calibration	All applicators
	• Consistent snow removal policies and application rates	Determine model policy and application rates as a base from which jurisdictions develop or modify individual policies.	Municipalities, LCDOT, IDOT, Township
	• Coordinate geographic-based plow routes among jurisdictions for efficiency and reduced travel, equipment and materials storage costs.	Optimize route efficiency recommendations and maintain coordinated effort/standards via Memorandum of Understanding	LCDOT, Municipalities, IDOT, Township
	• Applicator certification/ registration	State requirement Phase in as a requirement via municipal ordinance, County Township.	Illinois EPA/IDOT, Municipalities, Township, LCDOT
	• Coordinated intergovernmental purchase of private contractor services for winter maintenance	County takes lead in coordinating shared service with municipalities. Only qualified contractors eligible for bid.	LCDOT, Municipalities, Township, Private
Lack of water quality data to adequately assess	• Coordinated NPDES II monitoring	Watershed munis collaborate on developing coordinated monitoring program.	Future watershed council, SMC, LCHD-ES

Issue	Strategies to address issue	Potential actions	Responsibility
pollution impairments	• Participation in monitoring program of Des Plaines River Watershed Workgroup	Each NPDES community/agency participates in work group	Municipalities, Township, Drainage District, County
Poor stream quality	• Stream maintenance program • Stream restoration strategy	Develop and adopt standards for stream maintenance	SMC, Municipalities, County, Drainage District
Invasive plants and animals	• Communities participate in invasive plant control • Communicate/educate private landowners	Each community and transportation agency adds invasive plant management to current maintenance programs (technical support from invasive plant network and LCFPD). Coordinate outreach with established programs like NPDESII and LCFPD education programs.	Municipalities, County, Park Districts, LCFPD, CLC, U of IL Extension, LCDOT, IDOT, Township
Barriers to alternative transportation - connecting routes and modes	• Neighborhood connections with trails • Connecting trails and safe sidewalks to transportation hubs and work centers (train stations and bus stops, commercial centers, business parks etc.)	Assess underserved neighborhoods and disconnected transportation hubs, work and business centers. Meet with appropriate jurisdictions to formulate strategies to address in Lake County 2040 Transportation Plan.	LCDOT, Municipalities, IDOT, County
Flood damage	• Regional storage	Assess if regional storage will mitigate or prevent flood damage and implement priority storage sites.	SMC, Municipalities, County

4.4 GREEN INFRASTRUCTURE PLAN

Problem: Currently, approximately 26% of the open parcels and 14% of the partially open parcels that make up the green infrastructure of the watershed are in private ownership and unprotected. Forecasted changes in demographics and land use indicate that about half of the green infrastructure parcels in the watershed (mostly agricultural land uses – farms, equestrian, and nurseries) will be converted to developed land uses over the next twenty-five years. The other half has already been developed, mostly as residential properties. Green infrastructure provides innumerable benefits to the watershed: it filters the air and water providing water quality benefits; reduces the volume and energy of surface water runoff within the natural drainage system thereby preventing/reducing flood damage and mitigating the impacts of imperviousness on stream erosion; and provides wildlife habitat and recreation areas. These factors prove to be beneficial for social, economic, environmental and human health reasons.

Wetlands, a significant component of green infrastructure in the Mill Creek Watershed, have been significantly reduced by land use changes over the past century. Agricultural drainage activities followed by suburban development have resulted in 44% of the watershed's historic wetlands being drained or filled.

Primary Cause: The watershed as a whole is expected to experience significant growth in population, households, and employment from 2000-2040. The Mill Creek Watershed is forecasted to have a 27% increase in population adding about 11,000 people, while employment is projected to increase by 54% (See Table 3-7 for demographic summary.) Open land areas that are presently part of the green infrastructure inventory are expected to be converted to developed uses to accommodate the forecasted demographic changes. Residential land is projected to increase by 3,381 acres, or 45%, ultimately covering 7,453 acres (45%) of the watershed (Table 3-9). The area of agricultural land is projected to decrease by 288%, from 3,639 acres to 939 acres. Likewise, public/private open space and wetlands is projected to decrease by 3,098 acres, a 73% decline.

A primary objective of this watershed plan is to examine green infrastructure (open and partially open parcels) in the Mill Creek Watershed, and determine how open land would best be utilized as part of the green infrastructure system to meet major watershed goals including:

- flood prevention and reduction
- natural resource protection and enhancement
- water quality improvement
- stream or streambank restoration/preservation

4.4.1 PARCEL PRIORITIZATION CRITERIA

Defining the watershed's green infrastructure system began with first identifying all open and partially open parcels in the watershed (see Section 3.9 Green Infrastructure Inventory). Once the inventory was complete, the Mill Creek stakeholders reviewed and approved an appropriate set of GIS criteria to use to prioritize open areas for the green infrastructure system or network. Prioritization criteria were selected based on the benefits it would provide in meeting the four watershed green infrastructure goals (flood prevention/damage reduction; natural resource protection/enhancement; water quality protection/improvement; stream protection/restoration). See **Table 4-19** for a complete list of the prioritization criteria that includes a matrix indicating which goals are addressed by each criterion. The Green Infrastructure plan development process included the following tasks:

- Complete the green infrastructure inventory using open and partially open parcels (See Section 3.9 Green Infrastructure Inventory)
- Establish goals for the green infrastructure system
- Develop prioritization criteria
- Prioritize all open/partially open space in the green infrastructure inventory
- Create implementation recommendations for the green infrastructure network in the Action Plan (Chapter 6)

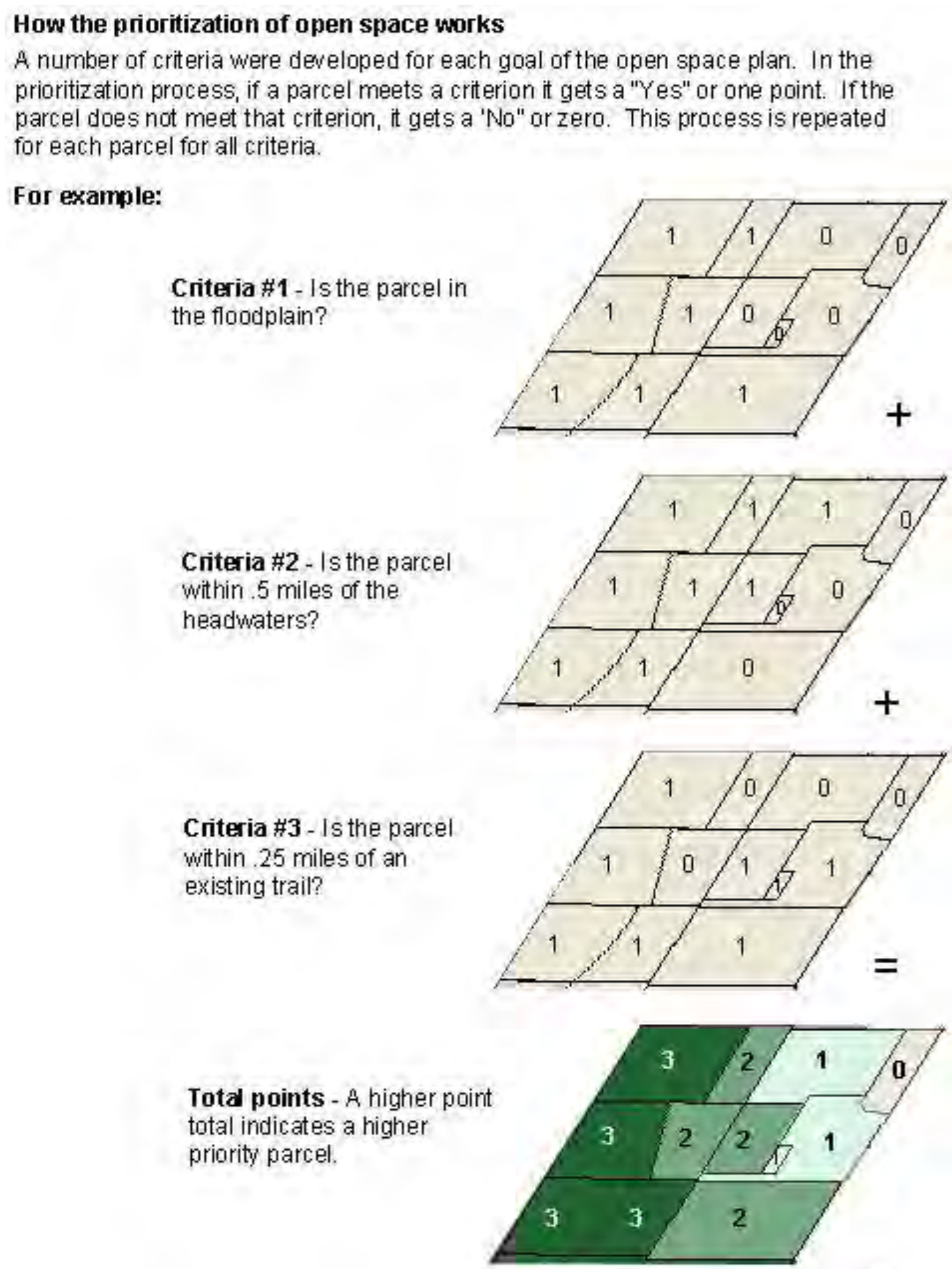
Table 4-19: Green infrastructure prioritization criteria.

Criteria	Flood Prevention and Reduction	Water Quality Improvement	Stormwater Management & Drainage	Natural Resources
1) Parcels that intersect the 100-year floodplain	X		X	
2) Parcels within 0.5-miles of the headwaters	X	X		X
3) Parcels that intersect with a wetland	X	X		X
4) Parcels that are adjacent to or include at least 2.5 acres of drained hydric soils	X	X		X
5) Parcels in a Subwatershed Management Unit where less than 10% of the SMU is existing wetland	X	X		

Criteria	Flood Prevention and Reduction	Water Quality Improvement	Stormwater Management & Drainage	Natural Resources
6) Parcels within 0.5 miles of a flood problem area	X			
7) Parcels that are within 100 feet of a watercourse or lake	X	X	X	X
8) Parcels that intersect with developed but undetained areas	X			
9) Parcels intersecting with a non-point source pollutant hotspot		X		
10) Parcels adjacent to or including forest preserves, land trusts, township, and privately and publicly protected open space				X
11) Parcels adjacent to or including high quality wetlands (ADID)		X		X
12) Parcels adjacent to or including Illinois Natural Areas Inventory sites and nature preserves				X
13) Parcels adjacent to or including threatened and endangered species sites				X

4.4.2 PARCEL PRIORITIZATION RESULTS

The open and partially open parcels were analyzed based on the prioritization criteria using a GIS and a binomial process. If a parcel met a criterion it received a "Yes" or one point. If the parcel did not meet that criterion, it received a "No" or zero points. GIS was then used to rank the parcels. Rank was determined based on the maximum points received by each parcel for each goal. For example the total maximum points for Flood Prevention and Reduction is 8. **Figure 4-11** depicts the parcel prioritization process.



Source: North Branch of the Chicago River Open Space Management Plan (Futurity Inc, Christy S.F. 2005)

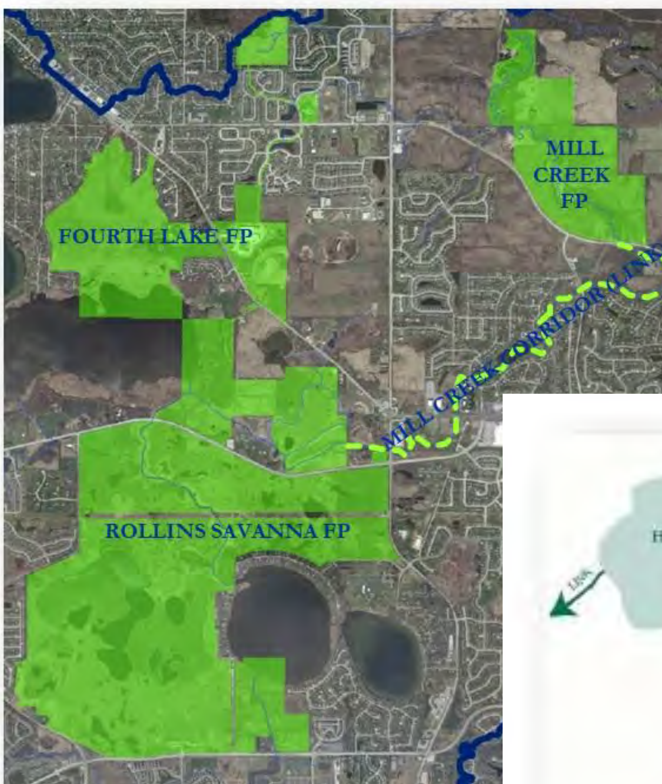
Figure 4-11: Green infrastructure parcel prioritization process.

After completion of the prioritization (ranking), parcels were categorized as ‘high’, ‘medium’ or ‘low’ priority based on natural breaks (in statistical histogram data) in the GIS data. Finally, the total points for each parcel were summed to determine the overall parcel priority for the green infrastructure system. Parcels with the highest number of points overall were ranked highest in the context of the system, meaning that they possess the greatest capacity for helping the watershed meet its multiple goals (flood prevention and reduction, natural resource protection and enhancement, water quality improvement and stream or streambank restoration/preservation). This categorization was visually displayed and evaluated and connector parcels were identified. Connector parcels were manually categorized. See **Figure 4-12** for the green infrastructure prioritization results.

4.4.3 OVERALL PRIORITIZATION - A GREEN INFRASTRUCTURE NETWORK

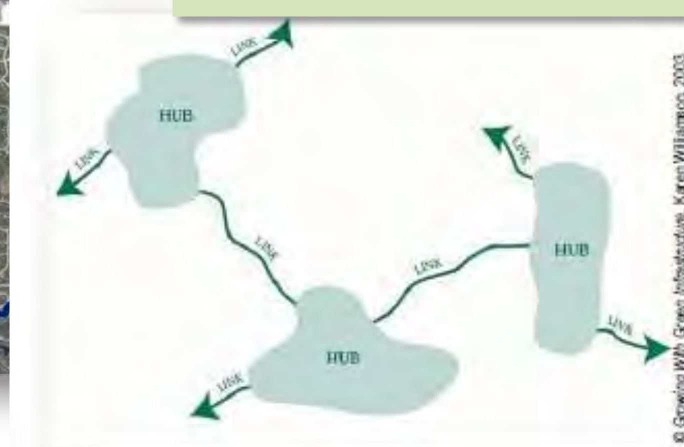
A general examination of **Figure 4-12** reveals the results of the parcel prioritization for all 13 criteria and the location of high, medium, and low priority parcels. The highest total value received by a parcel in the weighting process was 9 (having met 9 of the 13 criteria). Parcels meeting 7-9 of the criteria and along with the connector parcels are designated high priority for meeting the goal, while parcels meeting 4-6 criteria are designated medium priority. Parcels with a combined value of 1-3 are categorized low priority.

Much of the open space in the northern two thirds of the watershed is ranked high priority for meeting project goals. This area contains many protected parcels that are associated with stream/lake corridors, wetlands, and high quality natural areas. There are more medium priority open parcels in the northern and southern ends of the watershed. Much of this area is built out with fewer parcels having high quality natural areas, although the combined connecting parcels along and surrounding the waterways are important as buffer and riparian corridor. Figure 6-1 (Chapter 6: Prioritized Action Plan) uses the results of the parcel prioritization for all criteria (**Figure 4-12**) to specifically map high and medium priority parcels that are recommended for the green infrastructure system with greenway connections in the watershed.



Noteworthy: Green Infrastructure

- Network of open spaces and natural areas that mitigate runoff, recharge aquifers, and improve water quality
- Provide recreational opportunities and habitat
- Network of "hubs" and "corridors"
- Site-specific best management practices that maintain natural hydrologic functions on the local, municipal or neighborhood scale by absorbing and infiltrating precipitation where it falls



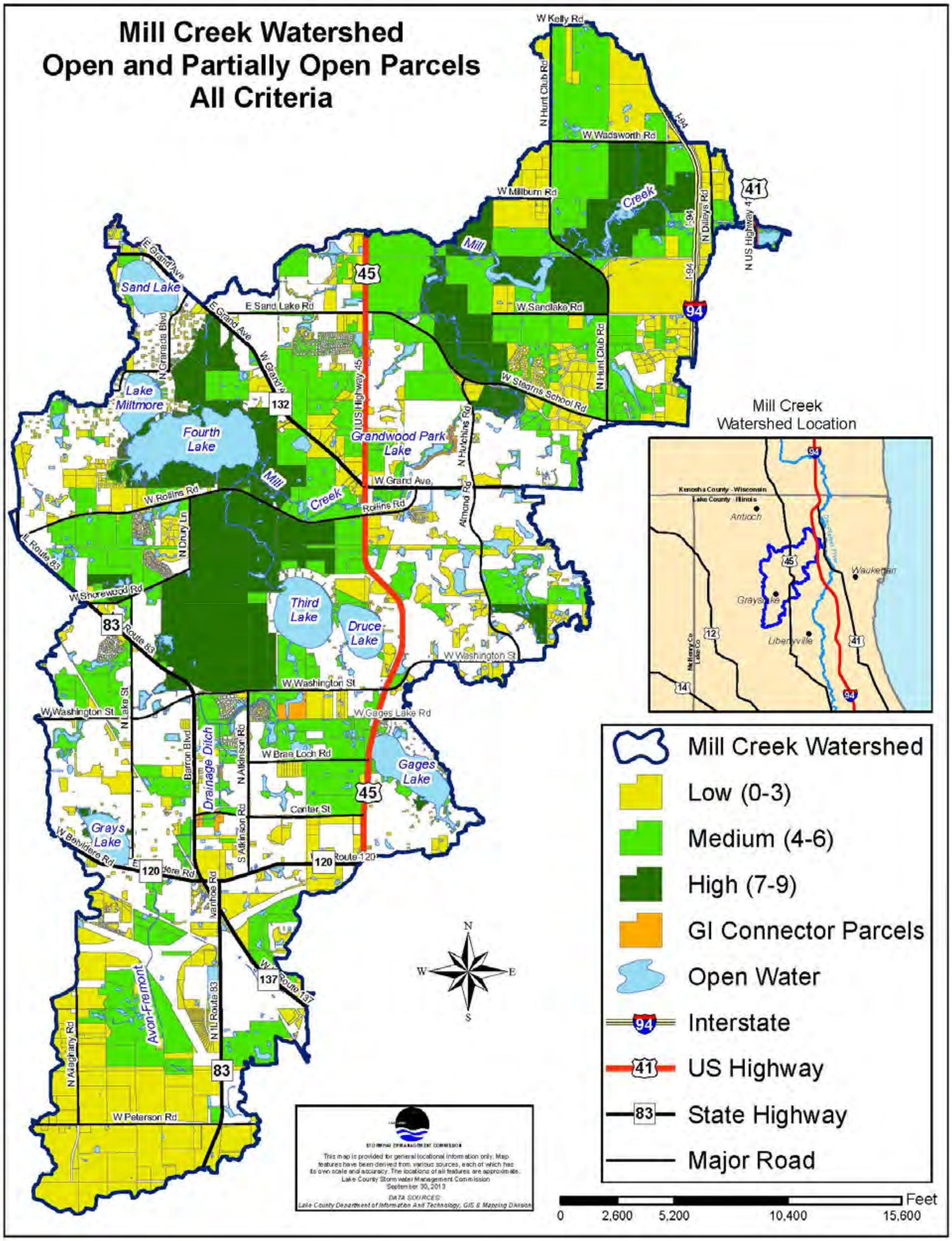


Figure 4-12: Green infrastructure network for the Mill Creek Watershed.

Out of the 2,422 open and partially open parcels in the watershed, 197 parcels were categorized as high priority. The high priority sites constitute approximately 3,189 acres, or 16% of the total watershed area. Two major areas of high quality open space include the area around and to the north and south of Fourth Lake and another area along the Mill Creek main stem in the northern part of the watershed north of Stearns School Road. These areas are important for conserving natural resources, such as Illinois Natural Area Inventory (INAI) sites, high quality Advanced Identification (ADID) wetlands, stream headwaters, threatened and endangered species sites, etc. There are 694 parcels that were classified as medium priority, covering 5,593 acres. These parcels are distributed throughout the watershed with the heaviest concentrations in the central and northern part of the watershed and make up 28% of the total watershed area. The majority of the parcels (1,531) are classified as low priority, which constitutes 4,258 acres. The parcels that are classified as low priority contain mostly agricultural land use.

Conclusion: Green infrastructure preservation at the landscape scale needs to be inter-jurisdictionally implemented throughout the watershed in order to achieve the plan goals. Strongest consideration should be given to high and strategically located medium priority ranked parcels. Open parcels in the designated green infrastructure network need to be maintained as green infrastructure whether they are privately or publicly-owned so they may continue to infiltrate precipitation, as well as providing other economic, habitat and recreational functions and benefits.

The watershed also needs to utilize well-situated parcels that have the ability to infiltrate rainwater for site or neighborhood scale stormwater infiltration practices. Parcels that will be developed or are currently developed will be important for implementing these green infrastructure practices.

References

Atlanta Regional Commission (ARC). 2001. Georgia Stormwater Management Manual. Volume 2. Technical Handbook. Atlanta Regional Commission. Atlanta, GA. Available Online: http://www.cwp.org/online-watershed-library/doc_download/595-impacts-of-impervious-cover-on-aquatic-systems-watershed-protection-research-monograph.

Bannerman, Roger T., D.W. Owens, R. B. Dodds, and N. J. Hornewar. 1993. Sources of Pollutants in Wisconsin Stormwater. Water Science and Technology.

Cappiella, K. and K. Brown. 2001. Impervious Cover and Land Use in the Chesapeake Bay Watershed. Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection (CWP). 1998A. Rapid Watershed Planning Handbook: A Comprehensive Guide for Managing Urbanizing Watersheds. Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection (CWP). 1998B. Better Site Design: A Handbook for Changing Development Rules in Your Community. Center for Watershed Protection. Ellicott City, MD.

Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Center for Watershed Protection. Ellicott City, MD. Available Online: http://www.cwp.org/online-watershed-library/cat_view/63-research/72-impacts.

Center for Watershed Protection (CWP). 2009. Georgia Coastal Stormwater Supplement. Georgia Department of Natural Resources. Environmental Protection Division. Atlanta, GA. Available Online: http://www.georgiaepd.org/Documents/CoastalStormwaterSupplement.html.

Cruse, R., D. Huggins, C. Lenhart, J. Magner, T. Royer and K. Schilling. 2012. Assessing the Health of Streams in Agricultural Landscapes: The Impacts of Land Management Change on Water Quality. Council for Agricultural Science and Technology. Ames, IA.

Dahl, T.E. 2006. Status and Trends of Wetlands in the Conterminous United States 1998-2004. U.S. Department of the Interior. U.S. Fish and Wildlife Service. Washington, DC.

Dahl, T.E. 2000. Status and Trends of Wetlands in the Conterminous United States 1986-1997. U.S. Department of the Interior. U.S. Fish and Wildlife Service. Washington, DC.

Dahl, T.E. 1990. Wetland Losses in the United States 1780s-1980s. U.S. Department of the Interior. U.S. Fish and Wildlife Service. Washington, DC.

Dahl, T.E. and C.E. Johnson. 1991. Status and Trends of Wetlands in the Conterminous United States Mid-1970s-Mid-1980s. U.S. Department of the Interior. U.S. Fish and Wildlife Service. Washington, DC.

Futurity, Inc. Christy S.F. 2005. North Branch of the Chicago River Open Space Plan. Prepared for the North Branch Chicago River Watershed Project.

Lowe, K.S., N. Rothe, J. Tomaras, K. DeJong, M Tucholke, J. Drewes, J. McCray, and J. Munakata-Marr. 2007. Influent Constituent Characteristics of the Modern Waste Stream from Single Sources: Literature Review. Water Environment Research Foundation.

Pitt, R. 1994. Small Storm Hydrology. Unpublished Manuscript. University of Alabama–Birmingham. Birmingham, AL.

Schueler, T. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban Best Management Practices. MWCOG. Washington, D.C.

Wright, T., J. Tomlinson, T. Schueler, K. Cappiella, A. Kitchell and D. Hirschman. 2006. Direct and Indirect Impacts of Urbanization on Wetland Quality. Article 1. Wetlands and Watersheds Article Series. Center for Watershed Protection. Ellicott City, MD. Available Online: http://www.cwp.org/online-watershed-library/doc_download/21-wetlands-and-watershed-article-series-article-1-direct-and-indirect-impacts-of-urbanization-on-wetland-quality.

Contents

Tables and Figures

Common Acronyms/Abbreviations Used in Chapter 5

ANHMP – All Natural Hazards Mitigation Plan
BFE – Base Flood Elevation
CTP – Cooperating Technical Partner
DMA – Disaster Mitigation Act
FEMA – Federal Emergency Management Agency
FIRM – Flood Insurance Rate Map
FIS – Flood Insurance Study
FPAI – Flood Problem Area Inventory
GIS – Geographic Information System
H and H – Hydrologic and Hydraulic
HMGP – Hazard Mitigation Grant Program
IDNR-OWR – Illinois Department of Natural Resources – Office of Water Resources
ISWS – Illinois State Water Survey
NFIP – National Flood Insurance Program
PDM – Pre-Disaster Mitigation
SFHA – Special Flood Hazard Areas
SMC – Lake County Stormwater Management Commission
USACE – United States Army Corps of Engineers
USDA-NRCS – U.S. Department of Agriculture – Natural Resources Conservation Service
WDO – Lake County Watershed Development Ordinance

5. FLOOD DAMAGE PROBLEM ASSESSMENT

5.1 FLOOD EVENTS: 2008 and 2013

Flood Problem Area (FPA): One or more structures in a geographical area that are damaged by the same primary source/cause of flooding. Structures include transportation, utility infrastructure, buildings, and well and septic failure caused by flooding. Areas also include locations where road flooding results in damage to infrastructure, loss of critical access, or is a threat to safety.
Nuisance Flooding: Includes yard or open space flooding where it does not result in damage to a structure, loss of access, or loss of septic or utility function.

Flooding is the number one natural hazard in Lake County and there is a long history of flooding in the Des Plaines River watershed including Mill Creek. There are 31 known ***flood problem areas*** in the Mill Creek Watershed and an estimated 337 structures (residences, churches, businesses) are at risk of flooding due to their location in the 100-year floodplain. Reports of flooding problems have been received since the Lake County Flood Problem Area Inventory was updated in 2002. Thirteen of those flood problem areas sustain flooding at a frequency of every 1-5 years, four of which were reported as a result of Hurricane Ike rainfall in September 2008.

In 2013, two flood events further exacerbated existing flood problem areas in the Mill Creek Watershed. The combination of late snow melt in April, heavy rains in southern Wisconsin between April 6th and 11th and over Lake County April 16th and 19th resulted in extended, widespread riverine flooding in the Des Plaines River watershed. Lake County was declared a Federal disaster area and included the impacted areas of the Mill Creek Watershed like Grandwood Park, Gurnee, Third Lake, Grayslake, Wadsworth, Lindenhurst, Wildwood/Gages Lake and unincorporated areas of the county. A June 2013 flash flood event caused sanitary and storm backs ups, and depressional and ***nuisance flooding***. The flood problem areas and the need for more detailed mitigation assessments and prioritized mitigation efforts are discussed below.

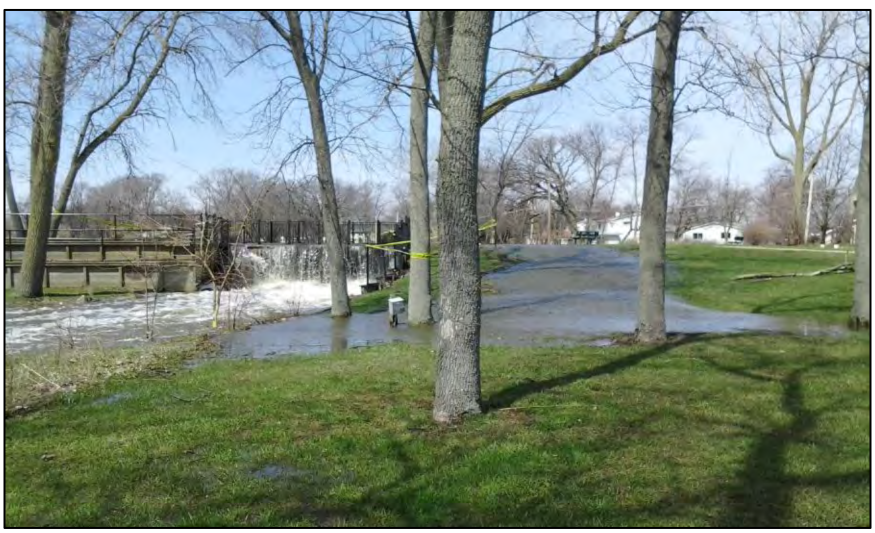


Photo 5-1: Grandwood Park dam overflowing from the March 20, 2013 rain event.

5.2 FLOOD PROBLEM AREA INVENTORY

5.2.1 SUMMARY OF THE FLOOD PROBLEMS AREA INVENTORY

The countywide Flood Problem Areas Inventory (FPAI) was conducted in 1995/1996 and updated in 2002 by the Lake County Stormwater Management Commission (SMC). The Flood Problem Areas Inventory and a flood risk assessment based on mapped floodplains identified structures that have been or may be damaged by flood events. The FPAI is used to locate flood damage problem areas based on reports of flood damage by residents or communities. The FPAI identifies the primary cause of flood damage for each area, and it is used to recommend flood mitigation priorities. The flood risk assessment identifies additional locations where structures occur in mapped floodplain areas and are likely at risk of flood damage. The purpose was to identify those structures that are at risk of flooding so that plan recommendations can be made that address flood damage reduction.

In 2013, SMC solicited information from Mill Creek watershed stakeholders, including jurisdictional entities and landowners, to update the FPAI for the watershed area. SMC distributed a questionnaire about flooding to the Mill Creek stakeholder group and residents living in known flood problem areas via electronic and postal mail. SMC sent out flood protection questionnaires to over 250 property owners adjacent to 21 known Flood Problem Areas identified in the watershed (11-1, 11-2, etc.). The questionnaire requested information about the damage extent and frequency of flooding. Information was also requested through a FPAI update request to all jurisdictional entities. Copies of the Flood Questionnaire and FPAI Update forms are included in Appendix J. SMC also hosted a facilitated session at the May 2, 2013 stakeholder meeting to gather information and discuss areas that flood in the watershed.

Based on 23 questionnaires that were returned to SMC, 6 residents experienced flooding in their basement; 4 residents experienced flooding in a crawl space; and 5 residents experienced yard flooding only or in addition to other types of flooding (**Table 5-1**). One home experienced flooding on the first floor of their single family home. Flooding of structures (basements and crawl spaces) ranged from approximately 3 inches to 4 feet. While data obtained from these types of surveys may be used in more comprehensive flood audits, flood audits for individual properties were not performed for this study because the reported flood damage levels for the residents who expressed interest in having a flood audit performed were not significant enough to warrant a flood audit.

Table 5-1: Summary of Flood Problem Areas Inventory Questionnaires.

Number of Homes or Properties Flooded	First Floor Flooding	Basement Flooding	Crawl Space Flooding	Yard Flooding
12	1	6	4	5

Thirty-one flood problem sites were identified in the watershed based on the FPAI and survey results, which resulted in the addition of 13 sites to the FPAI. **Table 5-3** and **Figure 5-1** illustrate the flood problem areas that are identified and characterized in this section. Chapter 6 includes action and implementation measures by jurisdiction to address the FPAI sites.

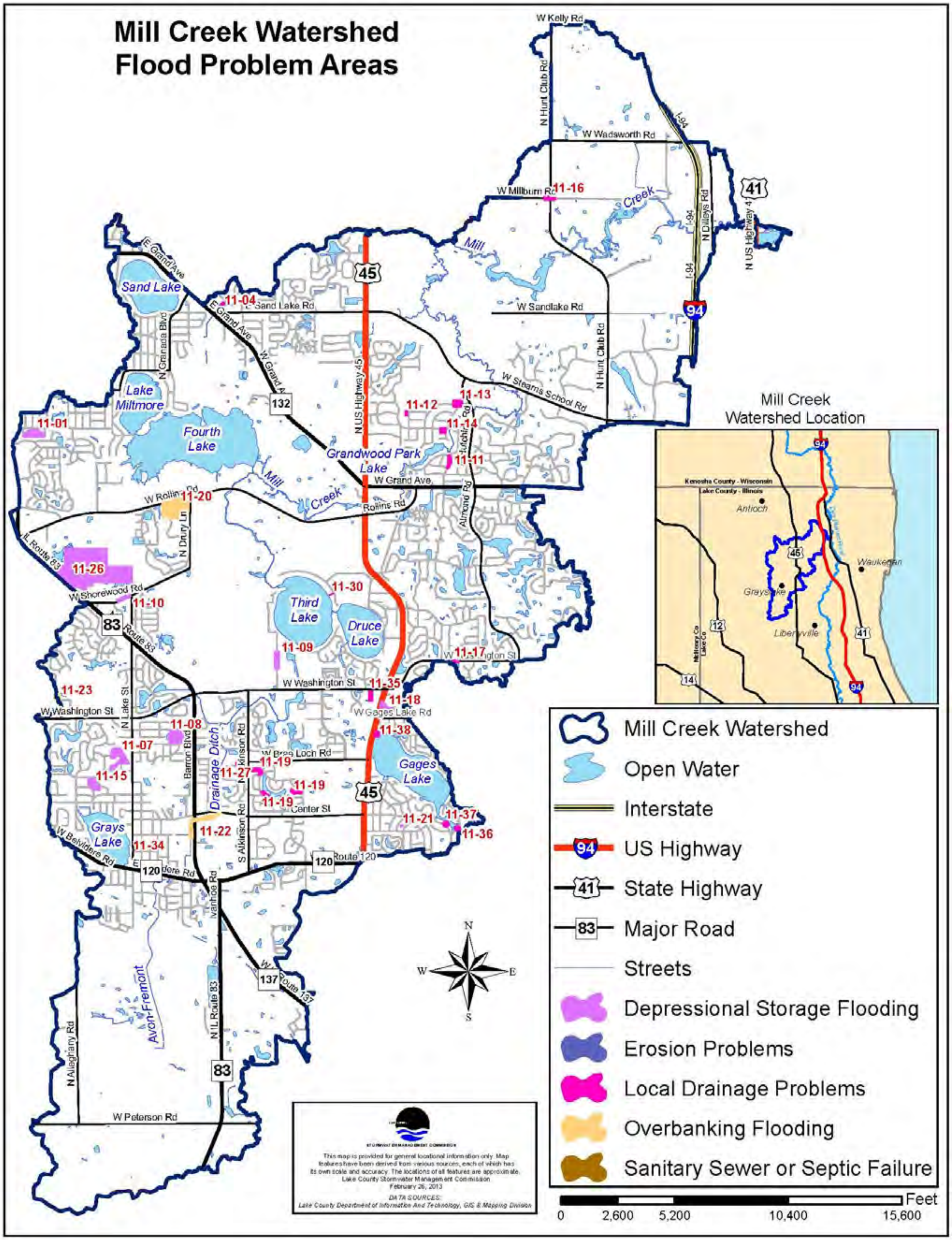


Figure 5-1: Flood Problem Areas.

For inventory purposes, flood damage was categorized by type based on the cause of flooding (**Table 5-2**). The following types of flood damage occur in the watershed and are identified on the flood problem areas map and in the summary tables that follows:

- Overbank flooding from a river or stream;
- A local drainage system that allows insufficient capacity to handle drainage from the surrounding neighborhood/built up area;
- Location within a depressional area in the landscape that does not include a sufficient outlet for stormwater and therefore floods.

Areas that experience "nuisance" flooding that does not damage buildings or infrastructure are not included in the FPAI. **Table 5-3** is an overview of all FPAI sites.

Table 5-2: FPAI Damage Categories.

FPAI Damage Type	Summary of Impacts in Mill Creek Watershed
Depressional Storage Flooding	Depressional flooding problems account for approximately 42% of the flood problem areas and impact the most residential structures and other buildings in the watershed. Six of the thirteen depressional flood areas are located in mapped 100-year floodplain. Flood insurance is not required for properties located outside of mapped floodplains, therefore it is more likely that new homebuyers in these areas may not be aware of their flood risk, and will not be adequately protected from flood damage.
Local Drainage Problems	Approximately 45% of the flood problem areas are associated with local drainage problems and three of the fourteen sites are located in mapped 100-year floodplain.
Overbank Flooding	Overbank flooding problems account for approximately 13% (4) of the flood problem areas. One of the reported problems was roadway related, while two of them impacted residents and another one impacted non-residential buildings. All but one of the overbank flood problem areas are located in mapped 100-year floodplain.

Table 5-3: Flood Problem Area Inventory Sites.

Flood Problem Area ID	Problem Category	Problem Description	Frequency of Reporting
11-01	Depressional Storage Flooding	3-4 Residents	40-yr event
11-04	Local Drainage Problems	Road	Annually
11-07	Depressional Storage Flooding	12 Residents	1.5" rain
11-08	Depressional Storage Flooding	Several Residents	4-6" rain
11-09	Depressional Storage Flooding	Road	Large rain
11-10	Depressional Storage Flooding	Road	Heavy rain
11-11	Local Drainage Problems	5 Residents	2-5 years
11-12	Local Drainage Problems	20 Residents	2-5 years
11-13	Local Drainage Problems	8 Residents	2-5 years
11-14	Local Drainage Problems	4 Residents	2-5 years
11-15	Depressional Storage Flooding	15 Residents	Any significant rain
11-16	Local Drainage Problems	Road	100-yr event
11-17	Local Drainage Problems	Road	?
11-18	Depressional Storage Flooding	1 Resident/1 Building/Road	Annually
11-19	Local Drainage Problems	12 Residents	?
11-20	Overbank Flooding	Road	?
11-21	Depressional Storage Flooding	2 Residents	Any major rain

Flood Problem Area ID	Problem Category	Problem Description	Frequency of Reporting
11-22	Overbank Flooding	2-3 Buildings	Heavy rain
11-23	Overbank Flooding	1 Resident	1986/1993
11-24	Local Drainage Problems	1 Resident	1990s/2010/2012
11-25	Depressional Storage Flooding	1 Resident	Any major rain
11-26	Depressional Storage Flooding	High School	2012/2013
11-27	Overbank Flooding	1 Resident	2010/2013/past
11-28	Depressional Storage Flooding	1 Resident	2000/2005/2008/2013
11-29	Local Drainage Problems	1 Resident	Annually
11-30	Depressional Storage Flooding	1 Resident	Annually
11-31	Depressional Storage Flooding	1 Resident	1986/several minor events
11-32	Local Drainage Problems	1 Resident	2007/two other years
11-33	Local Drainage Problems	1 Resident	Many times from 1970s-2010s
11-34	Local Drainage Problems	1 Resident	2009/2010/2013
11-35	Local Drainage Problems	1 Building	2006
11-36	Local Drainage Problems	4 Residents	Any major rain
11-37	Local Drainage Problems	4 Residents	Any major rain
11-38	Local Drainage Problems	Several Residents	Any major rain

5.2.2 CHARACTERIZATION OF FLOOD PROBLEM AREAS

The FPAI sites were visited by a water resources engineer in order to develop a better understanding of the flooding issues, the impacts, and to identify potential solutions, which are presented in Chapter 6. SMC staff performed the field reconnaissance in August 2013. Several of the problem areas were not evaluated because the exact location or dynamic of the problem could not be determined. **Table 5-4** through **Table 5-6** provide the details of the field characterization by flood problem type.

Table 5-4: Depressional Storage Flooding Problem Characterization.

Flood Problem Area ID	Engineer Characterization	Frequency of Reporting
11-01	Impacts approximately 3-4 residences located on or near Fox Chase Drive. There is a sump in front of the property at 840 Fox Chase Drive, and runoff from the north floods the backyards. The inlets on Fox Chase Drive also flood.	40-yr event
11-07	Located on Prairie View and 1st Street, and both streets experience floodwater on them during frequent rain events. There are sumps located on streets; this flooding problem also impacts 12 residents.	1.5” rain
11-08	Located on Pierce Court near Normandy Lane flooding impacts several residents. Pierce Court experiences 12-18 inches of floodwater during a 4-6” rain event. Storm water is managed by surface ditches that drain to beehive grates. The ditch along Normandy Lane, to the west side of Pierce Court, is non-existent or flat. Sites 11-25, 11-28 and 11-31 are located in the same area.	4-6” rain
11-09	Located on N. Linden Avenue, approximately 0.25 miles north of W. Washington Street. There is an existing sump in the road between two cattail marshes. The road is topped during large rain events.	Large rain
11-10	Located on Shorewood Road between Normandy Wood Court and N. Lake Street. There is an existing sump on Shorewood Road at this location. Water ponds during heavy rain events.	Heavy rain

Flood Problem Area ID	Engineer Characterization	Frequency of Reporting
11-15	Impacts 15 residents and is located between Woodland Drive and Behm Drive. The existing drains along Behm Drive are obscured, and the drainage swales are filled in causing the road to flood during any significant rain event.	Any significant rain
11-18	Located on N. Wright Avenue near the intersection with W. Gages Lake Road. There is an existing sump in N. Wright Avenue at this location and from the hill to the east and heading to the marsh to the west.	Annually
11-21	Located on N. Sears Boulevard where a resident is experiencing basement and yard flooding during any major rain event. The property drains to the front yard, below the basement grade.	Any major rain
11-26	Located at Grayslake North High School, along Illinois Route 83, where they have experienced 1 inch of water ponding on their ball fields in 2012 and 2013.	2012/2013
11-30	Located on S. Lake Avenue, approximately .10 miles from Sunshine Avenue. The resident experiences standing water next to the house and 4’ of water in the basement annually. The property backs to a lake and has the storm drainage system running through it. The property slopes from the lake to the road.	Annually

Table 5-5: Local Drainage Problem Characterization.

Flood Problem Area ID	Engineer Characterization	Frequency of Reporting
11-04	Located along Valley Drive at the intersection of Old Elm Road. There is an open lot on the southwest corner and a residential yard on the northwest corner. Storm water along Valley Drive is managed with drainage ditches. The drain under Old Elm Road on the northwest corner appears to be plugged, causing standing water in the ditch. Valley Drive is closed annually due to flooding.	Annually
11-11	Located on N. Grandwood Drive near W. Lakeview Terrace and impacts 5 residents. There are four inlet frames in the sump area along N. Grandwood Drive. Six inches of water has been on N. Grandwood Drive in the past 2-5 years. Problem area 11-29 is also located in this same area.	2-5 yrs
11-12	Located near the intersection of N. Beverly Avenue and W. Karen Lane where there are 2 small storm inlets. This impacts 20 residents where that has been flooding in the past 2-5 years.	2-5 yrs
11-13	Located near the intersection of N. Grandwood Drive and N. Streamwood Drive and impacts 8 residents in the area. This area is located in a flat sloped part of the N. Grandwood Drive. The crown on N. Grandwood Drive is high compared to N. Streamwood Drive. There is a yard drain located between 37334 and 37324 N. Grandwood Drive and two small inlets at the intersection. Also, the curb height along N. Grandwood Drive is half the normal curb height. Flooding has occurred in the past 2-5 years. Problem areas 11-24 and 11-32 area also located in this area.	2-5 yrs
11-14	Located on W. Geier Road and impacts 4 residents. There is one inlet frame and one open grate manhole lid with debris present located in the sump of W. Geier Road. In the past 2-5 years, water has ponded on W. Geier Road. Problem area 11-33 is also located in this area.	2-5 yrs
11-16	Located near the roundabout along N. Hunt Club Road near W. Millburn Road. There is a wooded area at the northwest corner, a cornfield at the northeast corner, and a roundabout center island. The existing culvert under N. Hunt Club Road to the north of the roundabout was open during the site visit. Flooding during a past 100-yr storm event caused N. Hunt Club Road to be closed.	100-yr event

Flood Problem Area ID	Engineer Characterization	Frequency of Reporting
11-17	Located along W. Washington Street at the intersection of Kingsport Drive. There is an existing V-ditch at the northwest corner of the intersection that drains to a shallow-height beehive grate.	?
11-19	Includes three areas located around a lake near Buckingham Drive and Cambridge Drive. During the site visit, the swales in two of the areas appeared to be blocked by shrubs. The third area includes a playground and courts in a common ground near the lake. Nothing was observed in this area during the site visit.	?
11-34	Located at the intersection of S. Lake Street and Junior Avenue. It was reported that the gutters were clogged causing flooding in the crawlspace of the resident to occur in 2009, 2010, and 2013. The exact location could not be determined during the site visit.	2009/2010/2013
11-35	Located on W. Washington Street near Mainsail Drive at Provida Family Medicine. There is an existing open grate manhole lid in the parking lot of the medical plaza. In 2006, a storm sewer backup caused five feet of water to pond in the parking lot.	2006
11-36	Depressional bowl area at Battershall Road and N Lakeshore Drive causes flooding southeast of Gages Lake	Any major rain
11-37	Residents adjacent to the south side of Gages Lake on Cove Road experience flooding	Any major rain
11-38	Maintenance of weir downstream of Gages Lake causes elevated lake levels which result in flooding	Any major rain

Table 5-6: Overbank Flooding Problem Characterization.

Flood Problem Area ID	Engineer Characterization	Frequency of Reporting
11-20	Located on W. Rollins Road, just west of the intersection with N. Drury Lane. There are fields on each side of W. Rollins Road, and there is a sump in the road at the problem area.	?
11-22	Located on Mill Creek near the intersection of Barron Boulevard and Center Street. There are 2-3 building impacted by this problem area during heavy rain events when the stream tops its banks. The stream grade is flat through this reach and the channel banks are vegetated.	Heavy rain
11-23	Located at the intersection of N. Lakeside Drive and W. Wilmar Avenue. The resident experienced seepage in 1986 and ice in 1993 on the road. There is a sump in N. Lakeside Drive, just north of W. Wilmar Avenue.	1986/1993
11-27	Located on Merrill Lane approximately 350 feet east of Bristol Lane. The resident experienced 10" of water in their basement in 2010, 2013 and in past years. The exact location could not be determined during the site visit.	2010/2013/past

5.3 FLOOD RISK ASSESSMENT

Hydrologists assign statistical probabilities to different size floods to describe a common or ordinary flood for a particular stream versus a less likely or a severe flood for the same stream. For example: a 2-year flood event has a 50% probability of occurring in any year; a 100-year flood event is a flood that has a 1% chance of being equaled or exceeded in any given year. The 100-year flood, also referred to as the "base flood", is the standard used by the National Flood Insurance Program (NFIP) for determining the ***base flood elevation*** (BFE) for floodplain management and is used to determine the need for flood insurance. However, 100-year floods can and do occur more frequently.

The 100-year flood has become the accepted national standard for floodplain regulatory purposes and was developed in part to guide floodplain development to lessen the damaging effects of floods. The ***100-year floodplain*** also includes the floodway. The floodway is the portion of the stream or river channel that includes the adjacent land areas that must be reserved to convey the 100-year flood without increasing the water surface. **Figure 5-4** illustrates floodplain and floodway. **Figure 5-3** shows areas where flooding is projected to occur during the 100-year design storm event, or the BFE.

100-year floodplain: A flood inundates a floodplain. A 100-year flood is a flood that has a 1-percent chance of being equaled or exceeded in any given year. A 100-year flood may also be referred to as the base flood.
Base Flood Elevation (BFE): The base flood elevation determines the area inundated during the base or 100-year flood, which is the 100-year floodplain.

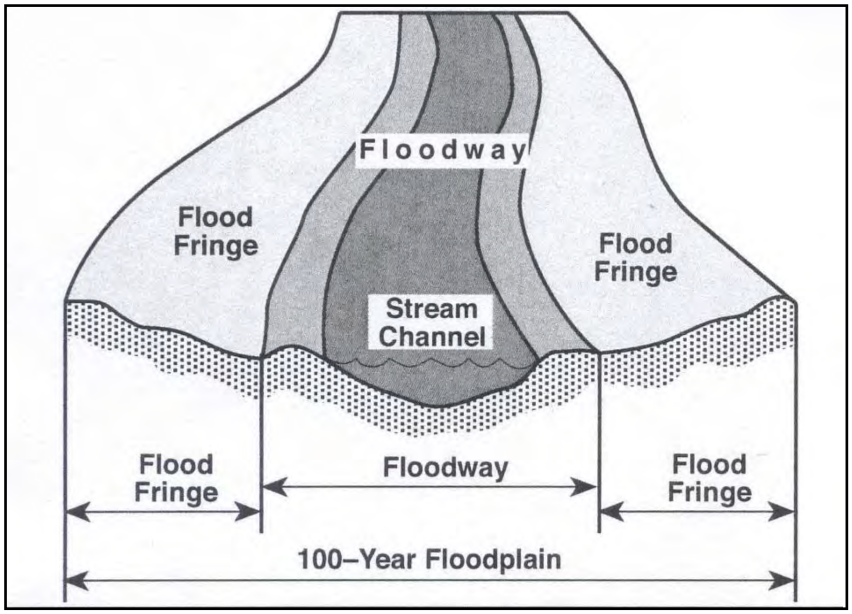


Figure 5-2: The 100-year floodplain.

Noteworthy: Floodplain

Floodplains along stream and river corridors perform a variety of functions. Some of these functions include flood storage, water quality, plant and wildlife habitat and aesthetic value. The most important function however, many would argue, is the capacity of the floodplain to hold water during significant rain events to minimize flooding issues.

The 100-year floodplain is defined as the area that would be inundated during a flood event that has a one percent chance of occurring in any given year (100-year flood or base flood elevation). The 100-year floodplain and floodway are indicated on FIRMs. Floodplain is typically mapped around lakes and larger wetlands in addition to along streams and rivers.

Flood Risk: What is more likely flood or fire?
The term "100-year flood" has caused much confusion for people not familiar with statistics. Another way to look at flood risk is to think of the odds that a 100-year flood will happen sometime during the life of a 30-year mortgage – a 26% chance for a structure located in the 100-year floodplain.
Compare those odds to the only 1-2% chance that the house will catch fire during the same 30-year mortgage.

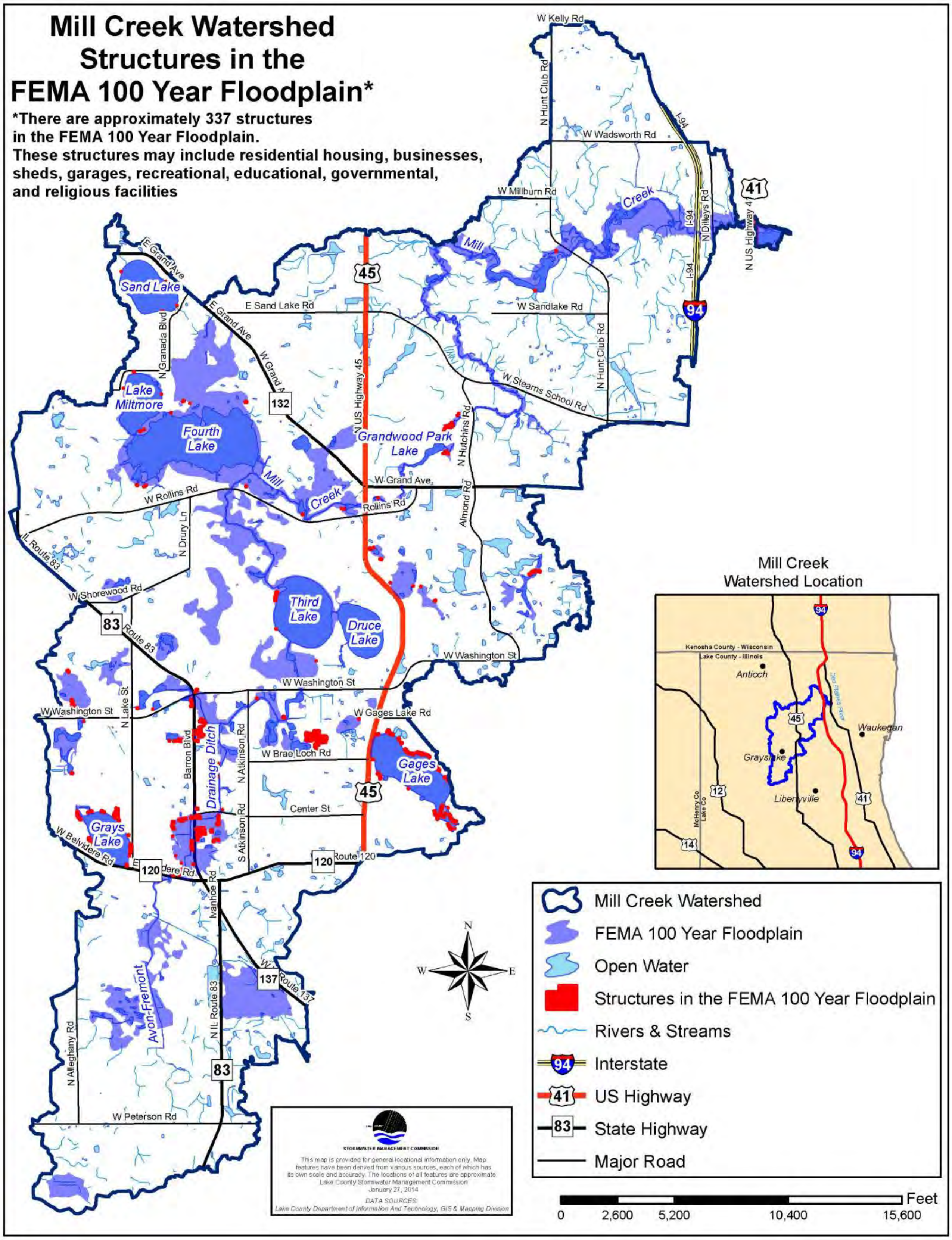


Figure 5-3: Areas Where Flooding is Predicted for the 100-Year Storm, and Structures in the 100-Year Floodplain.

5.3.1 FLOOD RISK – STRUCTURES IN THE FLOODPLAIN

Flood risk areas are Special Flood Hazard Areas (SFHA) where structures have been identified as being at risk for flood damage because of their location in the 100-year floodplain. The SMC compared the September 2013 (currently effective) floodplain maps with recent (2012) aerial photographs to locate structures in the floodplain. All structures located within the 100-year floodplain are shown in **Figure 5-5**. Many of the identified structures are in or near potential flood problem areas. **Table 5-7** includes a summary of these structures. According to the findings, 337 structures are located in the floodplain. Of these, houses (161), garages (60), sheds (52), and commercial/industrial structures (35) are the most common. Most of the structures that are at risk of flooding are in the central portion of the watershed, especially east of downtown Grayslake, in and near the east side of the Highland Estates subdivision, and around Gages Lake and Grays Lake.

Table 5-7: Structures, By Type, Subject to Potential 100-Year Flooding.

Structure, By Type	Number
House	161
Garage	60
Shed	52
Multi-family Building	8
Boat House	7
Pool House	1
Barn	2
Commercial/Industrial Structure	35
Municipal Structure	3
School	1
Pavilion/Gazebo	6
Utility Building	1
Total	**337**

Flood Insurance Study (FIS): Studies conducted by the Federal Emergency Agency (FEMA) to determine areas that have the highest probability for flooding.
Flood Insurance Rate Map (FIRM): A map prepared by the Federal Emergency Management Agency that depicts the special flood hazard area (SFHA) within a community. The FIRM includes zones for the 100-year and 500-year floodplains and may or may not depict Regulatory Floodways.
Zone AE: Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
Stillwater: Part of waterway that is level or where the level of inclination is so slight that no current is visible.

5.4 UPDATED FLOODPLAIN STUDY SUMMARY

The Illinois State Water Survey (ISWS) completed revised hydrologic and hydraulic (H and H) modeling for the mainstem of Mill Creek to update the floodplain study and develop floodplain maps based on current conditions (see Appendix I for the full report). The new floodplain study assesses approximately 19 miles of Mill Creek where the currently effective Flood Emergency Management Agency (FEMA) ***Flood Insurance Study (FIS)*** and ***Flood Insurance Rate Maps (FIRMs)*** show ***Zone AE*** floodplains and floodway. The current FIRMS are based on prior studies that no longer reflect existing conditions. Approximately 12 depressional areas (larger water bodies) were also reanalyzed. Revised ***stillwater*** elevations were determined for these areas.

To satisfy the objectives set forth for this project, information was collected, including existing hydrologic and hydraulic models, geospatial data, previous studies, reported problem areas, and other data relevant to the watershed plan. New discharge values and water surface profiles for the 10-, 4-, 2-, 1-, and 0.2% annual chance events with a floodway for the 1% annual chance event were derived from the H and H study. The new BFE floodplain is generally similar to the currently effective FEMA BFE floodplain. All H and H modeling is based on State of Illinois and FEMA criteria. Rainfall characteristics were in accordance with current Lake County Watershed Development Ordinance criteria (Huff, 1989). Non-mainstem water bodies and the majority of smaller depressional areas were not modeled or re-mapped as part of the study.

The detailed H and H models are currently being developed by ISWS, but were not complete at the time of this study. As the ISWS H and H study is still considered a "draft" product, the currently effective BFE floodplain, as defined by FEMA and most recently revised September 18, 2013, was used for the analyses provided in the flood risk assessment. The formal approval and adoption of ISWS's revised floodplain flows and elevations may take a considerable amount of time to go through the process set by FEMA and the IDNR-OWR. After completion of the Study by ISWS, it will be forwarded to IDNR-OWR for flow certification and floodway boundary approval and to FEMA's Cooperating Technical Partner (CTP) for review and approval of the entire study. Revisions to the models and maps may need to take place during this step if warranted by IDNR-OWR and CTP comments. A rough timeline of the approval process has been provided in **Table 5-8**.

Noteworthy: Hydrology and Hydraulics Models

Hydrologic and hydraulic computer models were developed for the watershed and are being used to generate up-to-date floodplain and floodway mapping for Mill Creek based on the existing land use, topography and stormwater conveyance systems.

Hydrology refers to the way that water behaves from its beginning as precipitation, through its movement on or beneath the surface of the earth, to its entry into sewers, streams, lakes, oceans and its eventual return to the atmosphere. A hydrologic assessment attempts to model how much precipitation falls in the watershed, what volume ends up in the creek, and the rate that it is discharged at critical locations.

Hydraulics addresses how water flows over the land surface, within sewers and stream channels, over and under bridges and dams and through culverts, wetlands, lakes and impoundments (detention basins and reservoirs). A hydraulic assessment studies flow paths, velocities and stages of water as it is conveyed, as a concentrated flow, through the watershed.

Table 5-8: Adoption Timeline of Revised Floodplain and Floodway Limits.

Estimated Due Process Timeline		**Lake County PMR – Mill Creek Watershed Study**
	April 1, 2014	Submission of floodplain and floodway to Illinois Department of Natural Resources - Office of Water Resources (IDNR-OWR) for flow certification and floodway boundary approval.
	April 1, 2014	Submission of floodplain and floodway to FEMA's Cooperating Technical Partner (CTP) through MT-2 application.
April to	July 1, 2014	Revisions to floodplain and floodway based on IDNR-OWE and CTP comments.
	July 1, 2014	IDNR-OWR approval of flows and floodway boundary.
	July 1, 2014	FEMA approval of MT-2 application.
	October 1, 2014	Preliminary products mailing **(Maps Preliminary)** through FEMA's Physical Map Revision (PMR) process.
	Early November	Flood Risk Information Open House.
Early November to	Early December	30-Day Comment Period.
January 2015	March	90-Day Appeal Period (start date dependent on Federal Register publication).

Estimated Due Process Timeline		Lake County PMR – Mill Creek Watershed Study
through		
Mid-April to	Mid-June	FEMA Final Review.
	Mid-June	Letters of Final Determination issued **(Maps Final).**
Mid-June	Mid-December	6-Month Community Compliance Period (Map and Ordinance Adoption).
	Mid-December2015	Effective date **(Maps Effective).**
	Mid-December2015	Revalidation letters mailed.

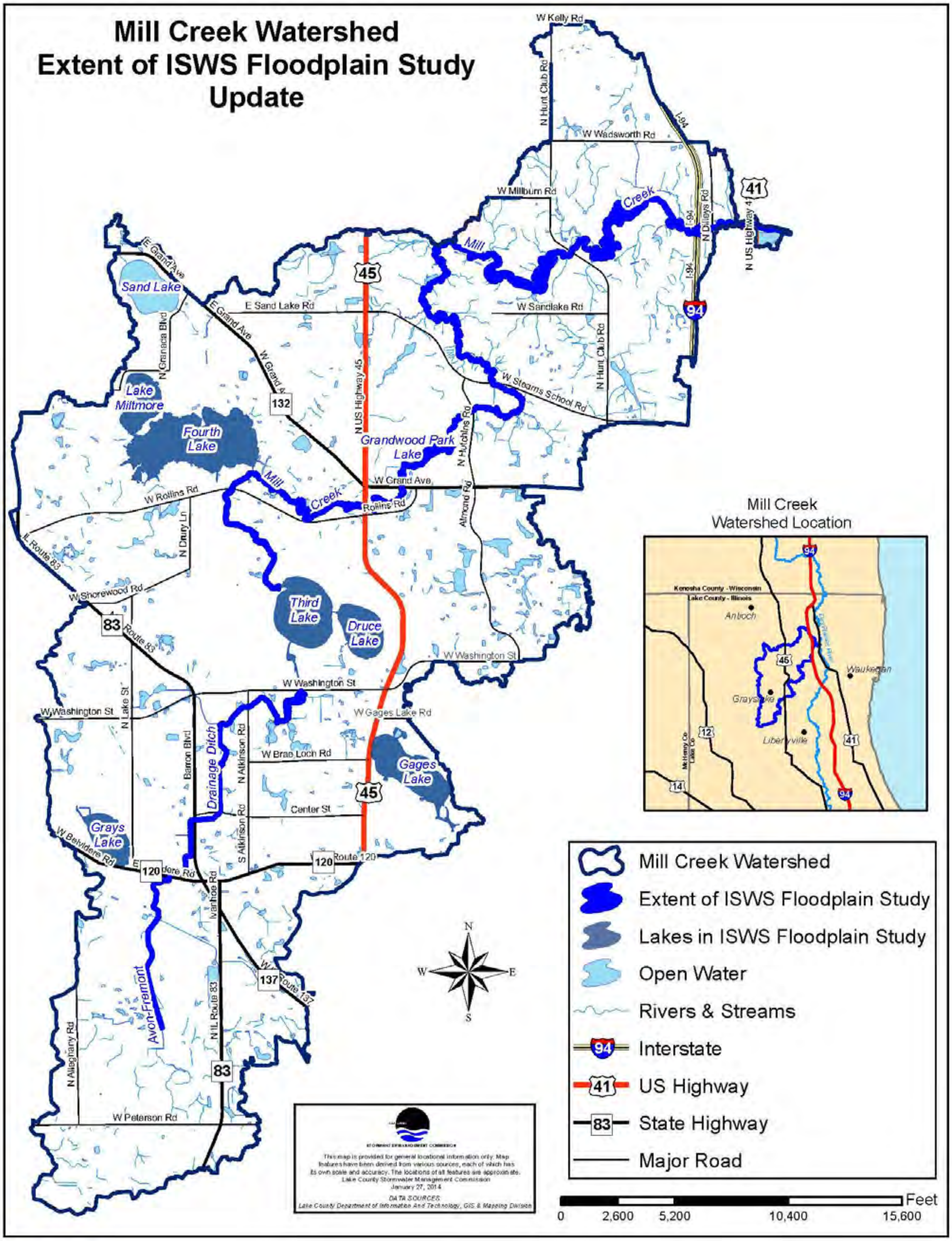


Figure 5-4: Extent of the Illinois State Water Survey floodplain study update.

5.5 FLOOD DAMAGE REDUCTION

Flooding and risk of flooding are fairly common in northeastern Illinois and Lake County, primarily due to the impact of urban development, which increases impervious surfaces, increases the rate and volume of stormwater runoff, and modifies and builds in natural storage and floodplain areas. These factors, coupled with a flat Illinois landscape where excess water tends to spread out over a wide area, have resulted in flooding problems. For this reason, it is important to preserve and not modify the existing flood storage capacity of the landscape including depressional areas, wetlands, and floodplains. In some cases this is not feasible as development may have already occurred in flood-prone areas. A more detailed approach to flood damage reduction is warranted in urbanized areas.

Flood damage reduction recommendations fall into two categories, which include: 1) preventative measures; and 2) remedial measures.

5.5.1 PREVENTATIVE MEASURES: MINIMIZING THE EXPANSION OF FLOOD DAMAGE

Flood prevention techniques seek to prevent flooding problems before they occur. Techniques such as zoning and floodplain regulations seek to prevent flood damages by limiting development in areas where flooding is most likely to occur. Land acquisition maintains open space, preserving rainfall infiltration and natural storage areas. Several categories of flood prevention techniques involve runoff reduction. Runoff reduction techniques reduce flood damage potential at the source by decreasing the amount of runoff from a developed site. One category looks at improved infiltration on-site; the other uses alternative development techniques that include natural drainage measures and minimization of impervious surfaces.

5.5.1.1 Floodplain Zoning

A zoning ordinance regulates development by dividing the community into zones or districts and setting development criteria for each district. Zoning can be used to control where new development or redevelopment occurs, so that new flood problems are not created and existing flood problems are not exacerbated. Two zoning approaches can be used to prevent flood damage caused by development in flood-prone areas. They involve establishing separate zoning districts or using overlay zoning. Separate districts designate floodplain as a special zoning district that only allows development that is not susceptible to flood damage, such as some recreational uses, conservation or agriculture. Overlay zoning adds special development limitations to the underlying zoning (i.e., residential, commercial, industrial, etc.) in areas subject to flooding.

5.5.1.2 Floodplain Regulations

In addition to zoning ordinances, regulations that restrict construction in floodplains are usually found in one or more of the following documents: subdivision ordinances, building codes, and/or separate stand-alone floodplain ordinances such as the Lake County Watershed Development Ordinance (WDO). If the zoning for a site allows a structure to be built, then the applicable subdivision and building regulations will impose construction standards to protect buildings from flood damage, and will require compensatory storage to prevent the development from aggravating the flooding problem. Subdivision ordinances specifically govern how land will be subdivided into lots, and regulate standards for infrastructure provided by the developer including roads, sidewalks, utilities, stormwater detention, storm sewers and drainage ways. Building codes should establish flood protection standards for all structures.

All development in floodplains requires a WDO permit. The WDO restricts development in mapped floodways and limits development in the 100-year floodplain. Lowest floor elevations (including basements) must be a minimum of 2 feet above the base flood elevation (BFE) for residential structures constructed in the floodplain. Non-residential structures must also meet these lowest floor elevation requirements, or be dry-flood-proofed to 2 feet above the BFE. In addition to elevating the structures, compensatory storage must be provided for water storage lost due to floodplain fill at a ratio of 1.2:1 for riverine floodplain and 1:1 for depressional floodplain.

All Lake County communities must adhere to the standards required in the WDO as minimum development requirements for their community. Depending on flood risk, individual communities can adopt floodplain regulations that are more restrictive than the minimum requirements of the WDO.

Since the WDO applies to both new developments and redevelopment projects, the WDO flood prevention and water quality provisions have the potential to improve conditions in redeveloped areas. In addition, although Mill Creek has areas of highly developed land use, there are still large areas of undeveloped land that will fall under the WDO purview when developed. These undeveloped parcels are mostly found in the northern and southern portions of the watershed.

5.5.1.3 Floodplain Acquisition

Floodplain acquisition can be an effective tool for reducing future flooding because it maintains floodplain as open space for floodwater storage and prevents developments in the floodplain. In addition to eliminating floodplain development and the resulting flooding damage, floodplain acquisition provides multiple benefits with the addition of amenities such as greenways, recreational trails, river access points and wildlife habitat corridors.

5.5.1.4 Runoff Reduction

Runoff reduction is divided into three broad categories. One category of techniques improves infiltration of precipitation at newly developed sites or for existing developed areas. Infiltration techniques may include natural landscaping with deep-rooted plants, permeable pavers or porous pavement, and bio-infiltration devices.

The second category of runoff reduction techniques involves implementing alternative site designs that incorporate non-structural practices like preserving the natural drainage system and reducing the amount of impervious surface in newly developed or redeveloped areas. Measures may include natural drainage measures, impervious area reduction, alternative streetscapes that reduce and infiltrate runoff, alternative parking lot designs, and green roofs.

Finally, stormwater regulations may be employed to help reduce the quantity of runoff from developments. The WDO explicitly requires the use of a runoff reduction hierarchy and specifies allowable release rates from new development or redevelopment. Combined, these measures decrease the volume and flow rate of stormwater that is discharged off a site.

5.5.2 REMEDIAL MEASURES: ALLEVIATING FLOOD DAMAGE

Flooding problems can generally be reduced or eliminated by both structural and non-structural means. Structural flood mitigation measures focus on reducing the probability of flooding (i.e., removing/reducing the ability of flood waters to reach a property/structure) while non-structural flood mitigation measures focus on reducing the consequences of flooding (i.e., flood-proofing a structure located in the floodplain).

Structural flood mitigation measures can be as simple as improving overland flow routes, increasing storm sewer capacity or implementing other conveyance-related drainage improvements. Care should be taken when designing improved conveyance practices to insure that adjacent and downstream properties and waterways will not be negatively impacted by the increased flows. More complex structural flood mitigation measures may involve the construction of structures such as reservoirs, levees and floodwalls to confine and/or re-delineate the flooding limits. Non-structural mitigation alternatives typically include practices such as acquisition or relocation of flood-prone structures, flood-proofing or implementation of ordinances/codes focused on runoff reduction techniques, which requires a more long-term and holistic approach to flood mitigation. Several common types of structural and non-structural mitigation measures are described below.

5.5.2.1 Structural Flood Mitigation Measures

Structural measures control or contain water and are generally designed to prevent floodwaters from reaching buildings and/or property. Structural alternatives generally include reservoirs, levees and floodwalls, diversions, stream channel conveyance improvements and drainage and storm sewer improvements. For large and/or complex structural flood mitigation alternatives, the projects are often costly to implement so local agencies and/or private land owners often request help from state or federal agencies such as the Illinois Department of Natural Resources - Office of Water Resources (IDNR-OWR), the United States Army Corps of Engineers (USACE), and the United States Department of Agriculture Natural Resources Conservation Services (USDA NRCS).

Since structural flood control is generally the most expensive type of mitigation measure in terms of installation time and costs, maintenance requirements and environmental impacts, a thorough assessment of alternatives should be conducted before choosing a structural flood control measure. The advantages and disadvantages of structural flood control techniques are discussed in **Table 5-9** (Association of State Floodplain Managers, 2007).

Table 5-9: Benefits and drawbacks to structural flood control measures.

Advantages	Shortcomings
May provide the greatest amount of protection for land area used	They disturb the land and disrupt natural water flow, often destroying wildlife habitat
Because of land limitations, may be the only practical solution in some circumstances	They require regular maintenance, which if neglected, can have disastrous consequences
Can incorporate other benefits into structural project design such as water supply and recreational uses	They are built to a certain flood protection level that can be exceeded by larger floods, causing extensive damage
Regional detention may be more cost efficient and effective than requiring numerous small detention basins	They can create a false sense of security, as people protected by a project often believe that no flood can ever reach them
	Although it may be unintended, in many circumstances they promote more intensive land use and development in the floodplain
	They can create new flooding problems if improperly designed or built
	Levees and reservoirs can significantly degrade riparian and aquatic habitat and water quality

Reservoirs/Regional Detention

Reservoirs and regional detention are large structures that control flooding by holding high flows behind dams or in storage basins. After a flood peaks, water is released or pumped out slowly at a rate that is equal to or less than the capacity of the downstream channel. Reservoirs that maintain a normal water level may be used for water supply and/or to provide water-based recreational benefits. In addition, wet or dry detention basins can serve multiple uses by doubling as parks or providing other open space uses.

The amount of land needed, coupled with the expense of construction, management and maintenance limit the use of reservoirs. Additionally, reservoirs may fail to prevent floods that exceed their design levels; may eliminate the natural and beneficial functions of the floodplain; and may negatively impact water quality and aquatic habitat.

Detention Basins

Some localized flooding problems can be remedied by enlarging or adjusting flows through existing detention basins, or by constructing new basins. Detention basins are considered to be effective at flood reduction in watersheds of up to 30 square miles. While regional detention is generally more cost-effective than constructing numerous small detention facilities, in some cases there may not be sufficient land available for regional detention. Also, for very localized flood problems, a smaller detention basin may be the most economical solution. In addition, slowing release rates from new and existing detention basins can reduce the downstream flood risk and some of the impacts of short duration-high velocity events on the stream channel. Retrofitting older detention basins to improve functionality and/or storage volume and/or constructing new detention basins are often viable flood mitigation alternatives, especially for smaller tributary areas (less than 100 acres).

Levees and Floodwalls

Earthen levees or concrete floodwalls are typically used to mitigate overbank flooding and are erected between the river and the properties to be protected. Levees and floodwalls confine water to the stream channel by artificially raising the banks. Regulatory levees must meet very strict and onerous design and permitting requirements. A serious concern with levees is that they frequently offer a false sense of security. In some cases land use behind a levee can change to high intensity, high-value occupation under the false assumption that all future floods will be controlled by the levee, when in reality, large floods may overtop or breach the levee creating more flood damage than would have occurred.

Levees and floodwalls have other limitations. Placed along the river or stream edge, they degrade riparian and aquatic habitat. Levees are expensive to construct, require considerable land and maintenance and are more likely to push floodwater onto other properties upstream or downstream. In some cases, it may be necessary to include expensive and noisy pumping operations for internal drainage. Levees also act as barriers to river access, block views and disrupt local drainage patterns.

Barriers

Constructing barriers such as non-regulatory low floodwalls and berms around an individual property can keep floodwaters from reaching the structure. Berms are commonly used in areas subject to shallow flooding. Not considered engineered structures, berms are made by re-grading or filling an area. Low floodwalls may be built around stairwells to protect the basements and lower floors of structures. By keeping water away from the structure walls, the problems of seepage and hydrostatic pressure are reduced. Barriers are commonly referred to as non-regulatory since a barrier typically cannot be used to remove a structure or property from the Regulatory Floodplain.

As with levees, the use of low floodwalls and berms must also include a plan to install drainpipes and/or sump pumps to handle leaks and water seepage through or under the barrier, and to remove water that may collect within the barrier. Care must be taken in the design, location and installation of low floodwalls or berms to ensure that flood waters are not inadvertently pushed onto adjacent properties.

Improved Channel Conveyance

Channel conveyance improvements alter the channel so that more water is carried away at a faster rate. Improvements generally involve making the channel wider, deeper, smoother and/or straighter. Some channels in urban areas have also been lined with concrete or put in underground pipes.

Straightening, deepening and/or widening a stream or river channel, commonly referred to as channelization, has often been the common remedy for riverine overbank flooding problems. Channelized rivers and streams drain water faster from areas adjacent to and upstream of the channel, but can increase or create new flooding problems downstream as larger volumes of water are transported at a faster rate. Channelized waterways tend to be less stable and more susceptible to streambank erosion. Therefore, the need for periodic reconstruction, streambank stabilization and silt removal becomes cyclic in these circumstances making stream and channel maintenance very expensive.

Dredging is another type of conveyance improvement. It is frequently cost prohibitive due to the expense of disposing of the dredged material. In addition, unless in-stream and/or upstream tributary erosion are corrected, the dredged areas usually fill back in within a few years, and the process and expense have to be repeated.

Channel conveyance improvements such as channelization and dredging are considered to be environmentally destructive with respect to habitat and water quality and are frequently unsustainable.

Drainage Improvements

Drainage improvements can be in the form of open ditches, swales or storm sewers. Man-made ditches and storm sewers help drain areas where the surface drainage system is inadequate, or where underground drainageways may be safer or more practical. Particularly appropriate for depressions and low spots that will not drain naturally, drainage and storm sewer improvements can be a quick and relatively cost-effective way to safely convey runoff for a wide range of smaller storm events. Storm sewer improvements may include the installation of new sewer lines or inlets, modifications to existing sewer inlets, installation of larger pipes, the construction of better defined and/or effective overland flow routes and the use of mechanical measures such as pumps, backflow preventers, etc.

Since drainage improvements typically result in runoff being more efficiently conveyed to a downstream location, these mitigation measures should only be used when the receiving waterway has sufficient capacity to handle the additional volume and flow of water. To prevent cumulative downstream flood impacts, drainage improvements are often combined with other storage volume creation or runoff reduction measures.

5.5.2.2 Non-Structural Flood Mitigation Measures

In addition to structural controls for flood mitigation, flooding problems can also be addressed using non-structural means. Some of the non-structural flood control techniques include flood-proofing, acquisition of structures in the floodplain, elevation of a structure and relocation of a structure. More communities and county-wide agencies could get involved in non-structural programs such as acquisition by helping to identify repetitively flooded properties. In addition to being used for prevention, runoff reduction techniques may also be used by individual homeowners or neighborhood associations in retrofit projects to lessen flooding problems.

Structure Relocation

Moving a structure to higher ground is an extremely effective way to protect it from flooding. While almost any structure can be moved, this flood mitigation measure can be cost prohibitive depending on the type, condition and size of the structure as well as the requirements associated with securing a new site. Structure relocation can be cost effective where flooding is relatively severe and/or frequent.

Although relocation can be expensive initially, in the long run moving can be less costly than paying for repetitive flood damages or high flood insurance premiums. While relocation is typically the responsibility of the structure owner, government-sponsored loans or grants may be available for cost-share.

Buyouts/Acquisition

Like relocation, acquisition ensures that structures in a flood-prone area will cease to be subject to damage. The major difference is that acquisition is undertaken by a government agency, so the cost is not borne by the property owner, and the land is converted to an appropriate permanent public use such as a park. Acquiring and clearing structures from the floodplain is not only the best long-term flood protection measure, it also is a way to convert a problem area into a community asset that can provide environmental and recreational benefits. To achieve maximum benefits from this type of public investment, acquisition and land reuse should be a component of a community's redevelopment plan, and be incorporated as a strategy in park, greenways and capital improvement plans.

Structure Elevation

Raising a structure above the floodplain elevation is the best way to protect a structure that cannot be removed from the floodplain. The structure is elevated on a foundation or piers so that the lowest floor is above the BFE. When flooding occurs, water levels stay below the main floor, causing minimal damage to the structure or its contents. Raising a structure above the flood level is less expensive than moving it, and can be less disruptive to a neighborhood. Commonly practiced in flood-prone areas nationwide, this protection technique is required by law for new and substantially damaged residences located in a 100-year floodplain.

Although flood damages can be reduced significantly or eliminated through structure elevation, there are some limitations to remaining in a flood-prone location. While the structure itself is sufficiently elevated to be protected from flood damage, flooding may isolate the building and make it inaccessible. Flood waters surrounding the structure can also result in a loss of utility service or septic use, making the structure uninhabitable. Additionally, pollutant contamination in flood waters may present health and safety concerns.

Flood-proofing

Flood-proofing measures can provide either dry flood-proofing or wet flood-proofing. In areas where there is shallow flooding, dry flood-proofing measures can be used to prevent water from entering at-risk structures. Wet flood-proofing allows water to enter the structure, but it minimizes the damage to the structure and its contents. Wet flood-proofing includes some of the least expensive and easiest mitigation practices to install. Although flood waters are not controlled, with wet flood-proofing damage can be greatly reduced.

- Dry Flood-proofing - Dry flood-proofing is a combination of practices that are used to make a building watertight so no flood waters enter the structure, including the basement and/or crawl space. The Federal Emergency Management Agency (FEMA) and the US Army Corps of Engineers (USACE) have various publications highlighting the range of practices that can be used to dry flood-proof a structure.

- Wet Flood-proofing - As defined by FEMA, wet flood-proofing includes permanent or contingent measures applied to a structure or its contents that prevent or provide resistance to damage from flooding while allowing flood waters to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the BFE, protection of mechanical and utility equipment, and use of openings or breakaway walls. At the very least, several low-cost steps can be taken to wet flood-proof a structure. Simply moving furniture and electrical appliances out of the flood-prone portions of the structure can prevent thousands of dollars in damages. One strong advantage of wet flood-proofing is that flood damage can be reduced through some common sense, low or no cost practices.

Runoff Reduction

Examples of runoff reduction techniques that can be implemented in developed or developing areas include the use of natural landscaping, permeable pavement, rain gardens, green roofs, etc. Implementing these runoff reduction retrofits is generally the responsibility of individual property owners. These techniques typically do not have a significant impact when applied individually on a single site, but the cumulative effect when used at numerous sites throughout the watershed can result in significant flood reduction benefits. That being said, the timing associated with recognizing measurable flood reduction benefits make this flood mitigation measure more of a long-term complementary mitigation measure rather than an immediate flood mitigation alternative.

5.6 EXISTING AND POTENTIAL REGIONAL FLOOD STORAGE

5.6.1 EXISTING FLOOD STORAGE

Existing flood storage defined as existing or created depressional areas that are presently storing, or potentially could store stormwater runoff to decrease flooding in the watershed. Besides flood protection, flood storage areas can be used for the mitigation of wetland losses (wetland restoration), channel protection, and water quality protection. While not all areas in the watershed present flooding issues, downstream flood damage along the Des Plaines River is a chronic problem. Creating or enhancing storage would provide many benefits including reduced runoff to streams; thus, minimizing channel erosion and runoff to the Des Plaines River. If designed and planted as a wetland restoration, storage areas would improve water quality and habitat as well as increase groundwater recharge. The criteria used to identify existing storage locations are summarized below.

Existing Flood Storage Areas Criteria:

- Include all existing open water (streams and lakes), wetlands, detention basins, and 100- year floodplains,
- Exclude parcels less than 1/3 acre, transportation, and building footprints,
- Calculate estimated storage assuming 2 feet of storage volume at each location,
- Minimum storage size of 1 acre-foot

The locations identified in

Figure 5-5 range from one acre-foot to over 2,000 acre-feet of storage. There are 694 storage areas encompassing 6,250 acres (30% of the watershed) and there is estimated potential to store 12,500 acre-feet of water (**Table 5-10**).

Table 5-10: Statistics of Existing Storage Locations.

Statistic	Result
Locations	694
Mean	18.0 acre-feet
Sum	12,516 acre-feet
Median	2.5 acre-feet
Percentile 75% (Q2)	5.12 acre-feet
Percentile 25% (Q1)	1.45 acre-feet
Range	1 – 4,882 acre-feet

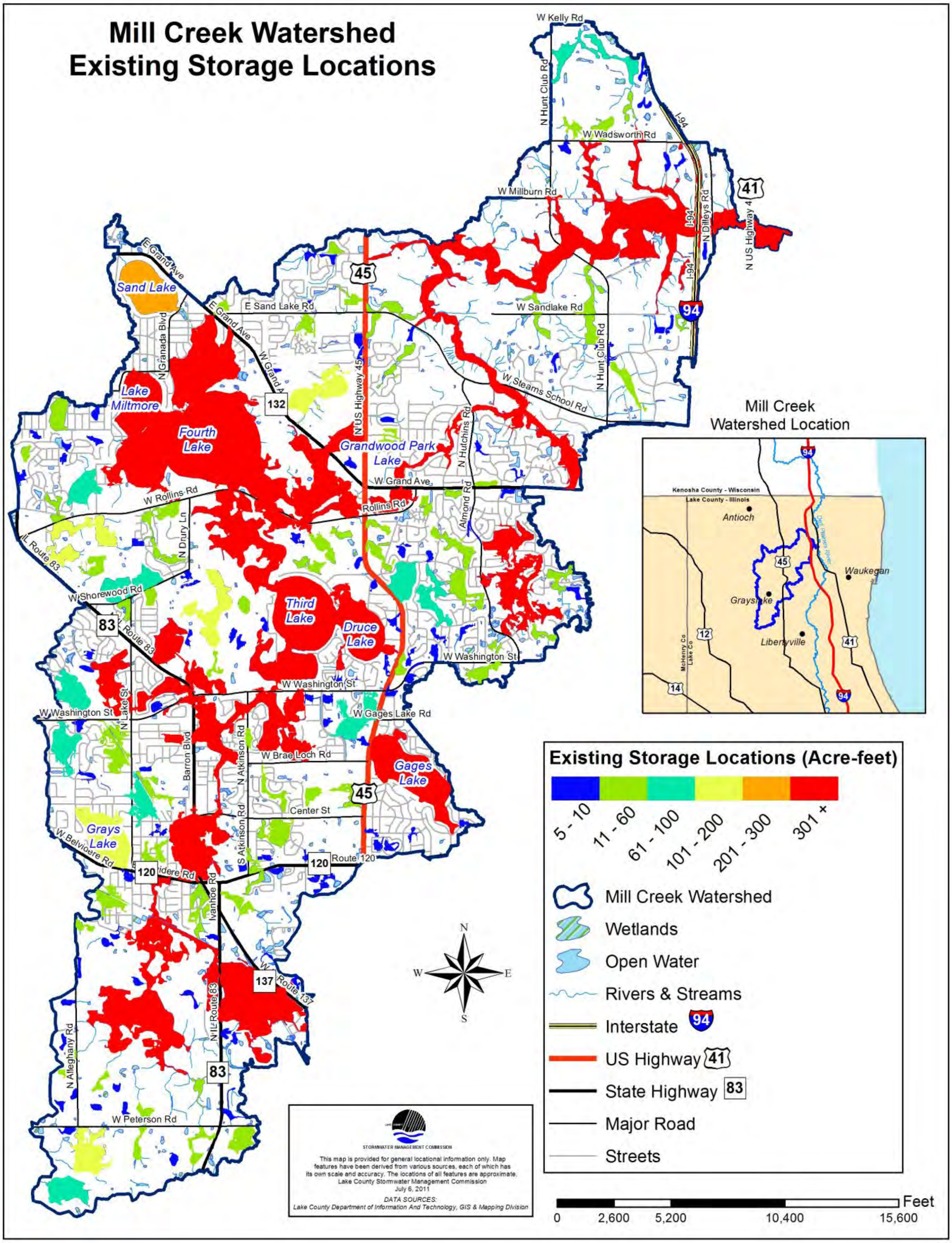


Figure 5-5: Existing Flood Storage Locations.

5.6.2 REGIONAL STORAGE ANALYSIS

A GIS analysis of the watershed was performed to identify regional storage locations and potential regional storage locations. The methodology for the analysis is in Appendix K.

Regional Storage Location: Depressional locations greater than 5-acres in size, with at least 100-acres of tributary area and located within "Open Space" that includes agricultural, forest, grassland, public/private open space, and water (excluding open water lakes and large wetland complexes). These sites provide storage and could be modified to increase storage but mostly include regulated wetlands.
Potential Regional Storage Location: Regional storage locations that do not include Lake County Wetland Inventory mapped wetlands. Flood storage could potentially be enhanced or created with the construction of berms and moderate grading and excavation.

Regional storage locations are depressional areas in the watershed that are within open space land use and are not currently classified as large lakes or large wetland complexes. Locations must be greater than 5-acres in size and have at least 100-acres of tributary drainage area.

Fifty-three sites were identified based on the defined regional storage criteria and forty-four provide existing storage of an estimated 1,704-acre-feet (**Figure 5-6** and **Table 5-11**).

In order to identify potential storage locations, all regional storage locations that included Lake County Wetland Inventory mapped wetlands were excluded. As a result, ten sites were found to be potential regional storage locations, it is estimated that up to 170 acre-feet of additional storage could be gained by constructing berms up to 2-feet in height and performing moderate grading and excavation. Additional storage volumes could be gained with larger berm structures or engineering solutions. Chapter 6 further details implementation actions regarding the identified potential regional storage locations.

Table 5-11: Regional Storage Analysis Results.

Site ID	Estimated Existing Storage (acre-feet)	Existing Lake County Wetland Inventory?	Estimated Potential Storage (acre-feet)
1	11	Yes	--
2	12	Yes	--
3	34	Yes	--
4	75	Yes	--
5	35	Yes	--
6	28.75	Yes	--
7	37.5	Yes	--
8	34.5	Yes	--
9	11	Yes	--
10	12.5	Yes	--
11	10.5	Yes	--
12	66.5	Yes	--
13	10.5	Yes	--
14	23.25	Yes	--
15	114.5	Yes	--
16	10	Yes	--
17	58.75	Yes	--
18	151	Yes	--
19	95.5	Yes	--
20	75.25	Yes	--
21	84.5	Yes	--
22	162.25	Yes	--

Site ID	Estimated Existing Storage (acre-feet)	Existing Lake County Wetland Inventory?	Estimated Potential Storage (acre-feet)
23	3.25	Yes	--
24	3	Yes	--
25	6	Yes	--
26	171	Yes	--
27	9	Yes	--
28	29.5	Yes	--
29	21	Yes	--
30	10.98	Yes	--
31	9.4	Yes	--
32	5.55	Yes	--
33	6.175	Yes	--
34	52.325	Yes	--
35	14.95	Yes	--
36	23.25	Yes	--
37	11.875	No	40
38	45.25	Yes	--
39	11	Yes	--
40	44.25	Yes	--
41	12.25	Yes	--
42	35.55	Yes	--
43	16.15	Yes	--
44	8	Yes	--
45	--	No	35
46	--	No	12
47	--	No	25
48	--	No	11
49	--	No	10
50	--	No	13
51	--	No	9
52	--	No	8
53	--	No	8

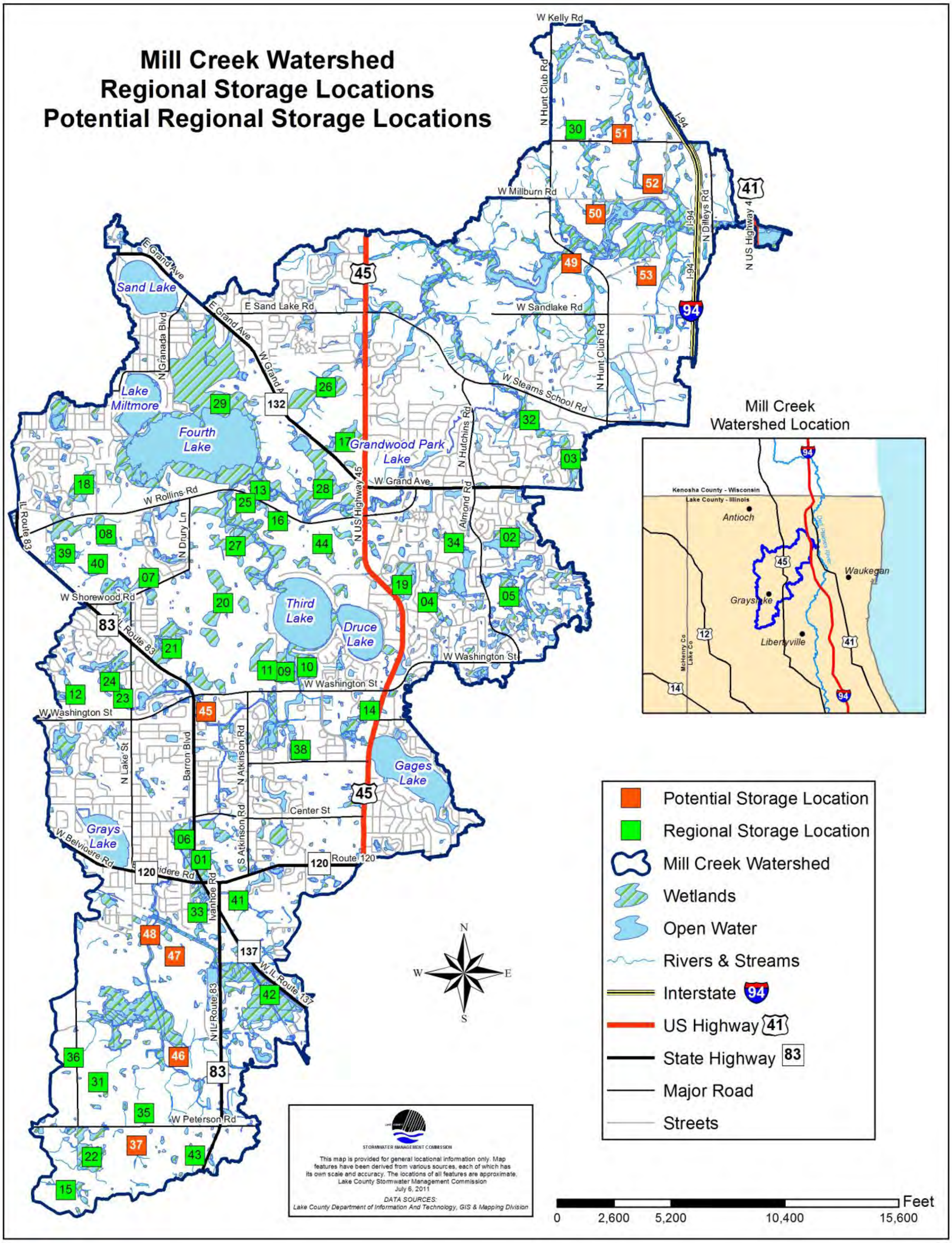
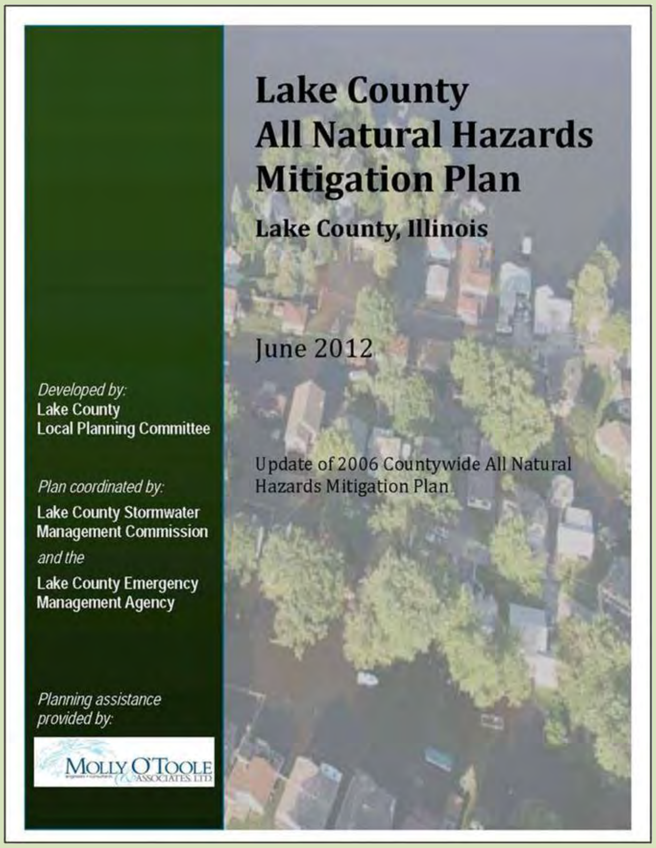


Figure 5-6: Regional and potential storage locations.

Noteworthy: All Natural Hazards Mitigation Plan



Hazard Mitigation: any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event.

The multi-jurisdictional Lake County All Natural Hazards Mitigation Plan (ANHMP) is a plan that addresses natural hazards that may impact Lake County, such as floods, severe summer storms, winter storms and tornadoes, and identifies activities that can be undertaken by both the public and the private sectors to reduce safety hazards, health hazards, and property damage caused by natural hazards.

Mitigation strategies include preventative measures, property protection, natural resource protection, emergency services, structural measures, and public information.

The entire Mill Creek Watershed is covered by the ANHMP as all watershed communities participated in developing and adopting the plan. Communities review the plan, hazards encountered, and action items every year at an annual meeting to evaluate plan progress and recommend updates. The ANHMP will be formally updated every five years and submitted to FEMA approval.

The Disaster Mitigation Act of 2000 (DMA 2000) states that in order to be eligible for Hazard Mitigation Grant Program (HMGP) or pre-disaster mitigation (PDM) project funds, a community must have a Multi-Hazard Mitigation Plan that is approved by FEMA. Communities that fail to prepare an individual mitigation plan or participate in the preparation of a multi-jurisdictional mitigation plan are potentially passing up grant funding to reduce or eliminate damages from natural disasters.

References

Huff, F. A. and J. R. Angel. 1989. "Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois." Illinois State Water Survey, Bulletin 70. Champaign. Illinois State Water Survey.

Association of State Floodplain Managers. May 2007. "Coastal No Adverse Impact Handbook." Madison, WI. Available for downloading free from the Association of State Floodplain Managers' website: http://www.floods.org.

Content

Tables and Figures

Common Acronyms/Abbreviations Used in Chapter 6

BMP – Best Management Practice
CMP – Corrugated metal pipe (culvert)
EQIP – Environmental Quality Incentives Program
FES – Flared End Section, outlet/inlet section of pipe that expands and opens outward to reduce scour
FPAI – Flood Problem Area Inventory
Illinois EPA – Illinois Environmental Protection Agency
SMC – Lake County Stormwater Management Commission
WASCB – Water and Sediment Control Basin

6. PRIORITIZED ACTION PLAN

This chapter presents specific recommended action items developed jointly by the watershed stakeholders, Lake County Stormwater Management Commission, and the consultant planning team. The critical implementation partners for the watershed are identified in Section 6.1.

> **Noteworthy:** Critical Areas
>
> Critical areas are four catchments that meet a series of established criteria and are designed to serve as priority zones for project implementation. They also include severe eroding shorelines, severe eroding streambanks, impaired lakes and highly erodible row crop lands.

There are three primary types of action plan recommendations presented in this chapter: 1) programmatic actions, 2) ***critical area*** analysis site-specific actions and 3) site-specific and basin-wide project actions. The action plan recommendations identify specific locations for projects and activities recommended for implementation at the watershed scale.

1) "Programmatic Actions" represent program, project and regulatory actions that are applicable throughout the watershed, the actions are based on achieving the goals and objectives of the watershed plan as outlined in Chapter 2.

2) "Critical Area Actions" identify critical areas to focus actions. These areas include the four critical catchments identified in the Chapter 4 critical areas analysis, severe eroding lake shorelines, severe eroding streambanks, impaired lakes, and row crop lands with highly erodible soils. Actions implemented in these critical areas will provide the greatest value and benefit to the watershed.

3) The "Project Specific Actions" address additional site-specific opportunities or issues that have been identified throughout the watershed. Site-specific projects were identified through a field survey, by local stakeholders and agency staff, and are based on observations. Basin-wide site-specific practices were identified using existing map data and have not been field verified; they do represent actual locations where recommended Best Management Practices (BMPs) are applicable. Overall, these site-specific actions are the result of watershed assessment activities, a detailed analysis of existing watershed data, and stakeholder input.

The action tables within this chapter include information regarding each action that includes: 1) priority, 2) cost estimate (if applicable), 3) lead partners and support partners (if applicable), 4) recommended implementation timeframe. Priority was assigned to each action item and classified as high (H), medium (M), or low (L). These rankings were based on factors that included lead partners, land ownership, costs, technical requirements and other action specific issues. Medium and low priority projects should not be disregarded because, in many cases, while assessed funding availability, technical assistance or other shortcomings may result in an action being classified as medium or low, circumstances or conditions may change with time. Timeframe is an indicator of when the action item should be implemented and whether it is an on-going action or not. The three timeframe classifications include: Short (1-5 years), Medium (6-10 years), and Long (10+ years).

This chapter serves only as a starting point for watershed implementation projects. It is designed to be a "kick start" to move quickly into implementation. As the plan is implemented and adapted over time, it is expected that additional projects will develop as the planning and implementation process continues. Chapter 7 outlines an implementation strategy for the Action Plan and Chapter 8 identifies outreach and education recommendations that will provide watershed stakeholders with the knowledge and skills necessary to implement the watershed plan.

6.1 IMPLEMENTATION PARTNERS

Lead Partners: Identify the lead public or private landowner, agency or other stakeholder with the greatest potential to implement the action.
Support Partners: Include parties that could be involved in assisting in the action implementation related to regulation, permitting, coordination, technical needs, and funding assistance.

Throughout the prioritized action plan tables and narrative, responsible parties are suggested for taking the ***lead partner*** role or providing a ***supporting partner*** role in plan implementation. This section presents the responsible parties as well as a brief description of their role. **Table 6-1** provides a concise reference or key of implementation partners for reviewing the programmatic and site-specific action plan tables that follow. Partners that have been identified in bold represent partners that have technical expertise to assist in plan implementation, which is further outlined in Section 7.6. Implementation partners do not necessarily have the resources at this time to complete a recommendation, but through coordination with other partners, grant funding, and more these recommendations can be become a reality.

Table 6-1: Key implementation partners.

Acronym	Responsible Party	General Responsibility
AFDD	**Avon-Fremont Drainage District**	**Maintain conveyance, stability, and function of drainage ways within district boundaries.**
AG	Agricultural Producers	Management and operation of cropped and other agricultural lands.
CL	**Conserve Lake County**	**Conservation @Home program and private land conservation easements.**
CLC	**College of Lake County**	**Educate adults in the watershed, maintain property.**
CMAP	**Chicago Metropolitan Agency for Planning**	**Technical and planning assistance, training, and funding assistance.**
CBL	Corporate and Business Landowners	Grounds management and maintenance.
DH	Developers and Homebuilders	Land development, stormwater management system design and construction.
DOT	Departments/Divisions of Transportation, including State, County, Municipal, and Township Highway and Streets Departments	Maintain, design and construct roadways in the watershed including stream, lake and wetland crossings.
EQ	Equestrian Facilities	Owners, managers, operators, tenants, and users of equestrian facilities and land uses.
EXT	**County Extension Service**	**U of I program provides education and technical support.**
FEMA	**Federal Emergency Management Agency**	**National Flood Insurance Program, floodplain mapping and enforcement, and mitigation funding.**

Acronym	Responsible Party	General Responsibility
IDNR	**Illinois Department of Natural Resources**	**Natural area preservation and management, research, technical and financial assistance.**
IEMA	**Illinois Emergency Management Agency**	**Flood and disaster planning, emergency response, and hazard mitigation.**
Illinois EPA	**Illinois Environmental Protection Agency**	**Water resource monitoring, pollution regulation and control, project funding.**
ISWS	**Illinois State Water Survey**	**Flood risk modeling and floodplain mapping.**
HOA/POA	Homeowners Associations/Property Owners Associations	Management of common areas and natural and constructed drainage system.
LA	Lake Associations	Lake management for water quality and recreation.
LCFPD	**Lake County Forest Preserve District**	**Manage and maintain green infrastructure, natural areas, and open space.**
LCHD	**Lake County Health Department**	**Monitor, manage, and provide technical support for water resources.**
LCPBD	**Lake County Planning Building and Development**	**Land use planning and permitting for unincorporated areas, natural resources, drainage system management.**
LCPW	Wastewater Treatment Facility and Collection System	Maintain wastewater treatment regulatory standards.
SMC	**Lake County Stormwater Management Commission**	**Technical and financial assistance for flooding, watershed planning, and water quality.**
M	Municipalities (all departments)	Land use and development, technical and financial support, and drainage system management.
NGRREC	National Great Rivers Research and Education Center	Stream, lake, wetland, and coastal data collection, watershed education and outreach.
NRCS/SWCD	**Natural Resources Conservation Service / Soil and Water Conservation Districts**	**Provide natural resource management technical and financial assistance.**
Nursery	Nursery and Landscaping Business	Grow and maintain landscaping plant materials that includes irrigation or watering and storage of equipment and materials.
PD	Park and Recreation Districts	Management and maintenance of parks and open space.
PRL/RL	Private Residential / Riparian Landowner	Land management and maintenance including stream channels and riparian corridors.
SI	Schools and Institutions	Schools and institutions with large properties or campus settings.
SWALCO	Solid Waste Agency of Lake County	Implements the Lake County Solid Waste Management Plan.
T	Townships	Road maintenance and support for watershed improvement project.
TOLLWAY	Illinois State Toll Highway Authority	Road maintenance and support for Illinois toll roads.
USACE	**US Army Corps of Engineers**	**Wetland protection and regulation, wetland restoration funding.**
USDA	**United States Department of Agriculture**	**Farmland and natural resource technical and financial assistance.**
USEPA	**US Environmental Protection Agency**	**Water resource monitoring, pollution regulation and control, technical assistance, and project funding.**
USFWS	**US Fish and Wildlife Service**	**Threatened and endangered species, technical and funding assistance for habitat restoration.**
WPC	Watershed Planning Council	Coordinate watershed plan implementation, education and outreach.

6.2 PROGRAMMATIC ACTION PLAN

The programmatic action plan includes recommended and suggested watershed improvement actions that are applicable throughout the entire watershed. The actions are designed to meet the goals and objectives of the watershed plan and are categorized by each goal. Many of the actions below are recommended for implementation at a specific watershed location in the site-specific action plan.

Goal 1: **Flooding:** Reduce flood damage to structures and infrastructure and prevent increased flood damage in the watershed.

Outcome: Future floods have minimal adverse effect on structures and infrastructure.

Table 6-2: Flooding programmatic actions.

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
1.A	Depressional Areas Preservation	Evaluate, preserve and enhance the flood storage functions of existing depressional areas in open and undeveloped parcels.	2,3,4	H	SMC, LCPBD, PD, LCFPD	M, T, IDNR, WPC	S - L
1.B	Riparian Area Preservation	Evaluate, preserve and enhance the flood storage functions of riparian zones in open and undeveloped parcels.	2,4	H	RL, LCPBD, M	SMC, IDNR, LCFPD, WPC	S - L
1.C	Flood-proofing Infrastructure and Structures	Mitigate flood damages by flood-proofing or elevating at-risk structures.		H, M	PRL, M, SMC, LCPBD	FEMA, IEMA, DOT	S - L
1.D	Voluntary removal of flooded structures	Consider opportunities for voluntary buyouts of repetitively flood-damaged structures.		H	PRL, SMC	LCPBD,M, IEMA	S - L
1.E	Sanitary Sewer Backups	Remediate aging and failing sanitary sewer lines that cross-connect with stormwater and seasonally high groundwater tables.	2	H, M	M, T, PRL, LCPW, NSSD, LCPBD	LCHD	S - L
1.F	Sump Pumps and Downspouts	Petition and lobby municipalities, communities and county to develop standards or ordinances that allow and encourage sump pump and downspout discharges into lawn, rain gardens/barrels or infiltration basins.	3	H, M	SMC, LCPBD, M, T WPC	DH, HOA, POA	M
1.G	Stream Inspection and Maintenance Program	Develop and implement a stream inspection and maintenance program throughout the watershed. Remove accumulated debris (woody and otherwise) to American Fisheries	3,4	H	SMC, M, LCPBD, AFDD, LCFPD, RL	T, DOT, LCPW	S

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
		Society standards. Maintains conveyance and reduces flood and scour damage to infrastructure.					
1.H	Inspection and Maintenance Program	Develop dam and weir inspection and maintenance guidance and implement a regular inspection and maintenance program for dams and weirs.		H	IDNR, LA, HOA/POA, M, CBL	SMC	S
1.I	Utilize Two-stage Channels	Two-stage channels maintain drainage from farmlands, improve habitat and increase channel conveyance. Develop technical specifications with the NRCS so that USDA can provide financial and technical support.	2,3,4	H, M	AG, RL, NRCS, AFDD	Illinois EPA, LCFPD, IDNR, SMC	S, M
1.J	In-Watershed Mitigation	Encourage, require or incentivize in-watershed mitigation for any floodplain or wetland permitting to maintain storage capacity. This may require the establishment of a wetlands mitigation bank in the watershed.	3	M	SMC, USACE	M, T, LCPBD	S
1.K	Floodplain Modeling	Develop consistent floodplain modeling based on anticipated future build-out land-use conditions in order to further develop flood mitigation and prevention priorities.	3	M	SMC	M, LCPBD	M
1.L	Floodplain Regulations	Consider modifying Lake County floodplain regulations to prohibit building in the 100-year floodplain.		M	SMC, M, T LCPBD		S
1.M	Flood Risk Modeling	Review/study the effect of changing precipitation patterns in northeast Illinois on flood risk.		M	ISWS, FEMA, IDNR	SMC	S

Goal 2: **Water Quality:** Improve and protect water quality in streams, lakes, ponds and wetlands within the Mill Creek Watershed.

Outcome: Lakes are removed from the impaired list, prevent additional water resources from being added to the impaired list; and overall water quality is improved. Pollutants of concern include: chloride, low dissolved oxygen, fecal coliform, total suspended solids and heavy metals.

Table 6-3: Water quality programmatic actions.

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
2.A	Stabilize Eroding Streambanks	Stabilize severely eroding streambanks, toe and side slopes using bioengineering practices with deep-rooted native plants or energy-dissipation BMPs where applicable.	4	H	M, AFDD, RL	USACE, Illinois EPA, SMC, LCFPD, T DOT	M
2.B	Stabilize Eroding Lake Shorelines	Stabilize eroding lake shorelines. Consider replacing riprap, concrete and turf grass shorelines with deep-rooted native landscaping and bioengineering where possible.	4	H	LA, M, HOA/ POA, CLC	LCPBD, SMC, Illinois EPA, DH	M
2.C	Stabilize Eroding Detention Basin Shorelines	Stabilize eroding detention basin shorelines. Consider replacing rip rap, concrete, and turf grass shorelines with deep-rooted native landscaping and bioengineering where possible.	4	H	CBL, HOA, M, LCPBD, SI	SMC, Illinois EPA, DH	M
2.D	Filter Strips and Stream Buffers	Establish/enhance minimum 50-foot filter strips and buffers along stream corridors, drainage ways, wetlands, lakes and other high quality areas.	4	M	AG, PRL/RL, EQ, PD, CBL	USDA, NRCS/SWC D, SMC, Illinois EPA	S - L
2.E	Stormwater Management Structure Retrofitting	Retrofit and naturalize existing stormwater detention basins to improve water quality and minimize nuisance wildlife (Canada geese).	3,4	M	DH, CBL, HOA/POA, SI	M, T, LCPBD, SMC, PD	S
2.F	De-icing BMPs	Establish and publish watershed-wide recommended guidance for winter de-icing BMPs including road salt application rates and methods. Perform outreach to applicators.	4	H	LCPBD, DOT, CBL, SI	M, T, SMC, LCHD, Illinois EPA	S
2.G	Agricultural Best Management Practices	Promote and implement agricultural best management practices to reduce nutrient and sediment loading from agricultural lands.	4	H	AG, USDA, NRCS/SW CD	Illinois EPA, SMC	S, M
2.H	Wetland Creation and Restoration	Create wetlands or restore existing to filter runoff and improve water quality (Locations further defined in site-specific plan.).	1,3,4	M	AG	NRCS, Illinois EPA, USACE, SMC	M

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
2.I	Fertilizer Ordinances	Consider ordinances or policy to limit the availability/use of fertilizers with phosphorus by homeowners in urban areas, especially in lake drainage areas.	4	M	M, LCHD, Illinois EPA	LCPW, LCPBD, T, SMC	S
2.J	Septic Systems	Develop outreach and inspections and consider a cost-share mechanism to help private property owners upgrade aging systems or fix failing septic systems.		M	M, T, LCHD, PRL	LA	M
2.K	Water Quality Monitoring Program	Implement a watershed wide water quality- monitoring program to assess whether water quality standards are being met and to evaluate watershed implementation effectiveness.		M	M, LCHD, SMC	Illinois EPA, LCFPD	S
2.L	Volunteer Lake Monitoring Programs	Support and continue Lake County Health Department and Illinois EPA's Volunteer Lake Monitoring Programs.		H	LCHD, LA	Illinois EPA, M	S
2.M	Zebra Mussels and Aquatic Invasive Species	Develop program to define and track the presence and intensity of aquatic invasive species within lakes in the watershed. Establish program that funds remedial measures.		H	LCHD, LA, Illinois EPA, USFWS	M, IDNR	S
2.N	Linear Infrastructure	Encourage new infrastructure and improvement projects to incorporate runoff reduction and water quality designs and BMPs	1,3,5	H	DOT, M, T	SMC, LCPBD	S
2.O	Pharmaceutical Disposal	Establish pharmaceutical disposal center(s) or a system to collect unused pharmaceuticals so they are not disposed of in drains and toilets.		M, L	SWALCO, LCHD, Illinois EPA	M, T, LCPW, Pharmacies	M
2.P	Grassed Waterways and Swales	Install and maintain grassed waterways and swales for drainages in agricultural fields, equestrian areas and nurseries.	1,3	H	AG, EQ, Nursery	USDA, NRCS/SWCD	S
2.Q	Lake Aeration Systems and Nutrient Inactivation	Consider the application of nutrient inactivation and dissolved oxygen enhancement techniques in lakes with known problems.		L	LA, Illinois EPA	LCHD, IDNR	M
2.R	Retrofit Existing Swales	Where feasible, retrofit existing swales and open drainage-ways to infiltrate runoff with natural landscaping.		M	PRL, HOA/ POA, CBL, DOT	DH, SMC, Illinois EPA, RP	S
2.S	Stabilize and Retrofit Stormwater Outfall Structures	Stabilize and retrofit stormwater outfall structures and the associated streambanks and channel.			M, T, DOT, HOA/ POA, AFDD	SMC, LCPBD,	S

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
2.T	Bioretention	Install bioretention practices to capture rooftop runoff, and filtration practices (sand, filtration basins, treatment wetlands, other filtration practices) downstream of government maintenance, industrial and commercial facilities; transportation runoff collection points; and other land uses potentially generating a heavy load of pollutants.		H, M	DH, CBL, DOT, M, LCPBD, SI	SMC, Illinois EPA, RP WIN	M
2.U	Lake-specific TMDLs and Plans	Establish total maximum daily loads (TMDLs) of priority nutrients and pollutants for each of the lakes in the watershed. Regulate so that loading thresholds are not exceeded for each lake.		M	Illinois EPA	LCHD, SMC, LA	M
2.V	Toxic Sediment	Perform an evaluation of existing data and information in the watershed to identify sites with the possible presence of toxic sediment. Identify the sites, potential contaminants of concern, human and ecological health risks, potential responsible parties. Pursue investigation and remediation if human and/or ecological risks likely.		M	LCHD, Illinois EPA, LA	CBL	M
2.X	Determinative Modeling	Develop watershed-wide model of continuous water quality and flow to evaluate effects of climate and land change on aquatic habitat, water quality and water quantity.	1,3,4	M	ISWS	SMC, USFWS. Illinois EPA, LCHD	M

Goal 3: **Stormwater Management and Drainage:** Reduce and manage stormwater runoff through the use of Best Management Practices, infiltration, detention and conveyance systems.

Outcome: Lower volume of stormwater runoff reaching natural resources and maintain an adequately functioning drainage system.

Table 6-4: Stormwater/drainage programmatic actions.

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
3.A	Stormwater Inspection and Maintenance Program	Monitor, maintain, and clean out stormwater detention facilities, storm drains and catch basins to ensure effective operation and provide maximum detention, water quality benefits and habitat. Develop a monitoring and maintenance plan that identifies who is responsible, a schedule, budget and funding source.	1	H	M, DH, CBL, CLC, HOA/POA	PD, SMC	S
3.B	Stormwater BMPs	Install stormwater green infrastructure BMPs in new and existing developments. Reduce sole use of centralized detention ponds and replace with distributed infiltration-based stormwater management system using bioretention practices. Consider applying lot- level infiltration practices in addition to overall development practices with a goal of keeping all of the precipitation that falls on a lot either infiltrated or evaporated at the lot level.	1,2	H	DH, PD, CBL, M, LCPBD, HOA/POA, Schools, CLC	SMC	M
3.C	Baseflow Preservation/ Drought Protection	Through a monitoring and modeling effort, develop a baseline annual hydrograph for Mill Creek. Preserve baseflow conditions of Mill Creek.	4	H	ISWS, IDNR	USFWS, SMC, Illinois EPA, WPC	M
3.D	Maintain Existing Infiltration Functionality	Maintain infiltration functionality of areas with high infiltration soil types as undisturbed open space features in developing/redeveloping sites.	1	H	DH, M, LCPBD	SMC	S
3.E	Infiltration Policy	Modify ordinances or develop countywide or jurisdictional-level incentives for including infiltration requirements for new developments.	1	H	SMC, M, LCPBD	DH	S
3.F	Native Landscaping	Requirements or incentives for native landscaping in open space areas of new and existing development. Use of deep-rooted native vegetation and native trees wherever possible will benefit hydrology and water quality.	2,4	M	M, PD, LCPBD, SMC	DH, PD	S-M

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
3.G	In-Watershed Mitigation	Identify potential wetland mitigation banking sites in the watershed and encourage private and/or public investment for in-watershed mitigation.	1,4	M, L	SMC, USACE, LCPBD	LCFPD, M	L
3.H	Minimize Impervious Surfaces	Jurisdictions require that developers demonstrate measures taken to minimize impervious surfaces (i.e. parking ratios, multi-level parking, permeable surface parking, reduced street widths, and sidewalks on one side of street, etc.).	1,2	M	DH, M, LCPBD	CBL, SI	M
3.I	Curb and Gutter Retrofit	Retrofit curb and gutter areas along roadways, parking lots, and other impervious surfaces to allow stormwater to enter swales or other naturalized drainage-ways. Use porous pavement or retrofit raised landscape beds adjacent to impervious surface to depressed landscaping as parking lots are being refurbished to reduce stormwater runoff.	1	H, M	CBL, DOT, M, T, LCPBD, SI	DH, SMC, Illinois EPA	M
3.J	Green Roofs	Promote and install green roofs where feasible and practical to capture, filter and evaporate stormwater.	1,2	L	DH, CBL, PRL	M, LCPBD	L
3.K	Non-Functioning Drainage Tile Removal	Disable and remove non-functioning drainage tiles following feasibility study to evaluate potential impacts to neighboring properties.	1	M	LCFPD	SMC	S-L
3.L	Sump pumps	Remove sump pump direct connections to waterways and sewers.		H	M, PRL		S-L

Goal 4: **Natural Resources and Green Infrastructure:** Protect and restore the natural resource components of the watershed, including wetlands, lakes, ponds, and streams and the upland components including prairies, savanna and woodland landscapes, developing a functioning green infrastructure system.

Outcome: Natural resources are protected, establishing a series of interconnected hubs and corridors that work to preserve the high quality natural areas and natural hydrology of the watershed.

Table 6-5: Natural resources/green infrastructure programmatic actions.

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
4.A	Conservation Design Development	Establish guidelines, ordinances or incentives for development design to incorporate, protect and enhance open space, green infrastructure and natural resources.	1,2,3	H, M	LCPBD, M	DH, SMC	S
4.B	Restore Degraded Natural Communities	Restore and manage existing preserved lands to natural ecosystem health and function. This includes restoring hydrology and native plants and managing invasive species.	2,3	M	LCFPD, PD, HOA/POA	IDNR, SMC, USFWS	S, M, L
4.C	Riparian Buffers	Maintain, establish and expand native riparian buffers throughout the watershed.	2	H	M, RL, LCPBD	SMC, IDNR, LCFPD, Illinois EPA	S - L
4.D	Open Space Preservation	Develop a preservation strategy to protect open space and high priority green infrastructure lands not readily protected through public ownership or by zoning including the natural drainage system of stream corridors and wetland complexes. The strategy may include purchase funds, developer fees and donations, conservation easements, purchase of development rights programs, or other measures. Target a maximum of 50% of the watershed in impervious land use.		H	CL, M, T, LCFPD, PD LCPBD	CMAP, IDNR, SMC, CBL, HOA/POA	S
4.E	Corridor and Passive Recreation Preservation	Develop environmental corridor and trail connections between new and existing forest preserves with community environmental corridor and trail systems, on private land, and using equestrian trail connections.		H, M	DOT, LCFPD, PD, M, T, LCPBD	HOA/POA	S-L
4.F	Linear Transportation and Utility Corridors	Incorporate naturalized drainage, landscaping, detention and wildlife crossings into infrastructure projects.	1,2,3	H	DOT, M, T	LCFPD, SMC	S-L

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
4.G	Wildlife Infrastructure Crossings	Identify wildlife crossing problem areas and develop solutions to be incorporated into future projects.		M	DOT, M	SMC, USFWS	M-L
4.H	Degraded Stream Channel Restoration	Restore stream channels, streambeds and aquatic habitat to a healthy condition. This includes in-stream habitat features, such as natural channel substrates and pools and riffles to improve water quality and aquatic biodiversity.	2	H, M	PRL/RL, AFDD, LCFPD	USACE, IDNR, Illinois EPA, M, SMC	S
4.I	Lake Management Plans	If not already completed, develop lake management plans/diagnostic studies that address water quality, invasive species, fisheries and recreational use. Can be done in conjunction with Lake TMDLs (2.U).		H, M	LA, IDNR,	CLC, CMAP, LCHD, M, PD	M
4.J	Aquatic Invasive Species Awareness	Promote invasive species awareness at public boat launches regarding boat transport, live-well water and use of live bait. Establish a zebra mussel and invasive species reporting and monitoring system.	2	H	LA, IDNR, LCHD	M, PD	S
4.K	Restore and Enhance Natural Areas on Agricultural Lands	On private lands, work with non-profit organizations and USDA programs such as CRP, CREP, WRP and EQIP to re-restore/enhance natural areas.	2	H, M	RL, AG, CL	IDNR, USDA, NRCS/SWCD, Illinois EPA	L
4.L	Under Utilized Space	Consider restoring and enhancing disregarded or under-utilized space at commercial, industrial and residential developments (e.g. fenced property perimeters and common grounds) with stormwater green infrastructure practices.		M	DH, M, HOA/PO CBL, SI	Illinois EPA, LCPBD, SMC	L
4.M	Adopt Green Infrastructure Plan and Strategy	Land planning jurisdictions such as municipalities, park districts etc. adopt a Green Infrastructure Plan based on the watershed Green Infrastructure Plan to use as a tool in prioritizing and implementing green infrastructure preservation and restoration programs.	1, 2, 3	H	M, T, SMC, LCFPD, PD, LCPBD	CMAP, IDNR, DOT, SMC	S
4.N	Green Infrastructure Public Relations	Clearly identify and designate areas prioritized in the Green Infrastructure Plan as green infrastructure conservation areas in county, park district and municipal comprehensive plans and maps.	1, 2, 3	H	M, PD, LCPBD	CMAP, IDNR, LCFPD, DOT	S

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
4.O	Identify and Assign Green Infrastructure Leaders	Identify and designate a lead person from each jurisdiction to serve as a watershed green infrastructure plan coordinator to participate in periodic meetings with other community partners to identify collaborative opportunities and strategies to protect and connect green infrastructure corridors.		H	CL, DOT, M, T, PD, LCPBD, SMC	CMAP, IDNR	S
4.P	Sensitive Land to Passive Land Use	Convert highly erodible land areas, 10-year floodplain and lands adjacent to ADID wetlands into passive land use practices.	1, 2	M	AG, EQ, LCFPD	NRCS/SWCD, SMC, USDA	M-L

A Green Infrastructure System composed of large hubs of green infrastructure connected by corridors is proposed in this action plan as reflected **Figure 6-1**. This proposed green infrastructure system includes both private and public lands that are made up of open parcels and some partially open parcels as described in Chapter 4.

The entire green infrastructure system includes 3,689 acres of larger land hubs, comprising of multiple parcels and including a 50-acre high priority isolated parcel. The corridor system is made up of 42 miles of stream corridors and 108 miles of existing and proposed trails. Sixty-three percent of the green infrastructure hubs are public owned and 37% percent are privately owned.

This mapped green infrastructure system presents a watershed-wide network of green infrastructure, but does not reflect the individual sites throughout the watershed that are recommended for stormwater green infrastructure best management practices. These practices are designed to address stormwater runoff from a particular developed site or area. Because of the numerous opportunities for these types of practices throughout the watershed, these smaller individual sites are not mapped as part of the larger network or system.

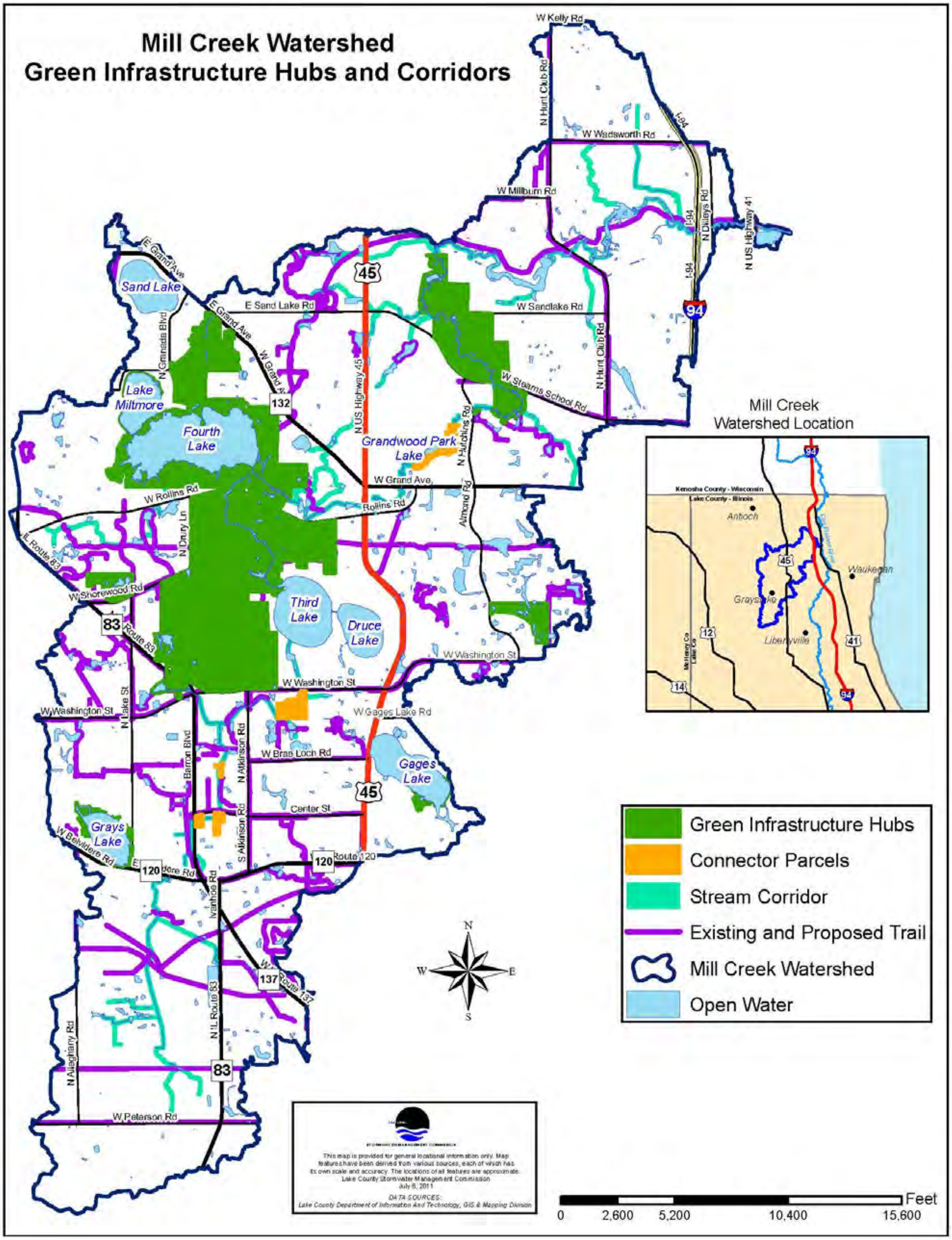


Figure 6-1: Green infrastructure hubs and corridors.

Goal 5: **Education, Outreach, Coordination and Implementation:** Provide watershed stakeholders with the knowledge, skills, resources, stewardship opportunities, and motivation to take action on implementing the watershed plan.

Outcome: Stakeholders have adequate resources to implement the watershed plan.

Table 6-6: Education and outreach programmatic actions.

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
5.A	Green Infrastructure Promotion	Provide education and outreach to residents and jurisdictions that outlines the Green Infrastructure plan and the value of implementing the plan and preserving open space.	4	H	WPC, M, SMC, LCFPD, PD, LCPBD	CMAP, IDNR, DOT, T	S
5.B	Signage	Install signage on primary roads that communicate the watershed boundaries to the public. Include stream name signs at all stream crossings. Incorporate watershed signage and information at public properties such as forest preserves, public parks and public lake boat slips and consider adding distinctive watershed signs with watershed names as an addition to street sign posts on frequently travelled roadways.		H	WPC, DOT, M, T, PD, LCFPD	SMC	S-M
5.C	Technical Assistance	Offer and provide technical assistance towards implementing the watershed plan.		H	WPC, SMC, NRCS/SWCD, EXT	Illinois EPA, CMAP	S
5.D	BMP and Native Plant Community Demonstration Sites	Partner with schools, churches and community to develop natural area demonstration sites for education and recreation opportunities. Showcase stormwater BMPs, the use of native plants and the benefits of invasive species control.	1,2,3,4	M	WPC, SMC		M
5.E	Lake and Stream Stewardship Program	Facilitate public training and engage students, lake associations and homeowner associations in volunteer lake and stream stewardship, monitoring and maintenance.	4	M	WPC, LA, HOA	SMC, Illinois EPA, LCHD	M
5.F	Low Impact Development Guidelines	Publish guidelines and recommended practices for low impact development and specific recommendations that would benefit the unique characteristics of the watershed. Distribute to jurisdictions and developers.		H	WPC, SMC, LCPBD	DH, M	S

ID	Name	Descriptive Action	Other Goals	Priority	Lead Partners	Support Partners	Time frame
5.G	Watershed Report Card	Update all watershed residents with a 5 and 10-year report card that illustrates the ecological health of the watershed and reports progress towards watershed goals.		H	WPC	SMC, Illinois EPA, LCHD	S
5.H	Watershed Introduction Flyer	Develop and distribute a watershed doorknocker flyer that educates the public about the key details of watershed, watershed issues, improvement goals and the importance of watershed health.		H	WPC	SMC, Illinois EPA, LCHD	S
5.I	Producer Outreach	Provide outreach, encouragement and education for agricultural producers (farmers, equestrian, and nurseries). Link producers with technical assistance and funding programs that encourage best management practices and promote conservation easements.		H	NRCS/SWCD, WPC	Illinois EPA, SMC, USDA	S-L
5.J	De-icing Outreach	Provide education and outreach to private property owners and managers who retain contractors for salt application and snow removal to encourage lower application rates; and limit unnecessary salt application.		H	LCHD, SMC	M, T, CBL, PRL, HOA/POA, WPC	S
5.K	Riparian Landowner Outreach	Provide education and training to riparian landowners related to best practices for stream restoration and channel maintenance.		M	AFDD, SMC	RL, NRCS/SWCD, WPD	S-M
5.L	Homeowner Association Outreach	Encourage homeowner association participation in watershed implementation by providing them with information on funding opportunities and support with project development.		M	SMC, WPC		S-L
5.M	Flood Damage Outreach	Provide outreach for the public and specifically residents and businesses affected by flood damage to educate them on the causes of flooding, flood mitigation practices and what can be done to prevent local and regional flood damage.		M	LCPBD, M, SMC	IEMA, FEMA, WPC	S-L
5.N	Establish Watershed Council	Establish representatives from each municipality, township and county along with other agencies and non-governmental partners to form a watershed council.		H	WPC	M, T, SMC	S

6.2.1 REGULATORY AND POLICY ACTIONS

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

An excellent source of information on model development principles and a sample code and ordinance review worksheet can be found in *Better Site Design: A Handbook for Changing Development Rules in Your Community* (Center for Watershed Protection, 1998). In addition, Appendix F includes a self-appraisal checklist that watershed communities may use to evaluate their existing codes and ordinances to identify where regulatory changes and modifications can be made to improve the preservation and use of green infrastructure in the watershed.

During the watershed planning process, stakeholders identified opportunities for policy and regulatory changes to benefit the watershed and address flooding, water quality and natural resource concerns. Recommended opportunities for policy and regulatory review and modification based on stakeholder input during planning sessions devoted to identifying issues and opportunities, development of plan objectives and identifying education and outreach needs are included in the following list of potential regulatory and policy issues along with regulatory and policy issues related to pollution impairments and sustainable transportation practices identified through the watershed assessment process. Recommended actions are included in **Table 6-8**.

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<u>Development and stormwater runoff</u>

- Local land development ordinances should allow and incentivize Low Impact Development standards/practices.
- Offset the effect of future impervious cover to insure that additional impervious cover does not degrade subwatershed management units.
- Reduce the rate and volume of stormwater runoff from areas that are already developed.
- Reduce the rates and volume of runoff from new development – maintain pre-development hydrology.
- Lake County and watershed municipalities will revise watershed development/subdivision ordinances to include credits or incentives for infiltration of precipitation.
- Establish rain garden program(s).
- Communities and the county enact ordinances and standards for sump pump and downspout discharges to be directed to lawn or rain gardens and infiltrated.

<u>Pollution prevention</u>

- Reduce the quantity of road salt (sodium chloride) needed for safe and cost effective winter maintenance to reverse the current trend of rising chloride levels in water bodies.

- Regulate the use of deicing chemicals/practices.
- Regulate and limit the use of lawn chemicals, seal coating, and allow only eco-friendly de-icers.
- Reduce phosphorus loads by watershed municipalities and the county passing an ordinance that bans the use of fertilizer with phosphorus unless a soil test indicates it is needed.

Monitoring and stream maintenance

- Develop and implement a watershed monitoring program to collect and monitor water quality and biological data on a regular basis.
- Establish institutional stream maintenance program and standards using the American Fisheries Society standards as guidelines.

Wetlands and floodplains

- Maintain riparian and depressional floodplain and wetlands to maximize flood storage and conveyance
- Restore and create wetlands where feasible with a minimum target of 10% wetland per Subwatershed Management Unit.

Green infrastructure

- Protect greater than 50% of the watershed as pervious open land by preserving open and partially open space.
- Identify and preserve open space in each Subwatershed Management Unit as green infrastructure or greenways to promote flood damage reduction, water quality improvement, natural resource protection, and wetland restoration.
- Adopt and prioritize Green Infrastructure Plan elements and support implementation of these elements through local land use plans, policies, and maps. Amend local and county zoning ordinances to encourage green infrastructure practices.

Pollution impairments

- Communities should also investigate policy and regulatory opportunities to eliminate the pollution impairments identified in nine watershed lakes. Pollutants identified by the IL EPA that are causing the water quality impairments include: phosphorus, total suspended solids (TSS), low dissolved oxygen (DO) and fecal coliform.

Transportation Sustainability Practices

- Use I-LAST Scoring System for all new roadway expansion and extension projects.
- Practices that reduce runoff volume from roads and parking lots (reduce pavement extent, use porous pavement where appropriate, infiltrate runoff where appropriate).
- Practices that capture and treat runoff.
- Route roadways to avoid waters and wetlands where possible.
- Include environmentally friendly stream crossings that protect aquatic habitat.
- Provide for safe, accessible and connected non-motorized transportation (including underserved and low to moderate income areas with alternative transportation options).
- Consider wildlife crossings.
- Monitor and maintain BMPs post-construction.

- Conduct street sweeping and inlet cleaning.

Table 6-7 illustrates the most significant local entities in the watershed that influence, develop and enforce local policy and regulation. State and federal agencies are not highlighted due to the fact that state and federal regulation and policy change should not be the focus of a locally led watershed planning effort.

Table 6-7: List of important regulatory and policy partners.

Entity	Abbreviation	Jurisdiction
Chicago Metropolitan Agency For Planning	CMAP	County/Chicago Metro Area
Lake County Government Departments (SMC, Transportation, Health etc.)	LCDOT, SMC, LCPBD, LCHD	County
Avon-Fremont Drainage District	DD	Drainage District Area (6.5 mi)
Village of Grayslake	M	Village/Municipality
Village of Gurnee	M	Village/Municipality
Village of Hainesville	M	Village/Municipality
Village of Libertyville	M	Village/Municipality
Village of Lindenhurst	M	Village/Municipality
Village of Old Mill Creek	M	Village/Municipality
Village of Round Lake Beach	M	Village/Municipality
Village of Round Lake Park	M	Village/Municipality
Village of Third Lake	M	Village/Municipality
Village of Wadsworth	M	Village/Municipality
Lake County Forest Preserve District	LCFPD	Forest Preserves
Illinois Department of Transportation	IDOT	State Highways
Illinois Tollway Authority	Tollway	Tollways
Townships (Avon, Fremont, Lake Villa, Newport, Warren)	T	Respective Townships/Roads
US Army Corps of Engineers	USACE	Water of the US (wetlands)

Table 6-8: Regulatory/policy action recommendations.

ID	Action	Priority	Lead Partners	Supporting Partners	Time frame
RP-1	Review and modify land and transportation development standards, practices, code and ordinances for new development and redevelopment low impact development design and green infrastructure practices.	H	M, LCPBD, LCDOT, IDOT, Tollway	SMC	
RP-2	Encourage the use of green infrastructure stormwater best management practices for detention credit.	M	LCPBD, M	SMC	
RP-3	Provide programs with incentives to retrofit existing developed areas with green infrastructure best management practices such as rain gardens.	H	LCPBD, M	SMC, Illinois EPA	
RP-4	Require downspout and sump pump discharges be disconnected from the stormsewer system and be directed to rain gardens or lawn for infiltration.	M	M, LCPBD		

ID	Action	Priority	Lead Partners	Supporting Partners	Time frame
RP-5	Jurisdictions with transportation maintenance authority should have an adopted winter maintenance/ snow and ice removal policy that includes snow removal priorities, practices, products used; and includes that all chemical applicators whether public or private must be registered with the jurisdiction and have appropriate training.	H	M, LCHD, LCDOT, IDOT, T, Tollway, LCFPD	SMC	
RP-6	Ban the use of fertilizer with phosphorus unless a soil test indicates it is needed.	H	M, LCPBD	LCHD	
RP-7	Investigate limiting or banning the use of seal-coating products and lawn pesticides known to runoff and pollute waters.	M	M, LCPBD	LCHD	
RP-8	In compliance with Illinois EPA, establish total suspended sediment (TSS) or other numerical water quality performance standard for new developments and redevelopment in Lake County.	M	SMC	M, LCPBD	
RP-9	Participate in a coordinated watershed monitoring program to collect and monitor water quality and biological data on a regular basis.	M	M, T, LCPBD, LCPW, LCDOT, DD, LCFPD	SMC, LCHD	
RP-10	Cooperatively establish, adopt and implement stream maintenance standards in conformance with American Fishery Society guidelines.	M	SMC, M, LCPBD, AFDD	LCHD, LCFPD	
RP-11	Review effectiveness of wetland regulations and develop watershed-specific provisions if needed.	L	SMC, USACE	M, LCPBD, LCFPD	
RP-12	Require in-watershed (Mill Creek) mitigation for all wetland impacts.	H	SMC, USACE		
RP-13	Map depressional wetlands/floodplain and investigate flood damage in these areas to determine if floodplain development in depressional areas should be restricted for safety reasons.	M	SMC, M, LCPBD		
RP-14	Adopt and prioritize Green Infrastructure Plan elements and support implementation of these elements through local land use plans, policies, and maps. Amend local and county zoning ordinances to encourage green infrastructure practices.	H	M, LCPBD	SMC, LCFPD	
RP-15	Adopt and implement "complete streets" and sustainable transportation policies that are multi-modal and provide safe, accessible and connected non-motorized transportation (including underserved and low to moderate income areas with alternative transportation options)	H	IDOT, M, T, Tollway	LCDOT, LCPBD, LCFPD	
RP-16	Develop and implement roadway design standards that Include environmentally friendly stream crossings that protect aquatic habitat, route roadways away from sensitive waters and wetlands where possible, and consider and incorporate wildlife crossings.	H	IDOT, M, LCDOT T, Tollway		

6.3 CRITICAL AREA ACTION PLAN

Critical areas are defined in **Table 6-9** and include the four critical catchments (defined in Chapter 4), severe eroding shorelines, severe eroding streambanks, impaired lakes and highly erodible agricultural lands. Actions addressing these critical areas will have the greatest value and benefit to the watershed.

Figure 6-2 identifies the locations of the critical areas in the watershed and **Figure 6-3** illustrates the four critical area catchments with jurisdictional boundaries. Throughout the Project Specific Action Plan by jurisdiction (Section 6.4), site-specific actions that address a critical area are highlighted in bold and identified as high priority "H". Jurisdictions can reference **Table 6-9** to evaluate which critical area categories are relevant to them.

Table 6-9: Critical area categories, jurisdictions and general actions.

Critical Area Category	Jurisdictions	General Actions
Critical Catchment W	Village of Grayslake, Unincorporated	Agricultural and urban BMPs, practice low impact development, maintain infiltration and hydrology of catchment, detention basin retrofits.
Critical Catchment H	Village of Gurnee, Village of Grayslake, Village of Third Lake, Unincorporated	Stabilize streambanks and lakeshores, apply agricultural and urban stormwater BMPs, detention basin retrofits.
Critical Catchment A	Village of Wadsworth, Lake County Forest Preserve District (Sedge Meadow Preserve), Unincorporated	Agricultural and urban BMPs, stabilize lakeshores, practice low impact development, maintain infiltration and hydrology of catchment.
Critical Catchment U	Village of Grayslake, Village of Libertyville, Unincorporated	Agricultural and urban BMPs, practice low impact development, maintain infiltration and hydrology of catchment, detention basin retrofits.
Severe eroding lake shoreline	Village of Third Lake, Village of Lindenhurst, Unincorporated	Stabilize severely eroding lake shorelines.
Severe eroding streambank	Lake County Forest Preserve District (Fourth Lake Forest Preserve, Mill Creek Forest Preserve, Sedge Meadows Forest Preserve), Village of Grayslake, Village of Old Mill Creek, Village of Gurnee, Unincorporated, Avon Freemont Drainage District	Stabilize severely eroding streambanks.
Impaired lakes	Lake County Forest Preserve District (Duck Farm Forest Preserve, Fourth Lake Forest Preserve, Rollins Savanna Forest Preserve), Village of Grayslake, Village of Gurnee, Village of Lindenhurst, Village of Round Lake Beach, Village of Third Lake, Unincorporated	Agricultural and urban BMPs, reduce fertilizer applications, practice low impact development, stabilize severe eroding shorelines, filter strips around lake shoreline.
Highly erodible row crop lands	Lake County Forest Preserve District (Brae Loch Golf Club, Fourth Lake Forest Preserve, Rollins Savanna Forest Preserve, Duck Farm Forest Preserve), Village of Old Mill Creek, Village of Gurnee, Village of Lindenhurst, Village of Round Lake Beach, Village of Third Lake, Village of Grayslake, Unincorporated	Implement agricultural BMPs and convert highly erodible crop ground to no-till, grassland, or timber.

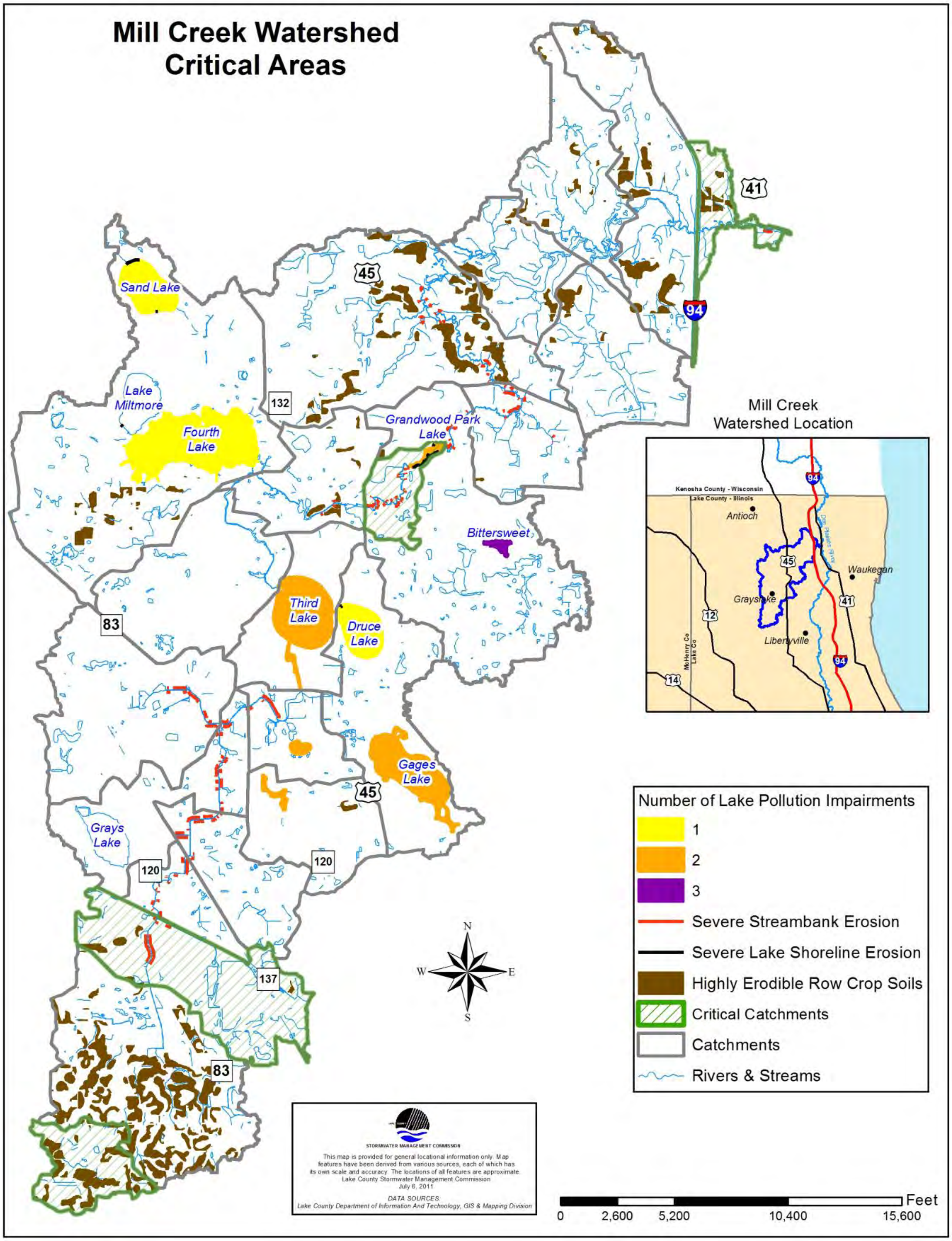


Figure 6-2: Critical areas.

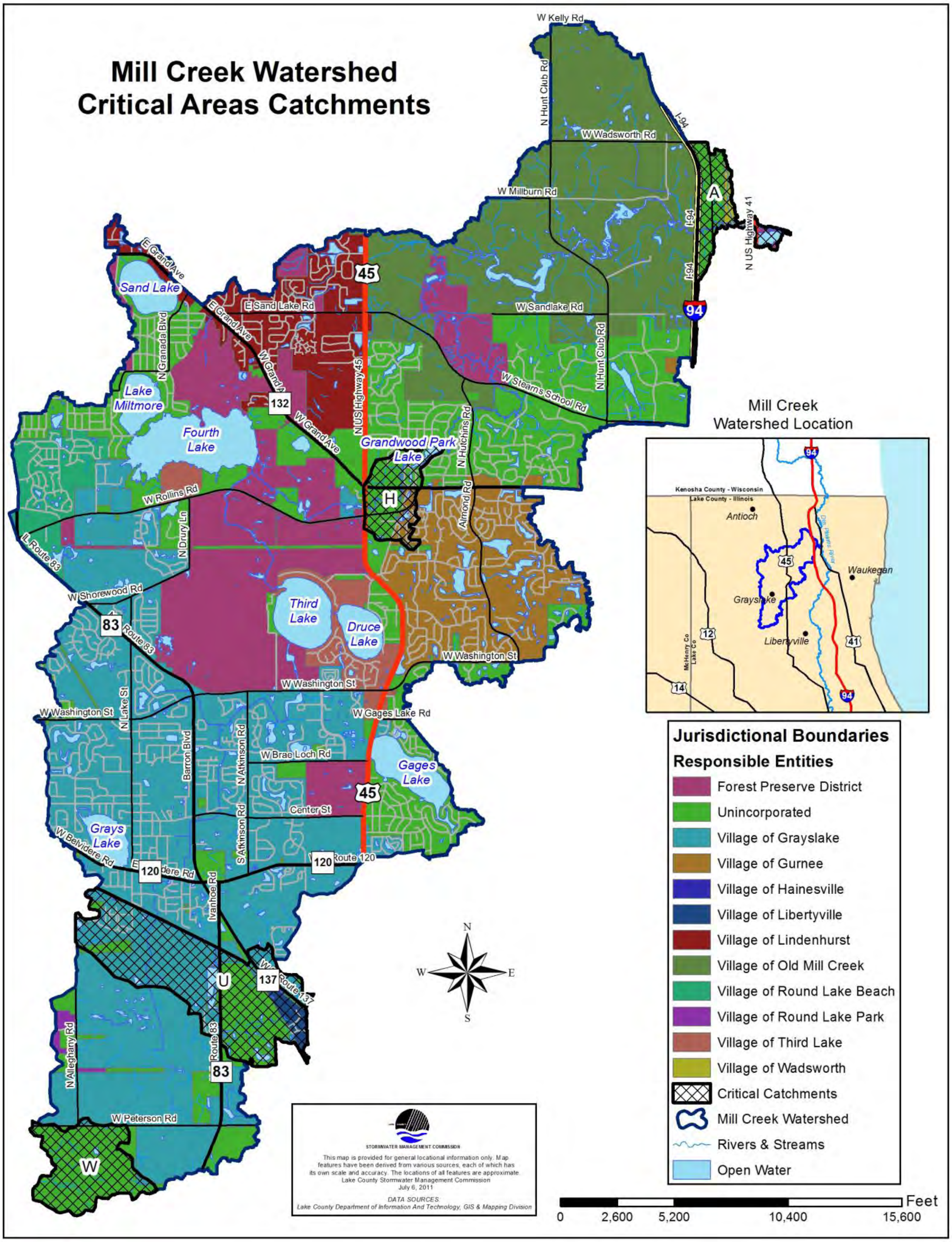


Figure 6-3: Critical area catchments and jurisdictional boundaries.

6.4 PROJECT SPECIFIC ACTION PLAN

Project specific action items and recommendations are tied to a particular location or locations in the watershed. As with the programmatic actions, these site-specific recommendations were developed to address watershed problems, to improve watershed resources and to achieve the watershed goals and objectives.

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

- Direct stakeholder input
- Detention basin inventory
- Stream inventory and assessment
- Lake shoreline inventory and assessment
- Flood problem area inventory
- Flood storage area analysis
- GIS analysis and water quality modeling
- 2013 windshield survey
- Wastewater facility review

> *Noteworthy:* Project Specific Actions
> Site-specific watershed projects/actions include urban and agricultural BMPs, detention basin retrofits, problem hydrologic/hydraulic structure modification, flood mitigation solutions, streambank and lake bank stabilization, and wetland preservation/restoration and creation priorities.

The identification of specific sites suited for watershed improvement projects has been ongoing during the planning process and will continue throughout plan implementation. This chapter is not intended to be a comprehensive inventory of all possible projects in the watershed; it is only intended to provide guidance on where to "kick start" implementation.

For the purposes of this plan, wetland restoration includes only existing wetlands and restoring their natural function, efficiency and biodiversity whereas wetland creation includes creating wetlands where they do not currently exist. Opportunity sites for flood mitigation and regionally significant storage site action recommendations are also highlighted.

The action recommendations are coded by project type category (**Table 6-10**). Actions/projects are summarized with maps and tables by jurisdictions. Within the Jurisdictional sections, actions that address critical areas are bolded.

There are nearly 400 site-specific action recommendations, spanning eleven separate jurisdictions. These actions are outlined in **Table 6-15** through **Table 6-42** and summarized in **Table 6-11**. If implemented, the actions would benefit nearly 10,000 acres and nearly 6 miles of streambank/lake shoreline. Project locations are illustrated by jurisdiction in **Figure 6-7** through **Figure 6-19**. Flood storage, flood problem mitigation and wetland restoration project locations are shown on **Figure 6-4**, **Figure 6-5** and **Figure 6-6**, respectively.

Table 6-10: Site specific action categories.

Project Specific Action Category	ID Code	Description
Site-specific best management practice projects	SS + ST	Site-Specific (SS) and Stakeholder Recommended (ST) project recommendations are based on coordination with stakeholders and project opportunities identified during a windshield survey. The practice applies to a very specific single location on the ground.
General site-specific BMPs	SG	General Site-Specific (SG) project recommendations are those practices that can be implemented over a large, generalized area. These sites are based on GIS analysis and although they are site specific, they are intended to cover a large geographic area.
Lake shore erosion control practices	L	Site-specific lakeshore recommendations include severely eroding lake banks identified during the inventory.
Detention basin retrofit projects	D	Detention basin retrofit recommendations are based on a basin survey completed by SMC. These projects include maintenance and actions to improve basin function.
Problem discharge locations	PD	Problem discharge points are any direct discharges to Mill Creek that should be evaluated and/or repaired.
Problem hydrologic impediments	PH	Hydrologic impediments are any notable issues that impede the conveyance and function of the waterway. These locations identified by SMC staff during the 2013 stream inventory.
Flood problem areas	FPAI	Site-specific flood mitigation projects to address the flood problem area inventory sites described in Chapter 5.
Potential regionally significant flood storage sites	FS	Potential storage areas that should be evaluated in the watershed.
Transportation specific actions	TP	Site-specific and general recommendations for future or proposed transportation projects
Wetland restoration and protection sites	W	An analysis performed by SMC of existing wetlands and opportunities for protection and restoration.

Table 6-11: Summary of site specific action items.

Type	# of Projects	Acres Benefited/ Acres Practice	Estimated Total Cost
Equestrian BMPs	16	100	$366,000
Filter Strips/ Riparian Buffers	n/a	9	$27,000
Nutrient Management Plan/Cover Crops	n/a	3,039	$212,730
Rain Gardens/Rain Barrel	n/a	759	$11,111,760
Blind Inlet/Drainage Management	50	992	$150,000
Septic System Inspections	88	n/a	$50,000
Water and Sediment Control Basins/Dry Dams	13	n/a	$52,000
Grassed Waterways	3	12.5	$50,000
Wetland Creation	20	111	$2,220,000
Existing Wetland Restoration	43	472	$4,720,000
Detention Basins	22	31	$1,100,000
Porous Pavement/Infiltration Basin	2 basins	373	$16,307,880
Streambank Stabilization	26,982 ft.	n/a	$2,293,470
Lake Shore Stabilization	2,975 ft.	n/a	$252,875
Hydrologic/Hydraulic Impediments	12	n/a	$240,000
Problem Discharge Locations	38	n/a	$760,000
Detention Basin Retrofits	177	2,124	$1,770,000
Flood Mitigation – Flood Problem Area Inventory Sites	31	n/a	$2,166,000
Regional Flood Storage	10	1,050-acres drainage	n/a

6.4.1 FLOOD PROBLEM AREA INVENTORY MITIGATION

Flood mitigation recommendations are provided for the flood problem area inventory (FPAI) sites that are characterized in Chapter 5. The mitigation projects are ranked as high (H), medium (M) and low (L) based on the type of flooding problem reported, the number of impacted landowners and the frequency of flooding. The recommendations are provided based on jurisdiction later in the chapter. **Figure 6-4** shows the locations of the FPAI sites with jurisdictional boundaries. FPAI sites were only present in five of the twelve jurisdictions: the Village of Grayslake, the Forest Preserve District, Unincorporated areas, the Village of Old Mill Creek and the Village of Third Lake.

A high priority (H) was given to ten flood problem areas that reported structural or roadway flooding on an annual basis (or more frequently) and impacted the most residents. A medium priority (M) was given to the four flood problem areas reported to have less frequent structural and roadway flooding and impacting fewer residents. The three flood problem areas that were given a low priority (L) included one roadway and two structural flooding incidents. The 1986 and 1993 storm events are two of the oldest reported storm events in the inventory and the most damaging storm events recorded in the last 40 to 50 years. Three problem areas were not given a ranking because the frequency of the event was not provided.

Although the FPAI is a good source for information on locations where flooding is known to occur in the watershed, it is likely not all-inclusive of problem areas and it lacks the necessary site specific detailed information (detailed topography, flooding depths, etc.) needed to accurately access flood damages and associated recommended mitigation alternatives. Typically, a detailed flood study or drainage analysis in combination with some level of engineering design and property owner input is required to determine the most feasible and cost-effective flood mitigation measures for a specific problem area. Recommendations are based on a brief field reconnaissance performed by a professional engineer; the flood mitigation recommendations are general in nature.

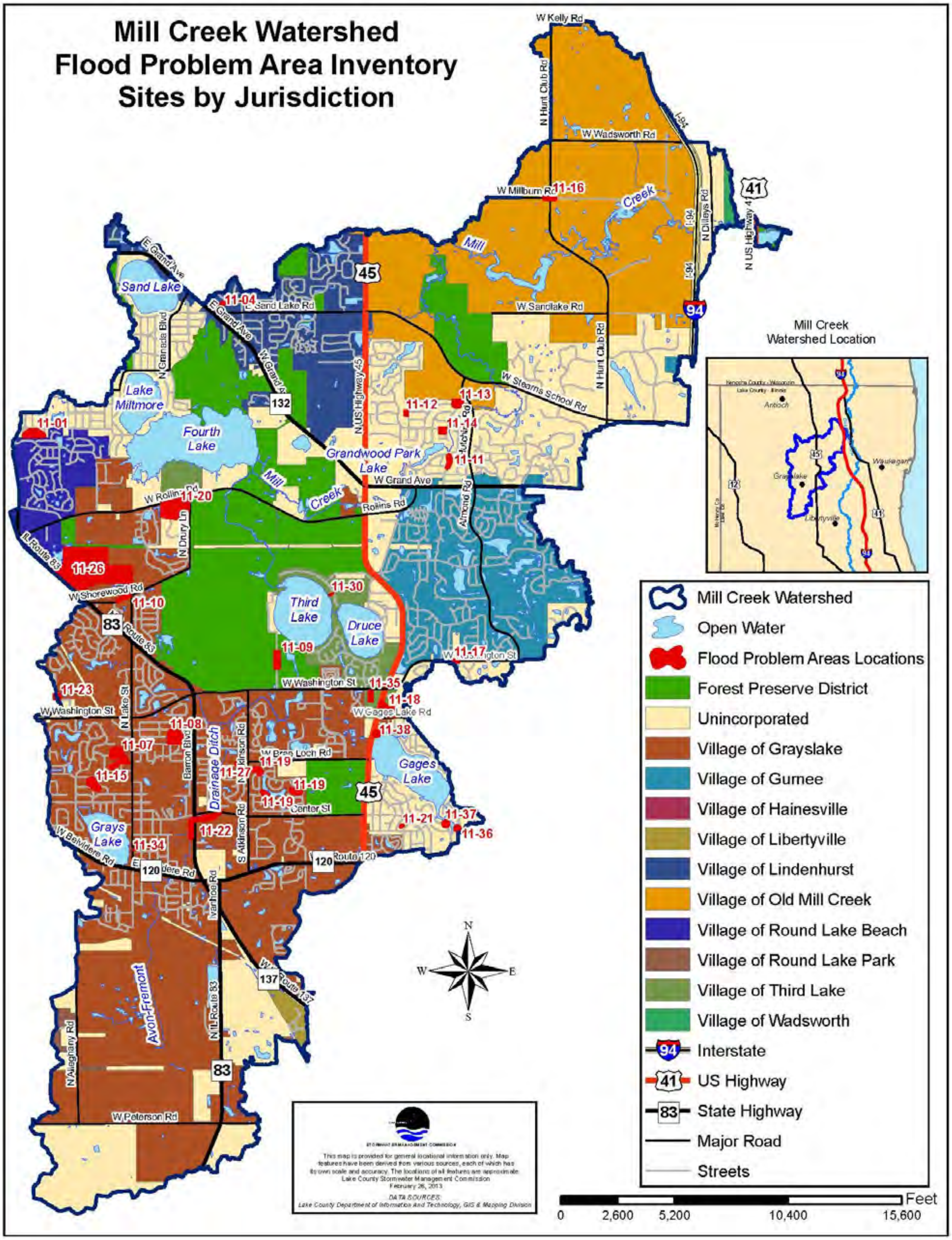


Figure 6-4: FPAI locations and jurisdictions.

6.4.2 POTENTIAL REGIONAL STORAGE LOCATIONS

Based on the analysis presented in Chapter 5, there were ten potential regional storage locations identified in the Mill Creek Watershed (**Table 6-12**). Sites are located in the villages of Grayslake and Old Mill Creek (**Figure 6-5**). A feasibility study is recommended for each of these sites to evaluate the cost and benefit of increasing or creating flood storage in these areas.

It is estimated that at least 170 acre-feet of storage could be created in the watershed by constructing berms and performing moderate grading and excavation at these locations. It is important to note that significantly more storage is available in the watershed in existing open water lakes and large wetland complexes; however these areas were excluded from this analysis in order to focus on previously unidentified areas of storage.

Noteworthy:

Regional Storage Location

Depressional locations greater than five acres in size, with at least 100-acres of tributary area and located within "Open Space" that includes agricultural, forest, grassland, public/private open space, and water (excluding open water lakes and large wetland complexes). These sites provide storage and could be modified to increase storage but mostly include regulated wetlands.

Potential Regional Storage Location

Regional storage locations that do not include Lake County Wetland Inventory mapped wetlands. Flood storage could potentially be enhanced or created with the construction of berms and moderate grading and excavation.

Table 6-12: Potential Flood Storage Locations in Watershed.

Site ID	Jurisdiction	Estimated Potential Storage (acre-feet)
FS37	Village of Grayslake	40
FS45		35
FS46		12
FS47		25
FS48		11
FS49	Village of Old Mill Creek	10
FS50		13
FS51		9
FS52		8
FS53		8

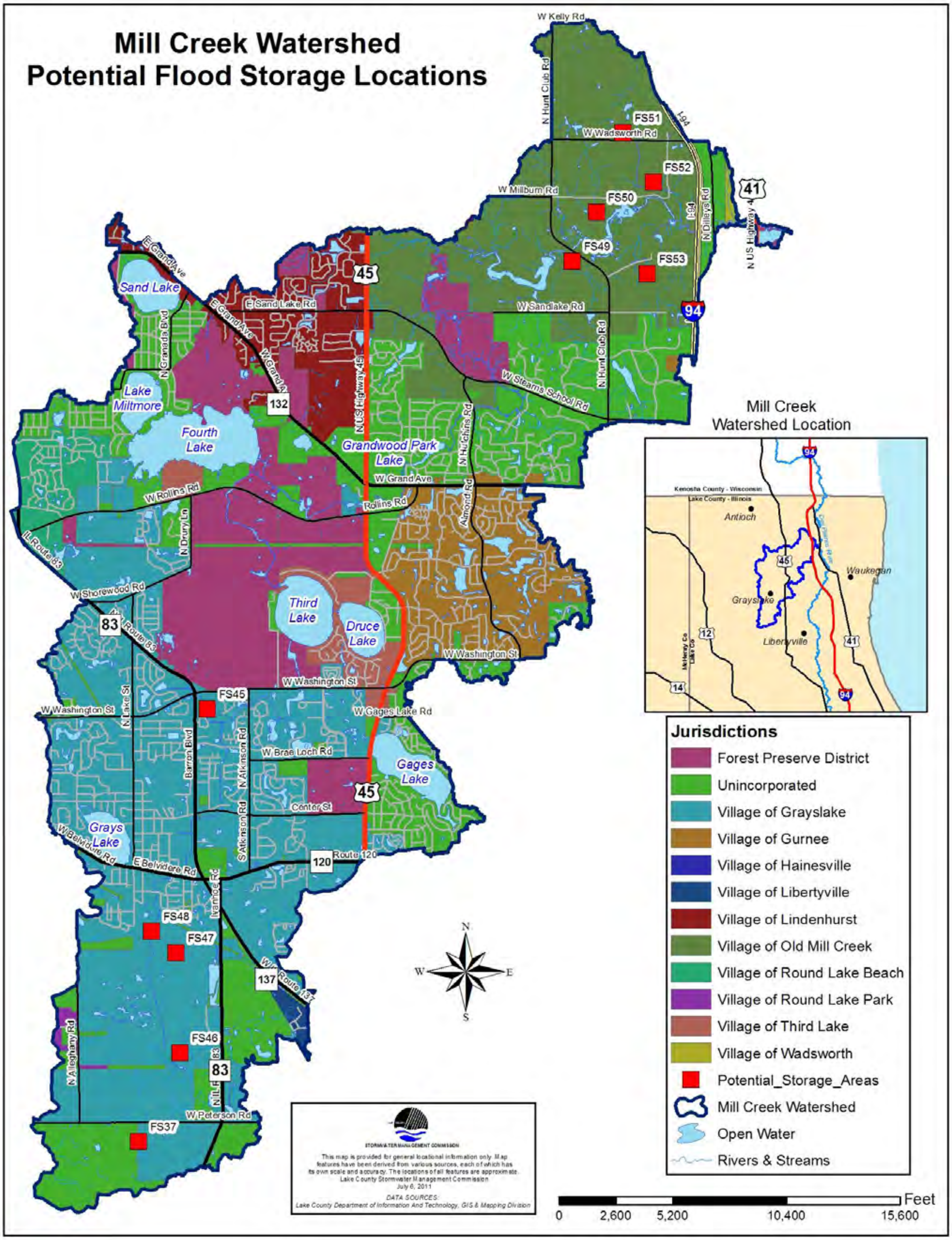


Figure 6-5: Potential flood storage locations and jurisdictions.

6.4.2 POTENTIAL WETLAND RESTORATION SITES

Wetland restoration can prove extremely beneficial in restoring the basic functions that historic wetlands once provided, including reducing flood volumes and rates, increasing biodiversity, and improving water quality conditions. Restorations typically occur on areas that have been drained, in most cases for agricultural practices. When a wetland is drained, the soil characteristics often remain intact and are referred to as hydric soils. Wetlands can be restored on drained hydric soils when drain tiles are disabled or other wetland dewatering systems (e.g., ditches) are modified. Wetlands restored in agricultural areas can reduce phosphorus levels in runoff by 60% and nitrates by 40%, resulting in cleaner water entering stream and lake systems and a potential decrease in algal blooms and aquatic vegetation overgrowth.

Potential wetland restoration sites in the watershed were identified using a two-step process: 1) an initial screening was performed using Lake County Geographic Information System (GIS) database information to locate and rank potential sites based on criteria developed for this watershed; and 2) a site-specific analysis was completed using 2013 Google Earth aerial imagery to determine the current status each site (i.e., developed vs. undeveloped).

For the initial screening, a potential restoration site was required to contain at least five acres of "drained hydric soils" (i.e., non-wetland) and be located on an "open" or "partially open parcel". The minimum five acre size was selected because this acreage of wetland restoration will typically hold large amounts of stormwater for a long period of time, providing significant additional flood storage volume and cleansing of the water by sediment deposition and plant uptake of nutrients. This size is also large enough to support a wide diversity of plant and animal species. Open and partially open parcels with at least five acres of drained hydric soils were chosen because they provide the most feasible opportunities for wetland restoration.

Each site was then assigned a ranking of low, moderate or high potential for restoration, based on five criteria: 1) site size (acreage of drained hydric soils), 2) ownership status (private vs. public), 3) location relative to existing wetlands, 4) location relative to a FEMA-mapped floodplain, and 5) location relative to a SMC-documented flood problem area (FPA). **Table 6-13** lists the evaluation criteria and ranking system for the potential wetland restoration sites.

Table 6-13: Ranking Criteria for Potential Wetland Restoration Sites.

Criterion	Category	Points
1) Size	5-10 acres 11-20 acres >20 acres	1 2 3
2) Ownership	Private Public 1 (e.g., Municipal, Park District, Township) Public 2 (e.g., Lake County Forest Preserve District)	1 2 3
3) Proximity to Existing Wetlands	Not Connected to Wetlands Connected to Wetland/Farmed Wetland Connected to Designated ADID Wetland	0 1 2
4) Proximity to FEMA-Mapped Floodplain	>500 feet from FEMA-Mapped Floodplain ≤ 500 ≥ 100 feet of FEMA-Mapped Floodplain <100' from FEMA 100-yr Floodplain	0 1 2
5) Proximity to SMC-Documented Flood Problem Area (FPA)	>1000 feet from FPA ≤ 1000 ≥ 100 feet of FPA < 100 feet from FPA	0 1 2

Ranking (total points): 2-4: Low Potential, 5-8: Moderate Potential, 9-12: High Potential

The Step 1 screening process identified 60 potential wetland restoration sites, 3 of which were ranked as having high potential for restoration, 25 as having moderate potential, and 32 as having low potential.

The Step 2 site-specific analysis of the potential restoration sites using 2013 Google Earth aerial imagery resulted in 17 of sites being omitted, leaving a total of 43 available sites. Fifteen of the omitted sites had been developed, mainly for residential subdivisions, and 2 of the sites located in the Rollins Savanna Forest Preserve had already been restored (see Section 3.14: *Current Management Activities*). The 43 potential restoration sites are depicted on Figure 6-6 and summarized in **Table 6-14**. Most of these sites are located in the northern and southern portions of the watershed.

In February 2001, SMC completed the Des Plaines River Wetland Restoration Study (DPRWRS, 2001) that identified potential wetland restoration sites in the entire Des Plaines River watershed, including the Mill Creek subwatershed. The study used the following criteria to locate and assess wetland restoration sites:

1) Greater than 16 acres in size
2) Within 50 meters of NIPC greenway and/or trail
3) Within NIPC or SMC's "open space" category or in Lake County Forest Preserve ownership

The DPRWRS study identified 114 potential wetland restoration sites in the Des Plaines River Watershed Wetland Restoration Study area, including 18 sites in the Mill Creek Watershed. Fifteen of the DPRWRS sites coincide with the potential restoration sites identified in this plan study, including 10 sites that remain undeveloped (Sites 4, 5, 10, 20, 26, 28, 31, 32, 33 and 34 highlighted in bold on **Table 6-14** and shown on **Figure 6-6** are located on privately owned land that is currently farmed. A more comprehensive study, beyond the scope of this evaluation, would need to be completed to further assess the feasibility of the potential restoration sites identified in this plan.

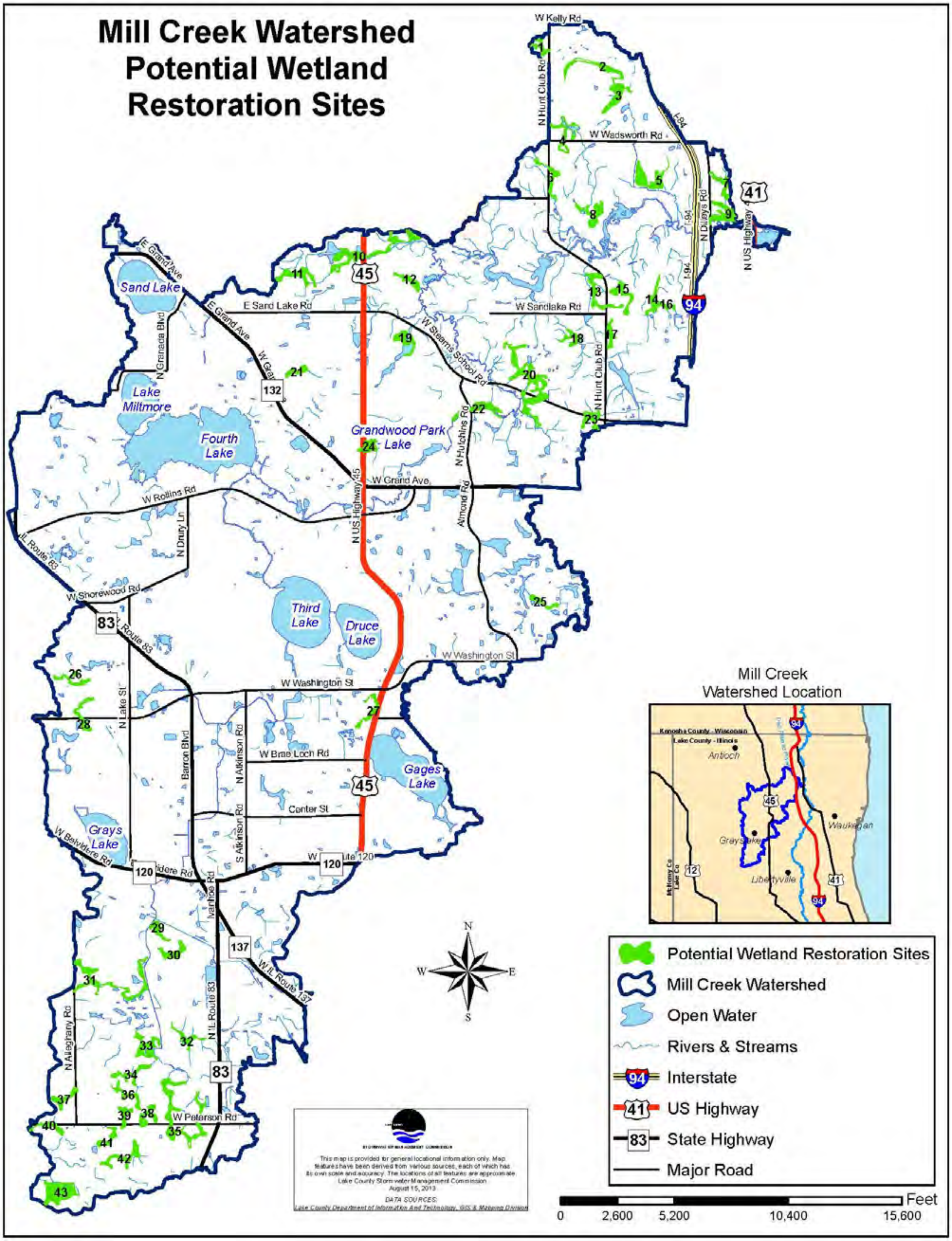


Figure 6-6: Potential wetland restoration sites.

Table 6-14: Potential wetland restoration sites.

Map ID#	Description	Size in Acres (Points)	Ownership (Points)	Proximity to Existing Wetlands (Points)	Proximity to FEMA-Mapped Floodplain (Points)	Proximity to Flood Problem Area (Points)	Total Points	Restoration Potential Ranking
1	Agricultural land	5 (1)	Private (1)	Connected (1)	100-500' (1)	>1,000' (0)	4	Low
2	Agricultural land, woodland	10 (2)	Private (1)	Connected (1)	100-500' (1)	>1,000' (0)	5	Moderate
3	Agricultural land	13 (2)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	4	Low
4	**Agricultural land, horse farm**	**8 (1)**	**Private (1)**	**Connected (1)**	**> 500' (0)**	**>1,000' (0)**	**3**	**Low**
5	**Agricultural land**	**18 (2)**	**Private (1)**	**Connected (1)**	**100-500' (1)**	**>1,000' (0)**	**5**	**Moderate**
6	Agricultural land	8 (1)	Private (1)	Connected (1)	>500' (0)	<100' (2)	5	Moderate
7	Agricultural land, woodland	7 (1)	Private (1)	Connected (1)	100-500' (1)	>1,000' (0)	4	Low
8	Agricultural land, woodland	12 (2)	Private (1)	Connected-ADID (2)	<100' (2)	100-1,000' (1)	8	Moderate
9	Agricultural land, woodland	16 (2)	Private (1)	Connected (1)	<100' (2)	>1,000' (0)	6	Moderate
10	**Agricultural land**	**12 (2)**	**Private (1)**	**Connected-ADID (2)**	**100-500' (1)**	**>1,000' (0)**	**7**	**Moderate**
11	Meadow	13 (2)	Public 2 (3)	No connection (0)	> 500' (0)	>1,000' (0)	5	Low
12	Agricultural land	7 (1)	Private (1)	Connected-ADID (2)	<100' (2)	>1,000' (0)	6	Moderate
13	Agricultural land	12 (2)	Private (1)	Connected (1)	100-500' (1)	>1,000' (0)	5	Low
14	Agricultural land	6 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
15	Agricultural land	10 (1)	Private (1)	No connection (0)	> 500' (0)	>1,000' (0)	2	Low
16	Agricultural land	5 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
17	Pasture, residential yards	6 (1)	Private (1)	No connection (0)	> 500' (0)	>1,000' (0)	2	Low
18	Agricultural land	6 (1)	Private (1)	No connection (0)	> 500' (0)	>1,000' (0)	2	Low
19	Agricultural land, residential yards	10 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
20	**Agricultural land, woodland**	**38 (3)**	**Public 1[b] (2)**	**Connected (1)**	**<100' (2)**	**>1,000' (0)**	**8**	**Moderate**
21	Woodland	5 (1)	Public 2[c] (3)	No connection (0)	> 500' (0)	>1,000' (0)	4	Low
22	Meadow, woodland	11 (2)	Private (1)	Connected-ADID (2)	<100' (2)	100-1,000' (1)	8	Moderate
23	Agricultural land, horse farm	8 (1)	Private (1)	No connection (0)	> 500' (0)	>1,000' (0)	2	Low
24	Agricultural land, residential yards	8 (1)	Private (1)	Connected (1)	100-500' (1)	>1,000' (0)	4	Low
25	Woodland, golf course	5 (1)	Private (1)	Connected (1)	100-500' (1)	>1,000' (0)	4	Low
26	**Agricultural land, woodland**	**7 (1)**	**Private (1)**	**Connected (1)**	**<100' (2)**	**100-1,000' (1)**	**6**	**Moderate**
27	Meadow	7 (1)	Private (1)	Connected (1)	<100' (2)	<100' (2)	7	Moderate
28	**Agricultural land, resid. yards**	**9 (1)**	**Private (1)**	**Connected (1)**	**<100' (2)**	**100-1,000' (1)**	**6**	**Moderate**
29	Agricultural land	6 (1)	Private (1)	Connected (1)	<100' (2)	>1,000' (0)	5	Moderate
30	Agricultural land	9 (1)	Private (1)	Connected (1)	<100' (2)	>1,000' (0)	5	Moderate
31	**Meadow**	**24 (3)**	**Private (1)**	**Connected (1)**	**<100' (2)**	**>1,000' (0)**	**7**	**Moderate**
32	**Agricultural land, meadow**	**7 (1)**	**Private (1)**	**Connected (1)**	**<100' (2)**	**>1,000' (0)**	**5**	**Moderate**
33	**Agricultural land**	**14 (2)**	**Private (1)**	**Connected (1)**	**<100' (2)**	**>1,000' (0)**	**6**	**Moderate**
34	**Agricultural land**	**8 (1)**	**Private (1)**	**Connected (1)**	**> 500' (0)**	**>1,000' (0)**	**3**	**Low**
35	Agricultural land	30 (3)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	5	Moderate
36	Agricultural land	7 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
37	Agricultural land	8 (1)	Private (1)	No connection (0)	> 500' (0)	>1,000' (0)	2	Low
38	Agricultural land	8 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
39	Agricultural land	6 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
40	Agricultural land, woodland	6 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
41	Agricultural land	6 (1)	Private (1)	Connected (1)	> 500' (0)	>1,000' (0)	3	Low
42	Agricultural land	12 (2)	Private (1)	No connection (0)	> 500' (0)	>1,000' (0)	3	Low
43	Agricultural land	25 (3)	Private (1)	Connected (1)	<100' (2)	>1,000' (0	7	Moderate

a Sites shown in bold also identified in Des Plaines River Wetland Restoration Study (SMC, 2001)
b Public 1 includes municipal, township, park district and other local ownerships
c Public 2 includes Lake County Forest Preserve District and other conservation organization ownerships

6.4.3 SITE SPECIFIC ACTIONS BY JURISDICTION

The following section provides site-specific project recommendations for each jurisdictional area within the watershed.

Figure 6-7 through **Figure 6-20** show site-specific actions by each major jurisdiction. Numerical codes on each map correspond to the BMP codes found in **Figure 6-15** through **Table 6-42**. With respect to basin retrofit recommendations, a large percentage of the basins assessed require some type of maintenance; only a subset of the total number of basins are detailed below, which are those with specific recommended actions.

6.4.3.1 LAKE COUNTY FOREST PRESERVE DISTRICT

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-15: Site specific actions, Lake County Forest Preserve District.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	Fourth Lake Forest Preserve - Implement rain barrels and rain gardens. These areas include residential land uses in unsewered areas of the watershed.	0.7 acres	L	L
SG	**Fourth Lake Forest Preserve - streambank stabilization**	**419 feet**	**H**	**L**
SG	**Mill Creek Forest Preserve - streambank stabilization**	**1,568 feet**	**H**	**L**
SG	**Sedge Meadow Forest Preserve - streambank stabilization**	**448 feet**	**H**	**L**
SG*	Fourth Lake Forest Preserve - Existing wetland restoration and protection.	3 acres	M	S
SG*	McDonald Woods Forest Preserve - Existing wetland restoration and protection.	7 acres	M	S
SG*	Mill Creek Forest Preserve - Existing wetland restoration and protection.	0.5 acres	M	S
SG	Fourth Lake Forest Preserve - Inspect septic systems and develop training program for septic pumpers.	1	L	M
SG	McDonald Woods Forest Preserve - Inspect septic systems and develop training program for septic pumpers.	1	L	M
SG	Mill Creek Forest Preserve - Inspect septic systems and develop training program for septic pumpers.	2	L	M
SG	**Sedge Meadows Forest Preserve - Inspect septic systems and develop training program for septic pumpers.**	**2**	**H**	**M**
ST1-ST4	Assess feasibility of removing debris jam.	4	H	S
ST18	**Stream restoration and bank stabilization.**	**3,000 feet**	**H**	**S**
SS13	**Mill Creek Forest Preserve - Water and Sediment Control Basins**	**3**	**H**	**S**
SS19	Millennium Trail and Greenway - Detention basin or wetland creation.	3.3 acres	H	S
TP	Rollins Savanna Forest Preserve - US 45 lane expansion project to minimize impacts to existing wetland using buffers, mitigate any impacts.	406 feet	H	L

* Sites identified in section 6.3.4

Table 6-16: Site specific actions, Forest Preserve District (Detention Basins, Hydrologic Impediments and Problem Discharge Points).

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D1	Detention Basin Retrofit	Investigate drain tile/pipe outlets for erosion issues.	Brae Loch Golf Club Pond 3	M	L
D2	Detention Basin Retrofit	Plant native grasses to replace turf grass.	Brae Loch Golf Club Pond 2	M	L
D3	Detention Basin Retrofit	Re-establish soil in eroded areas, lower outlet to expose submerged inlets.	Brae Loch Golf Club Pond 1	M	L
D4	Detention Basin Retrofit	Plant native grasses to replace turf grass. Coordinate with Lindenhurst basin 155 (D155).	Country Place - Lindenhurst Pond 5	M	L
PD1	Problem Discharge Point	Possible failed drainage tile, assessment needed.	Mill Creek Forest Preserve	L	M
PH1	Hydrologic Impediment	Beaver dam, restore channel conveyance.	Mill Creek Forest Preserve	M	S
PH2	Hydrologic Impediment	Beaver dam, monitor location for debris build up. Likely to be flushed out annually.	Mill Creek Forest Preserve	L	M
PH3	Hydrologic Impediment	Large logjam, debris built up. Remove large fallen tree and restore channel conveyance.	Mill Creek Forest Preserve	H	S
PH4	Hydrologic Impediment	Very large and well established beaver dam, 3 - 4 foot impoundment. Remove beaver dam to re-establish fish passage. Evaluate possible upstream ecological impacts prior to removal.	Mill Creek Forest Preserve	H	L
PH5	Hydrologic Impediment	CMP culvert partially filled with sediment; remove sediment from culvert and immediate upstream area to restore capacity of the drainage.	Mill Creek Forest Preserve	M	M

Table 6-17: Flood Problem Area Inventory recommendations, Forest Preserve District.

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-09	Unincorporated, Forest Preserve District	New Structure	Install a culvert under road. Possibly re-grade road.	$33,000	M	M
11-26, 11-27, 11-34	Forest Preserve District / Village of Grayslake	Study	Perform detailed stormwater analysis that expands on previous flood study for this area and develop concept/preliminary engineering level report that identifies 2-3 solutions.	$30,000 – 75,000	M	S

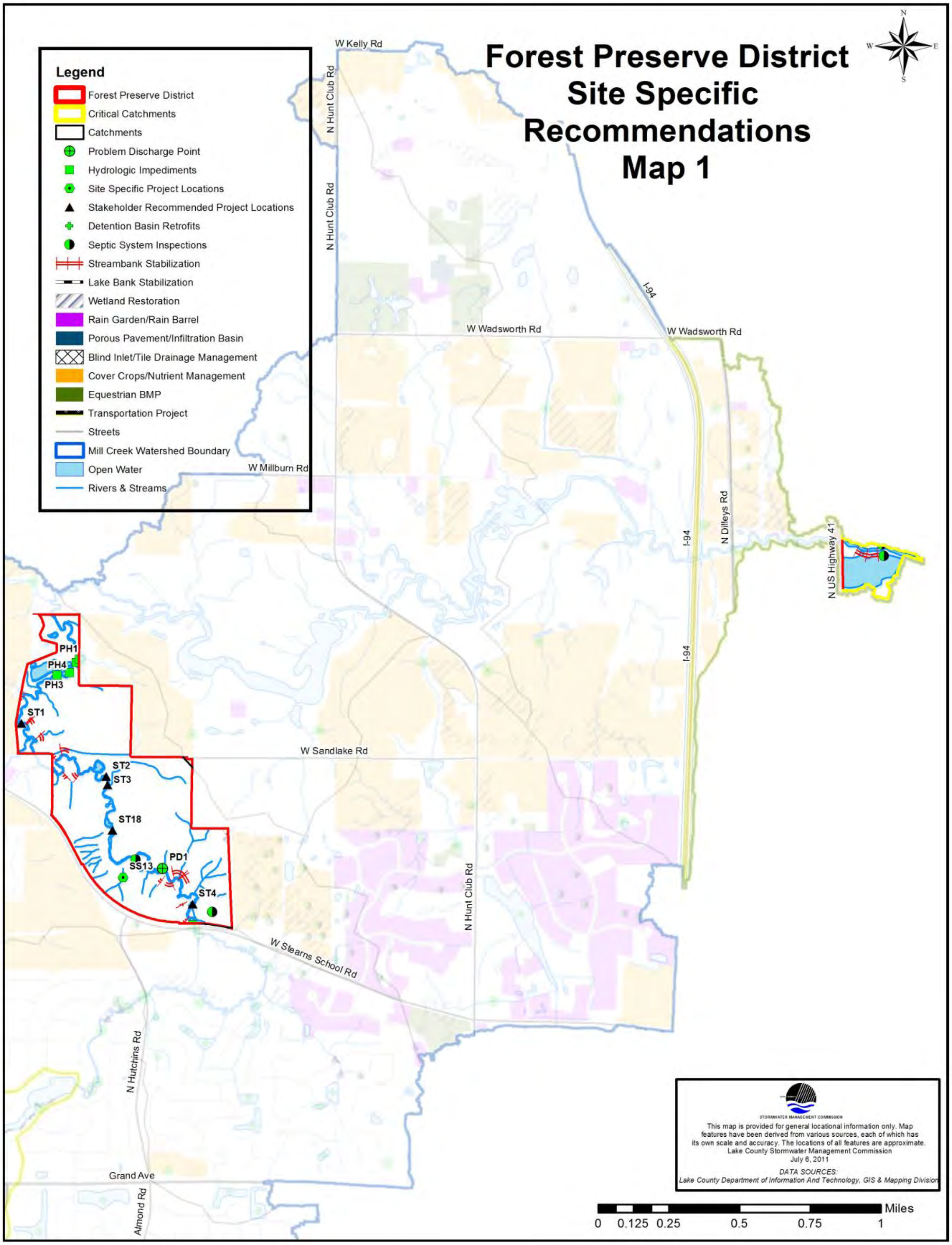


Figure 6-7: Site specific recommendations, Forest Preserve District map 1.

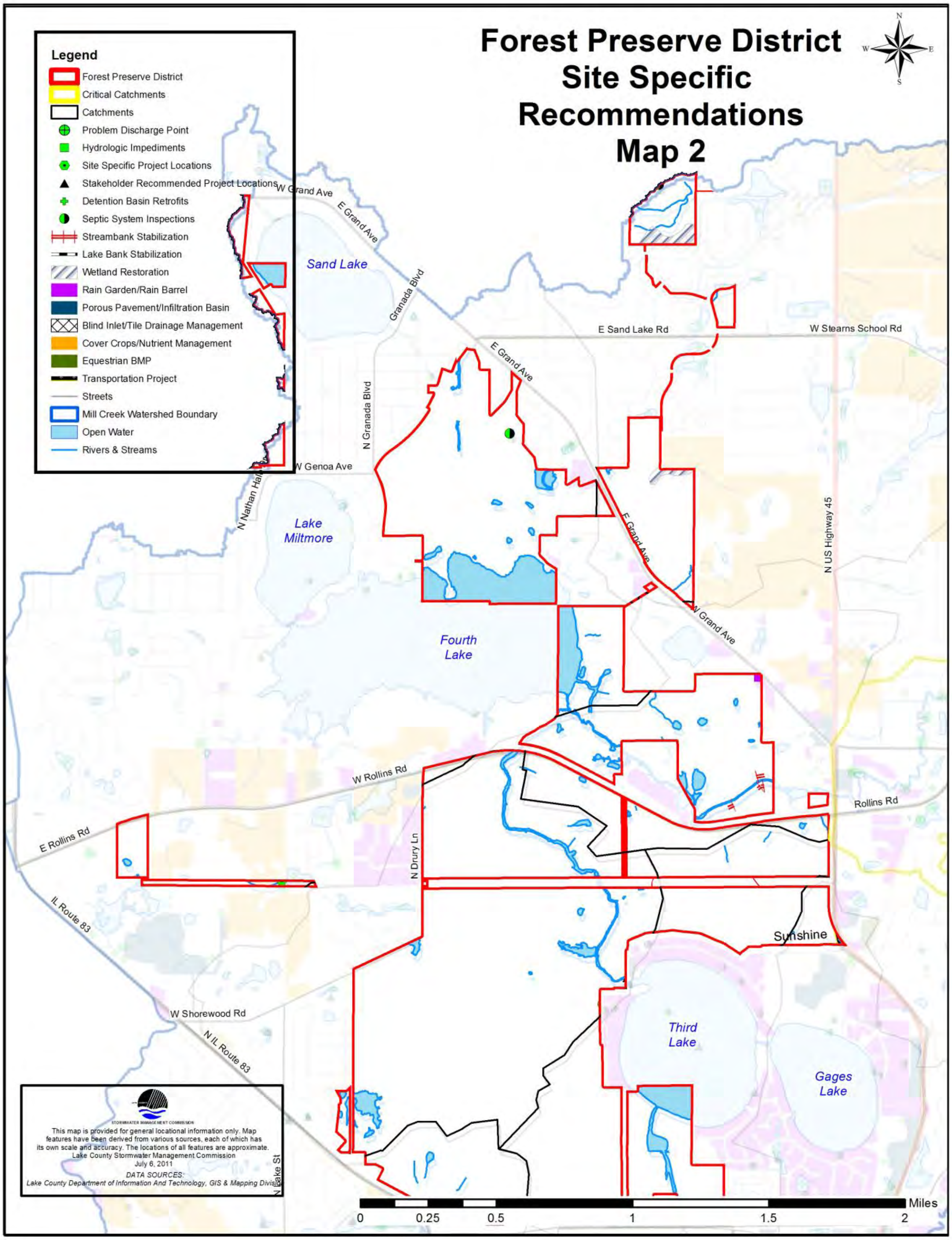


Figure 6-8: Site specific recommendations, Forest Preserve District map 2.

6.4.3.2 VILLAGE OF HAINESVILLE

Table 6-18: Site specific actions, Village of Hainesville.

BMP Code	Action	Number of Projects/Area Benefited	Priority	Time Frame
TP	Washington St. - lane additions, use BMPs in final design including bioswales and road salt management	438 feet	M	L

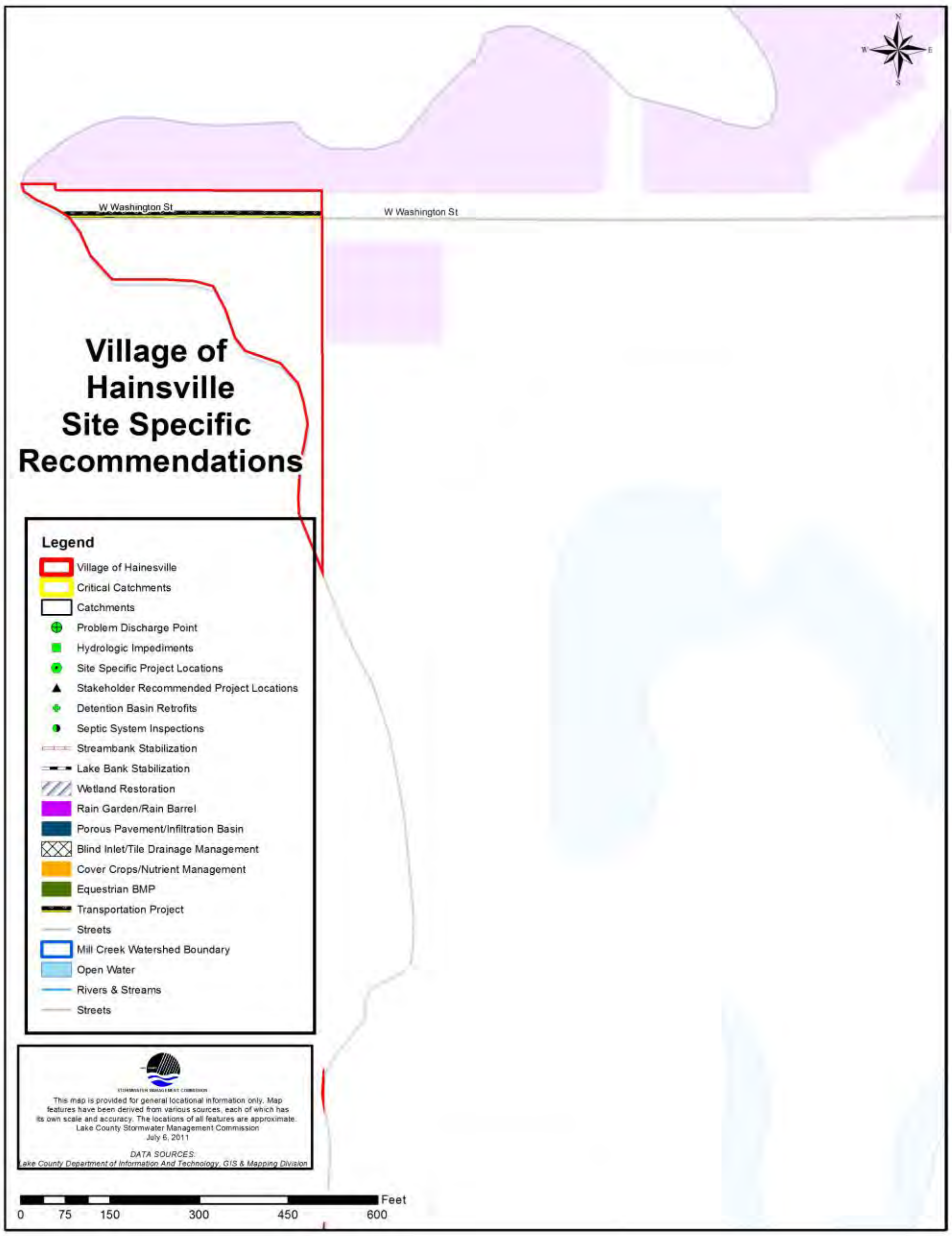


Figure 6-9: Site specific recommendations, Village of Hainesville.

6.4.3.3 VILLAGE OF GRAYSLAKE

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-19: Site specific actions, Village of Grayslake.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and install cover crops.**	**1,117 acres**	**H**	**M**
SG	**Install infiltration basins and/or porous pavement. These areas include commercial, cultural, institutional, and industrial land uses in unsewered areas of the watershed.**	**284 acres**	**H**	**L**
SG	**Install rain barrels and rain gardens. These areas include residential land uses in unsewered areas of the watershed.**	**74 acres**	**H**	**L**
SG	**Install blind inlets and/or tile drainage management on tiled agricultural ground.**	**602 acres**	**H**	**M**
SG	**Streambank stabilization**	**17,405 feet**	**H**	**L**
SG	**Inspect septic systems and develop training program for septic pumpers.**	**21**	**H**	**M**
SG*	**Existing wetland restoration and protection.**	**141 acres**	**H**	**M**
ST9	Educate landowners about yard waste dumping.	N/A	H	S
ST10 & ST14	Install riparian buffer.	0.5 acres	H	S
ST11	Bioretention/infiltration at end of road.	0.3 acres	H	S
ST12	Retrofit outlet structure.	N/A	H	S
ST13	Retrofit apron structure.	N/A	H	S
ST16	**Assess beaver activity and impact on flooding and hydrology.**	**N/A**	**H**	**S**
ST21, ST 24 & ST25, ST28-31	Chesapeake Landing detention basin retrofits/shoreline stabilization.	10 acres	H	S
ST27	Washington Village detention pond stabilization/sediment trap.	1	H	S
ST34	Complete Study - Manor Lake (Storm Drainage Area 3) - 1992 Study.	1	H	S
ST35	Replace Center Street / Mill Creek Culvert - 1997 Study.	1	H	S
ST36	Replace Northern Air Systems / Mill Creek Culvert (683 Center Street) - 1997 Study.	1	H	S
ST41	Preserve pickerelweed (*Pontederiacordata*) population	N/A	H	S
SS20	Area restoration; combination bioswales, wetland creation and native prairie.	16 acres	H	M
SS25	Infiltration practices in college parking lot including bioswales and permeable pavement.	1 acre	L	L
SS26	Two-stage ditch and floodplain wetland creation.	3 acres	M	L
SS27	Riparian zone restoration; wetland creation and buffer strips.	1 acre	H	S

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SS28	Wetland creation.	2 acres	M	L
SS29	Detention basin or rain garden.	0.2 acres	M	M
SS30	Wetland creation.	3 acres	H	M
SS31	Detention basin.	0.3 acres	M	M
SS32	Detention basin.	1 acre	H	S
SS33	Detention basin.	1.4 acres	H	S
SS34-SS36	Retrofit/expand existing basin for storage.	0.5 acres	L	L
SS37	Wetland creation in floodplain.	1.4 acres	M	M
SS38	Rain garden and gutter control.	0.1 acres	H	S
SS39	Porous pavement or infiltration basin for parking lot.	0.4 acres	M	M
SS40	Detention basin.	1.5 acres	H	S
SS41	Wetland creation.	4 acres	H	S
SS42	Detention basin.	2 acres	M	M
SS43	Retrofit existing detention basin for storage.	0.6 acres	L	L
SS44	Wetland restoration to increase storage.	3.2 acres	L	L
SS45	Detention basin.	11 acres	H	S
SS46	Rain garden or infiltration basin.	0.15 acres	M	M
SS47	Detention basin or porous pavement for parking lot.	1.5 acres	M	M
SS48	Detention basin or rain garden.	0.3 acres	L	L
SS49	**Wetland creation.**	**2.5 acres**	**H**	**M**
SS51	Wetland creation.	2 acres	L	L
SS52 & SS53	Large wetland creation.	49 acres	H	M
SS67, SS70, SS78	Riparian buffer/filter strip.	2.5 acres	L	M
SS77	**Riparian buffer/filter strip.**	**2 acres**	**H**	**S**
SS68 & SS72	Porous pavement/rain garden.	0.5 acres	L	M
SS69	Rain gardens for residential areas.	0.13 acres	M	M
SS71, SS74, SS76	Rain gardens for residential areas.	0.6 acres	L	L
SS73	Porous pavement, gutter control, infiltration basin.	0.21 acres	L	M
SS75	Rain garden, porous pavement, infiltration basin, and detention.	0.6 acres	M	M
TP	**US 45, IL83 and Peterson Rd lane expansion project; IL 53/120 project: (1) Preserve north/south bike path connection routes including Harris Road, Route 45, Route 83, Lake Street and Alleghany Road, (2) Use underpasses/pedestrian bridges to preserve corridors, (3) Provide access to wetland restoration area/overlook area, (4)Use Grayslake landscaping mix to include native landscaping on berms/detention basins, (5) Minimize impact on wetlands including those east of Route 45 and the Central Range wetland restoration area, (6) Use BMP's in the final design bioswales and road salt management.**	**25,053 feet**	**H**	**L**

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
TP	Washington St. - lane additions and railroad underpass, use BMPs in final design including bioswales and road salt management and coordinate with LCFPD on possible easement.	5,108 feet	M	L
TP	Install bike path on south side of Washington St.	3,391 feet	H	L
TP	Lake St, Lake Co. PASSAGE - no specific recommendations.	6,900 feet	L	L
TP	Peterson Rd - divided highway partial access control, minimize impacts to existing wetlands.	5,512 feet	L	L
TP	Rollins Rd - installation of signals, no specific recommendation.	4,619 feet	L	L
TP	Center St. resurfacing - minimize impacts to existing wetlands during resurfacing.	7,763 feet	M	S
TP	Alleghany Rd. resurfacing - minimize impacts to existing wetlands during resurfacing, mitigate impacts.	5,997 feet	M	S

* Sites identified in section 6.3.4

Table 6-20: Site specific actions, Grayslake (Detention Basins, Hydrologic Impediments and Problem Discharge Points).

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D34	**Detention Basin Retrofit**	**Clear outlet of debris, fix aerator.**	**n/a**	**H**	**L**
D35	Detention Basin Retrofit	Clear outlet of debris, sweep the basin for trash.	n/a	M	L
D36	Detention Basin Retrofit	Investigate BMP opportunity for sump pump or drainage pipe outlet, clear outlet of debris.	Grayslake Golf Course Pond 1	M	L
D37	Detention Basin Retrofit	Continue with native vegetation along banks; remove turf grass on SE banks.	Hidden Ponds Pond 1	M	L
D38	Detention Basin Retrofit	Disconnect sump pump, plant native vegetation on banks.	Prairies of Grayslake Pond	M	L
D39	Detention Basin Retrofit	Disconnect bypass, install FES inlet. Plant banks and bottom with native vegetation.	Grayslake Aquatic Center Pond 4	M	L
D40	Detention Basin Retrofit	Disconnect low flow bypass, install FES inlet, plant native grasses on banks and bottom.	Grayslake Area Public Library Pond 2	M	L
D41	Detention Basin Retrofit	Place energy-dissipation BMP at inlet 1, plant slopes with native vegetation.	Walden Square Pond	M	L
D42	Detention Basin Retrofit	Native vegetation maintenance.	Hidden Ponds Pond 3	M	L
D43	Detention Basin Retrofit	Investigate potential remedy for shoreline erosion.	Chesapeake Farms Pond 1	M	L
D44	Detention Basin Retrofit	Install energy-dissipation BMP at inlet and clear outlet of reed canary grass.	Lake Forest Hospital Detention 1	M	L
D45	Detention Basin Retrofit	Plant native vegetation.	Chesapeake Farms Pond 2	M	L
D46	Detention Basin Retrofit	Plant banks with wetland vegetation, and plant bed with native pond plants.	Canterbury Estates Pond 1	M	L

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D47	Detention Basin Retrofit	Investigate potential remedy for shoreline erosion.	Chesapeake Landing Pond 1	M	L
D48	Detention Basin Retrofit	Clear Inlet 2 of debris.	Cherry Creek Pond 4	M	L
D49	Detention Basin Retrofit	Clear inlet 3 and outlet A of sediment and debris.	Carillon North Pond 3	M	L
D51	Detention Basin Retrofit	Clean garbage out, repair slope behind inlet 1.	Atkinson Center Pond 1	M	L
D52	Detention Basin Retrofit	Clean clogged inlets.	Mapleview Pond 1	M	L
D53	Detention Basin Retrofit	Clear debris from inlets 3 and 4, install energy-dissipation BMP in front of inlet 5	Carillon North Pond 2	M	L
D54	Detention Basin Retrofit	Add energy-dissipation BMP to inlets	Mill Creek Park Lake	M	L
D55	Detention Basin Retrofit	Clear debris from inlet 2 and outlet, dredge sediment.	n/a	M	L
D56	Detention Basin Retrofit	Clear debris from outlet.	n/a	M	L
D57	Detention Basin Retrofit	Clear debris from Inlet 3, install energy-dissipation BMP at outlet 4.	Creekside Park Pond	M	L
D58	Detention Basin Retrofit	Replace soil around inlet 2, and replace inlets 2 and 3.	Grayslake Aquatic Center Pond 1	M	L
D59	Detention Basin Retrofit	Clear debris from inlets and outlet.	Center Street Square Pond 2	M	L
D60	Detention Basin Retrofit	Clear debris from manhole cover.	Center Street Square Pond 4	M	L
D61	Detention Basin Retrofit	Clear debris from inlets.	Mapleview Pond 2	M	L
D62	Detention Basin Retrofit	Clear debris from inlets, install or reinstall energy-dissipation BMP at some locations.	Hidden Ponds Pond 5	M	L
D63	Detention Basin Retrofit	Clear debris from inlets 2and 3 and outlet A.	Frederick School Pond 1	M	L
D64	Detention Basin Retrofit	Remove algae covering and plant native prairie/hydrophilic plants. Connect to gas station's storm sewer. Clear inlets, unable to locate openings with so much debris	Aldworth Pond	M	L
D65	Detention Basin Retrofit	Plant native vegetation on banks, clear inlets 1 and 3 and Outlet A of debris.	West Trail Pond 2	M	L
D66	Detention Basin Retrofit	Plant native vegetation on banks.	n/a	M	L
D67	Detention Basin Retrofit	Plant slopes with native vegetation, clear Inlet 1, fix outlet's trash grate.	Eastlake Farm Park Pond	M	L
D68	Detention Basin Retrofit	Unclog the inlet.	n/a	M	L
D69	Detention Basin Retrofit	Energy-dissipation BMP in front of Inlet 1, remove walls and slope to 3:1 and plant native plants.	n/a	M	L
D70	Detention Basin Retrofit	Replace turf grass with native grass. Install energy-dissipation BMP on inlet.	Meadows of Grayslake Pond	M	L

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D71	Detention Basin Retrofit	Replace vegetation on bank due to construction.	n/a	M	L
D72	Detention Basin Retrofit	Replace CMP with RCP and FES Grate. Combine this basin with 11-259.	Center Street Square Pond 3	M	L
D73	Detention Basin Retrofit	Remove plastic pipe and replace with concrete outlet.	n/a	M	L
D74	Detention Basin Retrofit	Plant native vegetation on banks.	West Trail Pond 3	M	L
D75	**Detention Basin Retrofit**	**Install energy-dissipation BMP in front of Inlet 2**		**H**	**L**
D76	Detention Basin Retrofit	Install energy-dissipation BMP and FES in inlets missing them. Replace turf grass with native plants. Cut back bank slope for planting.	Lake County High School Technology Campus Lake	M	L
D77	Detention Basin Retrofit	Algae treatment, prevent fertilizer runoff through buffer zone.	n/a	M	L
D78	Detention Basin Retrofit	Install trash grate and energy-dissipation BMP on inlet.	n/a	M	L
D79	Detention Basin Retrofit	Pull back inlets to banks and install energy-dissipation BMP.	Willow Lake	M	L
D80	Detention Basin Retrofit	Plant slopes with native vegetation.	Grayslake Senior Residence Pond 2	M	L
D81	Detention Basin Retrofit	Plant native vegetation on bottom and banks. Remove low flow bypass and put in FES inlet.	Grayslake Area Public Library Pond 1	M	L
D82	Detention Basin Retrofit	Monitor native plant establishment on slopes.	Mollys Lake	M	L
D83	Detention Basin Retrofit	Plant native vegetation on the slopes.	Haryan Farm Pond 1	M	L
D84	Detention Basin Retrofit	Plant slopes with native vegetation, clear outlet of debris and disconnect sump pump.	Churchill Pond	M	L
D85	Detention Basin Retrofit	Downspouts disconnect, clear Inlet 1 of debris and invasive species.	Chesapeake Farms Pond 4	M	L
D86	Detention Basin Retrofit	Remove low flow bypass and install FES inlet, plant slopes and bottoms with native vegetation.	Grayslake Area Public Library Pond 3	M	L
D87	Detention Basin Retrofit	Install energy-dissipation BMP on inlets.	College of Lake County Pond 3	M	L
D88	Detention Basin Retrofit	Plant slopes with native grasses.	College Trail Lake	M	L
D89	Detention Basin Retrofit	Add trash grate to inlets.	Country Faire Pond 2	M	L
D90	Detention Basin Retrofit	Establish native vegetation, redesign SW inlet to provide WQ increase.	Canterbury Estates Pond 2	M	L
D91	Detention Basin Retrofit	Disconnect several downspouts, plant hydrophilic plants in the channel.	Prairie Crossing Pond 9	M	L
D92	Detention Basin Retrofit	Install trash grate over inlet, open manhole for restrictor.	Phil-Mar Pond	M	L

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D93	Detention Basin Retrofit	Plant native vegetation on banks.	Grayslake Senior Residence Pond 1	M	L
D94	Detention Basin Retrofit	Plant native vegetation on banks and clear inlet 2.	Normandy Woods Pond	M	L
D95	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance.	Countryside Landfill Pond 12	M	L
D96	Detention Basin Retrofit	Install energy-dissipation BMP in front of inlet 1.	Carillon North Golf Course Pond 3	M	L
D97	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance.	n/a	M	L
D98	Detention Basin Retrofit	Relocate inlet 1 to center of west bank, plant slopes with native vegetation.	Grayslake Aquatic Center Pond 5	M	L
D99	Detention Basin Retrofit	Plant native vegetation on banks.	n/a	M	L
D100	Detention Basin Retrofit	Expand native buffer on turf grass side slopes.	Sunrise Park Pond 1	M	L
D101	**Detention Basin Retrofit**	**Plant native vegetation on slopes and bottom, clear inlet and install energy-dissipation BMP, remove low flow bypass, install FES outlet by Emergency Overflow Structure.**	**Grayslake Rail Station Pond 1**	**H**	**L**
D102	Detention Basin Retrofit	Establish native vegetation on slopes, clear debris and sediment from inlet 1.	n/a	M	L
D103	Detention Basin Retrofit	Establish native vegetation on banks that are not beaches.	Manor Lake	M	L
D104	**Detention Basin Retrofit**	**Plant native grasses on the slopes.**		**H**	**L**
D105	Detention Basin Retrofit	Relocate outlet to SW of basin.	Atkinson Center Pond 2	M	L
D106	Detention Basin Retrofit	Remove turf grass and invasive grasses and re-establish with native vegetation, clear trash and debris at inlet 1 (east bank inaccessible).	Valley Forge Park Pond	M	L
D107	Detention Basin Retrofit	Plant bottom and slopes with native vegetation.	n/a	M	L
D108	**Detention Basin Retrofit**	**Plant native grasses on slopes and Inlet 2. Install energy-dissipation BMP at inlet 1.**	**n/a**	**H**	**L**
D109	Detention Basin Retrofit	Plant slopes and bottom with native vegetation.	Augie Pond 1	M	L
PD12	**Problem Discharge Point**	**Rehabilitate discharge location, 4-inch corrugated plastic pipe not installed properly. Identify source of discharge location and dismantle if possible.**	--	**H**	**M**
PD13	**Problem Discharge Point**	**Identify source of water discharge and restore accordingly. Possible drainage tile with damaged outlet structure.**	--	**H**	**L**

BMP Code	Type	Action	Basin Name	Priority	Time Frame
PD14	**Problem Discharge Point**	**Drainage tile failure on left bank, reinforce outlet location with energy-dissipation BMP to reduce bank erosion.**	**--**	**H**	**M**
PD15	Problem Discharge Point	3-inch CMP filled with oxidized sediment, identify source and decommission if possible. Possible failed drainage tile that is choked with sediment.	--	M	M
PD16	Problem Discharge Point	6-inch CMP sticking out of bank 3 - 4 feet. Reinforce discharge location into bank.	--	M	M
PD17	Problem Discharge Point	Three 2-inch discharge pipes, identify source and decommission direct discharge to creek.	--	M	M
PD18	Problem Discharge Point	Evaluate broken plastic corrugated pipe discharging from swale.	--	L	L
PD19	Problem Discharge Point	Roadside gully forming due to stormwater drainage from commercial area or roadway. Disable source if possible and restore the eroding gully with a naturalized swale of larger dimensions and rip rap.	--	H	S
PD20	Problem Discharge Point	Loose 4-inch plastic corrugated pipe discharge, evaluate source and disable or reinforce outlet location.	--	L	L
PD26	Problem Discharge Point	3-inch CMP filled with sediment and 5-feet of erosion has exposed pipe. Identify source and disable or restore the outlet structure.	--	M	M
PD27	Problem Discharge Point	3-inch CMP filled with sediment and pipe broken. Identify source and disable or restore the outlet structure.	--	M	M
PD28	Problem Discharge Point	6-inch CMP broken. Identify source and disable or restore outlet structure.	--	H	S
PD29	Problem Discharge Point	8-inch CMP outlet is compromised due to bank erosion, corrugated pipe sharp and dangerous. Restore the outlet structure.	--	H	S
PD30	Problem Discharge Point	8-inch CMP outlet is compromised due to bank erosion, corrugated pipe sharp and dangerous. Restore the outlet structure or disable drainage tile.	--	H	S
PD31	Problem Discharge Point	Evaluate capacity and retrofit large discharge structure. Erosion is occurring and beginning to undermine the concrete structure supporting the drainage.	--	H	M
PD32	Problem Discharge Point	8-inch CMP outlet is compromised due to bank erosion, corrugated pipe sharp and dangerous. Restore the outlet structure.	--	H	S
PD33	Problem Discharge Point	4-inch CMP filled with sediment; outlet protrudes 3-feet from bank. Identify source and disable or restore the outlet structure.	--	H	S

BMP Code	Type	Action	Basin Name	Priority	Time Frame
PD34	Problem Discharge Point	3-inch CMP pipe broken. Identify source and disable or restore the outlet structure.	--	L	L
PD35	Problem Discharge Point	6-inch CMP. Identify source and disable or restore the outlet structure.	--	M	M
PD36	Problem Discharge Point	6-inch concrete pipe broken, identify source and disable or restore the outlet structure.	--	M	M
PD37	Problem Discharge Point	Evaluate location further, details not known.	--	M	M
PH7	Hydrologic Impediment	Primary channel drainage CMP protected by limestone blocks. Evaluate capacity of culvert and retrofit to accept higher flow capacity if necessary.	--	M	S
PH8	Hydrologic Impediment	Debris accumulation before large primary drainage CMP; appears that flow bypasses culvert on the LB during high flows.	--	M	S
PH9	Hydrologic Impediment	Riprap under the bridge impedes low-flow fish passage, consider modification to enhance.	--	M	M
PH10	**Hydrologic Impediment**	**Concrete retaining structure, flow bypasses. Requires further evaluation.**	**--**	**H**	**M**
PH11	**Hydrologic Impediment**	**10-inch concrete pipe filled with sediment, identify source and disable or restore the outlet structure.**	**--**	**H**	**M**

Table 6-21: Flood Problem Area Inventory recommendations for Village of Grayslake.

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-07	Village of Grayslake	Capacity	Increase capacity of swales or storm water system.	$27,000	H	S
11-08, 11-25, 11-28, 11-31	Village of Grayslake	Capacity	Replace 4 inlets and increase capacity of storm water system. Re-grade to form swales.	$117,000	H	S
11-15	Village of Grayslake	Capacity	Replace 3 existing inlets and increase capacity of storm water system. Re-grade swales or install new curb and gutter.	$101,000	H	S
11-22	Grayslake	Capacity	Re-grade channel to provide more capacity. Check the capacity of the under Center Street and Barron Blvd.	$774,000	H	S
11-10	Village of Grayslake	New Structure	Add inlets to sump area in road.	$66,000	M	M

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-26, 11-27, 11-34	Forest Preserve District / Village of Grayslake	Study	Perform detailed stormwater analysis that expands on previous flood study for this area and develop concept/preliminary engineering level report that identifies 2-3 solutions.	$30,000 – 75,000	M	S
11-19	Grayslake	Grading	Re-grade area to provide a drainage swale. Cleared blocked swales.	$17,000	n/a	M

Table 6-22: Potential flood storage in Village of Grayslake.

Site ID	Jurisdiction	Action	Estimated Potential Storage (acre-ft)	Priority	Time frame
FS37	Village of Grayslake	Feasibility study and cost/benefit analysis to evaluate the five potential flood storage locations in the village.	40	H	S
FS45			35	H	S
FS46			12	M	M
FS47			25	H	M
FS48			11	M	M

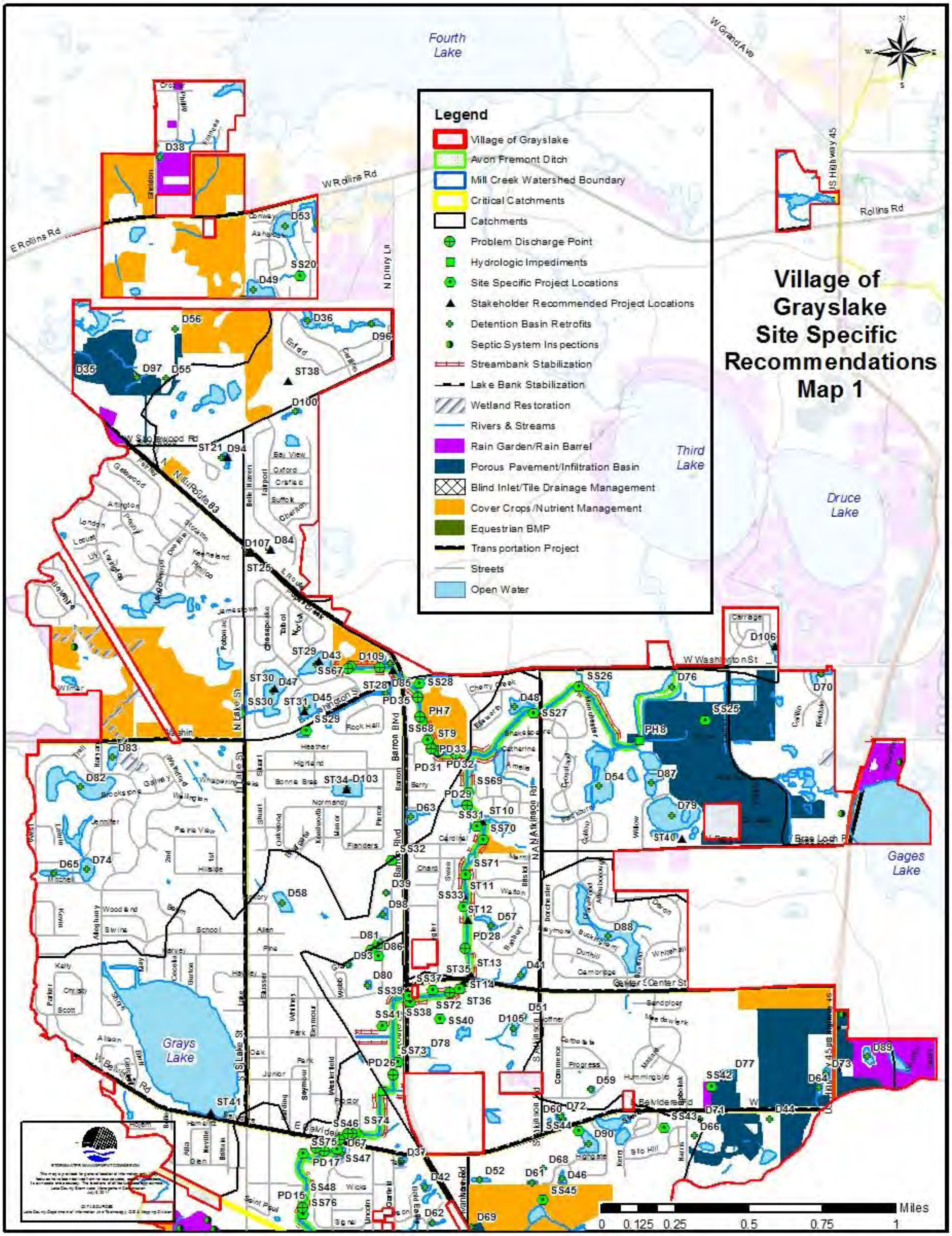


Figure 6-10: Site Specific Recommendations, Village of Grayslake Map 1.

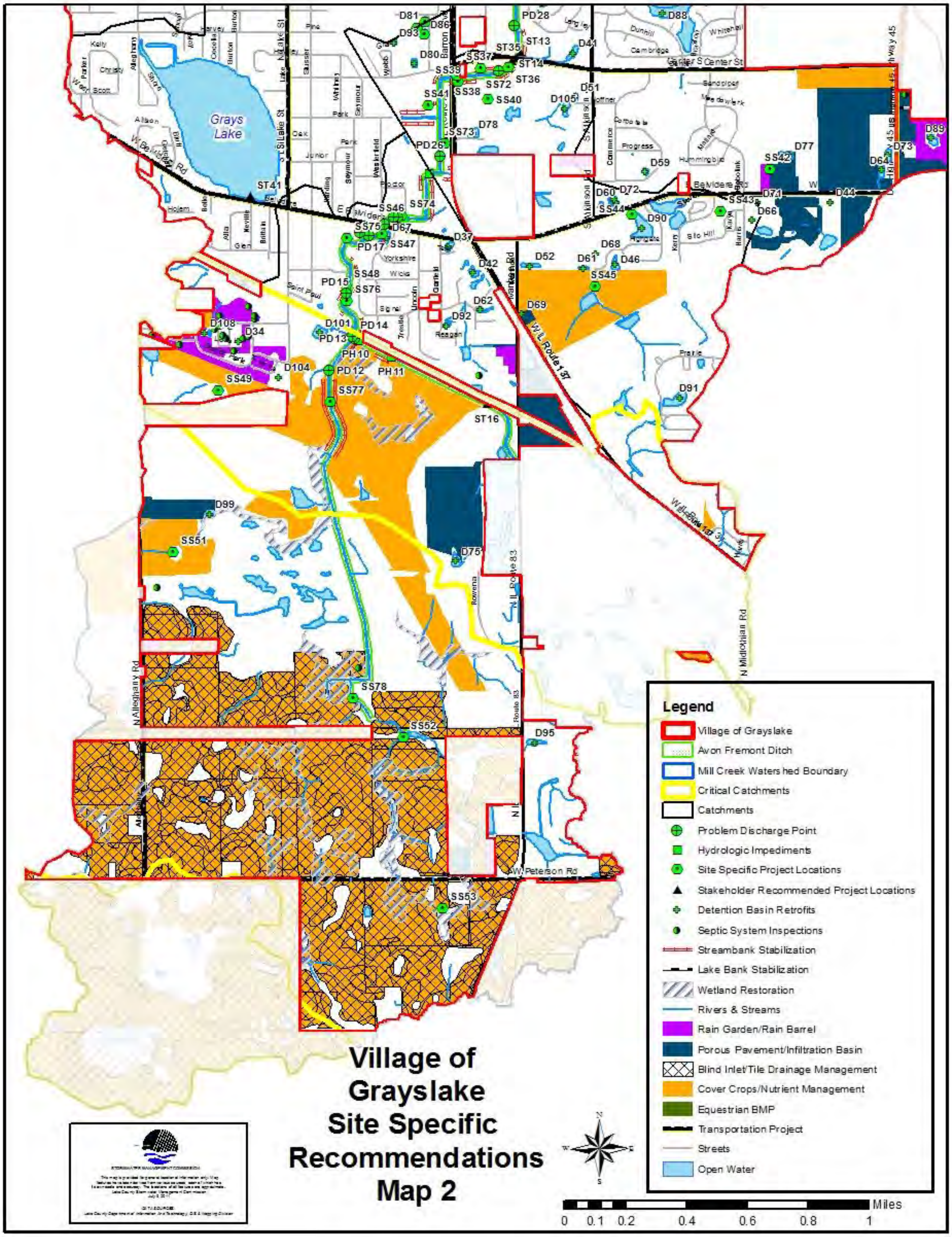


Figure 6-11: Site specific recommendations, Village of Grayslake map 2.

STORMWATER MANAGEMENT COMMISSION

6.4.3.4 VILLAGE OF GURNEE

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-23: Site specific actions, Village of Gurnee.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and install cover crops.**	**9.5 acres**	**H**	**M**
SG	**Streambank stabilization.**	**125 feet**	**H**	**L**
SG*	Existing wetland restoration and protection.	3.6 acres	L	M
SS17	Detention basin installed.	1.2 acres	H	S
SS21 & SS22	**Expand existing detention basins to increase storage.**	**2 acres**	**H**	**M**
SS24	Expand existing detention basins to increase storage.	1.6 acres	L	M
TP	US 45-lane expansion project minimize impacts to existing wetland using buffers.	3,290 feet	H	L
TP	**Rollins Rd - installation of signals, no specific recommendation.**	**1,147 feet**	**H**	**L**

* Sites identified in section 6.3.4

Table 6-24: Site specific actions, Gurnee (Detention Basins).

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D110	Detention Basin Retrofit	Fix FES at inlet 1 and grate, clear debris from inlet 6, install energy-dissipation BMP at inlets 1,2,5, and 6.	Village of Gurnee Lake	M	L
D111	**Detention Basin Retrofit**	**Clear outlet of debris.**	**Ravinia Woods Pond 1**	**H**	**L**
D112	Detention Basin Retrofit	Disconnect sump pumps, fix aerator, replace outlet, install trash grate on inlet 5.	Concord Oaks Pond	M	L
D113	Detention Basin Retrofit	Clear debris from outlet, locate and clear inlets.	Elysian Fields Pond 3	M	L
D114	Detention Basin Retrofit	Install energy-dissipation BMP around inlets and trash grates.	Hunt Club Park Pond 2	M	L
D115	Detention Basin Retrofit	Clear debris from outlet and perform algae treatment.	Ravinia Woods Pond 12	M	L
D116	Detention Basin Retrofit	Clear debris from inlets, install energy-dissipation BMP at inlets, remove inlet 7 and redirect flow to Inlet 6 to prevent short-circuiting.	Bittersweet Golf Club Pond 13	M	L
D117	Detention Basin Retrofit	Clear inlet 2 of vegetation and locate outlet and clear of debris.	Ravinia Woods 4 of 6	M	L

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D118	Detention Basin Retrofit	440 Hillview Dr. and 456 Hillview Dr. experience flooding each rain. Instead of having pipe turn to 11-167 go straight to 111-169 - this may prevent flooding.	Ravinia Woods Pond 11	H	S
D119	Detention Basin Retrofit	Clear debris from inlets.	Bittersweet Golf Club Pond 7	M	L
D120	Detention Basin Retrofit	Install trash grate and energy-dissipation BMP on inlet. Disconnect sump pumps.	Villas of Stonebrook Pond	M	L
D121	Detention Basin Retrofit	Plant native grasses on slopes.	Timberwoods Pond 1	M	L
D122	Detention Basin Retrofit	Clear debris from emergency overflow.	Bittersweet Golf Club Pond 18	M	L
D123	Detention Basin Retrofit	Remove brick wall and slope, replace turf grass with native grasses.	Bittersweet Golf Club Pond 22	M	L
D124	Detention Basin Retrofit	Replant slopes with native plants, replace outlet.	Elysian Fields Pond 1	M	L
D125	Detention Basin Retrofit	Install energy-dissipation BMP at the inlets and install trash grates.	Woodside Park Subdivision Pond 4	M	L
D126	Detention Basin Retrofit	Install energy-dissipation BMP at inlet 1, clear debris from outlet structures.	Bittersweet Golf Club Pond 15	M	L
D127	Detention Basin Retrofit	Relocate inlet to north bank, replant banks with native vegetation. Clear outlet of debris.	Ravinia Woods Pond 10	M	L
D128	**Detention Basin Retrofit**	**Remove brick walls and slope, plant native grasses, fix aerator.**	**n/a**	**H**	**L**
D129	Detention Basin Retrofit	Remove low flow bypass from inlet 1 to outlet, plant native vegetation.	Washington Park Subdivision Pond 2	M	L
D130	Detention Basin Retrofit	Put energy-dissipation BMP in front of Inlets 1 and 2 to prevent erosion.	Bittersweet Golf Club Pond 1	M	L
D131	Detention Basin Retrofit	Remove inlet 2, run to storm sewer then basin/new inlet on SE corner.	Greystone Commercial Pond 2	M	L
D132	Detention Basin Retrofit	Replace turf grass with native vegetation on banks.	Aberdare Estates Pond 2	M	L
D133	Detention Basin Retrofit	Move inlet 1 to north bank.	Woodside Park Subdivision Pond 3	M	L
D134	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance.	Bittersweet Golf Club Pond 12	M	L

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D135	Detention Basin Retrofit	Remove concrete wall and replace with slope.	Bittersweet Golf Club Pond 17	M	L
D136	Detention Basin Retrofit	Remove low-flow bypass, slope bottom more to promote greater water removal, clear inlets 1and 6 of debris and replace inlet 7 due to scour.	Gurnee Town Centre Pond	M	L
D137	Detention Basin Retrofit	Install energy-dissipation BMP at inlets.	Ravinia Woods Pond 13	M	L
D138	Detention Basin Retrofit	Plant slopes with native vegetation.	n/a	M	L
D139	Detention Basin Retrofit	Relocate outlet to SW corner, install trash grate on inlet, plant native vegetation on slopes.	Kingsport Woods Pond 4	M	L
D140	Detention Basin Retrofit	Relocate outlet to SW corner, install trash grate and energy-dissipation BMP to inlet, and replant banks with native vegetation.	Kingsport Woods Pond 3	M	L
D141	Detention Basin Retrofit	Plant banks and bed with native vegetation.	Kingsport Woods Pond 1	M	L
D142	Detention Basin Retrofit	Plant native vegetation along banks, repair aerator.	Warren Township Center Pond 1	M	L
D143	Detention Basin Retrofit	Plant native vegetation and install energy-dissipation BMP on inlets	n/a	M	L

Table 6-25: Flood Problem Area Inventory recommendations for Village of Gurnee.

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-17	Village of Gurnee	Capacity	Replace 1 existing inlet and increase capacity of storm water system. Re-grade swale to provide positive drainage to inlet.	$57,000	n/a	M

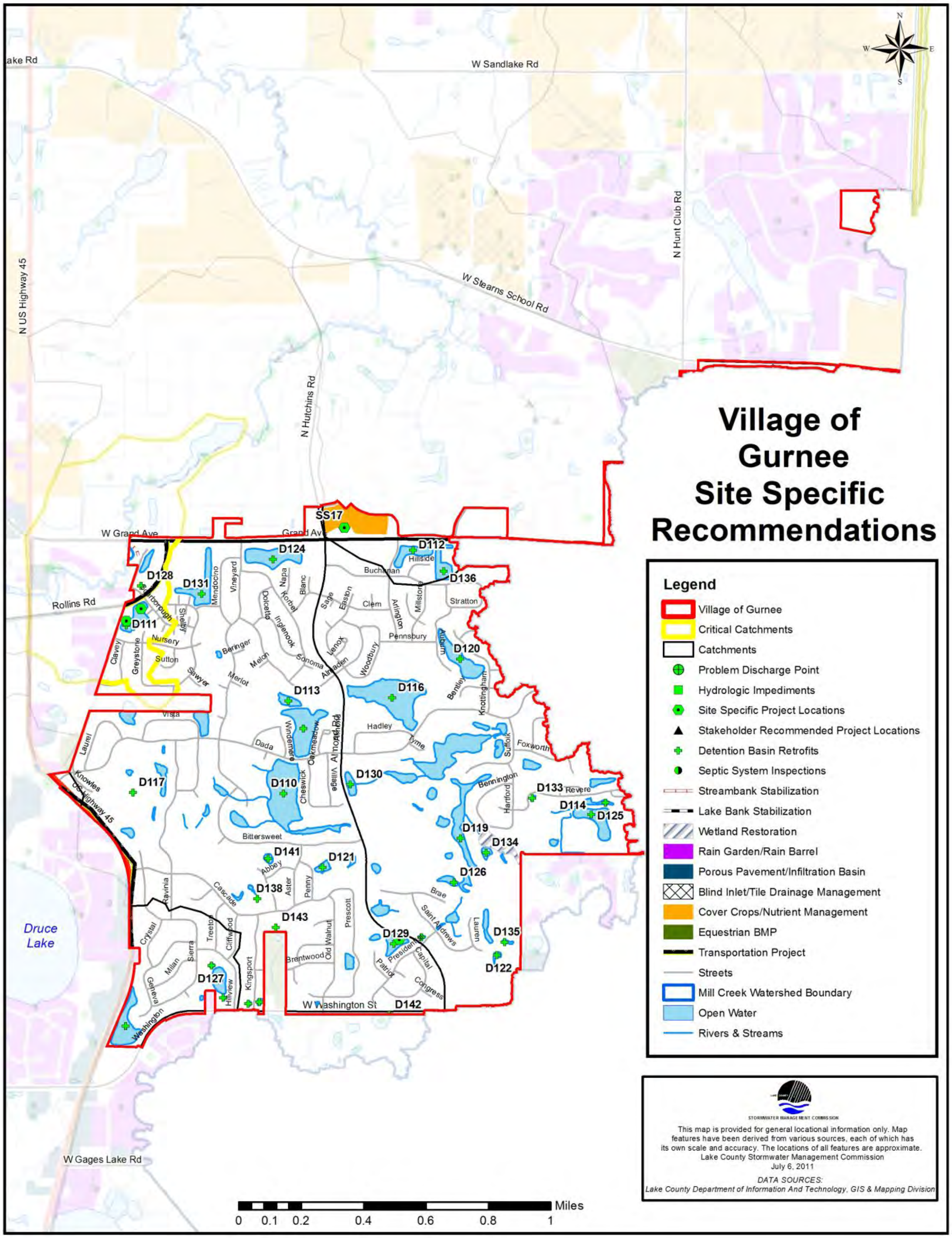


Figure 6-12: Site specific recommendations, Village of Gurnee.

6.4.3.5 VILLAGE OF LINDENHURST

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-26: Site specific actions, Village of Lindenhurst.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and install cover crops.**	**139 acres**	**H**	**M**
L11-L13	**Stabilize eroding lake banks using energy-dissipation BMP.**	**245 feet**	**H**	**S**
SG	Install rain barrels and rain gardens. These areas include residential land uses in unsewered areas of the watershed.	7 acres	M	L
SG	Inspect septic system and develop training program for septic pumpers.	2	M	M
SG*	Existing wetland restoration and protection,	23 acres	L	M
ST17	Assess drainage problem.	N/A	H	S
ST39	Shoreline stabilization, removal of invasives, and restoration with native vegetation for the Farmington Green detention basin	N/A	H	S
SS59	Detention, porous pavement or infiltration basin.	0.4 acres	L	M
TP	Sand Lake Rd. - HMA overlay, no specific recommendations.	6,913 feet	M	L

* Sites identified in section 6.3.4

Table 6-27: Site specific actions, Village of Lindenhurst (Detention Basins).

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D144	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance.	Country Place - Lindenhurst Pond 2	M	L
D145	Detention Basin Retrofit	Clear banks of woody vegetation.	Eagle Ridge Center Pond 2	M	L
D146	Detention Basin Retrofit	Clear inlet 3 of debris, install energy-dissipation BMP at inlet 2	Country Place - Lindenhurst Pond 3	M	L
D147	Detention Basin Retrofit	Clear inlet 6 of debris, remove woody veg. from N and E slopes, and replace turf grass and buckthorn with native vegetation on banks.	Harvest Hill Pond	M	L
D148	Detention Basin Retrofit	Clear outlet of debris and Pursue remedy to nutrient enrichment/algae abundance.	Country Place - Lindenhurst Pond 4	M	L
D149	Detention Basin Retrofit	Clear Inlet 1, install energy-dissipation BMP at inlet 2, reduce slope on N bank, plant banks with native plants.	Emerald Ridge Pond 1	M	L
D150	Detention Basin Retrofit	Remove concrete channel, replace inlet 1 and install energy-dissipation BMP in front, clear outlet A of debris, plant bed and slopes with native vegetation.	Venetian Village Pond 1	M	L

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D151	Detention Basin Retrofit	Fix aerator, disconnect sump pump, and remove woody vegetation from west slope. Plant native vegetation on all slopes.	Cross Creek Pond	M	L
D152	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance.	n/a	M	L
D153	Detention Basin Retrofit	Disconnect sump pump, plant native vegetation on slopes, clear inlet 3 of debris.	Country Place - Lindenhurst Pond 1	M	L
D154	Detention Basin Retrofit	Replace riprap with native vegetation.	n/a	M	L
D155	Detention Basin Retrofit	Replace turf grass with native vegetation.	Country Place - Lindenhurst Pond 5	M	L
D156	Detention Basin Retrofit	Remove low flow bypass with installation of FES inlet 1 and outlet A. Plant bottom and slopes with native plants, remove concrete channel at inlet 2.	Mallard Ridge Park Pond	M	L
D157	Detention Basin Retrofit	Plant slopes with native grasses.	n/a	M	L
D158	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance.	Country Place - Lindenhurst Pond 6	M	L
D159	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance, clear woody veg. and plant native vegetation.	Falling Waters Pond 2	M	L
D160	Detention Basin Retrofit	Replace riprap and turf grass banks with native vegetation. Create forebay around inlet 1 and install energy-dissipation BMP in front of inlet 2.	Emerald Ridge Pond 2	M	L
D161	Detention Basin Retrofit	Replace riprap with native vegetation.	n/a	M	L

Table 6-28: Flood Problem Area Inventory recommendations for Village of Lindenhurst.

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-04	Village of Lindenhurst	Capacity	Clean out culvert under Old Elm. Check capacity of existing culvert. Possibly increase capacity and re-grade swales.	$24,000	H	S

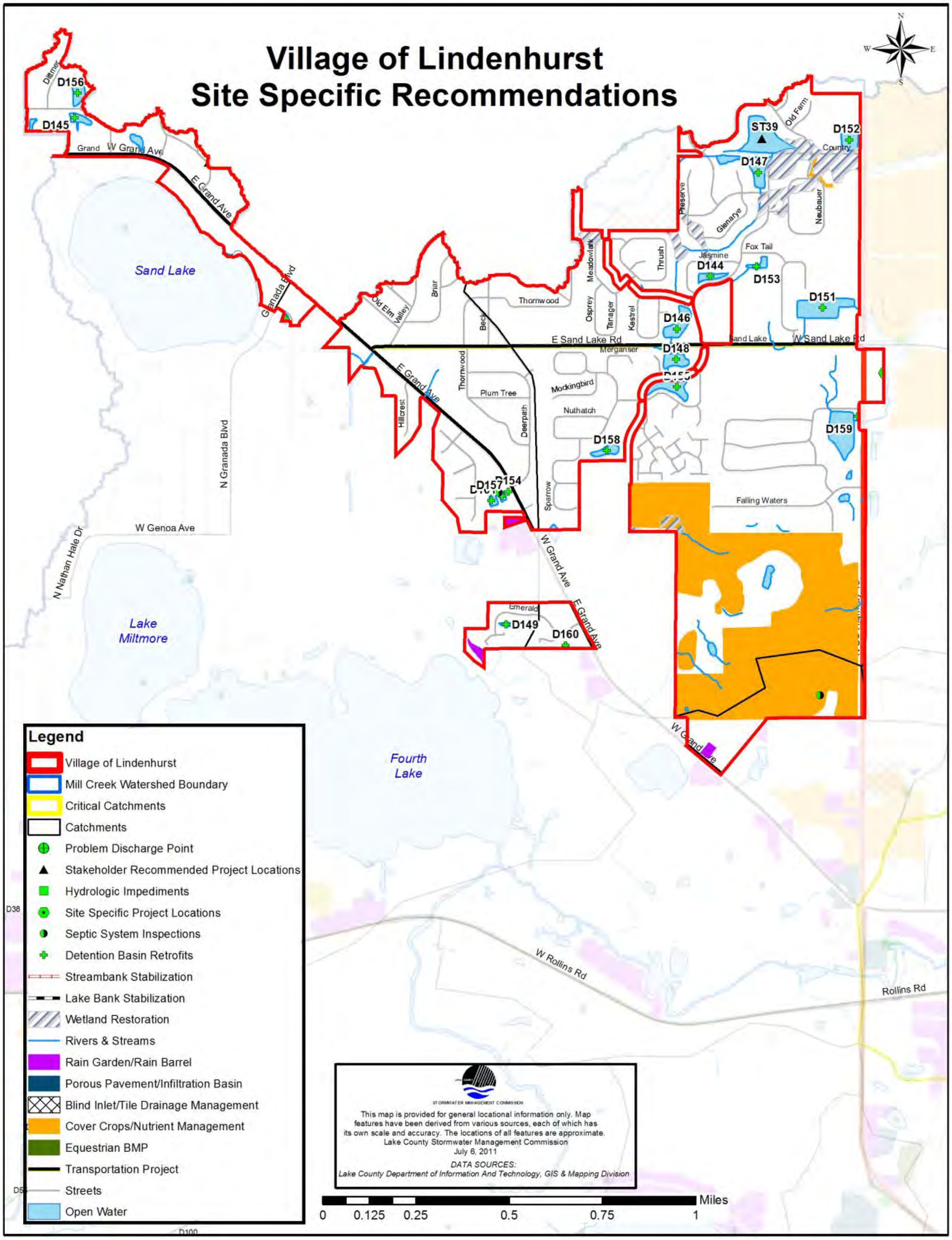


Figure 6-13: Site specific recommendations, Village of Lindenhurst.

6.4.3.6 VILLAGE OF OLD MILL CREEK

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-29: Site specific actions, Village of Old Mill Creek.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and install cover crops.**	**1,102 acres**	**H**	**M**
SG	Implement diversions, detention and gutter systems on equestrian facilities.	41 acres	M	M
SG	Implement diversions and detention on equestrian pasture.	29 acres	M	M
SG	Install infiltration basins and/or porous pavement. These areas include commercial, cultural, institutional, and industrial land uses in unsewered areas of the watershed.	4 acres	M	L
SG	Implement rain barrels and rain gardens. These areas include residential land uses in unsewered areas of the watershed	34 acres	M	L
SG	**Streambank stabilization.**	**718 feet**	**M**	**L**
SG	Inspect septic systems and develop training program for septic pumpers.	8	M	M
SG*	Existing wetland restoration and protection.	147	L	M
SS1	Wetland creation.	10 acres	H	M
SS2	Wetland creation and two-stage ditch construction.	1 acre	H	M
SS5	Large wetland creation.	5.5 acres	M	L
SS6 & SS7, SS10 & SS11	**Install water and sediment control basin.**	**9**	**M**	**S**
SS8	**Install grassed waterway.**	**0.3 acres**	**M**	**M**
SS9	Install riparian buffer/filter strip.	1 acre	L	M
SS56, SS58, SS60	Install riparian buffer/filter strip.	3.3 acres	L	M
TP	Sand Lake Rd. - HMA overlay, no specific recommendations.	72 feet	M	L
TP	Hunt Club Rd. resurfacing - minimize impacts to existing wetlands during resurfacing.	1,460 feet	M	S

* Sites identified in section 6.3.4

Table 6-30: Site specific actions, Village of Old Mill Creek (Detention Basins, Hydrologic Impediments and Problem Discharge Points).

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D162	Detention Basin Retrofit	Plant natural vegetation where inlet is bare.	Tempel Smith Lake 1 - ADID 47	M	L
PD38	Problem Discharge Point	4-inch CMP filled with sediment and 5-feet of lateral erosion has exposed pipe, pipe broken and is sharp and dangerous. Identify source and disable or restore the outlet structure.	n/a	H	L
PH12	Hydrologic Impediment	Secondary CMP under road is partially filled with sediment, lower conveyance capacity than designed. Remove sediment from the culvert.	n/a	M	S

Table 6-31: Flood Problem Area Inventory recommendations for Village of Old Mill Creek.

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-16	Village of Old Mill Creek	New Structure	Install new culvert under Hunt Club Road to provide adequate capacity.	$64,000	L	L

Table 6-32: Potential flood storage in Village of Old Mill Creek.

Site ID	Jurisdiction	Action	Estimated Potential Storage (acre-ft)	Priority	Time frame
FS49	Village of Old Mill Creek	Feasibility study and cost/benefit analysis to evaluate the five potential flood storage locations in the village.	10	M	M
FS50			13	H	S
FS51			9	M	M
FS52			8	M	L
FS53			8	M	L

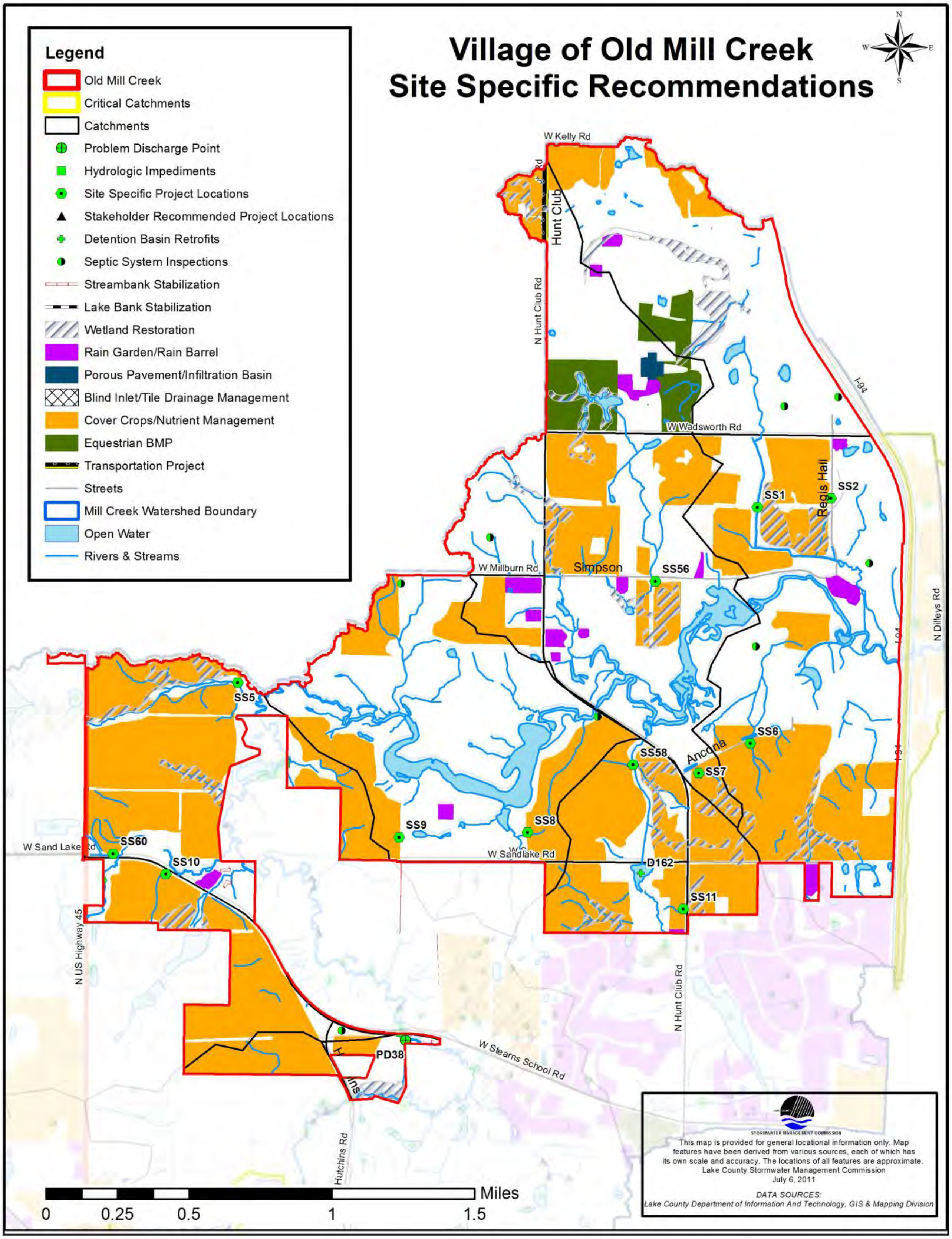


Figure 6-14: Site specific recommendations, Village of Old Mill Creek.

6.4.3.7 VILLAGE OF ROUND LAKE BEACH

Table 6-33: Site specific actions, Village of Round Lake Beach.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SS18	Detention basin or wetland creation.	6.4 acres	M	L
SS65	Porous pavement, bioswales, infiltration basin for parking lot.	0.23 acres	L	M
TP	US 83 lane expansion project - apply BMPs in the final design. Include bioswales and road salt management.	1,089 feet	H	L
TP	Rollins Rd - installation of signals, no specific recommendation.	2,972 feet	L	L

Table 6-34: Site specific actions, Round Lake Beach (Detention Basins).

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D163	Detention Basin Retrofit	Clear sediment and debris from inlet.	n/a	M	L
D164	Detention Basin Retrofit	Plant native vegetation on bed and slopes, replace inlet 2, unclog outlet A.	Foxchase Pond 1	M	L
D165	Detention Basin Retrofit	Plant native vegetation on banks and bed.	n/a	M	L
D166	Detention Basin Retrofit	Plant native vegetation on banks and clear inlet 4 of debris.	Sweetwater Mill Pond 1	M	L
D167	Detention Basin Retrofit	Plant full slopes with native vegetation, clear debris and sediment from inlet 1.	n/a	M	L
D168	Detention Basin Retrofit	Plant native vegetation on banks.	Coventry Estates Pond 2	M	L
D169	Detention Basin Retrofit	Clear outlet of debris, sweep the basin for trash.	n/a	M	L
D170	Detention Basin Retrofit	Sweep basin for trash, disconnect sump pump.	n/a	M	L
D171	Detention Basin Retrofit	Plant bed and slopes with native vegetation.	Foxchase Pond 2	M	L

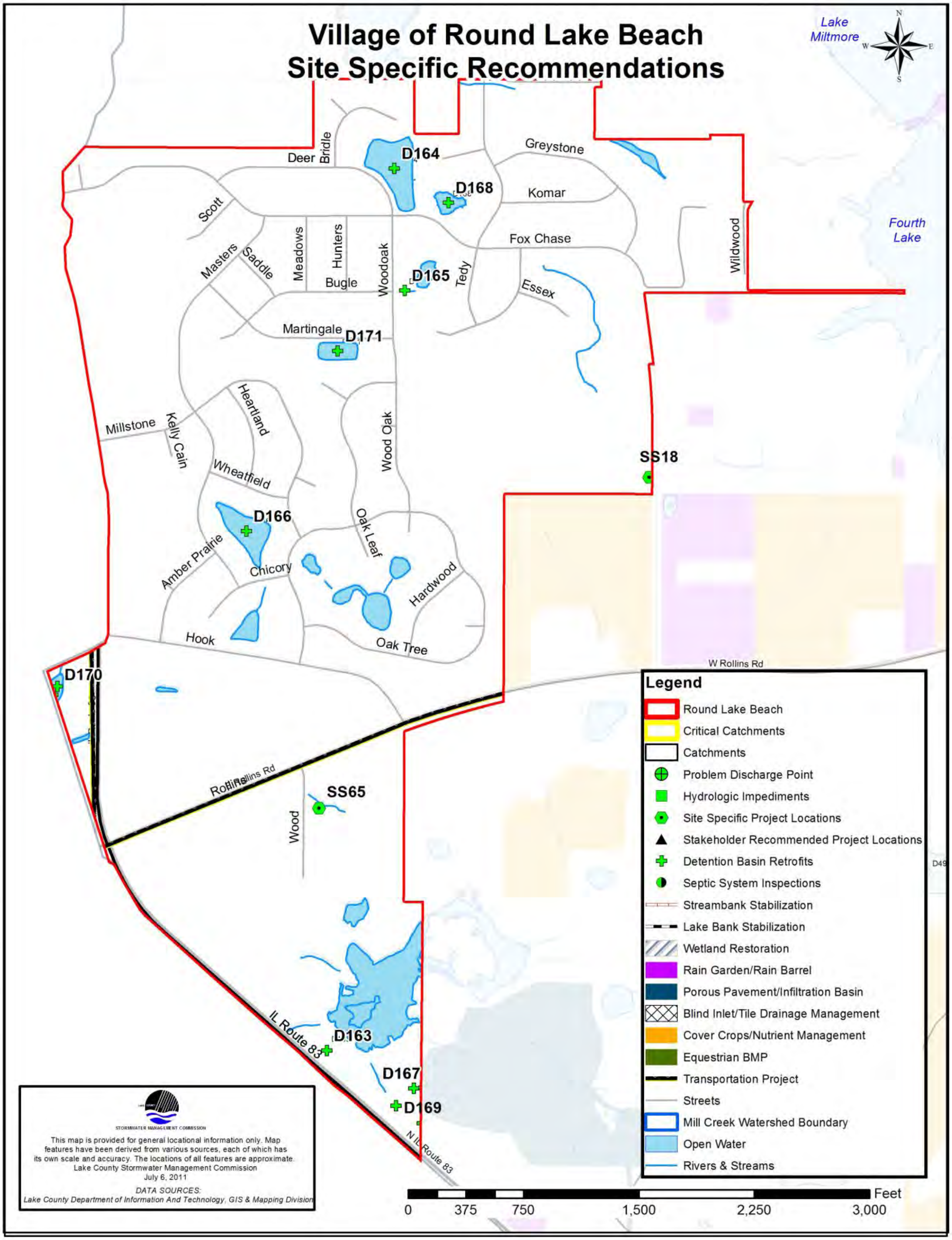


Figure 6-15:- Site specific recommendations, Village of Round Lake Beach.

6.4.3.8 VILLAGE OF ROUND LAKE PARK

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-35:- Site specific actions, Village of Round Lake Park.

BMP Code	Action	Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and install cover crops.**	**18 acres**	**H**	**M**
SG	**Install blind inlets and/or tile drainage management on tiled agricultural ground.**	**5 acres**	**H**	**M**
TP	Alleghany Rd. resurfacing - minimize impacts to existing wetlands during resurfacing.	527 feet	M	S

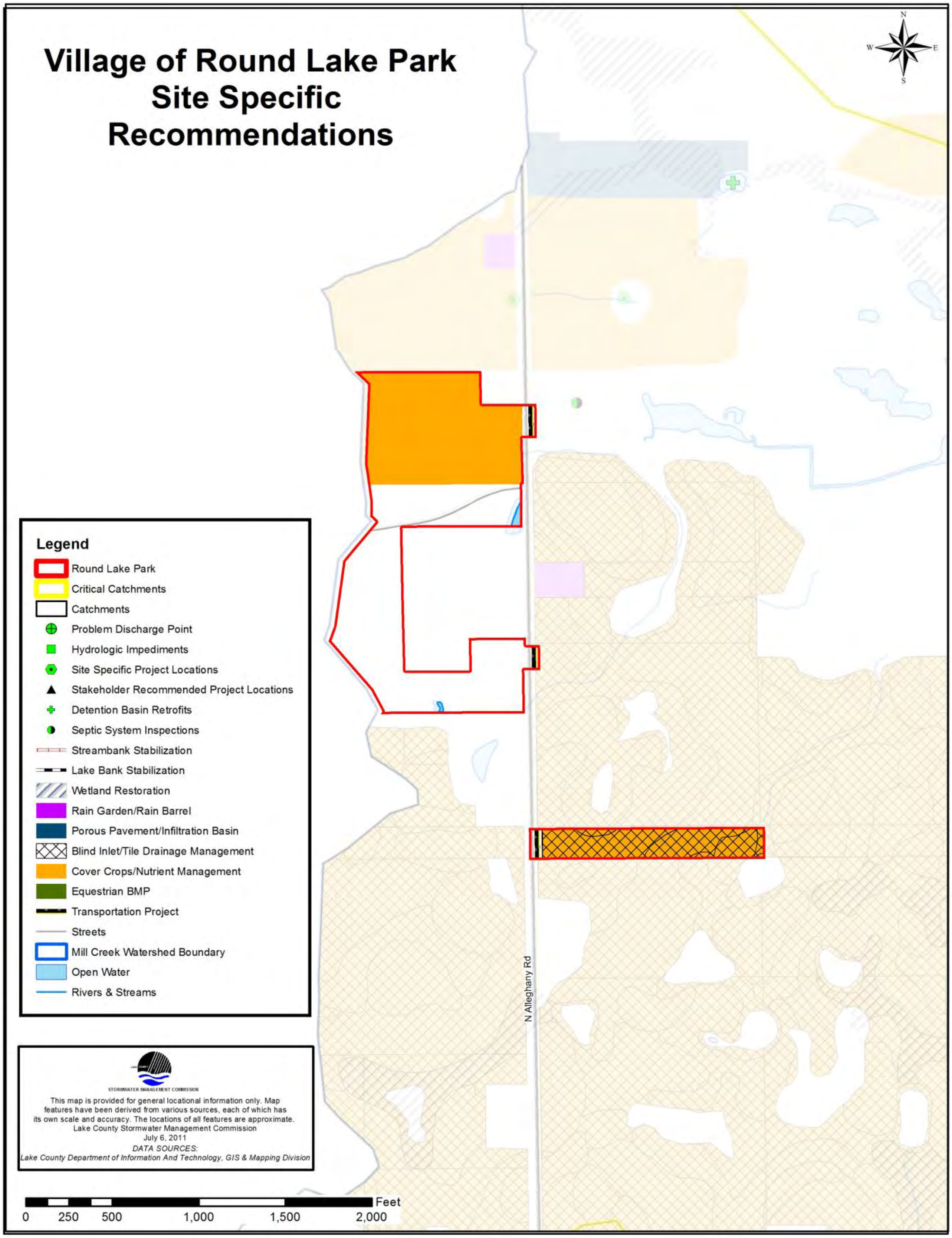


Figure 6-16: Site specific recommendations, Village of Round Lake Park.

6.4.3.9 VILLAGE OF THIRD LAKE

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-36: Site Specific Actions, Village of Third Lake.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and install cover crops.**	**17 acres**	**H**	**M**
L14	**Stabilize eroding lake banks using energy-dissipation BMP.**	**73 feet**	**H**	**S**
SG	Install infiltration basins and/or porous pavement. These areas include commercial, cultural, institutional, and industrial land uses in unsewered areas of the watershed.	36 acres	M	L
SG	Encourage the installation of rain barrels and rain gardens. These areas include residential land uses in unsewered areas of the watershed.	111 acres	M	L
SG*	Existing wetland restoration and protection.	4	L	M
ST20	**Dam replacement and maintenance.**	**1**	**H**	**S**
ST22	**Develop Third Lake Management Plan.**	**1**	**H**	**S**
ST23	**Erosion control and sediment trap.**	**1**	**H**	**S**
ST26	Washington Village detention pond stabilization/sediment trap.	1	H	S
SS23	Wetland creation.	0.8 acres	L	M
TP	**US 45 lane expansion project: 1) Minimize impact to existing wetlands using buffers and detention, 2) Use BMPs in final design bioswales and road salt management.**	**4,046 feet**	**H**	**L**
TP	Rollins Rd - installation of signals, no specific recommendation.	2,138 feet	L	L

* Sites identified in section 6.3.4

Table 6-37: Site specific actions, Village of Third Lake (Detention Basins).

BMP Code	Type	Action	Basin Name	Priority	Time Frame
D172	Detention Basin Retrofit	Plant native grasses on bottom and slopes, remove low-flow bypass.	Mariners Cove Pond 3	M	L
D173	Detention Basin Retrofit	Plant native grasses on banks, unclog inlet 1.	n/a	M	L
D174	Detention Basin Retrofit	Install trash grates over inlets, and plant native vegetation on northwest bank.	Mariners Cove Pond 2	M	L
D175	Detention Basin Retrofit	Algae treatment.	n/a	M	L
D176	Detention Basin Retrofit	Algae treatment.	n/a	M	L

Table 6-38: Flood Problem Area Inventory recommendations for Village of Third Lake.

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-20	Unincorporated / Village of Third Lake	Capacity	Replace 2 existing inlets and increase capacity of storm water system.	$49,000	n/a	M
11-35	Village of Third Lake	Capacity	Replace 1 existing inlet and possibly add more inlets. Re-grade parking lot to drain to inlets.	$100,000	L	M
11-30	Village of Third Lake	Study	Perform detailed stormwater analysis and develop concept/preliminary engineering level report that identifies 2-3 solutions.	$10,000 – 20,000	M	S

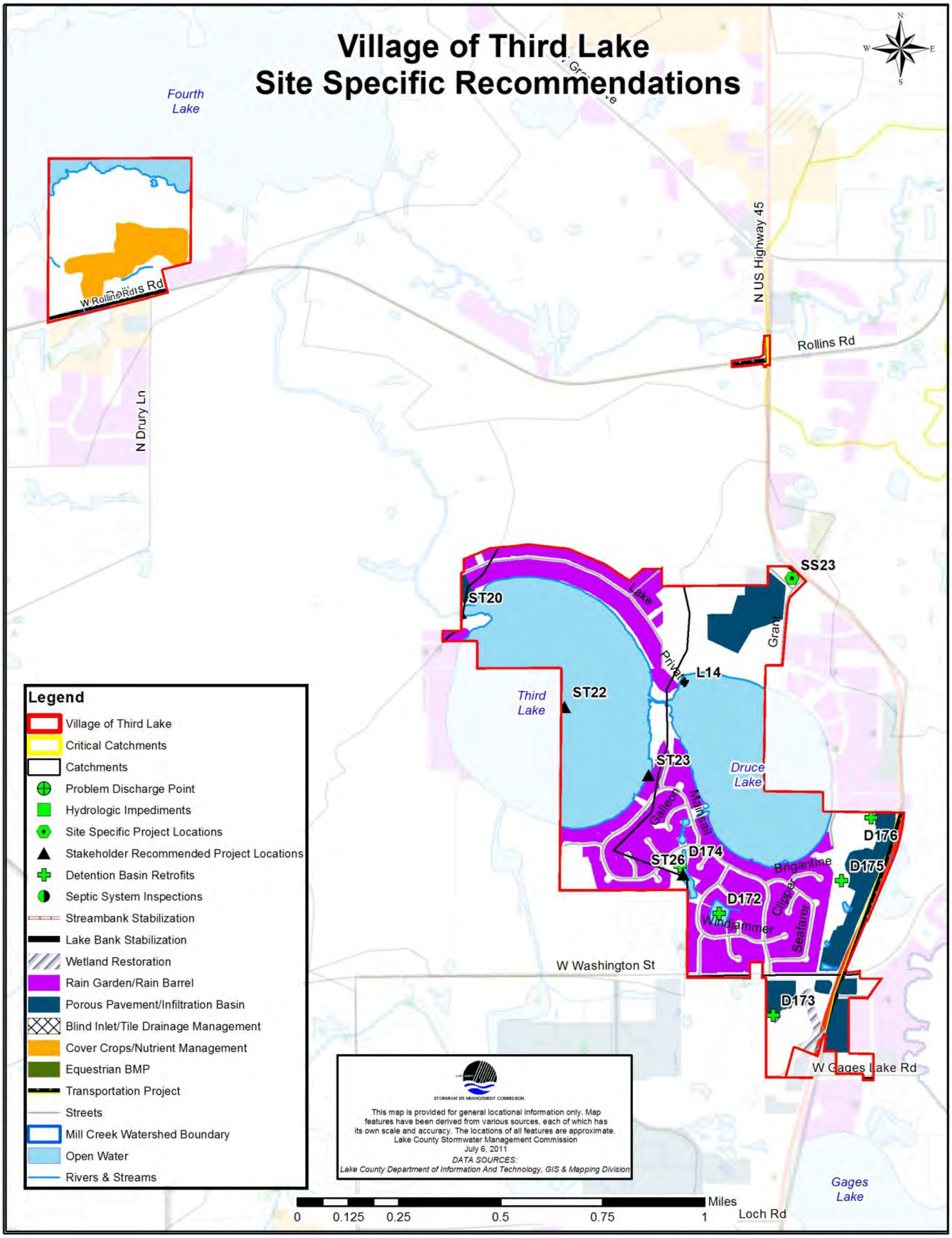


Figure 6-17: Site specific recommendations, Village of Third Lake.

6.4.3.10 VILLAGE OF WADSWORTH

Noteworthy:

Critical Area Actions

Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-39: Site Specific Actions, Village of Wadsworth.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and apply cover crops.**	**9 acres**	**H**	**M**
SG	**Inspect septic systems and develop training program for septic pumpers.**	**1**	**M**	**M**
SG*	**Existing wetland restoration and protection.**	**12**	**L**	**M**

* Sites identified in section 6.3.4

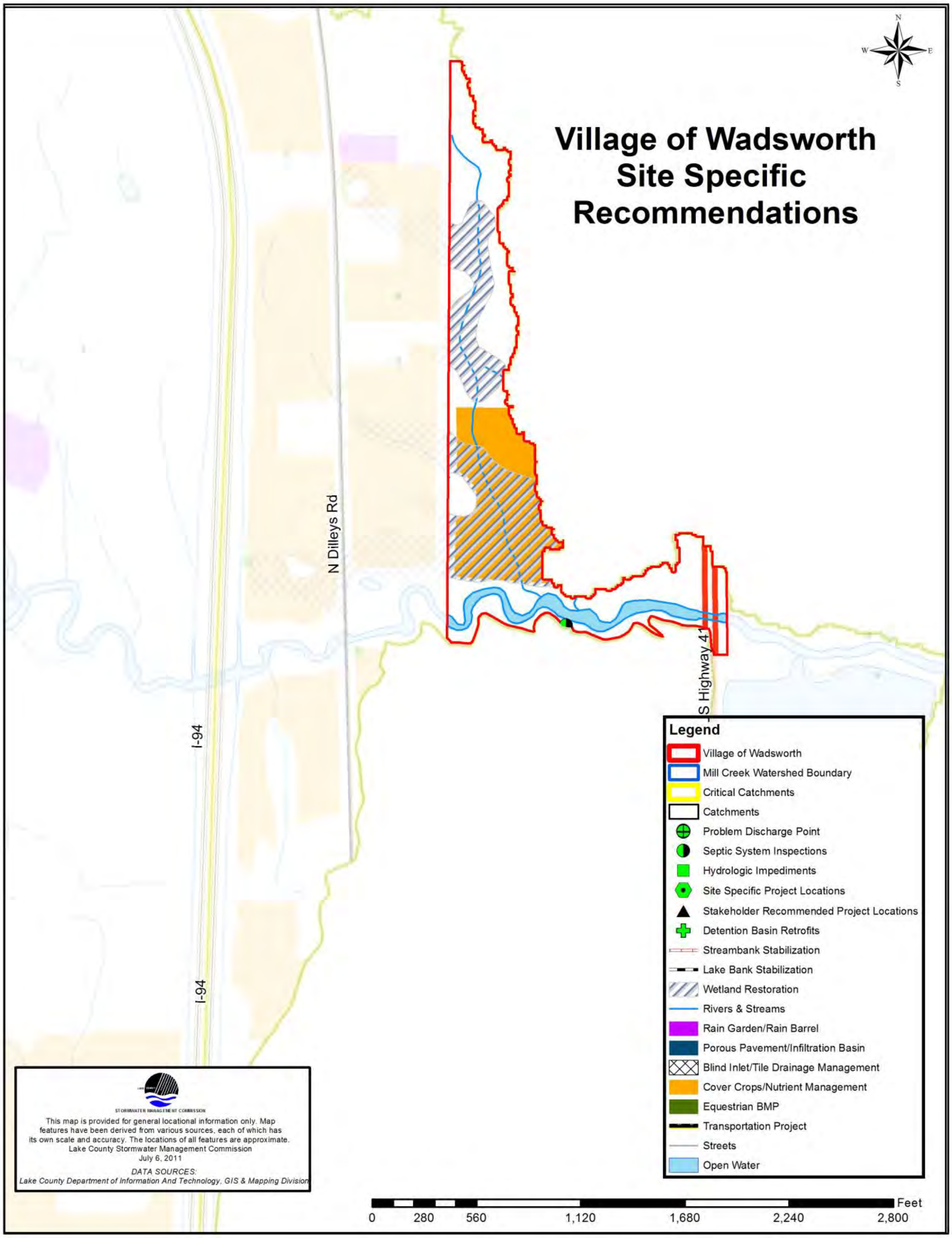


Figure 6-18: Site specific recommendations, Village of Wadsworth.

6.4.3.11 UNINCORPORATED LAKE COUNTY

Noteworthy:
Critical Area Actions
Actions in **bold** font address critical areas identified for the watershed and should be prioritized to achieve the greatest value and benefit.

Table 6-40: Site specific actions, Unincorporated Lake County.

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SG	**Implement nutrient management plans and install cover crops.**	**629 acres**	**H**	**M**
SG	Implement diversions, detention and gutter systems on equestrian facilities.	13 acres	L	M
SG	Implement diversions and detention on equestrian pasture.	13 acres	M	M
L1-L10	**Stabilize eroding lake banks using energy-dissipation BMP (1,750ft in Grandwood Park Lake).**	**2,657 feet**	**H**	**S**
SG	**Install infiltration basins and/or porous pavement. These areas include commercial, cultural, institutional, and industrial land uses in unsewered areas of the watershed.**	**47 acres**	**H**	**L**
SG	**Implement rain barrels and rain gardens. These areas include residential land uses in unsewered areas of the watershed.**	**528 acres**	**H**	**L**
SG	**Install blind inlets and/or tile drainage management on tiled agricultural ground.**	**384 acres**	**H**	**M**
SG	**Streambank stabilization.**	**6,300 feet**	**H**	**L**
SG	**Inspect septic systems and develop training program for septic pumpers.**	**50**	**L**	**M**
SG*	**Existing wetland restoration and protection.**	**131**	**H**	**M**
ST5, ST7, ST8	Grade control structure/gully stabilization.	5	H	S
ST8	Wetland with grade control structure.	1	H	S
ST37	**Grandwood Park dam restoration/modification/ removal and downstream stabilization**	**1**	**H**	**M**
SS3	**Construct detention basin**	**0.5 acres**	**H**	**M**
SS4	**Construct WASCB or detention basin.**	**1**	**H**	**S**
SS12	Construct detention basin.	0.5 acres	L	M
SS14	Retrofit existing detention basin for more storage.	1 acre	M	M
SS15	**Install grassed waterway (or detention).**	**0.8 acres**	**H**	**M**
SS16	Construct detention basin.	2 acres	M	L
SS50	Wetland creation.	2 acres	M	M
SS54	**Install grassed waterway (or detention).**	**11 acres**	**H**	**S**
SS55	**Wetland creation**	**0.8 acres**	**H**	**L**
SS57	Wetland creation, diversion and filter strip for equestrian facility.	0.4 acres	M	M
SS61 & SS63	Rain gardens for residential areas.	1.4 acres	M	M
SS79 & SS80	**Rain gardens for residential areas.**	**0.8 acres**	**L**	**M**

BMP Code	Action	Qty of Projects/Area Benefited	Priority	Time Frame
SS62	**Porous pavement opportunity.**	**2 acres**	**H**	**M**
SS64	**Construct detention basin or wetland.**	**0.35 acres**	**H**	**L**
SS66	Restore existing wetland.	2.1 acres	M	M
TP	**US 45, IL83 and Peterson Rd lane expansion project minimize impacts to existing wetland using buffers and install treatment wetland (BMP SS64).**	**11,443 feet**	**H**	**L**
TP	**IL Route 132, Rollins Rd. - installation of signals, no specific recommendation.**	**8,633 feet**	**H**	**L**
TP	Washington St. - lane additions and railroad underpass, use BMPs in final design. Include bioswales and road salt management.	316 feet	M	L
TP	**Peterson Rd. - divided highway partial access control, minimize impacts to existing wetlands.**	**3,006 feet**	**H**	**L**
TP	**Dilleys Rd. resurfacing - minimize impacts to existing wetlands during resurfacing.**	**4,944 feet**	**H**	**S**

* Sites identified in section 6.3.4

Table 6-41: Flood Problem Area Inventory recommendations for Unincorporated Areas.

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-12	Unincorporated	Capacity	Replace 2 existing inlets and increase capacity of storm water system.	$103,000	H	S
11-13, 11-24, 11-32	Unincorporated	Capacity	Replace 2 existing inlets and increase capacity of storm water system. Construct new curb and gutter.	$203,000	H	S
11-18	Unincorporated / Village of Third Lake	New Structure	Install a culvert under Wright Street.	$25,000	H	S
11-21	Unincorporated	Grading	Re-grade areas where water is standing and provide positive drainage away from the house.	$10,000	H	S
11-01	Unincorporated	Capacity	Replace 3 inlets and improve capacity of storm water system on Fox Chase Drive. Possibly re-grade and/or add an inlet to backyards on the north side of Fox Chase Drive.	$76,000	M	M
11-09	Unincorporated, Forest Preserve District	New Structure	Install a culvert under road. Possibly re-grade road.	$33,000	M	M
11-11, 11-29	Unincorporated	Capacity	Replace 4 existing inlets and increase capacity of storm water system.	$182,000	M	M
11-14, 11-33	Unincorporated	Capacity	Replace 2 existing inlets and increase capacity of storm water system.	$91,000	M	S

FPAI ID	Jurisdiction	Mitigation Category	Proposed Concept-Level Mitigation Measure	Total Project Cost Estimate	Priority	Time frame
11-20	Unincorporated / Village of Third Lake	Capacity	Replace 2 existing inlets and increase capacity of storm water system.	$49,000	n/a	M
11-23	Unincorporated	Capacity	Replace 2 existing inlets and increase capacity of storm water system.	$28,000	L	M

Table 6-42: Site specific actions, Unincorporated (Detention Basins, Hydrologic Impediments and Problem Discharge Points).

BMP Code	BMP Type	Action	Basin Name	Priority	Time Frame
D5	Detention Basin Retrofit	Replace turf grass with native vegetation and install energy-dissipation BMP on slopes.	Mill Creek Crossing Pond 8	M	L
D6	Detention Basin Retrofit	Relocate inlet 1 to south bank. Clear outlet of debris.	Deerpath - Lake Villa Pond 5	M	L
D7	Detention Basin Retrofit	Clear inlet 4.	n/a	M	L
D8	Detention Basin Retrofit	Replace turf grass channels with native vegetation.	Hunt Club Farms Lake	M	L
D9	Detention Basin Retrofit	Plan native grasses on slopes.	Hunt Club Farms Pond 20	M	L
D10	Detention Basin Retrofit	Re-grade slope to 3:1 or less, plant native vegetation on banks.	Mill Creek Crossing Pond 4	M	L
D11	Detention Basin Retrofit	Replace inlet and plant slopes with native vegetation.	Mill Creek Crossing Pond 6	M	L
D12	**Detention Basin Retrofit**	**Pursue remedy to nutrient enrichment/algae abundance.**		**H**	**L**
D13	Detention Basin Retrofit	Disconnect sumps, replace inlet 2, and establish native vegetation on slopes.	Mill Creek Crossing Pond 5	M	L
D14	Detention Basin Retrofit	Replant slopes with native vegetation, unclog inlet 3 of debris and pursue remedy to nutrient enrichment/algae abundance.	Bridlewood - Gurnee Pond 1	M	L
D15	Detention Basin Retrofit	Replant slopes with native vegetation.	Mill Creek Crossing Pond 7	M	L
D16	Detention Basin Retrofit	Replants slopes with native vegetation, remove inlet 1 and connect to basin 11-072.	Brookside Pond 1	M	L
D17	Detention Basin Retrofit	Pursue remedy to nutrient enrichment/algae abundance.	Deerpath - Lake Villa Pond 2	M	L

BMP Code	BMP Type	Action	Basin Name	Priority	Time Frame
D18	Detention Basin Retrofit	Replace turf grass with native vegetation, pursue remedy to nutrient enrichment/algae abundance, and reduce the slope of the east bank.	Hunt Club Farms Pond 14	M	L
D19	Detention Basin Retrofit	Install energy-dissipation BMP and a trash grate at inlet 1.	Oak Knoll PUD Pond 1	M	L
D20	Detention Basin Retrofit	Remove oaks and plant native prairie vegetation, install energy-dissipation BMP at inlets. Replace inlet 3, scoured mostly away.	Warren Township Center Pond 4	M	L
D21	Detention Basin Retrofit	Replace turf grass with native vegetation; remove inlet 1 and connect to storm sewer, energy-dissipation BMP at inlet 2.	Warren Township Center Pond 3	M	L
D22	Detention Basin Retrofit	Re-grade slope of east bank to 3:1 or lower, plant banks with native vegetation.	Brookside Pond 3	M	L
D23	Detention Basin Retrofit	Relocate outlet to NW corner, install energy-dissipation BMP at inlet.	Tangueray Meadows Pond 1	M	L
D24	Detention Basin Retrofit	Algae treatment.	n/a	M	L
D25	Detention Basin Retrofit	Flair the inlet, add energy-dissipation BMP and trash grate.	Oak Knoll PUD Pond 2	M	L
D26	Detention Basin Retrofit	Decrease slope, replace turf grass with native vegetation, replace inlet 2, and install energy-dissipation BMP due to scour.	Brookside Pond 2	M	L
D27	Detention Basin Retrofit	Trash clean up.	n/a	M	L
D28	Detention Basin Retrofit	Disconnect sump pump connections, clear inlets and outlets of debris.	n/a	M	L
D30	Detention Basin Retrofit	Grade steep slopes and plant native vegetation.	Bridlewood - Gurnee Pond 2	M	L
D31	Detention Basin Retrofit	Re-locate aerators to handle algae better.	n/a	M	L
D32	Detention Basin Retrofit	Clear litter from water, disconnect sump pump.	n/a	M	L
D33	Detention Basin Retrofit	Plant native vegetation along banks, repair aerator.	Warren Township Center Pond 1	M	L
PD2	**Problem Discharge Point**	**Loose 4-inch plastic corrugated pipe discharge, evaluate source and disable or reinforce outlet location.**	--	**H**	**M**
PD3	**Problem Discharge Point**	**Loose 4-inch plastic corrugated pipe discharge, evaluate source and disable or reinforce outlet location.**	--	**H**	**M**

BMP Code	BMP Type	Action	Basin Name	Priority	Time Frame
PD4	**Problem Discharge Point**	**Loose 4-inch plastic corrugated pipe discharge, evaluate source and disable or reinforce outlet location.**	**--**	**H**	**M**
PD5	Problem Discharge Point	8 - 10-inch CMP corroding, exposing sharp hazard. Identify source and disable or restore outlet structure.	--	M	M
PD6	**Problem Discharge Point**	**4-inch concrete/clay pipe, 1/4 filled with sediment. Rehabilitate outlet structure, evaluate source and disable or rehabilitate outlet location.**	**--**	**H**	**S**
PD7	Problem Discharge Point	Loose 4-inch plastic corrugated pipe discharge, evaluate source and disable or reinforce outlet location.	--	L	L
PD8	Problem Discharge Point	4-inch concrete/clay pipe, exposed 8-feet by bank erosion. Concrete pored over to protect creating an impediment. Remove concrete and rehabilitate outlet location to the bank.	--	H	S
PD9	Problem Discharge Point	Eroding bank exposing 6-inch concrete pipe. Stabilize bank and rehabilitate outlet structure.	--	M	M
PD10	Problem Discharge Point	Severely eroding channel, not large enough to support conveyance. Evaluation necessary.	--	M	M
PD11	Problem Discharge Point	8-inch concrete pipe, exposed by bank erosion. Stabilize bank erosion locally and rehabilitate outlet location.	--	M	M
PH5	Hydrologic Impediment	CMP structure in concrete is partially filled with sediment, limiting conveyance capacity of culvert. Remove sediment and stabilize eroding slopes on upstream end of culvert.	--	M	M
PH6	**Hydrologic Impediment**	**Conspan bridge with sediment and debris limiting conveyance capacity. Monitor bridge as part of a maintenance program.**	**--**	**H**	**M**

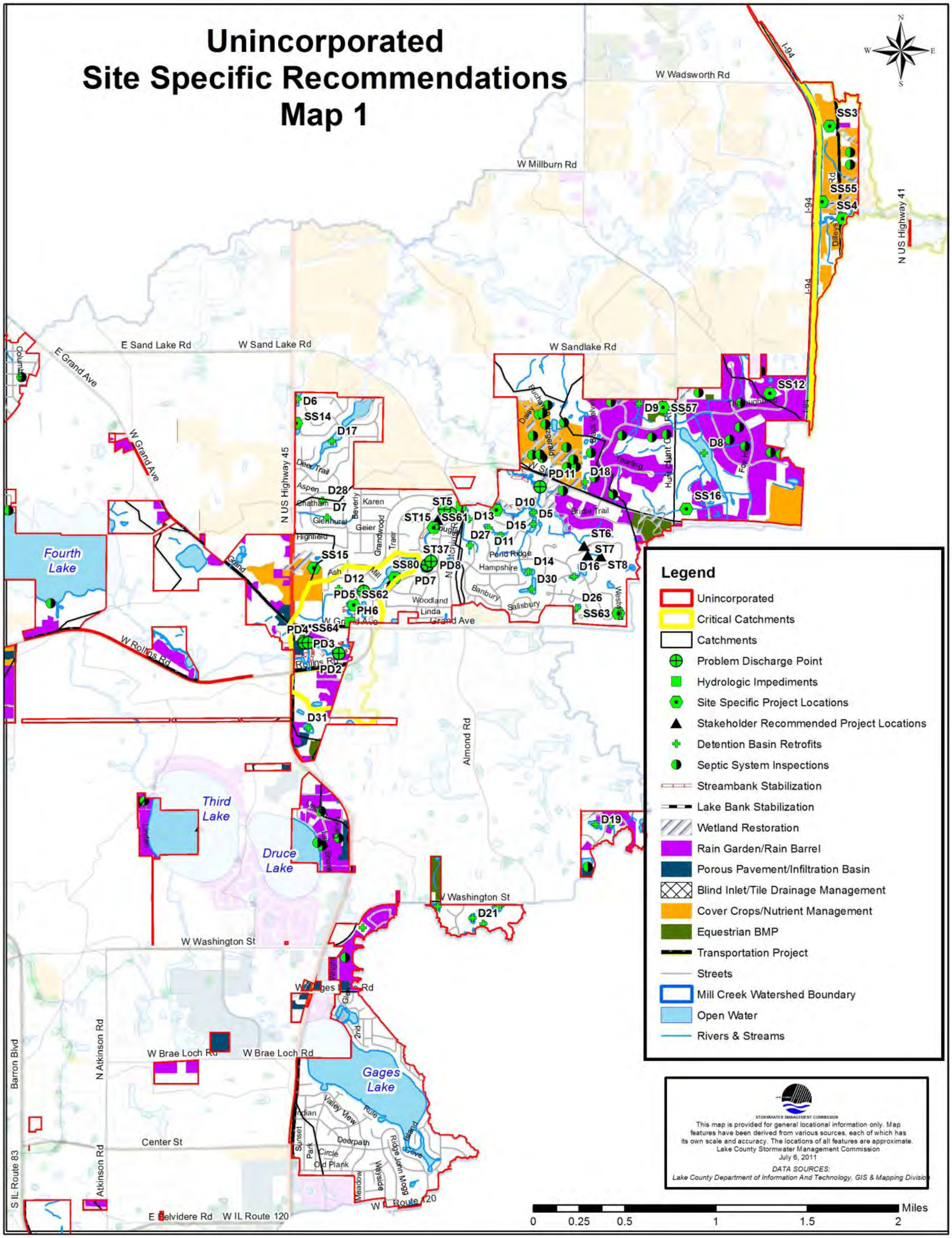


Figure 6-19: Site specific recommendations, Unincorporated Lake County map 1.

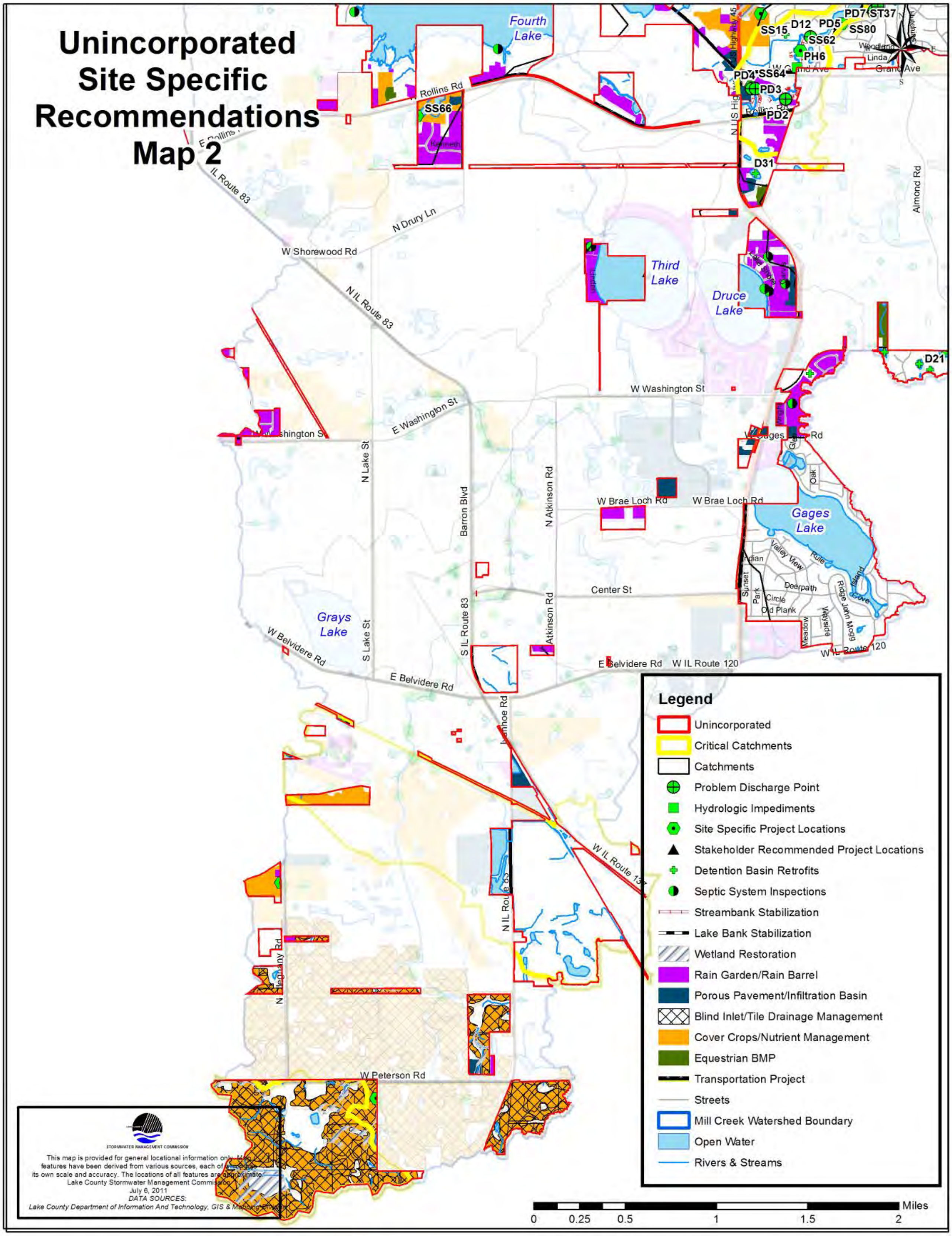


Figure 6-20: Site specific recommendations, Unincorporated Lake County map 2.

Contents

Tables and Figures

Common Acronyms/Abbreviations Used in Chapter 7

BMP – Best Management Practice
CRP – Conservation Reserve Program
EQIP – Environmental Quality Incentives Program
Illinois EPA – Illinois Environmental Protection Agency
IDNR – Illinois Department of Natural Resources
FSA – Farm Service Agency
LCHD – Lake County Health Department
LMU – Lakes Management Unit
NGRREC – National Great Rivers Research and Education Center
SMC – Lake County Stormwater Management Commission
SWCD – Soil and Water Conservation District
SWG – State Wildlife Grant
USFWS – U.S. Fish and Wildlife Service
USGS – United States Geologic Survey
VLMP – Volunteer Lake Management Program
WASCB – Water and Sediment Control Basin
WRF – Waste Reclamation Facility
WHIP – Wildlife Habitat Incentives Program

7. PLAN IMPLEMENTATION AND EVALUATION

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

- Pollution load reduction estimates for implementing action recommendations
- Estimated costs of plan implementation
- Watershed partners to lead and support plan implementation
- Initial steps for plan implementation
- Funding resources and opportunities
- Implementation schedule
- Evaluating plan performance
- Indicator and milestone grading system
- Water quality monitoring strategy

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

7.1 ESTIMATE OF POLLUTION LOAD REDUCTIONS AND REDUCTION TARGETS

Pollution load estimates were made using the nonpoint source model described in Chapter 4. The purpose of this exercise is to present a general idea of best management practice (BMP) implementation benefits and quantitatively assess which practices result in the greatest benefit to the watershed.

Load reduction estimates were **not** performed for all actions identified in Chapter 6; estimates were made for projects with specific on-the-ground locations, where project information was collected and reduction efficiencies are available in literature sources. In the case of many of the actions presented in Chapter 6, the available planning-level site-specific information is insufficient to make meaningful estimates. Load reduction estimates should be calculated for any individual implementation projects during the design stage of the project and BMP pollutant load reduction efficiencies should be monitored if funding allows. **Table 7-1** shows the categories of projects for which load reduction estimates are made and **Table 7-2** outlines the removal efficiencies that were applied.

It is important to note that overall sediment loads in the Mill Creek Watershed are relatively low on a per acre basis with much of the known excess sediment delivery resulting from severe and very severe streambank erosion. Nearly all fields observed during the watershed field survey utilize conservation practices to minimize soil loss. Except for using a selection of site-specific structural practices, or the widespread adoption of cover crops, little more can be done to further reduce sediment loads from agricultural ground.

Table 7-1: Project Categories Inclusive of Pollutant Load Reduction Estimates.

ID Code	Project Specific Action Category	Included in Load Reduction Estimates
SS + ST	Site-specific and stakeholder recommended best management practice projects	Yes*
SG	Site-specific BMPs that can be implemented over a large, generalized area	Yes
L	Lake shore erosion control practices	No
D	Detention basin retrofit projects	No
PD	Problem discharge locations into Mill Creek	No
PH	Problem hydraulic impediments in Mill Creek	No
FPAI	Flood problem areas identified in inventory	No
FS	Potential regionally significant flood storage sites	No
TP	Transportation specific actions	No
W	Potential wetland restoration and protection sites	No

*Load reductions are not calculated for 9 of the 37 stakeholder recommended practices. These practices lack sufficient information from which to calculate load reductions or will not result in measurable load reductions. These practices include: education, planning, dam removal, or drainage improvements already accounted for in load reductions for streambank stabilization.

Table 7-2: Best Management Practice Pollutant Load Reduction Efficiencies.

Best Management Practice	Phosphorus Reduction	Chloride Reduction	Sediment Reduction	Bacteria Reduction
Rain Garden/barrel (together)	45%-65%	15%-45%	60%-70%	40%-55%
Bioswale	55%	45%	65%	45%
Infiltration Basin/bioretention	50%-65%	45%-60%	60%-80%	40%-55%
Wetland Restoration/Two-Stage Ditch	40%-65%	15%-25%	50%-70%	40%-65%
Detention Basin	40%-55%	15%-25%	60%-70%	45%-55%
Cover crop/Nutrient Management Plan	90%	5%	40%	35%
WASCB	60%	25%	70%	35%
Restrictor/Blind Inlet/Drainage Management	50%	10%	70%	35%
Filter Strip/Riparian Buffer	40%-60%	20%-25%	55%-65%	30%-45%
Grass Waterway	45%	30%	60%	50%
Porous Pavement	45%-50%	50%-60%	70%-80%	35%-40%
Combined Equestrian BMPs (can include diversions, gutter system, detention)	50%	5%	56%	65%
Grade Control Structure*	50%	20%	60%	25%
Streambank Stabilization	100%	N/A	100%	N/A

*A grade control structure in a gully has a 100% pollution load reduction efficiency.

7.1.1 POLLUTANT LOAD REDUCTION ESTIMATES FOR SITE SPECIFIC ACTIONS

Pollutant load reduction estimates are provided for 87 project/site-specific BMPs throughout the watershed that are characterized in the action plan (Chapter 6). Load reductions also include an additional 5,252 acres of basin-wide site-specific BMPs, and 26,982 linear feet of severe streambank stabilization BMPs. The suite of projects would benefit over 7,070 acres if fully implemented. It is important to note that pollutant load reductions do not include all actions as illustrated in **Table 7-1**. **Table 7-3** summarizes the load reduction estimates by BMP type for the watershed. **Photos 7-1** through **Photo 7-5** show a selection of the site-specific BMP opportunities identified in the watershed.

The estimates also do not account for load reductions from programmatic, education and outreach and policy/regulatory actions since direct impacts are not easily determined at this stage of the planning process.

Project/site-specific actions identified in the plan are very effective for addressing sediment and phosphorus, moderately effective for addressing bacteria and do not effectively address chloride. Programmatic and regulatory actions will be more effective at addressing bacteria and chloride loading.

Table 7-3: Project/Site Specific BMP Load Reduction Estimates.

BMP	Quantity	Phosphorus Reduction (lbs/yr)	Chloride Reduction (lbs/yr)	Sediment Reduction (tons/yr)	Bacteria Reduction (billion CFU/yr)
Basin-Wide Site-Specific					
Streambank Stabilization*	26,982 feet	2,182	N/A	2,182	N/A
Nutrient Management/Cover Crops	3,039 acres	3,560	302	1,573	2,386
Equestrian BMPs; Diversions, Gutter Systems, Detention	100 acres	39	7	9	278
Porous Pavement/Infiltration basin	371 acres	182	80,975	54	262
Rain Barrel/Rain Garden	750 acres	124	19,975	33	1,193
Blind Inlet/Drainage Tile Management	992 acres	668	205	846	806
Site-Specific and Stakeholder BMP					
Grade Control	6	55	345	44	5
Bioretention/Infiltration Basin	0.3 acres	0.80	403	0.15	5
Bioswale/Infiltration Basin	2/1.2 acres	15	4,390	3.20	21
Detention Basin	31 acres	86	8,559	68	268
Filter Strip	8.4 acres	62	197	62	83
Grassed Waterway	12.5 acres	246	113	242	139
Porous Pavement	2.1 acres	0.60	379	0.20	5
Rain Garden	3.72 acres	12	2,811	2.50	72

BMP	Quantity	Phosphorus Reduction (lbs/yr)	Chloride Reduction (lbs/yr)	Sediment Reduction (tons/yr)	Bacteria Reduction (billion CFU/yr)
Rain Garden and Gutter System	1.5 acres	7	2,499	1.50	23
Riparian Buffer	0.6 acres	1	182	0.40	2
Two-stage Ditch with wetlands	4 acres	5	1,152	1	31
WASCB	13	198	466	181	44
Wetland Creation	111 acres	487	18,423	414	1,160
Grand Total		**7,930**	**141,383**	**5,717**	**6,783**

*Loading and load reduction estimates for streambank erosion are based on the Region 5 EPA's spreadsheet tool for "estimating pollutant load reductions for nonpoint source pollution control BMPs." All default values found in this spreadsheet tool are utilized for calculating estimates found in the Mill Creek plan.

Photo 7-1: BMP SS17, Detention

Photo 7-2: BMP SS38, Rain Garden/Gutter Control

Photo 7-3: BMP SS32, Retrofit to Wet Detention

Photo 7-4: BMP SS21, Retrofit Existing Basin

Photo 7-5: BMP SS20, Bioswale, Wetlands and Native Prairie

7.1.1.1 Pollutant Load Reductions by Catchment

Pollutant load reduction estimates are subtotaled by catchment as shown in **Table 7-4**; the four critical catchments are shown in bold and italics. Estimates show that urban BMPs and streambank stabilization in critical catchments H and U, would result in the most significant load reductions. In critical catchment W, the most significant load reductions will be realized by implementing agricultural BMPs. Catchment A will benefit primarily from streambank stabilization, cover crops, nutrient management, and wetland creation.

Table 7-4: Estimated Load Reductions by Catchment (see Critical Area Catchments map Figure 6-3 in Chapter 6).

Catchment Code	Acres Benefited	Phosphorus Load Reduction (lbs/yr)	Chloride Load Reduction (lbs/yr)	Sediment Load Reduction (tons/yr)	Bacteria Load Reduction (billion CFU/yr)
A	***86***	***118***	***314***	***69***	***66***
B	461	429	2,011	217	445
C	249	242	873	104	336
D	493	317	6,475	169	614
E	129	198	51	128	126
F	616	904	1,985	561	595
G	65	122	1,123	132	65
H	***53***	***302***	***2,738***	***292***	***73***
I	89	182	1,065	102	73
J	422	235	14,186	133	354
K	132	24	3,312	9	86
L	112	135	3,709	131	158
M	65	14	2,664	5	114
N	278	212	25,257	133	385
O	159	128	27,816	77	154
P	188	390	3,346	335	117
Q	21	355	2,299	348	21
R	36	180	4,756	172	27
S	324	92	19,228	52	255
T	111	482	458	440	90
U	***833***	***760***	***14,671***	***627***	***881***
V	1,630	1,597	2,962	1,050	1,304
W	***516***	***513***	***84***	***433***	***442***
Grand Total	**7,069**	**7,930**	**141,383**	**5,717**	**6,783**

7.1.1.2 Pollutant Load Reduction Estimates vs. Total Loading

Comparing the pollutant load reduction estimates to the total modeled pollutant loading suggests that significant reductions may result from BMP implementation (**Table 7-5**). The key points to consider are:

- Project/site specific actions are effective at addressing phosphorus and sediment.
- Project/site specific actions are moderately effective at addressing bacteria, but are not focused at addressing the major sources which are urban areas.

- Project/site specific actions are inadequate at addressing the sources of chloride; programmatic and regulatory actions better address chloride by reducing application rates. BMPs typically have poor chloride removal efficiencies because chloride dissolves in water.
- Sediment and phosphorus reduction estimates are high due to the significant streambank stabilization identified in the action plan (over 25,000-feet).

Table 7-5: Estimated Improvements of Watershed Pollutant Loading.

Pollutant	Estimated Annual Load Reductions	Total Modeled Pollution Loading
Sediment (tons/yr)	5,717	8,537
Phosphorus (lbs/yr)	5,748	12,689
Chloride (lbs/yr)	141,383	3,280,996
Bacteria (billion coliform forming units - cfu)	6,783	33,653

Sediment and phosphorus loading reduction estimates are significant, and in some cases exceed 50% of the modeled pollutant load. This is largely a result of the numerous streambank stabilization action recommendations in the plan. Further, the USEPA guidelines suggest that streambank stabilization results in 100% load reduction for sediment and phosphorus. The same efficiency guidelines also suggest a 1 pound reduction of the phosphorus load for every 1 ton reduction of the sediment load, regardless of land use. These efficiency estimates may result in phosphorus load reduction estimates that are elevated from actual conditions.

7.2 COST ESTIMATES

Table 7-6 summarizes the estimated amount of funding required for the site-specific projects identified in the action plan (Chapter 6), not limited to the subset of projects for which pollutant load reductions were made. Sources of funding are highlighted in section 7.3.1, and it must be understood that these estimates are for direct implementation of projects and not the administrative, project management and watershed coordinator costs.

Cost estimates are generated from a combination of technical experience, previous watershed plans, and the USDA's average practice cost list. Cost estimates are generalized for watershed-scale planning purposes and these estimates should not be used to estimate costs for individual projects, as costs may range significantly depending on site conditions. Appendix M includes further criteria and assumptions used to develop the cost estimates listed in **Table 7-6**.

Table 7-6: Cost Estimates for Action Plan Projects.

Type	# of Projects	Acres Benefited / Acres Practice	Unit Cost	Estimated Total Cost
Equestrian BMPs	16	100	$22,875	$366,000
Filter Strips/ Riparian Buffers	-	9	$3,000/ac	$27,000
Nutrient Management Plan/Cover Crops	-	3,039	$70/ac	$212,730
Rain Gardens/Rain Barrel	-	759	$14,640/ac	$11,111,760
Blind Inlet/Drainage Management	50	992	$3,000	$150,000
Septic System Inspections	88	-	$500	$44,000
Water and Sediment Control Basins/Dry Dams	13	-	$4,000	$52,000
Grassed Waterways	3	-	$3,000/ac	$19,000
Wetland Creation	20	111	$20,000/ac	$2,220,000
Existing Wetland Restoration	43	472	$10,000/ac	$4,720,000
Detention Basins	22	31	$50,000	$1,100,000
Porous Pavement/Infiltration Basin	2 basins	373	$43,678/ac	$20,716,047
Streambank Stabilization	26,982 ft.	n/a	$85/ft	$2,293,470
Lake Shore Stabilization	2,975 ft.	n/a	$85/ft	$252,875
Hydrologic/Hydraulic Impediments	12	n/a	$20,000	$240,000
Problem Discharge Locations	38	n/a	$20,000	$760,000
Detention Basin Retrofits	177	2,124	$10,000/ basin	$1,770,000
Dam Removal/Restoration (Grandwood Park Lake)	1	n/a	$1,000,000	$1,000,000
Flood Mitigation – Flood Problem Area Inventory Sites	31	-	-	$2,166,000
Regional Flood Storage	10	1,050-acres drainage	-	-
Grand Total				**$49,226,882**

7.3 NEXT STEPS FOR PLAN IMPLEMENTATION

Often, the biggest challenge of any watershed plan is its implementation. Successful implementation requires widespread coordination, effective partnerships and support, local leadership, financial and technical resources, time and a genuine willingness to translate planning to action on-the-ground. The Mill Creek Watershed includes many implementation partners and supporters (Section 7.6) that will have to coordinate efforts to implement the recommendations in the action plan. No single partner has the financial or technical resources to accomplish the plan goals and objectives; partners working together are necessary to achieve meaningful results. Combining and coordinating resources, funding, effort and leadership will be the most efficient and effective means of maintaining and improving watershed health. Implementation of this plan will also require the development of partnerships with local, state, and federal organizations for implementation, technical assistance, and funding. These efforts require the investment of a significant amount of time and resources. **Table 7-7** below shows five immediate (year one) priorities followed by a detailed description of the key components of successful and sustainable plan implementation.

Table 7-7: Year 1 Plan Implementation Priorities.

Recommended Action/Priority
1) Form watershed committee or council and determine specific year-1 implementation actions.
2) Research funding and technical assistance to implement recommendations identified in the action plan.
3) Submit grant applications if applicable and secure additional funding sources for plan implementation.
4) Coordinate available programs; policy changes and other local initiatives and those programs where private landowners are responsible for signing up.
5) Adopt the plan, prioritizing and incorporating the recommendations in the watershed plan into existing programs, activities and budgets.

7.3.1 PLAN ADOPTION

Buy-in and adoption from implementation lead and support partners needs to be officially established for the Mill Creek Watershed plan. Section 7.6 outlines the lead and support partners applicable to the watershed. The leaders need to adopt the plan so that it is incorporated into the operations and procedures of the organizations relevant to the watershed.

7.3.2 ESTABLISH FORMAL WATERSHED PLAN IMPLEMENTATION ORGANIZATION

One important step in plan implementation will be the establishment of a committee or organization to come forward as a leader to organize and coordinate plan implementation. Responsibilities of this organization would also include administration, coordination of stakeholders to support individual watershed projects, and working with community partners on recommended policies and programs.

Throughout the watershed planning process, the existing planning committee has provided valuable input to the plan regarding watershed issues, resources, priorities and actions. The committee can continue to hold regular meetings, take the lead in implementing plan recommendations, organize watershed field trips, host educational workshops and forums, and bring watershed stakeholders and multiple units of government together to discuss watershed issues and opportunities. The partners can consider whether a formal staff position is needed or existing resources can be appointed to lead and operate the committee. The established planning committee will likely transition to the plan implementation organization and will generate stakeholder interest and involvement with watershed implementation. As projects are initiated, the positive environmental, aesthetic, and community benefits will lead to enhanced participation throughout the watershed.

7.3.3 ENAGE STAKEHOLDER PARTICIPATION

There are tangible benefits to stakeholder participation in watershed activities, from positive media attention to improved quality of life for community residents. Increased involvement can also yield significant local, state, and federal funding opportunities to help share the cost of project implementation. Some implementation actions can be added to existing capital improvement and maintenance plans, budgets, and schedules. This is a fairly quick and easy approach to implementing recommendations within the purview of specific jurisdictions. In other cases, however, the action recommendation will require the involvement of multiple stakeholders for implementation, such as residents, a municipality, and a county, state, or federal agency to provide financial and technical support. Some actions require inter-jurisdictional coordination for issues; the establishment of a green infrastructure corridor along the stream channel or preservation and restoration often require inter-jurisdictional cooperation and may require a longer time frame for implementation. Other actions will require the cooperation of individual or groups of landowners, whether they are residents, homeowners associations, businesses, or institutions.

7.3.4 IDENTIFY IMPLEMENTATION CHAMPIONS

Implementation actions require a leader, or "champion" for the project, that can organize resources and keep the project moving forward. This champion may be the watershed organization, or a single entity such as a landowner or a municipal representative, or another organization. Conserve Lake County may be a champion for reducing runoff from residential properties through implementation of their Conservation @ Home program. The Avon-Freemont Drainage District may be a champion for stream restoration/stabilization since they have responsibility for maintenance of 6.5 miles of stream in the watershed. Actions that involve preservation of areas of land or water may also require the involvement of a local land trust, or other conservation organization such as the Lake County Forest Preserve District. These groups may be able to provide technical or financial assistance for preservation efforts. In some cases, actions recommend the adoption of new policies, plans, or standards that modify the form, intensity, or type of development or redevelopment in the watershed in a way that better protects watershed resources. These actions will require some effort on the part of municipalities to understand how plans and policies can be modified and to discuss and adopt new, or modify existing, policies, plans and standards.

7.3.5 RESOURCES AND FUNDING

Funding plan implementation and watershed coordination actions is a priority. Securing sources of funding encourages contract-level accountability and performance requirements to which stakeholders may be more responsive. There are numerous sources of funding available to support projects or provide cost-share to match other sources of funds. A list of numerous local, regional and state funding sources is identified in Error! Reference source not found.. Most of the programs require a local match of cash or in-kind services. Although these funding sources can provide a good source of revenue, significant local investment of time, technical and financial resources will be required to implement this plan. These soft costs must be evaluated and incorporated into the operating strategies of the individual implementation partners.

7.3.6 IMPLEMENTATION PARTNERS

Parties who are key potential partners whose support will lead to the realization of identified goals for the Mill Creek Watershed are identified below as "Implementation Partners". The organizations identified in section 7.6 are listed as such because they are expected to fulfill one or more of the following functions:

- oversee or implement watershed protection, restoration and remediation strategies
- acquire funding for watershed plan implementation
- organize or participate in data collection
- provide regulatory or technical guidance and/or issue permits
- monitor the success of the watershed plan
- acquire land for green infrastructure restoration or protection purposes
- develop education strategies

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

7.3.7 IMPLEMENTATION SUPPORTERS

Several local and regional agencies and organizations along with a number of state and federal agencies are listed as "Implementation Supporters" in Section 7.6. Regional, state and federal agencies are generally not identified as lead parties responsible for watershed plan implementation, but as resources that can assist with implementation or provide technical or funding support.

7.3.8 FUNDING RESOURCES AND OPPORTUNITIES

Many federal, state, local and private programs are available to fund plan implementation. Having a watershed coordinator to support the development of projects, budgets, and funding resources is a key element to successful watershed coordination and plan implementation.

Table 7-8 outlines the most common and available sources of funding for the actions identified in the plan, most BMPs recommended are eligible for some form of funding. Information regarding potential funding sources is readily available online and applicants should research available programs ahead of time to understand the funding cycles, conditions and terms. Most grant programs require financial or labor match, thus applications that "leverage" multiple funding sources also have the highest probability of being funded.

Table 7-8: Available funding sources.

Best Management Practice	Funding Sources	Notes/Cost Share Rates
• Filter strips and riparian buffers • Dry dams (WASCBs) • Grass waterways • Terraces • Diversions • Wetland creation • Blind inlets and tile drainage management • Nutrient management • Cover crops	Illinois EPA – 319 program NRCS – EQIP program FSA – CRP program SWCD – CPP program USFWS – Acres for wildlife program IDNR/SWCD – CREP program IDNR – SWG program NRCS – WHIP program IDNR – Special Wildlife Funds Grants	CREP eligible acres must be in the 100-year floodplain and/or have cropped ground with an erodibility index of 8 or greater adjacent to riparian zones; must have cropping history as defined by the USDA. SWG program requires 50% state match and must address goals/species outlined in the State of Illinois Comprehensive Wildlife Plan. NRCS, FSA, and SWCD programs generally provide 60% cost-share, however, some special programs and practices can provide up to 90%. FSA, CREP and some NRCS programs also provide annual rental payments for taking ground out of production.
• Streambank/lake shore stabilization and in-stream grade control or other grade control	Illinois EPA – 319 Program SWCD – SSRP program NRCS – EQIP program	Illinois EPA 319 offers 60% cost share SSRP offers 75% cost share EQIP offers 60% cost share
• Wetland restoration and other habitat practices	Illinois EPA – 319 program NRCS – EQIP program NRCS – WRP program FSA – CRP program USFWS – Landowner Incentive Program IDNR/SWCD – CREP program IDNR – SWG program IDNR – Special Wildlife Funds Grants	WRP program – multiple/stringent eligibility requirements. NRCS, FSA, and SWCD programs provide a minimum of 60% cost-share, however, some special programs and practices can provide up to 90%. FSA, CREP and some NRCS programs also provide annual rental payments for taking ground out of production.
• Livestock/equestrian practices, including fencing, stream crossings, pasture management, watering systems etc.	Illinois EPA – 319 program NRCS – EQIP program IDNR – Forestry Development Act funding (FLEP)	FLEP is applicable to livestock fencing for woodlands. Livestock management recommendations outlined in this report that includes wetland and/or habitat restoration can be funded by other programs such as the US F&W – Landowner Incentive Program EQIP typically provides 60% cost-share

Best Management Practice	Funding Sources	Notes/Cost Share Rates
• Urban BMPs • Stormwater detention basins • Rain gardens and barrels • Porous pavement; • Infiltration basins and bioswales • Other Green Infrastructure practices	Illinois EPA – 319 program Illinois EPA – Illinois Green Infrastructure Grant Program (IGIG)	The IGIG program helps local governments, nonprofit entities, and numerous other state, federal, and local partners to reduce nonpoint source pollution and stormwater runoff through technical and financial support.

Illinois EPA 319 program is a competitive grant program with applications accepted annually (August 1st deadline); focus is water quality; funding prioritized to "impaired waters" and in those areas with watershed plans in place; multiple BMP applications desirable; 40% non-federal match required; Applicants are generally not-for-profit organizations/watershed groups or entities acting on behalf of private landowners.

FSA/USDA/SWCD programs available on agricultural ground; require landowner cost-share (varies depending on program) and in most cases cropping history; continuous sign-up available for some programs; applicants must contact local FSA/NRCS/SWCD offices; applicants are individual landowners.

7.4 EVALUATING PLAN PERFORMANCE AND PROGRAMMATIC MONITORING

An important component of any watershed planning initiative is the ability to monitor performance towards goals and objectives. This section focuses on the administrative monitoring that tracks the activities of stakeholders and the range of actions that are implemented. Section 7.6 discusses direct scientific monitoring of quantitative criteria such as water quality and aquatic health that are indicative of the effectiveness of implementation actions.

7.4.1 EVALUATING PLAN IMPLEMENTATION PERFORMANCE

It is necessary to monitor the progress towards achieving the five goals of this plan that are outlined in Chapter 2. Tracking progress relevant to these goals is as simple as an organized system in each jurisdiction to keep track of what is happening in their portion of the watershed. Communicating and reporting progress towards goals is equally as important as tracking them in the first place.

The following recommendations are included to help track progress and achieve the goals with plan implementation.

- In the early stages of the plan implementation process, watershed stakeholders should establish a sustainable and active watershed committee or organization to implement the plan that will meet at least quarterly to discuss watershed activities and progress towards goals. A list of completed actions, proposed and in-progress actions should be tracked for each jurisdiction.

- The plan should be evaluated every five years to assess the progress made as well as to revise the plan, if appropriate, based on the progress achieved. The plan should also have a comprehensive review after 10-years. Amendments and changes may be made more frequently as laws change or new information becomes available that will assist in providing a better outlook for the watershed. As goals are accomplished and additional information is gathered, efforts may need to be shifted to watershed issues of higher priority.

- The watershed committee should request each major project partner in the watershed to provide an annual update on implementation, which could be in the form of a "scorecard" that tracks progress towards goal objectives via measureable milestones. The scorecard system is presented in section 7.5.2 and Appendix O. It is an easy and effective way to compile and track progress in the watershed in a measureable way and evaluate the effectiveness of achieving short, medium and long-term goals. Scorecards are an effective way to identify what needs attention and what stakeholders should focus on in the next planning year.

- Other opportunities for evaluating the status of plan implementation include the completion of quarterly project reports or group meeting minutes. Since this plan is a flexible tool tracking changes/modifications are anticipated based on usability and changes in priority throughout implementation.

7.4.2 MEASUREABLE MILESTONES AND SCORECARD SYSTEM

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

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

Table 7-9: Example Indicators and Milestones for Each Goal.

Goal	Indicator	2-yr milestone	5-yr milestone	10-yr milestone
1. Flooding	Number of flood problem areas addressed	1	10	25
2. Water Quality	Linear feet of severe streambank stabilized	1,000 ft	5,000 ft	10,000 ft
3. Stormwater	Percentage of Mill Creek with regular stream maintenance	20%	50%	75%
4. Natural Resources	Area of open space preserved	40	150	400
5. Education and Outreach	Number of workshops and trainings held for the public	6	10	25

Mill Creek Watershed scorecards were developed for each of the five plan goals and are located in Appendix O. **Table 7-9** provides an example indicator and associated milestones of each goal as taken from the complete scorecards in Appendix O. This scorecard system should serve as an organizational monitoring plan and a tool for tracking progress toward meeting plan goals and specific recommendations/action items. Realistic 2, 5 and 10-year milestones are included for each indicator in the scorecards (**Table 7-9** and Appendix O). Each milestone is a specific action recommendation and is intended to fulfill plan objectives if executed. Indicators are to be used as measurement tools when determining if each milestone has/has not been met. If the measurement of each indicator becomes problematic, the watershed committee should revisit and make adjustments where needed. It is up to local stakeholders to determine the priority of each milestone based on their ability to follow through with them. Scorecard evaluation on an annual basis is an effective way to identify priorities and what stakeholders should focus on in the next planning year.

Milestones in the scorecards can be graded based on the following criteria:

A = Met or exceeded milestone(s);

B = Milestone(s) 75% achieved;

C = Milestone(s) 50% achieved;

D = Milestone(s) 25% achieved;

F = Milestone(s) not achieved

7.4.2.1 Plan Implementation Schedule

Implementing actions should occur immediately where specific projects and willing stakeholders have been identified. A general implementation schedule is presented in **Table 7-10**. More detailed implementation timeframes are included in Chapter 6 for each action.

Table 7-10: General implementation schedule.

Task	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Form watershed committee or council	X									
Research funding and technical assistance to provide for watershed coordination and implement a series of recommendations identified in the action plan	X	X	X	X						
Submit grant applications, secure additional funding sources for watershed coordination and plan implementation	X	X	X	X	X	X	X	X		
Coordinate available programs; policy changes and other local initiatives and those programs that private landowners are responsible for signing up for	X	X	X	X	X	X	X	X	X	
Project planning, site surveys and project design and budget development		X	X	X	X	X	X	X	X	
Prioritizing and incorporating the recommendations in the watershed plan into existing programs, activities and budgets	X	X	X	X	X	X	X	X	X	X
Implementation and construction of projects			X	X	X	X	X	X	X	X
Report and monitor progress	X	X	X	X	X	X	X	X	X	X
Communicate success stories		X	X	X	X	X	X	X	X	X
Evaluate accomplishments			X			X				X

7.5 WATER QUALITY MONITORING STRATEGY

The need for water quality-monitoring has been identified by watershed stakeholders as a key objective due to the limited and sporadic water quality monitoring that has occurred in the watershed. The most recent and detailed water quality data that was collected by the Lake County Health Department – Ecological Services (LCHD-ES) in 2011 is for eight lakes in the watershed. This data was collected for lake studies that are repeated on a five year rotating basis. Mill Creek is not currently listed by Illinois EPA as an impaired water body, but stream water quality monitoring has not been performed by Illinois EPA since 1990. The most recent and detailed water quality data related to streams was collected for the Lake County Department of Public Works (LCPW) at locations upstream and downstream of the wastewater treatment facility on Mill Creek. Detailed water chemistry data are limited to analysis of grab samples from sampling stations east of Hunt Club Road, and no continuous water chemistry data for any time period or location are available.

A more robust monitoring program is needed to provide sufficient data to determine if water quality is affecting aquatic life in Mill Creek or if impairments related to water quality exist. Based upon trends in lakes and other streams in Lake County, there is interest in monitoring chloride, phosphorus, and TSS to assess current levels and trends. Available data from biological surveys suggest that biotic integrity in the stream may be moderately impacted, but it is unclear whether this is related to water quality or habitat degradation.

The purpose of the monitoring strategy for the Mill Creek Watershed is to establish baseline conditions and monitor the condition and health of the watershed in a consistent and on-going manner. The strategy allows for evaluation of the overall health of watershed lakes and Mill Creek and its changes through time. Another key purpose is to assess the effectiveness of plan implementation projects, and their cumulative watershed-scale contribution towards achieving the goals and objectives of the plan. Lastly, the monitoring data will be used to identify pollution "hotspots" that may require additional investigation or study to assess the causes and sources of pollution and biological impairments. Suggested further investigation to assess potential sources of pollutants or biological impairment may include:

- The use of a radial real estate environmental search that identifies local companies and institutions that handle hazardous and toxic wastes and also locations where pollutant spills or leakage have taken place.
- Acquiring detailed monitoring records for both groundwater and surface water for the Countryside Landfill facility, which can be cross referenced and reviewed to identify potential pollution sources and additional monitoring needs related to toxics.
- Based on observations of zebra mussel populations downstream of Third Lake in 2012 and 2013, future research may be directed to profile the ecological conditions that control distribution and elaboration of zebra mussel populations.

While section 7.4 tracks progress through achievement of actions, this section outlines a strategy to directly monitor the effectiveness of the actions from a water quality perspective; the proposed monitoring categories and associated recommendations are summarized in **Table 7-11**. The watershed plan committee specifically developed a water quality goal with associated objectives during the development of goals and objectives for the plan (Chapter 2). The goal objectives and monitoring categories are presented as a matrix in **Table 7-12** to illustrate how each water quality objective is addressed in the monitoring strategy.

Monitoring environmental criteria as outlined in this strategy is an effective way to measure progress toward meeting water quality objectives. One potential problem with in-stream and in-lake indicators is the issue of isolating dependent variables. There are likely many variables influencing the monitoring results, so drawing conclusions with regard to one specific constituent should be done with caution. It should be noted, however, that the indicators are excellent for assessing overall changes in a watershed's condition.

Table 7-11: Summary of Monitoring Categories and Considerations.

Monitoring Category	Summary of Considerations
Streamflow	USGS and Lake County SMC maintain a functioning stream flow gage in the watershed. Utilize gage data to develop baseline hydrograph and evaluate trends.
Ambient water quality	Develop and execute a program of regular monitoring for water quality.
Physical and biologic assessment	Develop and execute regular monitoring for fish, macroinvertebrates, habitat and channel morphology.
BMP effectiveness	Monitoring BMP effectiveness of specific practices or clusters of practices.
RiverWatch program	Partner with National Great Rivers Research and Education Center (NGRREC) to enhance the volunteer monitoring program in the basin.

<table>
<tr><th>Monitoring Category</th><th>Summary of Considerations</th></tr>
<tr><td>Lake County Health Department (LCHD) Lake monitoring</td><td rowspan="2">• Incorporate quantifiable and spatial monitoring of aquatic invasive species in lakes
• Incorporate monitoring for algal toxins
• Sample and assess all lakes in Mill Creek Watershed in the same year and on the same schedule
• Collect storm-event water quality samples from all lake inlets as part of program
• Conduct a lake nutrient balance assessment and evaluate available phosphorus in lake sediment</td></tr>
<tr><td>Illinois Volunteer Lake Monitoring Program (VLMP)</td></tr>
<tr><td>Continuous watershed model</td><td>Develop a continuous flow and water quality model for the Mill Creek Watershed to effectively evaluate future land use changes and climate change impacts on water balance and water quality for streams and lakes.</td></tr>
<tr><td>Storm event runoff monitoring</td><td>Evaluate pollutant concentrations from impervious surfaces by conducting water quality sampling during high runoff/flow/ storm events.</td></tr>
<tr><td>Winter chloride monitoring</td><td>Program to monitor chlorides during the winter and spring seasons.</td></tr>
</table>

Table 7-12: Water quality objectives and monitoring categories.

Objective Number	1	2	3	4	5	6	7	8
Monitoring Category	Reduce sediment	Minimize runoff volumes and velocities	Reduce impacts from agricultural practices	Storm-water retrofits	Reduce road salt	Offset impacts of future impervious surfaces	Reduce phosphorus loading	Develop regular monitoring program
Streamflow		X				X		X
Ambient water quality	X	X	X	X	X	X	X	X
Physical and biologic assessment	X	X	X	X	X	X	X	X
BMP effectiveness	X	X	X	X	X	X	X	X
RiverWatch program	X	X	X			X		X
Lake (VLMP & LCHD)					X		X	X
Continuous watershed model	X	X				X		X
Lake bethos	X	X		X	X	X	X	X

7.5.1 STREAMFLOW MONITORING

A continuously operating USGS stream gage is located where N. Hunt Club Road crosses Mill Creek (USGS ID: 05527950). The gage has data starting in 1989 and currently SMC partners with the USGS to maintain and operate the gage. The gage is important in terms of establishing baseline conditions and monitoring plan performance. It is recommended to continue maintenance and operation of this resource and apply its data to develop a baseline annual hydrograph for the watershed. The data from this gage is also extremely valuable to develop an accurate and effective continuous watershed model.

7.5.2 CONTINUOUS WATERSHED MODEL

The development of a continuous watershed model such as STORM, HSPF or XP-SWMM should be considered for the Mill Creek Watershed. Such a model allows for continuous simulations of a watershed system that incorporate the cumulative influence of the many storm-events and dry periods; simulations can be for hourly, daily, monthly or annual bases. Unlike single event models, continuous models account for changes in watershed factors and parameters during time between storms.

Continuous flow models require monitoring data for calibration. Once calibrated, the model will allow for the quantitative evaluation of changes in the watershed, for example, the future land use projections could be incorporated to simulate how Mill Creek's annual hydrograph will change, how much peak flood elevations would change, how much baseflow conditions may decrease to the detriment of aquatic health.

Another key example is climate change adaptation; some Midwest regulatory agencies are proactively increasing the storm-event design requirements due to the statistical increase of precipitation patterns over the last 10-years not aligning with historical trends. A continuous model would allow for the simulation of precipitation events based on climate change literature; this would allow stakeholders to understand the potential quantitative flooding and water quality impacts of climate change on the watershed and initiate regulatory and policy actions in a proactive manner.

With a stream gage in the watershed and an implemented water quality-monitoring program, the Mill Creek Watershed is an ideal candidate for continuous watershed modeling.

7.5.3 WATER QUALITY MONITORING IN STREAMS

Annual spring storm-event and summer baseflow condition water quality monitoring should be considered for at least five-stations in the watershed. Potential locations for monitoring stations include:

- Near watershed outlet at the Des Plaines River/ historical Illinois EPA station IL-GW-02 at Dilley's Road, where sampling was performed in 1990
- Downstream of the confluence of North Mill Creek
- Downstream of Grandwood Dam, where IDNR fish monitoring was performed in 2013
- Forest Preserve District property (Rollins Savanna)
- The location of the USGS stream gage at Hunt Club Road
- The sampling stations used by the 1995 Hey/WIU survey, which was performed prior to the construction of the Mill Creek WRF (Appendix M)/ Mill Creek WRF
- Waste Management's Countryside landfill in Grayslake

Table 7-13 includes the minimum parameters that should be considered for monitoring. Quantitative benchmarks that indicate impairment conditions are also illustrated in this table. The establishment of baseline conditions is important in order to evaluate trends and changes in water quality over time. Parameters such as total phosphorus, total suspended sediment, chloride and fecal coliform bacteria should be analyzed considering flow volumes in order to make relative comparisons, as concentrations of pollutants vary with flow volumes. The water quality monitoring results may also be used to calibrate models.

Table 7-13: Baseline Water Quality Analysis Parameters.

Parameter	Benchmark Indicators
Total Phosphorus	Less than 0.05 mg/l
Total Suspended Sediment (TSS)	Less than 750 mg/l (Illinois EPA standards)
Turbidity	Less than 20 NTU
Chloride	Less than 500 mg/l (Illinois EPA standard)
Fecal Coliform Bacteria	Less than 200 cfu/100 ml (May – October)
Dissolved Oxygen	Greater than 6.0 mg/l (Illinois EPA standards)
Temperature	Less than 90° F (Illinois EPA standards)
pH	Between 6.5 – 9.0 (Illinois EPA standards)
Fats, Oils & Grease (FOG)	Presence or absence
Flow	--

7.5.4 STREAM BIOASSESSMENT

Aquatic stream monitoring should be considered annually or at the maximum of three to five year increments. At least five stations are recommended in the watershed, located on Forest Preserve District property and in conjunction with potential water quality stations identified in Section 7.1.3. **Table 7-14** shows the typical stream bioassessment techniques that can be applied to the monitoring program.

Table 7-14: Stream Bioassessment Metrics.

Metric	Definition	Benchmark Indicators
Fish Index of Biologic Integrity (fIBI)	Index based on presence and populations of non-native and native fish species and their tolerance to degraded stream conditions.	**Exceptional** (50-60) **Very Good** (49-42) **Good** (41-34) **Fair** (33-27) **Poor** (26-17) **Very Poor** (<17)
Macroinvertebrate Biotic Index (MBI) and Macroinvertebrate Index of Biologic Integrity (mIBI)	Index indicative of stream quality based on the macroinvertebrate species and populations.	**Excellent** (MBI< 5.0) **Good** (MBI 5.0 – 5.9) **Fair** (MBI 6.0-7.5) **Poor** (MBI 4.6-8.9) **Very Poor** (MBI > 8.9)
Qualitative Habitat Evaluation Index (QHEI)	Index indicative of habitat quality that incorporates substrate, in-stream cover, channel morphology, riparian zone, bank erosion and riffle/pool condition.	**Excellent** (>70) **Good** (55-69) **Fair** (43-54) **Poor** (30-42) **Very Poor** (<17)
Stream Condition Index (SCI)	Index that incorporates macroinvertebrate community, habitat and water quality components to grade stream quality.	**Exceptional** (>70) **Good** (49.4-69.8) **Fair** (24.6-49.2) **Poor** (0-24.5)
Mussels	Live and dead mussels collected and species and populations indicative of stream condition. Consider adopting additional monitoring protocols for	Qualitative based on species diversity, population and live and dead specimens

Metric	Definition	Benchmark Indicators
	invasive Dreissenid species (zebra and quagga mussels) if evidence suggests a need.	
Channel Morphology	Establish fixed cross-section and longitudinal profile of channel along a 1,500 foot long fixed reach. Monitor regularly to assess changes in the channel.	Entrenchment ratio Width/depth ratio bankfull Bed material Cross-sectional area Water slope

7.5.5 LAKE BENTHOS MONITORING

A monitoring program should be considered to evaluate the benthic health of the lakes in the watershed, especially near inlets to the lakes. Many pollutants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), phosphorus, chloride and excessive total suspended sediment can accumulate in the lake benthos and seriously disrupt lake health. PAHs and chloride are common pollutants from asphalt surfaces, and phosphorus is common from residential, agricultural and turf-grass open space areas. Should benthic health issues be identified, extra focus should be devoted to implementing BMPs in appropriate areas to address the issue. Typically benthic toxicity issues result from relatively nearby sources.

Noteworthy: Lake Benthos

Lake benthos are a community of organisms that live on, in, or near the lakebed. It is sometimes referred to as a lake's immune system. A healthy benthos system consumes algae, organic particulate matter and a food supply for fish populations. Benthos is a critical component of the lake ecosystem and lake health. Pollutant accumulation in the benthos can result in toxicity and significantly degrade or immobilize the benthos system, thus disrupting the lake's immune system.

7.5.6 BMP EFFECTIVENESS MONITORING

As funding allows (and where feasible and practical), BMP effectiveness monitoring should be performed on projects to assess the performance of the actions in achieving plan goals and objectives. It is recommended to incorporate monitoring into the budget of BMP projects. Monitoring should be conducted by environmental consultants or independent agency staff experienced in sampling and monitoring methods.

Monitoring can be used to determine the overall effectiveness of individual or multiple spatially clustered BMPs toward achieving the plan goals. It is usually necessary to collect and analyze water quality data and perform bioassessment sampling of a BMP that directly addresses a stream reach. This can be accomplished by monitoring upstream of the practice (inflow) and downstream of the practice (outflow) and/or monitoring baseline and post-implementation conditions. It is also important to monitor the hydraulic performance and channel changes resulting from implementation of the BMP. Urbanized areas typically increase the total volume and rate of stormwater runoff that enters receiving streams and storm sewer systems, causing changes in both hydrology and morphology. A goal of BMPs is usually to attenuate these hydrological (flow) and morphological (form) impacts. **Table 7-13** and **Table 7-14** include quantitative assessment methods and benchmark indicators that can be used as guidelines in designing and evaluating a monitoring program to evaluate BMP effectiveness. Benchmarks are based on water quality criteria, on data analysis, reference conditions, literature values, or expert examination of water quality conditions to identify values representative of conditions that support "Designated Uses" (Illinois EPA, 2005) and biological integrity/quality.

Evaluation of the progress towards meeting targets indicates whether implemented BMPs are effective. If implemented BMPs are determined to be ineffective, the implementation approach should be reconsidered or changed altogether.

7.5.7 RIVERWATCH VOLUNTEER PROGRAM

The National Great Rivers Research and Education Center (NGRREC) administers the RiverWatch program, which educates and trains volunteers to collect high quality data from Illinois streams. The NGRREC holds open labs and workshops throughout the state to train volunteers. The RiverWatch program was previously called EcoWatch and was administered by the IDNR.

While the RiverWatch monitoring program collects basic information about macroinvertebrates and aquatic habitat, it provides a real opportunity to engage stakeholders and volunteers to actively participate in the watershed in a meaningful way. A continuous and consistent monitoring program under RiverWatch would be a valuable tool to evaluate the evolving condition of the watershed and monitor the effectiveness of watershed plan implementation. A RiverWatch program, however, should not be seen as a replacement for physical and biologic assessments performed by professionals.

It is recommended that the watershed committee select several designated RiverWatch stream reaches in the watershed. The reaches are typically 200 – 300 feet in length, depending on the type of macroinvertebrate habitat. The designated reaches should either be on public land or private lands with landowner permission. Stream reaches within Forest Preserve District property should be evaluated. The designated reaches should be communicated to the NGRREC so that volunteers in the area are focused to the designated stream reaches.

The watershed committee may want to consider a public relations program to educate the public regarding the RiverWatch program and enlist volunteers. Funding opportunities should be considered to reimburse travel expenses for volunteers to attend the necessary training provided by NGRREC.

7.5.8 LAKE MONITORING

There are 11 named lakes in the Mill Creek Watershed that are characterized as part of Chapter 3. The lakes make up 7% of the watershed and are a tremendous resource for recreation and watershed health and function. Lake monitoring should be considered a priority to maintain and manage the lake systems and their value as an ecological and recreational resource. Currently the Illinois Environmental Protection Agency (Illinois EPA), Lake County Health Department (LCHD) and individual lake associations administer lake monitoring programs in the watershed. These programs should be supported and enhanced by the watershed stakeholders and implementation partners. **Table 7-15** outlines each lake and their current monitoring situations.

Table 7-15: Named Lakes and Monitoring Details.

Lake	VLMP Years Assessed	VLMP Monitoring Status	LCHD – LMU Reports	Zebra Mussel Presence as of 2012[1]
Bittersweet[2]	None	Not Active	2004	No
College Trail[2]	2005-2006	Not Active	2004	No
Druce	1994 - 2013	Active	2001, 2011	Yes
Fourth	2012 – 2013	Active	2000, 2011	Yes
Gages	1994 - 2013	Active	2003, 2011	Yes

Lake	VLMP Years Assessed	VLMP Monitoring Status	LCHD – LMU Reports	Zebra Mussel Presence as of 2012[1]
Grandwood Park	None	Not Active	2000, 2011	No
Grays	1995 - 2013	Active	2002, 2011	No
Miltmore	2012 - 2013	Active	2011	No
Sand	1994-2013	Active	2000, 2004, 2007, 2011	No
Third	1994-2013	Active	2000, 2005, 2006, 2007, 2008, 2011	Yes
Willow	None	Not Active	2003	Yes

[1] – Based on correspondence with LCHD, January 2013
[2] – Small stormwater lakes not actively used for recreation

7.5.8.1 LCHD Lake Monitoring

The LCHD-ES has been collecting water quality data on Lake County lakes since the late 1960's. Starting in 1999, approximately 32 lakes per year are monitored, equating to about a 5-year period between monitoring efforts for any individual lake. Data collection includes temperature, dissolved oxygen, phosphorus, nitrogen, suspended solids, pH, alkalinity, conductivity, water clarity, plant community and shoreline characteristics. Detailed reports are written for each lake and include data analyses, a list of problems specific to each lake and recommendations on how to reduce or eliminate those problems. Reports are available online, however, a database format of the information is not readily available.

Nine of the eleven named lakes are part of the LCHD-ES monitoring program (**Table 7-15**). It recommended that the watershed committee continue support of this existing lake monitoring program and track the results of each of the monitored lakes in the Mill Creek Watershed to monitor the effectiveness of plan implementation.

7.5.8.2 Illinois Volunteer Lake Monitoring Program

The Illinois EPA established the VLMP program in 1981 to engage and educate the public about lake health and lake management while developing a means to collect data and observations about lakes throughout Illinois. The program funds volunteer training programs, technical/administrative support to volunteers and laboratory analysis costs. As volunteers gain experience they can graduate to higher tiers of data collection and lake assessment as shown in **Table 7-16**.

The LCHD-ES works directly with the Illinois EPA and the VLMP volunteers relative to Lake County. According to the LCHD-ES, each lake in the watershed has volunteer commitment through the VLMP program with the exception of Bittersweet and College Trail lakes, which serve as large stormwater basins and are not actively used for recreational purposes. Consequently, there has not been sufficient volunteer or public interest in their quality and health to establish a VLMP for these two lakes.

The VLMP program does not include quantity or spatial-based monitoring of aquatic invasive species, however, the volunteers are free to provide narrative description about aquatic invasive species.

Table 7-16: Monitoring Tiers of the Illinois VLMP.

Tier Level	Description of VLMP Monitoring Tiers
Tier 1	Volunteers perform Secchi disk transparency monitoring and field observations only. Monitoring is conducted twice per month from May - October, typically at 3 in-lake sites. Field observations include the presence of invasive species including installation and monthly observations of zebra mussel plate installed near boat launch.
Tier 2	In addition to the tasks of Tier 1, volunteers collect water samples for nutrient and suspended solid analysis at the representative lake site (site 1). Water quality samples are taken only once per month, May - August, and October in conjunction with one Secchi transparency monitoring trip.
Tier 3	In addition to tasks of Tier 1 and 2, volunteers collect water samples at up to three sites on their lake. Their samples are analyzed for nutrients and suspended solids. They also collect and filter their own chlorophyll samples. Dissolved oxygen and temperature profiles may also be performed, depending on equipment availability. Data collected in Tier 3 is used in the category 5 Integrated Report and is subject for use in designating state impaired waters.

7.5.8.3 Lake Monitoring Considerations

Between the individual lake associations, LCHD-ES, and the Illinois Volunteer Lake Monitoring Program, the following recommendations should be considered to continue or enhance the current monitoring activity that is performed on the lakes.

- Incorporate quantifiable and spatial monitoring of aquatic invasive species in lakes
- Develop a rugged and long-lasting Lake County-specific aquatic invasive species educational sign and install at all boat ramps in the watershed
- Incorporate monitoring for algal toxins in lakes used for recreation
- Sample and assess all lakes in the Mill Creek Watershed in the same year and on the same schedule
- Collect storm-event water quality samples from all lake inlets as part of the monitoring program
- Lake nutrient balance assessment; evaluate available phosphorus in lake sediment
- Lake benthos health monitoring program

7.6 IMPLEMENTATION PARTNER DETAILS

This section identifies all of the applicable implementation partners. Partners that are anticipated to provide technical assistance to the watershed committee and stakeholders are identified in boldface type. Watershed jurisdictions and homeowner associations are encouraged to adopt and participate in implementing the watershed plan.

7.6.1 IMPLEMENTATION LEAD PARTNERS

Avon-Fremont Drainage District (AFDD) - Technical Resource

The Avon-Fremont Drainage District (AFDD) is responsible for addressing drainage problems within its district boundary which includes a portion of Mill Creek upstream (south) of Washington Street. Thus, issues related to channel and stormwater management infrastructure along Mill Creek should include the AFDD as an implementation partner. AFDD will also be a key partner in a collaboration that establishes stream maintenance standards for the watershed.

Agricultural Producers (AG)

Agricultural producers, or private farmers, include anyone managing a crop or non-equestrian livestock operation within the watershed. This includes both tenant operators and land-owners. Because cropland accounts for more than 15% of the watershed, farmers are an important implementation partner. Farmers can work independently or with other partners to preserve farmland in the watershed and implement best management practices for erosion control, soil conservation, and nutrient reduction to reduce nonpoint source pollution.

Conserve Lake County (CL) - Technical Resource

Established in 1995, serves people who care about nature and want to protect and restore the land and water around us. They preserve Lake County's precious landscapes and improve the health of the land with land stewardship projects that bring vitality back to prairies, wetlands, and woodlands. Conserve Lake County inspires people to care about conservation and is involved in planning and advocacy for nature. Conserve Lake County administers the Conservation @ Home program and private land conservation easements.

The College of Lake County (CLC) – Technical Resource

A comprehensive community college accredited by the Higher Learning Commission. Major program areas include credit programs to prepare students for transfer or career entry, GED and adult basic education, non-credit offerings for personal or career development, and contract training and specialized services for businesses. Each semester CLC serves approximately 18,000 credit students, with more than 80 percent enrolled in transfer or career preparation programs. Located in Grayslake, CLC is an important implementation partner for education and outreach as well as for several site-specific BMPs recommended on campus property.

Corporate and Business Landowners (CBL)

Although commercial and industrial land uses make up a relatively small percentage of the watershed, these land uses frequently generate significant nonpoint source pollutant loads. An assessment of future land use suggests an increase in commercial and residential development. The active participation of CBLs in the planning and watershed implementation process can lead to significant positive impacts on the quality of the Mill Creek Watershed. Businesses can become involved by retrofitting existing facilities, managing their grounds, infiltrating or harvesting rooftop runoff, designing and retrofitting parking lots to reduce runoff volume and pollutant loadings, and by sponsoring watershed events. With an upfront commitment and support from the CBL community, new development can also be designed to minimize runoff and pollutant loadings.

Developers and Homebuilders (DH)

The practices of developers can significantly impact a watershed. Developers should be encouraged or required to employ sustainable development techniques such as low impact and conservation development and other practices. The watershed planning committee included a plan objective to design naturalized stormwater facilities that require minimal maintenance. In addition to designing new developments with sustainable best management practices (BMPs), homebuilders should use BMPs during the construction process, especially those related to soil erosion and sedimentation control. Failure to use BMPs, or improper use, can lead to soil erosion and other pollutant discharges.

Equestrian Facilities (EQ)

There are a number of privately-owned and operated equestrian facilities in the watershed. Many of these facilities include large paddock and pasture areas and large stables, barns, and other operational buildings. Like any land use, equestrian facility operation can impact water quality and runoff. However, because these facilities encompass large areas of land managed as a unit, they also offer excellent opportunities for implementation of best management practices and restoration. Additionally, the large buildings offer opportunities for practices such as rain gardens or cisterns.

Homeowners, Property Owners, and Lake Associations (HLA)

A number of subdivisions and lake areas in the watershed have established property owner associations that assess fees and have the responsibility of managing the common ownership/use areas including lakes, beaches, stormwater management facilities, wetlands, and neighborhood parks and open spaces. Lake associations generally conduct lake management for water quality and recreation. Many associations struggle with collecting fees and employing best management practices of the natural (wetlands, creeks and lakes) and constructed elements (detention basins) of the drainage system. These associations will be key implementers of the watershed management plan.

Illinois Department of Natural Resources (IDNR) - Technical Resource

The office of Conservation within the IDNR will be a key local partner for assisting with natural areas preservation and restoration. The Mill Creek Watershed in Illinois is also designated as a Conservation Opportunity Area in the Illinois Wildlife Action Plan, therefore IDNR has a strong interest in working with local stakeholders to conserve wildlife and enhance wildlife habitat.

Several offices within the IDNR provide services that will be key to the implementation of the Mill Creek Watershed plan for issues related to water resource management, habitat protection and management, wildlife management, invasive species control, wetland management, and hunting and fishing permitting.

- The Office of Water Resources (OWR) is the state’s lead organization for the regulation of floodplain development as well as for the implementation and funding of structural flood control and mitigation.
- The Office of Realty and Environmental Planning (OREP) is responsible for natural resource and outdoor recreation planning.
- The Office of Resource Conservation (ORC) reviews Clean Water Act Section 404 wetland permits for impacts on fish and wildlife resources; it manages threatened and endangered species issues; it also protects fisheries and other aquatic resources through regulation, ecological management and public education.
- The Office of Capital Development (OCD) administers state and federal grants for open space programs.

Illinois Department of Transportation (IDOT)

Responsible for the planning, construction, and maintenance of portions of Illinois state and U.S. highway routes in the Mill Creek Watershed. IDOT is studying potential improvements to approximately 11 miles of Illinois Route 83 (Milwaukee Avenue/Barron Boulevard) and Illinois Route 137 (Buckley Road) in the Mill Creek Watershed. Incorporation of best management practices and sustainable management measures into this project and other transportation projects, as well as using best management practices to reduce road salt usage, can provide significant reduction in the volume of stormwater runoff and nonpoint source pollution generated by major roadways in the watershed.

Illinois Tollway

The Tollway Manages the many tollways in Illinois. The Illinois Tollway is a revenue bond-financed administrative agency of the State of Illinois. Operations are funded by toll and concession revenues. The Illinois Tollway is a user-fee system that receives no state or federal funds for maintenance and operations. A future project of importance to the Mill Creek Watershed is the Illinois Route 53/120 Project. The current proposal is a modern boulevard with a small footprint to protect the natural environment and preserve the character of Lake County. While an Illinois Route 53 northern extension has been considered since the 1960s, it was not acceptable to various interests. The Illinois Tollway established the Illinois Route 53/120 Blue Ribbon Advisory Council (BRAC) in 2011 to develop regional consensus on whether the Tollway should move forward with the project.

Lake County - Technical Resource

Mill Creek is located entirely within Lake County, and twenty-six percent of the Mill Creek Watershed is unincorporated indicating the county has a role in land use planning, development, natural resource protection, and drainage system management in a large part of the watershed. Working with the County departments of planning, building and development (PB&D), public works and health departments (LCHD), and division of transportation (LCDOT), can help ensure that the Mill Creek Watershed enjoys responsible, sustainable land use planning, road and sewer maintenance, and public health policies.

Lake County Forest Preserve District (LCFPD) - Technical Resource

LCFPD is the largest single landowner in the watershed. LCFPD owns and manages 2,388 acres of green infrastructure open space and agricultural lands within the Mill Creek Watershed. Much of the LCFPD land is farmland, and the district is beginning the process of developing long term restoration and trail plans for these preserves including the conversion of row crops to native vegetation.

Lake County Health Department - Ecological Services (LCHD-ES)

The LCHD Ecological Services provides technical expertise essential to the management and protection of Lake County surface waters. The goal of the LCHD-ES is to monitor the quality of the county's surface water in order to maintain or improve water quality and alleviate nuisance conditions, promote healthy and safe lake conditions, and protect and improve ecological diversity. The LCHD is also responsible for septic system management programs and well testing and monitoring.

Lake County Planning, Building and Development (LCPBD)

Lake County Planning, Building and Development Department is responsible for land use planning and permitting for unincorporated areas, natural resources, drainage system management. The main functions of the Department are planning, reviewing building permits, reviewing and implementing stormwater and erosion control plans, overseeing the National Flood Insurance Program, and planning for and administering funds from the U.S. Department of Housing and Urban Development.

Lake County Stormwater Management Commission (SMC) - Technical Resource

Mission is to coordinate the stormwater activities of over 90 jurisdictions throughout the county. SMC manages Lake County's floodplains and watersheds by administering countywide floodplain and stormwater management standards; reduces flood damage through flood hazard mitigation projects, implementing BMPs, watershed management plans and effective floodplain and stormwater management regulations; and protects and restores natural resources by utilizing a mix of funding sources and partnerships to restore and enhance the natural drainage system. SMC also provides technical assistance, funding, local knowledge and problem-solving skills to accomplish its mission.

Municipalities (M)

Municipalities (elected officials and staff) have the principal responsibility for land use and development planning, policies, and standards. There are also opportunities to make others aware of the watershed management planning process through local government newsletters and presentations at board meetings, which are often televised on local cable television networks. Municipalities, such as Grayslake are therefore crucial to watershed protection efforts. By partnering with municipalities and encouraging the adoption of sustainable zoning and development practices, a watershed protection group can check the increase of water quality impairments. Municipalities are also a key part of any watershed protection strategy because they are responsible for the enforcement of local land use and development ordinances. Many are also responsible for enforcing the SMC's WDO.

Natural Resources Conservation Service / Soil and Water Conservation District (NRCS and SWCD) - Technical Resource

Provide technical expertise and education on conservation, development, management, and wise use of natural resources to landowners and land managers, county and local governments, and local organizations. Areas of expertise include streambank stabilization and soil erosion/ sediment control, wetland and habitat restoration, community planning, environmental education, agricultural conservation, water quality protection, nonpoint source pollution, stream health, conservation planning, and natural resource maps and reports. NRCS and SWCD also administer several cost-share programs targeted to water quality, wetland restoration, and other watershed priorities.

As part of its watershed protection effort, NRCS administers the USDA Watershed Program (under Public Law 83-566). The purpose of the program is to assist federal, state, and local agencies; local government sponsors; tribal governments; and other program participants in protecting watersheds from damage caused by erosion, floodwater, and sediment; restoring damaged watersheds; conserving and developing water and land resources; and solving natural resource and related economic problems on a watershed basis.

Park and Recreation Districts (PD) - Technical Resource

Often control a large amount of open space in a watershed and maintain recreational facilities and parks which comprise an important component of the watershed green infrastructure. Parks also contain many recreational opportunities and trails and Park Districts will be an important partner for establishing habitat corridors in the Mill Creek Watershed. Partnerships with local park districts can help ensure the preservation of open space while also facilitating recreational and other community opportunities that can help increase support for watershed protection efforts.

Plant Nurseries (NUR)

Several commercial nursery operations are located in the watershed. As a subset of the agricultural stakeholders, the nursery operators manage relatively large tracts of land. Their land management and operation decisions have the potential to affect drainage and sediment and nutrient delivery to water resources. Due to their size, nursery operations may provide opportunities for the implementation of best management practices to improve water quality and habitat.

Private Residential/Riparian Landowners (PRL)

The activities of residential landowners, often unknowingly and unintentionally, can have a significant impact of the quality of a watershed. Practices such as excess lawn fertilization, connection of downspouts to the sewer system, or destruction of riparian buffers can be significant sources of nonpoint pollution. Watershed protection efforts should educate residents on the consequences of their actions and present alternatives. More positively, political pressure from local residents on municipal or county officials can lead to increased emphasis on watershed protection. And many local residents play important roles in watershed planning and protection efforts.

National Great Rivers Research and Education Center (NGRREC) - Technical Resource
Administers the RiverWatch program and relies on a volunteer base to monitor, collect and record stream, lake, wetland, and coastal data for the state database. It is also a valuable educational resource that can be used to educate others about watershed issues and concerns.

Schools (SI)
Venues for education and outreach related to watershed plan implementation. Schools reach a wide audience of both children and adults (parents) and provide opportunities for education through both curricula related to watershed issues, innovative projects, and even small demonstration sites that can serve as laboratories or provide “real-life” learning experiences. In addition, educational facilities are identified as a source of nonpoint source pollution in the watershed; the option to install BMPs at these locations exists.

Townships (T)
While unincorporated townships generally play a secondary role in watershed protection, they often have responsibility for road upkeep and occasionally sponsor drainage system improvement projects. The use of BMPs by townships, especially for road maintenance, can help improve water quality within the watershed.

U.S. Department of Agriculture (USDA) - Technical Resource
USDA’s Farm Services Agency (FSA) has several programs that support watershed protection and restoration efforts. Under the Conservation Reserve Program (CRP), farmers receive annual rental payments, cost sharing, and technical assistance to plant vegetation for land they put into reserve for 10 to 15 years. The Conservation Reserve Enhancement Program (CREP) targets state and federal funds to achieve shared environmental goals of national and state significance. The program uses financial incentives to encourage farmers and ranchers to voluntarily protect soil, water, and wildlife resources. The Grassland Reserve Program (GRP) uses 30-year easements and rental agreements to improve management of, restore, or conserve up to 2 million acres of private grasslands. The Conservation Security Program (CSP) is a voluntary program that provides financial and technical assistance to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on tribal and private working lands.

7.6.2 IMPLEMENTATION SUPPORT PARTNERS

Chicago Metropolitan Agency for Planning (CMAP) - Technical Resource
CMAP provides technical and planning assistance to local communities, community organizations and watershed protection groups. CMAP has developed model ordinances tailored to the Chicago region for stormwater management, water conservation, sediment control, streams and wetlands, and floodplains. CMAP also offers technical assistance and training opportunities to local governments and watershed groups and helps local governments apply for state and federal funding programs.

Chicago Wilderness (CW) - Technical Resource

A regional alliance composed of more than 250 organizations that work together to restore local nature and improve the quality of life for all who live in the CW region by protecting land and water. CW's four key initiatives—to restore the health of local nature, green infrastructure, combat climate change, and leave no child inside—reflect its commitment to using science and emerging knowledge, as well as a collaborative approach to conservation, to benefit all the region's residents. The members of Chicago Wilderness include local, state and federal agencies, large conservation organizations, cultural and education institutions, volunteer groups, municipalities, corporations, and faith-based groups. CW has developed a "Green Infrastructure Vision" that maps key locations for green infrastructure of regional importance, into which the green infrastructure network outlined in this plan fits

Federal Emergency Management Agency (FEMA) - Technical Resource

Principal federal agency involved in flood mitigation and flood disaster response. Among its duties, FEMA is responsible for the National Flood Insurance program, helps municipalities develop and enforce floodplain ordinances, develops floodplain maps, and administers funding for flood mitigation plans and projects.

Illinois Environmental Protection Agency (Illinois EPA), Bureau of Water - Technical Resource

Under the federal Clean Water Act and state legislation, Illinois EPA is responsible for ensuring that Illinois' rivers, streams, wetlands and lakes will support all uses for which they are designated including protection of aquatic life, recreation and drinking water supplies. Illinois EPA was a key source of funding for the development of the watershed plan. In addition, several Illinois EPA activities are important to this plan implementation:

- Monitoring: Illinois EPA oversees data collection at various sites (rivers, streams, lakes, etc.) across the state, numerous lakes in the watershed. The Illinois Water Quality Report (305(b)) summarizes these monitoring efforts.
- Funding: Illinois EPA administers several state and federal grant programs. Primary examples are the Section 319 funding under the Clean Water Act and the Illinois Green Infrastructure Grant (IGIG) program, which helps local governments, nonprofit entities, and numerous other state, federal, and local partners to reduce nonpoint source pollution and stormwater runoff through technical and financial support.
- Regulation: Illinois EPA regulates point and nonpoint source pollution discharges into the state's waters through regulatory and non-regulatory programs.

Illinois Emergency Management Agency (IEMA) - Technical Resource

State agency responsible for flood and disaster planning, emergency response, and hazard mitigation. IEMA works with local governments on flood mitigation plans and provides operational support during floods. IEMA also administers FEMA-funded programs in the state, including flood mitigation grant programs.

Lake County Audubon Society - Technical Resource

The mission of the Lake County Audubon Society is education, conservation and restoration of natural ecosystems, focusing on birds, and other wildlife and their habitats for the benefit of humanity and the earth's biological diversity. The Audubon sponsors activities and educational programs.

Lake County Farm Bureau - Technical Resource

Established in 1914, it is one of the oldest farm organizations in the United States. Originally, the Bureau was formed to help farmers improve their production practices. Today, the Lake County Farm Bureau serves both rural and urban people who are interested in the production of a plentiful and safe food supply. It exists to provide programs and services for each and every member. Lake County Farm Bureau provides educational programs and technical assistance including their Ag in the Classroom program.

Lake County Extension Service (University of Illinois Champaign) - Technical Resource

Lake County Extension Service (University of Illinois Champaign) offers educational programs in five broad areas: healthy society; food security and safety; environmental stewardship; sustainable and profitable food production and marketing systems; and enhancing youth, family and community well-being.

Lake County Public Works (LCPW)

Primary responsibility is to provide water and sanitary sewer service to widely distributed portions of Lake County. LCPW is committed to protecting our natural resources and providing high quality service through strong customer support, progressive leadership, sound financial management and environmental responsibility. Public Works owns and operates 297 miles of water main and 354 miles of sanitary sewer main. They provide direct water service to over 20,000 customers within 12 water distribution systems totaling approximately 25 square miles. Four water reclamation sewage treatment facilities serve 25,000 direct customers as well as 100,000 indirect customers through contract agreements with 14 different Lake County municipalities.

McHenry-Lake County Soil and Water Conservation District (SWCD) - Technical Resource

Formed in the 1940s and 50s (a) for the conservation of soil, soil resources, water and water resources in the State, (b) for the control and prevention of soil erosion, (c) for the prevention of air and water pollution, and (d) for the prevention of erosion, floodwater and sediment damages. Services provided by the SWCD include soil erosion sediment control inspections, natural resource inventories, soil tests, soil borings, technical assistance and workshops and training opportunities. The SWCD also administers several small grant programs.

Sierra Club

Established in 1892 and describes itself as a “grassroots environmental organization” that works to “protect communities, wild places, and the planet itself.” The Sierra Club has about 1.4 million members nation-wide. The national club is divided into State-based chapters, and each chapter is further divided into groups. The Illinois portion of the watershed falls into the “Woods and Wetlands” (Northeastern Illinois) group of the Illinois chapter. Among their activities, the groups sponsor outings and other events related to the Club’s mission and goals.

Solid Waste Agency of Lake County(SWALCO)

Many local governments have solid waste programs that address the disposal of solid waste and yard waste. They might also handle the recycling, illegal dumping, and household hazardous waste programs.

U.S. Army Corps of Engineers (USACE)

USACE plays a major role in wetland protection and regulation through Section 404 of the Clean Water Act, which requires USACE to administer permit applications for alterations to wetlands and waters of the United States. The USACE Chicago district has also established a Wetlands Restoration Fund, which may be available to Mill Creek Watershed communities.

U.S. Environmental Protection Agency (USEPA)

Oversees the environmental protection efforts of the Illinois EPA and is the ultimate source for Section 319 and other environmental improvement programs. Section 404 of the Clean Water Act, which regulates the dredging and filling of wetlands, is jointly administered by USEPA and the U.S. Army Corps of Engineers.

U.S. Fish and Wildlife Service (USFWS)

USFWS provides technical assistance to local watershed protection groups. It also administers several grant and cost-share programs that fund wetland and aquatic habitat restoration. The USFWS also administers the federal Endangered Species Act and supports a program called Endangered Species Program Partners, which features formal or informal partnerships for protecting endangered and threatened species and helping them to recover. These partnerships include federal partners as well as states, tribes, local governments, nonprofit organizations, and individual landowners.

Contents

Tables and Figures

8. EDUCATION AND OUTREACH STRATEGY AND TOOLS

8.1 WATERSHED INFORMATION AND EDUCATION NEEDS

Community engagement, outreach, and education are essential components of the Mill Creek Watershed-based plan. The education and outreach strategy is designed to:

- Raise public awareness about watershed issues and foster support for solutions;
- Educate stakeholders, the public and other identified target audiences in order to increase awareness and encourage behavioral changes;
- Provide engaged stakeholders the knowledge and skills they need to become watershed stewards and implement the watershed action plan.
- Leverage public and private partnerships to implement action items

Figure 8-1: Mill Creek planning kick-off meeting. Mill Creek watershed planning stakeholders identified education and outreach needs for watershed plan implementation and defined the educational topics, audiences, partners, and potential messages in the education and outreach strategy presented in Table 8-2.

Because many watershed problems result from individual actions and the solutions are often voluntary, public involvement and participation will encourage changes in behavior that will help improve watershed resources. Furthermore, the general public is often unaware of the environmental impact of their day-to-day activities on environmental resources. An understanding of watershed issues and how individual activities can play a role in reducing flooding, and protecting water quality and natural resources, helps provide the motivation and basis for changing behavior.

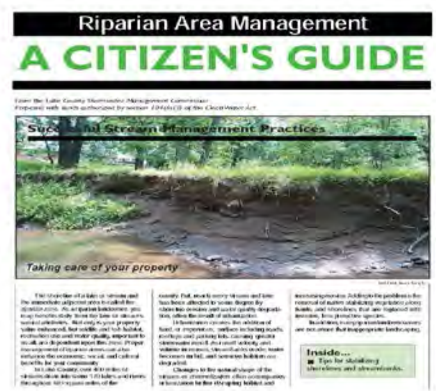


Figure 8-2: Brochure targeting riparian landowner best practices. Riparian landowners are one of the audiences targeted in the education and outreach strategy.

Different strategies may be appropriate for different scales and different topics or issues, e.g., a watershed-wide lake monitoring program or a targeted one-on-one outreach campaign for residents and landowners experiencing nuisance flooding.

8.2 TARGET AUDIENCES

Recommended target audiences, both existing as planning stakeholders, as well as those that have not been participants, were selected based on their ability to implement actions to reduce flooding, improve water quality, and enhance the natural resources in the watershed.

There can be multiple target audiences depending on which topic is being presented. The primary target audiences to meet watershed goals and objectives include residents and other landowners, land and resource managers and organizations, government officials and agencies, and developers and contractors. More specifically, target audiences include the following:

1) Residents and other landowners
   - Riparian, lakeshore residents and landowners
   - All residents and landowners
   - Homeowner associations, lake associations
   - Businesses and institutions
   - Civic organizations

2) Land and resource managers and organizations
   - Land and resource managers including homeowner associations, lake management associations, government, institutional and business facility managers, site stewards, nurseries, agricultural producers, equestrian operators,
   - Environmental organizations, committees, agencies, and special interest groups interested in the future and management of watershed resources

3) Government officials and agencies
   - Local governments, including municipalities, townships, drainage districts, park districts, forest preserve districts, and transportation departments that develop policies and regulations and manage land and projects within the watershed
   - Schools

4) Developers/contractors
   - Developers and homebuilders
   - Consultants and contractors (architects, engineers, planners, landscapers, lawn care) working in the watershed

8.3 PARTNER ORGANIZATIONS

Organizations that will be responsible for implementing the watershed plan recommendations can also help implement the education and information strategy as well as be target audiences. Each partner should couple plan implementation efforts with parallel efforts to inform and educate.

There are several educational programs that are currently being implemented by other organizations that watershed stakeholders may take advantage of for the Mill Creek watershed outreach and education program.

- Conserve Lake County, a county-wide land trust, provides technical assistance and a landscape certification program for watershed-friendly management practices such as native landscaping, rain gardens and rainwater harvesting for Lake County residents as part of a its Conservation @ Home program. Conserve's programming also

Education and Outreach Partners

Figure 8-3: Partners are key to project implementation. Demonstration projects like the Valley Lakes water quality improvement and shoreline restoration project are important opportunities for education and motivating watershed residents.

Figure 8-4: Stewardship events promote good practices and engage and educate residents. Grandwood Park residents got an early start on stewardship with a Grandwood Park Lake shoreline naturalization project completed in 2006. Continuing in their stewardship tradition, Grandwood Park Park District sponsored the first Mill Creek stream clean up in September 2013.

includes a speaker's bureau for community groups that want to learn more about private land protection. They have also sponsored controlled burning and invasive species control training programs.

- The various municipalities, townships, County departments and the Lake County Stormwater Management Commission (SMC) also provide pollution prevention and non-point source Best Management Practice information and workshops.

Noteworthy: Conservation @ Home

Conserve Lake County (Conserve) is a member-supported nonprofit organization dedicated to preserving Lake County's precious landscapes and improving the health of the land with land stewardship projects that bring vitality back to prairies, wetlands, and woodlands. In 2011, Conserve launched the Conservation @ Home program to improve the health of the land and water of Lake County by helping residents take care of nature in their own backyards. Conserve provides property evaluations to help homeowners identify and use fairly simple practices that retain property aesthetics while supporting clean water, rich soil and resilient ecosystems. Free consultation visits focus on native plants, rainwater, lawns and invasive species. Native plants are recommended for landscaping, and rainwater projects direct rooftop runoff into rain barrels and rain gardens or other landscaped areas of the yard. Eco-friendly yards may be certified as a Conservation @ Home property and receive a garden sign to display.
http://www.conservelakecounty.org/conservationhome/

Figure 8-5: Conservation @ Home yard placard indicates a yard that has been evaluated and certified as an eco-friendly landscape.

Figure 8-6: Rollins Savanna is one of the many high quality open spaces in the watershed. The Forest Preserve District converted agricultural fields to grassland, wetlands, and savanna, providing "green infrastructure" that infiltrates precipitation and reduces nonpoint source pollutant runoff to Mill Creek. The Forest Preserve District is a key partner that is expert in using appropriate messaging for educational events and programs in the watershed.

8.4 GUIDANCE FOR IMPLEMENTATION

The following provides general guidance for implementing the Education and Outreach Strategy. More detailed recommendations for addressing the specific Mill Creek watershed issues are included in **Table 8-2**.

- Use words that the general public can understand and speak to their existing values and priorities.
- Keep messages simple and straightforward, with only two or three take-home points at a time, use graphics and photos to illustrate the message, and repeat it frequently.
- Emphasize the connections between the message and the issue/resource being addressed for example: storms, the creek, lakes, Des Plaines River, land management, and urban landscape and streets.
- Develop multiple messages: one broad message for the general public and a series of more specifically targeted messages for specific audiences (e.g., landowners, business owners, and municipalities.)

- Identify and provide for the different level of understanding and needs of various audience groups. When interacting with a group, stress the dimensions of the project that apply most to them. For example, when interacting with homeowners, focus on items such as rain gardens, lawn care, pollution prevention and restoration and management of riparian buffers. Develop a similar "menu" of topics for each target audience.
- Coordinate the information and education strategy with partner organizations to combine efforts, achieve economies of scale, tap into each other's networks, share costs, and ensure a consistent message.
- Work to correct perception problems, such as Mill Creek being viewed as "drainage ditch" rather than as a community asset to be protected, enhanced, and enjoyed.
- Basic watershed science education (e.g., biology, the water cycle, stream ecology) may be needed when the audience has little knowledge about the creek, lakes, wetlands or watershed.
- Be sure to inform your audience about actions they can take, behaviors they can change, to help address watershed problems and issues.
- Use websites and other social media, as well as public places such as libraries and village halls, to post/promote your message.

8.5 MESSAGE FORMATS AND DELIVERY MECHANISMS

Numerous existing programs, tools, and materials are available that can be used or customized to accelerate outreach and education efforts.

Table 8-1: Outreach Tools.

Outreach Tools				
Print	**Electronic**	**Visuals**	**Personal Contact**	**Other**
Brochures	Websites	Displays	Workshops	Watershed Council
Fact sheets	Emails	Exhibits	Demonstrations	Partnerships
Newsletters	Videos/local cable channel	Signage	Presentations	Cooperative agreements
News releases	E-News	Photos	Events	Local ordinances
Feature articles	PSAs	Posters	Field trips, watershed tours	Local comprehensive planning
Inserts	Bulletin Boards	Bulletin boards	Meetings	
Flyers	Surveys	Presentations	Interviews	
Direct mail			Surveys	
Manuals, technical resources			Face-to-face	
Media kit			Open houses	

8.6 EVALUATING PLAN OUTREACH

Evaluation provides a feedback mechanism for ongoing improvement of your outreach effort and for assessing whether the effort is successful. It also builds support for further funding. The following ideas should be customized to the particular party responsible for implementing the education and information campaign. For a number of these evaluation strategies, baseline information should be collected and current knowledge surveyed before the outreach activities begin and checked periodically throughout the outreach campaign to help measure progress and effectiveness.

Figure 8-7: Signage targeting invasive aquatic species.

Actual achievement of the watershed plan objectives such as reductions in flooding and impairment of water quality in Mill Creek are perhaps the best indicators of outreach effectiveness. While it is difficult to attribute flood reduction and water quality improvement to specific outreach strategy programs or actions, there is little doubt that increased understanding and involvement in the watershed is essential to watershed improvement. Indicators to evaluate and monitor each topic listed in **Table 8-2** have been developed.

8.7 WATERSHED INFORMATION AND EDUCATION RESOURCES

There are a number of resources that include effective outreach messages, delivery techniques, watershed management planning, media relations, and strategies to assist with developing an outreach campaign. A web search provides many examples, but a good place to begin is with USEPA. They and others provide downloadable resources that can be customized for the Mill Creek Watershed.

8.8 EDUCATION AND OUTREACH STRATEGY

Watershed stakeholders participating in the watershed planning process assisted in developing an education and outreach strategy that includes priority topics, target audiences, potential messages and vehicles to convey the messages and identifies partner leads for conveying the messages. The stakeholder-based strategy is summarized in **Table 8-2**.

Table 8-2: Educational topics, messages, and partners.

Target Audiences	Education/Outreach Method or Vehicle	Partner Leads	Potential Messages
Topic	**Agriculture Best Practices to Preserve Soil and Control Nutrient Runoff**		
Farmers, Stable Owners, Nurseries, Landowners, Lake County Farm Bureau, Elected Officials,	One-on-One Meetings; Lake County Farm Bureau; Illinois Horse Council; University of Illinois Extension Service;	SWCD, NRCS, LCFPD, University of Illinois Extension Service, Illinois Department of Agriculture T-2000 Program	Good Practices Don't Have to Be Costly; Use Only What You Need (nutrient input); Cover Crops Increase Yield, Water Retention; Soil: Keep It on the Land, Out of the Water;
Topic	**Avoiding Flood Risk and How to Mitigate For It**		
Homeowners, Municipalities, Businesses, Drainage Districts, Insurance Companies, DOTs,	Direct Mailings/Outreach to Floodprone Property Owners; Floodproofing Workshop; Buyout Program; Newsletters, Websites; Technical Assistance With Flood Audits; Promote Via Partnerships (realtors, insurance agents, etc.); Television (CLC, LCTV),	LCSMC, Insurance Companies, Realtors, Municipalities, FEMA, NFIP, Chambers of Commerce, Drainage Districts, Schools	Maintain Your Culvert; Stream Maintenance Reduces ; Convert Grey to Green Infrastructure; Infiltration Practices Reduce Runoff; Use Native Vegetation Let It Soak In; Know How Your Property is Affected by Changes to Flood Maps; Floodproofing Tips For Your Home or Business; Maintain Your Detention Basin
Topic	**Lake and Shoreline Management**		
Lake Residents, Lake Management Associations, Lake Users, Shoreline Restoration Contractors, Municipalities, Park Districts	HOA/Lake Management Association Meetings; Newsletters; Websites; Outside Presenters; Demonstration Sites; Project Tours; Biological Monitoring Results; Television (CLC, LCTV); Signage	LCHD, CLC, HOAs, Park Districts, Lake Management Associations,	If You Don't Want It In Your Lake Don't Put It On Your Lawn; Manage Your Edge With A Native Buffer; What Fish Testing Can Tell You About Your Lake; Shore Up Your Streambank With Native Vegetation; Control the Invaders; Put a Buffer Between Your Lake and The Geese; Before Dropping Anchor, Check For Zebra Mussels

Target Audiences	Education/Outreach Method or Vehicle	Partner Leads	Potential Messages
Topic	**Low Impact Development and New Development Using Stormwater BMPs (runoff rate and volume control)**		
Regulatory Agencies, Builders, Developers, Consultants, Homeowners, HOAs, Plan Commissions	Handouts at Permit Facility; Local Codes, Ordinances	LCSMC, LCPB&D, Municipalities	Put A LID On Nonpoint Source ; Green Infrastructure: It Does It All; Let It Soak In; Keep It Recharging; Design With Infiltration In Mind
Topic	**Stormwater Infrastructure (incl. detention basin) and Outfall Management**		
Township Officials/Highway Commissioners, Chambers of Commerce, Municipalities, HOAs, Homeowners/Property Owners (adjacent to infrastructure)	Face-to-Face (for high-priority issues); Targeted Mailings (for initial contact); HOA Workshops; Technical Assistance; County Board/Municipal Websites/Newsletters; LCTV, CLC Video/Program	Municipalities, Townships, Drainage Districts, Local Elected Officials, LCSMC	Reduce Road Runoff, Road Pollutants; Purpose of/Need to Maintain HOA Detention Ponds; BMPs and How to Maintain Them; Adopt a Storm Drain; Regular Maintenance Keeps Your Facility Working
Topic	**Stream Restoration, and Streambank Stabilization (incl. dams, impoundments, obstructions, riparian buffers, habitat corridors)**		
Dam Owners; Landowners; Residents, **Riparian Landowners; Local Government Agencies; Consultants; Landscape Contractors; DOTs**	Door-to-Door, Letters, Meetings, Local Government Websites/Newsletters; Targeted Email Blasts; Brochures; Demonstration Projects; Field Trips; Public Meetings; Workshops for Developers; Certification Or Placards; Shoreline Assessments	Park Districts, Dam Owners, Elected Officials LCSMC, Park Districts, HOAs, Forest Preserve District, Elected Officials, Landscape Contractors, Consultants, Non-Profit Groups	Dam Maintenance, Replacement, Removal Save The Bank, Invest In Native Vegetation; Go Natural with Native Buffers; You Are Responsible for Maintaining the Creek On Your Property; Invasives Not Invited; Stream Maintenance Can Help Reduce Flooding; We Have Our Highways Give Them Theirs; What Shape Is Your Shoreline In

Target Audiences	Education/Outreach Method or Vehicle	Partner Leads	Potential Messages
Topic	**Preventing pollution from urban properties (incl. nutrients, pesticides etc.):** • **Yard and Landscape Management (native landscaping);** • **Maintaining Natural Hydrology on Your Property (infiltration & rain water harvesting)**		
Home/Property Owners (business/institutions/govern-ment), Condo Associations, Landscape Contractors, Business Owners, Elected Officials, Municipal/Consulting Engineers, Home Improvement Businesses, Garden Centers, CLC, HOAs	Conservation @ Home Program (Conserve Lake County); Schools; University of Illinois Extension Service; Local Government Websites/Newsletters; LCFPD; LCSMC; Local Nurseries Selling Native Plants; Famers Markets; Demonstration Lawns/Sites; Print Materials On Alternative/Natural Yard Care Products; Lake Education Days	Conserve Lake County, Garden Centers, Hardware Stores, Park Districts, LCSMC, CLC, LCFPD, SWALCO, HOAs, Schools, Municipalities	Cost Savings in Using Conservation Practices (ex. native landscaping); A Healthy Yard Has Low Impact on Environment, Improves Sustainability; What You Can Do To Improve Waters Quality Recycle Rain Water; Harvest Rain Water; A Healthy Yard = Less Time You Spend Maintaining It; Test Your Soil Before You Treat It
Topic	**Best Winter Maintenance Practices for "Reduced-Chloride" Waters**		
Local Government/Private Large Parking Lot Owners, Snow Plow Operators, HOAs/Private Roads, DOTs	Deicing Workshops; Deicing Operator Certification; Product Application & Calibration Demonstration; ILMA	LCSMC, LCHD, DOTs, Municipalities, Townships, State, APWA, BOMA, ILCA, Schools, Businesses Associations	Salt Alternatives Save Money, Reduce Impacts To Our Water Resources; Calibration Key to Effective Product Application; Store It Right; Save Our Lakes, Use Less Salt On Our Roads

Appendix A – Stakeholder Meeting Minutes

MILL CREEK
KICKOFF FLOOD MITIGATION AND WATERSHED PLAN MEETING
FEBRUARY 28, 2013 – 1:30 TO 3:30 PM AND 7:00 TO 9:00 PM

MEETING REPORT

Meeting Purpose: Familiarize attendees with watershed planning and the Mill Creek watershed and begin to develop a flood mitigation and watershed plan.

Meeting Objectives:

- Ensure that we have a representative group of engaged stakeholders.
- Start identifying watershed issues and opportunities.
- Start identifying flood problem areas.

MEETING SUMMARY

Introductions:

Mike Warner, Executive Director of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting and introduced Patty Werner, Andrea Cline, and Susan Vancil as SMC project staff. Also introduced were other SMC staff in attendance: Mike Novotney and Mike Prusila and other speakers: Vince Mosca, Hey and Associates (Vince has monitored stream water quality on behalf of the Mill Creek Water Reclamation Facility); Mike Adam (afternoon meeting) and Gerry Urbanozo (evening meeting) Lake County Health Department Environmental Services Division Lakes Management Unit (the Lakes Management Unit has monitored water quality of lakes in the watershed). All other meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Mike acknowledged that the Illinois Department of Commerce and Economic Opportunity (DCEO) is providing funding to SMC to develop a flood mitigation and watershed plan for the Mill Creek watershed due to the Ike storm system that moved through the area and caused damage throughout the county in 2008. The flood mitigation and watershed planning process will be completed in 2014. Plan development will involve active stakeholder participation including a series of stakeholder planning meetings that will be scheduled approximately monthly.

What is a Watershed Plan?

PDF files of the Power Points presented on this topic and watershed characteristics may be viewed and downloaded from the SMC website at:
http://lakecountyil.gov/Stormwater/LakeCountyWatersheds/Mill.htm

Patty Werner presented what a watershed plan is, how it is used, and explained why we are doing a watershed plan for the Mill Creek watershed. A watershed plan is a guidance document. It is not a regulatory ordinance and it is not a land use plan. Land use planning is conducted by local municipalities and counties who have land use planning authority. Since water flow does not conform to political jurisdictional boundaries, water impacts (flooding, water pollution etc.) may affect multiple jurisdictions located in the watershed. Watershed planning is a way for multiple jurisdictions, non-profit and business organizations, and individual landowners to coordinate activities and pool resources to reduce flooding, improve water quality and protect and enhance natural resources in the watershed. Having a watershed-based plan not only provides guidance to stakeholders on program and project needs to improve the watershed, but also opens the door to accessing grants to provide matching money for the projects and programs recommended in the watershed action plan.

Watershed Planning Process and Schedule:
Patty Werner briefly covered how the watershed planning process will work over the period of a year. The plan committee will meet approximately 10-12 times on a monthly basis. Once a draft of the plan is complete, SMC and this watershed planning committee will review the draft plan report before it goes out for public review and comment. Following any necessary revisions, the final plan will be adopted by the SMC and the Lake County Board as an amendment to the Lake County Comprehensive Stormwater Management Plan. Other stakeholder jurisdictions will also be asked to adopt the plan as a guidance document.

Watershed Characteristics:
Andrea Cline described the characteristics and condition of the Mill Creek watershed including historic land cover, ecology/natural resources, and current and projected watershed land use and demographic data. Mike Prusila summarized SMC's stream and detention basin inventory procedures; they will be conducted this summer.

Vince Mosca from Hey and Associates presented information pertaining to the stream quality monitoring that Lake County has contracted with them to conduct upstream and downstream of the Mill Creek Water Reclamation Facility (WRF). He described the elements that are surveyed at three collection points in the watershed, which include field parameters (temperature, DO, pH, conductivity, discharge), water chemistry, macroinvertebrates, fish and habitat. He concluded that the Mill Creek WRF does not seem to have an negative effect on water quality.

The Lake County Health Department (Mike Adam in the afternoon meeting and Gerry Urbanozo in the evening meeting) summarized the water quality monitoring program they last conducted in 2012 on 10 lakes in the Mill Creek watershed. They reviewed the equipment and processes they use to collect data for dissolved oxygen, conductivity, pH, water temperature, nutrients, chloride, flow, and aquatic plants. From previously collected data, the water quality in the watershed is considered to be poor and 10 of the waterbodies have been designated as "impaired" by the Illinois Environmental Protection Agency (Illinois EPA).

Watershed Issues and Opportunities:
Meeting participants were divided into groups (4 afternoon/2 evening) with a facilitator assigned to each group for this stakeholder input exercise. Andrea Cline asked that all of the meeting participants identify issues and opportunities that they think should be addressed in the watershed planning process. Each participant in turn provided the issues of greatest concern to them and opportunities to improve the watershed. These were recorded on flip charts and are compiled in an attached table.

Identification of Flood Damage Areas:
There was not adequate time to complete the exercise to identify areas in the watershed that experience flood damage, so this will be completed at the next stakeholder meeting.

Final Announcements/Next Meetings:
Andrea Cline will be compiling and sending out a summary of the stakeholder input on watershed issues and opportunities. Andrea also thanked meeting participants for attending today's meeting. They will be receiving an invitation for the March meeting in the next few weeks and a summary of this meeting will be sent out and posted on the SMC website.
http://lakecountyil.gov/Stormwater/LakeCountyWatersheds/Mill.htm

Meeting Attendees:

Last Name	First Name	Organization
Adam	Mike	Lake County Health Department
Amidei	Moses	Village of Wadsworth
Anders	Linda	Grandwood Park Park District
Anderson	James L.	Lake County Forest Preserve District
Beilfuss	Ed	Carillon North Wetland Committee
Berns	Leslie	Lake County Forest Preserve District
Bland	Jim	EPS Incoporated
Carlson	Nancy	Grandwood Park Park District
Carlson	Steve	Lake County SMC
Cline	Andrea	Lake County SMC
Conint	Brian	Weston Solutions
Courser	Jerry	
Cunz	Cecily	AES
DeGrave	Chuck	LCPW
Evans	Kip and Sue	
Flood	Rob	Gages Lake Conservation Committee
Gano	Chris	Grandwood Park Park District
Gentleman	Will	
Graft	Tony	Rollins North Wellness Committee
Gray	Bob	
Gray	Jean	
Grinnell	Keith	CCSD 46
Gutowski	Ken	Grayslake Lake Management
Gutowski	Lisa	Grayslake Lake Management
Halverson	Hillary	
Hanley	Marty	Land and Lakes
Heinz	Bill	Village of Grayslake
Holloway	David	Volkert
Hubbard	Kurt	
Husemoller	Dave	Lake County PB & D
Husemoller	Tim	Prairie Crossing Charter School
Keller	Michele	Lake Properties Venture
Klees	Mary	Grayslake Environmental Commission
Klick	Rory	College of Lake County
Kotulla	Wendy	Village of Third Lake
Kubillus	Sandy	Integrated Lakes Management
Kwepfer	George	
LeClair	Diane	Grandwood Park Park District

Last Name	First Name	Organization
Leffingwell	Larry	
McCoy	Mike	
Miller	Christine	
Miller	Diane	
Nasatir	Mikki	
Nehila	Jeff	Grayslake Park District
Novotney	Mike	Lake County SMC
Panther	Reed	Illinois Tollway
Paulus	Carl "Max"	
Paulus	Tom	Grayslake Lake Management
Penny	Dan	Village of Third Lake
Petrovich	George	Elysian Fields HOA (Gurnee)
Powel	Timothy	Avon-Freemont Drainage District
Prusila	Michael E.	
Rehlek	John	Gurnee Engineering Department
Reynolds	Del	
Rich	Karen	
Rich	Kathe	
Rieth	Lori	Mariner's Cove Community Association
Rybarczyk	R	
Salemi	Joe	
Schultz	Walt	
Smith	Rebecca	
Starzec	Kathi	
Swiatowitz	Mike	Land and Lakes
Vancil	Susan	Lake County SMC
Warner	Michael D.	
Wattleworth	Coleen	Grandwood Park Park District
Welsh	Wesley	Village of Lindenhurst
Werner	Patricia	
Wilson	Don	
Zachary	Dan	Carillon North HOA
Zachary	Rita	Carillon North HOA

MILL CREEK
KICKOFF FLOOD MITIGATION AND WATERSHED PLAN MEETING
APRIL 4, 2013 – 1:30 TO 3:30 PM

MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to complete and prioritize watershed priorities that the watershed action plan needs to address and to develop future meeting topics and plan goals.

Meeting Objectives:
- Prioritize watershed issues and opportunities.
- Develop a list of topics to be addressed at future meetings.
- Start identifying flood problem areas.

MEETING SUMMARY

Introductions:
Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting and introduced Patty Werner, Mike Prusila, Mike Novotney, and Susan Vancil as SMC project staff. Also introduced was Coleen Wattleworth, Executive Director, Grandwood Park Park District who provided the meeting venue and will be speaking about the Park District. All other meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Andrea asked for historical information about the watershed. Below is a brief summary of information provided. If stakeholders have any other information, please contact Andrea.
- Steve Carlson, County Board, stated the Grand Lake dam was built in the 1940s, and the lake used to be 15-20' and now about 6' deep.
- Jim Rogers, Trustee, Village of Third Lake stated the dam on Third Lake was built in 1972 with an upgrade in 1979. The lake was there before Mariner's Cove was built.

Review and Accept February 28, 2013 Meeting Summary
The summary was accepted without changes by consensus of the group.

Announcements:
Andrea Cline announced the results of the on-line survey about meeting day and time. The consensus was Thursday afternoons but SMC will hold night meetings to accommodate those who cannot attend day meetings.

Getting To Know: Grandwood Park Park District
Andrea described the 5-minute "Get To Know" segment on the agenda and invited stakeholders to share 5-minute descriptions of their organizations and their roles in the watershed at the beginning of future meetings. Andrea introduced the Coleen Wattleworth, Executive Director, Grandwood Park Park District (GPPD), who provided an overview of the District and how it fits into watershed management. The District was established in 1965 and is a municipal government

agency providing parks, recreation, and events and programs to 5,200 residents of Grandwood Park located in unincorporated Gurnee. The District has taken an active role in protecting natural resources with programs like its "Save the Lake" established in 1998 and led by volunteers. The District is responsible for the use and stewardship of the property along Mill Creek and Grandwood Park Lake. District goals for the watershed include water quality, flood reduction, a possible bird sanctuary on the southwest section of the creek, expansion of open space, walking paths, and the support of environment programs.

Goals and Objectives Presentation

Andrea Cline recapped the watershed planning process and plan components. The planning committee will develop the watershed goals and objectives, which should reflect watershed conditions; address stakeholder priority issues; consider expected future changes to the watershed; and meet funder's expectations. A vision statement will be developed asking the question, what members would like the Mill Creek watershed landscape to look like or be like in 20 years based on the value the committee values related to landscape, water resources, and living conditions, and preservation considerations.

The committee will develop a mission statement defining the purpose, role, and scope of the watershed group and its members. The mission statement should reflect what the group will do to achieve the desired vision for the watershed. The planning committee will develop the vision statement and mission statements at its next meeting.

Andrea reviewed how goals and objectives are developed with goals described as an end; objectives the means to those ends. Both should be measurable. Andrea then summarized the list of issues and opportunities compiled from the first planning committee meeting, and how the summary lists were tabulated. She reviewed each issue/opportunity that was listed, and asked if there were any additions to the list. The planning committee then discussed the issues and opportunities and provided clarifications where needed. The clarifications and additions are included in the final list of Issues/Opportunities for Prioritization.

Questions/comments from the committee during the discussion included:

- Under "Flooding," section of the Issues, there was discussion and a request for clarification on the flood control item.
    - Jim Rogers and Gary Beggan, Village of Third Lake, and Bill Heinz, Village of Grayslake commented on the updated FEMA floodplain maps and letters sent to each noting a September adoption deadline. Patty Werner, SMC, stated the floodplain maps are FEMA products and FEMA was modernizing (i.e., digitizing) the maps that included some updates to the floodplain boundaries. Patty asked one of the municipalities to forward SMC a copy of the FEMA letter it received. SMC is re-studying the floodplain as part of the Mill Creek planning effort and will be more accurate and when it's completed there may be changes to the floodplain map.
    - Jim Bland noted two properties in Third Lake experienced significant flooding and if any buyout funds were available. Patty Werner, SMC, stated SMC is still applying for buyout funds and has submitted two grants. Buyout funding consideration is based on FEMA's cost-benefit ratio where the benefit of the

purchase exceeds the cost to do so. If committee members have questions about voluntary buyouts they should contact Christine Gaynes, SMC, 847-377-7706.
    - It was determined the flood control comment pertained to the detention basin inventory SMC is undertaking over the summer.
- Under the "Stormwater and Drainage," section of the Issues, it was noted the Manor subdivision is in Grayslake.
    - Wendy Kotulla, Mariner's Cove, stated the site-specific catch basin sand accumulation concern applies to Mariner's Cove subdivision and Warren Township.
- Under "Water Quality," section of the Issues, Jim Bland commented on the College of Lake County's parking lot runoff and it will be included under the "Land/Water Use Impacts" issue.
    - Large parking lots will be added under the winter road maintenance item.
- Under "Land/Water Use Impacts," open space was added to the poor land management item. Patty Werner, SMC, noted that one planning meeting will be devoted to water quality presented by the Health Department's Lakes Management Unit and will include information on well testing and results for the watershed that indicate potential pollution from surface runoff.
- Under "Natural Resources," dredging and sediment and its impact on water quality and recreation versus habitat was discussed. Jim Bland noted blue green algae and it was added under the "Water Quality" issue. Steve Carlson asked about the differentiation between water quality in surface versus subsurface. Patty Werner, SMC, stated for this planning effort we are only interested in surface water quality, although the process indirectly will affect subsurface water quality.
- Under "Education/Information/Input," bio assessments are connected to natural resources for the purposes of this planning effort.
    - Jim Bland stated the definition of "sustainability" should reflect the EPA's revised definition.
- Under "Climate Change," there was a question on how climate change affects engineering and modeling.
    - Steve Carlson asked how the plan responds to the effects of drought and Lake Michigan water availability and groundwater. Patty Werner, SMC, stated the plan will not address Lake Michigan water or groundwater concerns.
- Under "Plan Implementation," a comment was made asking who will be responsible for what is important to include.
    - Jim Rogers and Gary Beggan, Village of Third Lake, noted an early 1990s study done on the inlet to the lake at the Fremont trench. Jim Bland noted it was a TR-20 study done 20 years ago by Randy Stowe. SMC will look in its files.
- Under "Watershed Opportunities," Wendy Kotulla, Mariner's Cove, asked whether dams are designed to also reduce zebra mussels and other invasive species. Dams were added under "Stormwater Management and Drainage" issues.
- Under "What do People Need to Know to Address Issues/Take Advantage of Opportunities?", a request was made for a template including a checklist of questions for every project included in the action plan.
- There are tools (e.g., metrics) for measuring participation and plan evaluation.

Andrea explained the voting system we will use to determine collective priorities for watershed issues and opportunities. Each member was allotted 5 votes, weighted from 1-5 and instructed to vote for 5 issues, assigning their votes based on their priority, with 5 being the highest priority and 1 being the lowest. A breakdown of the final count is attached. Votes will be aggregated by issue and by topic. The prioritized issues & opportunities will help the group formulate the goals and objectives of the watershed plan. The group was asked if there were any final comments they would like to share about one or more issues before the group votes. The issues and opportunities were voted on and will be tabulated by SMC staff and reported to the group. SMC will send the issues and opportunity lists to the participants from the first meeting that could not attend today so that they may vote also.

Future Meeting Topics and Schedule
Andrea Cline, SMC, went through the topics noting the first ones listed are required topics per the grantor. Steve Carlson asked about influencing transportation construction projects from new roads to bike paths. Patty Werner, SMC, stated water quality goals from a transportation standpoint should concentrate on design considerations (i.e., what kind of practices can be used) to reduce runoff into the watershed lakes. The plan would likely have more influence over local versus state level transportation projects. Jim Rogers, Village of Third Lake, asked how much land is considered agricultural. 21% is mapped and designated as agriculture land use. Bill Heinz, Village of Grayslake, asked how much of the 21% was used or zoned for agriculture. Tom Chefalo, Lake County Planning, Building and Development, stated the Forest Preserve District has property designated as agriculture but was not counted on the County GIS as zoned or active agriculture land. Steve Carlson asked in terms of runoff is there an incentive to including agriculture land in the goals and objectives. Patty Werner, SMC, stated SMC will look into the percentages and designations.

Each member was allotted 5 votes, weighted from 1-5 and instructed to vote for 5 meeting topics, assigning their votes based on their priority, with 5 being the highest priority and 1 being the lowest. A breakdown of the final count is attached.

Flood Problem Areas
Andrea Cline, SMC, gave an overview of the flood problem area inventory, and flooding issues identified in the issues and opportunities discussion. Watershed planning can help prevent flood damages in new areas, help prevent flood damage from increasing, and help correct existing problems. Andrea explained what the 100 floodplain is and the misconceptions of how it is defined. The 100-year flood term actually means the flood that has a 1% chance of occurring any given year.

Andrea explained the Mill Creek plan will update the existing flood study; update the flood problem area inventory; and propose solutions for flood problem areas. Floodplain studies are conducted to map construction that occurred in areas with undefined flood risk and to capture land uses changes resulting in increased flood levels and consequently flood risk.

Flood problem areas (FPA) were broken down into four areas: flood damaged structures, flooded roads, and health and safety hazards like septic failure and sanitary sewer back up. FPAs are caused by overbank flooding, depressional flooding, inadequate infrastructure, and sanitary sewer backups. The planning committee will be looking at new FPAs, old ones, and ones that have been mitigated.

Andrea stated Lake County has been conducting the Flood Problem Area Inventory (FPAI) since 1995 as part of the County's All Natural Hazards Mitigation Plan and updating it for the Mill Creek planning effort. Those efforts include planning committee feedback, letters to jurisidictional agencies, letters to homeowners in existing FPAs, and a flood survey to the stakeholder list.

Attendees met with SMC staff to document known FPAs. SMC will be sending out letters to gather more input and will seek input from meeting attendees unable to make the meeting.

Final Announcements/Next Meetings:
Andrea Cline will be compiling and sending out a summary of the stakeholder input on watershed issues and opportunities, and meeting topics. Andrea thanked meeting participants for attending today's meeting and the Grandwood Park Park District for hosting the meeting. Participants will be receiving an invitation for the May meeting in the next few weeks and a summary of this meeting will be sent out and posted on the SMC website.
http://lakecountyil.gov/Stormwater/LakeCountyWatersheds/Mill.htm

Meeting Attendees:

Last Name	First Name	Organization
Beggan	Gary	Village of Third Lake
Beilfuss	Ed	Carillon North Wetland Committee
Bland	Jim	EPS Incorporated
Carlson	Steve	Lake County SMC
Cassidy	Leslie	Grandwood Park Park District
Chefalo	Tom	Lake County PBD
Cline	Andrea	Lake County SMC
DeNomie	Jim	Avon Independents
Graft	Tony	Rollins North Wellness Committee
Gray	Keith	Upper Des Plaines Ecosystem Partnership
Heinz	Bill	Village of Grayslake
Hertel	Darcy	Lake County SMC
Keller	Michele	Lake Properties Venture
Klees	Mary	Grayslake Environmental Commission
Kotulla	Wendy	Village of Third Lake
Kure	Patt	Village of Third Lake
Novotney	Mike	Lake County SMC
Prusila	Michael	Lake County SMC
Rogers	Jim	Village of Third Lake
Vancil	Susan	Lake County SMC
Wattleworth	Coleen	Grandwood Park Park District
Welsh	Wesley	Village of Lindenhurst
Werner	Patricia	Lake County SMC
Wilson	Don	
Zachary	Rita	Carillon North HOA

MILL CREEK
FLOOD MITIGATION AND WATERSHED PLAN MEETING
MAY 2, 2013 – 1:30 TO 3:30 PM
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to complete and prioritize watershed priorities that the watershed action plan needs to address and to develop future meeting topics and plan goals.

Meeting Objectives:
- Have a common understanding about current and future land use changes in the watershed;
- Develop preliminary plan goals.

MEETING SUMMARY

Introductions:
Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting and introduced Mike Prusila, Darcy Hertel, and Susan Vancil as SMC project staff. All other meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Review and Accept April 4, 2013 Meeting Summary
The summary was accepted without changes by consensus of the group.

2013 Flood Event and Its Impact on the Mill Creek Watershed
Andrea handed out the Flood Problem Area (FPA) survey that will be mailed out to watershed residents and municipalities seeking input in existing and new FPAs. She defined a FPA as one or more structures damaged by the same sources/cause of flooding; and defined a critical facility as fire and police stations, schools, water or sanitary treatment facilities, other public utility providers, and institutions such as hospitals and nursing homes containing occupants who may not be sufficiently mobile during a flood event. Andrea showed a hydrograph of the rainfall event causing the flood emergency. The hydrograph showed the rate of flow (discharge) versus time past a specific point in a river or stream carrying flow. Wendy Kotula asked if it takes less rainfall to create more runoff in the watershed. Andrea stated that currently the rainfall/runoff ratio is not calculated. Photos were shown of the Grandwood Park area and other areas in the watershed at peak flow capturing the impacts to the Mill Creek watershed during the recent flooding.

Andrea also talked about how land use effects water quality and potential sources of increased runoff from an urbanized environment. Andrea provided examples of how changes in land is developed and managed affects watershed planning for pollution prevention and Best Management Practice (BMP) implementation. Andrea reviewed the watershed planning process, watershed topic areas, and watershed priorities from previous meetings. Participants broke into smaller groups to develop goal statements that will be compiled for the next meeting when objectives will be developed for each goal.

Getting To Know: Village of Grayslake
Mike May, Assistant Village Administrator, talked about the Village's history, efforts to improve the stormwater infrastructure to reduce flooding and improve water quality; and privatize Village services to reduce costs and improve efficiencies overall.

Lake County Department of Planning, Building and Development (PB&D)
Tom Chefalo, Principal Planner, PB&D talked about PB&D's core functions: plan for a better Lake County; protect residents and property; protection the natural environment; and assist low-income people and communities. He shared maps that show the current land use and anticipated future land use in 2030 for Lake County. Tom described the Lake County Regional Framework Plan, the countywide comprehensive plan for managing land use, directing growth, and protecting the natural environment. The Plan was adopted in 2004 with updates to environmental resources and land use sections in 2007. The Plan is currently being updated to include a sustainability chapter. Tom also discussed the division between the County's land use planning and zoning authority in unincorporated areas and municipalities' authority within their own corporate limits. Tom described how the Department uses existing zoning and the comprehensive plans of municipalities to develop the future land use maps for the County. Link to the Regional Framework Plan at:
http://www.lakecountyil.gov/planning/planningandsupportservices/Pages/frameworkplan.aspx

Final Announcements/Next Meetings:
Andrea Cline will be compiling and sending out a summary of the stakeholder input on watershed issues and opportunities, and meeting topics. Andrea thanked meeting participants for attending today's meeting and the Village of Grayslake for for hosting the meeting. Participants will be receiving an invitation for the June meeting in the next few weeks and a summary of this meeting will be sent out. Current and previous meeting agendas, meeting summaries, presentations, and handouts are posted on SMC's website:
http://lakecountyil.gov/Stormwater/LakeCountyWatersheds/Mill.htm

Next Meeting:
Wednesday, June 5, 2013
6:30 – 8:30 p.m.
Rule House, Wildwood Park District
33325 Sears Boulevard, Wildwood

Meeting Attendees:

Last Name	First Name	Organization
Amidei	Moses	Village of Wadsworth
Beggan	Gary	Village of Third Lake
Beilfuss	Ed	Carillon North Wetland Committee
Berns	Leslie	Lake County Forest Preserve District
Bland	Jim	EPS Incorporated
Carlson	Steve	Lake County SMC
Chefalo	Tom	Lake County PBD
Cline	Andrea	Lake County SMC
Gray	Jean	
Heinz	Bill	Village of Grayslake

Last Name	First Name	Organization
Hertel	Darcy	Lake County SMC
Keller	Michele	Lake Properties Venture
Klees	Mary	Grayslake Environmental Commission
Kotulla	Wendy	Mariner’s Cove HOA
Kure	Patt	Village of Third Lake
Miller	Diane	Grayslake Environmental Commission
Nehila	Jeff	Grayslake Park District
Prusila	Michael	Lake County SMC
Smith	Rebecca	
Vancil	Susan	Lake County SMC
Zachary	Rita	Carillon North HOA

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
JUNE 5, 2013 – 6:30 TO 8:30 PM
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to learn about invasive species in the watershed, to review and refine the draft plan goals, and to develop plan objectives.

Meeting Objectives:

- To become more educated about invasive species in the watershed and the problems they cause;
- Refine plan goals; and
- Develop plan objectives.

MEETING SUMMARY

Introductions:
Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Review and Accept April 4, 2013 Meeting Summary
The summary was accepted without changes by consensus of the group.

Getting to Know: Wildwood Park District
Maureen Jekot, Director of the Wildwood Park District, talked about the Park District's history and function. The Park District includes 4,000 residents of unincorporated Grayslake. There are two lakes and 11 parks. Wildwood Park District was established in the area that was part of the Sears family estate.

Jeannie Turf, President of the Wildwood Park District, talked about the Park District's shoreline stabilization projects. Valley Lake is a pond fed by stormwater. Rumor that there may be springs in the lake but that has not been verified. The Township stormsewer outlet into the lake created erosion problem. Wildwood Park District used STAG program funds to create a wetland plunge/filter pool inlet to diffuse and filter the water. The project has been a great educational process for residents who now have a better understanding of the benefits of a naturalized shoreline.

Gages Lake is 144 acres. It has a lot of erosion at beaches. Wildwood Park District got a grant for shoreline improvement, including native vegetation and interpretive signage. Sandy Cole got the grant money through the state of Illinois. It is a long process to get grant funding, and to educate the public. To begin with reaching the public, the Park District formed a committee to work on the project. Committee members talk with their neighbors and word gets around.

The following questions were asked and answered:

- How long until the plunge pool gets filled with sediment and has to be excavated? They have a maintenance plan that covers sediment removal via their regular operations budget. It is expected they will have to have sediment removed in 5-6 years.
- What happens to the sediment after it is removed? Sediment that is removed is trucked away by company that they employ to remove it.
- Valley Lake is polluted according to the state impaired waters list – geese, ducks, road salts have created a problem. Gages Lake also is on the state's impaired waters list, but it is spring fed and is deeper, so does not have the same/as severe of problems.

Rob Flood, Gages Lake Conservation Committee, talked about the Committee. It is made up of area residents that have lake rights, including four homeowner's associations. All in unincorporated Lake County. There are approximately 15 active members on the committee. Most of the money in their budget is spent on weed control and fish stocking. The budget this year is $13,000. Funding is based on the number of homes per subdivision. They collect $3.80/home right now. The Committee has no funding authority, but receives this funding for their work voluntarily.

Gages Lake has a 6.7' mean depth with maximum depth of 54'. Gages Lake has a small watershed of 531 acres that drain to the lake, but still facing challenges with getting the township highway department to use less road salt. They have seen improvement in water quality with most recent lake study compared to 2006 assessment by Lakes Management Unit.

Stormwater has the biggest impact on the lake. Storm drains are designed to dump right into the lake without any treatment. Gages Lake has had high *E. coli* counts occasionally. Erosion occurs from wave action and many residents are using steel sea walls to protect shoreline but they have eliminated the littoral zone habitat. Invasive species in the lake include zebra mussels, carp, Eurasian water milfoil, and curly pond weed. The Gages Lake Conservation Committee has a contract with Clark to do aquatic weed control on a targeted basis, they focus on beaches and boat ramps. They also have a volunteer lake monitor and sponsor an adopt a highway program.

The annual carp fishing derby, to encourage residents to catch and remove carp, is done in conjunction will Illinois free fishing weekend. The Gages Lake Conservation Committee is working on carp removal with the Illinois Department of Natural Resources using electro-shocking equipment to remove the carp. They have removed 7,000 pounds of carp to date. They put them in garbage bags and landfill them. They also have a fish-stocking program that is popular with anglers. The Committee stocks largemouth and smallmouth bass, pike, walleye for sport fishing. The Committee distributes educational information from the Lakes Management Unit, they put articles in the Wildwood Park District newsletter and have signage on the boat ramps related to transport of invasive species to educate residents. Their experience is that when invasive species get in, they expend thousands of dollars trying to deal with them and prevention is the most economical practice.

The following questions were asked and answered:

- Is poaching a problem? They have signs at the boat ramps and have not known poaching to be a big problem.
- Comment: Third Lake has had problems with poachers using snag lines. Poaching takes place from the Forest Preserve District property.
- How big is the winning carp at the derby? The Committee gets about 50-100 carp turned in at the derby, the winner is usually about 5 pounds. A 12 pound carp was caught during electroshocking.

James Adamson, Northwater Consulting, presented the role of his firm in the planning effort.

Invasive Species in the Watershed
Leslie Berns, Lake County Forest Preserve District presented information regarding invasive species in the watershed. Reed canary grass should be on the noxious list but because it has an agricultural use it has not. Purple loosestrife, which will dominate wetlands, is so prolific that one plant will produce 2.5 million seeds. Phragmites, also known as common reed, was introduced by horticulture trade and will grow as much as 50 feet/year and dominate to the exclusion of all other plants in the area. Burning alone won't control the species, it can help, but herbicide is needed too. European buckthorn seeds act as a laxative and birds spread the plant pervasively. This plant will change soil chemistry and decomposition of leaf litter, changing the whole soil biochemistry and soil microbes. As the plant breaks down in the soil it is toxic to salamander eggs and can change the whole ecosystem. The Natural Areas Department of the Forest Preserve District probably spends about 70% of their time combatting invasive species.

New Invaders: Spotted knapweed also changes the soil biochemistry and surrounding ecosystem. Japanese knotweed is one of the top 100 invasive species in the world. Giant hogweed is new to our area. It's a large plant that has red dots on the stems and can cause a burn if the sun is out. Stop aquatic hitchhikers from boats and stop dumping aquariums into local waters.

Andrea recapped where things are in the planning process and reminded the group of what goals and objectives are. The group reviewed and made suggestions for goal statements:

Flood goal

- Why address flood damage rather than controlling flooding?
- Does infrastructure include natural resources (ex.: erosion at the Grandwood Park dam)?
- Gages Lake kept too high and causes flooding of adjacent properties.
- Change outcome to reflect minimizing adverse effects – not possible to eliminate all flood damage.

Water quality goal

- Water quality impaired list based on Lakes Management Unit's data.
- Stream has not been sampled, but it is not listed as impaired.
- The Avon Fremont Ditch is part of the stream system.
- It should be requested that IDNR sample the stream. The request is in. Steve Carlson offered to help move the stream sampling forward if needed.

Stormwater management and drainage goal

- There was no discussion, just question about what a conveyance system is.

Natural resources goal

- What is green infrastructure?
- Will a watershed plan result in change/improvement?

Education goal

- Maybe adequate resources are too lofty of an outcome.
- Suggestion for Forest Preserve District and SMC to have greater influence in the schools.
- Comment that this may be the most important goal.

Final Announcements/Next Meetings:
Andrea Cline will be compiling and sending out a summary of meeting and asked everyone to develop at least one objective for at least one goal in preparation for the next meeting. Andrea thanked meeting participants for attending today's meeting and the Wildwood Park District for hosting the meeting. Participants will be receiving an invitation for the next meeting in the next few weeks and a summary of this meeting will be sent out. Current and previous meeting agendas, meeting summaries, presentations, and handouts are posted on SMC's website: http://lakecountyil.gov/Stormwater/LakeCountyWatersheds/Mill.htm

Questions and comments after meeting discussion:

- There is a large tree in Mill Creek that has created a blockage. Who is responsible for cleaning it out? If the portion of the Creek is under drainage district jurisdiction, the drainage district should clear it. If not in a drainage district, then the landowner is responsible for removing the tree causing blockage.
- Anecdote shared about IDNR not allowing landowner to remove a beaver dam.
- Walt along Gages Lake had basement flooding in April. Since his property is not in floodplain he wants to add fill to his yard to raise it. Mike P. is going to check the floodplain map and email to Walt. Walt was advised to call Mea Blauer at Planning Building and Development to determine if there are permit requirements before doing any work.
- Howard Simpson asked about the loss of detention storage if Rasmussen Dam is removed. Patty described live storage vs. dead storage and related that the lake is not providing significant storage now except for small rain events.

Next Meeting:
Thursday, June 27, 2013
1:30 – 3:30 p.m.
Third Lake Village Hall
87 N Lake Avenue, Third Lake

Meeting Attendees:

Last Name	First Name	Organization
Adamson	James	Northwater Consulting
Beggan	Gary	Village of Third Lake
Beilfuss	Ed	Carillon North Wetland Committee
Berns	Leslie	Lake County Forest Preserve District
Bland	Jim	EPS Incorporated
Carlson	Steve	Lake County SMC
Cline	Andrea	Lake County SMC
Flood	Rob	Gages Lake Conservation Committee
Glunz	Joe	
Hart	Sandy	Lake County Board
Jekot	Maureen	Wildwood Park District
Klees	Mary	Grayslake Environmental Commission
Martin	Chuck	Wildwood GLCC
Miller	Diane	Grayslake Environmental Commission
Prusila	Michael	Lake County SMC
Rogers	Jim	Third Lake Village Board
Salemi	Joe	North Lakeshore Realty Company
Schultz	Walter	Wildwood
Simpson	Howard	Tempel Farms
Turf	Jeannie	Wildwood Park District
Vancil	Susan	Lake County SMC
Werner	Patty	Lake County SMC
Wilson	Don	
Zachary	Rita	Carillon North HOA

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
JUNE 27, 2013 – 1:30 TO 3:30 PM
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to learn about invasive species in the watershed, to review and refine the draft plan goals, and to develop plan objectives.

Meeting Objectives:

- Learn about green infrastructure;
- Finalize plan goals; and
- Develop plan objectives and green infrastructure prioritization criteria.

MEETING SUMMARY

Introductions

Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting. She thanked Mayor Greg Beggan and Trustee Jim Rogers for hosting the meeting and providing snacks. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Review and Accept June 5, 2013 Meeting Summary

The summary was accepted without changes by consensus of the group.

Getting to Know: Third Lake Environmental Committee

Jim Rogers, Trustee, Village of Third Lake gave an historical overview of the efforts to maintain and improve Third Lake and Druce Lake.

- The Village has 1182 residents, 436 homes surround the lakes in Mariner's Cove and Sunshine subdivisions
- Third Lake is often referred to as Chittenden Lake, named for the Chittenden family who purchased land on the north side of the lake in the 1840s.
- 1990s a blue green algae biomass formed; a diagnostic/feasibility study was completed in 1995
- Study recommendations included removal of algal biomass; aeration
- 1995-97 hydraulic dredging was performed and 2 aerators installed; aerators operate in summer months
- Algal biomass still an issue today
- Druce Lake is name after Alexander Druce, who came from New York and settled on the south bank of the lake
- Druce Lake is bisected by a township line. West shore is Avon Township, east shore is Warren Township. Some parts of Druce Lake have a Lake Villa address
- Druce Lake issues: Lily pads, Eurasian Water Milfoil; remediation today include a manual rake, milfoil beetle
- During high water, Third Lake flows backward into Druce Lake
- Currently, maintenance is done to control Eurasian Water Milfoil
- Village works through a Third Lake Lakes Commission to address maintenance needs and issues

Tom Morthorst, Chairman, Third Lake Lakes Commission, talked about the Commission's efforts to keep the lake a valuable recreation and fishing asset to the community. Volunteer members are appointed by the village board. The Village takes their mission seriously to monitor and maintain Third Lake.

- Lakes Commission is eyes and ears of the lake, serve as a sounding board for resident concerns.
- Main duties: maintain the dam screen; review water testing results from Lake County Health Department Lakes Management Unit (LMU); educate boaters on Zebra Mussels; addressing Eurasian Water Milfoil issue
- Third Lake one of the first to ban the use of phosphorus
- Working with LMU to investigate the source of sand deposits at inlet
- Please contact the Village if you have further questions about the lake and Lakes Commission

Green Infrastructure Planning the Chicago Wilderness Region

Dennis Dreher, Geosyntec Consultants, introduced the topic of Green Infrastructure (GI) and how GI mapping could be used for the Mill watershed. The goal of GI is sustainability and biodiversity.

- The Lake County Stormwater Management Commission looks at green infrastructure on two scales:
  - ***Local scale*:** Green infrastructure consists of site-specific best management practices (such as naturalized detention facilities, vegetated swales, porous pavement, rain gardens and green roofs) that are designed to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls.
  - ***Regional Scale*:** Green infrastructure consists of the interconnected network of open spaces and natural areas that mitigate stormwater runoff, naturally recharge aquifers, improve water quality while providing recreational opportunities and wildlife habitat.
- Green infrastructure networks do not have to be concentrated on water resources, but it is logical and appropriate to do so in a watershed plan.
- GI strategies include: ecological restoration, greenway connections, private conservation easements, targeted land use planning and zoning, conservation development, retrofitting developed areas, and farmland preservation.
- Examples were presented on how GI is being mapped in the Chicago region at various scales: regional, county/community, neighborhood, site/lot level.
- Dennis explained the GI mapping process and the potential core layers of information based on the priorities planning entity.
- The McHenry County GI plan and map is a good example of a conservation development ordinance. Its GI map and corresponding layers of information were based on the county's planning priorities. The map inventoried open land, floodplains, water resources, threatened and endangered species, groundwater areas, buffers, and other natural resources. The City of Crystal Lakes GI plan and map was incorporated into its 2030 Comprehensive Plan.
- GI was incorporated into the Settler's Ridge Subdivision, Sugar Grove, IL conservation site development with a focus on people living and nature living in harmony with an emphasis on private to public trails. A good local example of conservation design is Prairie Crossing, Grayslake.
- At the site/lot scale, GI incorporates natural landscaping and stormwater Best Management Practices like natural landscaping, permeable paving, bio-swales and rain gardens, naturalized detention basins, and green streets.
- Question on permeable pavers effective in clay soils and freeze/thaw concerns. Dennis said over the past 20 years permeable pavers have been used successfully in clay soils. Paver design has gone from large sections to individual blocks, which is more cost effective. Individual blocks don't get blocked up in winter creating surface ice so less salt is used.

- See Dennis' presentation for resources on the cost/benefits of GI and additional information. http://www.lakecountyil.gov/Stormwater/Documents/Planning/Mill%20Creek/MC_Dreher_062713.pdf

Natural Areas Inventory
Leslie Berns, Lake County Forest Preserve District, talked about forest preserves in the Mill Creek watershed.

- Preserves include: 154-acre Brae Loch Golf Club, a Certified Audubon Cooperative Sanctuary; 30-acre Duck Farm; 35-acre McDonald Woods; 618-acre Fourth Lake; 277-acre Mill Creek; and the 1,220-acre Rollins Savanna.
- Rollins Savanna was acquired in phases between 1988 and 1993. Following work to renovate this unique preserve to restore its valuable ecosystems and provide new outdoor recreation and nature and history education opportunities, the site officially re-opened to the public in September 2004.
- More than 450 acres of former farmland was restored at Rollins as part of a massive habitat restoration and preservation project, representing the largest restoration effort undertaken by the District. Extensive habitat restoration efforts were completed along the Mill Creek corridor and on over 200 acres of wetlands. Rollins is considered "Birder's Field of Dreams" where you can view several species from the trails or the bird observation area.
- Link to more information about Mill Creek forest preserves at: http://www.lcfpd.org/preserves/index.cfm?fuseaction=preserves.view

Green Infrastructure and Mill Creek
Mike Prusila, SMC, talked about how Green Infrastructure (GI) relates to the watershed plan and the GI prioritization criteria.

- The Issues and Opportunities generated by the stakeholders at the previous watershed meetings showed that open space was a high priority topic, as it is an important component for "quality of life" and preservation of natural resources. Open space serves important stormwater management and water quality needs.
- Open space is defined as:
  - Any land that does not contain buildings, roads or impervious surfaces
  - Natural areas, recreational areas, working lands
  - Benefits hydrology, water quality, habitat, and biodiversity
- Mill Creek Open Space inventory shows 39.4% of watershed area is open space; 17.3% is partially open space.
- "Open" and "Partially Open" space is defined as:
  - ***Open Space***: no built structures or impervious cover
  - ***Partially Open Space***: structures or impervious areas cover only a small portion of the total parcel and provides open space benefits
- Mill Creek open space is made up of:
  - Publicly-owned open space: 14% of watershed area
  - Publicly-owned partially-open space: 4% of watershed area
  - Privately-owned open space: 26% of watershed
  - Privately-owned partially-open space: 14% of watershed
- An Open Space Inventory Map:
  - Maps the location of "open" space and "partially-open" space
  - Shows location of open space in relation to other development and to water resources
  - Includes "protected" areas, recreational land, undeveloped land, and working land; public and private ownership

- As we look at mapping GI, the planning committee may want to:
  - Add additional "components" of the network
  - Examine overlay of different components
  - Include or eliminate areas based on number of overlapping components
- As part of the GI network, it would be logical to include the following as part of a Natural Resource Inventory that will be conducted as part of the planning process:
  - "High Quality" natural resources in the watershed
  - Wetlands; Illinois Natural Areas; Illinois Nature Preserves; Lake County Forest Preserves; threatened/endangered species; & high quality ecological communities.

Develop a Green Infrastructure Prioritization Criteria

Andrea Cline, SMC, led a discussion on criteria used to prioritize parcels for each of the project goals.

Criteria	Flood Prevention & Reduction	Water Quality Improvement	Stormwater Management & Drainage	Natural Resources
1. Parcels that intersect 100-year floodplain	X		X	
2. Parcels within 0.5-miles of the headwaters	X	X		X
3. Parcels that intersect with a wetland	X	X		X
4. Parcels that are adjacent to or include at least 2.5 acres of drained hydric soils [Minimum 10 acres of drained hydric soils for other watersheds]	X	X		X
5. Parcels in an Subwatershed Management Unit where less than 10% of the SMU is existing wetland	X	X		
6. Parcels within 0.5-mile radius of flood problem area	X			
7. Parcels that are within 100 feet of a watercourse or lake (300 feet North Mill)	X	X	X	X
8. Parcels that intersect with developed but undetained areas	X			
9. Parcels intersecting with non-point source pollutant hotspot SMU		X		
10. Parcels adjacent to or including forest preserves, land trusts, township, and privately and publicly protected open space				X
11. Parcels adjacent to or including high quality wetlands (ADID)		X		X

12. Parcels adjacent to or including Illinois Natural Areas Inventory sites, nature preserves and high quality natural areas				X
13. Parcels adjacent to or including Threatened & Endangered species sites				X
14. Parcels intersecting with or adjacent to a National Pollution Discharge Elimination System permitted point source		X		
Criteria In Some, But Not All Plans				
15. Parcels with highly erodible soils		X	X	
16. Parcels greater than 5 acres (35 acres North Mill)	X	X		X
17. Parcels traversed by, adjacent to, or within 0.25 mi. of a mapped greenway or trail.				X
18. Parcels that connect existing protected open space areas.				X
19. Parcels that contain a depressional area.	X			
20. Parcels intersecting with an archaeological site.				

The discussion of green infrastructure criteria was tabled until a future meeting due to time constraints.

Questions and answers:

What will be done with the green infrastructure plan? How do we use it?
The green infrastructure plan will be part of the Mill Creek Watershed and Flood Mitigation Plan. Residents can use it to see how to make improvements to their properties and apply for financial assistance to implement green infrastructure practices. Municipalities can use the plan to assist in making land use decisions. Park Districts, the Lake County Forest Preserve District, and other open space land owners can use the plan to make purchasing and restoration decisions. In general, the plan is a guide to create a network of connected open spaces.

Will the plan have a regulatory affect?
NO. Lake County SMC has been including Green Infrastructure plans and maps with our watershed plans since 2000. There are six other watersheds within the County that have a green infrastructure plan, as well as many other areas throughout the region.

What if my property is within the mapped green infrastructure area?
Congratulations! You may be eligible for financial assistance to install green infrastructure practices on your property. We hope you consider installing a rain garden, porous pavement or other practice where applicable. Other than encouragement, no additional requirements are placed on the development or redevelopment of your property.

Final Announcements/Next Meetings:
Andrea Cline will be compiling and sending out a summary of meeting and asked everyone to develop at least one objective for at least one goal in preparation for the next meeting. Participants will be receiving an invitation for the next meeting in the next few weeks and a summary of this meeting will be sent out. Current and previous meeting agendas, meeting summaries, presentations, and handouts are posted on SMC's website:
http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Next Meeting:
Wednesday, July 31, 2013
6:30 – 8:30 p.m.
College of Lake County, Building C, Room C003 (located on Lower Floor)
19351 W. Washington, Grayslake

Meeting Attendees:

Last Name	First Name	Organization
Beggan	Gary	Village of Third Lake
Berns	Leslie	Lake County Forest Preserve District
Bland	Jim	EPS Incorporated
Cline	Andrea	Lake County SMC
Elan	Donna	
Gray	Jean	
Heinz	Bill	Village of Grayslake
Jersey	Barb	Avon Township
Klees	Mary	Grayslake Environmental Commission
Kotulla	Wendy	
Leach	Nick	
Miller	Diane	Grayslake Environmental Commission
Morthost	Tom	Chairman, Lakes Commission Third Lake
Nehila	Jeff	Grayslake Park District
Prusila	Michael	Lake County SMC
Rauscke	Lisa	
Rogers	Jim	Third Lake Village Board
Salemi	Joe	North Lakeshore Realty Company
Vancil	Susan	Lake County SMC
Welsh	Wes	Village of Lindenhurst
Werner	Patty	Lake County SMC
Wilson	Don	
Zachary	Dan	Carillon North HOA
Zachary	Rita	Carillon North HOA

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
JULY 31, 2013 – 6:30 TO 8:30 PM
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to learn about invasive species in the watershed, to review and refine the draft plan goals, and to develop plan objectives.

Meeting Objectives:

- Learn about lake water quality;
- Finalize plan goals; and
- Develop plan objectives; and
- Identify site specific problems

MEETING SUMMARY

Introductions

Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Andrea encouraged everyone to take a look at the Mill Creek website where past meeting agendas and presentations are posted. Andrea stated further conversation of Green Infrastructure (GI) will be tabled for now until staff and the planning committee can learn more about GI and the watershed. A GI fact sheet is posted on the webpage and gives an easy to understand overview of the definition of GI, the benefits of mapping a green infrastructure network in a watershed plan, how to map a green infrastructure network, and how the network will be used.

Mill Creek watershed webpage:
http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Review and Accept June 27, 2013 Meeting Summary

The summary was accepted without changes by consensus of the group.

Mill Creek Lake Water Quality

Mike Adam, Lake County Health Department, presented lake water quality data.

- The Mill Creek watershed planning process will identify ways to improve our lakes.
- 7 glacial lakes
- 4 man-made lakes
- Waters are put on the Illinois EPA's impaired waters list. When waters are put on the list, then once a Total Maximum Daily Load (TMDL) plan is done, they come off the list although they may still be impaired. A TMDL plan specifies a specific amount of pollutant that is allowed in a waterbody so that it can continue to meet its designated use.
- Grays Lake and Lake Miltmore should be on the impaired list.
- Main water pollutant concerns: phosphorous, Total Suspended Solids (TSS), fecal coliform. Beaches are mostly affected by fecal coliform due to geese or septic systems may be a source.
- Phosphorous levels are not bad in glacial lakes. Shallow lakes in watershed have higher amounts. Sometimes it's a legacy pollutant in sediments stirred up by carp. A legacy pollutant is one that entered the lake years before and has remained in bottom sediment.
- Anything over 4 is good for secchi depth measurement for water clarity.

- Zebra mussels are present in Third Lake, Fourth Lake, Gages Lake, Druce Lake. Zebra mussels make water clearer, but in the process eat plankton. There are 30 lakes in the county with zebra mussels.
- Total Suspended Solids tend to be highest in shallow lakes with carp. Prefer to see TSS below 5 – most glacial lakes doing well.
- Chloride or road salt has spiked over the past 15 years due to road salt. Nothing breaks chloride down, so once in the lakes, they stay in the lakes. The retention time on lakes is years so chloride accumulation builds.
- The newest threat is Hydrilla, a highly invasive aquatic species now in Indiana and Wisconsin. Keep an eye out for it because right now there is no way to control it. Learn more at http://www.niipp.net/hydrilla/
- Joe Salemi asked if there were a commercial use for carp and presently there is not a market for it. Carp can be managed with rotenone. There are no methods to control zebra mussels.
- There are two sources most lake management issues:
    - External – things coming into lakes we can control.
    - Internal – once in, it usually stays in.

Mill Creek Watershed Stream Quality

- Streams last sampled in 1990s, but Illinois EPA is sampling this year.
- Sampling looks at possible violations of state standards for phosphorous, dissolved oxygen.
- Jim Rogers, Village of Third Lake, noted that most of the county's streams and rivers are at the same elevation so fast flowing streams only occur after large events. Andrea noted that many stream restoration projects include rock riffles that offer some change in elevation and allow pollutants to settle out.

Site Specific Watershed Issues

Jeff Boeckler, Northwater Consulting, talked about issues and opportunities along Mill Creek for potential projects. Specifically, he asked the group to identify specific areas where invasive species, erosion, debris jams, agriculture runoff, infrastructure, flooding, poor water quality, detention pond retrofits, etc. Noted areas:

- Third Lake dam replacement
- Downstream of Grandwood Park Lake – severe erosion
- Potential pollution source from a salt dome
- Grandwood Park Lake storage capacity issue

Coleen Wattleworth, Grandwood Park Park District, asked how the planning process can benefit a lake improvement project. A watershed plan is needed to apply for grant funding especially Illinois EPA 319. Public access to a beach or lake is usually required when apply for/receiving grant money. Coleen is working with a committee to look at a possible dredging project and asked if funding existed for dredging. SMC is not aware of any dredging funding sources. Dam removal was also mentioned and will be brought up at a future meeting.

Develop Objectives

Andrea reviewed plan goal and how to develop measurable objectives. The five plan goals were posted around the room and participants were asked to provide objectives for each. The exercise will also be conducted at the next meeting as well.

Next Meeting:
Tuesday, September 3, 2013
6:30 – 8:30 p.m.
University of Illinois Extension Service
45 S. U.S. 45, Grayslake

Meeting Attendees:

Last Name	First Name	Organization
Beilfuss	Ed	Carillon North HOA
Colwell	Mary	Integrated Lakes Management
Courser	Jerry	Grandwood Park Park District
Cline	Andrea	Lake County SMC
Gray	Jean	Grandwood Park
Husemoller	David	Lake County Planning Building and Development
Husemoller	Tim	Prairie Crossing Charter School
Prusila	Michael	Lake County SMC
Rogers	Jim	Third Lake Village Board
Salemi	Joe	North Lakeshore Realty Company
Scheddin	Bill	College of Lake County
Todd	Thomas	Prairie Crossing Charter School
Vancil	Susan	Lake County SMC
Wattleworth	Coleen	Grandwood Park Park District
Warner	Mike	Lake County SMC
Werner	Patty	Lake County SMC
Wolterstorff	Greg	V3
Zachary	Rita	Carillon North HOA

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
SEPTEMBER 3, 2013 6:30-8:30 PM
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to learn about invasive species in the watershed, to review and refine the draft plan goals, and to develop plan objectives.

Meeting Objectives:

- Develop objectives for watershed plan goals;
- Have an understanding of the condition of Mill Creek based on the stream inventory; and
- Have stakeholders be aware of programs like Conservation @ Home that promote practices that residents and business can implement to improve water quality and why it is important to do so.

MEETING SUMMARY

Introductions

Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Andrea went over the goals and structure of the meeting. Past meeting presentations, agendas, meeting notes, and other materials are available at the Mill Creek watershed webpage:
http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Review and Accept July 31, 2013 Meeting Summary

The summary was accepted without changes by consensus of the group.

Review and Continue to Develop Plan Objectives

Attendees broke into groups and reviewed watershed plan goals, and developed and reported out objectives for two of the five major goals. The planning committee will be developing objectives for the remaining goals at the October meetings.

"Getting to Know" Series

Roy Anderson, Chairman, Avon-Fremont Drainage District, talked about the District's jurisdiction, mission, and activities.

- Jurisdiction starts at the headwaters of Mill Creek, south of Route 137 and west of Route 83 and continues north to Washington Street.
- Primarily responsible for removing blockages for water flow.
- Staff clears debris jams, fallen trees, and beaver dams mainly in the winter when the ground if frozen to reduce damage to property.
- If the cost of doing the work exceeds $5K the District contracts out the work.
- The District deals with outfall issues when they occur.
- The District board annually votes on the tax levy in the October/November time frame for projects. The levy is kept at a minimum unless there is an identified project(s). The annual levy meeting is open to the public.
- Jim Bland asked if fish surveys have been conducted. The District has not received a request to do one and a survey has not been done.

Sarah Surroz, Conservation and Outreach Manager, Conserve Lake County gave an overview of the Conservation @ Home program designed to assist landowners with landscaping ideas and information to support clean water, rich soil and resilient ecosystems.

- No other county in Illinois has the ecological diversity Lake County does.
- Conservation @ Home focuses on properties up to an acre, but more than one acre is welcome as well. Staff will visit your property and assess "ecological treasures and areas for consideration" and receive recommendations on eco-friendly landscaping.
- Landowners can get certified by meeting criteria on native plants, lawn care, soil, rain water, wildlife, invasive plant control, and local food production. Certification is free and includes a yard sign.
- Register to have a staff member visit your property. The program began in 2011 and to date over 431 properties have been visited and over 700 are enrolled. There is a waiting list but don't let that stop you from registering.
- Conserve Lake County now has a native plant nursery and plants are being sold this month on-line only.

Mill Creek Stream Inventory

Mike Prusila, SMC, gave an overview of the just completed stream inventory; how the inventory was conducted; types of information gathered by SMC interns; and how the information will be used in the watershed plan.

- Inventories are used to assess stream reaches; "reach" means a defined geographic unit of the overall stream system.
- Two SMC interns walked entire length of stream (18 miles) photographing, measuring, and geo-locating (GPS) channel conditions, hydraulic structures, discharge points, riparian corridor, and aquatic habitat. Plants were not inventoried.
- 46 reaches inventoried; large lakes and wetlands were not waded or inventoried.
- Several reaches not inventoried due to lack of access.
- Reaches consisting primarily of detention pond networks were captured in the detention basin inventory.
- Typical issues:
    - channelization most located upstream of Washington Street
    - debris loading and jams most common downstream of Hutchins Road
    - beaver activity greatest downstream of Stearns School Road, drainage ditch south of Metra MD-N line
    - substrate and sediment
    - streambank erosion occurs in all reaches, but less sever in wetland reaches
    - streambank armoring located in built environments (Grandwood Park, Grayslake)
    - structures and discharge points – 41 "problem" points, 7 "problem" structures
- Abundant opportunities for riparian landowner BMPs
- Inventories provide information for: watershed assessment in plan; plan recommendations; future stakeholder projects; baseline data for watershed; visual record of stream channel conditions.
- Data and photos will be available in an interactive map browser (GIS), database, and summary report & map.
- Data still needs to be processed and will be available to stakeholders once processed/formatted/completed.

Natural Channel Restoration

Leslie Berns, Land Management Ecologist, Lake County Forest Preserve District talked about stream behavior in an urban environment and focusing on the motion of sediment on the river bed.

- There is a direct correlation between the volume of water, the stream slope, and the size and volume of particles on how a stream functions. The relationship of these factors needs to be understood before undertaking a stream restoration project.
- Stream restoration: reconnecting the stream to the floodplain (i.e,. bring the stream up the floodplain or bringing the floodplain down the stream); and keeping the stream in place (i.e., must deal with energy and sediment).
- The Killdeer Creek and Springbrook Stream Remeandering case studies were presented and specific practices outlined. Stone toe, rootwads, riffles, and cross vanes were used.

Next Meeting:

Wednesday, October 2, 2013
1:30 – 3:30 p.m.
Grayslake Community Park District
240 Commerce Drive, Grayslake

Meeting Attendees:

Last Name	First Name	Organization
Anderson	Roy	Avon Freemont Drainage District
Beilfuss	Ed	Carillon North HOA
Berns	Leslie	Lake County Forest Preserve District
Bland	Jim	EPS Inc.
Carlson	Steve	Lake County Board District 7
Colwell	Mary	Integrated Lakes Management
Cline	Andrea	Lake County SMC
Gray	Jean	Grandwood Park
Koch	Jill	
Kotulla	Wendy	Village of Third Lake
Miller	Diane	Grayslake Environmental Commission
Nehila	Jeff	Grayslake Park District
Pasternak	Tim	Round Lake Management Commission
Prusila	Michael	Lake County SMC
Roskowski	John	Lake County Journal
Werner	Patty	Lake County SMC
Wilson	Don	

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
OCTOBER 2, 2013 1:30-3:30 PM
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to learn about invasive species in the watershed, to review and refine the draft plan goals, and to develop plan objectives.

Meeting Objectives:

- Develop objectives for watershed plan goals;
- Develop green infrastructure prioritization criteria.

MEETING SUMMARY

Introductions

Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Andrea went over the goals and structure of the meeting. Past meeting presentations, agendas, meeting notes, and other materials are available at the Mill Creek watershed webpage:
http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Review and Accept September 3, 2013 Meeting Summary

The summary was accepted without changes by consensus of the group.

"Getting to Know" Series

Jeff Nehila, Executive Director, Grayslake Community Park District talked about the District's history, landholdings, and natural area management.

- Over 400 acres of active and passive recreation parks and open space.
- In 2012, the District started a natural areas inventory of holdings and assets; nearly ½ of parkland is not developed and include woodland, wetlands and water.
- The inventory has identified shoreline restoration and invasive species control opportunities.
- The District applied for an Illinois Green Infrastructure Grant for a shoreline restoration project, and is looking for funding to restore Jones Island sea walls to reduce and control flooding.
- The District has sponsored a lakeshore clean up since 2010 with residents along a ditch that drains to Mill Creek.
- The District has a strong interest in the Mill planning process for looking at Best Management Practices and projects.

Green Infrastructure Prioritization Criteria

Andrea presented a draft Mill Creek Watershed Green Infrastructure map showing using specific criteria and based on the watershed goals established by the Planning Committee.

- Green Infrastructure (GI) utilizes natural systems (trees, plants, soil) to infiltrate, clean and store water.
- GI is defined as a network of decentralized stormwater best management practices (BMPs) that infiltrate rain water where it falls, reduce stormwater, and improve water quality.
- GI can be used on a local scale of site specific best management practices or on a regional scale using a combination of open space and natural areas to create hubs and corridors.

- GI is important to the Mill Creek watershed for several reasons including water quality improvement and flood reduction.
- A GI network is created by mapping open and partially open parcels and then assigned points for specific GI criteria. Examples of each criterion were presented.
- Jim Rogers, Third Lake Board of Trustees, asked if hydrocarbons will be included in the pollutant modeling. SMC stated it had not looked at hydrocarbons, but will ask Northwater about how much the additional modeling would cost.
- The Mill Creek Plan is just a recommendation. Forty-percent of the open and partially open parcels are privately owned so there would be a need to educate private landowners on GI and BMPs.
- A Mill Creek GI network is a tool to help inform land use decisions and identify opportunity areas for improving water quality and reducing flooding.
- The Mill Creek GI network will be available at the next meeting for final review and comments.

Review and Develop Objectives

- Attendees broke into groups to develop objectives for remaining goals. The draft objectives will be presented at the next meeting for final review and comments.

Next Meeting:
Wednesday, October 31, 2013
1:30 – 3:30 p.m.
Carillon North Clubhouse
1900 Carillon, Grayslake

Meeting Attendees:

Last Name	First Name	Organization
Amidei	Moses	Wadsworth
Beilfuss	Ed	Carillon North HOA
Chefalo	Tom	Lake County Planning Building and Development
Cline	Andrea	Lake County SMC
Evans	Kip	School District #46
Gray	Jean	Grandwood Park
Klick	Rory	College of Lake County
Miller	Diane	Grayslake Environmental Commission
Nehila	Jeff	Grayslake Park District
Pasternak	Tim	Round Lake Management Commission
Powell	Timothy	Avon-Fremont Drainage District
Prusila	Michael	Lake County SMC
Rogers	James	Third Lake
Vancil	Susan	Lake County SMC
Werner	Patty	Lake County SMC
Wildenberg	Jon	Round Lake Beach
Wilson	Don	
Zachary	Rita	Carillon North HOA

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
OCTOBER 31, 2013 1:30-3:30 P.M.
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to learn about critical areas and the pollutant load analysis, finalize plan objectives, and develop a watershed vision.

Meeting Objectives: By the end of the meeting we expect to:

- Review the findings of the critical areas and pollutant loading analyses;
- Finalize objectives for watershed plan goals; and
- Develop a vision for the watershed.

MEETING SUMMARY

Introductions

Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Andrea went over the goals and structure of the meeting. Past meeting presentations, agendas, meeting notes, and other materials are available at the Mill Creek watershed webpage: http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Review and Accept October 31, 2013 Meeting Summary

The summary was accepted without changes by consensus of the group.

"Getting to Know" Series

Kim Blaszczak, Terrestrial Restoration Specialist with Integrated Lakes Management presented the wetland restoration effort that has been going on at Drury wetland within the Carrilon North development. The group has focused on reed canary grass and phragmites invasive plant management:

- Takes about 5 years of management to eradicate phragmites.
- Manage with mowing and treating resprouts with herbicide late summer-early fall.
- Reed canary grass spray in early spring and in late summer/early fall – also treated by mowing in August and herbiciding resprouts.

Pollutant Load Analysis and Critical Areas Results

Jeff Boeckler, Principal with Northwater Consulting presented the results of the pollutant load analysis and critical areas results.

- Jeff gave an overview of the model used, SWAMM, to determine the areas with the most pollutant loading.
- Modeling annual loads and storm event loads (1.2 inch of rainfall).
- Discussion about what the basis was for projecting future land use. Lake County future land use projections for 2020 was used.
- Error on Catchment J slide loading rate for bacteria. Slide has been corrected on the website.
- Remove red Route 45 on bacteria slide.

- Convert lakes to white? Intuitively confusing for some pollutants.
- Jeff calibrated the model based on his windshield survey and those areas that have detention (lower pollutant loads due to detention basin treatment).

Finalize plan objectives
Andrea reviewed the draft objectives to see if there was any additional input from stakeholders for changes. Still to be completed: Andrea will be adding indicators to each objective and will compose some draft objective language for the suggested additions from the small group meetings and will send it out for review prior to the next meeting.

Agricultural lands are exempt from the Watershed Development Ordinance but are significant contributors of sediment. How can this be addressed? Andrea suggested that we may have to work on this on a voluntary basis as an outcome of the watershed planning process.

Develop a Watershed Vision
Each stakeholder jotted down thoughts on what the watershed should look like in 2030.

- Likes the way it used to be, open space, wildlife, clean water.
- Limiting development to preserve open space and wildlife.
- New road systems and wetland detention areas to sustain economy and new growth.
- Improve the golf courses.
- Preserve/protect the lakes from salt – have healthier waters in Lake County
- Plan in a balanced economical way.
- Look for a sustainable coexistence between natural and residential areas.
- Improve the health of everything we have now. Example of car washing in the driveway to the stormsewer at end of drive.
- Greg Evans – CLC – lots of new development at CLC with a vision of having an attractive campus that is attractive to students so that students want to attend school there. Campus that promotes native wildlife. Would like CLC to help educate residents on best sustainable practices. Needs to be teamwork – CLC should be an educator and role model for the community. New sustainability coordinator will be a member of the watershed group. Good knowledge base in the horticulture department – need to get them involved. Vision is to educate the community to get them involved.
- Value water quality
- Fishing, swimming and other water-based recreational opportunities
- Protected stream corridors, Clean streams for mussels and people, Lakes for boating and swimming, Marshes and wildlife
- Clean water, fishable, swimmable, more public access at FP for fishing and boating
- Clean air and clean water. Wants to see water flowing through native plants on its flow path
- Lack of heavy noise pollution, no apt houses, open space, wildlife, watershed signage on route 45 and 83 for Mill Creek watershed.

Andrea will compile the input from the group and send out a draft watershed vision with the next meeting agenda.

Next Meeting:
Wednesday, November 20, 2013
1:30 – 3:30 p.m.
Grayslake Library
100 Library Lane, Grayslake

Meeting Attendees:

Last Name	First Name	Organization
Amidei	Moses	Wadsworth
Beilfuss	Ed	Carillon North HOA
Berns	Leslie	Lake County Forest Preserve District
Blaszczak	Kim	Integrated Lakes Management
Boeckler	Jeff	Northwater Consulting
Carlson	Steve	Lake County Board
Cline	Andrea	Lake County SMC
Colwell	Mary	Integrated Lakes Management
DeGraff	Kara	Integrated Lakes Management
Evans	Greg	College of Lake County
Gray	Jean	Grandwood Park
Hertel	Darcy	Lake County SMC
Miller	Diane	Grayslake Environmental Commission
Prusila	Mike	Lake County SMC
Rogers	James	Third Lake
Coleen	Wattleworth	Grandwood Park Park District
Werner	Patty	Lake County SMC
Zachary	Rita	Carillon North HOA

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
NOVEMBER 20, 2013 1:30-3:30 P.M.
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to learn about critical areas and the pollutant load analysis, finalize plan objectives, and develop a watershed vision.

Meeting Objectives: By the end of the meeting we expect to:

- Develop an understanding of best management practices;
- Learn about the effect dams have on water quality and what others have done to address this;
- Finalize objectives for watershed plan goals; and
- Develop a vision for the watershed.

MEETING SUMMARY

Introductions

Andrea Cline, Water Resource Professional and Mill Creek project lead, of the Lake County Stormwater Management Commission (SMC), welcomed participants to the meeting. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Andrea went over the goals and structure of the meeting. Past meeting presentations, agendas, meeting notes, and other materials are available at the Mill Creek watershed webpage: http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Review and Accept October 31, 2013 Meeting Summary

The summary was accepted without changes by consensus of the group.

"Getting to Know" Series

Kurt Bowman, Consulting Engineer for the Village of Lindenhurst stated the Village is monitoring Best Management Practices at the wastewater treatment plant and previously completed, and is looking at BMPs for transportation projects.

Looking for Plan Action Items

Andrea is looking for action items in the form of project ideas and recommendations. Please forward your ideas to her as soon as possible.

A Look at Six Dams in DuPage County, Illinois

Stephen McCracken, Director of Watershed Protection, The Conservation Foundation and staff liaison for the DuPage River Salt Creek Workgroup (DRSCW) gave a presentation on dam removals and water quality for six dams in DuPage County.

- In response to concerns about the East & West Branch DuPage River Total Maximum Daily Load (TMDLs) and the Salt Creek TMDL, a local group of communities, publically owned treatment works (POTWs), and environmental organizations have come together to better determine the stressors to the aquatic systems through a long term water quality monitoring program and develop and implement viable remediation projects.

- Water bodies that do not meet applicable water quality standards with technology-based controls alone are placed on IL EPA section 303(d) list of impaired water bodies. Water bodies on the 303(d) list require development of a Total Maximum Daily Load (TMDL). A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. The TMDL is determined after study of the specific properties of the water body and the pollutant sources that contribute to the non-compliant status.
- The TMDL for the DuPage and Salt Creek included chloride or road salt and reducing dissolved oxygen (DO) for supporting aquatic life.
- The DRSCW looked at dam removal as one way to improve DO and monitored water quality behind six dams. DRCSW found low levels of DO but once dams were removed DO improved. As a result, the number of fish species increased.
- How dams damage river resource quality:
  - Damage rivers ability to move nutrients, sediment.
  - Dam impoundments created flooded or sediment covered habitat – poor breeding, feeding habitat for desirable species.
  - Lack of pools and riffles mean low biodiversity.
  - Low DO and higher algae mass means large DO swings.
  - Physical barrier to movement of fish and mussels lower biodiversity upstream.
- Dam removal pros: multiple benefits, high confidence in results, very cost effective.
- Dam removal cons: visible nature can lead to public opposition, removal may not always be feasible.
- Restoration of the streambanks after dam removal is important. People need to see what the project will look like. Pictures and other projects can be used as examples.

Best Management Practices

Patty Werner, Planning Supervisor for Lake County Stormwater Management Commission presented information about Best Management Practices (BMPs) for the watershed and practical solutions to water quality problems in Mill Creek.

- Problem: Lake and stream degradation, spread of invasive species, flood damage, and nonpoint source water pollution.
- Primary Cause: Caused by changes in watershed hydrology (runoff vs. infiltration and storage) and the installation of engineered drainage systems (i.e., storm drains, drain tiles).
- The Mill Creek watershed Action Plan will include recommendations to implement best management practices for: policy, programmatic, education best practices, and on-the-ground practices included in a BMP toolbox.
- The BMP toolbox categories and examples of each include:
  - Urban Stormwater
  - Transportation
  - Flood Mitigation
  - Agriculture
  - Natural Areas
  - Lakes
  - Streams
- Natural Area BMPs, specifically riparian area management BMPs, offer big opportunities to address water quality issues and improve water quality in the watershed.

Finalize plan objectives
Plan objectives were approved by consensus of the group.

Finalize a Watershed Vision
Two draft vision statements were presented. Andrea send out an on-line survey to vote on the desired vision statement.

Next Meeting:
Thursday, December 12, 2013
1:30 – 3:30 p.m.
Grayslake Village Hall, 2nd floor
10 S. Seymour, Grayslake

Meeting Attendees:

Last Name	First Name	Organization
Anderson	Jim	Lake County Forest Preserve District
Baumann	Kurt	Baxter & Woodman
Beilfuss	Ed	Carillon North HOA
Berns	Leslie	Lake County Forest Preserve District
Bland	Jim	EPS, Inc.
Carlson	Steve	Lake County Board
Cline	Andrea	Lake County SMC
Colwell	Mary	Integrated Lakes Management
Elan	Donna	Lake Villa
Gray	Jean	Grandwood Park
Hanlon	Theresa	Grand Park Park District
Heinz	Bill	Village of Grayslake
Hertel	Darcy	Lake County SMC
McCracken	Stephen	The Conservation Foundation
Miller	Diane	Grayslake Environmental Commission
Prusila	Mike	Lake County SMC
Salemi	Joe	North Lakeshore Realty Company
Urbanozo	Gerard	Lake County Health Department
Vancil	Susan	Lake County SMC
Wattleworth	Coleen	Grandwood Park Park District
Werner	Patty	Lake County SMC
Wylie	John	Candidate District 6 Lake County Board
Zachary	Rita	Carillon North HOA

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
DECEMBER 12, 2013 1:30-3:30 P.M.
MEETING REPORT

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to develop an education and outreach strategy, learn about water treatment facilities in the watershed, and view the final watershed vision statement.

Meeting Objectives: By the end of the meeting we expect to:

- Discuss and develop a strategy to provide watershed stakeholders with the knowledge, skills, resources, stewardship opportunities, and motivation to take action on implementing the watershed plan.

MEETING SUMMARY

Introductions

Susan Vancil of the Lake County Stormwater Management Commission (SMC) welcomed participants to the meeting. Meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report.

Susan went over the goal of the meeting. Past meeting presentations, agendas, meeting notes, and other materials are available at the Mill Creek watershed webpage: http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Review and Accept November 20, 2013 Meeting Summary

The summary was accepted without changes by consensus of the group.

"Getting to Know" Series

Chuck DeGrave from the Lake County Public Works Department (LCPWD) described the Water Reclamation Facility located east of Hunt Club Road in Old Mill Creek servicing parts of the Mill Creek watershed. LCPW has taken a holistic view of the treatment area to improve water quality.

Final Vision Statement

There is a tie in on-line survey to choose between two vision statements. The poll is still open. Please vote so the final vision statement can be presented at the January meeting.

Steps to Planning an Effective Education and Outreach Plan

Patty Werner, Planning Supervisor for Lake County Stormwater Management Commission presented background information for developing an education and outreach strategy that will include identification of education and outreach topics, the provider and vehicle(s) for education, the target audience(s) and some sample messages that may be used for outreach.

SMC staff led an education and outreach planning exercise that involved the group in brainstorming ideas for the education and outreach strategy. SMC will summarize the input and present a draft to the group in January.

Next Meeting:

Wednesday, January 15, 2014

1:30 – 3:30 p.m.
University of Illinois Extension Service
100 S. U.S. Highway 45, Grayslake

Meeting Attendees:

Last Name	First Name	Organization
Amidei	Moses	Village of Wadsworth
Baumann	Kurt	Village of Lindenhurst
Beilfuss	Ed	Carillon North HOA
Bland	Jim	EPS, Inc.
Carlson	Steve	Lake County Board
Chefalo	Tom	Lake County Planning, Building & Development
Cline	Andrea	Lake County SMC
Colwell	Mary	Integrated Lakes Management
DeGrave	Chuck	Lake County Public Works
Elan	Donna	Lake Villa
Gray	Jean	Grandwood Park
Heinz	Bill	Village of Grayslake
Nehila	Jeff	Grayslake Park District
Powell	Timothy	Avon-Fremont Drainage District
Prusila	Mike	Lake County SMC
Salemi	Joe	North Lakeshore Realty Company
Urbanozo	Gerard	Lake County Health Department
Vancil	Susan	Lake County SMC
Wattleworth	Coleen	Grandwood Park Park District
Werner	Patty	Lake County SMC
Zachary	Rita	Carillon North HOA

Mill Creek Watershed Meeting
January 15, 2014

Scott Drabicki
Village OF Gurnee

- Does stormwater inspections of detention basins (262 – 36 owned and maintained by Gurnee – others privately owned). Visually inspect about 95% per year based on access. Concerned with inspections related to volume and water quality features. About 22% of the basins have failure issues that Scott has to work with HOAs and businesses. Made an effort to get out and meet the detention basin owners. After 10 years, have a great working relationship now with private owners. Discuss algae blooms, geese, cattails in basins – looking at ecology and WQ more. As new requirements come out it will be interesting to see how the program will evolve in the next 5-10 years. Mill Creek takes drainage from the west side of Gurnee.
- What constitutes failure? – Frequently it is plugged up pipes. Likes an annual burn or mow to control woody vegetation. Another issue is muskrat damage to berms. Aerators on older basins – have motors that have burned out and no longer function.
- What kind of enforcement authority do you have related to detention basin retrofits? Do not have authority to require retrofits. Do put requirements on new basins – but Village is mostly built out so expect maybe 15 new homes in 10 years.
- Fountain aerators are pretty, but not functional for bring DO throughout the water column. Just the surface water level.
- Is annual burning a problem for people with asthma. Some basins are burned every few years rather than every year. Depends on the conditions related to the specific pond.
- If association is defunct, then Village goes in and does the work and bills all of the HO that are supposed to be in the HOA.

James Adamson and Jeff Boekler, Northwater

Review of Action Plan
What are:

- Programmatic
- Critical Area
- Site-specific Actions

Review of the 5 plan goals
Review of actions related to the flooding goal

Question about the upside to treating the SW that goes to the WTTP. (Ans: expensive and beyond the design capacity of the plant.) Also address sanitary backup flooding problems.

Review of actions related to water quality

Tom C asked question about how the lead and support partners have been identified.

Critical area recommendations
Questions
- What is a catchment?
- Discussion about how catchments were ranked that resulted in 4 catchments being defined has critical areas. Specific questions about F and H.
- Explained how ranking was done - all criteria were weighted equally
- Viewed as “opportunity” areas rather than as problem areas.
- Question about catchment A. Why is this small catchment area not treated by the wetlands demonstration site?
- Question about a watershed screening for toxic pollution from sites such as Countryside Landfill. Concern about materials being removed from Waukegan Harbor and being disposed off at Countryside Landfill. Need to do a Phase 1 environmental assessment – real estate radial search should be done. Cost a couple hundred dollars. Jeff said may be able to add to action plan.
- Question about water quality impairments. Only pertain to lakes that have been monitored in the watershed.
- Recommendations will not capture road resurfacing alone – only roadway expansion projects.

Tim recommended that there be photos provided rather than just a map. Going to do it as a Google map.

MILL CREEK
WATERSHED AND FLOOD MITIGATION PLANNING MEETING
MARCH 11, 2014 4:00-6:00 P.M.
U OF I EXTENSION, GRAYSLAKE

Meeting Purpose: To bring stakeholders in the Mill Creek watershed together to discuss the draft watershed plan report including the action recommendations, public review and adoption process and schedule.

Desired Outcomes: By the end of the meeting we expect the watershed stakeholders to be familiar with the content of the draft watershed plan and understand the public review and adoption schedule.

MEETING SUMMARY

Introductions and Announcements
Andrea Cline, Lake County SMC, welcomed participants to the meeting. The meeting attendees introduced themselves. A list of the meeting attendees is included with this meeting report. Past meeting presentations, agendas, meeting notes, and other materials are available at the Mill Creek watershed webpage:
http://www.lakecountyil.gov/Stormwater/LakeCountyWatersheds/DesPlainesRiver/Pages/MillCreek.aspx

Review and Accept February 13, 2014 Meeting Summary
The summary was accepted without changes by consensus of the group.

Presenting key content of the watershed plan and review of the action plan
Andrea Cline, Lake County Stormwater Management Commission presented an overview of the watershed plan and reviewed the action plan.

Open House
Please feel free to ask questions, look at maps on display, navigate through the action plan maps, and leave us a comment.

Next Steps
1. Public review – public comments accepted until March 14
2. Plan revision based on review
3. Plan adoption
4. Next watershed stakeholder meeting/Formation of watershed council

Appendix B – Stream Inventory Summary

2013

Mill Creek Stream Inventory Summary

Sharon Østerby

Lake County Stormwater Management

4/24/2014

INTRODUCTION

The Lake County Stormwater Management Commission (SMC) conducted a Stream Inventory in the Mill Creek Watershed during the summer of 2013 in addition to a number of other studies and projects related to the development of a watershed plan in the Mill Creek Watershed. The purpose of this assessment was to record quantitative and qualitative stream information, including the capture of visual information on the stream conditions in the Mill Creek Watershed. The information collected will provide a baseline of the overall stream conditions; which can be further extrapolated to indicate the conditions of the stream network of the Mill Creek Watershed. The assessments results will be incorporated into the watershed plan and provide a framework for prioritizing and implementing watershed management strategies.

WATERSHED OVERVIEW

The Mill Creek watershed is a subwatershed of the Des Plaines River Basin and encompasses approximately 31 square miles (20,107 acres) in north central Lake County. The Mill Creek watershed includes 38 miles of stream, more than 1,400 acres of wetland, and 23 named lakes encompassing over 1,100 acres. Smaller ponds and unnamed water bodies encompass approximately another 218.5 acres, bringing the open water total area in the watershed to over 2,500 acres.

The Mill Creek watershed is located in northeast Illinois, in north central Lake County and drains approximately from south to north through the Avon-Freemont Ditch, joining with North Mill Creek, and then flowing east to the Des Plaines River. The Des Plaines River then continues south through suburban Lake County, into a more urban Chicagoland, and eventually joins the Kankakee River near Morris, Illinois. The combined Des Plaines and Kankakee Rivers form the Illinois River. The Illinois River flows into the Mississippi River just north of St. Louis, Missouri. Mill Creek is a headwater tributary of the Mississippi River Basin, which covers 1,245,000 square miles of the continental U.S. Mill Creek flows into the Des Plaines and Illinois Rivers before reaching the Mississippi River and eventually the Gulf of Mexico, over a thousand miles away.

AVON-FREEMONT DRAINAGE DITCH

The Avon-Fremont Drainage Ditch provides drainage for agricultural land in Avon and Fremont Townships. The channel begins north of Peterson Road and runs north through the Village of Grayslake to Washington Street, where water flows into a wetland complex and ultimately into Third Lake.

LAMBS CORNER CREEK

Lambs Corner Creek is a small tributary that begins north of Grand Avenue (IL 132) and west of Hunt Club Road and runs generally northwest through residential developments, joining Mill Creek near the intersection of Stearns School Road and Mill Creek Drive.

MILL CREEK

Third Lake empties over a dam on the northwest shore into Mill Creek, which flows north to Rollins Road. North of Rollins Road, Mill Creek turns east, generally parallel to Rollins Road, to U.S. Route 45. Between Third Lake and U.S. Route 45, Mill Creek mostly flows through channelized wetlands. East of U.S. Route 45, Mill Creek flows north and east in a meandering channel to Grandwood Park Lake, an impoundment that was constructed in the mid-20th century. Below the Grandwood Park Dam, Mill Creek flows northeast under Hutchins Road and north under Stearns School Road. North of Stearns School Road, the stream meanders to the north, where North Mill Creek, the largest tributary to Mill Creek, enters south of Millburn Road. Mill Creek generally flows east from the mouth of North Mill Creek, through two impoundments on private land, under Interstate 94 and U.S. Route 41, to the Des Plaines River. The mouth of Mill Creek is located immediately south of a footbridge over the Des Plaines River on the Lake County Forest Preserves' Des Plaines River Trail south of Wadsworth Road

THE STREAM INVENTORY ASSESSMENT

The stream assessment includes the geomorphic characterization of the channel; identifying erosion, evaluating discharge points and hydraulic structures, obstructions, areas of deficient buffer zones, and areas with significant detrimental impact on the stream. Visual observations regarding vegetation, water quality conditions, habitat assessments, and aquatic and terrestrial life are included in the stream inventory and allow for a more comprehensive assessment of the stream conditions. Also, information captured during the inventory process includes notes and comments about the stream that may not be well represented in the other forms, such as specific restrictions to stream, restoration efforts or conversations with local residents. The stream inventory data is captured through a uniform and standard process to ensure it is accurate and reproducible. See Appendix D and Appendix F for methodology used for stream inventory assessment.

DATA COLLECTION AND METHODOLOGY

The stream network within the watershed is divided into reaches, smaller geographically-defined segments, for which data is aggregated. Data is collected by a team of two observers walking the entire length of every assessment reach. At representative points within each reach, the observers measure the channel dimensions, relative velocity (at the surface) of the stream, noting streambank and riparian conditions, and document hydraulic structures and discharge points using a standardized database. For the purpose of determining bank erosion (lateral recession) additional measurements are obtained, including bank height, lateral recession rate, severity, and lateral recession characteristics. The Rapid Assessment, Point Method (RAP-M) methodology and implementation for this approach can be found in Appendix F (Windhorn). The observers use a camera that is equipped with a GPS (global positioning system) to photograph areas of moderate to severe erosion, significant sediment deposition and debris jams, hydraulic structures and discharge points, and photos of the stream channel that are representative of the conditions throughout the reach. This combined method and technology allows for analysis and mapping of the collected data. A copy of the Stream Inventory Methodology can be found in Appendix D and the Inventory Report Form can be found in Appendix E.

The following types of data were collected during the inventory and are summarized in the following sections:

- **A.** Channel Conditions (and Dimensions)
  - Channelization
  - Pool-Riffle Development
  - Bank Erosion (Lateral Recession)
  - Sediment Accumulation
  - Debris Loading
- **B.** Hydraulic Structures (Bridges, Culverts, Dams, Weirs, or structures conveying flow in the channel)
- **C.** Point Discharges (stormsewers, pipes, and overland flow draining to the stream)
- **D.** Vegetation and Land Use
  - Floodplain Vegetation and Land Use
  - Riparian Buffer Zone Width
  - Bank Vegetation
  - Predominant Species on Bank
  - Aquatic Instream Vegetation
- **E.** Substrate and Water Quality
  - Substrate Composition and Stability
  - Turbidity
- **F.** Instream Cover for Fish
- **G.** Aquatic and Terrestrial Organisms

The following characteristics of the Mill Creek Watershed stream reaches are summarized by reach in Appendix A-Table A:

1. In-stream and Over-bank Debris Loads
2. Substrate Composition
3. Channelization and Sinuosity (none, low, moderate, or high)
4. Bank Erosion (9-10=none, 6-8=low, 3-5=moderate, 0-2=high)
5. Channel Dimensions, including bank height and channel width

RESULTS

The Mill Creek Watershed contains approximately 23 miles of stream channels (of which 11.4 miles were assessed during the stream inventory). The network of stream channels in the watershed includes natural meandering channels, channelized segments of natural streams, and wholly constructed channels or ditches that were created primarily to drain lands for agriculture in the early 20th century. In addition to the stream network, these channels are connected to an array of wetlands, lakes, and impoundments. The Mill Creek Watershed stream networks assessed during the stream inventory were divided into three geographic sections: Avon-Freemont Drainage Ditch, Lambs Corner Creek, and Mill Creek.

Rivers and stream ecosystems provide important ecological functions and services. Some of these ecological services consist of purification of water, groundwater recharge with wetlands, and providing habitats for wildlife. These services are important for many reasons, including economic benefits, and the protection of human health and safety. When the natural balance of an ecosystem is changed or damaged, some or all of the ecological services they provide may be lost. Restoring some or all of the functionality of an ecosystem is usually exceedingly expensive to do so.

In the Mill Creek Watershed, the stream channels exhibit a diversity of characteristics throughout the watershed, some of which impede the functionality of the stream and its ability to provide hydrologic connections. Like many streams in the region, the results from land and resource management practices have caused both direct and secondary impacts to channels in the Mill Creek stream network. Immediate impacts can be measured in terms of the changing channel conditions discussed throughout this inventory report. The secondary impacts are those which are more subtle and recorded over longer periods of time such as the loss of habitat, or corridors that allow safe passage of aquatic and terrestrial organisms. The Mill Creek and Avon-Freemont Drainage Ditch have many areas where the land use has shifted from agricultural to residential, or the response to improved drainage and surface runoff has resulted in channelized, redirected, and deepened stream channels.

As a result, in Mill Creek and the Avon-Freemont Drainage Ditch, stream channels where channelization, debris, aquatic vegetation, and sediment accumulation exist, or where the gradient has been altered can impact the streams ability to move, store and deposit sediments effectively. Streams with steep, narrow slopes have increased discharge, and cross-sectional width and depth, and therefore increased velocity moving downstream. These channels have areas of moderate to severe streambank erosion, debris and sediment accumulated in both the channel and hydraulic structures, and discharge points damaged from eroding streambanks during bankfull events. Additionally, beaver dams located in both Mill Creek and the Avon-Freemont Drainage Ditch are impeding stream flow, disturbing structure and ecological functions, and causing adverse effects to aquatic and terrestrial organisms, including blocking fish migration and movement.

Preserving natural vegetation and stabilizing exposed soil in riparian zones dissipates stream energy during high-water flow events, prevents flooding and minimizes erosion. In all three geographical areas, the width of the riparian zone was more than 50% impacted by human activities. Throughout the watershed, increasing areas of impervious surfaces such as parking lots, and/or the loss of natural vegetation increases surface runoff and in turn decreases the rate of infiltration, water entering streams, groundwater recharge through stream beds, downstream waterways, wetlands and springs.

Minimizing human impact on and modifications to stream channels and riparian zones is essential for river and stream ecosystems to continue to provide ecological functions and services in the Mill Creek Watershed.

CHANNEL CONDITIONS

TABLE MC-01: CHANNEL DIMENSIONS

	Bank Height (ft.)		Channel Width, Top (ft.)		Channel Width, Bottom (ft.)	
	Min.	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Avon-Fremont Drainage Ditch	1.0	9.6	26.3	51.1	2.7	21.5
Lambs Corners Creek	0.5	0.9	3.7	14.0	3.7	10.8
Mill Creek	0.5	5.3	18.75	57.4	10.45	25.5

CHANNELIZATION

Stream channelization describes any activity that moves straightens, shortens, cuts off, diverts, or fills in a stream channel. These activities, which include widening, narrowing, or lining a stream channel, alter the discharge and velocity of water flowing through it (Stevens). Consequently, modifications aimed to address a problem in one area of the watershed or stream channel is shifted to another area upstream, downstream or within the immediate area.
For instance, shortening the reach of a stream moves flooding from the channelized reach to a downstream reach. The degree of channelization is ranked according to the percent of channelization. Reaches with channelization of 1%-33% are ranked "low", 33%-66% ranked "moderate", and >66% of a reach is channelized ranked "high". Reaches ranked as "None" have no indication of channelization. Table MC-02 summarizes the degree of channelization in the Mill Creek Watershed.

TABLE MC-02: DEGREE OF CHANNELIZATION

	Avon-Fremont Drainage Ditch			**Lambs Corner Creek**			**Mill Creek**			**Watershed Total**		
	Reaches	**Miles**	**% of Miles**	**Reaches**	**Miles**	**% of Miles**	**Reaches**	**Miles**	**% of Miles**	**Reaches**	**Miles**	**% of Miles**
None	0	0	0%	1	0.3	50%	7	3.1	53%	8	3.4	29%
Low	0	0	0%	1	0.3	50%	1	0.7	12%	2	1.0	9%
Moderate	1	0.5	10%	0	0	0%	5	2.0	35%	6	2.5	22%
High	12	4.7	90%	0	0	0%	0	0	0%	12	4.7	41%

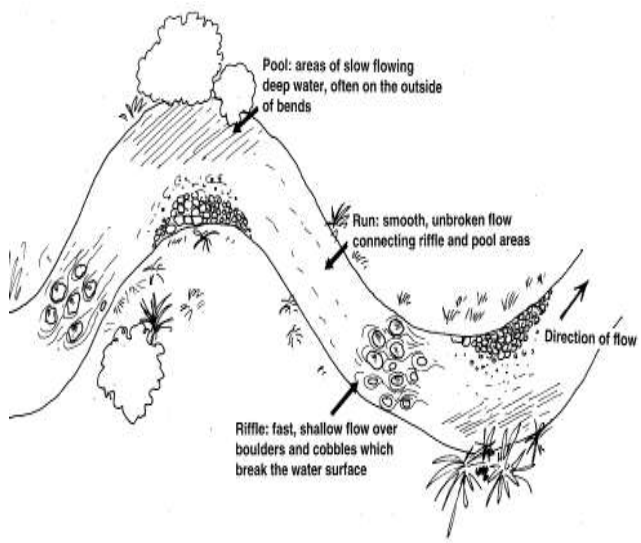
(None: 0%, Low: 0-33%, Moderate: 33%-66%, High: >66%)

POOL/RIFFLE DEVELOPMENT

Under baseflow conditions, pools are low-gradient areas of deeper water with slower velocity and riffles are high-gradient areas of shallow water with higher velocity. In general, pools represent localized deeper areas, whereas riffles represent localized shallows areas. During baseflow conditions, sediment erodes from riffles and is deposited into pools. During bankfull conditions, the relationship of relative velocity in riffles and pools is reversed and sediments along with substrate material are scoured from pools and the channel bed and deposited on riffles or bars. During periods of elevated flow when the velocity in pools exceeds that over riffles, deposition and bar formation tend to occur in areas adjacent to pools Figure MC-1.

In a single-thalweg meandering channel, pools are typically associated with the outer portions of meander bends while riffles are typically located above or below pools. Bars typically form alongside pools or runs. Because pools and riffles exhibit very different physical conditions and are often adjacent to one another in the channel, they are important to the ecological health of the stream channel. Because of their typically shallow depth, increased gradient and large sediment size, riffles cause turbulence throughout the water column and have the effect of aerating the stream, causing oxygen to dissolve from the air into the water. Pools, on the other hand, have slower velocities and increased depth, offering habitat to a wide range of aquatic species for a variety of uses. Channelization often reduces the extent of pool-riffle sequences in a stream. Most stream channels in the Mill Creek watershed exhibit some degree of pool-riffle development (see Table MC-03).

Figure MC-1: Pool-Riffle Sequence



http://www.niwa.co.nz/our-science/freshwater/tools/shmak/manual/9catchment
(National Institute of Water and Atmospheric Research Ltd)

TABLE MC-03: POOL/RIFFLE DEVELOPMENT

Pool / Riffle Development	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Watershed Total	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
None (<5%)	11	85%	1	50%	5	38%	17	61%
Low (5-33%)	2	15%	1	50%	4	31%	7	25%
Moderate (34-66%)	0	0%	0	0%	4	31%	4	14%
High (>67%)	0	0%	0	0%	0	0%	0	0%

*Percentage of reach in pools/riffles (None: <5%, Low: 5-33%, Moderate: >33-66%, High: >66%)

STREAMBANK EROSION


Streambank Erosion in the Avon-Freemont Drainage Ditch

The Rapid Assessment Point Method (RAP-M) for assessing lateral recession was employed to determine the degree of streambank erosion in the Mill Creek Watershed (Windhorn). Lateral Recession Rate (LRR) evaluates streambanks along the right and left bank (facing upstream) for each assessed reach. Within each reach, a segment of the channel with LRR characteristics is identified. Measurements for this segment are bank height and length, and any other supporting criteria are noted. This is repeated up left and right side of each bank, connecting each segment to the end of the reach. All segments of every reach are captured with a camera equipped with (GPS) which is then transferred to a geographic information system (GIS) which then manipulates, analyzes, and presents the data geographically. This combined analysis allows for an overall assessment to be made regarding the severity of the entire reach, including review of photographs, and repeatable measurements taken in the field. The methodology for lateral recession can be found in Appendix F (Windhorn).

Streams are dynamic systems, in a perpetual state of flux, therefore, all banks exhibit some form of erosion. Streambank erosion in the Mill Creek Watershed tends to occur in developed areas, particularly residential neighborhoods and urban areas. Surface runoff to streams contributes to streambank erosion and is dependent upon key factors such as storm events, their duration, timing, and amount of precipitation that falls and subsequently runs off; the type and condition of soil within watershed; and land use and vegetative buffers. In some reaches (e.g. MC-40 and MC-43 in Mill Creek, near Grandwood Park Lake), streambank erosion is severe and likely caused by increased runoff from highly development residential areas. While some severe cases of localized bank erosion were found, no reach exhibited high erosion over its entire length. The qualitative assessment criterion for each rating is slight, moderate, and severe and can be found in Table MC-04. Table MC-05 summarizes streambank erosion in the Mill Creek Watershed.

TABLE MC-04: BANK EROSION CRITERIA

Category	Description
Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
Moderate	Bank is predominantly bare with some rills and vegetative overhang.
Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.

TABLE MC-05: STREAMBANK EROSION

Extent of Erosion	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Watershed Total	
	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
Slight	2	2	0	0	0	0	2	2
Moderate	7	7	2	2	6	7	15	16
Severe	4	4	0	0	7	6	11	10

*Number of reaches with erosion problems (Slight: 0-33%, Moderate: >33-66%, Severe: >66 %)

SEDIMENT ACCUMULATION

Streams provide much of the hydrological connectivity in a watershed; therefore the condition in one part of watershed can affect other portions. Sediment erosion, transport and deposition are naturally occurring processes in stream systems, but the magnitude of these processes can be amplified due to land use changes and anthropogenic modifications within the watershed.

Typically a stream generates, suspends, and transports sediment through high-gradient reaches and deposits sediment in low gradient reaches and/or in areas where velocity decreases. These low-velocity areas may be naturally occurring areas such as pools or sloughs. They may also occur behind debris jams or beaver dams or upstream of channel constrictions (such as culverts) or dams. Decreasing discharge in the downstream direction thus promotes a stepwise movement of deposition and storage of sediment within stream network. The effect results in sediment movement that doesn't always reach the watershed outlet, but is instead remobilized during the next flow and redistributed within the watershed's channel network. The amount of sediment transported downstream during storm events will increase sedimentation rates in downstream channels. This increased sediment load can have negative effects on channel stability, fish, invertebrates, and overall stream productivity. When small or headwater streams are replaced with paved floodways during land development, sediment production may decrease, causing an increase in downstream erosion as sediment starved waters move through the watershed. Sediment deposition can have varying effects. For example, sediment deposited during flow events can encourage plant germination (i.e. by providing seed beds and scarifying seeds, but it also can inhibit the growth of seedlings or other vegetation. This can be beneficial in some instances where stream restoration efforts are occurring. However, excessive sediment deposition chiefly affects fish and the benthic community in several ways: the suspended sediment can interfere with food gathering or filtering organisms, decrease light levels which impact productivity and reproduction, and sediment accumulation on the bottom of channels can bury organisms to the point of starvation or death. All reaches in the Mill Creek Watershed exhibit some sediment accumulation (see Table MC-06).

TABLE MC-06: SEDIMENT ACCUMULATION

Sediment Accumulation	Mill Creek		Avon-Fremont Drainage Ditch		Lambs Corner Creek		Watershed Total	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
None (<5% of reach)	0	0	0	0	1	50	1	4
Low (5-33%)	4	31	4	31	1	50	9	32
Moderate (34-66%)	7	54	5	38	0	0	12	43
High (67-100%)	2	15	4	31	0	0	6	21

Of the 28 assessed reaches in the Mill Creek Watershed, (43%) had "'Moderate" sediment accumulations. Many of the stream channels had moderate and high cases of debris jams, and hydraulic structures causing constrictions; such as beaver dams. The Avon-Freemont Drainage Ditch has a fairly even distribution of sediment accumulation across the "Low", "Moderate" and "High" criteria. These sediment accumulations are due to local and upstream increases in runoff and/or erosion, especially areas with highly erodible soils, such as those on agricultural lands which are extremely susceptible to erosion. Despite the on-line impoundments within the Mill Creek Watershed (i.e., Third Lake), many are likely acting as sediment traps.

Point bars are depositional features located on the inside bend of a meandering streams. They accumulate fine silt, sand, gravel and debris, during high flow events, and overtime can become vegetated.

Sediment accumulation in Mill Creek

STREAM DEBRIS LOAD

Like sediment, most or all streams transport some amount of debris. Large organic debris such as tree limbs and branches can provide habitat, divert currents to create pools, bars, and slow-water habitat for aquatic organisms, and provide allochthonous energy inputs to the ecosystem that are not produced within the stream. Allochthonous inputs are those that enter the stream from some outside source, such as organic matter like leaves from terrestrial plants and trees that is washed into the stream). However, too much debris can be problematic and may result in debris jams. These debris jams may cause backwater flooding and sediment deposition and can divert current into one or both banks, leading to streambank erosion.

Debris jam in Mill Creek

In the Mill Creek Watershed, problematic or potentially problematic debris loads exist in more than half of all stream reaches. Table MC-07 summarizes the reaches that failed the debris load test, and have either moderate or high instream and/or overbank debris loads. Debris in these reaches cause or has the potential to cause backwater flooding, sedimentation, and bank erosion. Reaches that "failed the test" contain multiple debris jams or overhanging obstructions extending across all or a significant portion of the channel and/or onto the banks. In Mill Creek, 68% of the land use is defined as "Open Space" and in several of the stream channels assessed, the riparian and floodplain zones are heavily vegetated which contributes to the instream and overbank debris load. The Avon-Freemont Drainage Ditch also has significant "Open Space" (44%) land use with heavily vegetated riparian and floodplain areas.

TABLE MC-07: DEBRIS LOADING

Moderate or High Debris Load	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Watershed Total	
	Reaches	%	Reaches	%	Reaches	%	Reaches	%
Instream	5	38%	0	0%	11	85%	15	56%
Overbank	6	46%	0	0%	11	85%	16	59%
Both	4	31%	0	0%	11	85%	15	56%

*Reaches failing test for instream, overbank, or both types of debris loads

HYDRAULIC STRUCTURES

Hydraulic structures are any bridges, culverts, dams, weirs, levees, and fences in or across the stream channel. These structures modify the pattern or amount of flow and may act as constriction points causing backwater flooding. Culverts may act as temporary or permanent barriers if, over time, a plunge pool develops, causing the bottom of the culvert to become elevated above the water level of the pool. Additionally, dams and weirs can impede the movements of fish and other aquatic organisms within the stream network. Within the Mill Creek Watershed, there have been substantial modifications to the stream system.

Beaver Dam in Mill Creek

Large segments of Mill Creek and the entire length of the Avon-Fremont Drainage Ditch have been modified by channelization and the construction of hydraulic structures. These changes result in a decreased quantity of pool-riffle complexes, increased sediment accumulation, increased debris loads, habitat alteration and decreased biological productivity. Table MC-08 summarizes the numbers and types of hydraulic structures in the Mill Creek Watershed. A complete summary of the 53 hydraulic structures recorded in the Mill Creek Stream Inventory can be found in Appendix C, Table C-1.

TABLE MC-08: HYDRAULIC STRUCTURES

Hydraulic Structures	Avon-Fremont Drainage Ditch	Lambs Corner Creek	Mill Creek	Watershed Total
Beaver Dam	1	0	8	9
Bridge	5	0	11*	16
Culvert	17	5	4	26
Dam^	1	0	1*	2
Total Hydraulic Structures	24	5	24*	53
Hydraulic Structures (per stream mile)	4.6	8.3	4.1	17.0
Problem Hydraulic Structures	4	0	9	13

*The dam at Grandwood Park Lake is spanned by a bridge, both are counted individually.

^The dam at Third Lake and several dams on private property are not included because the reaches were not assessed as part of the stream inventory.

DISCHARGE POINTS

Discharge point in the Avon-Freemont Drainage Ditch

Discharge points include sanitary, storm sewer, agricultural drain tile and sump pump pipes greater than 4 inches in diameter. They also include open channels, swales, gullies and other significant tributaries. In the Mill Creek Watershed, 164 points of discharge were recorded into stream channels, of which 114 were pipes, storm sewers, culverts or drain tiles (see Table MC-09). The Avon-Freemont drainage Ditch contained 60% of the discharge points in the watershed, and also contained the highest numbers of pipes, storm sewers, culverts and drain tiles. Discharge points are most common in urban and residential areas where sump pump and stormsewer outfalls are numerous. Problem discharge points in the Mill Creek Watershed contribute to streambank erosion and/or transport excess sediment to the stream channel. Problematic discharges are most common in highly developed urban and residential areas. Another problem frequently noted during the stream inventory is the state of disrepair of some drain tiles, particularly those constructed of clay and concrete. As the streambank erodes, longer sections of the tile become exposed and eventually collapse under their own weight. This effectively shortens the pipe, causing the point at which runoff discharges from the pipe to retreat from the channel, further eroding the streambank.

TABLE MC-09: DISCHARGE POINTS

Discharge Points	Avon-Fremont Drainage Ditch	Lambs Corner Creek	Mill Creek	Watershed Total
Swales, gullies, and tributaries	15	1	34	50
Pipes, storm sewers, culverts and drain tiles	87	1	26	114
Total Discharge Points	102	2	60	164
Discharge Points (per stream mile)	19.6	3.3	10.3	33.2
Problem Discharge Points	26	0	12	38

VEGETATION & LAND USE

TABLE MC-10: DOMINANT LAND USE

	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Percentage of Watershed
	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	
Agriculture	9%	23%	0%	0%	0%	0%	7%
Open Space	38%	50%	48%	79%	68%	68%	57%
Recreational	5%	4%	0%	0%	1%	13%	5%
Commercial/ Industrial	18%	11%	0%	0%	3%	3%	8%
Residential	30%	13%	52%	21%	28%	16%	23%

FLOODPLAIN VEGETATION

Floodplain vegetation in Lambs Corner Creek

Floodplain vegetation serves as an important function in protecting the physical, biological, and chemical integrity of water. Vegetation acts as a natural barrier by dissipating the energy of lowing water and provides protection from flooding and erosion. Vegetation filters sediments originating from land while slowing overland flows and surface run-off into water bodies, and filters incoming floodwaters from materials scoured from the channel bank and bed. This filtering process can add nutrients to the floodplain soil. Slowed runoff across the floodplain allows additional time for infiltration and groundwater recharge. The slowing of runoff provides the additional benefit of natural purification of water as local runoff or overbank floodwater infiltrates through the floodplain alluvium. Vegetation provides habitat and nutrients for a wide variety of terrestrial and aquatic organisms in, adjacent to, and for downstream ecosystems.

The Floodplain Vegetation (Land Cover) is vegetation within 100 feet of the stream bank and summarized in Table MC-11. Land cover refers to the percent of the area occupied by the given land cover. Herbaceous plants, shrubs, trees, and wetland vegetation composed the majority of floodplain vegetation throughout the watershed. In Lambs Corner Creek, wetland vegetation and lawn were the predominant land cover. Additionally, many areas within the floodplain area and adjacent to streambanks have little or no vegetation due to human activities. The assessment of this area, referred to as the "Riparian Zone" or "Vegetated Buffer Zone" is summarized in Tables MC-12 and MC-13.

TABLE MC-11: LAND COVER

Land Cover	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Percentage of Watershed
	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	
Tree	15%	15%	13%	13%	25%	22%	19%
Lawn	15%	9%	45%	3%	4%	2%	8%
Wetland	7%	12%	7%	54%	9%	14%	13%
Crop	5%	11%	0%	0%	0%	1%	4%
Shrub	23%	19%	19%	21%	26%	28%	24%
Herbaceous	29%	29%	8%	10%	32%	32%	29%
Impervious	7%	5%	1%	0%	3%	0%	3%
Water	0%	0%	0%	0%	1%	0%	0%

VEGETATED BUFFER (RIPARIAN ZONE)

The riparian zone is the area extending 100 feet from the stream channel on both the left and right side of the stream channel. Riparian vegetation also provides beneficial shading to streams and lakes which helps to avoid temperature stress on fish and aquatic organisms. The quality of the riparian zone, the width, and land use characteristics were visually assessed during the Mill Creek Stream Inventory. Table MC-12 summarizes the assessment criterion for the width of the Riparian Zone is a visual representation of the quality of the riparian zone observed in 2013.

TABLE MC-12: RIPARIAN ZONE ASSESSMENT CRITERIA

Riparian Zone	None	Low	Moderate	High
Buffer Width	**<20 feet**	**20-40 feet**	**40-60 feet**	**>60 feet**
Description	Zone contains little or no riparian vegetation due to human activities	Zone is impacted a great deal by human activities	Zone is impacted minimally by human activities	Zone is not impacted by human activities (i.e., no parking lots, roadbeds, lawns, crops)

Throughout the Mill Creek Watershed, the width of the riparian zone is impacted by anthropogenic changes in land use resulting in wide riparian buffers ("High" buffer width) in locations where the stream flows through open space areas with minimal to no impact and narrow buffers ("Low" buffer width) in locations where the stream flows through developed areas. Generally, the portion of the stream network known as Mill Creek (in the northern portion of the watershed) has wider riparian buffers and flows through more open space areas, with the exception of "build out" neighborhoods such as Grandwood Park. The Avon-Fremont Drainage Ditch largely has narrower buffers, as it flows primarily through agricultural land and the Village of Grayslake. There are only a few reaches in the watershed in which there is no riparian buffer. Table MC-13 summarizes the Riparian Zones assessed in the Mill Creek Watershed.

Floodplain vegetation and low riparian zone in Mill Creek

TABLE MC-13: RIPARIAN ZONE

	Avon-Fremont Drainage Ditch			Lambs Corner Creek			Mill Creek			Watershed Total		
	Reaches	Miles	% of Miles	Reaches	Miles	% of Miles	Reaches	Miles	% of Miles	Reaches	Miles	% of Miles
None (<20 ft.)	0	0	0%	1	0.3	50%	7	3.1	53%	8	3.4	29%
Low (20-40 ft.)	0	0	0%	1	0.3	50%	1	0.7	12%	2	1.0	9%
Moderate (40-60 ft.)	1	0.5	10%	0	0	0%	5	2.0	35%	6	2.5	22%
High (>60 ft.)	12	4.7	90%	0	0	0%	0	0	0%	12	4.7	41%

Bank Vegetation (Predominant Vegetation) is vegetation existing within 10 feet of the stream bank. The most significant role of bank vegetation is its ability to control erosion, which in turn prevents sediment and other forms of pollution from entering the stream. Sedimentation is a very significant problem and though erosion is a natural process, it is often sped up through human activities, directly or indirectly. The increased rate of erosion and sedimentation affects the geomorphology of the stream channel, water quality, and aquatic life in the stream channel and throughout the watershed. Streams surrounded by vegetated riparian zones, have intricate root systems that help to stabilize the bank and prevent erosion. Woody stemmed plants, sedges, and grasses help physically trap sediment by slowing water runoff from the surrounding areas, allowing the sediment to settle out instead of entering the stream. Additionally, vegetated banks lend to deep and narrow channels as a result of their stability and lack of heavy sedimentation.

In the Mill Creek Watershed, the streambank vegetation is predominantly shrubs, herbaceous plants and trees. Lambs Corner Creek has a greater portion of wetland vegetation (52%), Avon-Freemont Drainage Ditch has a greater percentage of herbaceous plants (36%), and Mill Creek has largest portion of shrubs (31.5%) (See Table MC-14). Many of the plants that dominate these categories are non-native species such as as Buckthorn, Reed Canary Grass, and Multi Flora Rose. These species form dense stands, outcompete and displace native species, displace and threaten wildlife habitat and biodiversity, limit the diversity of bank vegetation and change the aesthetics of the landscape. These plants were recorded in a majority of assessed reaches.

Table MC-14: PREDOMINANT BANK VEGETATION

Bank Vegetation	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Percentage of Watershed
	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	
Unmowed Grass	0%	0%	0%	0%	0%	0%	0%
Lawn	3%	3%	7%	1%	2%	5%	3%
Wetland	11%	18%	46%	58%	11%	16%	16%
Trees	19%	18%	13%	12%	22%	17%	19%
Shrubs	27%	27%	16%	12%	33%	30%	29%
Crops	0%	1%	0%	0%	0%	0%	0%
Herbaceous	39%	33%	18%	18%	31%	32%	33%
Other	0%	0%	0%	0%	1%	0%	0%

*Within 10 feet of the stream bank

INSTREAM COVER FOR FISH

A diverse habitat with regard to instream cover is essential for diverse fish assemblages and other aquatic organisms. Instream fish cover availability was evaluated based on the presence of a number of structural elements and habitats, consisting of undercut banks, pools over 28 inches deep, aquatic macrophytes, logs, overhanging vegetation, rootwads, boulders, and backwaters. The presence of woody debris (logs and rootwads) in streams is a significant component of fish habitat which they utilize for spawning, rearing, and foraging. Woody debris creates areas of low flow, providing a refuge for fish during periods of high flow. Woody debris also provides cover for fish, lowering the risk of predation. Overhanging vegetation and canopy cover provide two important benefits; providing shade to the stream helps keep the temperature in the stream cool, and leaf litter and organic material provide nutrients to macroinvertebrates and other aquatic organisms. These aquatic organisms in turn, become an important source of food for fish and other animals in the ecosystem.

Instream Cover for fish in Lambs Creek Corner

Undercut banks and logs are the most abundant cover type, appearing in all of the assessed reaches, whereas boulders and backwaters are least abundant. In the Avon-Freemont Drainage Ditch and Lambs Corner Creek, these cover types are recorded in only one reach (See Table MC-15). Overhanging vegetation and macrophytes were also common in all stream channels in the Mill Creek Watershed, each occurring in more than three-quarters of the assessed reaches. Logs and other large woody debris (LWD) in stream systems and habitat restoration efforts is a matter of consideration. The presence of logs and other LWD divert flow, provide habitat and play an important role in pool, riffle, and bar development. The attenuation of flood flows, drainage of riparian wetlands, land use changes, management of beaver populations and invasive species are all factors that can contribute to the reestablishment of the riparian forest. Backwater areas have decreased over time and presently occur in wetlands and low-lying areas behind dams and debris jams.

Table MC-15: INSTREAM COVER FOR FISH

Instream Cover For Fish	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek	
	% of Watershed	# of Reaches	% of Watershed	# of Reaches	% of Watershed	# of Reaches
Undercut Banks	47	13	1	2	52	13

Instream Cover For Fish	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek	
	% of Watershed	# of Reaches	% of Watershed	# of Reaches	% of Watershed	# of Reaches
Pools >28"	37	7	1	1	62	11
Macrophytes	47	13	1	2	51	12
Logs	47	13	0	1	53	13
Overhanging Vegetation	44	12	1	2	55	12
Rootwads	29	3	2	1	69	9
Boulders	18	1	1	1	81	8
Backwaters	0	0	3	1	97	7

AQUATIC INSTREAM VEGETATION

Aquatic instream vegetation is an important part of the watershed ecosystem. Plants in the stream are important in food webs: each organism has characteristic feeding preferences and patterns, and can itself be prey to other consumers. Plants provide habitat and shelter for fish, waterfowl, and other wildlife. Since all plants, including those that grow underwater, produce oxygen as they photosynthesize, they are the major source of oxygen for aquatic animal life. Rooted plants stabilize shorelines and stream beds. They absorb nutrients and filter pollutants from runoff, which improves water quality.

Aquatic Vegetation in Mill Creek

Certain non-native plant species such as Eurasian water milfoil can be extremely aggressive, taking over large areas of aquatic habitat. Invasive plant species can completely destroy stands of native vegetation. An overabundance of aquatic plants and algae can reduce oxygen levels in the water, which can contribute to fish kills. Decomposing of dead fish and algae also contributes to oxygen depletion. Too much vegetation can impede water flow in stream channels, drainage ditches, and culverts or back up water completely. These areas can trap sediment and debris, and over time lead to a gradual filling in of lake and channels.

The Aquatic Instream Vegetation assessed in the Mill Creek Watershed show a majority of reaches with a significant portion of surface area without vegetation, indicating a low prevalence of aquatic vegetation. The reaches assessed in Lambs Corner Creek have equal proportions of "No Vegetation" (42%) to "Rooted Emergent" vegetation (51%) often along the shoreline that stand above the surface the water, such as grasses and cattails. The Mill Creek reaches have an even percentage of each type of vegetation with the greatest percentage of "No Vegetation" (69%). This distribution is somewhat preferred and indicates a variety of aquatic plant life without one dominant type. (See Table MC-16).

Table MC-16: AQUATIC INSTREAM VEGETATION

Instream Aquatic Vegetation	Avon-Fremont Drainage Ditch	Lambs Corner Creek	Mill Creek	Percentage of Watershed
Rooted Emergent	5%	51%	4%	5%
Rooted Submergent	11%	0%	7%	8%
Rooted Floating	0%	0%	3%	2%
Free Floating	4%	4%	5%	5%
Floating Algae	3%	0%	0%	2%
Attached Algae	9%	4%	11%	10%
No Vegetation	69%	42%	69%	68%

SUBSTRATE COMPOSITION AND WATER QUALITY

Mill Creek Watershed streambeds are composed of a variety of sediment grains that range in diameter from extremely fine clays (<1/1000th of an inch) to relatively coarse cobbles and boulders (>1 foot). Generally, fine sediments are transported in suspension until velocity slows enough that they are deposited on the streambed. Larger sediments are not transported as readily and may only move during increased flows. Clays are typically regarded as cohesive sediments that naturally adhere to one another (and are therefore more difficult to erode) while silts are more easily eroded. Sands and larger sediments (e.g., gravels and cobbles) are less cohesive. Clay and silt-dominated banks and beds, therefore, tend to be associated with narrow, incised channels while sand, gravel, and cobble-dominated channels are more often shallow and wide. Clay/silt channels tend to incise or deepen in response to increased flows while sand/gravel channels tend to widen. These relationships, however, are also contingent upon a number of other contributing factors such as gradient, bank slope, and bank vegetation

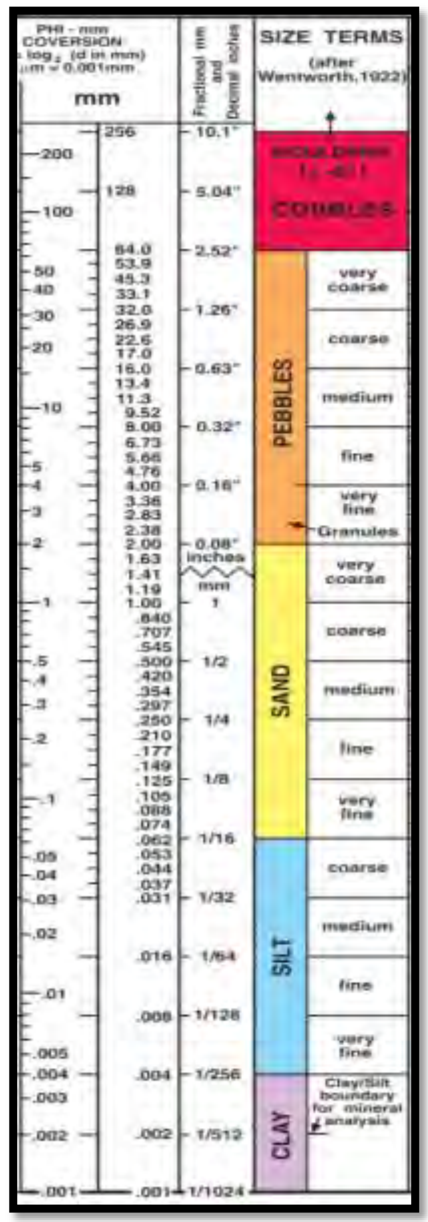
Course Substrate in Mill Creek

Substrate is also an important measure of habitat quality. Extremely fine sediments, such as clays, adhere closely to one another and may bury the streambed. Coarse-grained sediments like gravels present abundant interstices, allowing water, oxygen, and other dissolved and suspended materials to infiltrate the hyporheic zone. The hyporheic zone refers to the area surrounding the stream channel that is saturated and through which there is some percolation or flow. Essentially, the hyporheic zone is the area where the surface water and groundwater interface and mix. These interstitial pores also provide habitat to benthic (bottom-dwelling) macroinvertebrates, which play important roles in both aquatic food webs and ecosystem functioning. Excessive deposition of clays, silts, and fine particulate organic matter reduces the potential for infiltration and accessibility to the hyporheic zone. Excessive deposition also negatively affects filter feeders such as mussels, and may cause anoxia, or oxygen depletion, in the streambed as organic materials decompose.

In the Mill Creek watershed, most reaches contain a mixture of sediment types. Table MC-17 summarizes the relationship of these substrate types in the watershed. Across the entire watershed and among each geographic section, sand (34%) and gravel (25%) are the predominant substrate types recorded. Organic matter (16%) and silt (15%) are evenly distributed among each geographic section and third/fourth overall of predominant substrate types. Most reaches exceed 20% composition of any of these four substrate groups, suggesting that throughout a reach no one type dominates, but that combinations of the top four types likely occur.

Table MC-17: SUBSTRATE COMPOSITION

Substrate Composition	Avon-Fremont Drainage Ditch	Lambs Corner Creek	Mill Creek	Percentage of Watershed
Claypan	0%	0%	0%	0%
Silt	19%	18%	12%	15%
Sand	33%	29%	34%	34%
Gravel	25%	21%	25%	25%
Cobble	4%	6%	9%	7%
Boulder	0%	2%	4%	2%
Concrete	0%	0%	1%	1%
Organic Matter	18%	24%	14%	16%



Wentworth Grain Size Chart US Geological Survey (Williams)

WATER QUALITY

Turbidity

Visual inspections of several water quality indicators were made during the stream inventory. Turbidity, water color, and the presence of grease and oil in the sediment or water column were assessed. Turbidity is the measure of relative clarity of water. Material that causes water to be turbid includes clay, silt, fine inorganic and organic matter, algae, organic compounds, and plankton and other microscopic organisms (Turbidity). During periods of low flow, water in streams is a clear green color, and turbidities are low. During high flow events, sediment and material from the surrounding surfaces are washed into the stream. As the velocity and volume of water increases, sediments and other materials are stirred up causing the water to become muddy, brown, and turbid.

Turbidity among the three geographic areas is not a significant problem in the Mill Creek Watershed under baseflow conditions. Lambs Creek Corner has areas of “moderate” turbidity with extensive low gradient, depositional or backwater areas that collect fine sediment from upstream. In the Avon-Freemont Drainage Ditch, where 34% of the reaches have “high” turbidity, constrictions and debris jams in stream channels cause turbid conditions. Overall, the greatest percentage of reaches in the watershed have a “low” (56%) or “moderate” (28%) rating for turbidity. See Table MC-19.

Table MC-19: WATER QUALITY

Water Quality	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Percentage of Watershed	
	Reaches	% of Total Area	Reaches	% of Total Area	Reaches	% of Total Area	Reaches	% of Total Area
Turbidity								
Low	4	43%	0	0%	9	70%	13	56%
Moderate	4	23%	2	100%	4	30%	2	28%
High	5	34%	0	0%	0	0%	13	16%
Grease & Oil								
In Water & Sediment	9	67%	0	0	1	2%	10	32%
In Sediment Only	0	0%	0	0	1	5%	1	3%
In Water Only	1	5%	0	0	0	0%	1	2%
No Grease & Oil in Water or Sediment	3	28%	2	100%	11	93%	16	63%

Grease & Oil

Grease and oil is generally not present in most of the channel. In Avon-Fremont Drainage Ditch, the greatest percentages of reaches (67%) were encountered with grease and oil present in the water and sediment. In contrast, the Mill Creek stream channels assessed had neither grease nor oil in the water and sediment (93%). The Mill Creek Watershed has more than half all stream channels with no grease and oil in water and sediment (63%) and 32% with grease and oil in water and sediment (see table MC-19). Where grease and oil is present, it was detected in both the sediment and the water column. The origination of the grease and oil does not relate to any one particular site or land use and therefore is likely due to non-point source run-off. An additional note: iron bacteria are present in many soils in Illinois and can cause yellow, orange, red, or brown stains and colored water. It can also cause a rainbow colored, oil-like sheen on the water or in soil and sediments. Simple water testing is available to determine if the oil-like substance present is iron bacteria.

Grease and oils enter the stream from during rain storms as oil and grease from surrounding parking lots, roads, and bridges flush into the storm sewer system, often overflowing directly into the stream. Other potential sources of oil and grease results from illegal dumping that originate from automotive and transportation related services. Grease and oil in the water column and sediment will degrade the water quality of receiving streams by adding biological and chemical oxygen demand to the stream. Table MC-19 summarizes the turbidity, grease and oil in the Mill Creek Watershed.

ALGAE

Algae are an indicator of high nutrient loads. Generally, algae were not a significant problem in Mill Creek Watershed streams; however, some areas contained extremely high populations. Excessive algae growth can negatively impact aquatic organisms and habitat by causing large daily fluctuations in dissolved oxygen levels. Algae are photosynthetic and therefore take up carbon dioxide during the day and release oxygen into the water column and the air. At night, algae respire, taking oxygen out of the water column and releasing carbon dioxide. Therefore, larger populations of algae have greater potential to cause large daily oxygen fluctuations. In addition, abundant algae populations are often aesthetically undesirable and typically detract from the visual quality of water resources.

Filamentous Algae in Mill Creek

AQUATIC AND TERRESTRIAL ORGANISMS

Stream aquatic integrity in urban settings is directly affected by physical changes in the watershed, some of which result in the degradation of the chemical and/or physical condition of the stream. Habitat information is extremely important for discriminating between physical and chemical effects.

The inventory addressed aquatic and riparian life where possible or identifiable. Organisms were not specifically sampled during the stream inventory, but some animals were observed during the inventory. In particular, carp appear to be abundant in the Mill Creek and Avon-Freemont Drainage Ditch and may be limiting plant growth, increasing turbidity, and re-suspending sediment. Other species of fish present included bluegill and fathead minnows. Freshwater mussels and clams can be found in the Mill Creek and some areas of the Avon-Freemont Drainage Ditch. In these areas, invasive species of Asian Clams and Zebra Mussels can be found as well (U.S. Fish & Wildlife Services). While macroinvertebrate were not sampled during the inventory, snails, native crayfish (non- native rusty crayfish) aquatic worms, water beetles, mayflies and dragon and damsel fly nymphs were visible in both regions. Mallard ducks, Canadian geese, Great Blue Herons, Green Frogs, Bull Frogs, beavers, muskrats and deer were also encountered during the inventory. Table MC-20 summarizes Aquatic Organisms observed.

Table MC-20: AQUATIC ORGANISMS

Aquatic Organisms	Avon-Fremont Drainage Ditch		Lambs Corner Creek		Mill Creek		Percentage of Watershed	
	# Reaches	% of Total Area	# Reaches	% of Total Area	# Reaches	% of Total Area	Reaches	% of Total Area
Macroinvertebrates								
Observed	2	20%	1	23%	5	42%	8	32%
Mussel Beds								
Observed	4	31%	0	0	7	59%	11	45%
None	9	69%	2	100%	6	41%	17	55%

Zebra Mussel found in Mill Creek

Papershell Mussel found in Mill Creek

Whiite Heelsplitter found in Mill Creek

Works Cited

National Institute of Water and Atmospheric Research Ltd . *Natural Catchment Influences*. New Zealand, 24 04 2014. Picture. <http://www.niwa.co.nz/our-science/freshwater/tools/shmak/manual/9catchment>.

Stevens, Carl. "Wetlands-Region 7." Vers. Fact Sheet #1. n.d. *EPA.* Document. 14 04 2014. <http://www.epa.gov/region7/wetlands/pdf/ChannelizationFS04-Final.pdf>.

The USGS Water Science School. 8 April 2014. Document. 24 4 2014. <URL: http://water.usgs.gov/edu/>.

U.S. Fish & Wildlife Services. "Freshwater Mussels of the Upper Mississippi River System." *Species Identification and Location*. USGS, 28 12 2006. 24 04 2014. <http://www.fws.gov/midwest/mussel/species.html>.

Williams, Arsenault et al. "Wentworth grain size chart from the United States Geoligical Survey Open-File Report." 2006.

Windhorn, R.D. "Rapid Assessment Point Method,Inventory and Evaluationof Erosion and Sedimentation for Illinois." 2000.

APPENDIX A
TABLE A-1: SUMMARY OF MILL CREEK STREAM REACH CHARACTERISTICS

Stream reaches are segments of a stream channel with somewhat homogeneous hydraulic, geomorphic, and land cover/land use characteristics. The Mill Creek stream network in Lake County identified 91 reaches (38.1 miles) for assessment. Of those 91 reaches, 30 reaches (11.4 miles) were assessed in the inventory, 28 reaches (11.6 miles) were inaccessible or could not be waded safely by the observer(s), and 33 reaches (14.2 miles) lacked a defined channel, or were not streams (i.e., lakes, ponds, wetlands or engineered stormwater systems) (see Table MC-01). With an average of 5,000 linear feet of waterway per reach; 11 of these reaches were lakes or wetland complexes that were not assessed. The average length of assessed reaches in the Mill Creek inventory is 2,181 feet (less than one half-mile).

Reach identification and designation is based upon the topographic position of the reach relative to other reaches in the watershed as well as the stream network to which the reach belongs. All reaches have a designated four-digit alphanumeric identification number. In the Mill Creek inventory, all reaches begin with the alphabetic prefix "MC" to distinguish them from other stream inventories in Lake County. The suffix is a two-digit numeral that identifies the reach within the Mill Creek drainage network.

Reaches MC-01-MC-17 refer to Mill Creek which generally flows eastward from the mouth of North Mill Creek through two impoundments on private land, under Interstate 94 and U.S. Route 41, to the Des Plaines River. Reaches MC-18-MC-34 refer to Mill Creek upstream of Lambs Corner Creek, to the mouth of North Mill Creek. Reaches MC-35-MC-36 refer to Lambs Creek Corner, a small tributary that runs northwest and joins Mill Creek nears Stearns School Road and Mill Creek Drive in Gurnee. Reaches MC-39-MC-50 refer to Mill Creek which flows from Fourth Lake east through Grandwood Park Lake, then flows northeast where it joins Lambs Creek Corner and then flows northwest towards the mouth of North Mill Creek. Reaches MC-68-MC-81, and MC-86 refers to the Avon-Fremont Drainage Ditch and in general flows north from the southernmost portion of the watershed north of West Peterson Road and west of Route 83 where it enters Third Lake.

During the Mill Creek stream inventory in the summer of 2013, SMC personnel assessed each reach for the following characteristics:

1. In-stream and over-bank debris loads
2. Substrate
3. Channelization and sinuosity (none, low, moderate, or high)
4. Bank erosion (9-10=none, 6-8=low, 3-5=moderate, 0-2=high)
5. Channel dimensions, including bank height and channel width

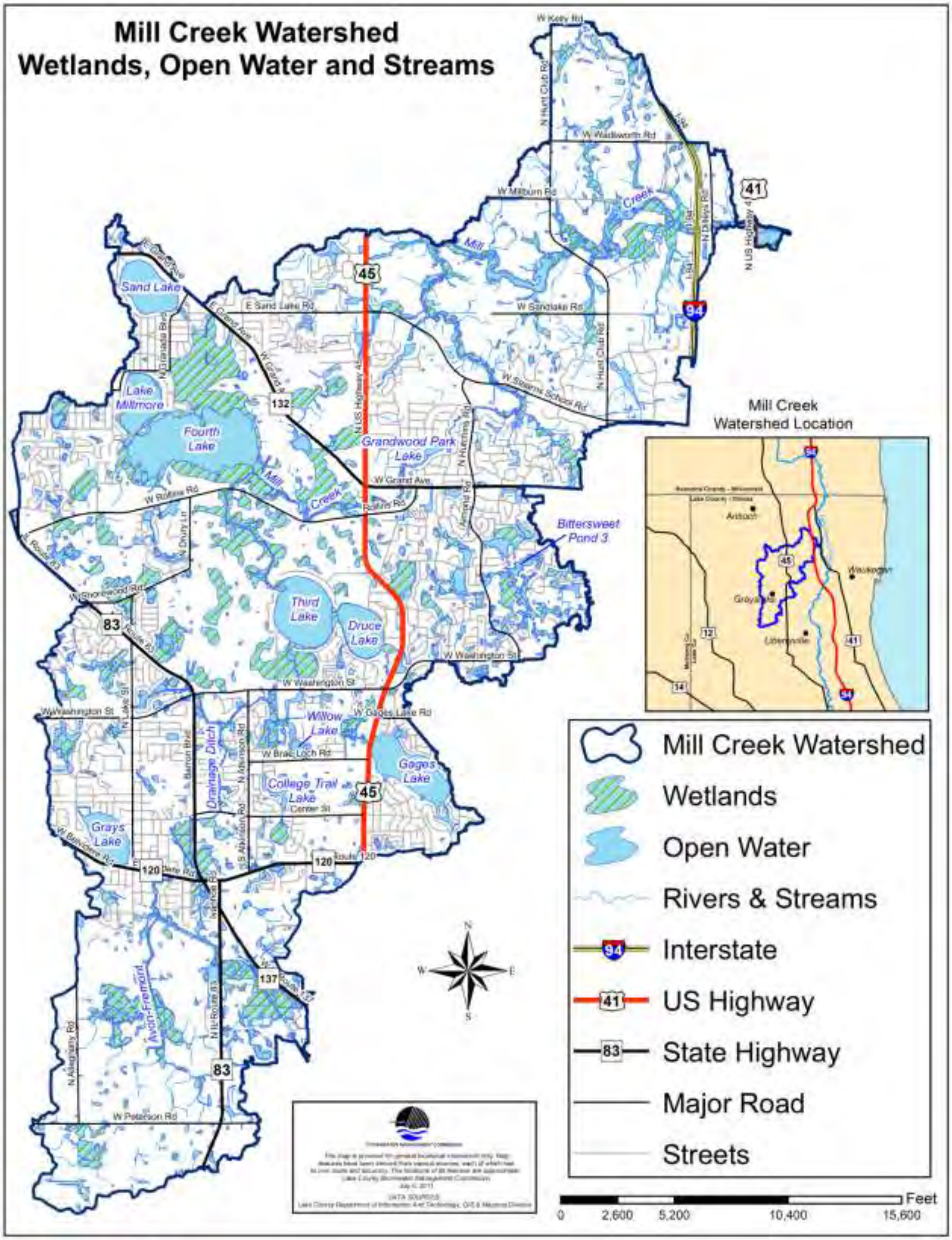
A summary of this data is listed in table A-1 below.

APPENDIX A

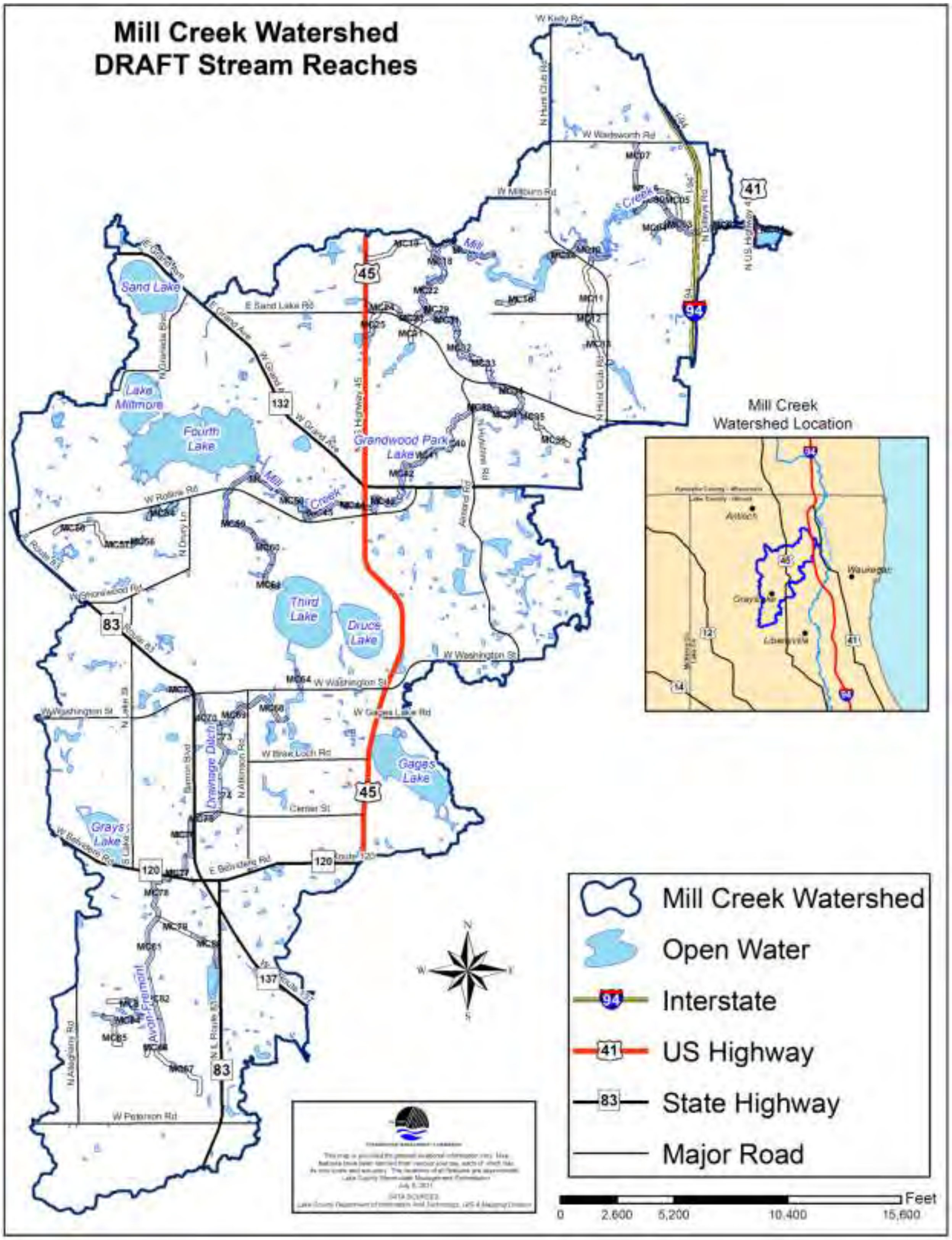
TABLE A-1: SUMMARY OF MILL CREEK STREAM REACH CHARACTERISTICS

BOUNDARY		CHANNEL CONDITIONS																CHANNEL DIMENSIONS									
		DEBRIS		SUBSTRATE COMPOSITION %									CHANNELIZATION	SINUOSITY		EROSION		TOTAL				MEAN				LENGTH	
Reach	Region	In-Stream	Over-Bank	CLAYPAN	SILT	SAND	GRAVEL	COBBLE	BOULDER	CONCRETE	OM	TOTAL		BANKFULL	BASEFLOW	L. BANK	R. BANK	DEPTH	BASE WIDTH	TOP WIDTH	BANK HT.	DEPTH	BASE WIDTH	TOP WIDTH	BANK HT.	FT.	MI
MC1	**MILL**	-	-		10	25	40	15	10			**100**	MOD	LOW	LOW	MOD	MOD	-	-	-	-	-	-	-	-	1,717.8	0.3
MC18	**MILL**	MOD	HIGH		15	40	5	10			30	**100**	NONE	HIGH	HIGH	SEV	MOD	8.4	32.5	180.5	13.5	2.8	16.3	60.2	2.3	2,493.3	0.5
MC22	**MILL**	HIGH	HIGH		15	50	10	10			15	**100**	NONE	HIGH	HIGH	SEV	MOD	7.0	19.0	119.0	9.5	3.5	19.0	59.5	2.4	2,557.6	0.5
MC31	**MILL**	HIGH	MOD	3	2	15	20	30	20		10	**100**	NONE	HIGH	HIGH	SEV	SEV	3.4	56.0	64.0	7.6	1.1	18.7	21.3	1.3	2,642.3	0.5
MC33	**MILL**	HIGH	HIGH		10	20	40	20	10			**100**	NONE	MOD	MOD	MOD	MOD	3.3	39.5	45.5	21.2	1.7	19.8	22.8	5.3	2,019.6	0.4
MC34	**MILL**	LOW	LOW		10	20	30	20	10		10	**100**	NONE	HIGH	HIGH	SEV	SEV	2.0	42.4	76.0	7.2	0.7	14.1	25.3	1.2	2,555.7	0.5
MC35	**LCC**	HIGH	HIGH		20	30	15	5			30	**100**	NONE	LOW	LOW	MOD	MOD	0.5	10.8	14.0	1.8	0.5	10.8	14.0	0.9	1,518.7	0.3
MC36	**LCC**	LOW	LOW	2	10	30	40	10	8			**100**	LOW	LOW	LOW	MOD	MOD	1.2	7.4	7.4	2.1	0.6	3.7	3.7	0.5	1,715.0	0.3
MC39	**MILL**	HIGH	HIGH		15	30	40	3	2		10	**100**	NONE	HIGH	HIGH	SEV	SEV	2.6	26.1	41.2	10.5	1.3	13.1	20.6	2.6	1,980.8	0.4
MC40	**MILL**	HIGH	HIGH			20	50	5	5	10	10	**100**	MOD	LOW	LOW	SEV	SEV	1.5	26.6	93.7	17.5	0.7	13.3	46.9	4.4	3,097.1	0.6
MC41	**MILL**	LOW	LOW		20	50	20				10	**100**	N/A	NONE	NONE	NA	NA	3.4	25.5	57.4	3.5	3.4	25.5	57.4	1.8	1,934.5	0.4
MC42	**MILL**	HIGH	HIGH		25	50	15				10	**100**	NONE	HIGH	HIGH	SEV	MOD	6.0	72.0	146.1	12.3	2.0	24.0	48.7	2.1	1,881.1	0.4
MC43	**MILL**	HIGH	HIGH			30	40	6	2	2	20	**100**	LOW	HIGH	HIGH	SEV	SEV	1.7	20.9	41.4	6.1	0.9	10.5	20.7	1.5	3,536.3	0.7
MC44	**MILL**	HIGH	HIGH		35	40	5	5			15	**100**	MOD	NONE	LOW	MOD	MOD	3.4	33.5	40.0	8.0	1.7	16.8	20.0	2.0	1,126.9	0.2
MC45	**MILL**	HIGH	HIGH		20	30	35	5			10	**100**	MOD	MOD	MOD	SEV	SEV	6.7	53.5	56.3	12.5	2.2	17.8	18.8	2.1	2,094.3	0.4
MC68	**AFDD**	LOW	LOW		25	50	10				15	**100**	HIGH	MOD	MOD	MOD	MOD	6.8	64.5	80.5	13.5	2.3	21.5	26.8	2.3	2,660.8	0.5
MC69	**AFDD**	LOW	LOW		15	40	20	5			20	**100**	HIGH	LOW	LOW	SEV	SEV	5.0	61.5	88.5	9.4	1.7	20.5	29.5	1.6	1,662.4	0.3
MC70	**AFDD**	MOD	MOD		10	35	35				20	**100**	HIGH	MOD	MOD	MOD	MOD	8.3	49.5	85.5	18.0	2.8	16.5	28.5	3.0	2,201.9	0.4
MC71	**AFDD**	LOW	LOW		30	30	15	5			20	**100**	HIGH	LOW	LOW	MOD	MOD	2.1	57.5	79.0	22.0	0.7	19.2	26.3	3.7	1,348.3	0.3
MC73	**AFDD**	MOD	MOD		30	40	10				20	**100**	HIGH	LOW	LOW	SEV	SEV	3.0	39.5	70.5	26.0	1.5	19.8	35.3	6.5	2,684.8	0.5
MC74	**AFDD**	LOW	LOW	5	15	20	50				10	**100**	HIGH	NONE	NONE	MOD	MOD	2.5	47.3	118.5	44.5	0.8	15.8	39.5	7.4	1,512.6	0.3
MC75	**AFDD**	LOW	LOW		20	30	10				40	**100**	HIGH	LOW	LOW	SEV	SEV	1.7	31.3	88.1	38.5	0.9	15.7	44.1	9.6	1,988.6	0.4
MC76	**AFDD**	LOW	MOD		20	30	35	5			10	**100**	HIGH	NONE	NONE	MOD	MOD	4.6	63.0	80.0	20.5	1.5	21.0	26.7	3.4	2,129.5	0.4
MC77	**AFDD**	LOW	LOW		10	20	40	10	5		15	**100**	HIGH	LOW	LOW	SLIGHT	SLIGHT	2.9	32.0	83.0	29.4	1.0	10.7	27.7	4.9	1,571.2	0.3
MC78	**AFDD**	HIGH	HIGH		15	25	40	8	2		10	**100**	MOD	MOD	MOD	SEV	SEV	1.8	30.2	153.3	43.5	0.6	10.1	51.1	7.3	2,667.8	0.5
MC79	**AFDD**	HIGH	HIGH		10	35	30	10			15	**100**	HIGH	NONE	NONE	SLIGHT	SLIGHT	0.6	5.4	70.3	5.0	0.3	2.7	35.2	1.3	1,657.0	0.3
MC80	**AFDD**	HIGH	HIGH		35	40	5				20	**100**	HIGH	LOW	LOW	MOD	MOD	9.4	53.0	128.0	6.0	3.1	17.7	42.7	1.0	2,190.4	0.4
MC81	**AFDD**	LOW	LOW		10	30	30	10			20	**100**	HIGH	LOW	LOW	MOD	MOD	2.6	31.6	125.0	11.0	0.9	10.5	41.7	1.8	3,199.6	0.6

APPENDIX B
MILL CREEK WATERSHED MAPS

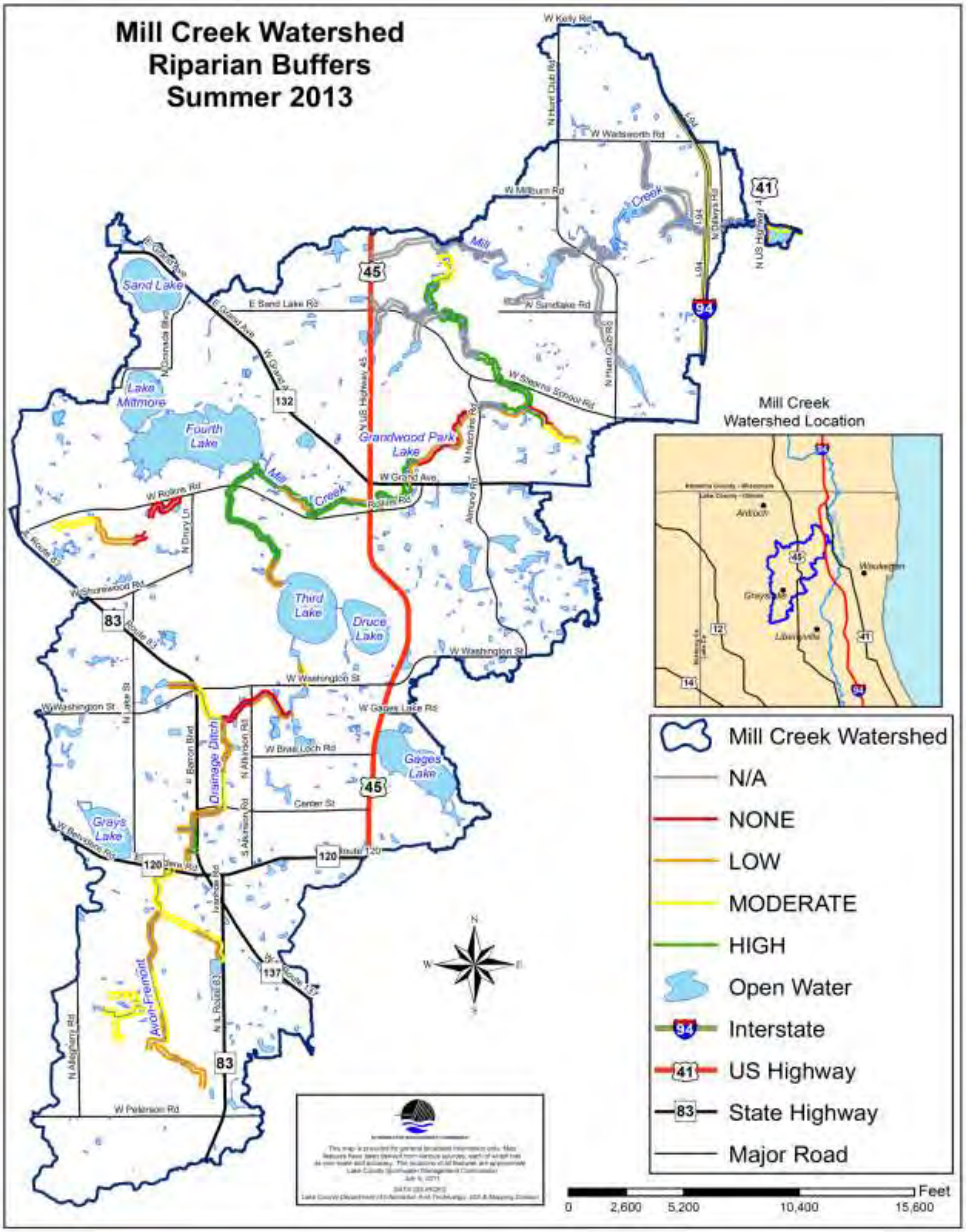


Provided by Lake County Stormwater Management Commission

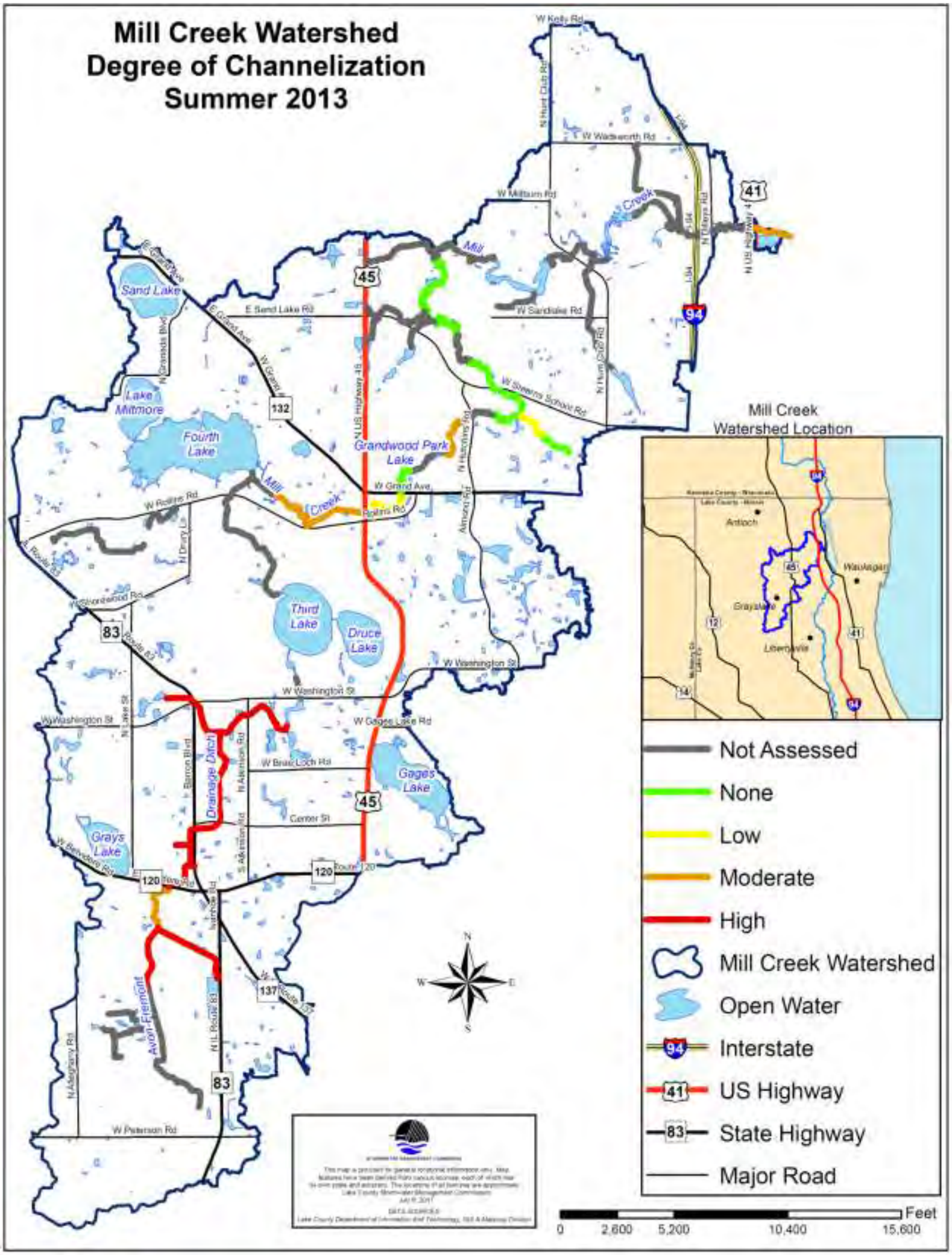


Provided by Lake County Stormwater Management Commission

APPENDIX B
MILL CREEK WATERSHED MAPS



Provided by Lake County Stormwater Management Commission



Provided by Lake County Stormwater Management Commission

APPENDIX C
MILL CREEK WATERSHED
TABLE C-1: SUMMARY OF HYDRAULIC STRUCTURES

APPENDIX D
2013 MILL CREEK WATERSHED
STREAM INVENTORY PROCEDURE AND METHODOLOGY

D.1 STREAM INVENTORY PROCEDURE

During the summer 2013, the Lake County Stormwater Management Commission conducted a stream inventory of channels in the Mill Creek Watershed. Water quality sampling was not performed as part of the stream inventory, but the sources and causes of water quality impairment in the streams were investigated. An important component of the assessment process is the evaluation of current hydraulic, geomorphic, and aquatic stream characteristics. The major stream characteristics that were assessed and noted include:

- Channel conditions such as bank height, erosion problems and bank vegetation
- Hydraulic structures such as bridges and culverts in the river or floodplain
- Point discharges into the river
- Land use and vegetative cover in the riparian corridor
- Channel substrate and degree of sedimentation.

These characteristics were identified for each stream reach using the stream inventory procedure described below. Several procedures were considered self-explanatory and were therefore not described. The discussion below is organized in the same order as the data was collected on the stream inventory report form (SIRF).

D.1.1 STREAM INVENTORY REPORT FORM

D.1.1.1 REACH BOUNDARIES

A stream reach is defined as a stream segment having fairly homogenous hydraulic, geomorphic and riparian cover and land use characteristics (such as all ditched agriculture or all natural and wooded). Reaches generally should not exceed 2,000 feet in length. Where possible, beginning and end stations should be established along the stream using permanent physical landmarks such as bridges that are readily recognized.

D.1.1.2 CHANNEL FLOW STATUS (STREAM STAGE)

Stream stage is the degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited. In high-gradient streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat. Channel flow is especially useful for interpreting biological condition under abnormal or lowered flow conditions. This parameter becomes important when more than one biological index period is used for surveys or the timing of sampling is inconsistent among *sites or annual periodicity*.

D.1.2 CHANNEL CONDITIONS (SIRF SECTION A)

D.1.2.1 CHANNELIZATION

Channelization refers to channel modifications performed by humans. ‘The one-third rule should be applied again where low means < 33% of the reach is channelized, moderate means 33 to 66% and high means > 66% of the reach is channelized. The presence of a pilot channel should be noted under ‘Pilot Channel Formed’ for channelized streams. A narrow, meandering pilot channel may develop within the wide and flat trapezoidal ditch that was excavated during channelization. A pilot channel is indicative of recovery from channelization.

D.1.2.2 SINUOSITY

Sinuosity is dependent on the stream stage in many channelized reaches. For instance, in many cases a narrow, highly sinuous pilot channel has developed during low stream stage within a wider, non-sinuous channel that was excavated during channelization. Therefore, sinuosity should be estimated for both baseflow conditions (describing sinuosity in the pilot channel) and for the bankfull-flow events. However, if the stream inventory report form is completed during bankfull flow, then sinuosity during baseflow conditions will be difficult to estimate. Figure D-1 should be used for estimating the degree of sinuosity.

FIGURE D-1: SINUOSITY ESTIMATION GUIDE

D.1.2.3 POOL/RIFFLE DEVELOPMENT

The proportion represented by riffles, runs, and pools should be noted to describe the morphological heterogeneity of the reach. Pools should be well-defined areas of deeper than average water. Pools generally do not extend in length more than three or four times the stream width. Pools should almost immediately be followed by a riffle environment for the stream to be characterized as having high pool/riffle development. A riffle is characterized by shallower water and higher velocities with rippling or disturbances to the surface water tension that allows turbulence and mixing to occur. Many streams in Lake County will have low or no pool/riffle development.

D.1.2.4 BANK EROSION

Severe bank erosion is a significant concern for Lake County's stream and rivers. Severely eroded banks have exposed soil on nearly vertical banks extending from the top of bank to the low water mark so erosion is constantly occurring. Highly eroded streambanks contribute heavy loads of sediment and erode during times of higher flows. Active slumping and sloughing may be apparent where fresh, moist, loose soil and other signs of recent bank movement such as exposed tree roots or suspended fences extending into the stream are found. Eroded areas are most prevalent in the outer edges of bends and meanders. All cases of severe erosion should be photographed and noted on the form and the map or aerial photo. If the photo is taken looking up/down stream the aspect should be noted. Structures that are present and threatened by slumping should also be recorded. Right and left bank are determined by facing upstream.

On impounded areas of streams, the absence of bank or littoral vegetation along the normal water mark resulting in constant erosion would also be considered severe.

D.1.2.5 ARMORING

Armoring refers to the placement of gabions, wood, metal, riprap or other similar artificial materials along the streambank to reduce bank erosion. The one-third rule should be applied again where low means < 33% of the reach is armored, moderate means 33 to 66% and high means > 66% of the reach is armored. Portions of armoring that are failing should be noted.

D.1.2.6 SEDIMENT ACCUMULATIONS

Sediment accumulations that affect the channel capacity and flow conveyance should be described. Sediment deposition measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. In some cases, sediment accumulations may not impact channel conveyance.

D.1.2.7 MID-STREAM BARS AND ISLANDS

Record whether exposed mid-stream bars or islands are present. Although these structures may increase habitat availability for organisms, they also reduce the unobstructed stream width and may enhance the debris-accumulating potential of the stream reach.

D.1.2.8 MEAN WATER DEPTH

Water depth should be measured at the deepest portion of the channel cross section (known as the thalweg) with a sturdy 4- to 5-foot rod inscribed with depth marks in inches. The range of water depths should reflect the variation between the deepest and shallowest portions of the channel cross-section in the reach.

D.1.2.9 MEAN BANK HEIGHT AND MEAN CHANNEL WIDTH (TOP AND BOTTOM)

Mean bank height should be measured from the top to the bottom of the streambank. The top of the bank occurs where there is a convex-shaped transition in bank slope between the stream bank and the outlying floodplain. The bottom of the bank occurs where there is a concave-shaped transition in slope between the stream substrate and the stream banks, and it may be below the water level.

Top and bottom mean bank widths refer to the mean bank-to-bank width across the top and across the bottom of the banks. If the top of one bank is higher in elevation than the top of the opposite bank, the top mean channel width should be measured from the elevation of the lowest bank. In estimating these and other values, the investigator should be conscious of longitudinal changes in bank dimensions in order to arrive at estimated values.

D.1.2.10 BEAVER ACTIVITY

Low beaver activity includes an occasional bank slide or chewed stump within the reach. These features must become progressively more apparent to rate as moderate activity. High activity is characterized by almost constant activity in the wooded areas with felled trees in excess of 12 inches; slides and beaver cut brush being common in the stream. All dams and lodges should be noted and indicate high beaver activity.

D.1.2.11 STREAM DEBRIS LOAD

1. ***INSTREAM DEBRIS LOAD:***

   Stream debris load refers to natural and man-made debris including leaves, sticks, logs, lumber, trash and sediment. The one-third rule should be applied again where low means < 33% of the reach contains debris obstructing or deflecting flow, moderate means 33 to 66% and high means > 66% of the reach is characterized by large accumulations of lodged and partially compacted debris spanning the entire stream width.

2. ***OVERBANK DEBRIS LOAD:***

The overbank debris load refers to loosened, floatable materials that are prevalent enough to potentially cause debris jams at culverts and bridges during high flows events. The locations and types of debris as well as how it may impact the reach should be noted. Similarly to the instream debris load section, the one-third rule should be applied.

D.1.3 HYDRAULIC STRUCTURES (SIRF SECTION B)

Hydraulic structures include low head dams, weirs, bridges, levees, and culverts. Dimensions as well as construction materials should be measured and recorded. Structures should be photographed and their locations should be recorded by taking a GPS waypoint. Elevations will be determined from existing data or field survey dependent upon the approved scope of work. Notes should include condition, drop or change in elevation, blockages and other characteristics.

D.1.4 POINT DISCHARGES (SIRF SECTION C)

Point discharges include all sanitary, storm sewer and agricultural drainpipes greater than 4 inches in diameter. They also include open channels, swales, gullies and other significant tributaries. Locations of all point discharges should be recorded by taking a GPS waypoint. Check the problem column (see SIRF) if the condition of the discharge point is blocked, cracked, etc. The volume of flow should be noted in the appropriate column using the following categories: none, trickle, moderate, substantial, other. Notes should include comments on odors, sheens or high turbidity if present.

D.1.5 VEGETATION AND LAND USE (SIRF SECTION D)

D.1.5.1 FLOODPLAIN VEGETATION (WITHIN 100 FT. OF STREAM)

For the respective banks the land use and vegetative cover should be noted as percentages of the floodplain surface area (note: percentages should total 100%). The vegetated buffer is given a score from 0-10 (see SIRF for specific criteria).

D.1.5.2 PREDOMINANT BANK VEGETATION (%) AND PREDOMINANT TREE/SHRUB SPECIES

These measurements provide an indication of bank stability and the potential for the development of debris blockages in the channel. For the respective banks the predominant vegetation type should be noted as percentages of the bank surface area (note: percentages should total 100%). Due to the rapid colonization capabilities of some tree and shrub species, the presence or absence of tree and shrub types should be documented even if trees or shrubs were uncommon in the stream reach. Also, where possible, tree and shrub species included in the ‘Other’ category should be identified. Canopy cover should be estimated as a percentage of shaded coverage of the channel.

D.1.5.3 AQUATIC VEGETATION

The general type and relative dominance of aquatic plants are documented in this section. Besides being an ecological assemblage that responds to perturbation, aquatic vegetation provides a refuge and food for aquatic fauna. Filamentous algae can grow in fast or slow flowing streams over solid surfaces within the stream channel. Extensive filamentous algae coverage is indicative of excessive nutrient levels. Submergent, emergent, free floating rooted floating or no vegetation should also be considered when estimating percentage of aquatic vegetation over the total area of the reach.

D.1.6 Substrate and Water Quality (SIRF Section E)

D.1.6.1 Substrates

The substrate in the stream channel should be classified using the following definitions:

1. *Claypan (Hardpan)*
   Claypan is made up of particles less than 0.0002 inches in diameter, which forms a dense, gummy surface that is difficult to penetrate.
2. *Silt*
   Silt particles are between 0.0002 to 0.002 inches in diameter. Silt is a fine material that generally feels "greasy" when rubbed between fingers.
3. *Sand*
   Sand is made up of materials from 0.002 to 0.08 inches in diameter. Sand exhibits a gritty texture when rubbed between fingers.
4. *Gravel*
   Gravel is a mixture of rounded coarse material from 0.08 to 2.5 inches in size.
5. *Cobble*
   Cobble is made up of stones from 2.5 to 10 inches in diameter.
6. *Boulder*
   Boulders are defined as rounded stones over 10 inches in diameter or large "slabs" over 10 inches in length.
7. *Organic*
   Organic substrate refers to living or decaying plant material.
8. *Concrete*
   Channels lined with concrete or other man-made materials should be noted.

D.1.6.2 Substrate Stability

Substrate stability will be assessed according to how well the stream substrate supports the weight of the observer walking within the stream. Assessing substrate stability requires that the observers walk through representative lengths of the stream channel in the reach. To help ensure the safety of the observers, waders should be worn at all times to prevent cuts and infections, and at least two observers should walk each reach together. Stream channels should not be walked if the safety of the recorder is in jeopardy at any time because of strong current, deep-water sections, soft substrate, or any other potential danger. Substrate stability classified as ‘None’ indicates that the substrate can't support the observer's weight and the observer quickly sinks into the substrate. These substrate types are usually deep silts that for obvious safety reasons must not be walked in. ‘Low’ substrate stability can be walked over, but the observer will sink several inches into the substrate if he stands for an extended time period. These substrates may include silts and loose sand or gravel. ‘Moderate’ substrate stability would describe substrate that can be walked over without sinking more than an inch or two into the substrate and may include coarse gravel, cobble, perhaps mixed with some boulders. ‘High’ substrate stability can be readily walked on without sinking into the substrate. ‘High’ substrate stability often occurs when cobble, boulders, shale or claypan covers the stream bottom.

D.1.6.3 Substrate Embeddedness

Substrates should be considered embedded if more than 50% of the surface of the substrates are surrounded, impacted in or covered by unnatural accumulations of fine material such as sand or silt. Embedded substrates can't be easily dislodged. Naturally silty or sandy streams are not considered embedded; however, if sedimentation has buried the natural coarse substrates with sand or silt then the stream reach should be considered embedded. The degree of embeddedness can often be determined by jabbing a sturdy rod into the stream bottom to determine whether the underlying stream substrate is coarse material, or sand and silt. Embeddedness is the extent to which cobbles, gravel, and boulder substrates are embedded.

High embeddedness would occur if over 66% of the site area was embedded (as defined above), moderate embeddedness would occur if from 33 to 66% of the site area was embedded and low means less than 33% of the area was embedded. 'N/A' ratings should be applied to stream channels that are naturally composed of silt and sand, because in such channels embeddedness of coarse substrates is 'not applicable.'

D.1.7 Instream Cover (SIRF Section F)

All types of cover present should be noted. Cover should not be counted when it is in areas of the stream with insufficient depth. General comments on perceived abundance of various cover types should be reported.

D.1.8 Aquatic and Terrestrial Organisms (SIRF Section G)

Some measurements for the Aquatic and Terrestrial Organisms section (SIRF Section G) require that riffles be distinguished from runs and pools. Pools and riffles were defined in section D.1.2.3. Runs are deeper than riffles, have relatively rapid, non-turbulent flow and are generally located downstream from riffles where the stream narrows. The streambed is often flat beneath a run and therefore the water surface is not visibly broken.

Biological information (versus chemical or physical information) is widely regarded as the most reliable type of data collection for evaluating the ecological conditions of stream reaches. For a very basic yet somewhat informative assessment of ecological conditions, the following procedures should be followed. For fish and macroinvertebrate sampling, the sample locations, the type of gear used for the sample collection and the approximate sample effort (in minutes or feet of stream reach) should be noted. Although SMC did not sample for fish, macroinvertebrates or birds in Mill Creek, their presence was noted when they were encountered in a stream reach.

D.1.8.1 Macroinvertebrates

If sufficient flow exists, macroinvertebrates should be sampled by kick net (approximately 3' x 3' screens) in riffle areas at least once per reach. The observer should stand upstream of the kick net and use one or both feet to disrupt the substrate and dislodge macroinvertebrates from the substrate so that they drift downstream into the kick net screen. If sufficient flow does not exist for the effective use of kick nets, macroinvertebrates should be handpicked from rocks in riffle areas. The presence should be noted of major groups of macroinvertebrates such as stonefly, mayfly and caddisfly larvae, snails, water pennies, riffle beetles, damselfly and dragonfly nymphs, isopods and sowbugs, leeches, and worms. If riffle areas and rocks do not exist such as in recently channelized streams, impounded streams, or under low-flow conditions, then macroinvertebrates should be sampled from vegetation, debris or other instream material.

D.1.8.2 Fish

Fish sampling should be performed with a seine (or ideally, electroshocking equipment) at three or more stream locations. The types and relative abundances (percent composition of the catch by species) should be noted for each fish species captured. However, high flow may in some circumstances not permit safe and effective seining. In such instances, visual observations of types of fish present should be made where water clarity permits. Based on past experience, some species or groups that can be tentatively identified by visual observation alone without sampling gear include carp, goldfish, minnows, pan fish and bass. In all biological evaluations, presence of rare or threatened and endangered animal and plant species is of great interest.

D.1.8.3 BIRDS

During the field investigation, types and numbers of birds that utilize streams and adjacent aquatic habitat should also be noted. Such birds that are common to Lake County include ducks, geese, herons, kingfishers, sandpipers, plovers, gulls, terns, swifts and some swallows.

Note: Any reptiles, amphibians or mammals observed should be noted as specific as possible.

D.1.9 ADDITIONAL COMMENTS

Additional notes or comments should include any irregularities such as cars in the stream, floodplain construction activity, and presence of livestock in the stream, foul smelling discharges, errors in existing mapping or other peculiarities. Opportunities and obstacles to access should also be noted on each form.

D.1.9.1 SUGGESTED EQUIPMENT LIST

- waders (2 pairs)
- digital camera, waterproof recommended
- GPS unit
- polarized sunglasses
- 100+ foot tape measure
- 4-foot wood rod with depth marks or metal yard stick
- watch with second hand
- sampling gear

D.1.9.2 ACCESS

Approval for access on private property is important. As many streams and channels are located on private property within the watershed, SMC worked with landowners to obtain permission to gain access to these streams in order to complete the assessment. Additionally, SMC staff prepared permission letters for presentation to members of the public encountered during the stream inventory as well as announcements of stream inventory activities to the community and local stakeholders in advance of the stream inventory. The sample permission letter /announcement used regarding the stream inventory is shown in Figure D-2.

FIGURE D-2 SAMPLE ACCESS PERMISSION LETTER

LAKE COUNTY
STORMWATER MANAGEMENT COMMISSION

February 13, 2014

To Whom It May Concern:

The Lake County Stormwater Management Commission (SMC) is working with local stakeholders in the Mill Creek and Buffalo Creek watersheds. As part of this process, we will be performing stream assessments of North Mill Creek, Buffalo Creek and its tributaries. This assessment will examine things such as channel conditions; outfalls; substrate conditions and water quality; as well as instream cover and channel shading. Two Watershed Interns from SMC, Sharon Osterby and Amanda McMullen, will perform the stream assessments. The above individuals are authorized by the SMC to gain reasonable access within the Mill Creek and Buffalo Creek watersheds to perform the stream assessments.

The information collected in the field assessments will be used in the development of a watershed plan for Mill Creek. This plan will address flooding problems and natural resource protection along with other problems and opportunities. The anticipated completion date of the field assessments is fall 2013.

If you would like additional information on the stream assessment, please contact Andrea Cline, Watershed Planner at SMC by phone (847-377-7710) or email (acline@lakecountyil.gov). Thank you for your cooperation.

Sincerely,

Andrea Cline
Watershed Planner

APPENDIX E
2013 MILL CREEK WATERSHED
STREAM INVENTORY REPORT FORM

STREAM NAME:______________________________________REACH ID:______________ DATE:__________

REACH BOUNDARY- DOWNSTREAM:_____________________________________ GPS Photo. #__________

REACH BOUNDARY-UPSTREAM:____ GPS Photo #__________

APPROX. LENGTH (ft):________________ TEMP. (°F)____________________ TIME:_____________________

INVESTIGATORS:________________ RECENT RAIN: (Now, 12, 24, 48 hours, week)__________________

GAGE READING:____________

A. CHANNEL CONDITIONS (LOOKING UP-STREAM)

WATER DEPTH	DEPTH (FT)	GPS PHOTO#	AVERAGE	RANGE
1				
2				
3				
MEAN WATER DEPTH				
BOTTOM CHANNEL WIDTH (FT)	WIDTH (FT)	GPS PHOTO#	AVERAGE	RANGE
1				
2				
3				
MEAN BOTTOM CHANNEL WIDTH (FT)				
TOP CHANNEL WIDTH (FT)	WIDTH (FT)	GPS #	AVERAGE	RANGE
1				
2				
3				
MEAN TOP CHANNEL WIDTH (FT)	WIDTH (FT)	GPS #	AVERAGE	RANGE
BANK HEIGHT	HEIGHT (FT)	WIDTH	SLOPE RUN/RISE	PHOTO #
1 LEFT				
1 RIGHT				
2 LEFT				
2 RIGHT				
3 LEFT				
3 RIGHT				
MEAN BANK LEFT				
MEAN BANK RIGHT				
VELOCITY (FT/S)				
1				
2				
3				
MEAN VELOCITY (FT/S)				

CHANNEL FLOW (STREAM STAGE):

NONE	LOW	MODERATE	NORMAL	HIGH
Very little water in channel and mostly present as standing pools	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed	Water fills > 75% of the available channel; or <25% of channel substrate is exposed	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed	Water levels are higher than the base of both banks
0 1	2 3 4	5 6	7 8	9 10

CHANNELIZATION: NONE_____ LOW____ MODERATE____ HIGH_______

PILOT CHANNEL FORMED (YES / NO)

SPOILS PILES ON BANKS (Left / Right / Both)

BANKFULL SINUOSITY: NONE____ LOW____ MODERATE____ HIGH____

BASEFLOW SINUOSITY: NONE____ LOW____ MODERATE____ HIGH____

POOL/RIFFLE DEVELOPMENT: % POOL ____ % RIFFLE ____ % RUN ____

DEGREE OF BANK EROSION (Overall):

	NONE		MODERATE			*SEVERE			*VERY SEVERE		
Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems; less than 5% of bank affected.			Moderately stable; infrequent, small areas of erosion mostly healed over; 5-33% bank has areas of erosion.			Moderately unstable; 33-66% of bank has areas of erosion; high erosion potential during floods.			Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 66-100% of bank with erosional scars.		
Left Bank	10	9	8	7	6	5	4	3	2	1	0
Right Bank	10	9	8	7	6	5	4	3	2	1	0

***Photos of Moderate to Very Severe Erosion will be taken**

DEGREE OF ARMORING: NONE____ LOW____ MODERATE____ HIGH____

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #_____________________

SEDIMENT ACCUMULATIONS:

NONE	LOW	MODERATE	HIGH
Little or no enlargement of islands or point bars and less than 20% of the bottom affected by sediment depositions	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 20-50% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected, sediment deposits at obstructions, constrictions and bends; moderate deposition of pools prevalent	Heavy deposits of fine material, increase bar development; more than 80% bottom changing frequently, pools almost absent due to substantial sediment deposition
10 9	8 7 6	5 4 3	2 1 0

TYPES OF HIGH CASES: ____________________________GPS PHOTO #____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #____________________

TYPES OF HIGH CASES: ____________________________GPS PHOTO #____________________

MID-STREAM BARS AND ISLANDS: YES:__________NO:_________

GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #_________
GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #_________
GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #_________
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GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #_________
GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #________ GPS PHOTO #_________

BEAVER ACTIVITY: NONE_____ LOW_____ MODERATE_____ HIGH______

DAM/LODGE: YES (NUMBER OF DAMS)__________ NO_________

STREAM DEBRIS LOAD (as defined in methodology):

INSTREAM: LOW _____ MODERATE _____ HIGH _____

OVERBANK: LOW _____ MODERATE _____ HIGH _____

NOTES:____

F. DEBRIS JAM: PHOTO #:______ LENGTH:______ WIDTH:______ HEIGHT:______
PHOTO #:______ LENGTH:______ WIDTH:______ HEIGHT:______
PHOTO #:______ LENGTH:______ WIDTH:______ HEIGHT:______
PHOTO #:______ LENGTH:______ WIDTH:______ HEIGHT:______
PHOTO #:______ LENGTH:______ WIDTH:______ HEIGHT:______
PHOTO #:______ LENGTH:______ WIDTH:______ HEIGHT:______

IMPOUNDED: YES:__________ NO:_________

SOURCE:____

BANK EROSION

LATERAL RECESSION CRITERIA

LRR (ft./yr.)	Category	Description
0.01 - 0.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang. No exposed tree roots.
0.06 - 0.2	Moderate	Bank is predominantly bare with some rills and vegetative overhang.
0.3 - 0.5	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees, drains and culverts eroding out and changes in cultural features as above. Massive slips or washouts common. Channel cross-section is U-shaped and stream course or gully may be meandering.

**Photos of Moderate to Very Severe will be taken*

LATERAL RECESSION CRITERIA-LOG

PHOTO #	L=left R=Right C=Center Looking Upstream	Aspect U=Up D=Down	Bank Height (ft.)	LRR Category Slight, Moderate, Severe, VerySev., ExtremelySev.	LRR (ft/yr)	LRR Characteristics (circle those that apply)	Notes (Use "many"or "some" where appropriate)
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	

APPENDIX E
2013 MILL CREEK WATERSHED
STREAM INVENTORY REPORT FORM

PHOTO #	L=left R=Right C=Center Looking Upstream	Aspect U=Up D=Down	Bank Height (ft.)	LRR Category Slight, Moderate, Severe, VerySev., ExtremelySev.	LRR (ft/yr)	LRR Characteristics (circle those that apply)	Notes (Use "many"or "some" where appropriate)
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	
	L C R	U D		SL Mod Sev VerySev ExtSev		undercutting-bare bank overhanging veg.-fallen trees exposed roots-(fine or woody) rotational slips or slides	

B. HYDRAULIC STRUCTURES:
(Note sizes & locations in channel or adjacent floodplain.)

TYPE & MATERIAL	DIMENSIONS L/W (INCHES)	L/R or Center of Channel Looking upstream	P	PHOTO #	NOTES:

New, Good, Fair, Needs repair or maintenance, Failure, Maintenance required

C. DISCHARGE POINTS:

(Pipes, ditches, swales, tributaries; note numbers, sizes and locations of discharges with diameters of 4 inches or more.)

TYPE & MATERIAL	DIMEN-SIONS (inches)	PHOTO #	L/R or Center of Channel	P	FLOW	NOTES

NOTES (ex: suspicious effluent etc.):____

P=Problem (check for yes)
None, trickle, moderate, substantial, other

D. FLOODPLAIN VEGETATION (within 100 ft of stream)

DOMINANT LAND USE (%):

LEFT: AGRICULTURAL:______ OPEN SPACE:______ RECREATIONAL: ______
COMMERCIAL/INDUSTRIAL:______RESIDENTIAL:______ OTHER:______

RIGHT: AGRICULTURAL:______ OPEN SPACE:______ RECREATIONAL:______
COMMERCIAL/INDUSTRIAL:_____ RESIDENTIAL:______OTHER:______

LAND COVER (%):

LEFT: TREES: ______ LAWN:______ WETLANDS:______ CROPS:______ SHRUBS:______
HERBACEOUS: ______ IMPERVIOUS:______ WATER:______OTHER: ______

RIGHT: TREES:______ LAWN:______ WETLANDS:______ CROPS:______ SHRUBS:______
HERBACEOUS:______ IMPERVIOUS:______ WATER:______OTHER:______

WIDTH OF VEGETATED BUFFER:

NONE			LOW			MODERATE			HIGH	
Width of riparian zone <20 feet; little or no riparian vegetation due to human activities			Width of riparian zone 20-40 feet; human activities have impacted zone a great deal			Width of riparian zone 40-60 feet; human activities impacted zone minimally			Width of riparian zone >60 feet; human activities (parking lots, roadbeds, lawns, crops) have not impacted zone	
Left Bank 0	1	2	3	4	5	6	7	8	9	10
Right Bank 0	1	2	3	4	5	6	7	8	9	10

Notes____

BANK VEGETATION (within 10 ft of stream):

PREDOMINANT VEGETATION (%)

LEFT BANK: UNMOWED GRASS:___ LAWN:___ WETLAND:___ TREES:___ SHRUB:___

CROP:___ HERBACEOUS: ___ NONE:___ OTHER:_____

RIGHT BANK: UNMOWED GRASS:___ LAWN:___ WETLAND:___ TREES:___ SHRUB:___

CROP:___ HERBACEOUS: ___ NONE:___ OTHER:_____

PREDOMINANT TREE/SHRUB SPECIES ON BANKS (CHECK ALL PRESENT)

WILLOWS________ BOX ELDER________ HONEYSUCKLE________
BUCKTHORN________ HARDWOODS________ OTHER________________________

CANOPY (PERCENT SHADED COVERAGE OF CHANNEL):______

AQUATIC/INSTREAM VEGETATION

VEGETATION (%): ROOTED EMERGENT:______ ROOTED SUBMERGENT:______
ROOTED FLOATING:______ FREE FLOATING:______ FLOATING ALGAE:______
ATTACHED ALGAE:______ NO VEGETATION:______

E. SUBSTRATE AND WATER QUALITY:

SUBSTRATE COMPOSITION (%): CLAYPAN______ SILT______ SAND______ GRAVEL______
COBBLE______BOULDER______ CONCRETE______ ORGANIC MATTER______

CATEGORIZE AS "NONE", "LOW", "MODERATE", OR "HIGH" (Locate worst cases.):

SUBSTRATE STABILITY OF ENTIRE REACH:______________________________

SUBSTRATE EMBEDDEDNESS OF ENTIRE REACH:______________________________

GREASE & OIL IN WATER COLUMN______________ GREASE & OIL IN SEDIMENT______________

TURBIDITY (including tributaries, point discharges; LOW, MODERATE, HIGH):______________________

WATER COLOR: CLEAR________ BROWN________ GREEN________ GRAY______

COMMENTS/PROBABLE CAUSES:______________________________

F. INSTREAM COVER FOR FISH:
(Check all that apply.)

UNDERCUT BANKS_______ POOLS OVER 28" DEEP________ MACROPHYTES_______ LOGS________

OVERHANGING VEGETATION______ ROOTWADS_______ BOULDERS______ BACKWATERS_______

COMMENTS:______________________________

G. AQUATIC AND TERRESTRIAL ORGANISMS:
(Check or note all that was observed.)

MACROINVERTEBRATES:
MAYFLIES:_____ CADDISFLIES:_____ DRAGONFLY/DAMSELFLY NYMPHS:_____

SNAILS:______ SCUDS:_____ SOWBUGS:______ LEECHES:______ WORMS: _____

WATER PENNIES:_____ BEETLES:_____ OTHER:______________________________

FISH:

CARP:____ BLACK BULLHEADS:____ CREEK CHUBS:____ GREEN SUNFISH:____ BLUEGILL: ____

LARGEMOUTH BASS:____ JOHNNY DARTERS:___ FATHEAD MINNOWS:____ GOLDEN SHINERS:

OTHERS:______________________________

BIRDS:

DUCKS:___GEESE:___ HERONS:___ KINGFISHERS:___ SANDPIPERS/PLOVERS:

GULLS/TERNS:______ OTHERS:______________________________

REPTILES:______________________________

AMPHIBIANS:______________________________

MAMMALS:______________________________

MUSSEL BEDS: NO ___ YES ___ IF YES: GPS #'S ____ ____ ____

PHOTO LOG: **PHOTOGRAPHER**:______________________________**DATE:** ______________

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RAP-M

Rapid Assessment, Point Method

Inventory and Evaluation of Erosion and Sedimentation for Illinois

R. D. Windhorn
12/00

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Introduction

Objective of this Booklet

The objective of this document is to provide guidance and a simplified procedure for inventory and evaluation of erosion and sedimentation within small watersheds. It is intended for use by Natural Resources Conservation Service (NRCS) and Soil and Water Conservation District (SWCD) field staffs. This guide summarizes and revises several earlier and more generalized attempts to estimate total erosion and sedimentation within watersheds.

Purpose of RAP-M

RAP-M is an assessment used by NRCS/SWCD field personnel since the mid-1990's to produce an estimate of the average annual rates of erosion and sedimentation by sampling small areas and expanding the results to illustrate the condition of the entire watershed. This procedure was prepared for local use to determine the magnitude of the erosion and sediment problem and to estimate additional technical assistance needs. The results of this procedure assist in assigning priorities, measuring the expected effects of land treatment, and evaluating the effectiveness of applied conservation practices. RAP-M can identify land treatment and structural needs on many watersheds where erosion and sedimentation has been determined to be a water quality problem.

NOTE: While this procedure was prepared for use on "lake" watersheds, it is also applicable to watersheds without a reservoir.

Overview of the Procedure

This procedure is a scaled-down version of that used by the NRCS Planning and Design Team to inventory and evaluate PL-566 Watershed Protection projects. It does not include detailed inventories and evaluation of environmental, hydraulic, and economic parameters. This procedure, when used appropriately, produces a good estimate of the watershed sediment problem.

RAP-M requires both field evaluations and in-office calculations to produce an estimate of the average annual rate of erosion and sedimentation. This includes sample area selection, slope and watershed type determination, channel and erosion measurements, and tillage system and ground cover determination. This information is then used to calculate an estimated average annual rate of erosion and sedimentation. (See fig. 19 for an outline of the RAP-M procedure.)

Time Needs

Plan to spend roughly one day of work per 1,500 acres of watershed to complete all field and office work associated with this procedure. This time frame relates to the smaller watersheds that are typical of Illinois NRCS projects.

Personnel Needs

This procedure is designed for use by NRCS/SWCD personnel who are familiar with field operations, tillage systems, and residue cover. A RAP-M erosion and sedimentation inventory and evaluation should be planned with the Field Operations District (FOD) Resource Planning Specialist who can organize any necessary assistance. The FOD Resource Planner also coordinates the efforts of field personnel with the assistance of the NRCS Planning and Design Team in the processing of data to ensure the consistency of erosion and sediment inventories statewide.

Equipment Needs

No special equipment is needed to complete the RAP-M inventory and evaluation. Be prepared to refer to the NRCS Field Office Technical Guide (FOTG).

Programs

This procedure is applicable to all conservation programs and should be used to make the initial evaluation of erosion and sedimentation for all special projects. The Field Office/SWCD can use this procedure to identify and target needs in high priority areas for on-going conservation programs. It can also be used to evaluate Priority Areas for EQIP projects and for possible PL-566 considerations.

Limitations

In order to use the procedure most effectively, it is important to keep in mind certain limitations. This system is flexible and can be adjusted to fit all local conditions and situations, but is most accurate when used on *small* watersheds. RAP-M has more limited practical use on large watersheds where field sampling becomes less concentrated, resulting in less reliable and less applicable data. RAP-M will not identify all severely eroding streambanks and is not to be used at the exclusion of more precise, measured data that is readily available. RAP-M is not a monitoring system or regulatory device in any way, shape or form.

RAP-M is, however, accurate and reliable when used for *planning purposes*, producing soft data that can then be used to estimate hard numbers.

What RAP-M *IS*

√ Snapshot of current conditions in a watershed
√ Estimate based on actual measurements and field evaluations
√ Way to evaluate and quantify natural conditions
√ An average annual rate of erosion and sedimentation
√ Accurate and reliable when used for planning purposes
√ Flexible system that can be adjusted to fit local conditions
√ Soft data that can be used to estimate hard numbers
√ Method of using statistics to compute reliable projections
√ Developed for small watersheds

What RAP-M *IS NOT*

✘ Not a monitoring system
✘ Not hard data
✘ Not to be used at the exclusion of more precise, measured data
✘ Not site-specific
✘ Not as reliable or applicable on large watersheds

Pre-Field Procedure

1. Project Base Map Preparation

Assemble the most current aerial photos, soil maps, and quadrangle maps of the watershed. It is desirable to have the maps at the same scale (either 4 inches = 1 mile or at the scale of the quadrangle maps) for ease in preparing a composite base map. The preparation of this composite map and future work can be simplified by using a mylar overlay to trace on. The increasing use of Geographic Information Systems (GIS) offers tremendous potential for future application. Using a GIS can increase the accuracy of all map measurements and help precisely locate important sites in the watershed.

2. Delineation of Land Use

Place the mylar overlay on top of the aerial photo and outline the major land uses in the watershed or any applicable subwatersheds. Capture areas of water, flat and sloping cropland, grass land, woodland, urban land, and any surface mined areas.

Cropland Slope Delineation: Using the land use overlay and the soils map, delineate any major areas of soils which are primarily A slopes. These have relatively low sheet and rill erosion rates.

Types of Watersheds: Sample selection will be based primarily on slope and land use delineations. In Illinois, there are three general types of watersheds with different topographic features. The inventory and evaluation of these types of watersheds should be performed somewhat differently. These three types of watersheds are:

Type A Those watersheds which have large areas of primarily A slope land. These areas often can be delineated as a separate unit from the more sloping areas. The A slope cropland is generally not a major problem in regard to erosion and sedimentation. The remaining B slope-and-greater land is then the major area of concern for inventory.

Type B Those watersheds with characteristics and features intermediate between Type A and Type C.

Type C Those watersheds that have rolling or steeply sloping topography with the slopes either interspersed throughout the watershed or occurring primarily along the major drainageways. Generally, these types have a low percentage of A slopes. If present, they are usually on the ridgetops only.

Measurement of Land Use Area: Measure the acreage of each delineated land use on the composite overlay map. Also measure the A slope area and B slope-and-greater area. Dot counting and estimating acreage are faster but, of course, less accurate than using a planimeter. Roads should only be counted if the area is extensive (i.e., in an urban area). If roads are measured, use an average width of 50-60 feet. (See fig.

3. Inventory Area Determination

This step is most critical and good judgment is necessary to select sample areas that are truly representative of the watershed. A suggested size of 160 acres for each sample unit will allow evaluation of several fields at each field stop. Selection of areas to be sampled and the number of samples should reflect a weighted percentage of the area based on drainage patterns, topography, soils, and cropping patterns. Example: if 75% of the watershed contains similar soils, slopes, and cropping patterns, then 75% of the acreage sample should be in this area. If only a small but significant part of the watershed contains gullies, this portion, no matter how small, still needs to be sampled to fully characterize the gully erosion situation.

Sampling Guidelines: Recommendations for this procedure are to inventory about 30 percent of a 4,000 acre or smaller area and about 15 percent for an area of 20,000 acres. Thus, for each 1,000 acre increase in size for watersheds over 4,000 acres in size, reduce inventory area by 1 percent (from the 30 percent). For watersheds exceeding 30,000 acres in size, use a 10 percent sample density. For example, using 160-acre sampling units in a 10,000 acre watershed, approximately fifteen (15) 160-acre units would need to be evaluated. [10,000 X (30%-6%) / 160 = 15] These sample units should also be selected "randomly." To do this, use random number tables or simply choose random numbers that would correspond to consecutively numbered quarter sections delineated on a quadrangle map.

In-Field Erosion Determination

Sheet and Rill Erosion

Within these sample units, calculate sheet and rill erosion loss using the Revised Universal Soil Loss Equation (RUSLE). Use the Universal Soil Loss Equation (USLE) for woodlands and urban areas. Obtain a **rate** of average soil loss for each of the major land uses represented. (Use fig. 9-10 for guidance.) On an inventory summary sheet (see example fig. 3), record by slope group (column 1), the acreage of each land use area (column 2). Using the erosion rate calculated above (column 3), compute gross sheet and rill erosion for the current conditions by multiplying column 2 by column 3. Place this value in column 4.

Ephemeral Gully Erosion

Ephemeral gully erosion generally occurs on cropland with B slopes and greater, but unless there is no A slope cropland in the watershed, sampling will need to include some of the A slope land as well. If not, the sampling will be biased toward ephemeral erosion. Normally, the area where concentrated flows occur can be visually distinguished in the field, whether or not a gully is present at the time. It may be difficult to determine where the gully will begin on the upper end, but one can usually determine the lower end of a potential gully from the much decreased slope gradient or stable outlet such as a grassed waterway.

Select the sample quarter-sections within the watershed which are adequate to truly represent the cropland area. Data to be collected for each ephemeral gully in each sample area is:

1) Length of each ephemeral gully,
2) Average slope of each ephemeral gully, and
3) Tillage system used where each gully occurred.

Example Ephemeral Gully Inventory

Pre-Field

1. On the photobase (overlay) map, mark the location and approximate length of each ephemeral gully. Show both existing gullies and also areas where gullies are likely to occur. This could be done in the office with good photos but will also require field observations and verification.

2. From the aerial photo, measure and record the ephemeral gully length.

3. Use the soils map and a working knowledge of soil slopes to estimate the average slope of the ephemeral gully and record.

Field

4. For each ephemeral gully, record the tillage system used in the area where the gully occurs (See sample example area below).

Example Sample Area - 160 acres

Example Ephemeral Gully Inventory

Gully No.	Length	% Slope	Tillage
1	820	3	Chisel
2	550	4	Chisel
3	690	4	Chisel
4	420	3	Chisel
5	520	3	Conv. Plow
6	570	3	Conv. Plow
7	770	2	Conv. Plow

Example Ephemeral Gully Inventory (continued)

Evaluation
The evaluation procedure is in the FOTG (NRCS Field Office Technical Guide) and can be used for reference.

Data Needs:
- √ Computation of ephemeral gully erosion for each sample area.
- √ Expansion factor of sampled area to the total cropland.
- √ Ephemeral gully erosion study data which includes the ephemeral gully erosion equation and Table 1 - Soil Loss Factor By Length, Table 2 - Soil Loss Factor By Percent Slope, and Table 3 - Soil Loss Factor By Fall Tillage.

Ephemeral Gully Erosion Equation:

Erosion (tons) = Mean tillage factor × length factor × slope factor × tillage factor × ephemeral gully length (feet)

a) Erosion = Soil loss in tons from a single voiding
b) Mean tillage factor = A constant 0.069
c) Length factor = See Table 1
d) Slope factor = See Table 2
e) Tillage factor = See Table 3
f) Ephemeral gully length = Length in feet

Table 1 - Soil Loss Factor By Length

Length Feet	Erosion - Tons Per Linear Foot	Length Factor
000-099	0.053	0.72
100-199	0.055	0.74
200-299	0.058	0.78
300-399	0.062	0.84
400-499	0.069	0.93
500-599	0.080	1.08
600-699	0.087	1.18
700-799	0.090	1.22
800-899	0.093	1.26
900-999	0.095	1.28
>1000	0.096	1.30

Table 2 - Soil Loss Factor By Percent Slope

Slope (Percent)	Erosion - Tons Per Linear Foot	Slope Factor
1	0.0750	1.15
2	0.0728	1.12
3	0.0706	1.09
4	0.0684	1.05
5	0.0662	1.02
6	0.0640	0.98
7	0.0618	0.95
8	0.0596	0.92
9	0.0574	0.88
10	0.0550	0.85

Example Ephemeral Gully Inventory (continued)

Table 3 - Soil Loss Factor By Fall Tillage

Fall Tillage	Erosion - Tons Per Linear Foot	Tillage Factor
Moldboard Plow	0.089	1.35
Chisel Plow	0.069	1.04
Untilled	0.041	0.62

Computation of Example Quarter Section:

Gully No.	Tillage Constant	Length Factor	Slope Factor	Tillage Factor	Length (Feet)	Erosion (Tons)
1	0.069	1.26	1.09	1.04	820	81
2	0.069	1.08	1.05	1.04	550	45
3	0.069	1.18	1.05	1.04	690	61
4	0.069	0.93	1.09	1.04	420	30
5	0.069	1.08	1.09	1.35	520	57
6	0.069	1.08	1.09	1.35	570	62
7	0.069	1.22	1.12	1.35	770	98
					4340	434

Total for example sample quarter section = 434 tons

Total the ephemeral erosion from all fifteen of the sample quarter sections. Knowing how much erosion is occurring in the samples, one is able to determine how much ephemeral erosion is occurring on the total cropland. If the sampling has been representative of the total cropland area, then A slope and steeper cropland areas will have been sampled. For this example, assume the total ephemeral erosion from sampling was 2,170 tons.

Expansion of sampled area to the watershed is based on a factor of the total cropland area to the cropland acres sampled:

Cropland area = 7,970 ac.

Sampled area = 160 ac. x 15 = 2,400 acres sampled

Expansion factor = 7,970 / 2,400 = 3.3

Therefore, gross ephemeral gully erosion = 2,170 tons × 3.3 = 7,161. Round up to 7,200 tons. This value now becomes the estimated ephemeral erosion for the entire watershed. Record this value in Column 4 on the summary sheet in the appropriate row (fig. 3).

Channel Erosion and Sediment Procedure

In Illinois, erosion from streambanks, gullies, and roadsides can be a major source of erosion in certain types of watersheds. Sediment yields from these sources can directly enter the stream delivery system. Two procedures, differing in amount of detail and field sampling involved, can be used to arrive at erosion and sediment values for channels.

Note: Recommendations are to use the **Detailed Procedure** for all purposes other than a *first-order estimate* for the watershed planning process. See Level of Detail for Erosion and Sedimentation Studies (fig. 20).

The detailed procedure is much more field-oriented but has higher statistical significance. The procedure is used to sample, measure, and summarize channel erosion and the sediment that it produces. This procedure should be used in conjunction with the sheet, rill, and ephemeral erosion measurements listed above to complete the entire inventory that is necessary in a small to medium-sized watershed. It is assumed that the inventory is conducted for an entire watershed, and that the watershed boundary has been marked on a (or several) USGS quadrangle map. A *channel* is defined as a concentrated flow area greater than 1 foot in depth and 2 feet in width and NOT destroyed by annual tillage operations. A vegetated waterway or other such stabilized conveyance of water, with a W:D ratio of greater than 20:1, is excluded from this definition. Both *gullies* and *streambanks* are included within this definition, as both are definitely channels. However, the distinction between the two is immaterial because the procedure for measurement is essentially the same. For informational purposes, generally a stream carries water on a perennial basis and a gully is more apt to carry only peak flows or intermittent water.

Refer to photos 1-5 for visual examples of the Average Annual Rate of Recession.

Detailed Sampling procedure: To sample a small tract of land, it may be possible to walk ALL the channels to gather data. To sample an entire watershed, this becomes impossible. Therefore, select a small portion of the channels, measure these, and then expand this data to fit the complete watershed. To be statistically accurate, approximately 5 to 20 percent of the channels should be measured, depending on the size of the watershed. The larger the watershed, the smaller the percentage of channels that need to be inventoried.

a. On the quadrangle map(s) set up earlier to show the watershed, delineate the areas that are more steeply sloping, that is, where the lines on the map are closer together. These generally occur along the main drainageways and streams. These are the areas of most interest, since the sampling areas should contain 75% or more of the channels that occur within the entire watershed.

b. Measure or estimate the number of acres in the delineated, sloping area. For example, if the entire watershed is 10,000 acres and by plainimeter, measures 6,000 acres in the sloping part, then a 10 percent sample would be 6,000 times 0.10, or 600 acres. This would give a good estimate as to the amount of erosion and sedimentation produced by the channels.

c. Use of the 160-acre sampling blocks set up for sheet and rill measurements makes the job somewhat easier. So, for the example, 600 divided by 160 equals four (4) of the 160-acre sampling units. Select these four randomly throughout the sloping part of the watershed. These sampling units now need to be inventoried in the field for channel erosion.

d. Select several channels within these units to walk and measure erosion. If there is one main channel, be sure to use it and any major tributaries to it. A good length of channel to choose is 1,300 feet (one-quarter mile) for streambank reaches and 500 to 2,000 feet for gullies. In bluff-type watersheds along the major stream valleys, there may be so many channels that it becomes almost impossible to choose. In these situations, select six or eight channels in a random order, for example skipping every other one. The length of each may be determined by scaling from maps or aerial photos, or by pacing or taping if the channels are relatively short.

e. Use the Channel Inventory Form (figure 6A, form and 6B, example) to complete this procedure. The top part of the form is self-explanatory. The formula used to calculate tons of erosion per year from that channel is also listed at the top of the form. To correctly complete the form, be sure to keep in mind that there is a right and a left side of every channel and that each side might erode at a different rate. Record the starting point as well as the direction travelled when conducting the inventory, either upstream or downstream. Both sides must be recorded. Therefore, to complete the form for a channel of 1,300 feet, for example, the numbers on the channel inventory form should total 2,600 feet. In the Height column, use only the height of the actively eroding slope segment NOT the entire cut-bank. For example, where a stream cuts into a steep, upland ridge, often the entire exposed bluff shows signs of slumping or movement. However, on closer inspection, only the lower three to four feet of the entire bank are actually undergoing active erosion by the stream on an average annual basis. The section above this is feeding fresh material down to it, but it is NOT being eroded by the bankfull channel flow. (See fig. 11-16 for additional information on the channel inventory.)

The *lateral recession rate* is taken from the attached chart (fig. 7- 8). This rate is a qualitative way to assess width or thickness of eroding surface on a channel. It is used to estimate an actual quantitative measurement. It is based on actual in-field observations and measurements made by the former MNTC in Lincoln, NE (fig.12). Recession rates of eroding banks for Illinois streams and gullies typically range from 0.05 feet 0.5 feet per year. Refer to photos 1-5 for visual examples. Values in the range of 0.05 feet to 0.40 feet are the most typical in perennial streams and rates of 0.05 feet to 0.3 feet most typical in intermittent flow channels. Stream banks with retreat rates of 1 or more feet per year do occur, but are uncommon and not usually widespread within a given watershed. Apply the rates as uniformly and consistently as you can along both sides of each channel. Remember, these numbers are used to obtain *average annual rates*, not those that occur after a 4-inch rain that washes out a bridge abutment. This is the same principle used with USLE and now RUSLE. Rates in the "Very Severe" category of 0.5+ feet of bank recession per year generally only occur in Illinois on segments of channels scattered throughout steep watersheds. If these rates were applied throughout the entire watershed, so much sediment would be produced that the current stream systems could not move it through; it would pile up as huge sediment bars that would block the actual flow of water. Bottom scour of some channels also occurs in some watersheds. Usually this is not as noticeable or as severe as bank erosion for a given channel. Rates of 0.05 feet to 0.4 feet are typical where the scour is occurring. Include any scour erosion totals with the bank erosion on the Channel Inventory Form. (See fig. 17 for general guidelines.)

For *density*, use a value of 95 pounds per cubic foot for channels eroding through loess and silty alluvium. For those cutting in glacial till, use a value of 110 pounds per cubic foot.

f. A *channel inventory form* should be completed for each selected channel in each of the four (4) 160-acre sampling units. The total of all these forms gives us the estimated channel erosion in our 600-acre sample unit. After walking the channel to measure the length and erosion for each, calculate a RATE of channel erosion per linear foot of channel. Only by walking ALL the channels in each of the 160-acre units, would one know exactly how many feet of channels occur within our 600-acre required sampling unit. If not, then we need to <u>estimate or measure</u> the total number of feet of channels in that 600 acres.

g. Expand the sample area to encompass the entire watershed. If, within the 600-acre sampling unit, 12,000 feet of channels were measured or estimated, then to expand this to the entire 6,000-acre, sloping watershed, simply multiply by 10 to arrive at 120,000 feet of channels in the ENTIRE watershed.

h. In most watersheds, 100 percent of the channel banks are not eroding. Some channel systems may actually be aggrading, or building up. A random, stratified sampling procedure should account for this. Based primarily on field observations, one can verify the percentage of channels that are currently eroding. In the example, which is in a non-bluff area, 120,000 feet multiplied by the rate of 0.035 tons per linear foot equals 4,200 tons of sediment produced by channel erosion.

i. As mentioned earlier, both gully and streambank erosion were considered channel erosion and could be calculated as a combined value as the previous example showed. However, to separate these within a watershed to show differences or to isolate a particularly serious sediment source; then inventory and calculate each separately, following the same procedure. On quadrangle maps, streams can sometimes be separated from gullies by using the solid blue lines. This is especially helpful for those who are not physically familiar with the stream in that part of the watershed.

j. The final step is to determine how much of the sediment that is produced by the channel erosion actually moves into and through the stream system. Use a SEDIMENT DELIVERY RATE (SDR) for this type of erosion and for each of the other types of erosion. This predicts sediment available for transport. If we are dealing only with channel erosion, then the SDR is usually near 100 percent (or 1.0). If material is moved from the wall of the gully or falls off the streambank itself, it is readily available for transport; use a value of 0.90 to 1.0 for this calculation. When channel erosion is due mostly to gullies, use 0.90, but if erosion occurs equally between streams and gullies, use 1.0. This number is multiplied by the total sediment number to arrive at the value of "sediment delivered to the ultimate sink" in the watershed. In our example, 4,200 tons times 0.90 equals 3,780 tons delivered to the sink.

k. This value should then be combined with similar totals for sheet, rill, ephemeral and other types of erosion and sedimentation to give a complete picture of the erosion and sedimentation for the entire watershed.

Note: These detailed inventories should be conducted in their entirety with in-the-field inventories, erosion computation, and the expansion of these results to the watershed by a factor. However, the following procedure provides a *first-order estimate* for the watershed planning process that does not involve the extensive field work and sampling.

Simplified Procedure:

1. Match the *Watershed Characteristics* listed below to those in the inventoried watershed.

2. Refer to Figures 1 & 2 to assist in the watershed type determination.

3. Multiply the calculated gross sheet and rill erosion by the *Channel Erosion* value below that matches the watershed type. See the Watershed Erosion and Sediment Yield Summary (figure 3).

Channel Erosion	Watershed Characteristics
10% of S & R	Wide flood plains with meandering channels, numerous upland wetlands and depressions, diverse land uses scattered randomly throughout the watershed, numerous large ponds or other sediment traps, abrupt flattening of the main stream gradient in downstream direction. (Type A)
15% of S & R	Intermediate between Type A and Type B (Type B)
20% of S & R	Narrow flood plains with straight channels, well drained convex uplands, uniformly distributed land uses, main channel uninterrupted by sudden gradient changes or man-made obstacles. (Type C)

Note: The above is a general rule of thumb, but judgment must also be used. If there is significant streambank or gully erosion greater than that listed above, for example in bluff-type watersheds along major rivers, values as much as 10-20 percent greater than what is listed can be used.

Example Channel Erosion Inventory

For a 10,000 acre watershed located in a Type B Watershed, the gross sheet and rill erosion is 57,900 tons.

The Channel Erosion factor is 15%.

57,900 tons x 0.15 = 8,685 tons (round to 8,700 tons channel erosion)

There is no evaluation needed for this source of erosion.

Total Gross Erosion

To arrive at a *Total Gross Erosion* figure for our example, simply go to Column 4 of the Watershed Erosion and Sediment Yield Summary (fig. 3) and add the values for Total Sheet and Rill, Total Ephemeral and Total Channel Erosion.

This procedure gives an estimated *current gross erosion* figure for the entire watershed. The effect of added conservation practices (cultural and structural) can be evaluated by substituting these new values into the summary and then simply comparing values. Also, subwatersheds can be broken out, using this same procedure with adjusted acreage.

Sediment Delivery Rate (SDR)

Only a portion of this Gross Erosion total actually is moved into a body of water (See fig. 4). One of the values used to help predict quantities delivered to the watershed outlet is the **Sediment Delivery Rate (SDR)**. Off-site sediment results in the degradation of water quality through delivery of the sediments, nutrients, and chemicals to a water body. Sediment also reduces water storage volume which impacts upon water supply and recreational uses and diminishes the quality of fish habitat. Suspended sediments can also increase water treatment costs.

The **SDR** predicts the sediment that is available for transport at field edge. This is viewed as an on-site sediment delivery figure and varies for each type of erosion. It can also vary for each different landscape position and slope. For our generalized purposes, only one SDR will be applied to each erosion type. However, most watersheds have several SDR's for each type of erosion.

Sheet and Rill

Sheet (interrill) and rill erosion have SDR base values that range from literally "0" in depressional areas to 0.65 on slopes 10% and greater. An average on-site sediment delivery rate (SDR) of 0.25 on slopes 5% and less and 0.55 on slopes 10% and greater are good numbers to use. Select one of these numbers or use an average for a combination of slopes and put this value in Column 5 (fig. 3) for all sheet and rill erosion slopes and land uses. Multiply Column 5 by Column 4 and place this value in Column 6. Total this Column.

Ephemeral

Ephemeral erosion produces sediment that, in general, has a much more direct path into the stream system. In some cases, there will be an area prior to the entrance into the delivery system where some sediment deposition occurs (See fig. 4). As an average, use a 0.75 SDR. Put this number in Column 5 and multiply by the *Ephemeral Gully Erosion* number in Column 4. Put the total in Column 6 under *Ephemeral Gully Erosion* (fig. 3)

Channel
Channel erosion delivers sediment directly into the stream system. Use a value of 0.85 to 1.0 for the SDR, depending on the predominance of gullies versus streams. Put this number in Column 5 and multiply by the value in Column 4 for Channel Erosion. Put total in Column 6 under *Channel Erosion Sources*.

The *Total Watershed Sediment* in Column 6 of the Watershed Erosion and Sediment Field Summary (fig. 3) now provides an estimate of the sediment that is available for transport or, in other words, ready to be moved through the stream system (Off-site).

Sediment Transport Factor (STF)

The other value needed to estimate sediment entering the lake is called the **Sediment Transport Factor (STF)**. This number predicts the efficiency and effectiveness of the entire stream system in moving sediment through it (fig. 4). Generally, use only one STF for each watershed. This number is based on stream density, slope, drainage coefficients, soils, roughness coefficients, etc. It also changes with the size of watershed. The larger the watershed, the less efficient it is in moving sediment, because there are so many more places for the sediment to be deposited.

For watersheds up to 20,000 acres in size, a chart has been provided (fig. 5) that allows a STF to be determined. A channel system with low transport efficiency entraps the sediments as they move through, thus less sediment is delivered to the lake or stream outlet. High transport efficiency channels have less sediment entrapments and thus produce higher sediment yields.

The following are some of the characteristics describing channel efficiency:

Efficiency	Watershed Characteristics	
Low	Wide flood plains with meandering channels, numerous upland wetlands and depressions, diverse land uses scattered randomly throughout the watershed, numerous large ponds or other sediment traps, abrupt flattening of the main stream gradient in downstream direction. (Type A)	***(See fig. 1A, 1B)***
Medium	Intermediate between Type A and Type C (Type B)	
High	Narrow flood plains with straight channels, well drained convex uplands, uniformly distributed land uses, main channel uninterrupted by sudden gradient changes or man-made obstacles. (Type C)	***(See fig. 2A, 2B)***

For watersheds larger than 20,000 acres in size, a Sediment Transport Factor rating guide will need to be used. This chart is based on watershed characteristics, but is specific to each part of the state.

Summary

Knowing the total watershed area and estimating the Sediment Transport Factor (STF) from the table, a total estimate of sediment reaching the lake (or any such watershed outlet) can be determined. The STF is multiplied by the *Total Watershed Sediment* to obtain the total tons of sediment entering the lake on an average annual basis (fig. 3). This estimate is accurate for planning purposes and general discussion concerning conditions in the watershed. It is NOT accurate enough to use for engineering design purposes. For this, a more detailed inventory of channel erosion would be necessary on an individual sub-watershed basis. (See fig. 18 for example of data produced and summarized. See Example Sediment Report, pg. 49, for presentation of the summary data.)

Note: To convert tons to acre-feet, use the following formula:

$$\frac{\text{Tons Sediment}}{\text{Density}} \times 0.04591 = \text{Acre-Feet}$$

For *Density*, use a value of 95 pounds per cubic foot for sediment coming from predominately loess soils or silty alluvial soils and value of 110 pounds per cubic foot for glacial till soils or coarse-textured alluvium. These values are for "aerated" sediments or in other words, those that are NOT deposited INTO any kind of water body. Thus, they have an opportunity to dry out. Density values of 40 to 50 pounds per cubic foot are more appropriate for submerged sediments that are deposited directly into a body of water. What this says is that the same **tonnage** of sediment will occupy much more **volume** if it enters a permanent pool of water.

R. D. Windhorn 2001

Watershed Erosion and Sedimentation Summation Process

(Sheet and Rill Erosion Rate for Cropped* A / B slopes × Acres × SDR 1)

(Sheet and Rill Erosion Rate for Cropped* C / D slopes × Acres × SDR 2)

(Sheet and Rill Erosion Rate for Pasture* × Acres × SDR 3)

(Sheet and Rill Erosion Rate for Timber* × Acres × SDR 4)

(Sheet and Rill Erosion Rate for Urban* × Acres × SDR 5)

(Ephemeral Rate × Acres of affected cropland × SDR 6)

(Gully Erosion Rate × Feet of eroding gullies × SDR 7)

(Streambank Erosion Rate × Feet of eroding streambank × SDR 8)

sum equals

Subtotal of Sediment Available for Transport

times

Sediment Transport Factor (STF)

product equals

Total Suspended Sediment Delivered to Watershed Outlet

* *Can be further subdivided*

Reminders

Other Issues to Consider

- Consistency! Consistency! Consistency!
- *Rates* of erosion are needed to complete the summary.
- Use guidelines. Do not overestimate channel erosion in the entire watershed
- Sheet and rill data can be gathered using different methods. Don't get bogged down!
- Use common sense to deal with field problems that arise.
- Use your normal inventory process. Don't adjust your methods to fit this procedure.
- Obtain acreage figures for each land use break in the watershed.
- **Local people must be comfortable with data gathering and results.**

-Photo 1-

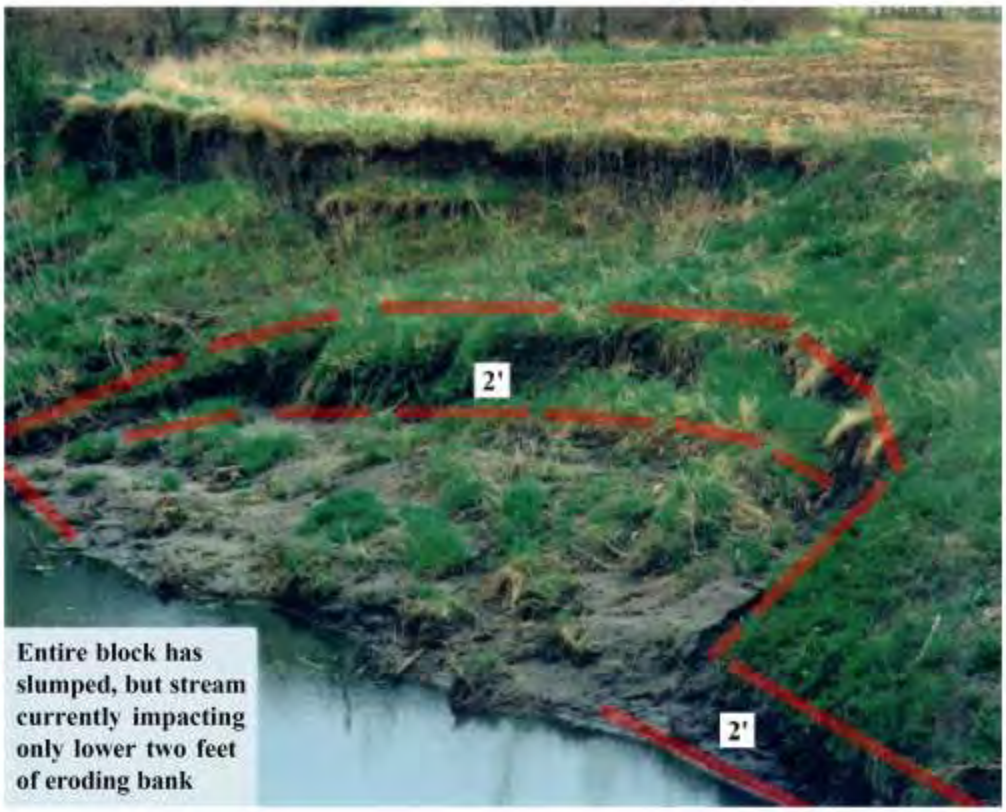
Average Annual Rate of Recession

Slight **Rate 0.03' or less**

-Photo 2-

Average Annual Rate of Recession

Moderate **Rate 0.2'**



-Photo 3-

Average Annual Rate of Recession

Moderate **Rate 0.15'**

-Photo 4-

Average Annual Rate of Recession

Severe **Rate 0.40'**

-Photo 5-

Average Annual Rate of Recession

Very Severe **Rate 0.5’**

-Figure 1A-

Low Channel Transport Efficiency

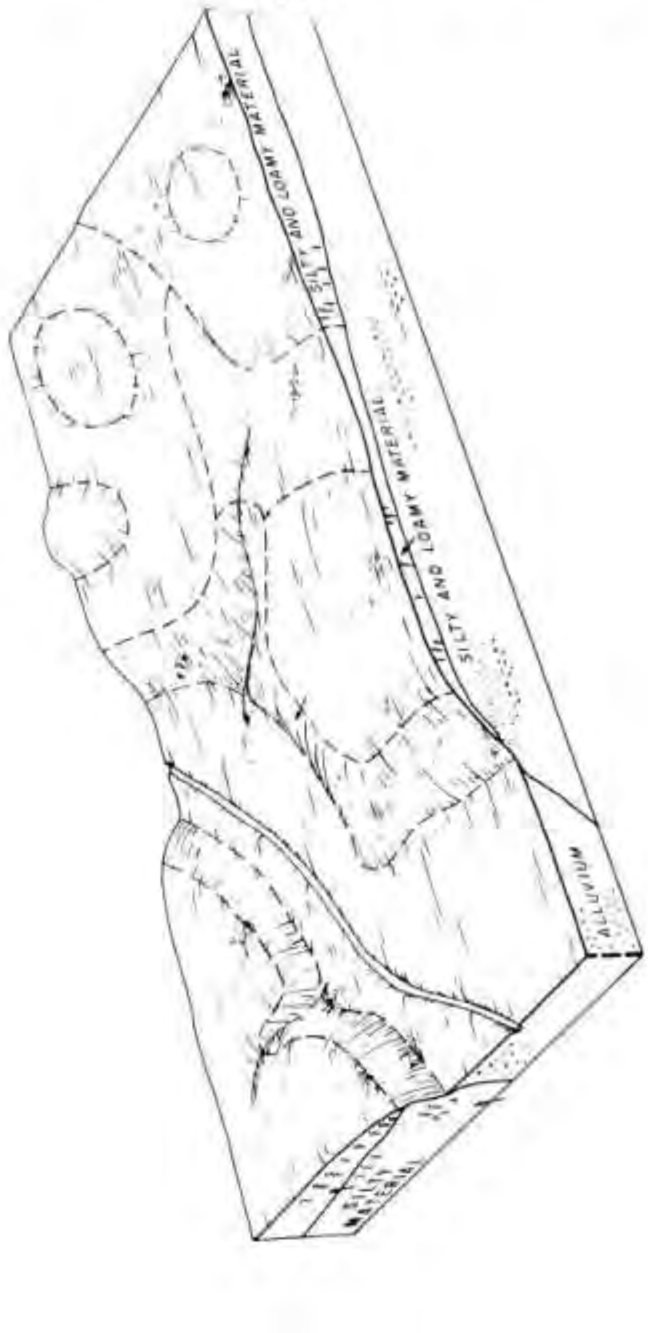
Type A

Widely-spaced lines indicate low slopes.

-Figure 1B-

Low Channel Transport Efficiency

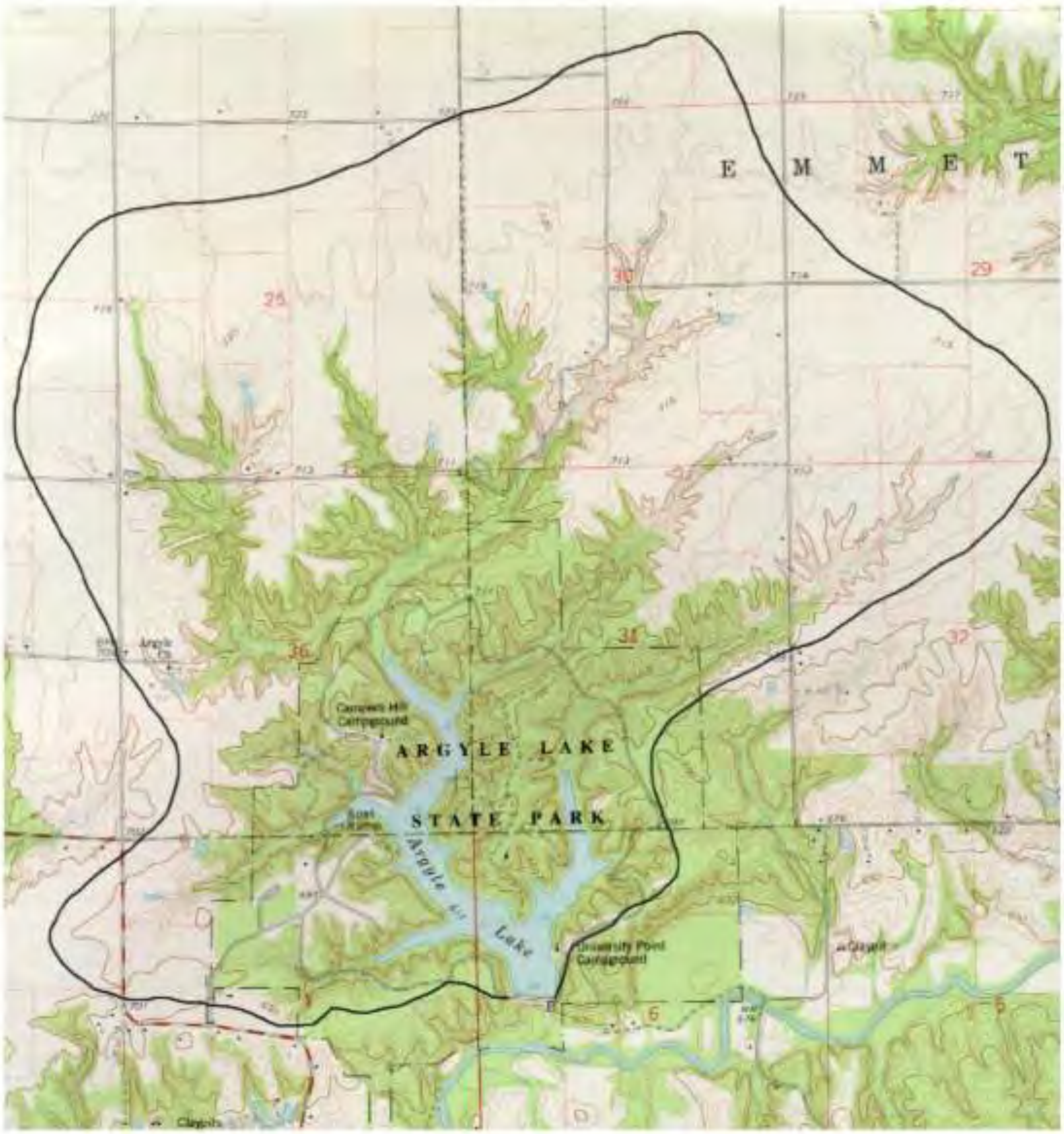
Type A



-Figure 2A-

High Channel Transport Efficiency

Type C

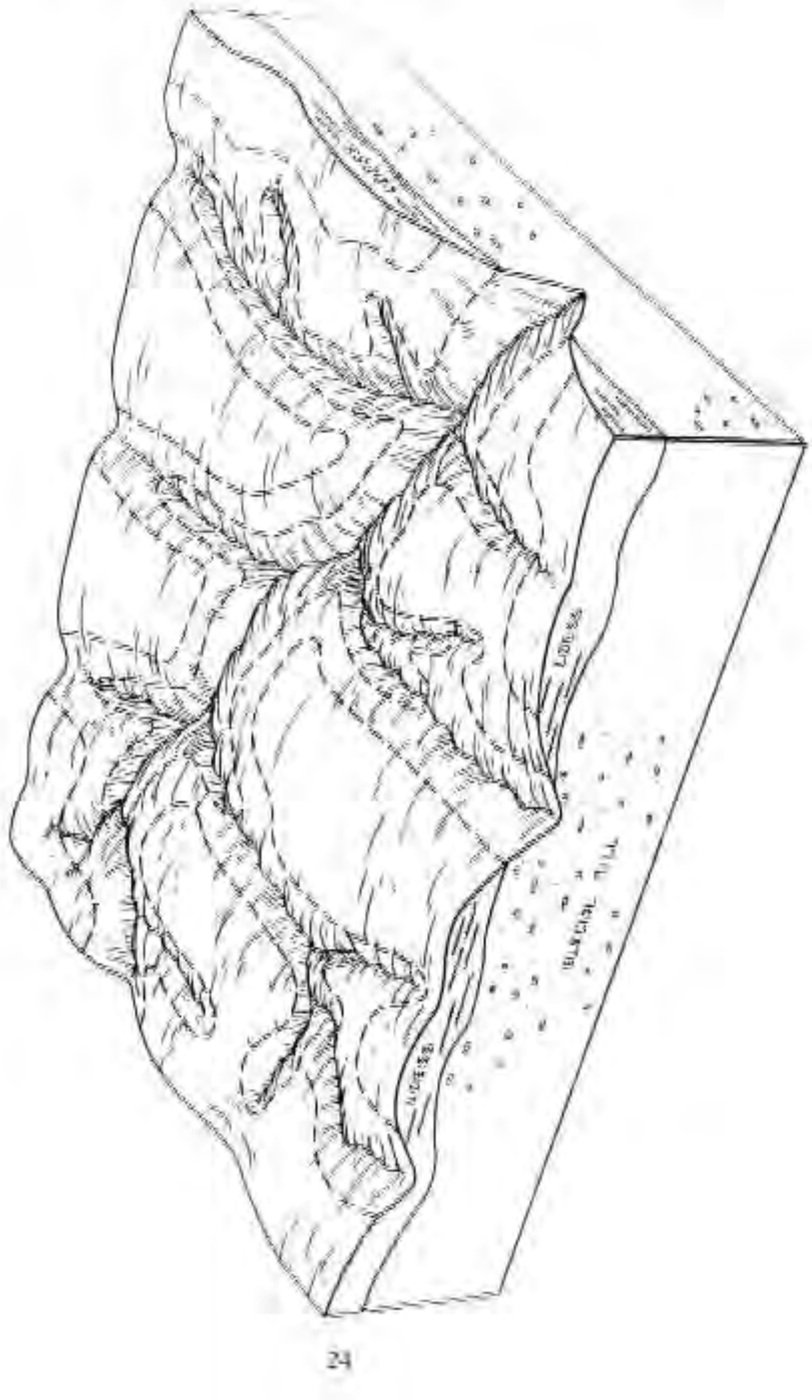


Steep slopes are indicated by closely-spaced lines.

-Figure 2B-

High Channel Transport Efficiency

Type C



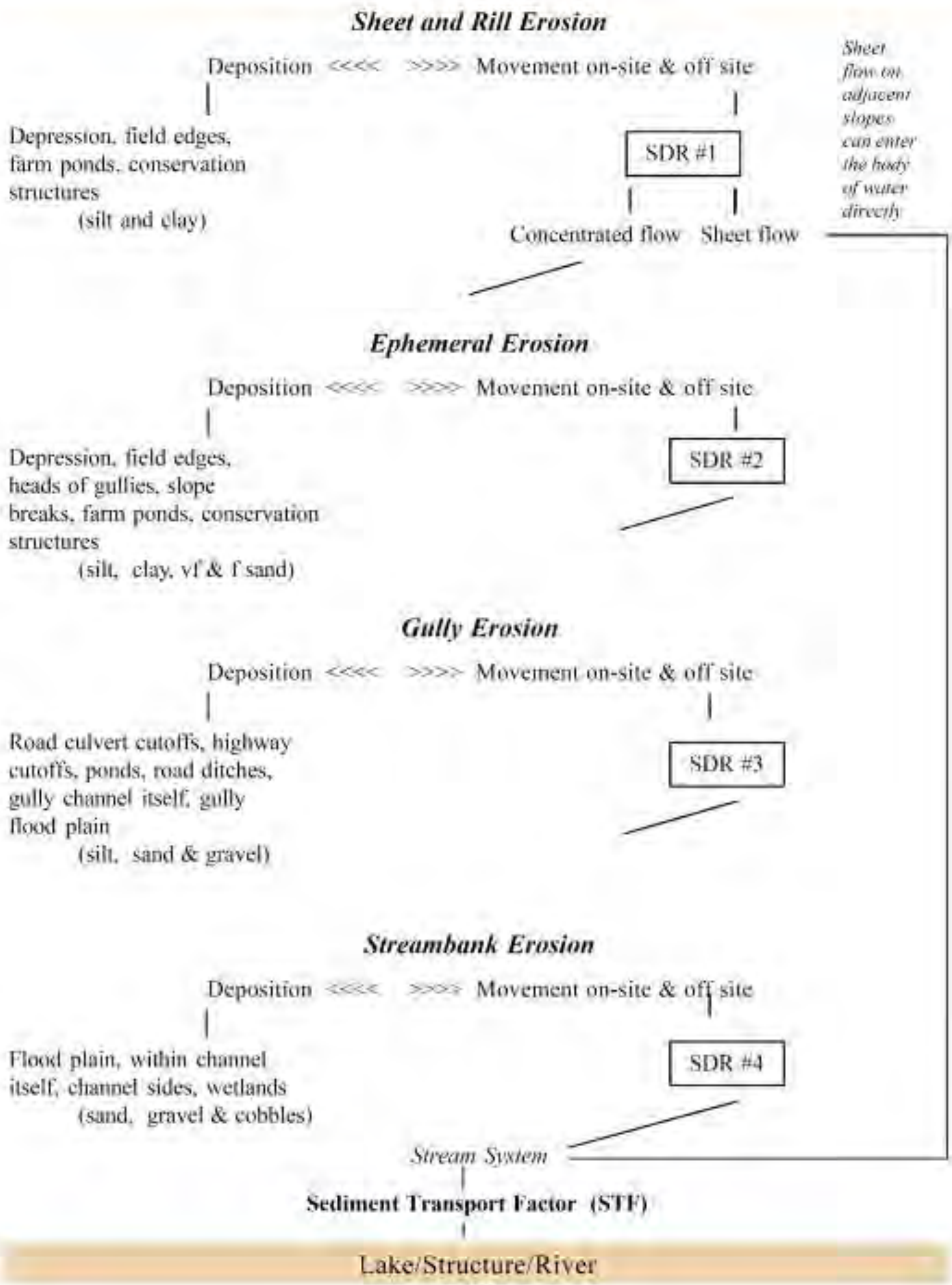
-Figure 3-

Watershed Erosion and Sediment Yield Summary

			Present Conditions			
			Erosion		Sediment Yield	
Sheet and Rill Erosion:	Slope Group	Area Ac.	Average Rate T/A/Yr	Gross T	SDR	Yield T
Cropland	"A"	2,400	2	4,800	0.6	2,900
	"A"	300	6	1,800	0.6	1,100
	"B"	500	4	2,000	0.6	1,200
	"B"	2,500	8	20,000	0.6	12,000
	"C"	300	4	1,200	0.6	700
	"C"	800	13	10,400	0.6	6,200
	"D"	100	4	400	0.6	250
	"D"	400	25	10,000	0.6	6,000
Grassland	All	400	2	800	0.6	500
	All	100	12	1,200	0.6	700
Woodland	All	800	1	800	0.6	500
	All	200	20	4,000	0.6	2,500
Urban Land	All	500	1	500	0.6	300
Water Area	-	500	-	-	-	-
Total Sheet and Rill Erosion				57,900	XXX	35,000
Total Ephemeral Gully Erosion				7,200	0.85	6,120
Total Channel Erosion				8,700	1.0	8,700
Total Watershed		**10,000**		**73,800**		**49,820**
Sediment Yield Off-Site (STF = 0.38)					*0.38 x 49,820 =*	**18,900**

-Figure 4-

Sediment Delivery and Transport



-Figure 5-

Channel Transport Factor
STF

Watershed Area (Acres)	Watershed Efficiency Low	Medium	High
0 - 1,999	0.43	0.64	0.86
2,000 - 3,999	0.34	0.51	0.67
4,000 - 5,999	0.30	0.45	0.60
6,000 - 7,999	0.28	0.42	0.55
8,000 - 9,999	0.27	0.40	0.52
10,000 - 11,999	0.26	0.38	0.49
12,000 - 13,999	0.25	0.37	0.47
14,000 - 15,999	0.24	0.36	0.45
16,000 - 17,999	0.23	0.35	0.44
18,000 - 20,000	0.22	0.34	0.43

R. D. Windhorn 7/00

-Figure 6A-

Channel Inventory Form

Watershed________________________ Name________________________ Date_______

Start Transect at____ Transect No.________

Type of Channel Erosion________________________

L (x) H (x) Lat. Rec. Rate (x) Density / 2000 = Tons / Year

	Reach Num	Length (ft)	Height (ft)	Lateral Recession Rate (ft/yr)	Density (pcf)	Erosion (tons/yr)	Comments
R	1						
L	2						
R	3						
L	4						
R	5						
L	6						
R	7						
L	8						
R	9						
L	10						
R	11						
L	12						
R	13						
L	14						
R	15						
L	16						

Total = _______ XXXXX XXXXXXX XXXX _______

EXAMPLE

-Figure 6B-

R. D. Windhorn 7/00

Channel Inventory Form

Watershed Anywhere Watershed Name R. D. Windhorn Date 12/25/00

Start Transect at E-W Road, Go North 1300' Transect No. 1-A

Type of Channel Erosion Streambank

L (x) H (x) Lat. Rec. Rate (x) Density / 2000 = Tons / Year

	Reach Num	Length (ft)	Height (ft)	Lateral Recession Rate (ft/yr)	Density (pcf)	Erosion (tons/yr)	Comments
R	1	100	2	0.13	95	1.2	
L	2	100	1	0.03	95	0.1	
R	3	200	0.5	0.03	95	0.1	
L	4	200	3	0.4	95	11.4	
R	5	50	6	0.4	95	5.7	
L	6	50	1	0.13	95	0.3	
R	7	300	0.5	0.03	95	0.2	
L	8	300	1.5	0.13	95	2.8	
R	9	150	2	0.3	95	4.3	
L	10	150	1	0.03	95	0.2	
R	11	300	0.5	0.03	110	0.2	
L	12	300	1.5	0.3	110	7.4	
R	13	200	1	0.13	110	1.4	
L	14	200	4	0.6	110	26.4	
R	15	2600/2 =					
L	16	1300					

Total = 1300 XXXXX XXXXXXX XXXX 61.7T (95 #/foot of streambank)

-Figure 7-

R. D. Windhorn 6/00

Lateral Recession Rates

Gully Erosion

Lateral Recession Rate (ft/yr)	Ave. (ft/yr)	Category	Description
0.01 - 0.05	0.03	Slight	Some bare bank but active erosion not readily apparent. Some rills, but no vegetative overhang. No exposed tree roots.
0.06 - 0.2	0.13	Moderate	Bank is predominantly bare with some rills and vegetative overhang. Some exposed tree roots. No slumps. Gullies generally V-shaped.
0.3 - 0.5	0.40	Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and some fallen trees. Slumping or rotational slips are present. Some changes in cultural features, such as fencelines out of alignment or pipelines exposed. Gullies becoming more U-shaped as the lower part of the channel erodes. Knickpoints present in channel bottom.
0.5 - 2.0	1.5	Very Severe	Bank is bare with rills and severe vegetative overhang. Many exposed tree roots and fallen trees. Slumping of sidewalls quite evident. Gullies are U-shaped, with vertical sidewalls at base of channels. Knickpoints present in channel bottom, with overfalls of 2 feet and greater possible. Soil material has often accumulated at base of slopes.

What recession rates mean:

at 0.01 feet / year and 90 pcf equals 20 tons / acre / year

at 0.05 feet / year and 90 pcf equals 100 tons / acre/ year

visible rills on the bank equals 12 tons / acre / year

***NOTE**: at 90 pcf, 1 acre-foot equals 2000 tons*

-Figure 8-

R. D. Windhorn 1999

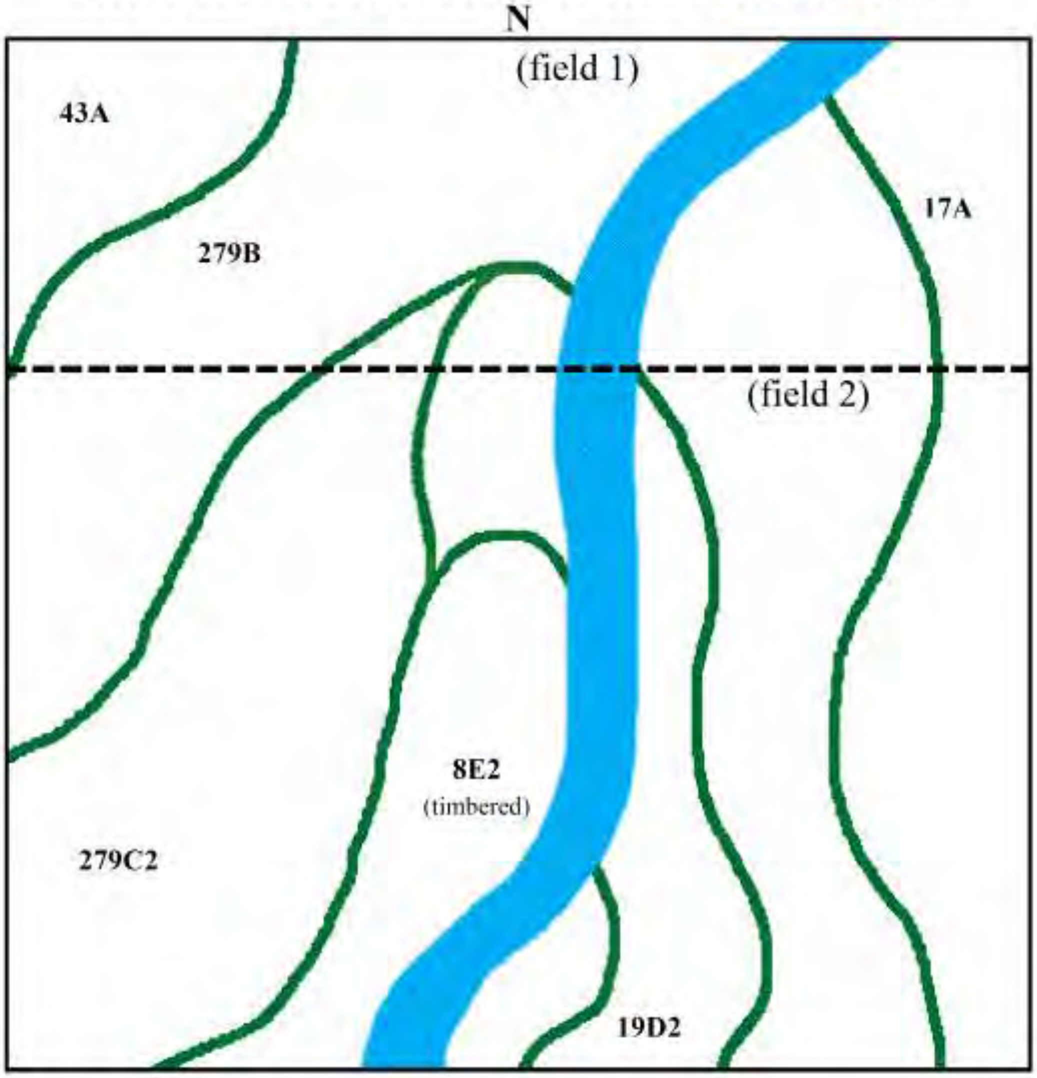
Lateral Recession Rates

Streambank Erosion

Lateral Recession Rate (ft/yr)	Ave. (ft/yr)	Category	Description
0.01 - 0.05	0.03	Slight	Some bare bank but active erosion not readily apparent. No vegetative overhang. No exposed tree roots. Bank height minimal.
0.06 - 0.2	0.13	Moderate	Bank is predominantly bare with some vegetative overhang. Some exposed tree roots. No slumping evident.
0.3 - 0.5	0.40	Severe	Bank is bare with very noticeable vegetative overhang. Many tree roots exposed and some fallen trees. Slumping or rotational slips are present. Some changes in cultural features, such as missing fence posts and realignment of roads.
0.5 - 2.0	1.5	Very Severe	Bank is bare and vertical or nearly vertical. Soil material has accumulated at base of slope or in water. Many fallen trees and/or extensive vegetative overhang. Cultural features exposed or removed or extensively altered. Numerous slumps or rotational slips present. Generally silty or sandy bank material, NOT glacial till or exposed shale bedrock.
2.0 - 5.0	3.5	Extremely Severe	Bank is bare and vertical. Soil material has accumulated at base of slope and oftentimes still contains living grass or other vegetative material. Extensive cracking of the earth parallel to the exposed face above the bank. Generally evidence of "block-size" material that has either recently fallen in or is about to fall in. Can be "pillars" of soil materials that have already been loosened by stream and indicate imminent failure into the stream. Trees have been undercut and lie in stream, often with root balls intact. Silty or sandy bank material, NOT glacial till or exposed shale bedrock. (These rates should be verified with several observations or with actual streambank monitoring.)

-Figure 9-

Determination of Sheet & Rill Erosion Rates



Average the rates of erosion for A & B slopes:	17A 43A 279B
Average the rates of erosion for C & greater slopes:	279C2 19D2

-Figure 10-

Resource Inventory

Watershed ____________________
County ____________________
Date ____________________

USLE R ____________________
RUSLE R ____________________
Assisted By ____________________

Sheet & Rill Erosion

Tract No.	Field No.	Land Use	Soil Map Unit	Acres	Crop Rotation	Slope Length	Slope %	LS	K	C	P	A= Soil Loss (t/ac/yr)	No-Till (acres)	Mulch Till (acres)	Grassed Waterway (feet)	Terrace (feet)	WASCOB (no.)	Grade Stab. Structure (no.)	Pond (no.)	Filter Strips (acres)	Other (units)

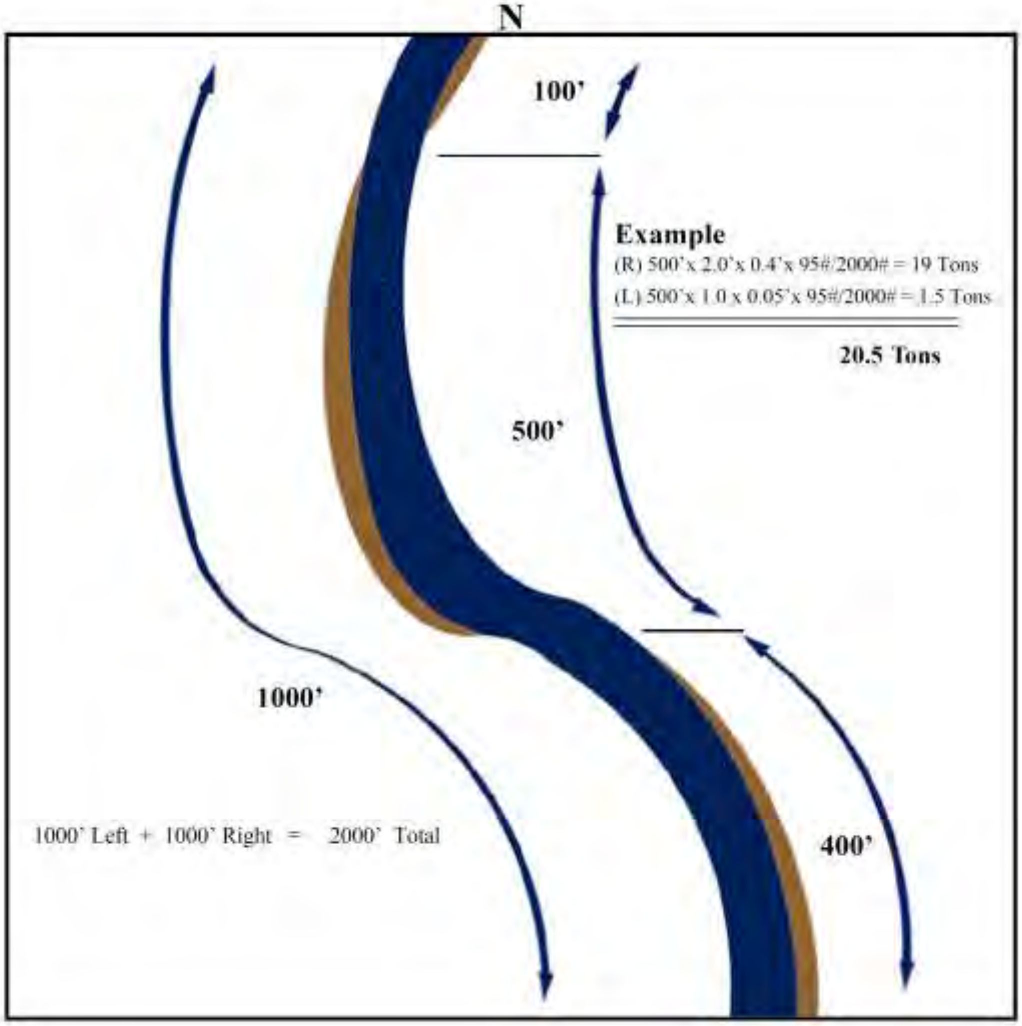
Ephemeral Erosion

Tract No.	Field No.	Tillage Constant 0.069 (1)	Length Factor Table 1 (2)	Slope Factor Table 2 (3)	Tillage Factor Table 3 (4)	Length (feet)	Erosion (tons)

Conservation Management Notes

-Figure 11-

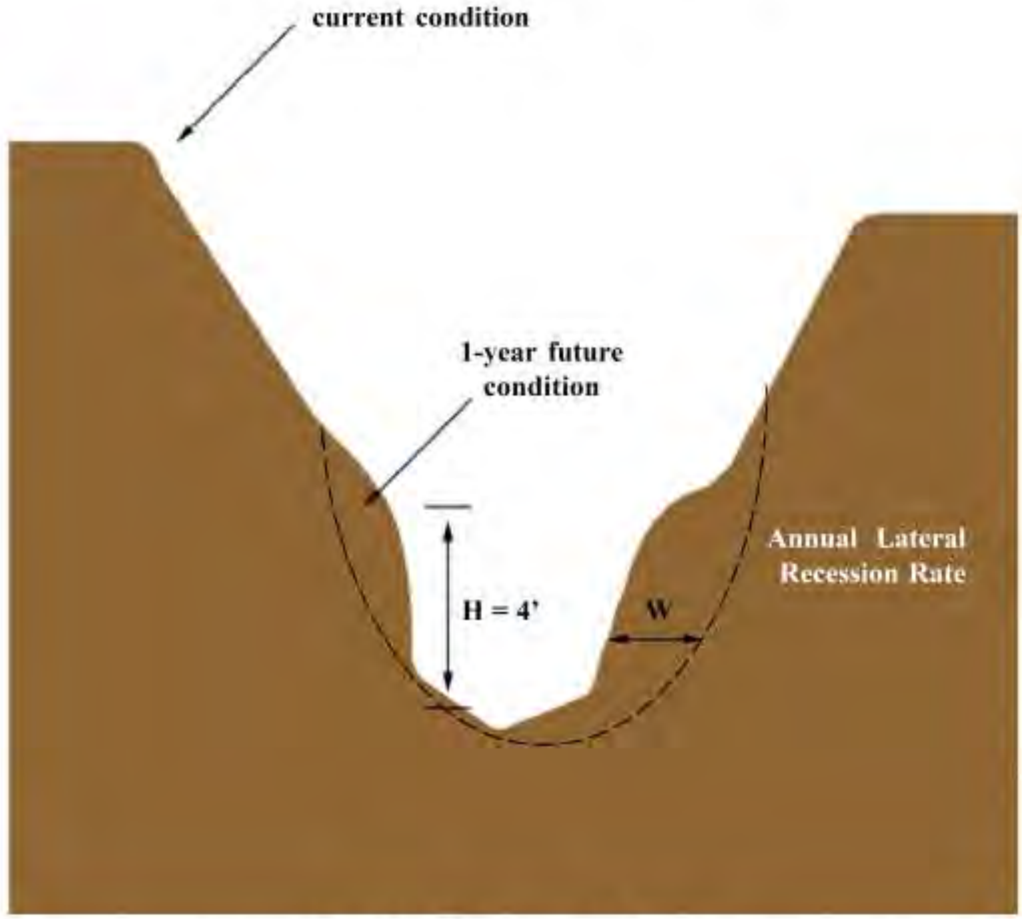
Channel Inventory Procedure



- Walk the thalweg or middle section. Measure the meandering reaches of the stream banks.
- The breaks are determined by the most severely eroding side.
- Use the total (2000' ***not*** 1000') to place on the worksheet.

-Figure 12-

Volume Determination Using Lateral Recession Rate

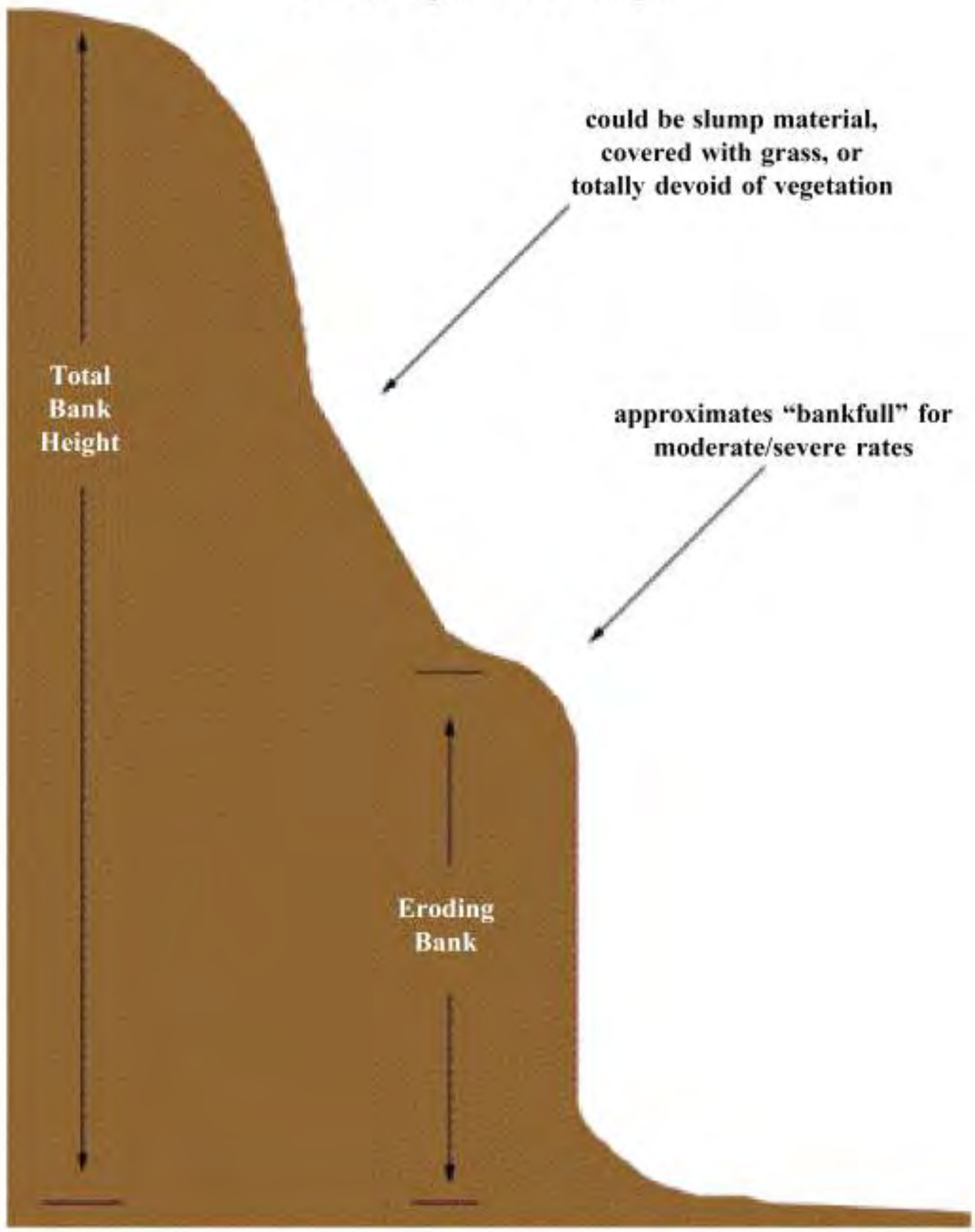


L x H x W = Volume

Length *(Gully Segment Eroding)* x **Height** *(Eroding Area)* x **Width** *(Lost Each Year - Lateral Recession Rate)* = **Volume** *(Annual Gully & Streambank Erosion)*

-Figure 13-

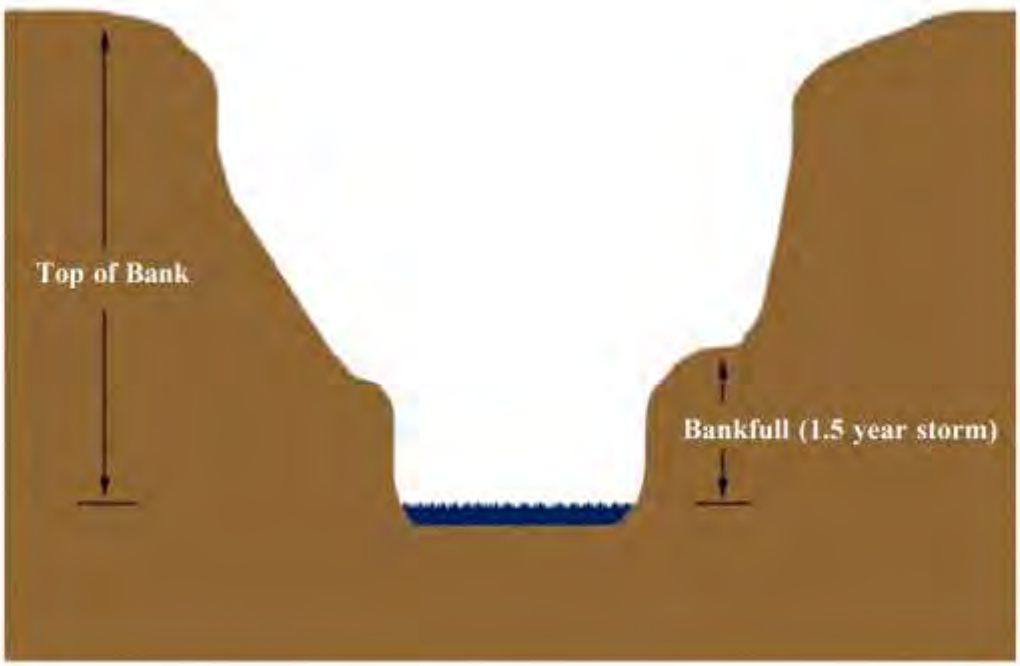
Eroding Bank Height



Use Photo 3 for reference.

-Figure 14-

Eroding Bank Height

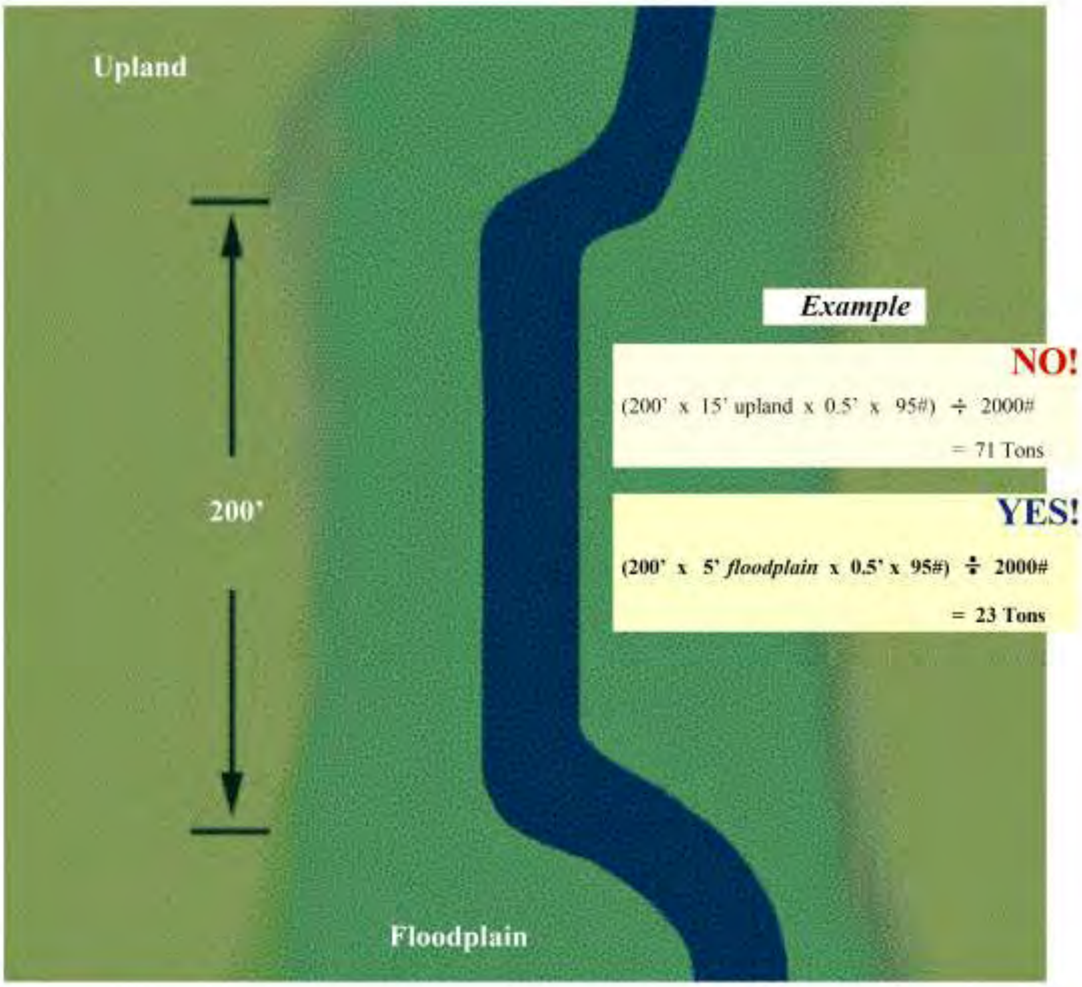


Bankfull ≠ Top of Bank

-Figure 15-

Eroding Bank Height

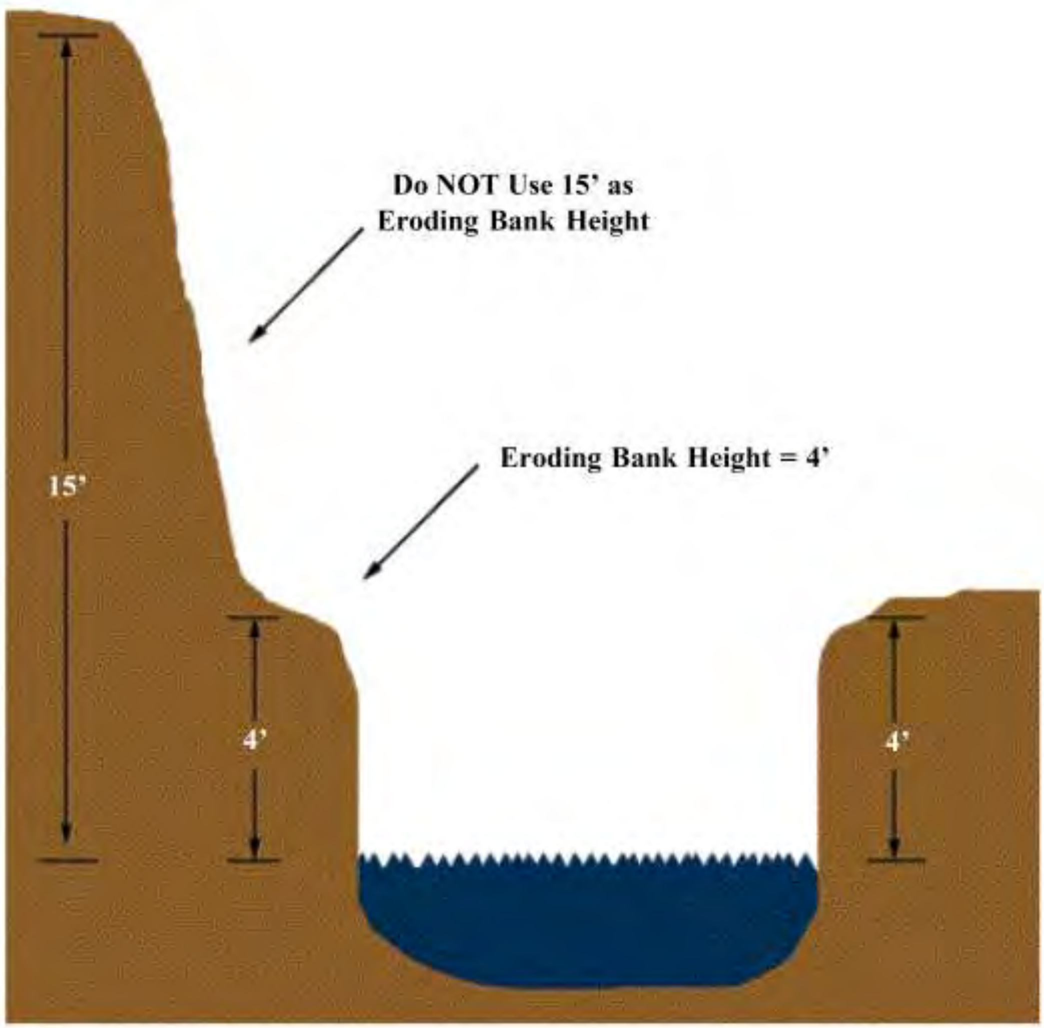
shown from above



Use Photo 3 for reference.

-Figure 16-

Eroding Bank Height



4' is the maximum, by definition, of ***bankfull***.

-Figure 17- R. D. Windhorn 2/99

Channel Erosion Quantities

Section Eroding = 100 feet long		Tons
4 foot high eroding bank	@ 0.15 foot recession rate	2.8
	@ 0.5	9.5
	@ 1.0	19.0
	@ 2.0	38.0
6 foot high eroding bank	@ 0.15 foot recession rate	4.3
	@ 0.5	14.0
	@ 1.0	28.5
	@ 2.0	57.0
8 foot high eroding bank	@ 0.15 foot recession rate	5.7
	@ 0.5	19.0
	@ 1.0	38.0
	@ 2.0	76.0
10 foot high eroding bank	@ 0.15 foot recession rate	7.1
	@ 0.5	24.0
	@ 1.0	47.5
	@ 2.0	95.0

Section Eroding = 200 feet long		
4 foot high eroding bank	@ 0.15 foot recession rate	5.7
	@ 0.5	19.0
	@ 1.0	38.0
	@ 2.0	76.0
6 foot high eroding bank	@ 0.15 foot recession rate	8.6
	@ 0.5	28.5
	@ 1.0	57.0
	@ 2.0	114.0
8 foot high eroding bank	@ 0.15 foot recession rate	11.4
	@ 0.5	38.0
	@ 1.0	76.0
	@ 2.0	152.0
10 foot high eroding bank	@ 0.15 foot recession rate	14.3
	@ 0.5	47.5
	@ 1.0	95.0
	@ 2.0	190.0

Note: Use 95 pounds per cubic foot

Section Eroding = 300 feet long			**Tons**
4 foot high eroding bank	@ 0.15	foot recession rate	8.6
	@ 0.5		28.5
	@ 1.0		57.0
	@ 2.0		114.0
6 foot high eroding bank	@ 0.15	foot recession rate	12.8
	@ 0.5		43.0
	@ 1.0		85.5
	@ 2.0		171.0
8 foot high eroding bank	@ 0.15	foot recession rate	17.1
	@ 0.5		57.0
	@ 1.0		114.0
	@ 2.0		228.0
10 foot high eroding bank	@ 0.15	foot recession rate	21.4
	@ 0.5		71.0
	@ 1.0		142.0
	@ 2.0		285.0

Section Eroding = 400 feet long			
4 foot high eroding bank	@ 0.15	foot recession rate	11.4
	@ 0.5		38.0
	@ 1.0		76.0
	@ 2.0		152.0
6 foot high eroding bank	@ 0.15	foot recession rate	17.1
	@ 0.5		57.0
	@ 1.0		114.0
	@ 2.0		228.0
8 foot high eroding bank	@ 0.15	foot recession rate	22.8
	@ 0.5		76.0
	@ 1.0		152.0
	@ 2.0		304.0
10 foot high eroding bank	@ 0.15	foot recession rate	28.5
	@ 0.5		95.0
	@ 1.0		190.0
	@ 2.0		380.0

Note: Use 95 pounds per cubic foot

Sheet 1

Figure 18

WATERSHED SUMMARY (Oct. 1998)	Argyle Lake	Lake Bloomington	Canteen Creek	Little Canteen Creek	Carbon Cliff	Lake Carlinville	Cain Creek	Crotty Creek	Lake Decatur	Governor Bond	Mauvais Terre	Nippersink	Palmer Creek	Powdermill Creek
(Updated after Metro-East Re-Eval.)							(incl. Wilson)							
												(Wonder Lake)		
Acres	3,618	43,100	14,500	5,095	1,470	15,966	6,818	737	593,400	22,061	20,510	62,270	2,932	2,765
Square miles	5.65	67.34	22.66	7.96	2.3	24.95	10.6	1.15	927.2	34.5	32	97.3	4.6	4.32
EROSION (tons)														
							(RUSLE)			0			(RUSLE)	
Sheet and Rill	11,382	128,200	109,486	28,070		77,500	101,000	1,129	2,460,600	98,546	121,000	304,100	43,000	10,150
Ephemeral	11,000	64,870	26,930	3,920		3,100	30,300	170		11,825	12,730	44,400	13,900	1,330
Gully	10,235	3,820	0.0496 20,250	15,000	(@0.017) 420	9,600	10,400	(@0.065) 2,866	185,240	(@0.022) 11,390	6,270	(@0.02) 7,590	7,375	(@0.04) 5,570
Streambank	(included)	(included)	2,800	0.055 725	(@ 0.032) 290	1,600	1,100	(@0.045) 235		(@0.025) 1,050	(included)	(@0.01) 575	900	(@0.055) 2,000
Shoreline	0	1,000	0	0	0	1,100								0
GROSS EROSION	33,597	197,890	159,466	47,714		93,400	142,800	4,400	2,645,840	122,800	140,000	356,635	64,700	19,050
Erosion (tons) / Acre watershed	9	4.6	11	9.4		5.85	20.9	5.97	4.46	5.56	6.8	5.7	22.1	6.9
Erosion (tons) / Square mile watershed	5,769.40	2,939	7,037	5,994		3,743	13,470	3,826	2,854	3,559	4375	3,665	14,000	4,398
SDR														
Sheet and Rill	0.2	0.245	.85 and .75	.85 and .75		0.13	.85 and .75	0.25		0.71	0.13	(ave.) 0.58	0.65 and 0.75	0.65 and 0.75
Ephemeral	0.25	0.245	0.75	0.8		0.35	0.85	0.5		0.9	0.2	0.75	0.8	0.85
Gully	0.75	0.95	0.9	0.9	0.9	0.53	0.95	0.8	0.18	0.9	0.63	0.85	0.95	0.95
Streambank	0.75		1	1	1	0.53	1	1		1	(included)	1	1	1
Shoreline	0	1	0	0	0	0		0		0	0	0		0
(or Watershed SDR)	-0.37	0.26							0.15					
Sediment from each source (tons)														
Sheet and Rill	1,806	31,430	77,734	20,160		9,900	73,800	263		70,000	15,864	201,500	28,500	7,459
Ephemeral	2,750	15,890	20,000	3,100		1,100	25,300	84		10,600	2,496	33,300	11,100	1,130
Gully	7,676	3,830	18,000	13,500	375	6,700	9,800	2,293		10,250	3,940	6,425	7,000	5,291
Streambank			2,800	725	290	(included)	1,100	235		1,050	(included)	575	900	2,000
Shoreline	0	1,000	0	0	0	(included)		below Rt 6 135		0				0
TOTAL SEDIMENT	12,232	51,960	(Rt. 157) 118,534	(Rt. 157) 37,484		17,765	110,000	3,030	385,310	91,900	22,300	241,800	47,500	15,880
Sediment Transport Factor (if used)	no	no	0.41	0.59	0.78	no	0.55	no	no	0.35	no	0.15	0.68	0.66
(In-watershed Sediment Basins?)			0.15	No			0.05						0.1	No
DELIVERED SEDIMENT (tons)	12,232	51,960	41,000	22,100		17,765	57,000	I & M 3,030	385,310	32,200	22,300	36,270	29,000	(Rt. 157) 10,400
Sediment (tons) / Acre of watershed	3.4	1.21	2.8	4.3		1.11	8.4	4.11	0.65	1.46	1.09	0.58	9.9	3.8
Sediment (tons) / Square mile of watershed	2,165	772	1,809	2,776		712	5,380	2,635	416	933	697	373	6,300	2,407
Sediment (ac-ft) aerated at 95 pcf			19.8	10.7			27.5						14	5
Sediment (ac-ft) submerged at 45 pcf			41.8	22.6			58.2						29.6	10.6
Sediment (cu-yds) aerated at 95 pcf			31,900	17,200										8,000
Sediment (cu-yds) submerged at 45 pcf			67,000	36,300										17,000
Trap Efficiency	0.96	0.93				0.87		0.96	0.65	0.9	0.65	0.8		0
Deposited in Sink (tons)	8,247**	48,400				15,300		both sinks 2,970	250,450	28,960	14,500	29,000		(@ Rt 158) 8,100
Pounds / cubic foot (submerged)	42	50	45			54				50	53	50		95
Pounds / cubic foot (aerated)			95											
Deposited in Sink (acre-feet)	9	44.4				13		I & M only 1.1		26.6	12.5	26.8		3.9
(cubic yards)														6,290
Through Sink, back into system (tons)	344	3,640				2,465		60	134,860	3,310	7,800	7,270		
	** 3640 trapped in road culverts													

Sheet 2

-Figure 18-

Richland Creek	Sand Creek	Schoenberger Creek	Schoolhouse	Spring Lake	Lake Taylorville	Washington Lake	Judy's	Embarras River	Burdick's	Mackinaw River
17,223	8,370	7,704	4,615	12,966	80,400	6,822	5,527	1,566,450	1,789	744,300
26.91	13.08	12.04	7.21	20.26	125.63	10.66	8.64	2,440	2.81	1,163
66,000	14,600	19,922	35,639	49,775	250,900	16,130	47,115	5,172,800	14,839	3,000,000
9,900	1,460	2,526	7,100	5,000	37,600	3,200	9,600	775,920	3,030	280,000
(@0.0496) 46,000	ave. .035 2,100	(@0.04) 13,250	11,800	(ave. 0.21) 10,400	17,500	1,030	10,500	683,760	3,700	250,000
(@0.055) 10,000	(@0.07) 1,700	(@0.055) 4,000	1,200	(@0.014) 405	12,500	140	670	93,500	700	200,000
0	0	0		350	0	710				
132,000	19,600	39,698	55,639	65,930	318,500	21,210	67,885	6,725,960	22,269	3,730,000
7.66	2.37	5.2	12	5.08	3.96	3.11	12.3	4.29	12.4	5.01
4,905	1,514	3,297	7,703	3,254	2,535	1,990	7,857	2,756	7,925	3,207
0.75	0.25	0.65 and 0.75	0.65 and 0.75	0.75	0.27	0.75	0.65 and 0.75	0.75	0.65 and 0.75	0.7
0.85	0.35	0.8	0.85	0.75	0.4	0.85	0.85	0.85	0.85	0.8
0.9	0.75	0.9	0.95	0.85	0.95	0.85	0.95	0.8	0.95	0.85
1	0.9	1	1	1	1	1	1	1	1	1
0	0			1	0	1				
49,500	3,600	14,200	26,016	37,331	67,700	12,097	34,000	3,879,600	10,981	2,100,000
8,400	500	2,000	6,035	3,750	15,000	2,700	8,160	659,500	2,576	224,000
41,000	1,500	11,900	11,020	8,850	16,600	880	9,975	547,000	3,515	212,000
10,000	1,500	4,000	1,200	405	12,500	139	670	93,000	700	200,000
0	0			350	0	705				
108,000	7,100	32,100	44,271	50,686	118,800	16,521	52,805	5,180,000	17,772	2,736,500
0.35	no	0.54	0.6	0.37	no	0.44	0.57	0.25	0.74	0.25
		0.17	No				0.1		0.05	
(to Rt. 158) 38,000	7,100	14,300	26,500	18,750	118,800	7,269	27,000	1,295,000	12,500	684,000
2.21	0.85	1.9	5.7	1.48	1.48	1.11	4.9	0.83	6.9	0.92
1,412	543	1,187	3,675	925	946	692	3,125	531	4,448	588
		6.9	12.8				13		6	
		14.6	27				27.5		12.8	
		11,100	20,600				21,000		9,600	
		23,500	43,600				44,300		20,600	
				0.9	0.87	0.9				
(@ Rt 158) 38,000				16,675	97,300	6,570				
95	aerated 110			60	55	50				
18.4	3			12.9	81.4	6				
29,679	4,800			20,800	131,300	9,700		2,000,000		1,000,000
				1,675	21,500	700				

-Figure 19- R. D. Windhorn 2011

Watershed Erosion and Sedimentation Inventory Procedure

I. Introduction

A. Purpose

- To estimate suspended sediment load at outlet of watershed
- To help determine highest priority watershed for future work
- To gather information in a manner that is both cost- and time-effective
- To create statistically reliable data that will allow all land users to better manage their land for future generations

B. Level of Detail

- Determined by scale and intensity of project
- Match detail to actual need within the watershed

C. Evaluation Criteria for natural conditions or processes that are difficult to quantify with hard numbers

D. Limitations of the Procedure - NOT a monitoring system and NOT site specific, i.e. will not pick out every eroding streambank in the watershed

E. Results (Product) - Predicts average annual rates

II. Background and General Procedure

A. Rapid Assessment, Point Method (RAP-M) - allows for measurement of current conditions in selected statistically valid sampling units and then projects this data to entire watershed

B. Consistency is the key! Follow same procedures throughout each individual watershed for each method

C. Overall sampling unit selection

- Random stratified sampling procedure
- Sampling units of 160-acre blocks

D. Gross Erosion totals - need acreage totals for each major type of land use and slope group class (A and B slope, cultivated) vs. (C+ slope, cultivated)

III. Erosion

A. Sheet and Rill - RUSLE procedure (USLE in woodland, urban areas)

- Apply to each land use type
- Determine rates of erosion
- Apply rates to total acres of each land use type to give overall sheet and rill quantity
- Expand from sample areas to represent entire watershed

B. Ephemeral - in-field measurement or estimated as percent of sheet and rill erosion

- Procedure developed years ago now in FOTG
- Use same 160-acre sampling blocks
- Determine rates of erosion
- Expand these rates from sampled areas to represent entire watershed

C. Gully - use Lateral Recession Rate method

- Randomly selected gully reaches within the 160-acre sample units
- Determine rates of erosion per foot of linear gully
- Measure total gullies in the selected 160-acre sampling units - expand this measurement to entire watershed
- Use erosion rate and total miles of gullies to determine erosion for the watershed

D. Streambank - use Lateral Recession Rate method

- Randomly selected streambank reaches of approximately one-quarter mile in length
- Determine rates of erosion per foot of linear streambank
- Use aerial photography to locate eroding reaches of streams
- Measure miles of streambank within the watershed
- Apply erosion rate to number of miles to arrive at streambank erosion total for the watershed

E. Other

- Shoreline - use Lateral Recession Rate or actual measured quantity, project for the entire lake shore
- Roadside - only used in areas undergoing recent construction activities

F. Gross Erosion - Gross erosion for entire watershed is summation of all the above totals

IV. Sedimentation

A. Sediment Delivery Rates (SDR)

- Each type of erosion produces sediment, but each also produces differing amounts
- Sheet and rill erosion has the most variable SDR's due to the laminar or sheet flow
- Ephemeral, gully and streambank erosion are considered different forms of channel flow, with generally greater SDR's but less variability
- The appropriate SDR is multiplied by the total erosion amount for that type of erosion within a given land use to obtain sediment delivered to the field edge and ready for flow into the stream system. (on-site delivery)
- The total of these products give the proportion of the gross erosion in the watershed that is mobile (See page 12 for SDR guidelines)

B. Sediment Transport Factor (STF)

- Each type of stream system transports sediment at different rates. STF estimates off-site sediment movement through different types of stream systems
- STF captures the watershed differences that are NOT associated with cultural activities of man, for example watershed size, drainage density, stream gradients, etc.
- If SDR totals are summed and multiplied by the STF, the total suspended sediment load at the watershed outlet is determined (See page 13 for STF guidelines)

-Figure 20-

R. D. Windhorn 10/00

Level of Detail for Erosion and Sedimentation Studies -Illinois-

Level of Detail	Purpose	Procedures Used	By whom	Time Involved
Level 1 (General)	Overall view of eros/sed in large w.s. > 100,000 ac or smaller ones where only magnitude of loss needed	Map work Use similar watershed 1 SDR /erosion type 1 STF /watershed Generalized assumptions	FO staff RSS ENG	Office: 90% Field: 10%
Level 2	**RAP-M** ***(Simplified Version)***	Use average S & R / land use Measure Ephemeral in field Estimate Gully/Stream erosion by watershed type	FO staff RSS ENG	Office: 80% Field: 20%
Level 3	Determine eros/sed at level necessary for Planning and selecting Alternatives to observed watershed problems - PL 566 - Project-neutral Planning **- RAP-M Plus** ***(Detailed Version)***	Use ave. S & R rates/land use Ephemeral measured in field SDR's for S & R calculated in field Gully/streambank sampling - set up 5-20% sample Can use multiple SDR's	Sed. Specialist	Office: 40& Field: 60%
Level 4 (Very Detailed)	Detailed enough for engrn. determinations regarding sediment storage. Generally small subwatersheds.	Measure S & R in watershed Measure Ephemeral in field Walk ALL gullies/streams Calculate SDR for S & R in field. Use multiple SDR's Sediment source analysis	Sed. Specialist	Office: 20% Field: 80%

Literature Referenced

Biedenharn, D.S., C.M. Elliott, and C.C. Watson, 1997. *The WES Stream Investigation and Streambank Stabilization Handbook.* U.S. Army Corps of Engineers, Waterways Experiment Station (WES), Vicksburg, Mississippi.

Environmental Protection Agency. 1997. *Techniques for Tracking, Evaluating, and Reporting The Implementation of Nonpoint Source Control Measures.* U.S. Environmental Protection Agency, EPA-841-B-97-010, Office of Water, Washington D.C.

The Federal Interagency Stream Restoration Work Group. 1998. *Stream Corridor Restoration – Principles, Processes, and Practices.*

Harvey, M.D., C.C. Watson, and S.A. Schumm. 1985. *Gully Erosion.* Technical Note 366. U.S. Department of the Interior, Bureau of Land Management. Denver, Colorado.

Natural Resources Conservation Service, U.S. Department of Agriculture, Field Office Technical Guide, Sections I and II.

Natural Resources Conservation Service, U.S. Department of Agriculture. *National Engineering Handbook,* Section 3 Sedimentation.

Renard, K.G., Foster, G.A. Weesies, D.K. McCool, and D.C. Yoder, coordinators. 1997. *Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE).* U.S. Department of Agriculture, Agriculture Handbook No. 703, 404 pages.

Schumm, S.A., M.D. Harvey, and C.C. Watson. 1984. *Incised Channels: Morphology, Dynamics and Control.* Water Resources Publications, Littleton, Colorado.

Steffen, Lyle J., 1983. *Erosion and Sediment Yield.* Channel Evaluation Workshop, U.S. Department of Agriculture, Soil Conservation Service. Ventura, California.

Wishmeier, W.H., and Smith, D.D. 1978. *Predicting Rainfall Erosion Losses – A Guide to Conservation Planning.* U.S. Department of Agriculture, Agriculture Handbook No. 537.

Example Sediment Report Using RAP-M Inventory

LAMOTTE CREEK INVESTIGATION CONDUCTED

An erosion/sedimentation inventory was conducted for Lamotte Creek watershed in Crawford County. The watershed totals approximately 15,390 acres or about 24.0 square miles. Sediment Delivery Rates (SDR) for each type of erosion occurring within the watershed and a Sediment Transport Factor (STF) for the entire watershed were also calculated. The main goal was to estimate total suspended sediment load at the mouth of LaMotte Creek where it flows into the Wabash River. This sediment load is considered to be an **average annual rate**.

Surficial geology in this watershed is somewhat variable. This watershed is in the Till Plains Section of the Central Lowland Province physiographic area. Within the Till Plains Section it is considered to be in the Springfield Plain. What these designations allow us to do is group soils and landscapes that are similar and make more generalized, regional statements. In most areas, Peoria Loess (Wisconsin) overlies diamictons (glacial till) of the Glasford Formation (Illinoian) that is generally loam, clay loam or silty clay loam in texture. The thickness of this loess is variable, with depths ranging from less than 2 feet thick to greater than 5 feet thick. This till unit has been named the Vandalia Till and underlies much of southeastern Illinois. Stream dissection has also exposed the underlying Pennsylvanian-aged shale in a few areas. The major stream valleys are composed of deposits of Cahokia Alluvium (old) that is generally less than 20 feet thick. Shale bedrock is below this alluvium on the major valleys, but glacial till can be below the alluvium on the upper reaches of the streams or where smaller tributaries join the main drains as they exit from the surrounding uplands. In the north-central and northeast part of the watershed, loamy and sandy surficial units, designated as the Henry Formation, are present that are stream and terrace deposits laid down by the Wabash River during the Wisconsin time period. On the steeper slopes, especially in the western and southern part of the watershed, the glacial till is the surface unit, with the loess having been truncated. Soils mapped in this watershed reflect the parent material differences discussed above. The surface texture of the soils in greater than 70% of the watershed is a silt loam, reflecting the characteristics of the loess cover that blankets nearly the entire region. This material is quite erosive and is easily removed if exposed to running water. Soils having fragipan characteristics are scattered throughout the watershed, and can be quite erosive if occurring on gentle slopes. The alluvium in the streambanks can contain a variety of materials with a variety of textures and grain size content. Stability of the streambanks is greatly dependent on the shear characteristics of the material, and on a watershed scale, it is difficult to make "general" statements about overall conditions. Site specific determinations are essential for future streambank stabilization activities.

The entire watershed was divided into "pieces" to analyze. To do this, three Geomorphic Units (GU) were set up. These Geomorphic Units are simply landscape units that are similar in geology, slope, soil, etc. and in anticipated response to erosion. These units are: **GU1**, Major floodplains and large wetlands (sinks); **GU2**, Upland flats and depressions with slopes generally 5% or less; **GU3**, Upland, sloping areas, with slopes generally greater than 5%. Each GU produces differing sediment amounts depending on dominant erosion within it. Some, as in GU1, serve more as sediment "sinks" or deposition areas than they do as "sources" or eroding areas. Within GU2, there are a few areas that literally produce no sediment that will impact a surface water body. These areas are called Areas-of-No-Significant-Sediment (ANoSS). Generally, they are relatively flat or even depressional areas of less than 2 percent slope that are not impacted by run-on water, and are more than 2,000 feet from a concentrated flow area (waterway, ditch, gully). These areas have a very low priority for watershed land treatment, in regards to affecting water quality at the outlet.

At least five different types of erosion can produce sediment: sheet, rill, ephemeral, gully, and streambank. In the LaMotte Creek watershed, sheet and rill erosion values were computed from data gathered during the Erosion and Sediment Inventory. In NRCS, we use a process referred to as the Rapid Assessment, Point Method (RAP-M) to statistically estimate erosion and sedimentation rates within any given watershed by sampling a portion and then expanding this data to fit the entire watershed. A Random-Stratified Sampling Procedure was used to select areas to be sampled. Generally, these units were 160 acres in size, and were selected throughout the watershed, with an attempt to characterize all different land uses that are present. Inventory data collected in the field from these sites includes all information necessary to compute sheet and rill erosion losses. Using this data, an **annual** soil loss rate for each type of major land use within the watershed was determined. If the total number of acres for each land use is multiplied times this rate, a gross amount of sheet and rill erosion occurring within the watershed can be estimated. From these same 160-acre sample units, ephemeral gully and "classic" gully reaches were also selected, again using a random procedure.

Ephemeral or "annual gully" erosion was evaluated in the field by either actual measurement of area voided or by applying a standard formula to estimate the total erosion produced on an average **annual** basis. The rates produced using these methods were then projected and expanded to fit the rest of the LaMotte Creek watershed.

Gully erosion ("classic gully" or "perennial gully") was measured in the field within the above mentioned selected sample units. A selected number of the gullies were walked and in-field measurements were made on both the left and right banks in regard to severity of erosion or deposition. An erosion rate, called a "Lateral Recession Rate", was applied to each measured section. These values were summarized and combined to produce an **annual** rate of erosion in tons or pounds of soil material removed per linear foot of gully. The estimated feet of gullies per sample unit was obtained by map wheel measurement from 7.5 minute quadrangle maps, with in-field checking and verification. This value was then expanded to fit the watershed, by first determining which GU unit is most affected by this type of erosion. In LaMotte Creek watershed, GU 3 contains virtually all of the "classic" gullies. So, this unit will represent the entire watershed.

Streambank erosion, the final type of erosion measured, was calculated in a manner very similar to that used for the gully erosion. Selected segments of the main creek and all of the major tributaries were walked. In general, if the selected reach represents a perennial water body (solid blue line on quad map), it was called a "stream"; if it was intermittent (dashed blue line) with a flood plain, it was also called a "stream"; other concentrated flow areas were designated as "gullies." By measurement, approximately 26.9 miles of perennial streams exist within the total watershed. Of this total, approximately 11.6 miles are from the main channel of LaMotte Creek itself. The rate of streambank erosion was calculated exactly as it was done for the previously mentioned gully erosion, using slightly different qualitative parameters and then summarized. Using the measured rates of streambank erosion and the map measured miles of streams that are currently eroding, an estimate of the quantity of erosion taking place was obtained.

In a dynamic environment that is constantly adjusting to man-made and geologic conditions, gullies and streams (as well as all other landscape characteristics!) are in a perpetual state of shifting between downcutting and deposition. During field measurements, an attempt was made to verify the overall general percentage of gullies and streambanks eroding or, if possible, changes in these percentages based on landforms, soils, etc. If this field-verified value was significantly different from that percentage arrived at from the sample inventory, then a slight adjustment was made in the overall rate of gully erosion to account for this.

SHEET AND RILL EROSION in LaMotte Creek

Sheet and rill erosion occurs on all land whether it is cultivated or not. It is a very natural, unending process. It is more of a concern when it is accelerated by man's activities. In the LaMotte Creek watershed, sheet and rill erosion was estimated, on a per acre basis, for all the dominant land uses. For cropland, evaluations were made for both the "A" and "B" slope areas (0 to 4%), for the "B2" areas with slopes up to 5% and moderately eroded, and for the "C" slope and greater areas (5%+). Average rates of soil loss for A/B slope areas were 2.4 T/A/year. For B2 slope areas, the rate was 5.3 T/A/year. For C slope and steeper areas of cropland, soil loss was 8.5 T/A/year. In this watershed, land currently in CRP was still considered to be Cropland, and was included in the above appropriate category.

Areas of woodland were grouped together, regardless of slope, and had an overall rate of erosion of about 0.6 T/A/year. This included a few areas that had been grazed in the past but now were relatively undisturbed. Pastures and other grasslands were grouped regardless of slope because there were only a small percentage of fields that fell into this category. The average soil loss on these areas was 1.9 T/A/year. "Urban" areas in this watershed consisted of farmsteads, roads, feedlots, city parks, and a few other areas, of all slopes. Soil loss from these areas was low, with an average annual rate of 0.8 T/A/year. The only other type of land use considered in this watershed was Wildlife Land, which consisted of land of all slopes that was brushy or otherwise unmanaged for anything else. It was generally moderately rolling to steep and had an average annual soil loss rate of 0.5 T/A/year.

Total sheet and rill erosion from **cropland** is estimated to be 37,310 tons per year. This figures out to be about 3.2 T/A/year for all cropland. Sheet and rill erosion from pasture and grassland is about 1,170 tons per year, with woodland areas producing about 920 tons per year. Rural "urban" areas produce only about 620 tons of erosion per year and Wildlife Land about 310 tons per year. **Total sheet and rill erosion** in the LaMotte Creek watershed is estimated to be 40,330 **tons per year**. This is roughly 2.6 T/A/year for each acre of land in the entire watershed.

EPHEMERAL EROSION in LaMotte Creek

Ephemeral erosion occurs when tiny rills coalesce into small channels that tend to "funnel" water in a concentrated flow. These ephemeral, or "annual" gullies, are usually destroyed each year as the tillage for the year is completed. However, if the rate of erosion is great enough, the small channels will enlarge, even in a year's time, to concentrated flow areas that are too large to be crossed with normal tillage implements. This, then, becomes the beginning of the more "classic" perennial gully. These ephemerals generally begin to form where relatively "flat" or gently sloping soils "break" into steeper areas. Often times, they form on the edge of cultivated fields where the native vegetation is no longer in place to hold the soil during the higher flow times. In the past couple years, more emphasis has been placed on attempting to measure the amounts of erosion from these gullies. Studies have indicated that in some states, these contribute as much erosion, and thus sediment, as does sheet and rill erosion. For this field study, the length and grade of each ephemeral, and the type of tillage surrounding each of these was recorded. This information was then plugged-in to a predictive formula that has been developed to estimate tonnage of erosion, assuming one annual voiding. In this watershed, approximately **8,500** tons of erosion can be contributed to the **ephemerals**.

GULLY EROSION in LaMotte Creek

Gully erosion was estimated in the entire watershed by selecting random "reaches," evaluating these "qualitatively" to obtain "quantitative" values, and then "expanding" this data to fit the remainder of the watershed. The premise for this is that if enough segments are sampled, areas that are only slightly eroding as well as those that are very severely eroding will be selected to evaluate. This percentage then, can be used throughout the watershed with statistical validity. The "qualitative assessment" used to assign Lateral Recession Rates is one that bases observed physical features of the gullies with actual measured amounts from many Midwest watersheds. In LaMotte Creek, many gullies contained "knickpoints," or small overfalls in the base of the channel. This can indicate recent downcutting and also indicate a difference in soil material. In areas where loess overlies glacial till, a whole series of these knickpoints can be traced up many of the gullies. In regard to sediment production, each type of material produces different rates - the loess is most susceptible and will readily collapse into the gully and be moved off-site. The glacial till has more strength and is more difficult to erode, but can be eroded over time. Glacial till generally contains the large stones and much of the sand and gravel that is observed in the streambed farther down. With the degree of dissection present in this watershed, the erosion produced by eroding gullies can become significant quickly. In LaMotte Creek watershed, approximately **6,000** tons of soil is eroded each year that can be attributed to **gullies.**

STREAMBANK EROSION AND SEDIMENTATION in LaMotte Creek

Streambank erosion in any watershed is a rather complex and detailed process. As the stream meanders across its valley or floodplain, "new" sediment is being added continually as the stream cuts into its banks. However, sediment is also being deposited in perhaps another portion of the stream as energy levels of the stream rise and fall. If the "net effect" remains somewhat constant over a period of years, the stream is considered "stable" and the changes are considered to be part of a "dynamic equilibrium" condition that exists within the watershed. If, however, this ongoing process is skewed one way or the other and either severe downcutting and bank caving predominates or extreme rates of sedimentation within the stream are occurring, then it is considered to be "unstable." In truth, many streams experience all of this variation if all stream reaches from headlands to mouth are considered. To determine the magnitude of the dominant process occurring, then, the stream itself must be walked and evaluated. In most cases, no other "measured" streambank data has been gathered in the past, so these **estimates** become the base for determining present sediment yield and future projections that would be modified by treatment measures in the watershed.

The field data collected by NRCS staff conducting the Streambank Inventory, contained estimates of Lateral Recession Rates (erosion rates) that ranged from "slight" (0.03 of a foot per year) up to "very severe" (3.0 feet per year) of actual bank recession. These estimates could underestimate the erosion amounts coming from the most severely eroding sites. It is assumed that on every stream reach in Illinois the "slightly" and "moderately" eroding areas probably contribute very small amounts of sediment to the overall average annual yield. This has helped to bring these more in line with actual measured values.

In this inventory and using NRCS methods of "visual assessment," an overall rate of streambank erosion, on an **average annual basis**, was calculated for LaMotte Creek and several of the major tributaries. The average annual recession rate calculated for LaMotte Creek and its tributaries was 53 pounds of soil per linear foot of streambank. Using this rate and the known length of perennial streams in the watershed, total **streambank** erosion is estimated to be **3,760** tons, which is considered to be an **average annual rate.**

SEDIMENT DELIVERY RATES (SDR) and SEDIMENT TRANSPORT FACTOR (STF)

Only a portion of the sediment produced reaches a concentrated water source. Then, the stream system itself transports only a portion of what actually enters it. To account for this, Sediment Delivery Rates (SDR) and Sediment Transport Factors (STF) are used. These factors are similar to the Blue Book value of a used car -- for a car, start out with a base value and then add or subtract from that, depending on the options and mileage on the car. For this watershed, start out with a "standard" value and then adjust this number up or down based on landscape characteristics. The LaMotte Creek watershed is somewhat complex when it comes to overland flow of water and sediment. It is a mature watershed, geologically, with an abundance of short, steep slopes along the major drains but longer, more gentle slopes away from the drains. Stream dissection and downcutting is quite evident in some parts of the watershed. What this means is that some of the sediment moves just to the base of the slopes while other sediment may move entirely through the watershed.

SDR's vary for each type of erosion, as would be expected. Sheet and rill erosion and the sediment it produces varies dramatically across this watershed. In the area surrounding the main LaMotte Creek segment and the other major tributaries, sheet and rill erosion potential is greatest. The land is more sloping and the slopes are often short and "choppy." Conversely, in the areas of the watershed where the slopes are longer and more gradual or the land is nearly level, the soils do not have a high erosion potential. Along the path to a concentrated water flow area, many options are available for the sediment. Small sinks or traps are found within this watershed and include potholes, small ponds, wetlands, and even the flat parts of upland fields. In many cases, the wide floodplains can serve a very natural and useful purpose by also keeping sediment from entering the streams. Some of these "local" sinks effectively capture nearly 100% of the sediment produced above them in their subwatershed.

SEDIMENT DELIVERY RATES in LaMotte Creek

Sediment Delivery Rates (SDR) are used to predict the quantity of sediment that is moved "on-site" to be "available for transport." For example, sediment is produced on a sloping, cultivated field each year as the farmer chisel plows the field. The sediment moves down the slope, and here, some of it becomes immobile as it imbeds itself within the grass or is deposited where there is a change in slope. Some of it, however, is in a position near a waterway, or ditch, or shallow field channel that makes it available to move farther with the next storm event. SDR's are developed for each type of erosion and often times, several are developed for sheet and rill erosion, based on where the slopes are within the watershed.

Sheet and rill erosion has the most complicated Sediment Delivery Rate, because it involves sheet or laminar flow, as opposed to channel flow. Some of the factors involved in determining this are land slope, distance from a concentrated flow area, slope configuration, NRCS runoff curve number, and a surface roughness coefficient. Usually a "base rate" is determined for the conditions in the watershed or subwatershed, and then adjustments are made to that rate based on subsidiary conditions. A strong attempt is made to apply these criteria in a uniform and consistent manner throughout. Since sheet and rill erosion from the cropland areas was so varied, due to slope and land use, no single value of SDR seemed to suffice. For cropland areas, three different SDR's were used, generally based on whether the soils were less than or greater than 5%. For pastureland and grassland, only one SDR was used. Woodland was the major land use along some of the main stream tributaries and was comprised of those areas that were relatively undisturbed and those areas that had been grazed in the past. Also, a range of slope phases were included within this category. Because of this variation, only one SDR was applied. Wildlife Land also was composed of a variety of slopes and ground cover conditions. Only one SDR was used here. Finally, "urban" areas also had a separate SDR applied because the close-cut lawns, feedlots, city parks, etc. causes transport factors to be significantly different than cultivated fields. The different SDR's used in this watershed for sheet and rill erosion ranged from 0.11 to 0.60.

Ephemeral, gully, and streambank erosion are all considered to be a form of "channel" erosion which have larger SDR's because often times the erosion-produced sediment comes from the channel bottom and sides themselves, therefore naturally being more directly tied to delivery into the stream system. Ephemeral SDR's commonly are in the 0.75 to 0.85 range. In the LaMotte Creek watershed, a value of 0.70 was used for all the ephemeral erosion sediment routing purposes.

Gullies serve as almost the "perfect funnel" to move sediment directly into the entire stream system. Gullies that lie immediately adjacent to the main channel have SDR's of 0.90 to 1.0. Gullies that occur on the extreme upper reaches of the watershed may have a range of 0.70 to 0.90. In this watershed, a rate of 0.75 was used for all the gullies.

Streambanks, of course, have an SDR of 0.95 to 1.0. Literally everything that is eroded from the streambanks falls in the stream and is immediately available for transport. This is one of the reasons that even though the quantities of sediment produced by streams is not as great as compared to some of the other sources, it is literally 100% "delivered." Sheet and rill produces large quantities of erosion and sediment, but only a fraction of it actually enters the system. Therefore, it is often times more important to treat the streambank areas because the sediment is much more "concentrated" and can often be considered a "point" source of pollution.

SEDIMENT TRANSPORT FACTOR for LaMotte Creek

Sediment Transport is the final step in our erosion/sediment cycle. Sediment Transport Factors (STF) attempt to rate the overall effectiveness of the entire stream system in moving sediment through. Stream systems that are relatively small, have high gradients, and have small tributaries that reach to almost all the segments of the uplands move sediment through much more completely and rapidly than ones that are quite large with numerous locations for sediment to drop out, have low stream gradients, and have numerous undrained upland areas. The STF is based on several factors, including drainage density, drainage texture, relief/length ratios, valley slope of 3rd order streams, size of the watershed, type of sediment that is predominant, percent of the watershed "controlled" by natural or man-made "sinks," stage of stream system development, etc. These factors are weighted and then applied to the stream system in as uniformly and consistent manner as is possible. The number produced by the rating system is simply multiplied times the total sediment "available for transport" and this number is then the total sediment, from all sources, delivered to the Wabash River. For this watershed, a STF of 0.57 was used for sheet, rill, ephemeral, gully and streambank erosion.

SUMMARY OF EROSION AND SEDIMENTATION IN LAMOTTE CREEK WATER SHED

In LaMotte Creek watershed, an estimated **58,590 tons of erosion** occurs on an annual basis from the five major types of soil erosion. If this number is divided by the number of acres in the watershed, a rate of about 3.8 tons per acre per year is obtained, when ALL sources of erosion are considered. Of this total, approximately **12,900** tons of **sediment** is actually "delivered" to the outlet end of the watershed at the Wabash River. This gives an overall rate of 0.8 tons per acre per year or 512 tons of sediment per square mile of watershed. At 50 pounds per cubic foot for submerged (saturated) sediment, this also calculates to be 11.8 acre-feet of sediment deposition on an annual basis.

Roughly 38% of the sediment comes from sheet and rill erosion and 26% from ephemeral erosion (channel). Gully erosion (channel) contributes about 20% and about 16% comes from streambank erosion (channel). Remember, though, that sheet and rill sediment comes from all 15,390 acres of the watershed, while the streambank sediment comes from only about 26.9 miles of stream, of which less than one-third of the total mileage is producing nearly three-quarters of the total load. Likewise, there is still much discussion on SDR rates for slopes less than 5%. It is believed presently that SDR **base rates** of 0.10 to 0.15 may be more appropriate.

Bedload material is very seldom measured as an output at the point of delivery, because of the cost and extensive sampling equipment that is necessary to complete this job. USGS gage stations do not routinely sample or measure this material. General estimates can be made, based on suspended sediment quantities. In Illinois, estimates of 5 to 10 percent of this total can be used. In this case, then, using NRCS methods, roughly 645 to 1290 tons could be added to the total suspended load delivered of 12,900 tons. In most cases, bedload type, composition, and grain size coming from the streambanks and streambeds, is used extensively in channel design and channel geomorphology studies but is not routinely reported.

Assessing the overall "dynamic equilibrium" stage in a watershed is most difficult indeed! In other words, is the stream system still degrading or has the sediment production in the watershed reached a peak and now will begin to decline?! Years ago, several geomorphologists developed a landscape model called the Channel Evolution Model that was intended to determine the relative differences between gullies/streambanks that were progressing from a "stable" condition, Stage 1, through a series of "unstable" steps to a new, but geologically lower "stable" condition called Stage 5. This process can take decades or several millennium. LaMotte Creek is definitely undergoing incision or downcutting in many of its tributaries (Stage 2). As long as downcutting is occurring, continual amounts of sediment will be produced. This rate of sediment production will only begin to decrease when the streams reach a condition of bed stability that will in turn allow the streambanks to stabilize (Stage 4). Watershed efforts can assist this progression, but total watershed stability is a long way in the future!

SUGGESTIONS FOR EROSION AND SEDIMENT CONTROL

1. For the most effective land treatment control, concentrate any land treatment alternatives on the sloping (>5%) areas that lie immediately adjacent to the channels or streams themselves . In other words, because the "flat" land doesn't really produce much sediment that reaches the Wabash River, it is not necessary to spend unproductive time and effort in these areas.

2. If needed, select a "pilot" subwatershed and concentrate land treatment or structural control efforts here. From this "base" a better estimate as to effectiveness of these controls could be made for the remainder of the entire watershed. These smaller subwatersheds also give the local people a better visual example of how their erosion control methods will work.

3. Select highly visible or locally "known" eroding sites for demonstration areas, particularly if streambank stabilization is included as part of the project. It will be easier to point at these to demonstrate how effective local efforts have been.

4. If structural measures are used in the watershed, it is important to remember that they generally will "control" the **sediment** produced from **all types of erosion** above them in their subwatershed. This is an important point from a watershed management perspective: structures control sediment more so than erosion. What does this mean? If a structure (WASCOB, pond, dry dam, etc.) is placed in a drainageway and surface water runs into it or through it, a sediment reduction will occur due to the trapping efficiency of the water pool. The surface water might be carrying sediment derived from sheet, rill, ephemeral, and gully erosion, but much of the suspended and nearly all the bedload is trapped, regardless of the source. These small structures will also dramatically reduce the peak runoff flows developed during rainfall events. The magnitude and timing of these peak flows can significantly affect channel erosion and overall movement of sediment within a given subwatershed. In general, it is more efficient and effective to have these structures as "low" in the watershed as is possible. The more of a subwatershed that occurs above them, the greater the amount of the runoff and sediment that is "controlled" or "captured." A word of caution: When dealing with "cleaned" water, if the water channels are silts and fine sands, the additional energy of "clean" water can lead to accelerated channel erosion below these structures. Stabilization and sediment reduction must always be handled in combination during any engineering design.

5. Streambank stabilization projects "attack" localized sediment production directly. However, streambank projects do not deal with reducing sediment already in the stream system from other upland sources. Therefore, it is important to remember that, in general, the entire watershed must be "treated" to effectively reduce the overall sedimentation rate.

6. If significant land use changes are anticipated in a certain segment of the watershed, these areas should probably be "monitored" more closely because of the potential for more rapid change in sediment rates. Even relatively small areas can significantly increase the sediment load on the stream system or subsystem.

7. Structural means of sediment control have been effective on smaller watersheds, utilizing time-tested measures, such as WASCOB's, dry dams, ponds, etc. Do not overlook these but always be on the lookout for new, innovative ideas and methods that can be applied **in** the watershed. Streambank stabilization methods are being developed and perfected in each new watershed they are used in. Progress is being made!!

8. One of the "new" (experimental??) methods referred to above would be the use of off-channel wetland diversions. These could allow for surface water from the creeks that exceeded a certain designated discharge to flow into a wetland area that was immediately adjacent and parallel to the stream. Water that has time to slow down will begin to drop a certain proportion of its sediment load. Even small amounts of deposition 20 to 40 percent of the total suspended load--could have a dramatic influence over the entire watershed.

Appendix C – Detention Basin Inventory

Basin Name	Basin ID	Political Jurisdiction	Predominant Land Use	Basin Type	Problems and Concerns/Other Observations
Mallard Ridge Park Pond	11-012	Lindenhurst	Public	Dry	Short-Circuiting, concrete channels
Eagle Ridge Center Pond 2	11-014	Lindenhurst	Commercial	Wet/Wetland	Inlet Clogging, algae, excess woody debris
Farmington Green Estates Pond	11-015	Lindenhurst	Residential	Wet	Algae, sump pump connections
	11-017	Lindenhurst	Residential	Wet	Short-Circuiting, algae, could not find outlet
Harvest Hill Pond	11-020	Lindenhurst	Residential	Wet	Sump pump connections
Country Place - Lindenhurst Pond 1	11-025	Lindenhurst	Residential	Wet	Inlet Clogging, sump pump connections
Country Place - Lindenhurst Pond 2	11-026	Lindenhurst	Residential	Wet	Algae
Cross Creek Pond	11-027	Lindenhurst	Residential	Wet	Algae, sump pump connections
Country Place - Lindenhurst Pond 3	11-028	Lindenhurst	Residential/Public	Wet	Inlet Clogging, insufficient riprap, sump pumps
Venetian Village Pond 1	11-029	Lindenhurst	Commercial/Residential	Dry	Clogging, insufficient riprap, concrete channels
Tempel Smith Lake 1 - ADID 47	11-030	Old Mill Creek	Residential	Wetland	Algae
Country Place - Lindenhurst Pond 4	11-031	Lindenhurst	Residential	Wet	Outlet Clogging, algae
Country Place - Lindenhurst Pond 5	11-033	Lindenhurst	Residential	Wet	Algae, sump pump connections
Falling Waters Pond 2	11-036	Lindenhurst	Public	Wet	Algae
Deerpath - Lake Villa Pond 5	11-039	Unincorporated	Residential	Wet	Outlet Clogging, Short-Circuiting, algae
Deerpath - Lake Villa Pond 1	11-040	Unincorporated	Residential	Wet	
Country Place - Lindenhurst Pond 6	11-041	Lindenhurst	Residential	Wet	Algae
Hunt Club Farms Pond 20	11-042	Unincorporated	Residential	Wet	
	11-046	Unincorporated	Public	Wet	
	11-047	Unincorporated	Public	Wet	
Hunt Club Farms Lake	11-049	Unincorporated	Residential	Wet	Inlet clogging and erosion.
Deerpath - Lake Villa Pond 2	11-050	Unincorporated	Residential	Wet	Algae
Hunt Club Farms Pond 14	11-054	Unincorporated	Residential	Wet	Algae
Emerald Ridge Pond 1	11-056	Lindenhurst	Residential	Wet	Inlet Clogging, insufficient riprap
Emerald Ridge Pond 2	11-057	Lindenhurst	Commercial/Residential	Wet	Inlet erosion, insufficient riprap, downspouts connected
Mill Creek Crossing Pond 4	11-060	Unincorporated	Residential	Wet	
Mill Creek Crossing Pond 5	11-062	Unincorporated	Residential	Wet	Inlet Scouring, sump pump connections
Mill Creek Crossing Pond 8	11-063	Unincorporated	Residential	Wet	Short-Circuiting
Hunt Club Farms Pond 11	11-065	Unincorporated	Residential	Wet	
Mill Creek Crossing Pond 6	11-066	Unincorporated	Residential	Wet	Inlet Scouring
Mill Creek Crossing Pond 7	11-067	Unincorporated	Residential	Wet	Algae
Foxchase Pond 1	11-069	Round Lake Beach	Residential	Dry/Wetland	Inlet Scouring, Outlet Clogging
Coventry Estates Pond 2	11-071	Round Lake Beach	Residential	Wet/Wetland	Algae
Brookside Pond 3	11-072	Unincorporated	Public	Wet	
Bridlewood - Gurnee Pond 1	11-073	Unincorporated	Residential	Wet	Inlet Clogging, Short-Circuiting, Algae
Brookside Pond 1	11-075	Unincorporated	Residential	Wet	Short-Circuiting, algae
Bridlewood - Gurnee Pond 2	11-076	Unincorporated	Residential	Wet	Downspouts connected
Foxchase Pond 2	11-078	Round Lake Beach	Residential	Dry	
Brookside Pond 2	11-080	Unincorporated	Residential	Wet	Short-Circuiting, sump pumps connected
Prairies of Grayslake Pond	11-083	Grayslake	Residential	Wet	Turbidity, sump pumps connected
Sweetwater Mill Pond 1	11-084	Round Lake Beach	Public	Wet	Inlet clogging, algae, downspouts connected
Gurnee Town Centre Pond	11-085	Gurnee	Commercial	Dry	inlet clogging, scouring, short-circuiting
Concord Oaks Pond	11-086	Gurnee	Residential/Commercial	Wet	Outlet Scouring, Short-Circuiting, Algae, sump pumps connected
Elysian Fields Pond 1	11-087	Gurnee	Commercial	Wet	Outlet scouring
Greystone Commercial Pond 2	11-088	Gurnee	Residential	Wet	Short-Circuiting

Basin Name	Basin ID	Political Jurisdiction	Predominant Land Use	Basin Type	Problems and Concerns/Other Observations
Carillon North Pond 1	11-094	Grayslake	Residential	Wet	
Greystone Pond	11-095	Gurnee	Residential	Dry	Short-Circuiting
Carillon North Pond 2	11-096	Grayslake	Residential	Wet	Inlet clogging and insufficient riprap
	11-097	Round Lake Beach	Commercial	Wet	
Ravinia Woods Pond 1	11-099	Gurnee	Residential	Dry	Outlet clogging
Villas of Stonebrook Pond	11-100	Gurnee	Residential	Wet	Insufficient inlet riprap, algae, sump pumps connected
Carillon North Pond 3	11-103	Grayslake	Residential	Wet	Clogging
Bittersweet Golf Club Pond 13	11-104	Gurnee	Public	Wetland	Inlet clogging, insufficient riprap, short-circuiting
Elysian Fields Pond 3	11-106	Gurnee	Residential	Wetland	Outlet clogging
	11-109	Unincorporated	Residential/Public	Wet	Algae, downspouts connected
Bittersweet Golf Club Pond 22	11-110	Gurnee	Residential	Wet	Algae
Carillon North Golf Course Pond 1	11-111	Grayslake	Public	Wet	Outlet clogging, Algae, sump pumps connected
Ravinia Woods Pond 3	11-112	Unincorporated	Residential	Wet/Wetland	Could not locate outlet
Carillon North Golf Course Pond 3	11-113	Grayslake	Public	Wetland	Insufficient inlet riprap
Carillon North Golf Course Pond 2	11-114	Grayslake	Public	Wet	
Village of Gurnee Lake	11-122	Gurnee	Public	Wet	Inlet erosion, scouring, clogging, and insuffiecient riprap. Algae
Bittersweet Golf Club Pond 1	11-127	Gurnee	Public	Wet	Algae
Bittersweet Golf Club Pond 7	11-128	Gurnee	Public	Wet/Wetland	Inlet clogging
Woodside Park Subdivision Pond 1	11-129	Gurnee	Residential	Wet	
Woodside Park Subdivision Pond 3	11-131	Gurnee	Residential	Wet	Short-Circuiting
Woodside Park Subdivision Pond 4	11-132	Gurnee	Residential	Wet	Inlet Scouring and insufficient riprap, algae
Hunt Club Park Pond 2	11-136	Gurnee	Public	Wet	Short-Circuiting, Algae
Sunrise Park Pond 1	11-138	Grayslake	Public	Wet/Wetland	Could not locate outlet
Bittersweet Golf Club Pond 20	11-140	Gurnee	Public	Wet	Short-Circuiting
Bittersweet Golf Club Pond 12	11-142	Gurnee	Public	Wet	Algae
Kingsport Woods Pond 1	11-143	Gurnee	Residential	Dry	
Timberwoods Pond 1	11-145	Gurnee	Residential	Wet	Algae, excess litter
Normandy Woods Pond	11-146	Grayslake	Residential	Wet	Inlet clogging
Oak Knoll PUD Pond 2	11-147	Unincorporated	Residential	Wet	Could not locate outlet
Oak Knoll PUD Pond 1	11-148	Unincorporated	Residential	Wet/Wetland	Inlet erosion and insufficient riprap, algae, could not locate outlet
Bittersweet Golf Club Pond 15	11-149	Gurnee	Public	Wet	Insufficient inlet riprap, outlet clogging
Bittersweet Golf Club Pond 16	11-153	Gurnee	Public	Wet/Wetland	Outlet clogging
Washington Park Subdivision Pond 2	11-157	Gurnee	Residential	Dry	Short-circuiting
Aberdare Estates Pond 2	11-159	Gurnee	Residential	Wet	
Oak Knoll PUD Pond 3	11-160	Unincorporated	Residential	Wet	
Bittersweet Golf Club Pond 17	11-161	Gurnee	Public	Wet	Outlet clogging and scouring, algae
Bittersweet Golf Club Pond 18	11-163	Gurnee	Public	Wet	Outlet clogging
Churchill Pond	11-165	Grayslake	Commercial	Wet/Wetland	Outlet clogging, sump pumps connected
Ravinia Woods Pond 10	11-167	Gurnee	Public	Wet	Outlet Clogging, Short-Circuiting
	11-168	Grayslake	Commercial	Wet/Dry	
Ravinia Woods Pond 11	11-169	Gurnee	Residential	Wet	Algae
Ravinia Woods Pond 13	11-171	Gurnee	Public and Residential	Wet/Wetland	Insufficient riprap, algae, could not locate outlet
Mariners Cove Pond 2	11-173	Third Lake	Residential	Wet	Short-circuiting, algae, downspouts connected
Ravinia Woods Pond 12	11-174	Gurnee	Public	Wet	Clogging, Algae
Kingsport Woods Pond 4	11-176	Gurnee	Public	Wet	Insufficient riprap, short-circuiting, shoreline erosion, algae

Basin Name	Basin ID	Political Jurisdiction	Predominant Land Use	Basin Type	Problems and Concerns/Other Observations
Kingsport Woods Pond 3	11-177	Gurnee	Public	Wet	Insufficient riprap, short-circuiting, algae
Meadowview Woods Park Pond 3	11-178	Grayslake	Residential	Wet/Wetland	Inlet clogging, could not locate outlet
Warren Township Center Pond 1	11-179	Unincorporated	Public	Wet	
Tangueray Meadows Pond 1	11-180	Unincorporated	Residential	Wet/Wetland	Insufficient riprap, short-circuiting, algae
Mariners Cove Pond 3	11-183	Third Lake	Residential	Dry	Short-circuiting, algae
Warren Township Center Pond 3	11-184	Unincorporated	Residential	Wet	insufficient riprap, short-circuiting
Warren Township Center Pond 4	11-185	Unincorporated	Public	Dry	Inlet erosion, scouring, and insufficient riprap
Valley Forge Park Pond	11-186	Grayslake	Public	Wet	Short-circuiting, excess litter, downspouts connected
Mariners Commercial Village Pond	11-187	Third Lake	Public	Dry	Could not locate outlet
Chesapeake Farms Pond 1	11-188	Grayslake	Residential	Wet	Downspouts connected
Doolittle Park Pond 7	11-189	Grayslake	Public	Wet	Unable to locate inlets
CVS - Third Lake Pond	11-190	Third Lake	Commercial	Wet/Wetland	Inlet clogging, insufficient riprap, short-circuiting
Augie Pond 1	11-192	Grayslake	Commercial	Dry	
Lake County High School Technology Campus Lake	11-194	Grayslake	Institutional	Wet	
Chesapeake Landing Pond 1	11-195	Grayslake	Residential	Wet	Downspouts connected
Meadows of Grayslake Pond	11-196	Grayslake	Residential	Dry	Short-circuiting
University Center of Lake County - Grayslake Pond	11-197	Grayslake	Public	Wet	
Chesapeake Farms Pond 4	11-198	Grayslake	Residential	Wet	Inlet clogging
Rouse Basin 1	11-199	Third Lake	Commercial	Dry	
Chesapeake Farms Pond 2	11-200	Grayslake	Residential	Wet	Downspouts connected
Cherry Creek Pond 4	11-202	Grayslake	Residential	Wet	
Mill Creek Park Lake	11-206	Grayslake	Public	Wet/Wetland	Insufficient inlet riprap
Haryan Farm Pond 1	11-208	Grayslake	Residential	Wet	Algae
Cherry Creek Pond 2	11-209	Grayslake	Residential	Wet	Algae
College of Lake County Pond 1	11-211	Grayslake	Public	Wet	
Mollys Lake	11-213	Grayslake	Residential	Wet	Could not locate outlet
College of Lake County Pond 3	11-214	Grayslake	Public	Wet	Insufficient riprap, short-circuiting, shoreline erosion
Manor Lake	11-216	Grayslake	Residential	Wet	Algae
Willow Lake	11-219	Grayslake	Public	Wet	Inlet erosion, scouring, insufficient riprap
Frederick School Pond 1	11-222	Grayslake	Institutional	Wet	Clogging
West Trail Pond 3	11-225	Grayslake	Residential	Wet	Downspouts connected
Brae Loch Golf Club Pond 2	11-226	Unincorporated	Golf Course	Wet	Shoreline erosion
West Trail Pond 2	11-227	Grayslake	Residential	Wet	Clogging
Brae Loch Golf Club Pond 1	11-228	Unincorporated	Golf Course	Wet/Wetland	Shoreline erosion
College Trail Lake	11-229	Grayslake	Residential	Wet	Algae, sump pump and downspout connections
Grayslake Aquatic Center Pond 4	11-230	Grayslake	Institutional	Dry	Short-circuiting
Grayslake Aquatic Center Pond 1	11-231	Grayslake	Public	Wet	Inlet erosion and scouring
Brae Loch Golf Club Pond 3	11-232	Unincorporated	Golf Course	Wet	Short-circuiting, algae, downspouts connected
Grayslake Aquatic Center Pond 5	11-233	Grayslake	Public	Wet	Short-circuiting
Creekside Park Pond	11-234	Grayslake	Residential	Wet/Wetland	Inlet clogging, insufficient riprap
Brae Loch Golf Club Pond 4	11-235	Unincorporated	Golf Course	Wet	inlet erosion, short circuiting, algae
Grayslake Area Public Library Pond 1	11-236	Grayslake	Institutional	Dry	Short-circuiting
Grayslake Area Public Library Pond 2	11-237	Grayslake	Institutional	Dry	Short-circuiting
Grayslake Area Public Library Pond 3	11-238	Grayslake	Institutional	Dry	Short-circuiting
Grayslake Senior Residence Pond 1	11-239	Grayslake	Public	Dry	

Basin Name	Basin ID	Political Jurisdiction	Predominant Land Use	Basin Type	Problems and Concerns/Other Observations
Walden Square Pond	11-240	Grayslake	Commercial	Wet	Sump pump and downspout connections
Grayslake Senior Residence Pond 2	11-241	Grayslake	Public	Wet	
Atkinson Center Pond 1	11-242	Grayslake	Commercial	Wet	Inlet scouring, excess litter
Atkinson Center Pond 2	11-243	Grayslake	Commercial	Wet	Inlet clogging, short-circuiting
NJB Operations Inc 1	11-246	Grayslake	Commercial	Wetland	Inlet erosion, insufficient riprap
Country Faire Pond 2	11-247	Grayslake	Residential	Wet	Downspouts connected
Ddr/Skw Grayslake Llc 1	11-249	Grayslake	Wetland	Wet	Insufficient riprap, algae
H Rothacker	11-250	Grayslake	Commercial	Wet	Algae
Aldworth Pond	11-253	Grayslake	Public	Dry	Inlet clogging, covered in dead algae with no plant life
Center Street Square Pond 2	11-254	Grayslake	Commercial	Wet/Wetland	Clogging, Algae
Center Street Square Pond 3	11-255	Grayslake	Commercial	Wet	Inlet erosion, scouring, and insufficient riprap
Canterbury Park Pond 1	11-258	Grayslake	Residential	Wet	Inlet erosion, and insufficient riprap
Center Street Square Pond 4	11-259	Grayslake	Commercial	Wet	Short-circuiting and algae
Canterbury Estates Pond 2	11-262	Grayslake	Residential	Wet	Inlet erosion, scouring, and insufficient riprap, shoreline erosion, algae, downspouts connected causing mild erosion.
Lake Forest Hospital - Grayslake Pond 1	11-263	Grayslake	Institutional	Wetland	Insufficient riprap
Eastlake Farm Park Pond	11-264	Grayslake	Residential	Wet	Inlet clogging
Hidden Ponds Pond 1	11-266	Grayslake	Residential	Wet	
Canterbury Estates Pond 1	11-267	Grayslake	Residential	Wet	Downspouts connected
Mapleview Pond 1	11-268	Grayslake	Commercial	Wet	Inlet clogging
Hidden Ponds Pond 3	11-269	Grayslake	Residential	Wet	Insufficient riprap, short-circuiting, algae
Mapleview Pond 2	11-270	Grayslake	Commercial	Wet/Wetland	Inlet clogging
Hidden Ponds Pond 5	11-273	Grayslake	Residential	Wet	Inlet clogging, insufficient riprap, short-circuiting
	11-274	Grayslake	Commercial	Dry	Insufficient riprap, could not locate outlet
Phil-Mar Pond	11-276	Grayslake	Residential	Wet	Inlet scouring
Grayslake Rail Station Pond 1	11-277	Grayslake	Public	Dry	Inlet clogging and insufficient riprap
	11-279	Grayslake	Residential	Wet	Insufficient riprap
Prairie Crossing Pond 10	11-283	Grayslake	Residential	Wet/Wetland	Downspouts connected
Prairie Crossing Pond 9	11-286	Grayslake	Residential	Wet/Wetland	Inlet erosion
Countryside Landfill Pond 18	11-291	Unincorporated	Industrial	Wet	
	11-292	Grayslake	Commercial	Wet	
	11-293	Grayslake	Industrial	Dry	Insufficient riprap, could not locate outlet
Countryside Landfill Pond 12	11-308	Grayslake	Commercial	Wet	Algae
	11-313	Gurnee	Residential	Wetland	
Ravinia Woods 4 of 6	11-314	Gurnee	Residential	Wetland	Inlet clogging, Excess woody debris, could not locate outlet
Lake Forest Hospital Detention 1	11-316	Grayslake	Institutional	Wet	Outlet clogging
	11-318	Unincorporated	Residential	Wet	Outlet clogging, algae, excess litter, downspouts connected
	11-319	Unincorporated	Residential	Wet	Algae
	11-320	Unincorporated	Residential	Wet	Clogging, short-circuiting, sump pumps connected
	11-321	Unincorporated	Residential	Wet	Inlet clogging, algae, downspouts connected
	11-322	Unincorporated	Residential	Wet	
	11-323	Unincorporated	Residential	Wet	Downspouts connected
Waterstone Third Lake LLC Basin 1	11-325	Third Lake	Public	Wet	Algae, could not locate outlet
Canterbury Estates Subdivision 4	11-328	Grayslake	Residential	Wet	Inlet clogging
	11-329	Grayslake	Residential	Wet	

Basin Name	Basin ID	Political Jurisdiction	Predominant Land Use	Basin Type	Problems and Concerns/Other Observations
	11-332	Grayslake	Residential	Wet	Outlet clogging
JY&I Properties LLC Basin 1	11-333	Third Lake	Public	Wet	Algae
Stonebridge HOA Basin 1	11-334	Unincorporated	Residential	Wet	Algae
	11-089	Gurnee	Agricultural	Wet	
Kingsport Woods HOA Basin 3	11-335	Gurnee	Residential	Dry	Insufficient riprap
	11-336	Grayslake	Institutional	Wet	Outlet clogging, algae, excess litter
	11-337	Grayslake	Institutional	Wet	Algae, excess sediment
	11-339	Grayslake	Institutional	Wet	Clogging, excess sediment
	11-340	Grayslake	Public	Wet	Outlet clogging, algae
	11-341	Grayslake	Institutional	Wet	Algae
	11-338	Round Lake Beach	Public	Wet	Inlet clogging, algae, excess sediment
	11-074	Round Lake Beach	Public	Dry	
	11-342	Unincorporated	Public	Wet	
Northwestern Lake Forest Hospital 1	11-343	Grayslake	Institutional	Wet	Short-Circuit
Northwestern Lake Forest Hospital 3	11-315	Grayslake	Institutional	Wet	

Basin Name	Basin ID	Preliminary Retrofit Opportunities
Mallard Ridge Park Pond	11-012	Remove low flow bypass with Installation of FES Inlet 1 and Outlet A. Plant bottom and slopes with native plants, remove concrete channel at Inlet 2.
Eagle Ridge Center Pond 2	11-014	Clear banks of woody veg, install aerators.
Farmington Green Estates Pond	11-015	
	11-017	Install aerator
Harvest Hill Pond	11-020	Clear Inlet 6, remove woody veg. from N and E slopes, plant native plants over turf grass and woody veg.
Country Place - Lindenhurst Pond 1	11-025	sump pump disconnect, plant natives on slopes, clear inlet 3 of debris.
Country Place - Lindenhurst Pond 2	11-026	Install aerators.
Cross Creek Pond	11-027	fix aerator, sump pump disconnect, remove woody veg from west slope, plant native plants on all slopes.
Country Place - Lindenhurst Pond 3	11-028	Clear inlet 3 of debris, put more riprap in front of Inlet 2
Venetian Village Pond 1	11-029	remove concrete channel, replace Inlet 1 and install riprap in front, clear Outlet A of debris, plant bottom and slopes with native plants.
Tempel Smith Lake 1 - ADID 47	11-030	plant natural plants where inlet is bare, aerators in basin.
Country Place - Lindenhurst Pond 4	11-031	Clear Outlet of debris, install an aerator.
Country Place - Lindenhurst Pond 5	11-033	replace turf grass with native plants, install aerator on East Side.
Falling Waters Pond 2	11-036	Install an aerator, clear woody veg. and plant native plants.
Deerpath - Lake Villa Pond 5	11-039	Install aerator, shift Inlet 1 to Southern bank. Clear outlet of debris.
Deerpath - Lake Villa Pond 1	11-040	none
Country Place - Lindenhurst Pond 6	11-041	Install an aerator.
Hunt Club Farms Pond 20	11-042	plant slopes with native grasses
	11-046	Plant slopes with native grasses
	11-047	replace riprap with native plants
Hunt Club Farms Lake	11-049	plant native plants on channels that turf grass lined.
Deerpath - Lake Villa Pond 2	11-050	Aerator near Inlet 2.
Hunt Club Farms Pond 14	11-054	replace turf grass on banks and Inlet with native plant. Install an aerator. Reduce East Bank's slope.
Emerald Ridge Pond 1	11-056	Clear Inlet 1, riprap inlet 2, reduce slope on N bank, plant banks with native plants.
Emerald Ridge Pond 2	11-057	downspouts disconnected, replace riprap and turfgrass banks with natve plants. Expand around Inlet 1 to create a forebay with riprap and riprap in front of Inlet 2.
Mill Creek Crossing Pond 4	11-060	regrade slope to 3:1 or lower, and then plant native grasses and plants on banks
Mill Creek Crossing Pond 5	11-062	replant with native vegetation, disconnect sumps, replace inlet 2
Mill Creek Crossing Pond 8	11-063	replace turf grass and riprap slopes with native vegetation
Hunt Club Farms Pond 11	11-065	
Mill Creek Crossing Pond 6	11-066	replace inlet 1, line slopes with native plants
Mill Creek Crossing Pond 7	11-067	replant slopes with native plants, install aerator by outlet
Foxchase Pond 1	11-069	plant native vegetation on rest of bottom and slopes, replace inlet 2, unclog outley A
Coventry Estates Pond 2	11-071	install aerator, plant native vegetation on the rest of the bank heights
Brookside Pond 3	11-072	fix slope of east bank to 3:1 or lower, plant banks with native plants
Bridlewood - Gurnee Pond 1	11-073	replant slopes with native plants, unclog Inlet 3 and install an aerator on the west side.
Brookside Pond 1	11-075	Replants slopes with native plants, remove Inlet 1 and connect that to basin 11-072
Bridlewood - Gurnee Pond 2	11-076	downspout disconnect. Reduce slopes and plant native plants.
Foxchase Pond 2	11-078	plant bottom and slopes with natived vegetation
Brookside Pond 2	11-080	decrease slope, plant native plants instead of turf grass and riprap, reaplace inlet 2 with new due to scour.
Prairies of Grayslake Pond	11-083	disconnect sump pump, plant native vegetation on banks
Sweetwater Mill Pond 1	11-084	plant native vegetation on banks, downspout disconnect and clear inlet 4
Gurnee Town Centre Pond	11-085	Remove low-flow bypass, slope bottom more to prouce greater water removal, clear Inlets 1&6 of debris & replace Inlet 7 due to scour.
Concord Oaks Pond	11-086	disconnect sum ppumps, fix aerator, replace outlet, instal trash grate on Inlet 5.
Elysian Fields Pond 1	11-087	Replant slopes with native plants, raplce outlet.
Greystone Commercial Pond 2	11-088	Remove Inlet 2, run to stormsewer then basin/new inlet on SE corner.

Basin Name	Basin ID	Preliminary Retrofit Opportunities
Carillon North Pond 1	11-094	None
Greystone Pond	11-095	
Carillon North Pond 2	11-096	clear inlets 3 and 4 of debris, install riprap in fron of inlet 5
	11-097	clear litter from water, disconnect sump pump
Ravinia Woods Pond 1	11-099	Clear outlet of debris
Villas of Stonebrook Pond	11-100	install aerator for algae, put trash grate and riprap on inlet. Disconnect from sumppumps. Run them into stormsewer first.
Carillon North Pond 3	11-103	clear inlet 3 and clear outlet A
Bittersweet Golf Club Pond 13	11-104	clear inlets of debris, riprap inlets, remove inlet 7 and redirect flow to Inlet 6 to prevent short-circuiting
Elysian Fields Pond 3	11-106	Clear outlet, locate and clear inlets.
	11-109	downspout disconnect, spread aerators out to handle algae better.
Bittersweet Golf Club Pond 22	11-110	Remove brick wall and slope, replace turf grass with native grasses, install aerators for algae.
Carillon North Golf Course Pond 1	11-111	disconnect sump pump, clear outlet of clogging and install aerator
Ravinia Woods Pond 3	11-112	None, find Outlet
Carillon North Golf Course Pond 3	11-113	install riprap in fron of inlet 1
Carillon North Golf Course Pond 2	11-114	None
Village of Gurnee Lake	11-122	fix inlet 1's FES and grate, clear inlet 6, riprap 1,2,5, and 6. Install Aerators.
Bittersweet Golf Club Pond 1	11-127	Install aerator against algae, put riprap in front of Inlets 1 and 2 to prevent erosion.
Bittersweet Golf Club Pond 7	11-128	clear away debris from inlets so they can flow smoothly.
Woodside Park Subdivision Pond 1	11-129	
Woodside Park Subdivision Pond 3	11-131	Move Inlet 1 to Northern Bank
Woodside Park Subdivision Pond 4	11-132	Riprap the inlets and add trash grates
Hunt Club Park Pond 2	11-136	Install a 3rd aerators in the middle to combat algae. Put riprap around inlets and trash grates.
Sunrise Park Pond 1	11-138	plant native grasses on turf grass slopes
Bittersweet Golf Club Pond 20	11-140	
Bittersweet Golf Club Pond 12	11-142	Install aerator to combat algae problem
Kingsport Woods Pond 1	11-143	plant and banks and bottom with native vegetation
Timberwoods Pond 1	11-145	install aerator, plant native grasses on slopes.
Normandy Woods Pond	11-146	plant native vegetation on banks and clear inlet 2
Oak Knoll PUD Pond 2	11-147	Flair the Inlet, add riprap and trash grate.
Oak Knoll PUD Pond 1	11-148	Install riprap and a trash grate at Inlet 1.
Bittersweet Golf Club Pond 15	11-149	riprap inlet 1, clear outlets of debris
Bittersweet Golf Club Pond 16	11-153	
Washington Park Subdivision Pond 2	11-157	remove low flow bypass from Inlet 1 to Outlet, plant native veg.
Aberdare Estates Pond 2	11-159	plants banks with native plants instead of turf grass.
Oak Knoll PUD Pond 3	11-160	None
Bittersweet Golf Club Pond 17	11-161	Install aerator to reduce algae, remove concrete wall and replace with slope.
Bittersweet Golf Club Pond 18	11-163	clear emergency overflow of debris
Churchill Pond	11-165	plant slopes with native vegetartion, clwear outlet of debris and disconnect sump pump
Ravinia Woods Pond 10	11-167	reposition inlet to north bank, replant banks with native vegetation. Clean outlet.
	11-168	plant bottom and slope with native vegetation
Ravinia Woods Pond 11	11-169	aerotor to reduce algea, 440 Hillview Dr and 456 Hillview Dr ecperiance flooding every rain. Instead of having pipe turn to 11-167 go straight to 111-169 - this may prevent flooding
Ravinia Woods Pond 13	11-171	install aerator to reduce algea and prevent mosquitoes. Install riprap at inlets
Mariners Cove Pond 2	11-173	put trashgrates over inlets, downspouts disconnected, plant native vegetation on NW bank.
Ravinia Woods Pond 12	11-174	clear outlet and reduce algea
Kingsport Woods Pond 4	11-176	move outlet to sw corner, put trash grate on inlet, plant native plants on slopes

Basin Name	Basin ID	Preliminary Retrofit Opportunities
Kingsport Woods Pond 3	11-177	move outlet to sw corner, add trash grate and riprap to inlet, replant banks with native species
Meadowview Woods Park Pond 3	11-178	
Warren Township Center Pond 1	11-179	Plant native plants along banks, repair aerator
Tangueray Meadows Pond 1	11-180	move outlet to nw corner, riprap inlet
Mariners Cove Pond 3	11-183	Downspout disconnect, plant native grasses on bottom and slopes, remove low-flow bypass.
Warren Township Center Pond 3	11-184	replace turf with native plants, remove inlet 1 and conect to stormsewer, riprap at Inlet 2.
Warren Township Center Pond 4	11-185	Remove oaks and plant native prairie plants, riprap inlets. Replace inlet 3, scoured mostly away.
Valley Forge Park Pond	11-186	downspout disconnect, remove turf grass and invasive grasses and plant native plants, clear trash and debris by inlet 1.
Mariners Commercial Village Pond	11-187	
Chesapeake Farms Pond 1	11-188	downspout disconnect
Doolittle Park Pond 7	11-189	
CVS - Third Lake Pond	11-190	remove metal pipe if possible, remove walls and put in natural slops with riprap on inlets
Augie Pond 1	11-192	plant bottom abd slopes with native plants
Lake County High School Technology Campus Lake	11-194	riprap and install FES in inlets missing them. Replace turf grass with native plants. Cut back bank slope for planting.
Chesapeake Landing Pond 1	11-195	downspout disconnect
Meadows of Grayslake Pond	11-196	replace turf grass with native grass. Put riprap on inlet 1
University Center of Lake County - Grayslake Pond	11-197	
Chesapeake Farms Pond 4	11-198	Downspouts disconnect, clear Inlet 1 of plants
Rouse Basin 1	11-199	plant native grasses on banks, unclog inlet 1
Chesapeake Farms Pond 2	11-200	downspout disconnect, expand strip of native plants
Cherry Creek Pond 4	11-202	Clear Inlet 2
Mill Creek Park Lake	11-206	add riprap to inlets
Haryan Farm Pond 1	11-208	Plant native vegetation on the slopes.
Cherry Creek Pond 2	11-209	None, good basin
College of Lake County Pond 1	11-211	
Mollys Lake	11-213	Plant natives on slopes!
College of Lake County Pond 3	11-214	install riprap on inlets
Manor Lake	11-216	Install aerators, put in native vegetation on banks that are not beaches.
Willow Lake	11-219	pull back inlets to banks and put riprap on them
Frederick School Pond 1	11-222	Clear Inlets 2&3 and Outlet A of plants
West Trail Pond 3	11-225	plant native plants on banks
Brae Loch Golf Club Pond 2	11-226	plant native grass instead of turf grass
West Trail Pond 2	11-227	plant native plants on banks, install aerators, clear inlets 1 and 3 and Outlet A of debris. Downspout disconnect.
Brae Loch Golf Club Pond 1	11-228	resoil eroded areas, lower outlet to expose submerged inlets.
College Trail Lake	11-229	downspout disconnect, install aerators, plant slopes with native grasses
Grayslake Aquatic Center Pond 4	11-230	Disconnect bypass, install FES Inlet. Plant banks and bottom with native plants.
Grayslake Aquatic Center Pond 1	11-231	Aerator, replace soil around Inlet 2, replace inlets 2 And 3
Brae Loch Golf Club Pond 3	11-232	downspout disconnect
Grayslake Aquatic Center Pond 5	11-233	move inlet 1 to center of west bank, plant slopes with native vegetation
Creekside Park Pond	11-234	Clear Inlet 3 of Debris and riprap the opening of Outlet 4
Brae Loch Golf Club Pond 4	11-235	
Grayslake Area Public Library Pond 1	11-236	plant native vegetation on bottom and banks. Remove low flow bypass and put in FES inlet.
Grayslake Area Public Library Pond 2	11-237	disconnect low flow bypass, install FES inlet, plant native grasses on banks and bottom.
Grayslake Area Public Library Pond 3	11-238	remove lowflow bypass and install FES inlet, preplant slopes and bottoms with native plants
Grayslake Senior Residence Pond 1	11-239	replant banks with native vegetation

Basin Name	Basin ID	Preliminary Retrofit Opportunities
Walden Square Pond	11-240	disconnect downspouts, place additional riprap @ Inlet 1, plant slopes with native plant
Grayslake Senior Residence Pond 2	11-241	plant slopes with native vegetation
Atkinson Center Pond 1	11-242	clean garbage out, repair slope behind inlet 1
Atkinson Center Pond 2	11-243	move outlet to SW of basin
NJB Operations Inc 1	11-246	put in trash great and rip rap on inlet
Country Faire Pond 2	11-247	downspout disconnections, add trash grate to inlets
Ddr/Skw Grayslake Llc 1	11-249	Remove plastic pipe and replace with concrete outlet
H Rothacker	11-250	removal of algea problem. Prevent fertilizer runoff through buffer zone.
Aldworth Pond	11-253	remove algea covering and plant native prairie/hydrophylic plants. Connect to gas station's storm sewer. Clear inlets, unable to locate openings with so much debris
Center Street Square Pond 2	11-254	Clear inlets and outlet
Center Street Square Pond 3	11-255	Replace CMP with RCP and FES Grate. Combine this basin with 11-259.
Canterbury Park Pond 1	11-258	leave as is.
Center Street Square Pond 4	11-259	Clear manhole cover
Canterbury Estates Pond 2	11-262	downspout disconnect, replant with native grasses, redesign SW inlet to previde WQ increase.
Lake Forest Hospital - Grayslake Pond 1	11-263	good condition
Eastlake Farm Park Pond	11-264	Plant slopes with native vegetation, clear Inlet 1, fix outlet's trash grate.
Hidden Ponds Pond 1	11-266	continue with native vegetation along banks, remove turf grass on SE banks.
Canterbury Estates Pond 1	11-267	downspout disconnect if needed, plant banks with wetland grass, plant bed with native pond plants
Mapleview Pond 1	11-268	Clean clogged inlets
Hidden Ponds Pond 3	11-269	continue native vegetation maintenance
Mapleview Pond 2	11-270	Clear Inlets
Hidden Ponds Pond 5	11-273	clear partially plugged inlets, reinstall riprap at some locations
	11-274	Riprap in front of Inlet 1, remove walls and slope to 3:1 and plant native plants.
Phil-Mar Pond	11-276	grate over inlet, put e diss at end of outlet, open manhole for restrictor
Grayslake Rail Station Pond 1	11-277	plant native veg on slopes and bottom, clear and riprap Inlet, remove low flow bypass, install FES outlet by Emergency Overflow Structure.
	11-279	plant native grasses on rest of slopes and Inlet 2. Install more riprap at Inlet 1.
Prairie Crossing Pond 10	11-283	downspout disconnect
Prairie Crossing Pond 9	11-286	Downspout disconnetions, pland hydrophilic plants in the channel
Countryside Landfill Pond 18	11-291	None
	11-292	plant banks with native plants
	11-293	put riprap in front of Inlet 2
Countryside Landfill Pond 12	11-308	install aerator
	11-313	Plant slopes with native plants
Ravinia Woods 4 of 6	11-314	clear inlet 2 of vegetation and locate outlet
Lake Forest Hospital Detention 1	11-316	clear outlet entrance of reeds, put riprap at inlet
	11-318	downspout disconnect, aerator installment. Trash clean up.
	11-319	Install aerator
	11-320	disconnect sump pumps, clear inlets and outlets
	11-321	Install aerators, clear inlet 4, Downspout disconnect.
	11-322	none
	11-323	downspout disconnect
Waterstone Third Lake LLC Basin 1	11-325	remove algea
Canterbury Estates Subdivision 4	11-328	Unclog the inlet
	11-329	Plant native grasses on rest of the slopes.

Basin Name	Basin ID	Preliminary Retrofit Opportunities
	11-332	clear outlet of debris, fix aerator.
JY&I Properties LLC Basin 1	11-333	remove algea
Stonebridge HOA Basin 1	11-334	remove algea
	11-089	Remove brick walls and slope and plant native grasses, fix aerator.
Kingsport Woods HOA Basin 3	11-335	plant native vegetation and install riprap on inlets
	11-336	clear outlet of debris, sweep the basin for trash, install aerator
	11-337	plant full slopes with native vegetation, install aerators, clear debris and sediment from inlet 1
	11-339	clear inlet 2 and outlet, dredge
	11-340	clear outlet of debris, install aerator
	11-341	install aerator
	11-338	clear sediment and debris from inlet, install aerators
	11-074	plant native vegetation on banks and rest of bottom
	11-342	replace riprap with native plants
Northwestern Lake Forest Hospital 1	11-343	replace vegetation on bank thart was removed because of construction.
Northwestern Lake Forest Hospital 3	11-315	plant native veg on banks and in bed

Appendix D – Ecological Assessment of Mill Creek

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ECOLOGICAL ASSESSMENT OF MILL CREEK IN RELATION TO EXPANSION OF THE MILL CREEK WATER RECLAMATION FACILITY (NPDES PERMIT NO. IL0071366)

PREPARED FOR:

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MAY 12, 2008

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Introduction and Project Description

This report provides a preliminary ecological and water quality assessment of Mill Creek, Lake County, Illinois in connection with the planned expansion of the Mill Creek Water Reclamation Facility (WRF). Mill Creek is the receiving stream for the treated effluent released by the Mill Creek Water WRF. The WRF is owned and operated by the Lake County Department of Public Works and is located east of Hunt Club Road and west of Interstate 94 in Section 33, Township 46 North, Range 11 East (Exhibits 1 and 2).

The Mill Creek Water Reclamation Facility was constructed and became operational in 1999 and allowed the old Grandwood Park wastewater treatment plant that discharged to the South Branch of Mill Creek to be phased out. The Mill Creek facility has a current design capacity of 1.0 million gallons per day (MGD) and a service area that includes Old Mill Creek, Grandwood Park, and the eastern portion of Antioch. Plans call for the facility to be expanded to 2.1 MGD to meet the needs generated by forecasted growth and development. According to the *Mill Creek WRF Design Basis Report*, population forecasts prepared for the Northeast Lake Facilities Planning Area (FPA) by NIPC (now the Chicago Metropolitan Agency for Planning) show a Year 2030 FPA population of 45,207 and the Mill Creek WRF will service much of this population.

The WRF operates in accordance with NPDES Permit No. IL0071366 which established monthly average concentration limits of 10 mg/l BOD and 12 mg/l suspended solids. The monthly average ammonia nitrogen limits are set at 1.5 mg/l (March-October) and 5.4 mg/l (November-February). A daily maximum for fecal coliform set at 400 CFU/100 ml has been established from May through October. When the WRF is expanded, an effluent limit of 1.0 mg/l will be placed in effect for total phosphorus. The NPDES permit lists the Des Plaines River rather than Mill Creek as the receiving stream for the effluent

Identification and Characterization of Affected Water Body and Uses

Mill Creek and the Des Plaines River are classified General Use waters and both are subject to the applicable Illinois General Use water quality standards established by the Illinois Pollution Control Board. The General Use standards apply to most waters of the state and are intended to protect fish and other aquatic life, primary and secondary human contact (swimming, wading, boating, etc.), wildlife, and agricultural and industrial water uses. The standards also protect the aesthetic quality of lakes, rivers, and streams.

Mill Creek is not included on the current (2006) Section 303(d) list of Impaired Waters compiled by the Illinois Environmental Protection Agency (Illinois EPA). According to the Illinois EPA's 2006 305(b) Report, Mill Creek is fully supportive of aquatic life. Other "designated uses/attainments" have not been assessed according to the 305(b) Report. The Des Plaines River (to which Mill Creek is tributary) is listed as impaired throughout its length in Illinois. In the vicinity of the confluence with Mill Creek (Segment ILG-25), the Des Plaines River is considered impaired for aquatic life due to low dissolved oxygen and sedimentation and siltation. It is also rated impaired for fish consumption due to mercury found in fish tissue samples (Illinois EPA, 2006).

Mill Creek is not classified as a biologically significant water body ("A" or "B" Stream) in the 1992 Illinois Natural History Survey publication *Biologically Significant Illinois Streams* and according to that report, there are not any threatened or endangered species supported by Mill Creek. However, from other sources, it is known that there are historical records of Iowa darter (*Etheostoma exile*, a State Threatened species) from Mill Creek. The only other known point source discharges in the watershed are the Lindenhurst Sanitary District plant (which discharges to Hastings Creek, a tributary of the North Branch of Mill Creek) and the private Rainbow Lake Manor wastewater treatment plant in Kenosha County that discharges to Mud Lake (which is tributary to Dutch Gap Canal and thence to the North Branch of Mill Creek).

The Mill Creek watershed area is approximately 65.5 square miles and includes areas of Lake County, Illinois as well as areas of Kenosha County, Wisconsin. Land use in the watershed is a mix of agricultural and suburban, with the WRF site itself situated in an area where the land cover is predominantly old pasture, abandoned cropland, and young woodland. Mill Creek flows into the Des Plaines River about one mile downstream of the WRF. Mill Creek tributaries include the North and South Branches as well as Hastings Creek and the Dutch Gap Canal. Larger lakes in the watershed (all of which are upstream of the Mill Creek WRF) include Grays, Gages, Third, Fourth, Druce, Crooked, Hastings, Waterford, and Potomac. Rasmussen Lake and Lake Elisabeth are two of several small impoundments formed by earthen dams along the course of Mill Creek.

In the vicinity of the Mill Creek Water Reclamation Facility, Mill Creek is a well meandered, low gradient stream. The stream is 10 to 15 feet wide and shallow (1 to 2.5 feet) except for deeper water in the frequent pools along the flow path. Bottom substrate is predominantly silt, with gravel in riffle areas. Shading is provided by an extensive tree canopy along most stream reaches.

Like most streams in northeastern Illinois, Mill Creek is subject to high and low flows which tend to be seasonal but can also fluctuate in response to prolonged precipitation and runoff. Over the period 1990-2006, monthly mean discharges at the USGS gaging station on Mill Creek ranged from a high of 103 cfs (April) to a monthly mean low of 7.8 cfs in September. In late August-September of 2007 when fieldwork for this ecological assessment was being conducted, discharge at the USGS gaging station on Mill Creek spiked to nearly 900 cfs on August 20 and remained above 40 cfs through September 11. By way of comparison, normal August average discharges are less than 10 cfs. Such prolonged high flows exacerbate bank erosion and can be very stressful on fish and aquatic life in a stream.

The 7-day, 10-year low flow of Mill Creek below the confluence of its North and South Branches and upstream of the Mill Creek Water Reclamation Facility is 0.1 cubic feet per second (cfs) (Illinois State Water Survey, February 2003 revised on-line map). Therefore, under conditions of extreme low flow as typically occur in late summer of dry years, the effluent from the Mill Creek WRF provides the preponderance of streamflow needed to sustain fish and other aquatic life in the lower reaches of Mill Creek downstream of the impoundments. The proportion of effluent comprising stream baseflow during low flow conditions will increase after the WRF is expanded to 2.1 MGD.

Historical Fish Survey Data

The following sections present data from fish surveys conducted in 1995, 2001, and 2005 (the 2005 survey was conducted on Rasmussen Lake only).

<u>1995 Hey/WIU Survey</u> Hey and Associates, Inc. arranged for an extensive stream survey of the Mill Creek watershed in 1995 to characterize fish, mussel, and macroinvertebrate communities prior to the initial construction of the Mill Creek WRF. The survey was completed under the direction of Dr. Richard Anderson of Western Illinois University. A total of 14 sample sites were investigated on the North Branch, South Branch, and mainstem Mill Creek. The 1995 sampling sites that were closest to the eventual WRF site in either upstream or downstream directions are listed in Table 1 and are also depicted in Exhibits 1 and 2.

Table 1: September 1995 Fish Survey Results, Mill Creek

Location	No. of Fish Species	No. of Intolerant Species	IBI Score
Site 10, 1.5 miles upstream of WRF at Hunt Club Road	11	0	31
Site 11, 0.75 mile upstream of WRF	16	1	31
Site 12, at eventual WRF outfall	13	0	33
Site 13, 0.5 mile downstream at Dilleys Road	13	0	25
Site 14, 1.25 miles downstream of WRF at U.S. Rt. 41	14	0	31

Green sunfish (*Lepomis macrochirus*), golden shiners (*Notemigonus crysoleucas*), and bluntnose minnows (*Pimephales notatus*) were the dominant species captured in terms of numbers of individuals. Green sunfish (*Lepomis cyanellus*) alone accounted for 577 (52 percent) of the total 1,109 fish collected in the 1995 survey.

Based on fish community characteristics, the Western Illinois University researchers determined that South Mill Creek was the lowest quality area with low diversity and a preponderance of green sunfish. Higher diversity and habitat quality was found on the North Branch, while Mill Creek proper below the confluence of its two branches had the highest diversity and highest IBI values.

USGS Fish Data The United States Geological Survey's (USGS) water resources data for Illinois (USGS, 2005) includes the results of a fish survey conducted on July 11, 2001 downstream of the WRF just upstream of the confluence of Mill Creek with the Des Plaines River. A total of 355 fish representing 19 native species and one non-native species (carp) were captured. The species collected are typical of small to mid-size Lake County streams and included no threatened or endangered species. Sand shiners (*Notropis stramineus*) (133 captured), spotfin shiners (*Cyprinella spiloptera*) 103), and green sunfish (36) were the three most numerous species encountered in terms of numbers of individuals captured. Other species collected included bluegill (*Lepomis macrochirus)* (20), johnny darter (*Etheostoma nigrum*) (11), and channel catfish (*Ictalurus punctatus*) (8). One individual of one species considered to be intolerant of habitat degradation and siltation was collected (a hornyhead chub).

IDNR 1984 and 1990 Fish Surveys The Western Illinois University study done in 1995 also documented the results of IDNR (then the Illinois Department of Conservation) electrofishing surveys undertaken in 1984 and in 1990. Neither of those IDNR surveys collected intolerant species, and neither resulted in any listed species being collected.

IDNR Survey of Rasmussen Lake (2005) The Illinois Department of Natural Resources (IDNR) conducted a fish population analysis of Rasmussen Lake in May 2005 for the Lake County Forest Preserve District as part of an alternatives analysis regarding the future of this lake (which was formed by damming Mill Creek about 4 miles upstream of the WRF). A total of 370 fish representing 13 species were collected via electrofishing. Bluegill and yellow bass (*Morone mississippiensis*) accounted for over half of the fish collected and carp (*Cyprimus carpio*) were the third most numerous with 60 individuals taken. However, there also was fair representation of largemouth bass (*Micropterus salmoides*, 37 collected) and channel catfish (7 collected). No listed species were collected in the 2005 Rasmussen Lake survey.

Historical Mussel Survey Data

Mussels were collected along 100 meter reaches at each of 14 sampling sites in the 1995 Hey/WIU stream survey. Live mussels were found at all 5 mainstem sampling sites downstream of the confluence of the North and South Branches. However, mussels were not abundant at any of the sampling sites and density was generally less than 1 per 100 square meters (Anderson, 1996). The dominant live species found in 1995 (43 collected) was the white heelsplitter (*Lasmigona complanata*). The largest number of live species (4) was collected at the most downstream sampling site above the creek's confluence with the Des Plaines River. No listed threatened or endangered species were collected in the survey. All five of the species found in the survey are categorized as widespread and common or locally abundant (Cummings, 1992). Table 2 provides summary survey results, and the site locations are as depicted in Exhibits 1 and 2.

Table 2: September 1995 Mussel Survey Results, Mainstream Mill Creek Sampling Sites

Common Name	**Site 10 1.5 miles upstream of WRF at Hunt Club Road**	**Site 11, 0.75 mile upstream of WRF**	**Site 12, at (eventual) WRF outfall**	**Site 13, 0.5 mile downstream at Dilleys Road**	**Site 14, 1.25 miles downstream of WRF at Rt. 41**
Giant floater	4 L, 5 D	3 L, 13 D	4 L, 2 D	3 L, 11 D	8 L, 3 D
White heelsplitter	21 L, 3 D	8 L, 5 D	7 L, 10 D	1 L, 8 D	6 L, 15 D
Lilliput		6 L, 3 D	2 D		1 L
Fatmucket		3 D	2 D		
Plain pocketbook				2 D	2 L, 1 D
Total	**25 L, 8 D**	**17 L, 24 D**	**11 L, 16 D**	**4 L, 21 D**	**17 L, 19 D**

L = Number of live individuals collected
D = Number of recently dead (full shell) specimens collected

Historical Macroinvertebrate Data

Aquatic macroinvertebrate organisms are good indicators of habitat and water quality. Macroinvertebrate information is available from the Hey/Western Illinois University study in 1995 and from sampling from two surveys conducted by Illinois *EcoWatch* volunteers since 1996.

<u>1995 Hey/WIU Survey</u> This survey investigated the benthic macroinvertebrate community at each of the 14 sampling sites in the watershed using a combination of kicknet and handpicking sampling methods. After the collected organisms were identified and tabulated, the Macroinvertebrate Biotic Index or MBI was calculated to rate relative benthic community quality. The MBI assigns pollution tolerance values to organisms based on each macroinvertebrate's relative ability to tolerate adverse water quality conditions. The methodology yields a numerical value (the MBI) for a sampled site which indicates relative degrees of quality. MBI values range on a scale from 0 to 11. Lower MBI values indicate higher relative quality while higher MBI values reflect relatively lower quality. Taxa composition and organism density variance between sites were primarily the result of the bottom substrate at each site. Those sites that had at least some rocky or cobble substrate (often combined with shallow riffles) tended to support higher quality species such as caddisflies and mayflies. Sampling sites 11 and 12 in the stream section near where the WRF was ultimately constructed had the two highest quality macroinvertebrate communities of the 14 sites sampled. Summary results from 1995 sampling from the sites nearest to where the WRF was eventually constructed are presented in Table 3 (locations as depicted in Exhibits 1 and 2).

Table 3: 1995 Macroinvertebrate Sampling Results

Common Name	**Site 10, 1.5 miles upstream of WRF at Hunt Club Road**	**Site 11, 0.75 mile upstream of WRF**	**Site 12, at (eventual) WRF outfall location**	**Site 13, 0.5 mile downstream of WRF at Dilleys Road**	**Site 14, 1.25 miles downstream of WRF at Rt. 41**
Total Taxa (incl. mussels)	24	22	25	21	22
MBI	**6.7**	**5.2**	**5.3**	**7.3**	**6.6**

<u>EcoWatch Surveys</u> Illinois EcoWatch volunteers have monitored Mill Creek macroinvertebrates at three sites on two occasions since 1996. Two of the sites are on tributaries well upstream of the WRF. The third site (Site R0213402) is on the stream reach between Dilley's Road and the confluence with the Des Plaines River. The composited MBI for this site was 5.81.

2007 Biological, Water Quality, and Habitat Surveys

Hey and Associates, Inc. sampled Mill Creek for water quality, macroinvertebrates, mussels and fish both upstream and downstream of the Mill Creek WRF in 2007 as shown in Exhibits 1 and 2. Color photographs of Mill Creek in the project area are in Exhibit 3.

Methods

Water Sampling

Grab samples were collected on three occasions (May 29, July 11, and September 18, 2007) to characterize water column quality during critical warm season conditions. The sample site locations and distances from the WRF are as follows:

- Site 1, upstream of the WRF outfall channel and 300 feet downstream of the dam that created Lake Elisabeth on Mill Creek;
- Site 2, in the WRF outfall channel just upstream from its confluence with Mill Creek (samples from Site 2 therefore are comprised primarily of treated effluent);
- Site 3, 150 feet downstream of the WRF outfall channel's confluence with Mill Creek, and
- Site 4 at Dilleys Road, 0.5 mile downstream of the outfall channel

Field measurements were made of dissolved oxygen, water temperature, and pH. Water samples were taken to the Lake County Health Department's Environmental Health Laboratory and to McHenry Analytical Water Laboratory in McHenry, Illinois for processing and analyses. Constituents tested in the Environmental Health Laboratory included total suspended solids, total dissolved solids, conductivity, total phosphorus, alkalinity, chloride, sulfate, hardness, total Kjeldahl nitrogen, and ammonia nitrogen. Heavy metals were analyzed by McHenry Analytical Water Laboratory and included total and dissolved forms of barium, boron, cadmium, copper, lead, manganese, nickel, silver, zinc, and mercury.

Habitat Evaluation

A habitat survey was completed on June 18, 2007 to evaluate the physical conditions at each of the three sampling sites/reaches to coincide with biological sampling locations (Sites 1, 3, and 4 described above) according to methods outlined in Rankin 1989. The qualitative habitat evaluation index (QHEI) score was calculated for each site to determine the aquatic life support potential related to the physical habitat found in each sampling site.

Fish Survey

Hey conducted fish surveys on July 23-24, 2007 on stream reaches above and below the WRF on reaches associated with the 2007 habitat sampling sites (Sites 1, 3, and 4). Fish data were not collected in the outfall channel (Site 2). At each site, a 350-foot (100 meter) sampling reach was measured and block nets were placed at both the upstream and downstream ends to prevent fish from escaping. At Sites 1 and 4, sampling was conducted with a shock-boat. Sampling at Site 3 used a backpack electro-shocker. In both cases, the equipment temporarily stuns fish and allows them to be captured and placed in an aerated water tub for later identification and enumeration.

When reach sampling was completed, fish were identified (assisted by Smith 1979), tallied and released back into the stream. Additional information was collected on physical features, including channel configuration, water clarity, water temperature, instream vegetation, stream width, stream depth, air temperature, bottom type, and general stream and surrounding conditions. Digital vouchers were collected for all larger-bodied fishes while physical voucher specimens were collected for smaller fishes and to confirm field identifications.

The analysis of fisheries data in Illinois has been standardized since the early 1980's. Karr et.al. (1986) developed the Index of Biotic Integrity (IBI), an ecologically based system of 12 metrics evaluating the species composition, trophic condition, and general health of the fish community at a sample site. Variations in assigned metric values were based on stream order and watershed. This system was revised in 2000 to make the IBI a better bio-mathematical tool for evaluating fish community samples. The new index contains 10 metrics: 6 species composition/richness metrics, 3 trophic/reproductive metrics, and one tolerance metric. The new index eliminates imprecise evaluations and better reflects species' tolerance for disturbance (IDNR 2000). Variations in assigned metric values are largely based on stream width and IBI region in the modified scoring system.

Macroinvertebrate Sampling

Sampling of the macroinvertebrate community is an excellent tool for determining stream quality and the role that natural and anthropogenic factors play in determining that quality. Macroinvertebrate sensitivity to environmental impairments is typically high due to the sedentary or slow-moving nature of the organisms and their frequent dependence on coarse substrates and high dissolved oxygen.

Hey and Associates, Inc.'s 2007 investigation of Mill Creek's macroinvertebrate fauna utilized both kicknet sampling (using the QMH method) and Hester-Dendy sampling devices which provide submersed surfaces for organisms to colonize over a period of about 6 weeks. Hester-Dendys consist of 14, 3-inch square masonite panels separated by a variable number of washers, all held together by a long eye bolt. The devices were deployed in the stream and tethered to the streambank or stream bottom by a piece of rope and a metal stake. The devices were left in place for 6 weeks, allowing sufficient time for macroinvertebrates to establish themselves on the surfaces of the plates.

At the time of retrieval, the Hester-Dendy devices were removed one at a time by placing a 500 micron mesh sieve bucket around each trap and bringing the combination to the surface to avoid sample loss. Each Hester-Dendy was dismantled in the sieve bucket, and each plate was examined and picked for organisms and then scraped for more. All specimens were placed in bottles of 95% ethanol preservative. This included a large number of macroinvertebrates removed from the bottom of the sieve bucket with forceps.

Kicknetting also was conducted at each sampling site using a 20-jab qualitative multi-habitat (QMH) method. The QMH method emphasizes proportionately sampling habitat types as they occur in the stream channel into 20 kick net collections called dips. The first division of effort between dips is associated with the stream bottom and the submerged portions of the banks. At each site, the sampling effort was allocated at 14 dips from the stream bottom and 6 dips from the submerged bank zone based on an average width of 30 feet. At each site, the number of dips was further allocated according to bottom-zone and bank-zone habitats present. The QHEI habitat evaluation was used to approximate the proportion of habitats and determine the average stream width prior to sampling. The kick netting samples were collected at the end of Hester-Dendy colonization period. Dips were combined into a single sample bottle after net contents were examined for live organisms. Bottles were appropriately labeled and filled with 95% ethanol as a preservative.

At the end of the survey, all samples were transported to Hey's office and identified according to standard IEPA laboratory protocols. A number of index values including Shannon-Weiner Diversity, Macroinvertebrate Biotic Index (MBI), and Stream Condition Index (SCI) were calculated as appropriate for each sample.

Mussel Sampling

Hey conducted a mussel survey on July 18, 2007 on approximately the same three stream reaches as were used for fish surveying in 2007 (Sites 1, 3, and 4). Each sample reach (approximately 330 feet long) was investigated by wading or crawling over the substrate and searching for live and fresh dead mussels. Collected specimens were identified, tallied as live or fresh dead, and then returned to the stream.

2007 Results and Discussion

The following sections describe the results for each component of the 2007 assessment of Mill Creek. Relationships between water quality, habitat, and stream biota are discussed as appropriate.

Water Sampling Results

The results of water sampling are summarized in Tables 4, 5, and 6. The results are consistent with the Illinois EPA's 305(b) Report which determined Mill Creek to be fully supportive of aquatic life. Samples on May 29 and July 11 were obtained during average flow conditions for those dates while the samples taken on September 18 were obtained while the floods of August 2007 were still receding (the September 18, 2007 discharge was 21 cfs at the Mill Creek USGS gage compared with the median discharge of 4 cfs for that date).

- Total phosphorus (TP) was high at all sampling locations on all sampling dates. The highest TP levels were recorded from the outfall channel from the WRF, which reinforces the County's decision to provide phosphorus removal at the facility when it is expanded.

- Conversely, while ammonia nitrogen levels were high in Mill Creek (except for on September 18), they were quite low in the samples taken from the effluent outfall channel.

- The pH measures were within the General Use standard range (6.5-9.0) at each site for each sampling event.

- Total suspended solids (TSS) varied from sampling site to sampling site with in-stream values ranging from about 50 to about 75 mg/l which is fairly typical of streams in Lake County where clay soils are common. In the WRF effluent channel, total suspended solids values concentrations were 8 mg/l or less.

- Total dissolved solids (TDS) levels were within the General Use water quality standard of 1,000 mg/l at all sites on all occasions.

- Water temperatures did not exceed the summer maximum standard of 32.0° C at any site.

- Dissolved oxygen levels (all DO readings were daytime readings) were well above the 5 mg/l minimum standard at all sites on all occasions indicative of conditions favorable for fish and other aquatic life.

- Conductivity was generally high at all sites and was highest in the samples obtained from the effluent channel.

- Chloride was fairly stable between sites and between sampling events and all sampled values were well within the 500 mg/l standard.

- Sulfate was higher in the outfall channel than in the creek but all values were well within standard.

- Alkalinity and total hardness were fairly uniform between sites. Values are typical for streams in northeastern Illinois.

- All metals were measured at low levels and some where at levels below the limits of laboratory detection. Mercury, which had been cited by Illinois EPA as being high in tissue samples from fish downstream in the Des Plaines River, was below the limit of lab detection for both total and dissolved forms in all samples analyzed.

Table 4: Mill Creek Water Sampling Results (2007)

	5/29/07				*7/11/07**				*9/18/07*			
PARAMETER	***SITE1***	***SITE2***	***SITE 3***	***SITE 4***	***SITE1***	***SITE2***	***SITE 3***	***SITE4***	***SITE 1***	***SITE 2***	***SITE3***	***SITE 4***
Total Phosphorus (mg/l)	0.189	4.28	--	0.358	0.275	4.24	0.268	0.468	0.202	2.73	0.209	0.22
Total Kjeldahl Nitrogen (mg/l)	1.91	<0.5	--	2.0	1.83	<0.5	1.79	1.85	1.32	<0.5	1.39	1.35
Ammonia-N (mg/l)	0.279	<0.1	--	0.248	0.365	<0.1	0.328	0.312	<0.1	<0.1	<0.1	<0.1
pH	8.12	7.92	--	8.11	8.11	7.85	8.09	8.11		7.56	8.12	8.12
Total Suspended Solids (mg/l)	51.2	2.9	--	58.0	65.8	8.0	62.0	74.4	51.8	3.7	47.2	46.4
Total Dissolved Solids (mg/l)	628	868	--	599	670	808	646	652	518	806	518	510
Temperature (°C)	21.1	19.1	--	22.2	28.2	22.2	27	26.1	18.5	19.1	18.6	18.7
Dissolved Oxygen (mg/l)	6.89	10.7	--	6.93	6.78	8.4	6.75	6.43	8.83	6.65	7.64	7.68
Conductivity (uS/cm)	998	1,400	--	1,020	1,250	1,450	1,240	1,230	910	1,350	920	860
Chloride (mg/l)	159	211	--	162	206	189	206	207	114	162	115	117
Sulfate (mg/l)	57.4	139	--	61.0	55.3	129	54.0	54.9	37.7	124	36.8	36.5
Alkalinity (mg/l)	234	158	--	231	193	153	193	192	230	208	230	230
Hardness (mg/l)	322	344	--	322	288	315	286	286	277	347	297	297

Site 1: Site 1: 300 ft. downstream of the dam impounding Mill Creek (Lake Elisabeth) and upstream of WRF
Site 2: WRF outfall channel 120 ft. downstream from outfall structure and before confluence with Mill Creek
Site 3: 150 ft. below confluence of Mill Creek and outfall channel
Site 4: Dilleys Road

Notes:

1. On May 29, the water sampling team inadvertently sampled from the WRF outfall channel (Site 2) near its confluence with Mill Creek rather than sampling from the creek below the confluence with the outfall channel as originally planned. Accordingly, there are no data to report for Site 3 for May 29. In the subsequent sampling conducted on July 11 and September 18, the sampling team obtained samples from both Sites 2 and 3.
2. All dissolved oxygen readings are daytime field measurements.

Table 5: Mill Creek Total Heavy Metals Sampling Results (2007)

	5/29/07				7/11/07				9/18/07			
PARAMETER	*SITE1*	*SITE2*	*SITE 3*	*SITE 4*	*SITE1*	*SITE2*	*SITE 3*	*SITE4*	*SITE 1*	*SITE 2*	*SITE3*	*SITE 4*
Total Barium (mg/l)	0.036	0.018	--	0.036	0.048	0.017	0.042	0.047	0.041	0.021	0.04	0.04
Total Boron (mg/l)	0.075	0.58	--	0.1	0.065	0.63	0.072	0.1	0.066	0.6	0.072	0.072
Total Cadmium (mg/l)	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Copper (mg/l)	<0.005	0.017	--	<0.005	<0.005	0.017	<0.005	0.0054	<0.005	0.01	<0.005	<0.005
Total Lead (mg/l)	<0.01	<0.01	--	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Manganese (mg/l)	0.051	<0.01	--	0.027	0.23	0.011	0.14	0.21	0.17	0.063	0.16	0.16
Total Nickel (mg/l)	<0.005	<0.005	--	<0.005	0.006	<0.005	0.0056	0.0063	<0.005	<0.005	<0.005	<0.005
Total Silver (mg/l)	<0.003	<0.003	--	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Total Zinc (mg/l)	<0.01	0.034	--	<0.01	<0.01	0.045	<0.01	0.014	<0.01	0.022	<0.01	<0.01
Total Mercury (mg/l)	<0.0002	<0.0002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.002	<0.002	<0.002

Site 1: Site 1: 300 ft. downstream of the dam impounding Mill Creek (Lake Elisabeth) and upstream of WRF
Site 2: WRF outfall channel 120 ft. downstream from outfall structure and before confluence with Mill Creek
Site 3: 150 ft. below confluence of Mill Creek and outfall channel
Site 4: Dilleys Road

Note: On May 29, the water sampling team inadvertently sampled from the WRF outfall channel (Site 2) near its confluence with Mill Creek rather than sampling from the creek below the confluence with the outfall channel as originally planned. Accordingly, there are no data to report for Site 3 for May 29. In the subsequent sampling conducted on July 11 and September 18, the sampling team obtained samples from both Sites 2 and 3.

Table 6: Mill Creek Dissolved Heavy Metals Sampling Results (2007)

	5/29/07				*7/11/07*				*9/18/07*			
PARAMETER	***SITE1***	***SITE2***	***SITE 3***	***SITE 4***	***SITE1***	***SITE2***	***SITE 3***	***SITE4***	***SITE 1***	***SITE 2***	***SITE3***	***SITE 4***
Dissolved Barium (mg/l)	0.035	0.018	--	0.036	0.037	0.016	0.037	0.036	0.031	0.02	0.032	0.031
Dissolved Boron (mg/l)	0.078	0.59	--	0.1	0.069	0.62	0.068	0.094	0.066	0.59	0.075	0.073
Dissolved Cadmium (mg/l)	<0.0001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dissolved Copper (mg/l)	<0.005	0.017	--	<0.005	<0.005	0.012	<0.005	<0.005	<0.005	0.0075	<0.005	<0.005
Dissolved Lead (mg/l)	<0.01	<0.01	--	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dissolved Manganese (mg/l)	<0.01	<0.01	--	<0.01	0.017	<0.01	0.012	<0.01	0.012	0.065	<0.01	<0.01
Dissolved Nickel (mg/l)	<0.005	<0.005	--	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dissolved Silver (mg/l)	<0.003	<0.003	--	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Dissolved Zinc (mg/l)	<0.01	0.038	--	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	0.015	<0.01	<0.01
Dissolved Mercury (mg/l)	<0.0002	<0.0002	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002

Site 1: 300 ft. downstream of the dam impounding Mill Creek (Lake Elisabeth) and upstream of WRF
Site 2: WRF outfall channel 120 ft. downstream from outfall structure and before confluence with Mill Creek
Site 3: 150 ft. below confluence of Mill Creek and outfall channel
Site 4: Dilleys Road

Note: On May 29, the water sampling team inadvertently sampled from the WRF outfall channel (Site 2) near its confluence with Mill Creek rather than sampling from the creek below the confluence with the outfall channel as originally planned. Accordingly, there are no data to report for Site 3 for May 29. In the subsequent sampling conducted on July 11 and September 18, the sampling team obtained samples from both Sites 2 and 3.

As stated in Earth Tech, Inc.'s *Design Basis Report*, the Mill Creek facility provides a higher level of treatment than the requirements set forth in the facility's NPDES permit (Table 7). This has had a beneficial effect on water quality, particularly for such constituents as total suspended solids where background levels in streamflow are substantially higher than those from the WRF. Copper, one of the constituents mentioned by Earth Tech to be of interest in the *Design Basis Report*, was higher in the 2007 effluent channel samples (17 μg/l) than in the Illinois EPA's samples taken from the Des Plaines River at Station G 07. Nonetheless, the copper levels were within both the acute and chronic water quality standards. For nickel, another constituent of interest, the 2007 effluent channel samples (5 μg/l) were at the permit minimum detection limit, were well within acute and chronic standards, and were lower than the 25 μg/l Des Plaines River average at Station G 07.

Table 7: Comparison of NPDES Permit Limits with WRF Treatment Performance

	NPDES Limits (Monthly Average)	Reported Average Effluent Values (January-December 2005)
CBOD	10 mg/l	2.3 mg/l
Total Suspended Solids	12 mg/l	1.8 mg/l
Ammonia		
March-October	1.5 mg/l	0.23 mg/l
November-February	5.4 mg/l	0.30 mg/l
Fecal Coliform	400/100 ml (daily maximum, May through October	5/100 ml

From: Earth Tech, Inc. *Mill Creek WRF Design Basis Report for Lake County Department of Public Works*

Habitat Evaluation

In assessing habitat quality, the Ohio EPA (Rankin 1989) states a QHEI score >60 is required for full use support for warmwater fish communities. A score from 45-60 indicates an intermediate category where full support may be possible, but the status of the aquatic communities may be dependent on factors other than habitat limitations. A score from 32-45 is considered modified warmwater habitat while under 32 is limited warm water habitat. Neither of the latter categories is expected to fully support aquatic organisms. Results of Hey and Associates, Inc.'s 2007 habitat survey are presented in Table 8 and show an upstream to downstream decline in habitat quality.

Table 8: QHEI Scores for Mill Creek (2007)*

Site	QHEI Total Score (100)	Substrate (20)	Instream Cover (20)	Channel Morphology (20)	Riparian Zone and Bank Erosion (10)	Riffle/Run (8)	Pool/Current (12)	Gradient (10)	QHEI Rating
1	85	19	20	16	4.5	7.5	12	6	Full Support
3	71.5	9.5	16	14	9	6	11	6	Full Support
4	57	8	15	9	10	0	9	6	Questionable Support

*Maximum possible scores are indicated in (parentheses) for each scoring metric

Fish Survey Results

A total of 1,241 fish were collected from the three survey sites representing 26 native and one non-native species (non-native common carp were found at all three sampling sites). Two species considered intolerant of ecological disturbance, hornyhead chub (*Nocomis bigguttatus*) and spotted sucker (*Minylrema melanops*), were collected. No listed species were encountered although researchers had been alerted to the possible presence of Iowa darters prior to the survey.

- At the upstream site above the WRF outfall (Site 1), 622 fish were collected. The three most common species captured in terms of numbers collected were bluntnose minnow (*Pimephales notatus*), spotfin shiner (*Cyprinella spiloptera*), and orangespotted sunfish (*Lepomis humilis*). A total of 70 hornyhead chubs (Intolerant) were collected from this sampling reach.

- At the survey reach just downstream of the WRF outfall channel's confluence with Mill Creek (Site 3), 396 fish were collected. The three most common in terms of numbers collected were spotfin shiner, bluntnose minnow, and green sunfish (*Lepomis cyanellus*). 19 hornyhead chubs were collected in this section.

- At Dilleys Road (Site 4), 223 individuals were collected with the three most common being bluntnose minnow, green sunfish, and blackstripe topminnow (*Fundulus notatus*).

Summary information from the survey, including the IBI values, is presented in Table 9. The species lists and counts for each site are included in Exhibit 4. The IBI rating system has been routinely used to assess and compare the quality of streams in Illinois. The IBIs obtained in 2007 are similar to (actually somewhat better than) the IBI values obtained in 1995 before the Mill Creek WRF went into operation, suggesting that the facility has not had an adverse impact on the fish resource of Mill Creek.

Table 9: Summary Results of 2007 Mill Creek Fish Survey

Sample Site	No. of Fish Captured	No. of Species	No. of Intolerant Species*	IBI
Site 1, below dam forming Lake Elisabeth and upstream of WRF	622	25 native and 1 non-native species	2	40
Site 3, 150 ft. downstream of WRF outfall channel confluence with Mill Creek	396	18 native and 1 non-native species	1	27.5
Site 4, at Dilleys Road downstream of WRF	223	18 native and 1 non-native species	2	32.5

*Hornyhead chubs were collected from all three fish survey reaches.

The values of their constituent metrics for each of the three fish survey reaches are provided in Table 10. Each metric value for the IBI is standardized on a scale of 0-6 and wetted stream width. By convention, if a raw metric score falls on the border of two categories, it is assigned the lower of the two values.

Table 10: Mill Creek 2007 IBI Region 3 Metric Scores

Category	Metric	1	3	4
Species-Richness	# Native Fish Species	6	3	4
	# Native Sucker Species	3	2	3
	# Native Sunfish Species	6	6	6
	# Intolerant Native Species	2	1	2
	# Native Minnow Species	4	3	4
	# Native Benthic Invertivore Species	4	2	2
Trophic and/or Reproductive Structure	% Individuals Specialist Benthic Invertivores	1	1	1
	% Individuals Generalist Feeders	6	3	4
	% Individuals Obligate Coarse Mineral Spawners (not tolerant)	2	1	1
Tolerance	Proportion of Tolerant Species	5	5	5
	Overall IBI Score	**39**	**27**	**32**

Macroinvertebrate Survey Results

Three primary assessment endpoints (biological metrics) were used to evaluate the macroinvertebrate data. They are the stream condition index (SCI, Tetra Tech 2005), the macroinvertebrate biotic index (MBI, Hilsenhoff 1982), and Shannon-Wiener diversity index (SDI, Shannon 1948).

The SCI is a multi-metric index that relies on macroinvertebrate community composition to objectively evaluate stream quality. The SCI reflects both the water quality and the habitat quality of a stream. It is composed of a suite of seven metrics that reflect the tolerance, richness, and trophic status of the benthic macroinvertebrate community. The individual metric scores were averaged to determine the overall index score. The SCI metrics and response to disturbance are listed in Table 11.

Table 11: Stream Condition Index Metrics

Metric	Metric Category	Reference Value	Response to Disturbance
Coleoptera Taxa	Richness	5	Decrease
Ephemeroptera Taxa	Richness	10.2	Decrease
Total Taxa	Richness	46	Decrease
Intolerant Taxa	Tolerance	9	Decrease
% Scrapers	Trophic Status	26.8	Decrease
% EPT	Richness	74	Decrease
MBI Score	Tolerance	4.9	Increase

Source: Tetra Tech 2005

The interpretation of overall SCI score, or average of each of the seven component metrics, uses the guidelines in Table 12.

Table 12: SCI Scores Boundaries and Stream Rating

SCI Score			
Lower Boundary	**Upper Boundary**	**Comparison to Reference**	**Narrative Description**
69.9	100.0	> 75th percentile	Exceptional
49.3	69.8	> 25th percentile	Good
24.6	49.2	bisect 25th percentile (upper)	Fair
0.0	24.5	bisect 25th percentile (lower)	Poor

Source: Tetra Tech 2005

While the MBI is a component of the SCI, it is also widely used as a stand alone tool to assess overall stream quality. The MBI was created by Hilsenhoff (1982) to provide an objective means for evaluating stream quality. Ratings vary from 0 to 11, with lower values assigned to species least tolerant of disturbance. MBI scores are interpreted according to Table 13 with lower values reflecting progressively better conditions.

Table 13: MBI Score Interpretation

MBI Score	Narrative Description
<5.0	Excellent
5.0-5.9	Good
6.0-7.5	Fair
7.6-8.9	Poor
>8.9	Very Poor

The MBI was the primary method used to evaluate the Hester-Dendy samples. One advantage of the Hester-Dendy samplers is that they provide a standard habitat (i.e. the sampler plates) for macroinvertebrates to colonize. Because the Hester-Dendy samplers provide a standard habitat for macroinvertebrates, they isolate the effect of water quality on the macroinvertebrate community. At sites with obvious habitat limitations, Hester-Dendy samples can be used to approximate a site's potential if habitat is improved. Conversely, if habitat is adequate Hester-Dendy samples may be used to infer impacts related to water quality.

The SDI is an index that measures the diversity of a sample by quantifying the distribution of individuals across taxa groups. The most diverse communities are those with higher numbers of total species with an even distribution of individuals. Contrary to the MBI, higher SDI values indicate better quality. The SDI values vary between 0 and a theoretical maximum determined by the total number of species. The SDI values were calculated for samples and standardized on a scale of 0 to 1 (SWI/SWI_{max}) so sites and years could be compared.

a. Hester-Dendy Sampling The Hester-Dendy sampling results are summarized in Table 14. Raw data from the full macroinvertebrate survey (both Hester-Dendy and QMH) are included in Exhibit 5.

Table 14: Hester-Dendy Sampling Results (2007)

Sample Station	2007		
	1	3	4
# Individuals	240	688	343
# Taxa	15	14	14
MBI	6.70	5.86	5.47
SDI/ SDI_{max}	0.70	0.32	0.53

The number of individuals was high at all stations. The numerically dominant taxon (79 percent of all individuals) at Station 3 was a filter-collector Caddisfly (*Cheumatopsyche sp.*). The dominance of *Cheumatopsyche sp.* is likely explained by large amount of detritus input from the forested riparian zone. This explains the relatively low diversity (depressed SDI/SDI_{max}) encountered at Site 3 which is just downstream of the WRF outfall swale. The number of taxa was consistent across sites even thought the composition of taxa varied slightly from site to site. Leeches and aquatic worms were found at the upstream site (Site 1) and the downstream site (Site 4), but not at the site nearest the outfall where aquatic sow-bugs and scuds were found. Aquatic sow-bugs and scuds are common in ditches and it is likely they are moving downstream into the main stream channel from the smaller outfall swale.

The MBI scores decline (improve) in an upstream to downstream fashion moving downstream from Site 1 to Site 4. Site 1 is rated “fair” according to Table 11 criteria while Sites 3 and 4 are rated “good”. It is possible that there is some negative influence exerted by Lake Elisabeth because high MBI scores at the upstream site (Site 1) were driven by the presence of a tolerant Chironomid taxon (*Glyptotendipes sp.*) usually associated with eutrophic conditions and slow moving water in soft sediments or aquatic plants (Epler 2001). This suggests that Lake Elisabeth may be serving as a population source.

As measured by the Hester-Dendy results, macroinvertebrate community quality declined at the upstream site from 1995 to 2007, declined slightly at the site nearest the WRF, and improved considerably at the Dilleys Road site downstream of the WRF. Overall, the MBI results of the Hester-Dendy sampling in 2007 are fairly consistent with prior sampling of Mill Creek done by Hey/WIU in 1995: upstream of the WRF (MBI = 5.2 in 1995 and 6.7 in 2007), at the outfall location (MBI=5.3 in 1995 and 5.9 in 2007), and at Dilley’s Road (MBI=7.3 in 1995 and 5.5 in 2007).

b. QMH (kicknet) Sampling The results of the QMH sampling are presented in Table 15.

Table 15: Results of QMH Sampling and SCI Scores

Metric	Site		
	Upstream	Confluence	Downstream
# Coleoptera Taxa	80.0	40.0	40.0
# Ephmereotera Taxa	9.8	19.6	19.6
# Taxa	50.0	45.7	37.0
# Intolerant Taxa	11.1	22.2	22.2
% Scrapers	46.1	45.3	94.1
% EPT	6.1	10.4	3.5
MBI	74.7	78.7	72.2
Overall SCI	39.7	37.4	41.2
Narrative Rating	Fair	Fair	Fair

The SCI scores indicate "fair" environmental quality at all sites and no upstream to downstream pattern. Precision estimates for the QMH/SCI method is approximately ±9 indicating the total difference between sites is insignificant. In summary, there is some variation in the community composition between sites, but all sites are similar in terms of community quality (tolerance to pollution). This result indicates the combined impacts of water quality and habitat is similar at all sites.

Mussel Survey Results

A total of 266 live and 102 fresh dead mussels were collected by Hey stream researchers. The distribution of live mussels was approximately even between the three sampled reaches suggesting no impairment of the mussel community by the effluent from the Mill Creek WRF. Indeed, the highest number of live mussels was found in the stream reach downstream of the WRF at Dilleys Road. The mussel species list was essentially the same as was obtained in the 1995 Hey/WIU survey of this section of Mill Creek with the numbers of individuals collected in 2007 much higher than the number collected back in 1995. This would suggest that the WRF is not having a negative impact on the mussel fauna of the stream. Summary data are presented in Table 16. No listed mussel species (live or dead) were found in the survey.

Table 16: 2007 Mussel Survey Results for Mill Creek

	Sample Site	1		3		4	
Species	**Scientific Name**	**Live**	**Fresh Dead**	**Live**	**Fresh Dead**	**Live**	**Fresh Dead**
Giant Floater	*Pyganodaon grandis*	30	21	14	6	38	9
White Heelsplitter	*Lasmigona complanata*	50	50	65	11	65	1
Fatmucket	*Lampsilis siliquoidea*	1	2	1	0	0	1
Lilliput	*Toxolasma parvus*	2	0	0	0	0	1
Totals		**83**	**73**	**80**	**17**	**103**	**12**

LISTED SPECIES CONSULTATION

A listed species consultation request for the water reclamation facility expansion was submitted to the IDNR via Illinois' EcoCAT system (IDNR 0715171). Following review, the IDNR concluded that the project was unlikely to adversely affect protected resources and terminated consultation on March 27, 2008. The consultation request and closure are included in Exhibit 6.

CONCLUSIONS

- Mill Creek is not classified an Impaired Water on the Illinois EPA's 303(d) list and the Illinois EPA's 305(b) report indicates that the creek is fully supportive of aquatic life. Data from sampling and surveys conducted in summer 2007 tend to validate the Illinois EPA's assessment that Mill Creek is not impaired.

- The Lake County Department of Public Works has committed to protecting the water quality and biotic integrity of Mill Creek ever since the Mill Creek WRF was constructed. The facility provides a high level of treatment which fully protects water quality and fish and aquatic life. This was borne out by the biologic sampling conducted by Hey and Associates, Inc. in 2007. The creek further benefits from extra measures that have been taken such as the vegetated outfall swale which further polishes effluent between the WRF outfall and the creek and the use of ultraviolet radiation as the means for disinfection. The water quality data presented in Table 7 indicate that the Mill Creek WRF is in compliance with its NPDES permit and consistently produces treated effluent quality better than is required by permit.

- Mill Creek in the vicinity of the Mill Creek Water Reclamation Facility offers water quality and physical habitat conditions similar to other streams found in Lake County. Taxa collected represented a good array of northeastern Illinois fish species and ranged from 18 to 25 native fish species for the three sampling reaches. Calculated IBIs ranged from 39 to 27 and are comparable to the IBIs obtained in the Hey/WIU fish survey that was done in 1995 prior to the Mill Creek WRF being built. Two intolerant species (hornyhead chub and spotted sucker) were collected both upstream and downstream of the outfall. No Iowa darters or any other listed fish species were collected in either the 1995 or the 2007 surveys.

- The 2007 Hester-Dendy macroinvertebrate survey indicated a good quality benthic community downstream of the WRF where MBIs of 5.86 and 5.47 were achieved. Macroinvertebrate community conditions were not quite as good upstream of the treatment facility at Site 1 where the score was 6.7. The QMH (kicknet) macroinvertebrate results showed a consistent "fair" rating from upstream to downstream based on overall SCI scores.

- Live mussels were abundant in all sampled reaches, both upstream and downstream of the WRF, which also indicative of a healthy stream ecosystem. The number of species collected in 2007 was essentially the same as were collected in 1995 with a greater number of individuals being collected in 2007. No listed mussel species were encountered in either 1995 or 2007 and no listed mussel species were identified during the IDNR listed species consultation process.

- The County of Lake also follows the rules and procedures set forth in the *Watershed Development Ordinance* which regulates stormwater, erosion and sediment control, floodplain development, and isolated wetlands in the county. This ordinance and others, such as the *Lake County Unified Development Ordinance* and the Village of Old Mill Creek's *Greenway Plan* will provide a higher than normal level of water quality and stream corridor protection as new growth and development occurs in the Facilities Planning Area. Additional voluntary Best Management Practices may be implemented by developers seeking to incorporate conservation design principles into their site plans. Measures recognized as being useful in this regard include utilization of naturalized wetland detention basin designs and using open vegetated swales whenever possible rather than constructing conventional storm sewers.

- The expanded WRF is expected to continue to produce effluent in full compliance with applicable standards. The current treated effluent is low in oxygen-demanding organics, low in suspended solids, low in ammonia, and provides an input of clear water to Mill Creek. The proposed expansion will include a treatment upgrade to remove phosphorus, and this will address problems with high phosphorus observed in the 2007 sampling. Water quality, fish and aquatic life, and existing uses of Mill Creek should continue to be fully protected. The continued high level of treatment at the Mill Creek WRF will also benefit the upper Des Plaines River.

REFERENCES

Anderson, Richard V. 1996. *Biotic Communities Macroinvertebrates and Fish Survey, Mill Creek Lake County, Illinois.* Western Illinois University Department of Biological Sciences. Prepared for Hey and Associates, Inc.

Cummings, Kevin S. and Christine A. Mayer. 1992. *Field Guide o Freshwater Mussels of the Midwest.* Illinois Natural History Survey Manual 5.

Earth Tech, Inc. December 2006. *Mill Creek WRF Design Basis Report for Lake County Department of Public Works.* Sheboygan, WI.

Epler, J.H. 2001. Identification Manual for the Larval Chironomidae (Diptera) of North and South Carolina (technical report available online at: http://www.esb.enr.state.nc.us/BAUwww/Chironomid.htm).

Hilsenhoff, W. L. 1982. Using a biotic index to evaluate water quality in streams. Tech. Bull. No. 132. Wisconsin Department of Natural Resources. Madison.

Illinois State Water Survey. February 2003. *7-Day, 10-Year Low Flows of Streams in Northeastern Illinois.* Champaign, Illinois (http://www.sws.uiuc.edu/docs/maps/lowflow/images/maps/map2.gif.)

Illinois Environmental Protection Agency. April 2006. *Illinois Integrated Water Quality Report and Section 303(d) List-2006.*

Karr, J.R., P.L. Angermeir, P.R. Yant, and I. J. Schlosser. 1986. Assessing biological integrity in running waters: Illinois Natural History Survey Special Publication 5. Urbana, Illinois 23pp.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): Rationale, methods, and application. Ohio Environmental Protection Agency. Division of Water Quality Planning and Assessment, Ecological Assessment Section, Columbus, Ohio.

Shannon, C.E. (1948) A mathematical theory of communication. Bell System Technical Journal, 27, 379–423.

Smith, P.W. 1979. *The Fishes of Illinois*, Urbana, IL: University of Illinois Press, 314pp.

U.S. Geological Survey. Water Resources Data for Illinois. Online Biological Data found at: (http://pubs.usgs.gov/wdr/2005/wdr-il-05/data/index5.htm).

U.S. Geological Survey. USGS Real-Time Water Data for Illinois. At http://waterdata.usgs.gov/il/nwis/rt

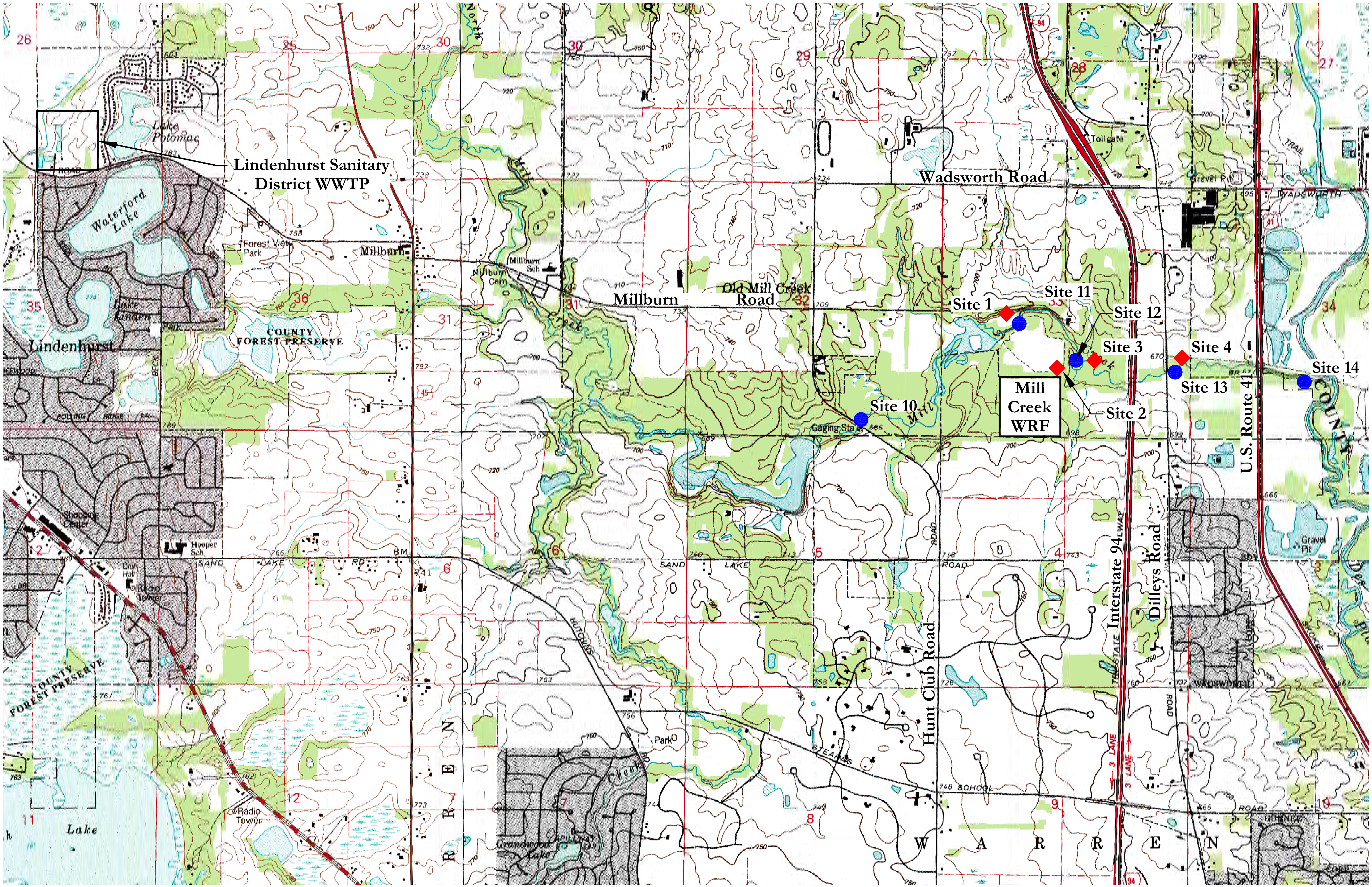

EXHIBIT 1

MILL CREEK WRF

PROJECT AREA ON USGS MAP

1995 MUSSEL AND MACRO-INVERTEBRATE SAMPLING SITES

2007 MUSSEL, FISH, MACRO-INVERTEBRATE AND WATER QUALITY SAMPLING SITES

SCALE: 1" = 2000'

N

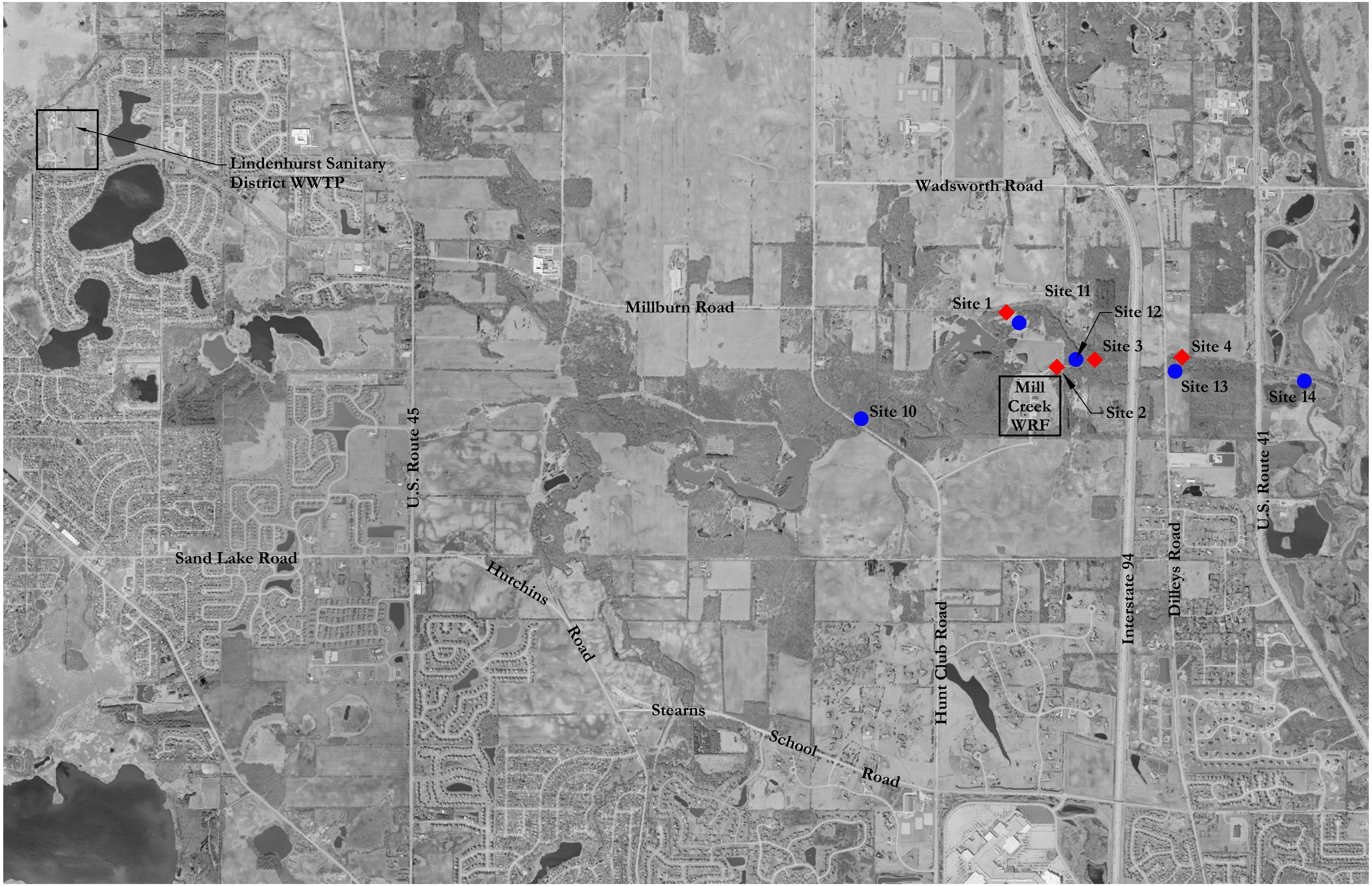

EXHIBIT 2

MILL CREEK WRF

PROJECT AREA ON 2006 AERIAL PHOTOGRAPH

● 1995 MUSSEL AND MACRO-INVERTEBRATE SAMPLING SITES

◆ 2007 MUSSEL, FISH, MACRO-INVERTEBRATE AND WATER QUALITY SAMPLING SITES

SCALE: 1" = 2000'

N

EXHIBIT 3

MILL CREEK WRF

COLOR PHOTOS

Photograph 1: Mill Creek near Sampling Site/Reach 1, upstream of Water Reclamation Facility and downstream of Lake Elisabeth

Photograph 2: Area of streambank erosion near Sampling Site/Reach 1

Photograph 3: Mill Creek near Sampling Site/Reach 3 (near the point where the WRF outfall channel flows into Mill Creek)

Photograph 4: Sampling Site/Reach 4 at Dilleys Road, downstream of WRF

Photograph 5: View of bank erosion near Dilleys Road

Photograph 6: Stonecat captured during fish survey

EXHIBIT 4

MILL CREEK WRF

FISH SURVEY
SPECIES LISTS AND
IBI CALCULATIONS

Site 1 Upstream of WRF and Downstream of Lake Elisabeth

Common Name	Family	Count	Native	Native Benthic Invertivore	Specialist Benthic Invertivore	Generalist Feeder	Mineral Substrate Spawner (Excluding Tolerants)	Tolerance
Spotted Sucker	Catostomidae	3	yes	yes		yes	yes	intolerant
White Sucker	Catostomidae	15	yes			yes		tolerant
Pumpkinseed	Centrarchidae	24	yes					
Bluegill	Centrarchidae	51	yes			yes		
Largemouth Bass	Centrarchidae	7	yes					
Orangespotted Sunfish	Centrarchidae	71	yes					
Black Crappie	Centrarchidae	30	yes					
Green Sunfish	Centrarchidae	18	yes			yes		tolerant
Spotfin Shiner	Cyprinidae	107	yes			yes		
Golden Shiner	Cyprinidae	2	yes			yes		tolerant
Bluntnose Minnow	Cyprinidae	112	yes			yes		tolerant
Hornyhead Chub	Cyprinidae	70	yes				yes	intolerant
Sand Shiner	Cyprinidae	18	yes			yes		
Common Carp	Cyprinidae	1	no			yes		tolerant
Central Stoneroller	Cyprinidae	1	yes				yes	
Northern Pike	Esocidae	1	yes					
Grass Pickerel	Esocidae	1	yes					
Blackstripe Topminnow	Fundulidae	35	yes					
Channel Catfish	Ictaluridae	23	yes			yes		
Black Bullhead	Ictaluridae	2	yes			yes		
Yellow Bullhead	Ictaluridae	5	yes			yes		tolerant
Stonecat	Ictaluridae	12	yes	yes				
Tadpole Madtom	Ictaluridae	2	yes	yes	yes			
Yellow Perch	Percidae	1	yes					
Blackside Darter	Percidae	9	yes	yes	yes		yes	
Johnny Darter	Percidae	1	yes	yes	yes			
		622						
	Metric	Raw	Score					
IBI Calculations	*Species-richness*							
	NFSH	25	6					
	NSUC	2	3					
	NSUN	6	6					
	INTOL	2	2.5					
	NMIN	7	4					
	NBINV	5	4					
	Trophic- or Reproductive-structure							
	SBI	0.019	1					
	GEN	0.574	6					
	LITOT	0.133	2					
	Tolerance							
	PRTOL	0.231	5.5					
		Total	**40**					
IBI Region	3							
Wetted Width	30							

Site 3 Mill Creek just downstream of confluence with WRF outfall channel

Common Name	Family	Count	Native	Native Benthic Invertivore	Specialist Benthic Invertivore	Generalist Feeder	Mineral Substrate Spawner (Excluding Tolerants)	Tolerance
White Sucker	Catostomidae	3	yes			yes		tolerant
Pumpkinseed	Centrarchidae	11	yes					
Bluegill	Centrarchidae	17	yes			yes		
Largemouth Bass	Centrarchidae	1	yes					
Orangespotted Sunfish	Centrarchidae	12	yes					
Green Sunfish	Centrarchidae	60	yes			yes		tolerant
Spotfin Shiner	Cyprinidae	135	yes			yes		
Bluntnose Minnow	Cyprinidae	74	yes			yes		tolerant
Hornyhead Chub	Cyprinidae	19	yes				yes	intolerant
Sand Shiner	Cyprinidae	31	yes			yes		
Common Carp	Cyprinidae	1	no			yes		tolerant
Central Mudminnow	Umbridae	1	yes					
Blackstripe Topminnow	Fundulidae	12	yes					
Channel Catfish	Ictaluridae	1	yes			yes		
Black Bullhead	Ictaluridae	2	yes			yes		
Yellow Bullhead	Ictaluridae	4	yes			yes		tolerant
Stonecat	Ictaluridae	2	yes	yes				
Blackside Darter	Percidae	8	yes	yes	yes		yes	
Johnny Darter	Percidae	2	yes	yes	yes			
		396						
	Metric	Raw	Score					
IBI Calculations	*Species-richness*							
	NFSH	15	3					
	NSUC	1	2					
	NSUN	5	6					
	INTOL	1	1.5					
	NMIN	5	3					
	NBINV	3	2					
	Trophic- or Reproductive-structure							
	SBI	0.025	1					
	GEN	0.828	3					
	LITOT	0.068	1					
	Tolerance							
	PRTOL	0.263	5					
		Total	**27.5**					
IBI Region	3							
Wetted Width	30							

Site 4 0.5 Mile Downstream of WRF at Dilleys Road

Common Name	Family	Count	Native	Native Benthic Invertivore	Specialist Benthic Invertivore	Generalist Feeder	Mineral Substrate Spawner (Excluding Tolerants)	Tolerance
Spotted Sucker	Catostomidae	5	yes	yes		yes	yes	intolerant
White Sucker	Catostomidae	8	yes			yes		tolerant
Pumpkinseed	Centrarchidae	7	yes					
Bluegill	Centrarchidae	15	yes			yes		
Largemouth Bass	Centrarchidae	4	yes					
Orangespotted Sunfish	Centrarchidae	19	yes					
Black Crappie	Centrarchidae	6	yes					
Green Sunfish	Centrarchidae	30	yes			yes		tolerant
Spotfin Shiner	Cyprinidae	10	yes			yes		
Golden Shiner	Cyprinidae	1	yes			yes		tolerant
Bluntnose Minnow	Cyprinidae	62	yes			yes		tolerant
Hornyhead Chub	Cyprinidae	1	yes				yes	intolerant
Sand Shiner	Cyprinidae	18	yes			yes		
Common Carp	Cyprinidae	3	no			yes		tolerant
Grass Pickerel	Esocidae	1	yes					
Blackstripe Topminnow	Fundulidae	25	yes					
Channel Catfish	Ictaluridae	2	yes			yes		
Stonecat	Ictaluridae	2	yes	yes				
Blackside Darter	Percidae	4	yes	yes	yes		yes	
		223						
	Metric	Raw	Score					
IBI Calculations	*Species-richness*							
	NFSH	18	4					
	NSUC	2	3					
	NSUN	6	6					
	INTOL	2	2.5					
	NMIN	6	4					
	NBINV	3	2					
	Trophic- or Reproductive-structure							
	SBI	0.018	1					
	GEN	0.691	4					
	LITOT	0.045	1					
	Tolerance							
	PRTOL	0.263	5					
		Total	**32.5**					
IBI Region	3							
Wetted Width	30							

Exhibit 5

Mill Creek WRF

Macro-invertebrate Sampling Data

Site 1: Upstream of WRF and downstream of Lake Elisabeth (Hester-Dendy Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance		H_{calc}	FFG		Habit
Ephemeroptera	Heptangeniidae	Stenacron	10	4	40		0.136731	SC		
Megaloptera	Sialidae	Sialis	3	4	12		0.056792	PR		
Coleptera	Elmidae	Stenelmis	9	7	63		0.127199	SC		
Trichoptera	Hydropsychidae		9			(dam.)		FC		
	Hydropsychidae	Cheumatopsyche	88	6	528		0.367519	FC		
	Hydropsychidae	Ceratopsyche	1	4	4		0.023728	FC		
	Polycentropodidae	Cyrnellus	6	5	30		0.095423	FC		
Diptera	Chironomidae		2			(dam.)		GC		
	Chironomidae	Stenochironomus	18	3	54		0.199914	GC		
	Chironomidae	Glyptotendipes	56	10	560		0.344405	FC	GC	
	Chironomidae	Dicrotendipes	3	6	18		0.056792	GC	FC	
	Chironomidae	Polypedilium	11	6	66		0.145826	SH	GC	
	Chironomidae	Natarsia	18	6	108		0.199914	PR		
Oligochaeta			1	10	10		0.023728	GC		
Mollusca	Physidae	Physella	2	9	18		0.041402	SC		
	Lymnaeidae		1	7	7		0.023728	SC		
Hirudinea			2	8	16		0.041402	PR		
			MBI N	229	1534					
			Total N	240						
				MBI	6.70					
				Total Taxa	15					
				H_{max}	2.71					
				H'	1.88					
				H'/H_{max}	0.70					

Site 3: Downstream of WRF Outfall Channel (Hester-Dendy Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	Notes	H_{calc}
Ephemeroptera	Heptangeniidae	Stenacron	14	4	56		0.081369
	Baetidae	Baetis	10	4	40		0.063188
Megaloptera	Sialidae	Sialis	1	4	4		0.009787
Coleptera	Elmidae	Stenelmis	7	7	49		0.047992
Trichoptera	Hydropsychidae	Cheumatopsyche	542	6	3252		0.165715
Diptera	Chironomidae		24			dam.	
	Chironomidae	Cryptochironomus	1	6	6		0.009787
	Chironomidae	Stenochironomus	22	3	66		0.11289
	Chironomidae	Polypedilium	45	6	270		0.182414
	Chironomidae	Glyptotendipes	5	10	50		0.036814
	Chironomidae	Natarsia	10	6	60		0.063188
Mollusca	Lymnaeidae		1	7	7		0.009787
Decapoda	Cambaridae		2	5	10		0.017485
Isopoda	Asellidae	Asellus	3	6	18		0.024396
Amphipoda	Hyallidae		1	5	5		0.009787
			MBI N	664	3893		
			Overall N	688			
				MBI	5.86295181		
				Taxa	14		
				H_{max}	2.63905733		
				H'	0.83459824		
				H'/H_{max}	0.31624862		

Site 4: Downstream of WRF at Dilleys Road (Hester-Dendy Sampling Results)

Order	Family	Genus	Species	n	Tolerance	n*Tolerance	H_{calc}
Ephemeroptera	Heptangeniidae	Stenacron		16	4	64	0.145559
	Heptangeniidae	Stenonema		1	4	4	0.017399
	Baetidae	Baetis		2	4	8	0.030647
Coleptera	Elmidae	Stenelmis		1	7	7	0.017399
	Elmidae	Dubiraphia		1	5	5	0.017399
Trichoptera	Hydropsychidae	Cheumatopsyche		193	6	1158	0.316919
	Polycentropodidae	Cyrnellus		1	5	5	0.017399
Diptera	Chironomidae			9			
	Chironomidae	Stenochironomus		63	3	189	0.314624
	Chironomidae	Polypedilium		27	6	162	0.203333
	Chironomidae	Glyptotendipes		5	10	50	0.0629
	Chironomidae	Natarsia		12	6	72	0.119505
	Chironomidae	Tribelos		1	5	5	0.017399
Oligochaeta				1	10	10	0.017399
Hirudinea				10	8	80	0.105047
				MBI N	334	1819	
				Total N	343		
					MBI	5.44610778	
					Taxa	14	
					H_{max}	2.63905733	
					H'	1.40292565	
					H'/H_{max}	0.53160105	

Site 1: Upstream of WRF and downstream of Lake Elisabeth (QMH Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	FFG	H_{calc}
Ephemeroptera	Baetidae	Baetis	22	4	88	CG	0.140698618
Megaloptera	Sialidae	Sialis	1	4	4	PR	0.012795066
Coleptera	Elmidae	Stenelmis	58	7	406	SC	0.254524371
	Elmidae	Macronychus	1	2	2	-	0.012795066
	Elmidae	Dubiraphia	1	5	5	CG	0.012795066
	Hydroptilidae	Tropisternus	2	-	-	PR	0.022719956
Trichoptera	Hydropsychidae	Cheumatopsyche	216	6	1296	CF	0.359882942
	Hydropsychidae	Ceratopsyche	9	4	36	CF	0.074213517
Diptera	Chironomidae		5	6	6	CG	-
	Chironomidae	Glyptotendipes	41	10	410	CF	0.209366932
	Chironomidae	Chironomus	3	11	33	CG	0.031561518
	Chironomidae	Polypedilum	76	6	456	SH	0.290984538
	Chironomidae	Microtendipes	2	6	12	CF	0.022719956
	Chironomidae	Cladopelma	1	6	6	CG	0.012795066
	Chironomidae	Natarsia	10	6	60	PR	0.080278086
	Simuliidae	Simulium	1	6	6	CF	0.012795066
Heteroptera	Nepidae	Ranatra	1	-	-	PR	0.012795066
Odonata	Coenagrionidae	Ischnura	5	6	30	PR	0.04731448
Isopoda	Asellidae	Asellus	4	6	24	CG	0.039699563
Oligochaeta	Oligochaeta	Oligochaeta	15	10	150	CG	0.107825045
Mollusca	Physidae	Physella	2	9	18	SC	0.022719956
	Sphaeridae	Sphaeridae	3	5	15	CF	0.031561518
Decapoda	Cambaridae	Cambaridae	2	5	10	CG	0.022719956
Hirudinea	Hirudinea	Hirudinea	5	8	40	PR	0.04731448
			MBI N	483	3113		
			Total N	486			
					Metric Value	Reference Value	B-IBI Score
				H_{max}	3.14	-	-
				H'	1.88	-	-
				H'/H_{max}	0.60	-	-
				# Coleoptera Taxa	4	5	80.0
				# Ephmereoptera Taxa	1	10.2	9.8
				# Taxa	23	46	50.0
				# Intolerant Taxa	1	9	11.1
				% Scrapers	12.35	26.8	46.1
				% EPT	4.53	74	6.1
				MBI	6.45	4.9	74.7
				Overall B-IBI	-	-	39.7
					>69.8	Exceptional	
					49.3-69.8	Good	
					24.6-49.2	Fair	
					<24.6	Poor	

Site 3: Downstream of WRF Outfall Channel (QMH Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	FFG	H_{calc}
Ephemeroptera	Baetidae	Baetis	19	4	76	CG	0.197303797
	Ephemerellida	Seratella	1	1	1	CG	0.022305216
Coleptera	Elmidae	Stenelmis	28	7	196	SC	0.246806264
	Elmidae	Dubiraphia	3	5	15	CG	0.053572179
Trichoptera	Hydropsychidae	Cheumatopsyche	80	6	480	CF	0.365137393
	Hydropsychidae	Ceratopsyche	1	4	4	CF	0.022305216
	Mollanidae	Molanna	1	3.5	3.5	SC	0.022305216
Diptera	Chironomidae						
	Chironomidae	Glyptotendipes	5	10	50	CF	0.078946365
	Chironomidae	Chironomus	2	11	22	CG	0.038997904
	Chironomidae	Polypedilum	55	6	330	SH	0.334465722
	Chironomidae	Cryptochironomus	1	8	8	PR	0.022305216
	Chironomidae	Microtendipes	5	6	30	CF	0.078946365
	Chironomidae	Natarsia	14	6	84	PR	0.162690826
	Chironomidae	Procladius	9	8	72	PR	0.120686129
	Chironomidae	Stenochironomus	1	3	3	SH	0.022305216
	Simuliidae	Simulium	1	6	6	CF	0.022305216
Isopoda	Asellidae	Asellus	3	6	18	CG	0.053572179
Amphipoda	Hyallelidae	Hyallelidae	1	4	4	CG	0.022305216
Oligochaeta	Oligochaeta	Oligochaeta	8	10	80	CG	0.111091394
Mollusca	Physidae	Physella	1	9	9	SC	0.022305216
	Sphaeridae	Sphaeridae	8	5	40	CF	0.111091394
			MBI N	247	1531.5		
			Total N	247			
					Metric Value	Reference Value	B-IBI Score
				H_{max}	3.04	-	-
				H'	2.13	-	-
				H'/H_{max}	0.70	-	-
				# Coleoptera Taxa	2	5	40.0
				# Ephmereoptera Taxa	2	10.2	19.6
				# Taxa	21	46	45.7
				# Intolerant Taxa	2	9	22.2
				% Scrapers	12.15	26.8	45.3
				% EPT	7.69	74	10.4
				MBI	6.20	4.9	78.7
				Overall B-IBI	-	-	37.4
					>69.8	Exceptional	
					49.3-69.8	Good	
					24.6-49.2	Fair	
					<24.6	Poor	

Site 4: Downstream of WRF at Dilleys Road (QMH Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	FFG	H_{calc}
Ephemeroptera	Ephemerellida	Seratella	2	1	2	CG	0.070465825
	Heptanageniidae	Stenacron	1	4	4	SC	0.041260279
Coleptera	Elmidae	Stenelmis	19	7	133	SC	0.297472781
	Elmidae	Dubiraphia	5	5	25	CG	0.136325835
Trichoptera	Hydropsychidae	Cheumatopsyche	25	6	150	CF	0.33175137
	Mollanidae	Molanna	1	3.5	3.5	SC	0.041260279
Diptera	Chironomidae						
	Chironomidae	Polypedilum	7	6	42	SH	0.170375251
	Chironomidae	Microtendipes	17	6	102	CF	0.282601907
	Chironomidae	Natarsia	10	6	60	PR	0.212378003
	Chironomidae	Procladius	1	8	8	PR	0.041260279
	Chironomidae	Stenochironomus	2	3	6	SH	0.070465825
	Muscidae	Muscidae	1	8	8	PR	0.041260279
Isopoda	Asellidae	Asellus	2	6	12	CG	0.070465825
Oligochaeta	Oligochaeta	Oligochaeta	13	10	130	CG	0.246432835
Mollusca	Physidae	Physella	7	9	63	SC	0.170375251
	Sphaeridae	Sphaeridae	2	5	10	CF	0.070465825
	Lymnaeidae	Lymnaeidae	1	7	7	SC	0.041260279
			MBI N	115	758.5		
			Total N	115			
					Metric Value	Reference Value	B-IBI Score
				H_{max}	2.83	-	-
				H'	2.29	-	-
				H'/H_{max}	0.81	-	-
				# Coleoptera Taxa	2	5	40.0
				# Ephmereoptera Taxa	2	10.2	19.6
				# Taxa	17	46	37.0
				# Intolerant Taxa	2	9	22.2
				% Scrapers	25.22	26.8	94.1
				% EPT	2.61	74	3.5
				MBI	6.60	4.9	72.2
				Overall B-IBI	-	-	41.2
					>69.8	Exceptional	
					49.3-69.8	Good	
					24.6-49.2	Fair	
					<24.6	Poor	

EXHIBIT 6

MILL CREEK WRF

ILLINOIS DNR
ECOCAT
CONSULTATION
AND CLOSURE

Illinois Department of
Natural Resources

One Natural Resources Way • Springfield, Illinois 62702-1271
http://dnr.state.il.us

Rod R. Blagojevich, Governor

Sam Flood, Acting Director

March 27, 2008

RECEIVED
MAR 31 2008
BY: 07086

Vince Mosca
Hey and Associates, Inc. (for Lake County DPW)
26575 West Commerce Drive Suite 601
Volo, IL 60073

Re: Expansion of Mill Creek Water Reclamation Facility
Project Number(s): 0715171 [Hey 07086, Info Request 0710859]
County: Lake

Dear Applicant:

This letter is in reference to the project you recently submitted for consultation. The natural resource review provided by EcoCAT identified protected resources that may be in the vicinity of the proposed action. The Department has evaluated this information and concluded that adverse effects are unlikely. Therefore, consultation under 17 Ill. Adm. Code Part 1075 is terminated.

Effects of this project will be both beneficial and detrimental to this species, but the benefits of nutrient removal are likely more important than adverse effects from endocrine-disrupting chemicals.

This consultation is valid for two years unless new information becomes available that was not previously considered; the proposed action is modified; or additional species, essential habitat, or Natural Areas are identified in the vicinity. If the project has not been implemented within two years of the date of this letter, or any of the above listed conditions develop, a new consultation is necessary.

The natural resource review reflects the information existing in the Illinois Natural Heritage Database at the time of the project submittal, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, you must comply with the applicable statutes and regulations. Also, note that termination does not imply IDNR's authorization or endorsement of the proposed action.

Please contact me if you have questions regarding this review.

Keith Shank
Division of Ecosystems and Environment
217-785-5500

EcoCAT
Ecological Compliance Assessment Tool

Applicant:	Hey and Associates, Inc. (for Lake County DPW)	*IDNR Project #:*	0715171
Contact:	Vince Mosca	Alternate #:	Hey 07086, Info Request 0710859
Address:	26575 West Commerce Drive Suite 601 Volo, IL 60073	Date:	06/01/2007

Project: Expansion of Mill Creek Water Reclamation Facility
Address: West of Interstate 94, south of Wadsworth Road, Old Mill Creek

Description: Expand existing water reclamation from 1 MGD to 2.1 MGD to meet increased capacity needs. Phosphorus removal will be added. Treated effluent is discharged to Mill Creek (Des Plaines River watershed).

Natural Resource Review Results

Consultation for Endangered Species Protection and Natural Areas Preservation (Part 1075)
The Illinois Natural Heritage Database shows the following protected resources may be in the vicinity of the project location:

Common Moorhen *(Gallinula chloropus)*
Iowa Darter *(Etheostoma exile)*
Least Bittern *(Ixobrychus exilis)*
Yellow-Headed Blackbird *(Xanthocephalus xanthocephalus)*

An IDNR staff member will evaluate this information and contact you within 30 days to request additional information or to terminate consultation if adverse effects are unlikely.

Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Lake
Township, Range, Section:
46N, 11E, 33

IL Department of Natural Resources Contact
Keith Shank
217-785-5500
Division of Ecosystems & Environment

Local or State Government Jurisdiction
Lake County Department of Public Works
Mr. Dennis Price, P.E.
Lake County Department of Public Works
650 W. Winchester Road
Libertyville, Illinois 60048

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

Terms of Use

By using this website, you acknowledge that you have read and agree to these terms. These terms may be revised by IDNR as necessary. If you continue to use the EcoCAT application after we post changes to these terms, it will mean that you accept such changes. If at any time you do not accept the Terms of Use, you may not continue to use the website.

1. The IDNR EcoCAT website was developed so that units of local government, state agencies and the public could request information or begin natural resource consultations on-line for the Illinois Endangered Species Protection Act, Illinois Natural Areas Preservation Act, and Illinois Interagency Wetland Policy Act. EcoCAT uses databases, Geographic Information System mapping, and a set of programmed decision rules to determine if proposed actions are in the vicinity of protected natural resources. By indicating your agreement to the Terms of Use for this application, you warrant that you will not use this web site for any other purpose.

2. Unauthorized attempts to upload, download, or change information on this website are strictly prohibited and may be punishable under the Computer Fraud and Abuse Act of 1986 and/or the National Information Infrastructure Protection Act.

3. IDNR reserves the right to enhance, modify, alter, or suspend the website at any time without notice, or to terminate or restrict access.

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EcoCAT operates on a state of Illinois computer system. We may use software to monitor traffic and to identify unauthorized attempts to upload, download, or change information, to cause harm or otherwise to damage this site. Unauthorized attempts to upload, download, or change information on this server is strictly prohibited by law. Unauthorized use, tampering with or modification of this system, including supporting hardware or software, may subject the violator to criminal and civil penalties. In the event of unauthorized intrusion, all relevant information regarding possible violation of law may be provided to law enforcement officials.

Privacy

EcoCAT generates a public record subject to disclosure under the Freedom of Information Act. Otherwise, IDNR uses the information submitted to EcoCAT solely for internal tracking purposes.

Appendix E – Biological Monitoring Data

APPENDIX E

Aquatic Biological Monitoring Data for the Mill Creek Watershed

The following appendix contains summary tables for biological monitoring data collected in the Mill Creek Watershed and available to Lake County SMC at the time of publication of the Mill Creek Watershed and Flood Mitigation Plan. In some cases, the tables are taken directly from the source. Lake County SMC does not take credit or responsibility for the data or its quality. Questions about the data and methods of collection should be directed to the data source, all of which are credited here.

Summary of mussel survey data, conducted by Hey and Associates, Inc. for Lake County Public Works, 2007.

	Sample Site	1		3		4	
Common name	Scientific name	Live	Fresh Dead	Live	Fresh Dead	Live	Fresh Dead
Giant Floater	*Pyganodaon grandis*	30	21	14	6	38	9
White Heelsplitter	*Lasmigona complanata*	50	50	65	11	65	1
Fatmucket	*Lampsilis siliquoidea*	1	2	1	0	0	1
Lilliput	*Toxolasma parvus*	2	0	0	0	0	1
Totals		83	73	80	17	103	12

Sample Sites: 1) Mill Creek upstream of LCPW WRF outfall and downstream of Lake Elisabeth (Tempel Farms) dam; 3) Mill Creek downstream of LCPW WRF outfall; 4) Mill Creek downstream of Dilleys Rd.

Summary of recent fish sampling data for streams in the Mill Creek watershed. Numeric values in columns A-F represent the number of individuals of a particular species collected. "X" values in columns G-H represent presence of a species in the collection. Cells with no value indicate absence of a particular species in the collection.

		Sample ID (see below for explanation)							
Common Name	**Scientific Name**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Bowfin	*Amia calva*							X	X
Central mudminnow	*Umbra limi*				1			X	
Grass pickerel	*Esox americanus*	2		1		1			
Northern pike	*Esox lucius*	1	5			1			X
Common carp	*Cyprinus carpio*	2		3	1	1	12		
Golden shiner	*Notemigonus crysoleucas*	2	1	1		2	43	X	X
Hornyhead chub	*Nocomis biguttatus*	1		1	19	70			
Central stoneroller	*Campostoma anomalum*		2			1			
Spotfin shiner	*Cyprinella spiloptera*	103	58	10	135	107			
Fathead minnow	*Pimephales promelas*	3							
Bluntnose minnow	*Pimephales notatus*	7	360	62	74	112	6		
Sand shiner	*Notropis stramineus*	133	58	18	31	18			
White sucker	*Catostomus commersoni*		1	8	3	15	2		
Spotted sucker	*Minytrema melanops*	1	3	5		3			
Channel catfish	*Ictalurus punctatus*	8		2	1	23			
Yellow bullhead	*Ameiurus natalis*		3		4	5	16	X	X
Black bullhead	*Ameiurus melas*	4			2	2	5	X	
Stonecat	*Noturus flavus*		1	2	2	12			
Tadpole madtom	*Noturus gyrinus*		1			2		X	
Blackstripe topminnow	*Fundulus notatus*	3	635	25	12	35	1		
Yellow bass	*Morone mississippiensis*							X	
Black crappie	*Pomoxis nigromaculatus*	4		6		30	3	X	X
Largemouth bass	*Micropterus salmoides*	5	13	4	1	7	16	X	
Smallmouth bass	*Micropterus dolomieu*							X	
Warmouth	*Lepomis gulosus*						1		
Green sunfish	*Lepomis cyanellus*	36	3	30	60	18	17	X	X
Bluegill	*Lepomis macrochirus*	20	9	15	17	51	143	X	X
Redear sunfish	*Lepomis microlophus*		5						
Pumpkinseed	*Lepomis gibbosus*			7	11	24	22	X	
Orangespotted sunfish	*Lepomis humilis*		30	19	12	71			
Yellow perch	*Perca flavescens*					1		X	X
Blackside darter	*Percina maculata*	6	24	4	8	9			
Johnny darter	*Etheostoma nigrum*	11	12		2	1		X	
Total Species		19	19	19	19	26	13	15	8
fIBI (reported)		NA	35	32	27	39	18	NA	NA

A) United States Geological Survey (USGS), 2001. Mill Creek downstream of U.S. Rt. 41.
B) Illinois Department of Natural Resources (IDNR), 2013. Mill Creek downstream of U.S. Rt. 41
C) Hey & Associates for Lake County Public Works (LCPW), 2007. Mill Creek downstream of Dilleys Rd.
D) Hey & Associates for Lake County Public Works (LCPW), 2007. Mill Creek downstream of LCPW WRF outfall.
E) Hey & Associates for Lake County Public Works (LCPW), 2007. Mill Creek upstream of LCPW WRF outfall and downstream of Lake Elisabeth (Tempel Farms) dam.
F) Illinois Department of Natural Resources (IDNR), 2013. Mill Creek downstream of Grandwood Park Lake dam.
G) United States Army Corps of Engineers (USACE), 2004. Mill Creek downstream of Third Lake dam.
H) United States Army Corps of Engineers (USACE), 2004. Third Lake (above Third Lake dam).

Summary tables of recent fish sampling data for lakes in the Mill Creek watershed, courtesy of Illinois Department of Natural Resources (IDNR). Dates for individual samples are included with each table.

TABLE 1. DRUCE LAKE SPECIES CATCH SUMMARY, 5/4/2009.

			LENGTH (inches)		
SPECIES	NUMBER	PERCENT	MINIMUM	AVERAGE	MAXIMUM
LARGEMOUTH BASS	83	39.3	7.6	13.0	20.0
SMALLMOUTH BASS	0	0.0			
BLUEGILL	69	32.7	4.0	6.2	8.0
WARMOUTH	2	0.9	8.3	8.4	8.5
BLACK CRAPPIE	6	2.8	8.6	10.0	11.0
YELLOW BASS	8	3.8	8.5	10.0	11.4
YELLOW PERCH	13	6.2	2.8	6.0	8.3
JOHNNY DARTER	2	0.9	2.5	2.6	2.7
IOWA DARTER*	4	1.9	2.0	2.2	2.5
NORTHERN PIKE	6	2.8	22.2	25.3	30.3
CARP	2	0.9	26.0	28.8	31.7
FATHEAD MINNOW	2	0.9	2.0	2.1	2.2
BLUNTNOSE MINNOW	9	4.3	1.8	2.2	2.7
QUILLBACK CARPSUCKER	5	2.4	21.0	22.6	23.8
SPECIES= 13 TOTAL=	211	100.0			

*ENDANGERED OR THREATENED SPECIES.

TABLE 1. FOURTH LAKE CATCH SUMMARY, 4/28/2008

SPECIES	NUMBER	PERCENT	LENGTH (in) MINIMUM	AVERAGE	MAXIMUM
LARGEMOUTH BASS	42	19.1	4	9.2	17.1
SMALLMOUTH BASS		0.0			
BLUEGILL	117	53.2	1.3	4.7	7
PUMPKINSEED SUNFISH	6	2.7	4.2	4.9	5.5
ORANGESPOT SUNFISH		0			
GREEN SUNFISH		0			
LONGEAR SUNFISH		0			
REDEAR SUNFISH		0			
SUNFISH HYBRID		0			
WARMOUTH	3	1.4	5.3	6.1	7.2
ROCK BASS		0			
BLACK CRAPPIE	2	0.9	7.5	7.6	7.7
WHITE CRAPPIE		0			
YELLOW BASS		0			
WHITE BASS		0			
WHITE PERCH		0			
WALLEYE		0			
YELLOW PERCH	13	5.9	4.8	6.5	7.7
LOGPERCH		0			
JOHNNY DARTER		0			
IOWA DARTER*		0			
MUSKELLUNGE		0			
TIGER MUSKIE		0			
NORTHERN PIKE	1	0.5	26.1	26.1	26.1
GRASS PICKERAL	2	0.9	7.7	10.3	12.9
CHANNEL CATFISH		0.0			
FLATHEAD CATFISH		0			
BLACK BULLHEAD		0			
BROWN BULLHEAD		0			
YELLOW BULLHEAD		0			
BOWFIN	1	0.5	22.6	22.6	22.6
LONGNOSE GAR		0			
FRESHWATER DRUM		0			
CARP	31	14.1	18.3	20.4	22.3
GRASS CARP		0			
GOLDFISH		0			
GOLDEN SHINER	2	0.9	8.4	8.7	9
COMMON SHINER		0			
EMERALD SHINER		0			
SPOTFIN SHINER		0			
SPOTTAIL SHINER		0			
BIGEYE SHINER		0			
BLACKCHIN SHINER*		0			
BLACKNOSE SHINER*		0			
FATHEAD MINNOW		0			
BULLHEAD MINNOW		0			
BLUNTNOSE MINNOW		0			
BROOK SILVERSIDE		0			
BANDED KILLIFISH*		0			
GIZZARD SHAD		0			
QUILLBACK CARPSUCKER		0			
WHITE SUCKER		0			
SPOTTED SUCKER		0			
SHORTHEAD REDHORSE		0			
LAKE CHUBSUCKER		0			
ROUND GOBY		0			
ALEWIFE		0			
SPECIES= 11 TOTAL=	220	100.0			

* ENDANGERED OR THREATENED SPECIES

Table 1. Catch Summary for Fourth Lake 5/16/2013
(60 minutes D/C electrofishing sample)

Species	**Number**	**Min. Length (in.)**	**Avg. Length (in.)**	**Max. Length (in.)**
Largemouth bass	2	5	7.3	9.5
Bluegill	35	1.7	6.1	7.7
Black crappie	8	5.5	8.3	9.3
Yellow perch	5	4.8	7.2	9
Grass pickerel	4	6.7	8.7	11.8
Pumpkinseed sunfish	5	5.2	5.5	6.0
Golden shiner	6	3.9	4.7	5.5
Common carp	5	8.2	18.6	22.6
Yellow bullhead	1	8.0	8.0	8.0
Bowfin	3	20.7	22.1	24.4
Northern pike	1	30.0	30.0	30.0

TABLE 1. GAGES LAKE CATCH SUMMARY, 9/17/2008
(60 minute D/C Sample, Carp subsampled for 6 minutes, Bluegill for 30 minutes)

			LENGTH (In)		
SPECIES	**NUMBER**	**PERCENT**	**MINIMUM**	**AVERAGE**	**MAXIMUM**
LARGEMOUTH BASS	19	7.1	4.8	12.3	17.9
SMALLMOUTH BASS	2	0.7	11.7	12.6	13.5
BLUEGILL	57	21.2	2.4	4.4	7.4
PUMPKINSEED SUNFISH	10	3.7	4.3	4.8	5.8
WARMOUTH	1	0.4	4.2	4.2	4.2
BLACK CRAPPIE	59	21.9	4.2	6.1	10.8
YELLOW BASS	8	3.0	3.1	6	7.7
WALLEYE	7	2.6	10.3	14.5	18.2
YELLOW PERCH	9	3.3	2.6	4.4	5.6
NORTHERN PIKE	3	1.1	14.6	20.4	26
CHANNEL CATFISH	1	0.4	21.8	21.8	21.8
BROWN BULLHEAD	1	0.4	10.7	10.7	10.7
CARP	90	33.5	14.8	16.1	17.7
BLUNTNOSE MINNOW	1	0.4	1.8	1.8	1.8
BROOK SILVERSIDE	1	0.4	2.9	2.9	2.9
SPECIES= 15 TOTAL=	**269**	**100.0**			

Table 1. Grayslake Catch Summary, 5/3/2012

30 minute D/C electrofishing Run (BLG collected for 15 minutes)

Species	Number	Relative Abundance (%)	Length (in) Minimum	Length (in) Average	Length (in) Maximum
Largemouth bass	118	38.2	4.6	11.8	18.3
Smallmouth bass					
Bluegill	100	32.4	2.4	3.8	6.6
Pumpkinseed sunfish	3	1.0	4.1	5.1	5.9
Green sunfish					
Sunfish hybrid					
Warmouth					
Black crappie					
White crappie					
Yellow bass	9	2.9	4.2	9.2	11.5
White bass					
Walleye					
Yellow perch	3	1.0	5.3	6.4	8
Logperch					
Johnny darter					
Iowa darter*					
Muskellunge					
Tiger muskie					
Northern pike	2	0.6	20.5	26	31.5
Grass pickerel					
Channel catfish					
Flathead catfish					
Black bullhead					
Brown bullhead					
Yellow bullhead	2	0.6	9.6	11.2	12.9
Bowfin					
Longnose gar					
Carp	42	13.6	21.6	22.7	25
Grass carp					
Goldfish					
Golden shiner	3	1.0	7.9	8.3	8.7
Emerald shiner					
Blackchin shiner*					
Blacknose shiner*					
Fathead minnow					
Bullhead minnow					
Bluntnose minnow	23	7.4	2.4	3	3.6
Brook silverside	4	1.3	3.5	3.7	3.9
Banded killifish*					
Gizzard shad					
White sucker					
Lake chubsucker					
Species = 11 Total =	**309**	**100.0**			
* E&T Species					

Table 1. Catch Summary for Miltmore Lake 9/24/2013
(60 minutes D/C electrofishing sample)

Species	**Number**	**Min. Length (in.)**	**Avg. Length (in.)**	**Max. Length (in.)**
Largemouth bass	30	3.4	10.9	16.5
Bluegill	56	1.6	5	6.9
Black crappie	13	4.9	6.8	10.8
Yellow perch	11	4.3	6	9.6
Bluntnose minnow	7	1.9	2.6	3.4
Grass pickerel	6	5.7	9	10.5
Pumpkinseed sunfish	4	4.5	5.4	6.0
Golden shiner	3	7.1	7.5	7.8
Warmouth	2	4.6	4.7	4.8
Common carp	2	21.5	21.6	21.9
Brown bullhead	2	8.9	9.1	9.3
Sand shiner	2	2.2	2.3	2.2
Bowfin	1	24.8	24.8	24.8
Northern pike	1	24	24	24
Yellow bass	1	8.3	8.3	8.3
Brook silverside	1	3.3	3.3	3.3

TABLE 1. SAND LAKE CATCH SUMMARY, 6/11/2002

			LENGTH (inches)		
SPECIES	NUMBER	PERCENT	MINIMUM	AVERAGE	MAXIMUM
LARGEMOUTH BASS	18	11.4	3.9	12.2	17.7
BLUEGILL	79	50	4.3	6.0	7.9
PUMPKINSEED SUNFISH	21	13.3	3.9	4.8	5.5
ROCK BASS	2	1.3	10.8	10.8	10.9
BLACK CRAPPIE	1	0.6	7.4	7.4	7.4
YELLOW PERCH	12	7.6	5.1	5.8	6.3
NORTHERN PIKE	2	1.3	26.5	30.2	34.0
CHANNEL CATFISH	3	1.9	11.1	12.5	15.2
CARP	19	12	13.4	15.5	18.5
GOLDEN SHINER	1	0.6	8.1	8.1	8.1
SPECIES= 10 TOTAL=	158	100			

*ENDANGERED OR THREATENED SPECIES.

TABLE 1. CATCH SUMMARY THIRD LAKE, 5/4/2009
D/C ELECTROFISHING GEAR
60 MINUTES EFFORT

			LENGTH (In)		
SPECIES	**NUMBER**	**PERCENT**	**MINIMUM**	**AVERAGE**	**MAXIMUM**
LARGEMOUTH BASS	41	32.3	4.4	13.4	19.1
BLUEGILL	29	22.8	3.3	6.3	8.3
BLACK CRAPPIE	5	3.9	10.1	10.6	11.1
YELLOW BASS	28	22.0	3.1	8.6	11.1
YELLOW PERCH	5	3.9	4.5	4.9	5.3
NORTHERN PIKE	6	4.7	12.3	24.8	30.9
BOWFIN	1	0.8	23.7	23.7	23.7
CARP	6	4.7	18	18	18
GOLDEN SHINER	2	1.6	3.5	3.6	3.7
BLUNTNOSE MINNOW	1	0.8	2.2	2.2	2.2
BROOK SILVERSIDE	2	1.6	3	3.1	3.3
QUILLBACK CARPSUCKER	1	0.8	23.8	23.8	23.8
SPECIES= 12 TOTAL=	**127**	**100.0**			

Summary tables of fish tissue sampling from Gages and Third Lakes, along with explanatory notes, courtesy of IEPA.

Notes regarding tables of fish contaminant data:

- Prior to 1985, samples could be analyzed by one of four laboratories, and there were known inconsistencies between the laboratories; results during this time period, especially for Chlordane and PCBs, should be viewed with caution.
- A contaminant concentration followed by a check mark means the contaminant was not detected, the listed value is the detection limit (all values are mg/kg wet weight); if mercury was analyzed and not detected, the check mark follows the "Lipid content" column.
- Prior to 1996, check marks were often not included when a contaminant was not detected; values for Chlordane of 0.01 and 0.02, for DDT and Dieldrin of 0.01, for PCBs of 0.1 and 0.2, and for Mercury of 0.1 during this time period are likely to be detection limits rather than detected concentrations.
- The "Whole/fillet" column designating the sample type often contains no entry; if the value in the "Number of individuals" column is >1 the sample is a composite of fillet samples; if the value is 1 the sample is likely a whole fish.
- In 2000 and 2001, values were entered in the "Lipid content" column as either percents (as normal, ex. 4.5) or as decimals (ex. 0.045).

THIRD L.

Fish data sorted by station code

Fish species	Sampling date	Whole /fillet	Number of individual	Sample weight (lbs)	Sample length (in)	Chlordane (total)	DDT (total and analogs)	Dieldrin	PCB (total)	Mercury	Lipid content
Station code	**RGW**										
Black crappie	9/2/1993	whole	1	0.62	10.5	0.007 ☐	0.018 ☐	0.007 ☐	0.177 ☐		0.22 ☐
Carp	9/2/1993	whole	1	4.74	23	0.006 ☐	0.023 ☐	0.01 ☐	0.21 ☐		2.73 ☐
Summary for 'Station code' = RGW (2 detail records)											
Min			1	0.62	10.5	0.006	0.018	0.007	0.177		0.22
Max			1	4.74	23	0.007	0.023	0.01	0.21		2.73

– SAMPLES COLLECTED 2010, AWAITING ANALYSIS: 2 CARP, 2 LARGEMOUTH BASS, 1 BLACK CRAPPIE, 1 BLUEGILL

GAGES L.

Fish data sorted by station code

Fish species	Sampling date	Whole /fillet	Number of individual	Sample weight (lbs)	Sample length (in)	Chlordane (total)		DDT (total and analogs)		Dieldrin		PCB (total)		Mercury	Lipid content	
Station code	RGI															
Bluegill	9/1/2011		5	0.08	5.2	0.02	☑	0.01	☑	0.01	☑	0.1	☑		0.31	☐
Carp	9/17/2008		5	2.2	16.7	0.02	☑	0.014	☐	0.01	☑	0.1	☑		0.75	☐
Carp	9/1/2011		4	2.2	16.3	0.02	☑	0.023	☐	0.01	☑	0.038	☐		0.83	☐
Carp	9/1/2011		4	4.88	21.5	0.011	☐	0.097	☐	0.01	☑	0.2	☐		6.2	☐
Largemouth bass	9/17/2008		4	1.37	13.9	0.02	☑	0.011	☐	0.01	☑	0.1	☑	0.028	0.39	☐
Largemouth bass	9/1/2011		3	2.68	17.3	0.02	☑	0.011	☐	0.01	☑	0.1	☑		0.23	☐
Walleye	9/17/2008		3	1.76	17.9	0.02	☑	0.011	☐	0.007	☐	0.1	☑	0.036	0.32	☐
Summary for 'Station code' = RGI (7 detail records)																
Min			3	0.08	5.2	0.011		0.01		0.007		0.038		0.028	0.23	
Max			5	4.88	21.5	0.02		0.097		0.01		0.2		0.036	6.2	

- SAMPLES COLLECTED 2013, AWAITING ANALYSIS: 2 CARP, 2 LARGEMOUTH BASS, 1 WALLEYE, 1 BLACK CRAPPIE, 1 BLUEGILL

Summary tables of aquatic macroinvertebrate survey data collected by Hey and Associates, Inc. for Lake County Public Works, 2007.

Site 1: Upstream of WRF and downstream of Lake Elisabeth (Hester-Dendy Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance		H_{calc}	FFG		Habit
Ephemeroptera	Heptangeniidae	Stenacron	10	4	40		0.136731	SC		
Megaloptera	Sialidae	Sialis	3	4	12		0.056792	PR		
Coleptera	Elmidae	Stenelmis	9	7	63		0.127199	SC		
Trichoptera	Hydropsychidae		9			(dam.)		FC		
	Hydropsychidae	Cheumatopsyche	88	6	528		0.367519	FC		
	Hydropsychidae	Ceratopsyche	1	4	4		0.023728	FC		
	Polycentropodidae	Cyrnellus	6	5	30		0.095423	FC		
Diptera	Chironomidae		2			(dam.)		GC		
	Chironomidae	Stenochironomus	18	3	54		0.199914	GC		
	Chironomidae	Glyptotendipes	56	10	560		0.344405	FC	GC	
	Chironomidae	Dicrotendipes	3	6	18		0.056792	GC	FC	
	Chironomidae	Polypedilium	11	6	66		0.145826	SH	GC	
	Chironomidae	Natarsia	18	6	108		0.199914	PR		
Oligochaeta			1	10	10		0.023728	GC		
Mollusca	Physidae	Physella	2	9	18		0.041402	SC		
	Lymnaeidae		1	7	7		0.023728	SC		
Hirudinea			2	8	16		0.041402	PR		
			MBI N	229	1534					
			Total N	240						
				MBI	6.70					
				Total Taxa	15					
				H_{max}	2.71					
				H'	1.88					
				H'/H_{max}	0.70					

Site 3: Downstream of WRF Outfall Channel (Hester-Dendy Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	Notes	H_{calc}
Ephemeroptera	Heptangeniidae	Stenacron	14	4	56		0.081369
	Baetidae	Baetis	10	4	40		0.063188
Megaloptera	Sialidae	Sialis	1	4	4		0.009787
Coleptera	Elmidae	Stenelmis	7	7	49		0.047992
Trichoptera	Hydropsychidae	Cheumatopsyche	542	6	3252		0.165715
Diptera	Chironomidae		24			dam.	
	Chironomidae	Cryptochironomus	1	6	6		0.009787
	Chironomidae	Stenochironomus	22	3	66		0.11289
	Chironomidae	Polypedilium	45	6	270		0.182414
	Chironomidae	Glyptotendipes	5	10	50		0.036814
	Chironomidae	Natarsia	10	6	60		0.063188
Mollusca	Lymnaeidae		1	7	7		0.009787
Decapoda	Cambaridae		2	5	10		0.017485
Isopoda	Asellidae	Asellus	3	6	18		0.024396
Amphipoda	Hyallidae		1	5	5		0.009787
			MBI N	664	3893		
			Overall N	688			
				MBI	5.86295181		
				Taxa	14		
				H_{max}	2.63905733		
				H'	0.83459824		
				H'/H_{max}	0.31624862		

Site 4: Downstream of WRF at Dilleys Road (Hester-Dendy Sampling Results)

Order	Family	Genus	Species	n	Tolerance	n*Tolerance	H_{calc}
Ephemeroptera	Heptangeniidae	Stenacron		16	4	64	0.145559
	Heptangeniidae	Stenonema		1	4	4	0.017399
	Baetidae	Baetis		2	4	8	0.030647
Coleptera	Elmidae	Stenelmis		1	7	7	0.017399
	Elmidae	Dubiraphia		1	5	5	0.017399
Trichoptera	Hydropsychidae	Cheumatopsyche		193	6	1158	0.316919
	Polycentropodidae	Cyrnellus		1	5	5	0.017399
Diptera	Chironomidae			9			
	Chironomidae	Stenochironomus		63	3	189	0.314624
	Chironomidae	Polypedilium		27	6	162	0.203333
	Chironomidae	Glyptotendipes		5	10	50	0.0629
	Chironomidae	Natarsia		12	6	72	0.119505
	Chironomidae	Tribelos		1	5	5	0.017399
Oligochaeta				1	10	10	0.017399
Hirudinea				10	8	80	0.105047
				MBI N	334	1819	
				Total N	343		
					MBI	5.44610778	
					Taxa	14	
					H_{max}	2.63905733	
					H'	1.40292565	
					H'/H_{max}	0.53160105	

Site 1: Upstream of WRF and downstream of Lake Elisabeth (QMH Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	FFG	H_{calc}
Ephemeroptera	Baetidae	Baetis	22	4	88	CG	0.140698618
Megaloptera	Sialidae	Sialis	1	4	4	PR	0.012795066
Coleptera	Elmidae	Stenelmis	58	7	406	SC	0.254524371
	Elmidae	Macronychus	1	2	2	-	0.012795066
	Elmidae	Dubiraphia	1	5	5	CG	0.012795066
	Hydroptilidae	Tropisternus	2	-	-	PR	0.022719956
Trichoptera	Hydropsychidae	Cheumatopsyche	216	6	1296	CF	0.359882942
	Hydropsychidae	Ceratopsyche	9	4	36	CF	0.074213517
Diptera	Chironomidae		5	6	6	CG	-
	Chironomidae	Glyptotendipes	41	10	410	CF	0.209366932
	Chironomidae	Chironomus	3	11	33	CG	0.031561518
	Chironomidae	Polypedilum	76	6	456	SH	0.290984538
	Chironomidae	Microtendipes	2	6	12	CF	0.022719956
	Chironomidae	Cladopelma	1	6	6	CG	0.012795066
	Chironomidae	Natarsia	10	6	60	PR	0.080278086
	Simuliidae	Simulium	1	6	6	CF	0.012795066
Heteroptera	Nepidae	Ranatra	1	-	-	PR	0.012795066
Odonata	Coenagrionidae	Ischnura	5	6	30	PR	0.04731448
Isopoda	Asellidae	Asellus	4	6	24	CG	0.039699563
Oligochaeta	Oligochaeta	Oligochaeta	15	10	150	CG	0.107825045
Mollusca	Physidae	Physella	2	9	18	SC	0.022719956
	Sphaeridae	Sphaeridae	3	5	15	CF	0.031561518
Decapoda	Cambaridae	Cambaridae	2	5	10	CG	0.022719956
Hirudinea	Hirudinea	Hirudinea	5	8	40	PR	0.04731448
			MBI N	483	3113		
			Total N	486			
					Metric Value	Reference Value	B-IBI Score
				H_{max}	3.14	-	-
				H'	1.88	-	-
				H'/H_{max}	0.60	-	-
				# Coleoptera Taxa	4	5	80.0
				# Ephmereoptera Taxa	1	10.2	9.8
				# Taxa	23	46	50.0
				# Intolerant Taxa	1	9	11.1
				% Scrapers	12.35	26.8	46.1
				% EPT	4.53	74	6.1
				MBI	6.45	4.9	74.7
				Overall B-IBI	-	-	39.7
					>69.8	Exceptional	
					49.3-69.8	Good	
					24.6-49.2	Fair	
					<24.6	Poor	

Site 3: Downstream of WRF Outfall Channel (QMH Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	FFG	H_{calc}
Ephemeroptera	Baetidae	Baetis	19	4	76	CG	0.197303797
	Ephemerellida	Seratella	1	1	1	CG	0.022305216
Coleptera	Elmidae	Stenelmis	28	7	196	SC	0.246806264
	Elmidae	Dubiraphia	3	5	15	CG	0.053572179
Trichoptera	Hydropsychidae	Cheumatopsyche	80	6	480	CF	0.365137393
	Hydropsychidae	Ceratopsyche	1	4	4	CF	0.022305216
	Mollanidae	Molanna	1	3.5	3.5	SC	0.022305216
Diptera	Chironomidae						
	Chironomidae	Glyptotendipes	5	10	50	CF	0.078946365
	Chironomidae	Chironomus	2	11	22	CG	0.038997904
	Chironomidae	Polypedilum	55	6	330	SH	0.334465722
	Chironomidae	Cryptochironomus	1	8	8	PR	0.022305216
	Chironomidae	Microtendipes	5	6	30	CF	0.078946365
	Chironomidae	Natarsia	14	6	84	PR	0.162690826
	Chironomidae	Procladius	9	8	72	PR	0.120686129
	Chironomidae	Stenochironomus	1	3	3	SH	0.022305216
	Simuliidae	Simulium	1	6	6	CF	0.022305216
Isopoda	Asellidae	Asellus	3	6	18	CG	0.053572179
Amphipoda	Hyallelidae	Hyallelidae	1	4	4	CG	0.022305216
Oligochaeta	Oligochaeta	Oligochaeta	8	10	80	CG	0.111091394
Mollusca	Physidae	Physella	1	9	9	SC	0.022305216
	Sphaeridae	Sphaeridae	8	5	40	CF	0.111091394
			MBI N	247	1531.5		
			Total N	247			
					Metric Value	Reference Value	B-IBI Score
				H_{max}	3.04	-	-
				H'	2.13	-	-
				H'/H_{max}	0.70	-	-
				# Coleoptera Taxa	2	5	40.0
				# Ephmereoptera Taxa	2	10.2	19.6
				# Taxa	21	46	45.7
				# Intolerant Taxa	2	9	22.2
				% Scrapers	12.15	26.8	45.3
				% EPT	7.69	74	10.4
				MBI	6.20	4.9	78.7
				Overall B-IBI	-	-	37.4
					>69.8	Exceptional	
					49.3-69.8	Good	
					24.6-49.2	Fair	
					<24.6	Poor	

Site 4: Downstream of WRF at Dilleys Road (QMH Sampling Results)

Order	Family	Genus	n	Tolerance	n*Tolerance	FFG	H_{calc}
Ephemeroptera	Ephemerellida	Seratella	2	1	2	CG	0.070465825
	Heptanageniidae	Stenacron	1	4	4	SC	0.041260279
Coleptera	Elmidae	Stenelmis	19	7	133	SC	0.297472781
	Elmidae	Dubiraphia	5	5	25	CG	0.136325835
Trichoptera	Hydropsychidae	Cheumatopsyche	25	6	150	CF	0.33175137
	Mollanidae	Molanna	1	3.5	3.5	SC	0.041260279
Diptera	Chironomidae						
	Chironomidae	Polypedilum	7	6	42	SH	0.170375251
	Chironomidae	Microtendipes	17	6	102	CF	0.282601907
	Chironomidae	Natarsia	10	6	60	PR	0.212378003
	Chironomidae	Procladius	1	8	8	PR	0.041260279
	Chironomidae	Stenochironomus	2	3	6	SH	0.070465825
	Muscidae	Muscidae	1	8	8	PR	0.041260279
Isopoda	Asellidae	Asellus	2	6	12	CG	0.070465825
Oligochaeta	Oligochaeta	Oligochaeta	13	10	130	CG	0.246432835
Mollusca	Physidae	Physella	7	9	63	SC	0.170375251
	Sphaeridae	Sphaeridae	2	5	10	CF	0.070465825
	Lymnaeidae	Lymnaeidae	1	7	7	SC	0.041260279
			MBI N	115	758.5		
			Total N	115			
					Metric Value	Reference Value	B-IBI Score
				H_{max}	2.83	-	-
				H'	2.29	-	-
				H'/H_{max}	0.81	-	-
				# Coleoptera Taxa	2	5	40.0
				# Ephmereoptera Taxa	2	10.2	19.6
				# Taxa	17	46	37.0
				# Intolerant Taxa	2	9	22.2
				% Scrapers	25.22	26.8	94.1
				% EPT	2.61	74	3.5
				MBI	6.60	4.9	72.2
				Overall B-IBI	-	-	41.2
					>69.8	Exceptional	
					49.3-69.8	Good	
					24.6-49.2	Fair	
					<24.6	Poor	

Appendix F – Code and Ordinance Worksheet

Municipality or County:

Does the ordinance.....

Stormwater Drainage and Detention			Yes / No	Code section	Current standard	Recommended standard or action	Reference	Notes
1	Purpose	Include control of runoff rate, volumes, and quality in the purpose statement?					NIPC Model Stormwater Drainage and Detention Ordinance, Section 100.0	
2	Minimize stormwater quantity	Encourage the use of permeable paving, greenroofs, and similar practices that reduce the quantity of runoff that must be handled with innovative or conventional drainage practices?					Village of Lakewood's Best Management Practices for R-2 Zoning, BMP hierarchy	
3	Natural drainage practices	Encourage/require the use of natural drainage practices (e.g., swales, filter strips, bio-infiltration devices, and natural depressions over storm sewers) to minimize runoff volumes and enhance pollutant filtering?					Campton Hills Zoning Code Analysis and Ordinance Language Recommendations; NIPC Model Stormwater Drainage and Detention Ordinance, Sections 500.0 and 711	
6	Detention credits	Provide detention credit for practices, such as permeable paving or bio-infiltration, that provide temporary storage of runoff in the sub-surface void spaces of stone or gravel?					Kane County Stormwater Management Article 2, Sec. 200 e5 (as amended in 2009).	
9	Discharge	Require that peak post-development discharge from events less than or equal to the two-year, 24-hour event be limited to 0.04 cfs per acre of watershed? (The Kane County Stormwater Ordinance effectively achieves a 2-year control similar to this by virtue of its 0.1 cfs/acre requirement for the 100-year event.)						
10	Detention design	Require detention design standards that maximize water quality mitigation benefits, with a requirement for "naturalized" wet bottom and/or wetland basins over dry basins?					NIPC Model Stormwater Drainage and Detention Ordinance, Sections 600, 705, and 706, provides design guidelines.	
12	Water quality performance standards	Require conformance to numerical water quality performance standards (such as percent removal of sediment or phosphorus)?					New practice being used elsewhere in the country, yet to be implemented in NE Illinois.	
13	Detention - on-stream and floodway	Prohibit on-stream detention and detention in the floodway, unless it provides a regional stormwater storage benefit (e.g., for upstream properties and/or multiple sites) and is accompanied by other upstream water quality BMPs, such as bio-infiltration?					NIPC Model Stormwater Drainage and Detention Ordinance Section 708.3	

14	Stormwater discharge	Prohibit the direct discharge of undetained stormwater into wetlands?					NIPC Model Stormwater Drainage and Detention Ordinance, Section 709.4	
15	Maintenance	Require formal maintenance plans and contracts for the long-term maintenance and vegetative management of all new detention facilities?					Performance criteria outlined in the stewardship plan section (A1118) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures. NIPC Model Stormwater Drainage and Detention Ordinance, Section 713 and 1100.	
Soil Erosion and Sediment Control			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Limiting sediment delivery	Include a comprehensive purpose statement which limits sediment delivery, as close as practicable, to pre-disturbance levels and minimizes effects on water quality, flooding, and nuisances?					NIPC Model Soil Erosion and Sediment Control Ordinance, Section 100	
2	Minimize sediment transport	Include a comprehensive set of principles that minimize sediment transport from the site for all storms up to the ten-year frequency event? (These principles should include provisions to minimize the area disturbed and the time of disturbance; follow natural contours; avoid sensitive areas; require that sediment control measures be in place as part of land development process before significant grading or disturbance is allowed; and require the early implementation of soil stabilization measures on disturbed areas.)						
3	Ordinance applicability - size	Require ordinance applicability for any land disturbing activity in excess of 5,000 square feet?						
4	Ordinance applicability - location	Require ordinance applicability for any land disturbing activity in excess of 500 square feet if adjacent to stream, lake, or wetland?						
5	Site design requirements	Include explicit site design requirements for sediment control measures, conveyance channels, soil stabilization, construction adjacent to water bodies, construction entrances, etc.?						

6	Site design references	Adopt by reference the "Illinois Urban Manual" published by the Natural Resources Conservation Service and the Illinois Environmental Protection Agency (1995, updated 2010) and the "Illinois Procedures and Standards for Urban Soil Erosion and Sedimentation Control" published in 1988 (the Greenbook)? (These references provide additional design standards and guidelines beyond the specific standards spelled out in the ordinance.)						
7	Maintenance	Require routine maintenance of all erosion and sediment control practices?						
8	Inspection	Require inspection by appropriately trained personnel of construction sites at critical points in the development process to ensure that measures are being correctly installed and maintained?					NIPC Model Soil Erosion and Sediment Control Ordinance, Section 506; City of Elgin (Article 3, Sec. 300 and Article 7, Sec. 701).	
9	Enforcement	Provide effective enforcement mechanisms including performance bonds, stop-work orders, and penalties, as appropriate?						
Floodplain Management							**Reference**	
1	Purpose	Include protection of hydrologic functions, water quality, aquatic habitat, recreation, and aesthetics in the purposes for the ordinance?						
2	Floodway restrictions - use	Restrict modifications in the floodway to the following appropriate uses: public flood control projects, public recreation and open space uses, water dependent activities, and crossing roadways and bridges? (The ordinance would thereby prohibit new treatment plants and pumping facilities; detached garages, sheds, and other non-habitable structures; parking lots and aircraft parking aprons; and roadways which run longitudinally along a watercourse.)					NIPC Model Floodplain Ordinance, Section 802.1 *Alternative*	
3	Limit stream channel modification	Discourage stream channel modification and require mitigation of unavoidable adverse water quality and aquatic habitat impacts? (This would be done in cooperation with the Army Corps of Engineers for federally jurisdictional waterways.)					NIPC Model Floodplain Ordinance, Sections 801.1.q and 802.1.i	

5	Floodway restrictions - erosion	Require effective soil erosion and sediment control measures for ALL disturbances in the floodway?						
Stream and Wetland Protection			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Purpose	Include a comprehensive purpose statement which addresses the protection of hydrologic and hydraulic, water quality, habitat, aesthetic, and social and economic values and functions of wetlands?					NIPC Model Stream and Wetland Protection Ordinance, Section 3.00	
2	Waterbody protection	Protect the beneficial functions of streams, lakes, and wetlands from damaging modifications, including filling, draining, excavating, damming, impoundment, and vegetation removal? (This could be done through some combination of avoidance and mitigation requirements, similar to Army Corps of Engineer requirements for federally jurisdictional waters.)					NIPC Model Stream and Wetland Protection Ordinance, Sections 6.03, with the definition of development outlined in Section 4.00.h.	
3	Waterbody modification	Prohibit the modification of high quality, irreplaceable wetlands, lakes, and stream corridors?						
4	Waterbody - stormwater	Discourage the modification of wetlands for stormwater management purposes unless the wetland is severely degraded and nonpoint source BMPs are implemented on the adjacent development?					NIPC Model Stream and Wetland Protection Ordinance, Section 6.03	
5	Waterbody setback	Designate a minimum 75 to 100 foot setback zone from the edge of identified wetlands and water bodies in which development is limited to the following types of activities: minor improvements like walkways and signs, maintenance of highways and utilities, and park and recreational area development?					NIPC Model Stream and Wetland Protection Ordinance, Section 6.03	
6	Waterbody buffer	Establish a minimum 30-foot wide protected native vegetation buffer strip along the edge of identified wetlands and water bodies?					NIPC Model Stream and Wetland Protection Ordinance, Section 6.08	
7	Relocation	Prohibit watercourse relocation or modification except to remedy existing erosion problems, restore natural habitat conditions, or to accommodate necessary utility crossings; and require mitigation of unavoidable adverse water quality and aquatic habitat impacts?					NIPC Model Stream and Wetland Protection Ordinance, Sections 7.00, 7.01, and 7.02	

8	Restoration	Encourage the restoration of stream and wetland habitat, hydrology, and morphology on development sites that contain degraded aquatic systems? (This could be accomplished through a streamlined permitting process and/or other development incentives.)					Minimum performance standards for restoration, planting, maintenance, and monitoring of natural open space and naturalized stormwater facilities are included in Stewardship Plan section (A1118) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures.	
Natural areas and open space			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Natural areas protection	Protection of remnant natural areas, including steep slopes, prairies, woodlands, and savannas (in addition to regulated wetlands and floodplains)?					Applicability section (A1102) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures; Village of Algonquin Conservation Design Standards and Procedures (Zoning Sec. 21.11 J); City of Crystal Lake Conservation Developments (UDO Article 5 Section 5-300).	
3	Open space - amount	Setting aside onsite open space for residential development, generally conforming to the following guidelines: estate residential: 60%; moderate residential: 45%; urban residential: 30%? (Common open space is preferable, but deed-restricted open space also is acceptable.)					Bulk requirements section (A1112) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures.	
5	Restoration	Restoration of protected natural areas to reduce invasive species and enhance biodiversity?					Stewardship plan section (A1118) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures.	
6	Open space - ownership	Identification of an open space ownership entity, with a preference for a qualified public or private land conservation organization?					Open space ownership and funding section (A1117) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
8	Open space - easement	Dedication of natural open space via a binding conservation easement or similar binding legal instrument that ensures protection in perpetuity?					Open space ownership and funding section (A1117) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	

9	Open space - management	Secure and permanent funding arrangements for the long-term management and maintenance of open space, natural areas, and stormwater facilities once responsibilities are turned over to a conservation entity or the homeowners/property owners association? (Said funding arrangements shall be noted and made part of the Covenants and Restrictions.)					Open space ownership and funding section (A1117) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
11	Open space - funding	Establishment of a back-up special service area (SSA) in order to provide funds necessary to support the maintenance of open space and stormwater management areas (in the event that the responsible land owner/manager does not meet the required maintenance standards)?					Open space ownership and funding section (A1117) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
12	Open space - management plans	Long-term management/stewardship plans for all common open space areas, natural areas, and stormwater facilities?					Stewardship plan section (A1118) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
13	Open space - performance criteria	Meeting measurable performance criteria for managed natural areas, including ground coverage, species diversity, and control of invasive species?					Minimum performance standards for restoration, planting, maintenance, and monitoring of natural open space and naturalized stormwater facilities are included in the Stewardship Plan section (A1118) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures.	
Landscaping			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Native landscaping	Include "noxious weed" provisions that might intentionally, or unintentionally, preclude natural landscaping because of vegetation height standards or similar restrictive provisions?					*Plants of the Chicago Region* (Swink and Wilhelm, 1994) and Green Landscaping: Greenacres, A source book on Natural Landscaping for Public Officials	
2	Native landscaping	Encourage/require the use of native plant materials for the default landscaping of common areas, stormwater facilities, common open space areas, and the buffers of streams, lakes, wetlands and other natural areas?					Natural landscaping standards section (A1110) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
6	Native landscaping - management	Require provisions for long-term oversight, management, funding, and performance criteria for common areas and natural landscapes (as referenced above in greater detail)?						

7	Street trees	Require planting street trees? If yes, how many trees?					Park Forest Sustainability Audit of Zoning and Subdivision Codes	
8	Tree protection ordinance	Require protection of native/desirable trees (i.e., a tree protection ordinance)?					Tree protection standards section (A1119.2 C) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Practices; City of Elgin Tree Protection Ordinance (Zoning 19.16).	
9	Tree replacement	Require replacement of any trees that are unavoidably impacted by construction activities?					Tree protection standards section (A1119.2 C) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Practices.	
12	Tree replacement - funding	Require payment into a tree replacement fund or "mitigation bank" when removed trees cannot be replaced/mitigated on site?						
Transportation			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Street network - location	Require the street network to minimize encroachment in sensitive natural resources and take advantage of open space vistas, while providing an interconnection of internal streets and street connections to adjoining land parcels to create opportunities for future connectivity?					Blackberry Creek Zoning Code Analysis and Ordinance Language Recommendations	
2	Street network - Stream crossings	does the ordinance limit stream crossings by the street network?					Campton Hills Zoning Code Analysis and Ordinance Language Recommendations	
3	Street connectivity - external	require connections to surrounding areas?					LEED for Neighborhood Development Walkable Streets Prerequisite.	
4	Street connectivity - internal	Require subdivisions to achieve a certain score on an index for internal street connectivity?					Park Forest Sustainability Audit of Zoning and Subdivision Codes	
5	Street - Widths	Encourage/require residential street widths that are narrower than suburban norms (i.e., encourage streets to be no wider than is necessary to move traffic effectively, to slow traffic and create safer conditions, and to safely accommodate pedestrians and bicyclists)?					Model language in Conservation Design Resource Manual, NIPC and Chicago Wilderness; Center for Watershed Protection Better Site Design; ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach; CNU Emergency Response & Street Design; Village of Plainfield Traditional Neighborhood District (Zoning Sec. 9-54); City of Crystal Lake Street Standards for Conservation Design (UDO Article 4 Section 4-100 E).	

6	Street - Frontage roads	Discourage frontage roads?					ITE Designing Walkable Urban Thoroughfares: A Context Sensitive Approach.	
7	Street - Length	Front and side yard setbacks, minimum lot size					Center for Watershed Protection Better Site Design; Village of Plainfield Traditional Neighborhood District (Zoning Sec. 9-54).	
8	Cul-de-sacs	Discourage cul-de-sacs?					Center for Watershed Protection Better Site Design	
9	Driveways - Commercial	Encourage/require reduced driveway widths?						
10	Driveways - Residential	Encourage/require reduced driveway widths for single-family developments?					Center for Watershed Protection Better Site Design	
11	Driveways - Shared	Encourage/require shared driveways?					Street and trail standards section (A1108.1 H) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Practices; NIPC Conservation Design Resource Manual, Common Drives model ordinance.	
12	Curb and gutter requirements	Encourage/require the use of natural drainage practices?					Campton Hills Zoning Code Analysis and Ordinance Language Recommendations	
13	Paving materials - streets and driveways	Promote use of pervious materials for paved areas, including alleys, streets, sidewalks, crosswalks, driveways, and parking lots?					Center for Watershed Protection Better Site Design; Campton Hills Zoning Code Analysis and Ordinance Language Recommendations	
15	Sidewalks	Promote connected sidewalks in new developments and use of pervious materials?					Blackberry Creek Zoning Code Analysis and Ordinance Language Recommendations; LEED for Neighborhood Development Walkable Streets Prerequisite.	
Parking			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Purpose	Does the purpose include a statement about tailoring parking requirements to meet average day-to-day demand as opposed to peak demand?						
2	Applicability	Do off-street parking requirements only apply to lots of a certain size or greater?					Village of Riverside: no off-street parking spaces required for non-residential uses under 3,000 sq. ft GFA. City of Evanston: no offf-street parking spaces required for buildings between 2,000 to 3,000 sq. ft. GFA in specific districts.	
3	Requirements	Establish parking requirements as a maximum or a minimum?					Campton Hills Zoning Code Analysis and Ordinance Language Recommendations	

4	Parking ratio - office	Require a parking ratio for a professional office building that is 3 spaces, or less, per 1,000 square feet?					NW Connecticut Model Zoning Regulations for Parking and State of Oregon's Model Development Code and User's Guide for Small Cities	
5	Parking ratio - retail	Require a parking ratio for retail that is 4.5 spaces, or less, per 1,000 square feet?					NW Connecticut Model Zoning Regulations for Parking and State of Oregon's Model Development Code and User's Guide for Small Cities	
6	Parking ratio - residential	Require a parking ratio for a single family home that is 2 spaces, or less?					NW Connecticut Model Zoning Regulations for Parking and State of Oregon's Model Development Code and User's Guide for Small Cities	
7	Requirements - flexibility	Provide flexibility regarding alternative, reduced parking requirements and discourage over-parking of developments?					Campton Hills Zoning Code Analysis and Ordinance Language Recommendations	
8		Allow a reduction in the number of current parking spaces?						
9	Off-site parking	Provide flexibility regarding alternative, reduced parking requirements (e.g., shared parking, off-site parking) and discourage over-parking of developments?					NW Connecticut Model Zoning Regulations for Parking	
11	Shared parking	Provide flexibility regarding alternative, reduced parking requirements (e.g., shared parking, off-site parking) and discourage over-parking of developments?					NW Connecticut Model Zoning Regulations for Parking; City of Elgin Shared Off-Street Parking Facilities (Zoning 19.45.055); Village of Plainfield Shared parking (Zoning Sec. 9-74).	
12	Requirements - location	Provide for uses in downtown areas by reducing or not requiring parking given the walkable, transit served location?						
13	Credits - on-street parking	Allow a reduction in off street parking requirements when nearby on street parking is available?					State of Oregon's Model Development Code and User's Guide for Small Cities	
14	Credits - bicycle	Allow a reduction in off street parking requirements when bicycle parking is provided?					Campton Hills Zoning Code Analysis and Ordinance Language Recommendations	
15	Size - parking stall	Require parking stalls to be less than or equal to 9 x 18 feet?					Center for Watershed Protection Better Site Design, State of Oregon's Model Development Code and User's Guide for Small Cities	
16	Size - parking stall	Allow for reduction in parking stall size to account for vehicle overhang onto landscaped islands or perimeter landscaping? (E.g., such flexibility might allow for an 18-foot deep stall to be reduced to 16 or 16.5 feet deep.)					Center for Watershed Protection Better Site Design	

17	Size - compact stalls	Specify that a percentage of all parking stalls can be dedicated for compact cars, with correspondingly smaller stall dimensions?						
18	Size - parking aisles	Establish narrower aisle widths to minimize impervious surfaces?					Blackberry Creek Zoning Code Analysis and Ordinance Language Recommendations	
19	Paving materials	Promote use of pervious materials for paved areas, including parking lots?					Center for Watershed Protection Better Site Design; LEED for Neighborhood Development Heat Island Reduction Credit.	
20	Landscaping - amount	Specify a minimum percentage of pervious landscaping for parking lots?					City of Crystal Lake: Site Landscaping (UDO Article 4 Section 4-400 F1 and F2)	
21	Landscaping - design	Encourage/require the use of recessed landscape islands (vs. raised islands) to facilitate the infiltration and filtering of parking lot runoff?					City of Crystal Lake Standards for Parking Areas in Conservation Developments (UDO Article 4 Section 4-200 E5); Village of West Dundee Parking Lot Design and Maintenance Standards (Zoning 10-9-1-6 C); Parking lot standards section (A1111.1) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Practices.	
Conservation design and infill			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Natural Resource inventory	Require a site analysis map that includes a natural resources inventory at the Concept Plan stage or prior to the Preliminary Plan stage?					Site analysis (A1104.1) requirements of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
3	Site Design	Require that the proposed development be designed to preserve natural drainage patterns, use and preserve native vegetation, stabilize soils during construction, and protect, enhance, and maintain natural resources (such as remnant woodlands, prairies, and steep slopes)?					Site analysis (A1104.1), general standards for design (A1108), and open space (A1114) requirements of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures; Village of Algonquin Conservation Design Standards and Procedures (Zoning Sec. 21.11 J); City of Crystal Lake Conservation Developments (UDO Article 5 Section 5-300 E2).	
6	Clearing and Grading						Campton Hills Zoning Code Analysis and Ordinance Language Recommendations	
7	Clustering	Encourage/require clustering of residential lots around sensitive natural areas, thereby creating a protected common open space area?					Site capacity (A1105) and conservation design development standards (A1108.1) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	

8	Open space requirements	Require a minimum area of protected naturalized open space in new residential developments?					Bulk requirements section (A1112) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures.	
9	Density bonus	Provide density bonuses for conservation developments that exceed minimum standards (such as additional open space, providing for regional trails and greenways, or incorporating environmentally sensitive design features beyond what is required by the Ordinance)?					Density bonuses for open space and innovative design section (A1106) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
10	Conservation design - by right	Allow conservation design as a "by-right" form of development?					Applicability section (A1102) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures; Village of Plainfield Conservation District (Zoning 9-52).	
11	Conservation design - zoning map	Does the zoning map indicate areas where conservation development is required?					Applicability section (A1102) of the McHenry County Subdivision Ordinance on Conservation Design Standards and Procedures	
12	Mixed use	Is there a downtown overlay district or another mechanism to encourage mixed-use development in neighborhood centers?						
13	Impact fees	Are there reduced impact fees or other incentives to encourage infill development?						
Water efficiency and conservation			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Water conservation - indoor	Encourage/require plumbing fixtures and fittings in all new and remodeled construction to not exceed specific flow rates and be labeled a WaterSense product if available? Encourage/require dishwashers and clothes washers in all new and remodeled construction to comply with US EPA Energy Star Program requirements?					CMAP Model Water Use Conservation Ordinance, 1.0, 2.0, 3.0, 8.0, 9.0, 10.0, 11.0, 12.0, and 13.0.	
2	Outdoor - landscape design	Set guidelines for the amount of development area dedicated to turf, high water use plants, or water features; and the minimum amount of topsoil for turf areas?					CMAP Model Water Use Conservation Ordinance, 4.0., 14.0	
3	Outdoor - irrigation equipment	Set requirements for automatic landscape irrigation systems?					CMAP Model Water Use Conservation Ordinance, 5.0., 15.0	

4	Outdoor - irrigation schedule	Set requirements for landscape watering days and schedules?					Northwest Water Planning Alliance's Regional Water Conservation Lawn Watering Ordinance; CMAP Model Water Use Conservation Ordinance, 5.0., 6.0, 7.0, 15.0, 16.0, 17.0, and 23.0.	
5	Rainwater harvesting and water reuse	Allow the installation of a rainwater harvesting system to be used for landscape irrigation and indoor non-potable uses?					CMAP Model Water Use Conservation Ordinance, 18.0 and 19.0; McHenry County Water Reuse Model Ordinance	
6	Downspout - sanitary sewer connection	Are there restrictions on downspouts being directly connected to a sanitary sewer?						
7	Downspout - storm sewer connection	Are there restrictions on downspouts being directly connected to a storm sewer?					City of Milwaukee Downspout Disconnection ordinance	
8								
9								
10	Water waste prevention	Does the community prohibit water waste or inefficient use of water?					CMAP Model Water Use Conservation Ordinance, 21.0.	
11								
12								
13	Water pricing	Does the community use a conservation pricing structure or other economic incentive to promote water conservation?					CMAP Model Water Use Conservation Ordinance, 32.0	
Pollution Prevention			**Yes / No**	**Code section**	**Current standard**	**Recommended standard or action**	**Reference**	**Notes**
1	Groundwater protection	Regulate activities within groundwater protection areas?					City of St. Charles, IL Chapter 13: Groundwater Protection; City of Marengo, IL, M.C. Chapter 30: Groundwater protection; Fox River Grove, IL, M.C. Article IX, Section 23-200 Groundwater protection; McHenry County Groundwater Protection Action Plan.	
2	Surface water protection	Regulate activities within the flood plain or buffer areas of waterbodies?						
4	Phosphorus reduction	Discourage the use of phosphorus in manufactured fertilizers in order to reduce the amount of phosphorus that enters water resources?					McHenry County Phosphorus Model Ordinance	
5		Discourage the use of phosphorus in dishwasher detergents in order to reduce the amount of phosphorus that enters water resources?						
6	Chloride management	Specify road salt storage and handling requirements that ensure proper storage, handling, and transport?						
7		Specify alternative compounds or methods for dust control?						
8		Encourage water softeners be set to recharge on demand?						

9	Coal tar sealants	Discourage use of coal tar sealants to prevent loss of aquatic life?					McHenry County Coal Tar Sealants Model Ordinance	
10	Pet waste disposal	Include pet waste disposal requirements?					State of New Jersey Pet Waste Model Ordinance	
11	Private sewage treatment and disposal	Require regular inspection and maintenance of private sewage treatment (septic) systems?					Public Health Ordinance for McHenry County, Article X, Wastewater & Sewage Treatment and Disposal for McHenry County Illinois	

Model ordinance references

Algonquin, Illinois, "Conservation Design Standards and Procedures, Zoning Sec. 21.11 J." See http://www.algonquin.org

Association of Illinois Soil and Water Conservation Districts, "Illinois field manual for implementation and inspection of erosion and sediment control plans," 1990.

Campton Hills, Illinois, "Village of Campton Hills Comprehensive Plan and Code Assessment," 2010.

Center for Watershed Protection, "Better Site Design: Code and Ordinance Worksheet," 1998. See http://www.cwp.org/documents/cat_view/77-better-site-design-publications.html

Chicago Metropolitan Agency for Planning, "Ferson-Otter Creek Watershed Plan," 2011. See http://cmap.is/198vurA

Chicago Metropolitan Agency for Planning, "Model Water Use Conservation Ordinance," 2010. See http://cmap.is/1biqDop

Chicago Wilderness, Chicago Metropolitan Agency for Planning, "Green Infrastructure Vision," 2012. See http://www.cmap.illinois.gov/green-infrastructure

Congress for the New Urbanism, "Emergency Response and Street Design," 2009. See http://www.cnu.org/emergencyresponse

Crystal Lake, Illinois, "Conservation Developments, UDO Subdivision Standards: Article 5, Section 5-300." See http://www.crystallake.org/index.aspx?page=367

Crystal Lake, Illinois, "Street Standards for Conservation Design, UDO Development & Design Standards: Article 4, Section 4-100 E." See http://www.crystallake.org/index.aspx?page=372

Crystal Lake, Illinois, "Tree Preservation, UDO Development & Design Standards: Article 4, Section 4-300." See http://www.crystallake.org/index.aspx?page=377

Crystal Lake, Illinois, "Landscaping and Screening Standards, UDO Development & Design Standards: Article 4, Section 4-400 F1 and F2." See http://www.crystallake.org/index.aspx?page=379

Elgin, Illinois, "Tree Preservation, Zoning 19.16," See http://www.cityofelgin.org/

Elgin, Illinois, "Shared Off-Street Parking Facilities, Zoning 19.45.055," See http://bit.ly/16mZfV5

Elgin, Illinois, "Parkway Rain Garden Program," See http://bit.ly/12rik7Z

Evanston, Illinois, "Exemption of Required Parking Spaces, Municipal Code 6-16-1-4." See http://bit.ly/12AYXeE

Fox River Grove, Illinois, "Groundwater Protection Regulations – Chemical Substance Controls, Article IX, Section 23-200." See http://bit.ly/19gZ0xv

Geosyntec, "Hickory Creek Watershed Plan Ordinance Review and Checklist," 2011. See http://www.hickorycreekwatershed.org/learn/plan/

Geosyntec, "Jelkes Creek-Fox River Watershed Action Plan, Appendix C: Ordinance Checklist Highlights/Summary of Results," 2012. See http://www.kanedupageswcd.org/Jelkes/Docs/JelkesCreekPlan12-12.pdf

Institute of Transportation Engineers, "Designing Walkable Urban Thoroughfares: A context Sensitive Approach," 2010. See http://www.ite.org/css/

Kane County, Illinois, "Blackberry Creek Watershed: Zoning Code Analysis and Ordinance Language Recommendations," 2004. See http://www.co.kane.il.us/kcstorm/blackberry/zoning/FinalReport.pdf

Kane County, Illinois, "Kane County Stormwater Management Ordinance," 2009. See http://www.co.kane.il.us/kcstorm/

Lakewood, Illinois, "Best Management Practices for R-2 Zoning, BMP hierarchy," 2012. See http://bit.ly/13RLU44

Marengo, Illinois, "Groundwater Protection ordinance, Chapter 30" See http://bit.ly/11aP3di

McHenry County, Illinois, "Green Infrastructure Plan," 2012. See http://bit.ly/12mkvbK

McHenry County, Illinois, "Wastewater and Sewage Treatment and Disposal, County Code, Article X,"2007. See http://bit.ly/ZF1yjP

McHenry County, Illinois, "Groundwater Protection Action Plan," 2009. See http://www.co.mchenry.il.us/departments/waterresources/Pages/GroundwaterProtectionProgram.aspx

McHenry County, Illinois, "McHenry County Water Resources Action Plan," 2010. See http://bit.ly/13xzKhM

McHenry County, Illinois, “McHenry County Phosphorus Model Ordinance.” See http://bit.ly/13tKTyw

McHenry County, Illinois, “Addendum to the McHenry County Subdivision Ordinance Conservation Design Developments: Standards and Procedures,” 2009. See http://bit.ly/14sjwrt

McHenry County, Illinois, “Water Reuse Model Ordinance.” See http://bit.ly/13RLNFK

New Jersey Department of Environmental Protection, “Pet Waste Model Ordinance,” See http://www.state.nj.us/dep/stormwater/tier_A/ordinances.htm

Northeastern Illinois Planning Commission, “Conservation Design Resource Manual,” 2003. See http://bit.ly/105Lyd2

Northeastern Illinois Planning Commission, “Green Landscaping: Greenacres, a source book on natural landscaping for public officials,” 1997. See http://www.epa.gov/greenacres/toolkit/

Northeastern Illinois Planning Commission, “Natural Landscaping for Local Officials: Design and Management Guidelines,” 2004. See http://bit.ly/15LnknQ

Northeastern Illinois Planning Commission, Illinois Department of Natural Resources, and Office of Water Resources, “Model Floodplain Ordinance for Communities Within Northeastern Illinois,” 1996. See http://cmap.is/15UXgGJ

Northeastern Illinois Planning Commission, “Model Stormwater Drainage and Detention Ordinance: A Guide for Local Officials,” 1994. See http://cmap.is/1cRfXz4

Northeastern Illinois Planning Commission, “Model Stream and Wetland Protection Ordinance for the Creation of a Lowland Conservancy Overlay District,” 1999. See http://cmap.is/18horf3

Northeastern Illinois Planning Commission, “Model Soil Erosion and Sediment Control Ordinance: A Guide for Local Officials,” 1991. See http://cmap.is/1cAiAGE

Northwestern Connecticut Council of Governments, et al. “Model Zoning Regulations for Parking for Northwestern Connecticut,” 2003. See http://www.nwctplanning.org/ParkingStudyPhase2.pdf

Northwest Water Planning Alliance, “Regional Water Conservation Lawn Watering Ordinance,” 2013. See http://bit.ly/105IBZX

Oregon Transportation and Growth Management Program, “Model Development Code and User’s Guide for Small Cities, 2nd Edition,” 2005. See http://www.oregon.gov/LCD/TGM/docs/modelcode05/pdf/guide.pdf

Park Forest, Illinois, “Sustainability Audit of Zoning and Subdivision Codes,” 2011. See http://www.cmap.illinois.gov/park-forest

Plainfield, Illinois, “TN Traditional Neighborhood District, Zoning Sec. 9-54.” See http://bit.ly/16mXPtV

Plainfield, Illinois, “CV Conservation District, Zoning Sec. 9-56.” See http://bit.ly/1aZsK0m

Plainfield, Illinois, “Shared Parking, Zoning Sec. 9-74.” See http://bit.ly/135V77V

Riverside, Illinois, “Required Off Street Parking Spaces, Municipal Code 10-8-8 and 10-8-9,” See http://bit.ly/1bon8Lv

Saint Charles, Illinois, “Groundwater Protection, Municipal Code Chapter 13.18,” See http://bit.ly/16AiOYs

Swink, Floyd and Gerould Wilhelm, *Plants of the Chicago Region*, Bloomington: Indiana University Press. 1994.

U.S. Environmental Protection Agency, “Green Infrastructure Case Studies: Municipal Policies for Managing Stormwater with Green Infrastructure,” 2010. See http://1.usa.gov/cgrVHw

U.S. Environmental Protection Agency, “Water Quality Scorecard: Incorporating Green Infrastructure Practices at the Municipal, Neighborhood, and Site Scales,” 2009. See http://www.epa.gov/smartgrowth/water_scorecard.htm

U.S. Environmental Protection Agency, “What is Nonpoint Source Pollution?” See http://water.epa.gov/polwaste/nps/whatis.cfm

U.S. Green Building Council, “LEED for Neighborhood Development Rating system,”2011. See http://www.usgbc.org/neighborhoods

Appendix G – Pollutant Loading and Pollutant Reduction

<u>SWAMM™ Results & Methodology</u>

Spatial Watershed Assessment & Management Model

Mill Creek Watershed

Lake County, Illinois

Prepared By:
Northwater Consulting
For:
Lake County Stormwater management Commission (LCSMC)

January 1st, 2014

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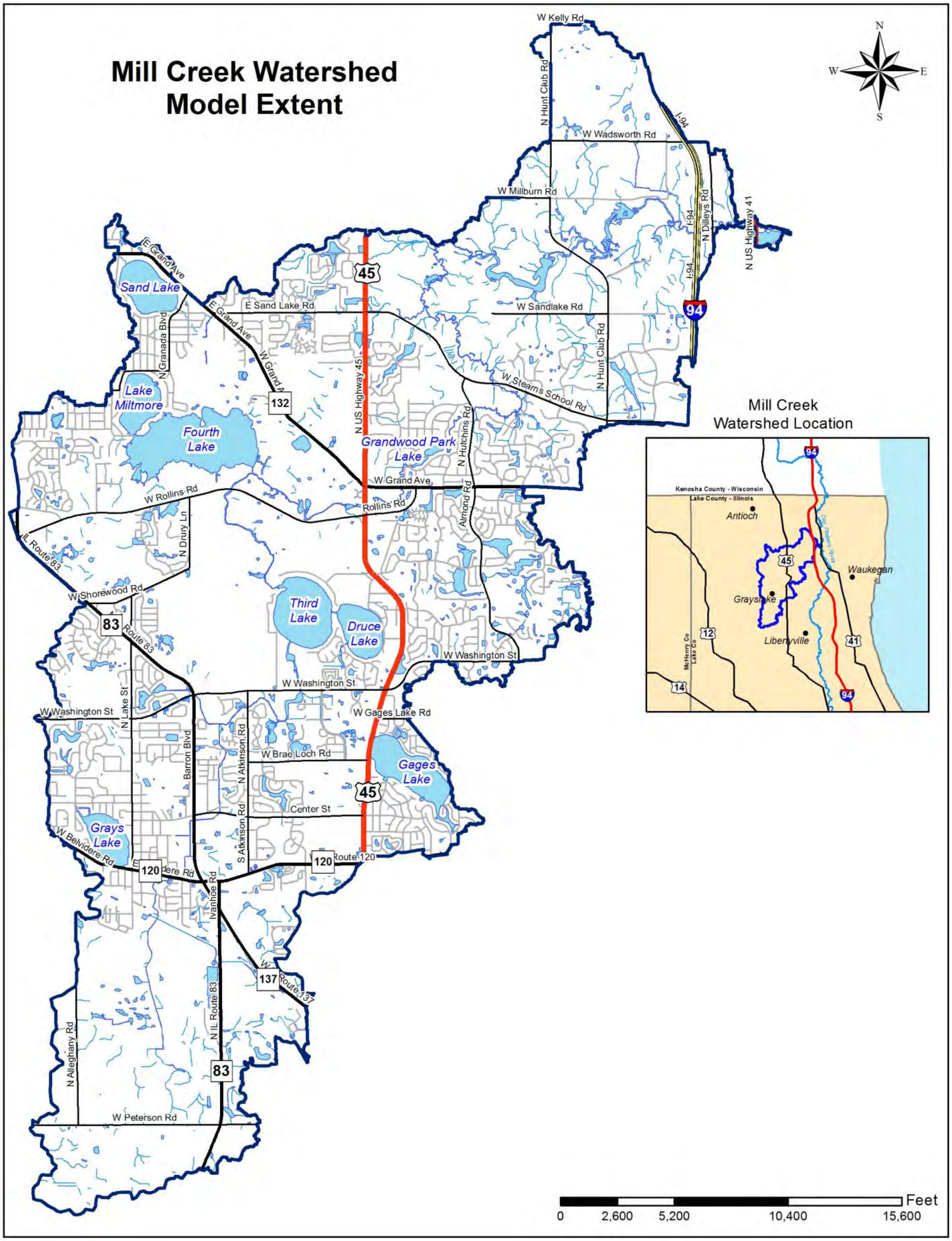
Tables and Figures

Figure 1 - Model Extent; Location Map



NORTHWATER CONSULTING

SWAMM™ Methodology

1.0 Introduction

A customized SWAMM™ (Spatial Watershed Assessment and Management Model) was developed for the Mill Creek Watershed for both current and future (2020) landuse. The custom model estimates parcel level pollutant loading of Phosphorus (TP), Sediment (TSS), Chloride (Cl) and Fecal Coliform Bacteria. This paper summarizes the results and methodology of the model.

The model is built using custom GIS data layers and existing public data layers that encompass soils, landuse, climate and parcel boundaries. Model results are aggregated into individual units of pollution loading based on landuse, parcel boundaries and soil types. A series of industry standard equations are built into the model to estimate runoff, soil erosion, delivery ratios and ultimately estimate total nonpoint-source pollutant loading of the selected parameters. For this model, Northwater worked directly with SMC to compile Event Mean Concentration (EMC) values for different land uses, which were incorporated into the model.

The model was calibrated to acceptable ranges by comparing to other studies and results from the Chicagoland area. Climate data from 1980 through 2012 were used to generate rainfall statistics for the model.

The model results can be analyzed by subwatershed, parcel boundaries and landuse. Results can also be analyzed based on user defined boundaries and presented in map format, easily overlaid on existing base maps. The model includes 48,764 unique records for current landuse and 43,402 unique records for future 2020 landuse from which pollution loading can be analyzed.

2.0 SWAMM™ Methodology

The custom SWAMM™ model consists of two primary components:

- Universal Soil Loss Equation (USLE) Component
- Event Mean Concentration (EMC) Component

2.1 Universal Soil Loss Equation (USLE) Component

The overall analysis methodology was modified by Northwater from*:*

Mitasova and Lubos Mitas: Modeling soil detachment with RUSLE3d using GIS, 1999; University of Illinois. http:/skagit.meas.ncsu.edu/~helena/gmslab/erosion/usle.html

The USLE component of the model was applied to agricultural land uses within the watershed. The USLE methodology incorporated into the model is summarized below:

- 1:24,000 NRCS Soil Survey Geographic Database (SSURGO) Digital Soils.
- Selected appropriate soil types and relevant USLE factors identified and calculated from SSURGO soils dataset.
- Local input from local Soil and Water Conservation District (SWCD) and Natural Resource Conservation Service (NRCS) staff.

Table 1 - USLE Parameters

USLE EQUATION: Annual Soil Loss = LS □ K □C □ R

Land Use	C factor	K factor	LS factor	R factor	P factor
Row Crops	A and B slopes = 0.21 C and D slopes = 0.1 E, F, G slopes = 0.001 All Wheat Fields = 0.1	Values included in SSURGO tabular data	SSURGO tabular data; calculated from slope and slope length values or from local NRCS	140	1 used for all soil polygons

2.2 Event Mean Concentration (EMC) Component

All formulas and selected variables were derived from: *STEPL (Spreadsheet Tool for Estimation of Pollutant Load) Version 3, Tetra Tech, 2004.*

EMC values and runoff curve numbers were derived from several sources, which are annotated in section 5.0.

Bacteria

For Bacteria, Schueler's Simple Method (1987) was modified for estimating bacterial loads.

Precipitation & Storm Runoff

Storm runoff module was created to estimate runoff and pollutant loading from first flush rainfall event. Runoff was computed as described in the table 20. The first flush P value was provided by SMC and is set at **1.01** inches.

Annual precipitation, number of rain days and correction factors were determined using the Elgin and Antioch weather stations. A period of 32 years was used (1980-2012) to determine the parameters outlined in Table 3:

Table 2 – Rainfall Factors

Average Number of Rain Days	Rain Days Correction Factor	Average P Value (inches)
112.81	**0.434**	**0.65**

Delivery Ratio

A distance based delivery ratio was applied to soil, based on:

Minnesota Board of Water & Soil Resources, Pollution Reduction Estimator Water Erosion - Microsoft Excel® Version September 2010.

Delivery Ratio = Polygon Distance from Stream $^{\wedge -0.2069}$

Table 3 - Model Parameters

Model	Rain days	Correction Factor (precipitation and rain days)	Curve Number (by soil hydrologic group)	Runoff (by soil hydrologic group in inches)	EMC for P, Chloride, TSS, Bacteria
All landuse	see Table 2 above	see Table 2 above	see Table 4 below	Calculated using the following equation: $Q = \frac{((P-(IaXS))^{2}}{P + 0.8 X S}$ $S = \frac{1000}{CN} - 10$ Q = Runoff (inches) P = Precipitation (inches) S = Potential max retention (inches) CN = Curve Number Ia = Initial abstraction factor; set to 0 for annual runoff and 0.2 for the first flush event	see Table 4 below

Table 4 - Event Mean Concentrations & Curve Numbers; Current Landuse

Landuse Category	EMC Chloride (mg/l)	EMC P (mg/l)	EMC TSS (mg/l)	Bacteria (counts/ 100ml)	Curve # A Group	Curve # B Group	Curve # C Group	Curve # D Group
1526 - Bus Facility	148	0.34	240	1400	91	91	91	91
1380 - Cemetery	148	0.46	153	1400	77	79	80	81
1240 - Commercial Mix (High)	148	0.42	206	1800	92	93	94	95
1240 - Commercial Mix (Medium)	148	0.4	153	1400	89	90	91	92
1240 - Commercial Mix (low)	148	0.4	153	1400	84	85	86	87
1550 - Communication	120	0.3	65	1400	49	69	79	84
1250 - Cultural and Entertainment (High)	148	0.3	206	1800	92	93	94	95
1250 - Cultural and Entertainment (Medium)	148	0.29	153	1400	87	88	89	90
1250 - Cultural and Entertainment (Low)	148	0.29	153	1400	84	85	86	87
1320 - Educational Facilities (High)	148	0.42	153	1800	91	94	96	97
1320 - Educational Facilities (Medium)	148	0.42	153	1400	89	92	94	95
2320 - Equestrian Facility (High)	0.91	0.55	300	8700	74	83	88	90
2320 - Equestrian Facility (Medium)	0.91	0.53	240	5200	67	78	85	89
2320 - Equestrian Facility (Low)	0.91	0.344	115	5200	59	74	82	86
2420 - Equestrian Pasture (Medium)	0.91	0.53	240	8700	57	72	81	86
2420 - Equestrian Pasture (Low)	0.91	0.344	115	5200	39	61	74	80
1120 - Farmhouse (High)	71	0.5	300	9000	85	86	87	88
1120 - Farmhouse (Medium)	15	0.42	160	8400	78	79	80	81
1120 - Farmhouse (Low)	15	0.33	72	8400	57	72	81	86
4110 - Forest	0.91	0.15	30	1000	30	55	70	77
3120 - Golf Courses	0.91	0.6	84	2600	76	79	80	81
1340 - Government Facility (High)	148	0.42	206	1800	92	93	94	95
1340 - Government Facility (Medium)	148	0.4	153	1400	87	88	89	90
1340 - Government Facility (Low)	148	0.4	153	1400	84	85	86	87
4140 - Grassland	0.91	0.13	15	1000	39	61	74	80
1250 - Hotel/Motel	148	0.23	153	2500	85	86	87	88
5200 - Lakes, Reservoirs, Lagoons	120	0.025	1.5	500	100	100	100	100
1570 - Landfill	148	0.31	230	2500	81	88	91	93
1420 - Manufacturing and Processing (High)	148	0.31	230	2500	92	93	94	95
1420 - Manufacturing and Processing (Medium)	148	0.31	230	2300	88	89	90	91
1310 - Medical Facility (High)	148	0.42	153	1400	92	93	94	95
1141 - Mobile Home	50	0.4	153	8700	61	75	83	87
1130/1131/1132 - Multi-Family Apartments (High)	148	0.32	206	8400	89	92	94	95
1130/1131/1132 - Multi-Family Apartments (Medium)	148	0.3	153	8400	88	89	90	91
1130/1131/1132 - Multi-Family Apartments (Medium)	148	0.3	72	8300	85	86	87	88
2310 - Non Equestrian Farm Building (Medium)	15	0.42	160	3200	78	79	80	81
2310 - Non Equestrian Farm Building (Low)	15	0.33	72	2600	57	72	81	86
4220 - Non Residential Under Development	15	0.18	153	1300	77	85	91	94
1220 - Office Campus/Research Park (High)	148	0.42	153	1400	92	93	94	95
1220 - Office Campus/Research Park (Medium)	148	0.42	153	1400	87	88	89	90
1540 - Off-Street Parking (paved)	148	0.34	153	1700	91	91	91	91
1540 - Off-Street Parking (un-paved)	70	0.3	390	2200	85	86	87	88
3210/3230 - Open Space Conservation	0.91	0.15	15	1000	35	58	72	79
3300 - Open Space Stormwater Management	0.91	0.19	10.2	500	38	60	74	80
2200 - Orchards, Vineyards, and Nurseries	0.91	0.4	240	2600	62	71	78	81
1390 - Other Institutional (High)	148	0.3	72	1400	92	93	94	95

1390 - Other Institutional (Medium)	148	0.3	72	1400	87	88	89	90
1390 - Other Institutional (Low)	148	0.3	72	1400	84	85	86	87
3130 - Other Open Space	0.91	0.15	30	1000	76	79	80	81
4300 - Other Vacant	0.91	0.15	30	1000	34	57	72	78
3110 - Parks and Gardens (High)	0.91	0.2	30	1000	77	79	81	82
3110 - Parks and Gardens (Medium)	0.91	0.2	30	1000	76	78	80	81
3110 - Parks and Gardens (Low)	0.91	0.2	30	1000	72	73	75	77
1581/1592 - Railroad Right-of-Way and Rail Station	148	0.34	240	1700	87	88	89	90
1360 - Religious Facility (High)	148	0.42	206	1800	92	93	94	95
1360 - Religious Facility (Medium)	148	0.4	153	1400	87	88	89	90
1360 - Religious Facility (Low)	148	0.4	153	1400	84	85	86	87
3140 - Residential Open Space	0.91	0.053	11.1	1000	76	79	80	81
4210 - Residential Under Development	15	0.18	153	1300	77	85	91	94
5100 - Rivers, Streams, Canals	70	0.11	3.1	500	100	100	100	100
1521/1522/1523 - Road	300	0.34	153	1700	91	91	91	91
1521/1522/1523 - Road (Driveway paved)	148	0.3	65	1600	87	88	89	90
1521/1522/1523 - Road (unpaved)	70	0.3	390	1600	85	86	87	88
1521/1522/1523 - Road (Driveway unpaved)	70	0.3	390	1600	84	85	86	87
2110 - Row Crop	0.91	0.6	N/A*	2600	74	84	91	95
2110 - Row Crop (Wheat)	0.91	0.6	N/A*	2600	72	82	86	90
2110 - Row Crop with Nutrient Management Plan		0.275						
1210 - Shopping Mall	148	0.49	206	1400	92	93	94	95
1230 - Single Structure Office (High)	148	0.35	206	1400	92	93	94	95
1230 - Single Structure Office (Medium)	148	0.3	153	1400	87	88	89	90
1230 - Single Structure Office (Low)	148	0.3	153	1400	84	85	86	87
1111/1112/1114/1115 - Single, Duplex, Condo, and Townhouse Units (High)	148	0.32	206	8400	88	89	90	91
1111/1112/1114/1115 - Single, Duplex, Condo, and Townhouse Units (Medium)	148	0.3	153	8400	85	86	87	88
1111/1112/1114/1115 - Single, Duplex, Condo, and Townhouse Units (Low)	148	0.3	73	8300	78	79	80	81
3150 - Trail	0.91	0.15	72	1000	85	86	87	88
4150 - Transitional Vegetation	0.91	0.15	30	1000	76	78	80	81
1560 - Utilities and Waste Facilities	148	0.34	153	1400	85	86	87	88
1270 - Vehicle Dealership	148	0.49	153	1400	92	93	94	95
1430 - Warehousing/Distribution Center and Wholesale (High)	148	0.4	206	2300	92	93	94	95
1430 - Warehousing/Distribution Center and Wholesale (Medium)	148	0.31	153	2300	88	89	90	91
1430 - Warehousing/Distribution Center and Wholesale (Low)	148	0.31	153	2300	85	86	87	88
4120 - Wetland	0.91	0.19	10.2	500	38	60	74	80

* Replaced by USLE - used 456 mg/l EMC for storm events

Table 5 - Event Mean Concentrations & Curve Numbers; 2020 Landuse

Landuse Category	EMC Chloride (mg/l)	EMC P (mg/l)	EMC TSS (mg/l)	Bacteria (counts/100ml)	Curve # A Group	Curve # B Group	Curve # C Group	Curve # D Group
Agricultural	0.91	0.6	N/A*	2600	62	71	78	81
Government/Institutional	148	0.49	153	1400	92	93	94	95
Industrial	148	0.31	153	2300	92	93	94	95
Mixed Use/General	148	0.42	153	1400	77	85	90	92
Residential Multi-Family	148	0.32	206	8400	89	92	94	95
Office and Research Parks	148	0.42	153	2500	92	93	94	95
Public/Private Open Space	0.91	0.15	20	1000	76	79	80	81

Single-family Residential	148	0.32	206	8400	88	89	90	91
Retail/Commercial	148	0.49	206	1400	92	93	94	95
Right-of-Way	300	0.34	153	1700	91	91	91	91
Single-family Large Lot	148	0.32	206	8400	88	89	90	91
Single-family Medium Lot	148	0.3	153	8400	85	86	87	88
Single-family Small Lot	148	0.3	153	8300	78	79	80	81
Transportation	300	0.34	153	1700	91	91	91	91
Utility/Waste Facilities	148	0.34	153	1400	85	86	87	88
Water	70	0.11	3.1	500	100	100	100	100

* Replaced by USLE - used 456 mg/l EMC for storm events

3.0 Model Calibration

The model was calibrated using average per acre loading data from several regionally-derived plans, publications, and other documents.

1. Quality Assurance / Quality Control – to find and correct user errors in the model scripts and algorithms.
2. To evaluate whether stream-flow (runoff) and pollutant loading were in the correct ranges based on existing data and literature.
3. To calibrate model by adjusting parameters so that cumulative model results represent regional average.s

The model is estimating accumulated/delivered pollutant loading, represented mostly in the literature. Important notes on the model include:

- The model does not directly account for point-source pollution.
- The model estimates annual pollutant mobilization from individual parcels of land and does not take into account storage, fate and transport watershed processes.
- The model accounts for precipitation runoff; but not base flow, point source discharges or drainage-tile contributions.

The model was calibrated based using the delivery ratio; to account for differences between the delivery of sediment versus the delivery of dissolved pollutants. Since the delivery ratio is based on studies of sediment transport and not dissolved pollutants, an adjustment or multiplier of **1.25** was applied to the delivery ratio for Chloride, Phosphorous and Bacteria to get the results within acceptable regional ranges. The assumption was made that dissolved pollutants are delivered at a slightly higher rate than that of sediment.

4.0 Bibliography of EMC Literature

1. *Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT) Technical Guide, Version 1.0 Release 1, November 2004.*
2. *Lower DuPage River Watershed Plan Pollution Load Model Methodology, 2010.*
3. *Cotton-Mutton Creek, Slocum Lake Drain/Fiddle Creek, and Tower Lakes Drain Watershed Pollution Load Model Methodology, Northwater Consulting, 2013.*
4. *North Mill Creek-Dutch Gap Canal Watershed-Based Plan, Pollutant Load Model Methodology, 2011.*
5. *Price, Thomas H., 1993. Unit Area Pollutant Load Estimates for Lake County Illinois Lake Michigan Watersheds.*
6. *Todd D. Stuntebeck, Matthew J. Komiskey, Marie C. Peppler, David W. Owens, and Dennis R. Frame 2011. Precipitation-Runoff Relations and Water-Quality Characteristics at Edge-of-Field. Stations, Discovery Farms and Pioneer Farm, Wisconsin, 2003–08.*

7. Walton R. Kelly, Samuel V. Panno, Keith Hackley, 2012. The Sources, Distribution, and Trends of Chloride in the Waters of Illinois.
8. Robert Pitt, Alex Maestre, and Renee Morquecho, 2004. The National Stormwater Quality Database (NSQD, version 1.1).
9. Holly Hudson, Chicago Metropolitan Agency for Planning, April 2013 (e-mail: hhudson@cmap.illinois.gov; ph: 312-386-8700).
10. Adam, M., M. Colwell, C.L. Sanders, J. Wudi, and M. Pfister. 2005. 2004 Summary Report of Woodland (Highland) Lake. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/WoodlandLake.pdf (accessed Feb. 2013)
11. Brant, C.L., M. Colwell, M. Adam, J. Marencik, and M. Pfister. 2005. 2003 Summary Report of Island Lake. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/Island%20Report.pdf (accessed Feb. 2013)
12. Brune, G.M. 1953. Trap efficiency of reservoirs. Transactions American Geophysical Union 34(3):407-18.
13. Davis, A., M. Adam, L. Dane, and S. Keseley. Undated. 2005 Summary Report of Slocum Lake. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/Slocum05.pdf (accessed Feb. 2013)
14. Deem, K., M. Adam, L. Dane, and K. Paap. Undated. 2008 Summary Report of Bangs Lake. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/Bangs08.pdf (accessed Feb. 2013)
15. Deem, K., M. Adam, L. Dane, and K. Paap. Undated. 2009 Summary Report of Ozaukee Lake. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/Ozaukee%2009.pdf (accessed Feb. 2013)
16. Deem, K., M. Adam, L. Dane, and K. Paap. Undated. 2009 Summary Report of Lake Napa Suwe. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/NapaSuwe%202009.pdf (accessed Feb. 2013)
17. Kelly, W.R, S.V. Panno, and K. Hackley. 2012. The Sources, Distribution, and Trends of Chloride in the Waters of Illinois. Illinois State Water Survey Bulletin B-74, 59 pp., Champaign. http://www.isws.illinois.edu/pubdoc/B/ISWSB-74.pdf (accessed Feb. 2013)
18. Keseley, S., M. Adam, L. Dane, and A. Orr. Undated. 2007 Summary Report of Lake Fairview. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/2007Fairview.pdf http://health.lakecountyil.gov/Population/LMU/Lakes/Slocum05.pdf (accessed Feb. 2013)
19. Keseley, S., M. Adam, L. Dane, and A. Orr. Undated. 2007 Summary Report of Timber Lake. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/2007Timber(S).pdfhttp://health.lakecountyil.gov/Population/LMU/Lakes/Slocum05.pdf (accessed Feb. 2013)
20. Müller, B. and R. Gächter. 2012. Increasing chloride concentrations in Lake Constance: characterization of sources and estimation of loads. Aquatic Sciences 74(1):101-112. http://www.eawag.ch/forschung/surf/publikationen/2011/2011_mueller.pdf (accessed Feb. 2013)
21. Novotny, E.V., D. Murphy, and H.G. Stefan. 2008. Increase of urban lake salinity by road deicing salt. Science of the Total Environment 406(2008):131-144. http://dx.doi.org/10.1016/j.scitotenv.2008.07.037; http://www.geology.wmich.edu/Koretsky/EnvironmentalGeochemistry/Novotny2008.pdf (accessed Feb. 2013)
22. Novotny, E., A. Sander, O. Mohseni, and H. Stefan. 2008. A Salt (Chloride) Balance for the Minneapolis/St. Paul Metropolitan Area Environment. Project Report No. 513. Prepared by Univ. of Minnesota St. Anthony Falls Laboratory for Local Research Board, Minnesota Dept. of Transportation. St. Paul. http://conservancy.umn.edu/bitstream/115339/1/pr513.pdf (accessed Feb. 2013
23. Orr, A., M. Adam, L. Dane, and S. Keseley. Undated. 2007 Summary Report of Lake Barrington. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/2007Barrington.pdf http://health.lakecountyil.gov/Population/LMU/Lakes/Slocum05.pdf(accessed Feb. 2013)
24. Orr, A., M. Adam, L. Dane, and S. Keseley. Undated. 2007 Summary Report of Tower Lake. Lake Co. Health Dept., Libertyville, IL. http://health.lakecountyil.gov/Population/LMU/Lakes/2007Tower.pdf http://health.lakecountyil.gov/Population/LMU/Lakes/Slocum05.pdf(accessed Feb. 2013)

25. *Striegl, R.G. and E.A. Cowan. 1987. Relations between Quality of Urban Runoff and Quality of Lake Ellyn at Glen Ellyn, Illinois. USGS Water-Supply Paper 2301. U.S. Gov't Printing Office, Denver, CO. http://pubs.usgs.gov/wsp/2301/report.pdf (accessed Feb. 2013)*

5.0 Supplemental Model Notes & Output GIS Metadata

1. 2005 landuse data were used. 2005 landuse data were modified to represent a hybrid landuse/landcover layer by interpreting recent aerial imagery, digitizing/labeling polygons and reclassifying existing land use categories. Additional information was appended to the landuse to represent type of row crops for example (wheat vs. Corn/soybeans). Where applicable, many landuse categories were modified and classified into high, medium and low density.
2. High, medium and low areas for Imperviousness were determined based on a visual interpretation of density. High areas generally represented greater than 50% impervious, medium 25-50% impervious and low, less than 25%. Curve numbers and EMC values were adjusted accordingly to represent greater runoff potential from higher impervious surfaces.
3. In general, farmhouse categories also include some type of animal feeding area/barn and therefore received higher EMC values for nutrients, sediment and bacteria.
4. EMC values for Phosphorus were reduced from 0.6 to 0.275 if a farm field was known to have a Nutrient Management Plan.
5. EMCs in Sewered areas reduced by 10% for CL, 20% for P, 30% for TSS and 15% for bacteria.
6. Equestrian areas were further delineated to represent living quarters/buildings and dry/concentrated feeding areas versus pasture/grazing or grass areas. Equestrian pasture areas were classified into high, medium and low based on pasture quality. Equestrian buildings were classified into high, medium and low based on the relative impervious surface density of the landuse polygon and data collected in the field.
7. The stream/waterbody file used to run proximity calculations for the purposes of determining a delivery ratio was modified using a National Hydrography Dataset (NHD) file and a streams and lake file provided by the Lake County Stormwater Management Commission representing linear water features and the outer boundary of water feature areas (e.g., lakes and ponds). These stream and lake files were combined into one GIS file, overlaid on aerial imagery and edited to ensure they represent actual watershed features. This line file represents lake, pond and lagoon outlines and perennial and intermittent stream centerlines.
8. An EMC of 456 mg/l for TSS was used for calculating row crop sediment loading from the first flush storm event, replacing the USLE.

Appendix H – Critical Area Criteria and Methodology

Critical Area	Description
Highly Erodible Soils	Highly erodible soils in agricultural and pasture land use; with significant enough watershed area to produce concentrated flow during rain events
Area of Greatest Landuse Change	Areas that are predicted to experience the greatest overall change in landuse with future development; from 2013 landuse to 2020. These areas were spatially analyzed and the catchments with the greatest density of these areas are identified as critical areas
Pollution Loading Hotspots	Highest percentile pollutant loading catchments in the watershed for nitrogen, phosphorus, sediment, chloride and fecal coliform bacteria
Stream and Lake Bank Erosion	Lake County Stormwater Management Commission developed an inventory of stream and lake bank erosion within the watershed, this data is spatially analyzed to identify catchments with the greatest density of bank erosion
Number of Water Quality Impairments	Areas with the greatest total number of stream/lake impairments according to the most recent IEPA water quality impairment data

Highly Erodible Soils

The delivery of sediment and pollutants in a watershed can significantly increase in areas where highly erodible soils exist. Many existing government cost share and water quality programs are specifically designed to address highly erodible soils. The following criteria were used address these critical areas in the watershed:

1) Agricultural highly erodible soils: This analysis represents highly erodible soil areas that are within row crop agricultural areas.

Pollution Loading Hotspots

A custom GIS-based pollution load model (SWAMM) was developed for the Mill Creek watershed and is presented in chapter 4. Results from SWAMM can be used to identify pollution loading “hotspots” or those areas with the highest relative contribution of pollution. Targeting these areas with Best Management Practices will produce the greatest impact on water quality and the greatest load reduction value for dollar spent.

2) Pollution Loading Hotspots: Based on results from the pollution load model for the watershed, the statistical quartiles of, phosphorus, sediment, chloride and fecal coliform bacteria were established based on loading per acre for each catchment.

Each of the catchments were ranked based on the statistical quartile analysis for each pollutant.

- Catchments with loading in the upper quartile were ranked high as ‘3’
- Catchments with loading between the 1st and 2nd quartiles (25% - 75%) were ranked moderate as ‘2’

- Catchments with loading values beneath the 1st quartile (25%) were ranked low as ‘1’

The ranking values for each pollutant were summed for each catchment to develop the pollutant load hotspot ranking criteria. Since the ranking scheme includes five pollutants with ranking values from 1 – 3; the highest loading score per catchment is 15 and the lowest loading score per catchment is 3.

Stream and Lake Bank Erosion

A survey conducted by the Lake County Stormwater Management Commission assessed and quantified streambank erosion; the Lake County Health Department assessed the degree of erosion severity for 9 local lakes. Eroding stream and lake banks deliver sediment and nutrients directly to waterways. Focusing stabilization measures to these areas can offer great opportunities for reducing sediment and nutrient loading while stabilizing aquatic habitat.

3) Greatest area of highly eroding lake and stream banks: The erosion assessment was spatially analyzed based on catchment; the lake and streambank units with the most severe erosion rates and density received the highest possible score.

Areas of Greatest Future Land Use Change

Mitigating future development impacts in an important proactive strategy to address water quality and hydrologic issues before they become a problem. Understanding future development trends can assist stakeholders in making informed decisions related to land development and economic growth.

4) Percentage area (acres) of highest future development change: Lake County developed a 2020 future land use analysis that identified areas within the watershed most likely to experience future land use changes. This data was spatially analyzed by density for each subwatershed management unit to identify the critical areas that may experience the greatest change.

Number of Water Quality Impairments

The IEPA and the Lake County Health Department assesses lakes in the watershed to determine if water quality is meeting or not meeting state standards. Understanding where impairments are occurring can help planners determine the causes and sources of pollution leading to a determination of impairment. Solutions to address these causes and sources are a core component of any watershed plan.

5) Total number of impairments: The total number of 2012 listed lake impairments was totaled for each catchment. Causes of impairments include Phosphorus (Total), Total Suspended Solids (TSS), Dissolved Oxygen, Fecal Coliform and “Cause Unknown.”

Hydrologic and Hydraulic Modeling and Floodplain Mapping for Mill Creek, Lake County, Illinois

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ILLINOIS STATE WATER SURVEY
PRAIRIE RESEARCH INSTITUTE

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SECTION 1.0
INTRODUCTION

1.1 Project Objective

The Illinois State Water Survey (ISWS) has prepared a submittal of a flood study on Mill Creek for the Lake County Stormwater Management Commission (LCSMC) in accordance with University of Illinois grant HUD LCSMC 2014-00267 (Mill Creek Floodplain Study), effective August 1, 2013. The objective of the project is to provide LCSMC with updated hydrologic and hydraulic models and accurate floodplain and floodway boundaries based on those models that meet both the Illinois State standards and Federal Emergency Management Agency (FEMA) standards for inclusion in the Lake County and Incorporated Areas, Flood Insurance Rate Maps. Incorporation of the new values into the FEMA Flood Insurance Rate Maps (FIRMs) is beyond the scope of this project.

This study revises approximately 19 miles of Mill Creek where currently effective FIRMs show Zone AE floodplains and floodway based on prior studies, which no longer reflect existing conditions. This study will provide information for floodplain management in predominantly urban areas and will integrate information and modeling from the following existing studies: 1) *South Mill Creek Watershed Hydrologic and Hydraulic Report, revised September 2008,* originally performed by Tetra-Tech (Bleck Engineering, Inc., 2008); 2) a FEMA MT2 application for the Old Center Street culvert replacement project titled, *Village of Grayslake, Lake County, Illinois. Letter of Map Revision Application, Mill Creek* (Village of Grayslake, 2011); and 3) the effective FEMA WSP-2 model (Federal Insurance Administration, 1979). These studies will be described further in **Section 2.4 Previous Studies**. Cross section and bridge geometry data were updated with the following: 1) field-surveyed data consisting of channel sections and bridge geometry (Thomson Surveying, Ltd, 2013) collected specifically for this project for structures not included in the previous models; and 2) the 2007 countywide light detection and ranging (2007 LiDAR) topographic dataset (Lake County, 2011). High water marks were also obtained from LCSMC for use in model calibration and verification.

For this report submittal, the hydraulic model will produce water surface profiles for the 10-, 4-, 2-, 1-, and 0.2% annual chance events with a floodway for the 1-percent-annual-chance event, based on the State of Illinois criteria using the peak discharge values proposed in this report.

1.2 Watershed Description

Mill Creek is a tributary of the Des Plaines River within the HUC-8 watershed (HUC 07120004) in Lake County. The studied reach of the tributary is approximately 19 miles in length. The watershed is predominately urban with agricultural areas in the headwaters and drains parts of the Village of Grayslake, Village of Third Lake, Village of Old Mill Creek, the Village of Wadsworth, and Unincorporated Lake County. The stream begins just northwest of the junction of West Peterson Road and Ivanhoe Road and flows north-eastwards to its confluence with the Des Plaines River east of Route 45. Figure 1 shows the location and boundary of the Mill Creek Watershed. The Mill Creek watershed is largely residential.

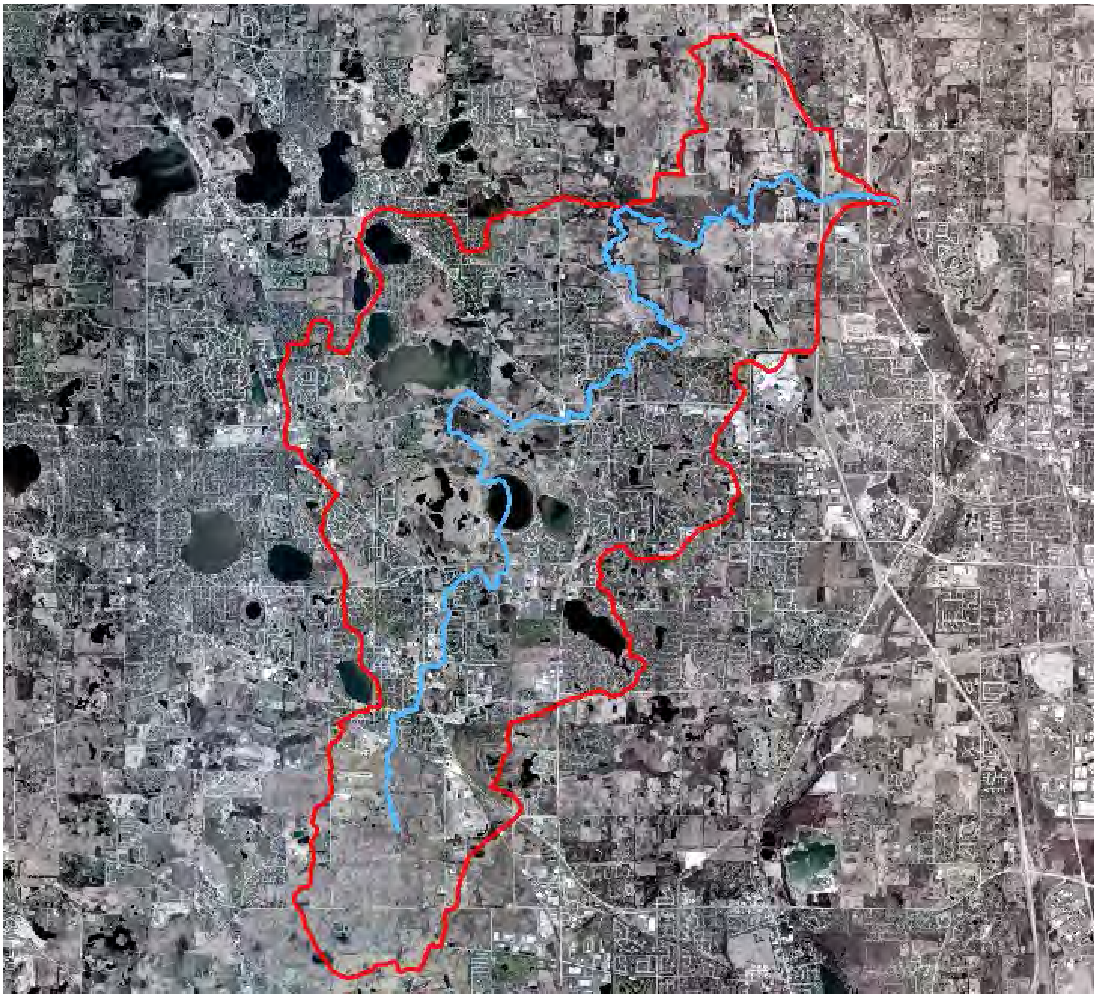


Figure 1. Mill Creek Watershed overview

1.3 Project Model Approach

To satisfy the objectives set forth for this project, information was collected, including existing hydrologic and hydraulic models, geospatial data, previous studies, reported problem areas, and other data relevant to the watershed plan. A “kick-off” meeting was held on August 26, 2013 between members of the LCSMC and the ISWS in Libertyville, Illinois (reference Appendix P).

For this hydrologic analysis, statistical frequency analysis of stream gage data on Mill Creek was completed in addition to the creation of a watershed hydrologic model developed within the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) Version 3.5.0 (Hydrologic

Engineering Center, 2010) modeling application. For Mill Creek downstream of the confluence with North Mill Creek, design peak frequency discharge values were determined based on the frequency analysis of the annual peak discharge data of the Mill Creek at Old Mill Creek stream gage operated by the United States Geological Survey (USGS). Upstream of the confluence of North Mill Creek, identified in this study as South Mill Creek, the design peak discharge values were based on the HEC-HMS analysis. The Soil Conservation Service (SCS) curve number (CN) loss method was used with the Clark Unit hydrograph methodology (Clark, 1945) within HEC-HMS to model basin hydrology. HEC-HMS has an extensive toolkit named HEC-GeoHMS (USACE) to interface with geographic information systems (GIS) software to produce input data and display model results. Recent additional gage data was available to complete calibration of the HEC-HMS model to larger flood events. The critical duration event (i.e., the rainfall duration that produces the highest stages) was determined for the watershed.

Hydraulic models were developed within the USACE Hydrologic Engineering Center – River Analysis System (HEC-RAS) Version 4.1.0 (USACE, 2010). The steady flow routing methodology was used within HEC-RAS. HEC-RAS has an extensive toolkit (HEC-GeoRAS) (USACE, 2002) to interface with GIS software to produce input data and display model results. This analysis reflects existing conditions, as available through field survey, 2012 aerial imagery (Lake County Ortho photo, 2012), and 2007 2007 LiDAR topography (Lake County, 2011).

Floodplain maps were created, depicting the limits of the 1-percent-annual-chance floodplains developed for each stream. DRAFT inundation mapping for existing conditions for the 1-percent-annual-chance of exceedance event in Appendix H (Floodplain Comparison Map) was compared with the effective Flood Insurance Rate Maps (FIRMs).

SECTION 2.0
AVAILABLE DATA

2.1 Stream Gage Data

There are four stream gages in the Mill Creek Watershed in Lake County. Mill Creek gage at Old Mill Creek has a historical record of 40 years (occurring between 1960 and 2013), a length appropriate for statistical analysis. The other stream gages were reviewed for HEC-HMS model calibration and verification. A summary of the stream gages with their history of record is included in Table 1 and the stream gage locations are displayed in Figure 2. A fifth historical stream gage, USGS 05527870 Mill Creek at Wedges Corner with a drainage area of 18.2 square miles, recorded annual peak stream flow data from 1960 to 1976 but has not been included in this analysis.

Figure 3 graphs the annual peak discharge historical record at the Mill Creek at Old Mill Creek stream gage. The data is available in tabular form in Appendix K. Stream data for frequency analysis and specific historical events are further discussed in the hydrologic analysis and model calibration sections of this report.

Table 1. Locations of existing stream gages

Location	*Gage Owner*	*Gage Number*	*Years of Record*	*Drainage Area (sq miles)*
Mill Creek at Old Mill Creek, IL	USGS	05527950	1960, 1962-1976, 1990-2013	61.0
North Mill Creek near Milburn, IL	USGS	05527910	2008-2012	28.4
Mill Creek at Stearns School Rd.	Lake County	E-5	04/26/2006 - 11/06/2008	
Mill Creek at College of Lake County	Lake County	E-7	04/26/2006 - 01/16/2012	

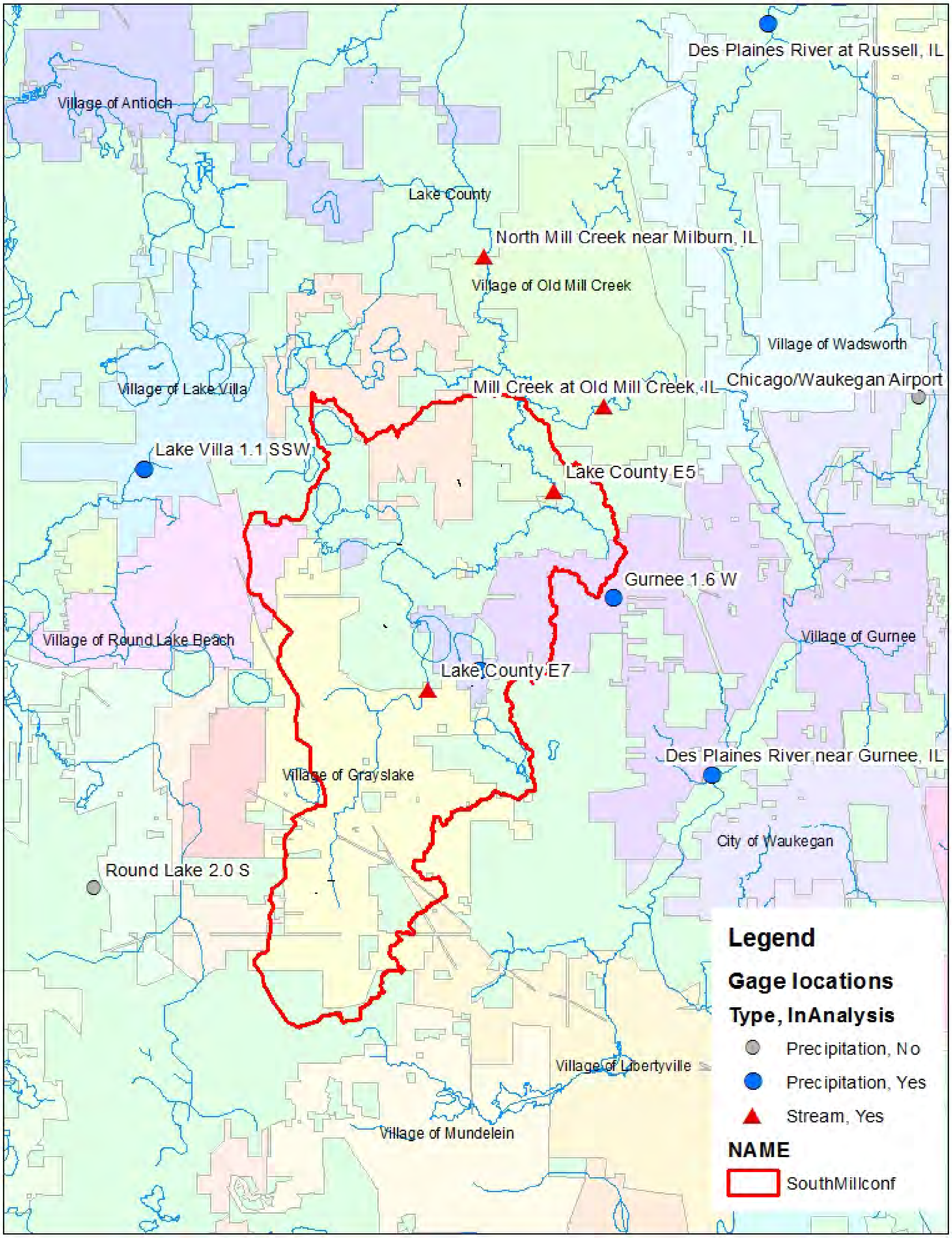


Figure 2. Map of stream and rain gage locations

All stream gage data was used in the analysis when applicable. Rain gage data was utilized based on proximity to the watershed analyzed using the HEC-HMS rainfall runoff model.

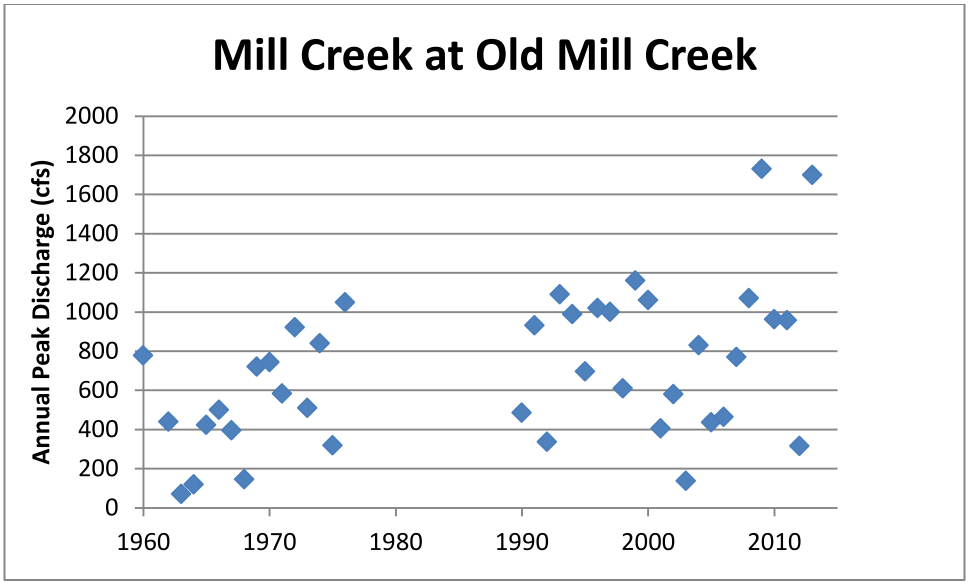


Figure 3. Annual peak discharge historical record at Mill Creek gage at Old Mill Creek, USGS gage 05527950

2.2 Rain Gage Data

USGS rain gage stations at Des Plaines River near Gurnee and Des Plaines River near Russell were the primary source for historical rainfall event distribution. Additional daily rain gage data were utilized to adjust the rainfall volume over the watershed. The daily rain gage data was obtained from the National Oceanic and Atmospheric Administration National Climatic Data Center Global Historic Climate Network (NCDC GHCN). This online data source includes observations from multiple sources including the Community Collaborative Rain Hail & Snow (CoCoRaHS) network. When observation times were not recorded, it was assumed to be at 0700 CST. Table 2 lists the rain gages that were used in this analysis. Figure 2 includes the locations of the rain gages.

Table 2. Rain gage data

					Total Event Rainfall (inches)		
Location	*Source*	*Time Step*	*Latitude*	*Longitude*	*Jun-08*	*Jun-09*	*Apr-13*
Des Plaines River near Russell	USGS	15 min	42.489	87.926	1.75	5.12	2.99
Des Plaines River near Gurnee	USGS	15 min	42.344	87.941	2.33	3.04	3.37
Third Lake 0.4 SE	NCDC GHCN	Daily	42.364	88.002	1.15	3.48	3.6
Lake Villa 1.1 SSW	NCDC GHCN	Daily	42.403	88.090	3.83	3.73	3.96
Gurnee 1.6 W	NCDC GHCN	Daily	42.378	87.967	2.57	3.76	4.18
Round Lake 2.0 S	NCDC GHCN	Daily	42.322	88.103	3.19	3.06	--

2.3 Topographic Data

The 2007 Countywide 2007 LiDAR topographic dataset (Lake County Department of Information and Technology, 2007) was available for use for this project. Field-surveyed data was obtained by Spaceco for channel sections and structures for the original 2003 Tetra-Tech report. Additional field surveying (consisting of surveys for channel sections and new structures) was performed by Thomson Surveying and has been incorporated into this report. A more detailed description of the field survey locations (by Thomson Surveying) is described in Appendix R.

2.4 Previous Studies

The FEMA Flood Insurance Study (FIS) effective hydrologic analysis for North Mill Creek and Mill Creek is the 1976 Des Plaines River Watershed Floodwater Management Plan (USDA, 1976) using the SCS TR-20 model. The FEMA effective hydraulic analysis (WSP-2 model) was first included in the 1982 Unincorporated FIS and December 1979 Village of Grayslake FIS.

In 2003, Tetra-Tech completed a report revising the floodplain for the South Mill Creek watershed. The study included hydrologic analysis using a HEC-HMS model, and steady state HEC-RAS hydraulic analysis.

An independent technical review of the 2003 Tetra-tech report was completed by Bleck Engineering in 2008 (Bleck Engineering, Inc., 2008). In addition, the USACE also provided comments, some of which were addressed by Bleck Engineering in their report. Changes made to the initial 2003 Tetra-Tech analysis included conversion of the 2003 HMS hydrologic model to an HEC-1 model and hydrologic parameter corrections. In addition, the steady-state HEC-RAS model was converted to an unsteady-state HEC-RAS model for purposes of incorporating floodplain storage into an unsteady state hydraulic model.

In 2010, the Village of Grayslake contracted with Baxter and Woodman Consulting Engineers to complete a Letter of Map revision (Village of Grayslake LOMR, 2010) for a portion of the reach of Mill Creek using the 2008 revised analysis by Bleck Engineering. The LOMR revised the hydraulic analysis but did not revise the hydrologic analysis. Revisions to the hydraulic model included a culvert replacement for Old Center Street.

Mill Creek has several previous studies and associated independent technical reviews that were reviewed and utilized for available data and comparison of this analysis. The existing 2008 South Mill Creek Watershed report (Bleck Engineering, Inc., 2008) used an HEC-1 model to generate peak flows for use in an unsteady HEC-RAS model of Mill Creek. Reach routing and the critical duration analysis were performed in the unsteady HEC-RAS model.

SECTION 3.0
MODEL DEVELOPMENT

3.1 Introduction

Hydrologic and hydraulic models were developed for Mill Creek. Both the hydrologic and hydraulic models are based on past hydrologic and hydraulic modeling efforts.

3.2 Hydrologic Analysis

Hydrologic analysis was completed using different techniques for the reach of Mill Creek downstream of the North Mill Creek confluence and upstream of the North Mill Creek confluence. Downstream of the North Mill Creek confluence, the Mill Creek at Old Mill Creek stream gage provided hydrologic data appropriate for a statistical frequency analysis. Upstream of the confluence, peak annual stream discharge measurements are not available for a statistical analysis. Here stream stage gages and local knowledge of the area were utilized to calibrate a rainfall runoff model.

The discharge values at the stream gage were calculated as weighted averages based on two approaches: the frequency analysis using the USGS PeakFQ software (Bulletin 17B, IACWD, 1982) and the regression equations (Soong, et al., 2004) using StreamStats (Ishii,et al., 2010).

The hydrologic rainfall runoff model was developed within the USACE Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) Version 3.5.0 modeling application. The Natural Resources Conservation Service (NRCS) curve number (CN) loss method was used with the Clark Unit hydrograph methodology (Clark, 1945) within HEC-HMS to model basin hydrology. HEC-HMS has an extensive toolkit (HEC-GeoHMS) to interface with GIS software to produce input data and display model results. Peak flow values were also calculated from regression equations in the urban watersheds in order to check and analyze the HEC-HMS results.

3.2.1 Flood Frequency Analysis

Statistical frequency analysis of the record of annual peak discharge values at the Mill Creek gage at Old Mill Creek was completed using USGS PeakFQ version 5.2.0 software (Bulletin 17B, IACWD, 1982). The general skew value of -0.4 was used for the analysis based on "Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural streams in Illinois" (Soong, et al., 2004). PeakFQ files have been included in Appendix L (PeakFQ Output File).

3.2.2 Regression Equation Analysis

While regression equations were not the source of peak discharge values, regression equation analysis was completed for comparison and for obtaining a weighted gage and regression discharge value near the Mill Creek at Old Mill Creek stream gage.

"Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural streams in Illinois" (Soong et al., 2004) developed annual maximum series regression equations for Illinois rural streams for recurrence intervals from 2 to 500 years. The regression equations were established by estimating peak discharges using a Log-Pearson Type III distribution. Independent variables in the equation include drainage area, channel slope, soil permeability, and a regional factor, where drainage area and main channel slope are determined from a topographic map, soil permeability is determined from an average soil permeability map (the arithmetic average of the high and low soil permeability values from STATSGO database), and the regional factor is a constant dependent upon the geographical location of the site within Illinois. Equation 1 estimates the peak discharge for the T% annual chance event:

$$Q_T = a(TDA)^b(MCS)^c(PermAvg)^d RF(N)$$

Equation 1

Where:
Q_T = T% annual chance peak discharge (ft^3/s)
TDA = drainage area (sq mi.)
MCS = main channel slope (ft/mi.)
$PermAvg$ = average permeability (in/hr)
$RF(N)$ = regional factor for region N
a = coefficient for T% annual chance event
b, c, d = exponents for T% annual chance event

Drainage area, channel slope, and permeability were obtained from StreamStats, a web-based GIS application created by the USGS in cooperation with the Environmental Systems Research Institute (Ishii, et al., 2010). The Stream Stat regression equation flow rates are provided in Appendix M (StreamStats Output Summary).

The regression equation flow rates were adjusted to represent increases in storm runoff due to urbanization. The urbanization adjustment methodology detailed in Section 4-101.02 of the Illinois Department of Transportation Drainage Manual was utilized.

3.2.3 HEC-HMS Model

The rainfall-runoff hydrologic model for the Mill Creek watershed upstream of North Mill Creek was developed using the USACE Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) Version 3.5.0 modeling application.

3.2.3.1 Precipitation

Design event rainfall data was obtained from the Lake County Watershed Development Ordinance effective June 11, 2013 as shown in Table 3. Huff rainfall distribution was assumed (Huff and Angel, 1992).

Table 3. Rainfall depth-duration frequency for Lake County

	(Percent Annual Chance Event)					
Duration	*50*	*10*	*4*	*2*	*1*	*0.2**
12 hours	2.44	3.38	4.13	4.79	5.66	7.90
18 hours	2.63	3.65	4.47	5.17	6.11	8.53
24 hours	2.80	3.88	4.75	5.50	6.50	9.07
48 hours	3.02	4.19	5.13	5.94	7.02	9.81
72 hours	3.25	4.50	5.51	6.38	7.54	10.52
120 hours	3.67	5.08	6.33	7.21	8.52	11.90
240 hours	4.12	5.70	6.98	8.09	9.56	13.34

* Rainfall depth for 500-year design rainstorm were extrapolated

3.2.3.2 Watershed And Subwatershed Delineation

Terrain preprocessing and watershed delineation were completed using the HEC-GeoHMS v10.1 toolkit for ArcGIS 10.1. The topographic data for Lake County was developed from light detection and ranging (2007 LiDAR) data generated in 2007 (Lake County, 2011). A digital elevation model (DEM) was developed by the Illinois State Water Survey for Lake County based upon the 2007 LiDAR data.

Occasionally, the elevation data contains constructed structures that do not represent surface hydrology, for instance, raised roadways that do not restrict overland flow. The delineation in these areas was modified to best represent surface hydrology. Channels visible from the 2012 aerial photography were delineated and used to create low paths through the topography such that the channels were represented and the subbasins delineated and connected appropriately. Reference of previous studies and consultation with community representatives were also considered.

Subbasin naming was created to allow for easy correlation between this and previous analyses. Many subbasins from the previous analysis were subdivided further after consideration of the technical review comments. When a subbasin was further divided, a letter was added to the end of the previous subbasin name. Figure 4 shows the drainage paths and subbasins of Mill Creek.

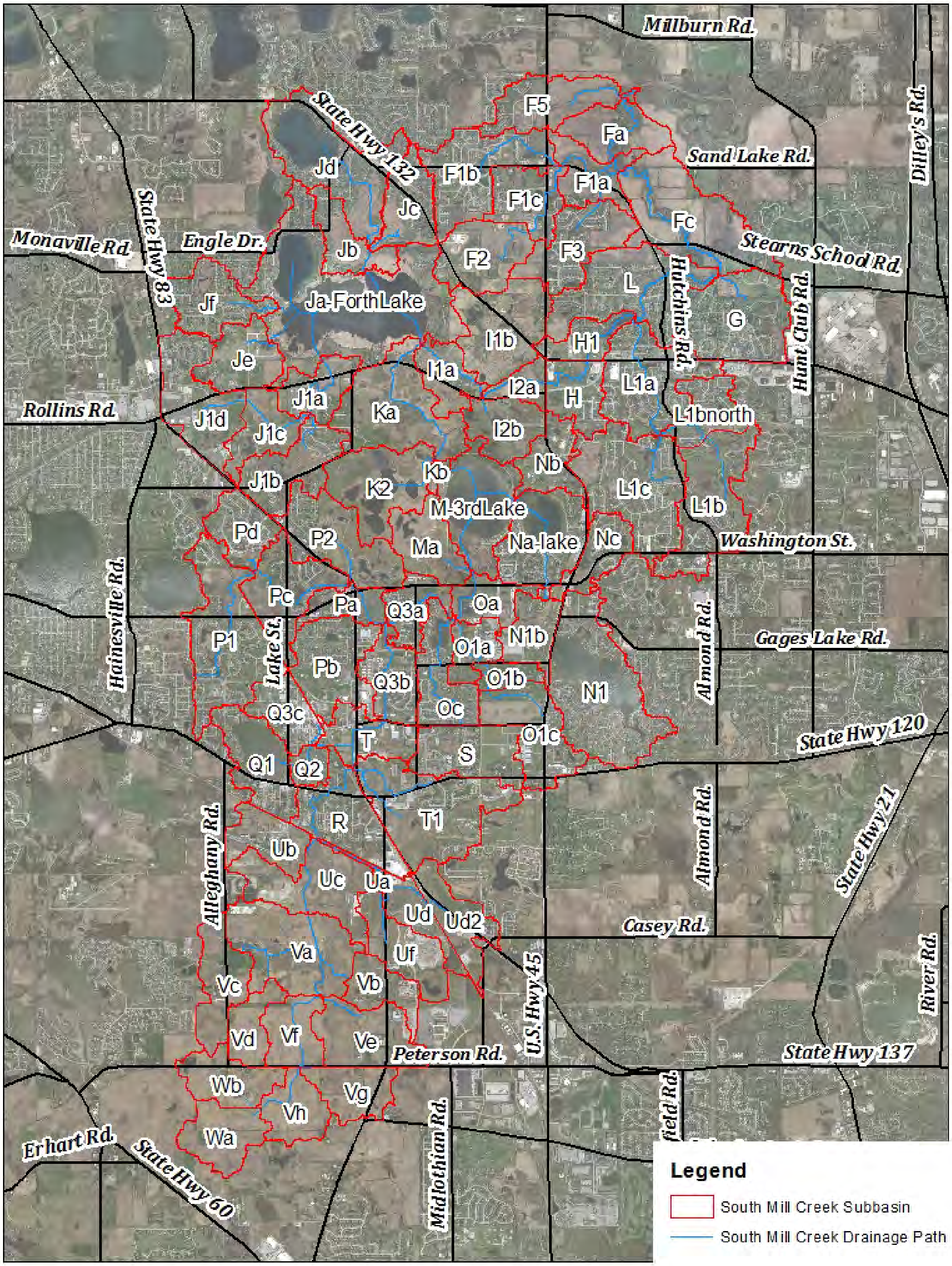


Figure 4. Mill Creek Watershed subbasins and drainage network

3.2.3.3 Land Use, Soil Classification, and Composite Curve Number

Land Use

Land use has a significant effect on basin hydrology, affecting the volume of runoff produced by a given area and the speed of runoff delivered to the receiving system. Impervious areas restrict infiltration and produce more runoff, which is often delivered to receiving systems more rapidly through storm sewer networks. Land use was one of two principal inputs into the calculation of Curve Number (CN) for the Mill Creek Watershed. The 2005 Lake County Land Use Inventory provided by Lake County Planning and Support Services with adjustments for recent development was used to define land use. The data was used to characterize existing conditions land use within Lake County.

The Mill Creek watershed is highly developed with some agricultural lands in the headwaters. Figure 5 shows the distribution of general land use categories throughout the watershed.

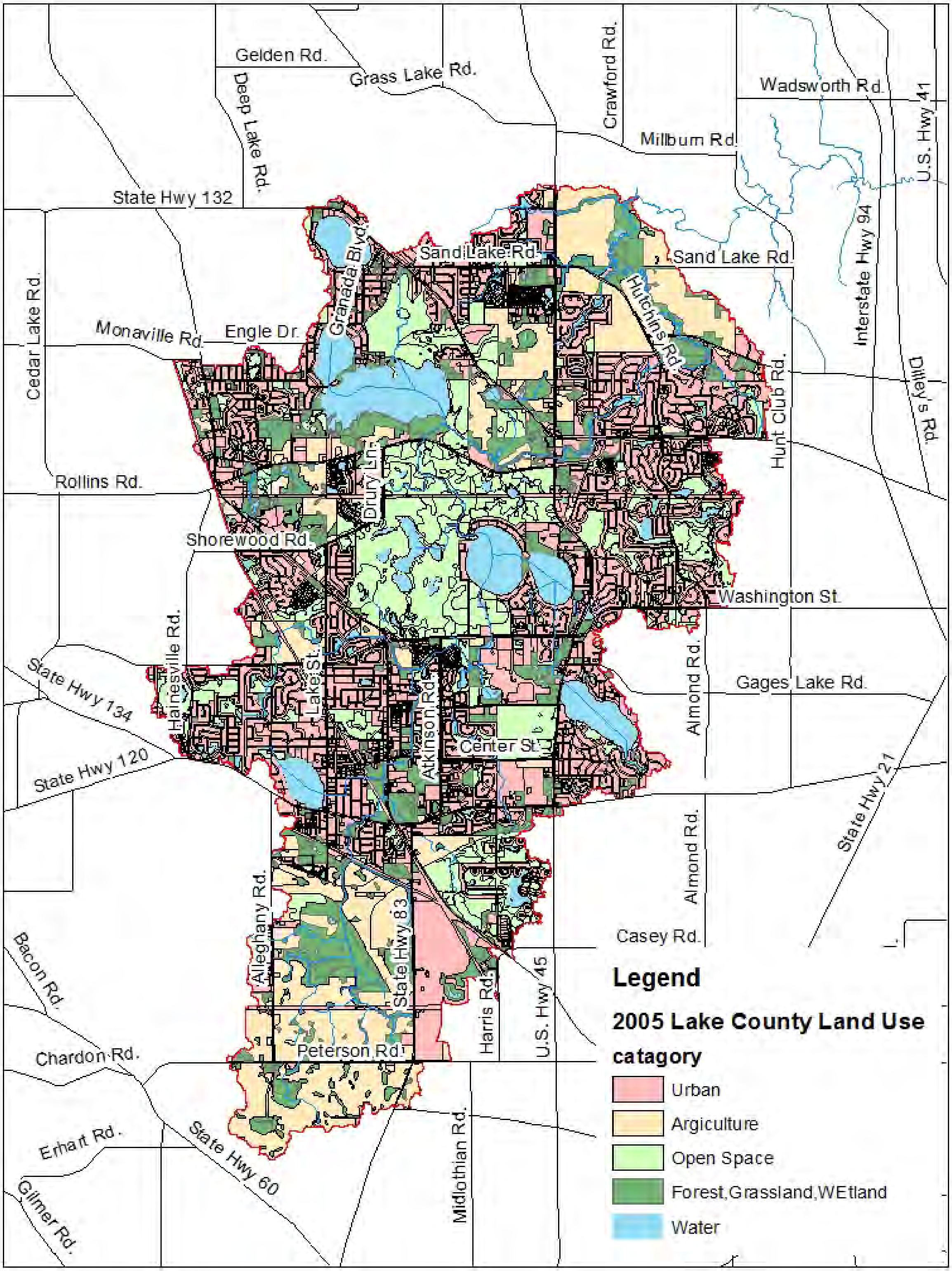


Figure 5. Mill Creek Watershed land use map

Soil Classifications

The 2007 U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) soil data was obtained for Lake County. The NRCS soil data includes hydrologic soil group, representing the minimum infiltration rate of the soil after wetting. Table 4 summarizes the hydrologic soil groups.

Table 4. Hydrologic soil groups

Hydrologic Soil Group	*Description*	*Texture*	*Infiltration Rates (in/hr)*
A	Low runoff potential and high infiltration rates even when wetted	Sand, loamy sand, or sandy loam	>0.30
B	Moderate infiltration rates when wetted	Silt loam or loam	0.15-0.30
C	Low infiltration rates when wetted	Sandy clay loam	0.05-0.15
D	High runoff potential and very low infiltration when wetted	Clay loam, silty clay loam, sandy clay, silty clay or clay	0-0.05
All data from *Technical Release 55, Urban Hydrology for Small Watersheds* (USDA, 1986)			

The majority of the drainage area has soils in the "B" hydrologic group (see Figure 6). Soil groups with drainage characteristics affected by a high water table are indicated with a "/D" designation, where the letter preceding the slash indicates the hydrologic group of the soil under drained conditions.

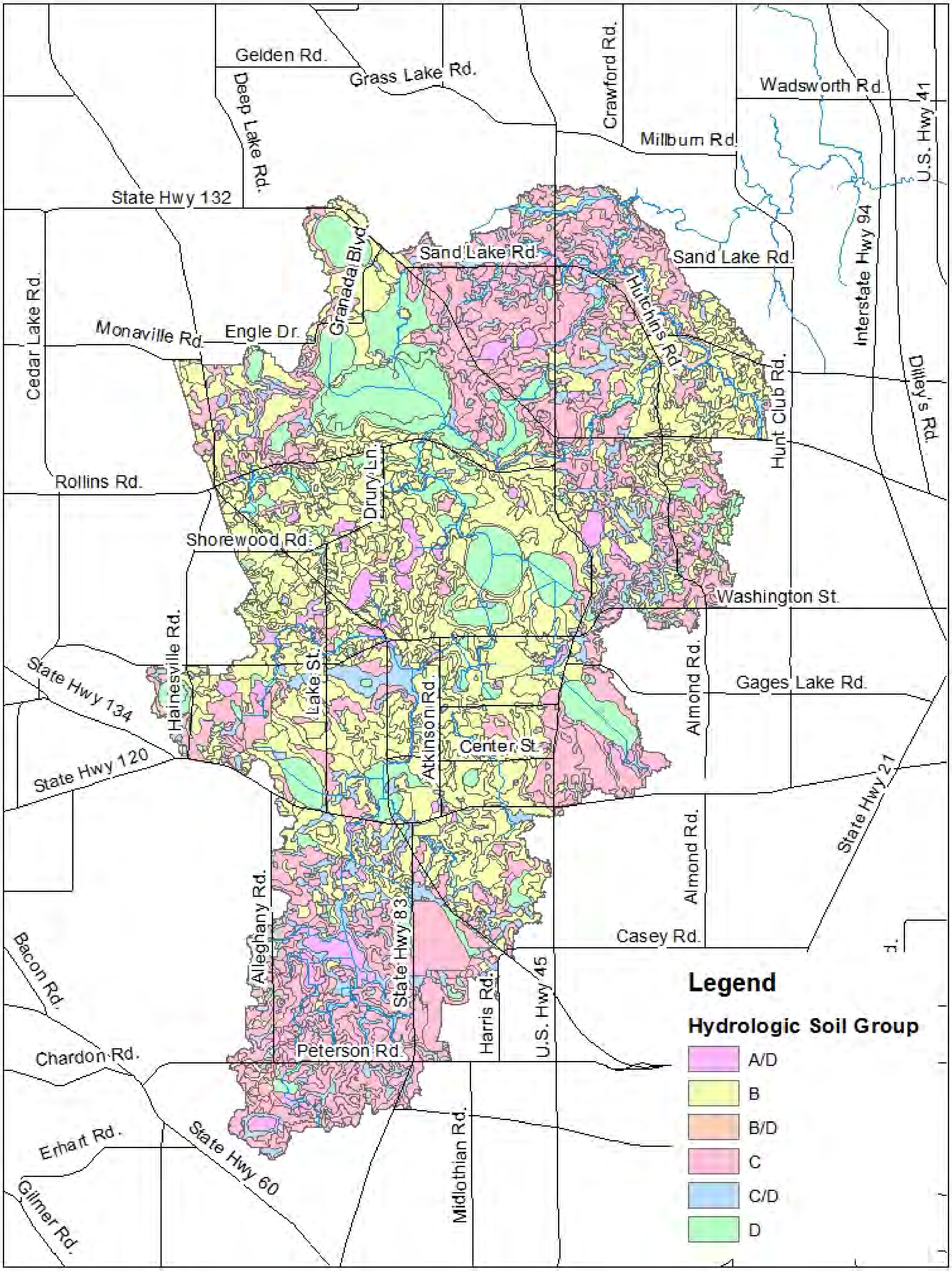


Figure 6. Mill Creek Watershed hydrologic soil groups

Curve Number

Specific combinations of land use and soil type were linked to CN values using a lookup table in Appendix N. CN values were based on land use descriptions and corresponding CN values from *TR-55: Urban Hydrology for Small Watersheds* (USDA, 1986).

The CN matrix includes assumptions about the imperviousness of land use classes, and therefore, percent impervious does not need to be explicitly considered as the SCS runoff volume calculation. However, imperviousness was estimated based on the land use inventory for determination of rural/urban ratios for regression equation adjustments.

A GIS raster file was created for Lake County to digitize the CN values for use in HEC-GeoHMS. Figure 7 shows the distribution of CN values throughout the watershed.

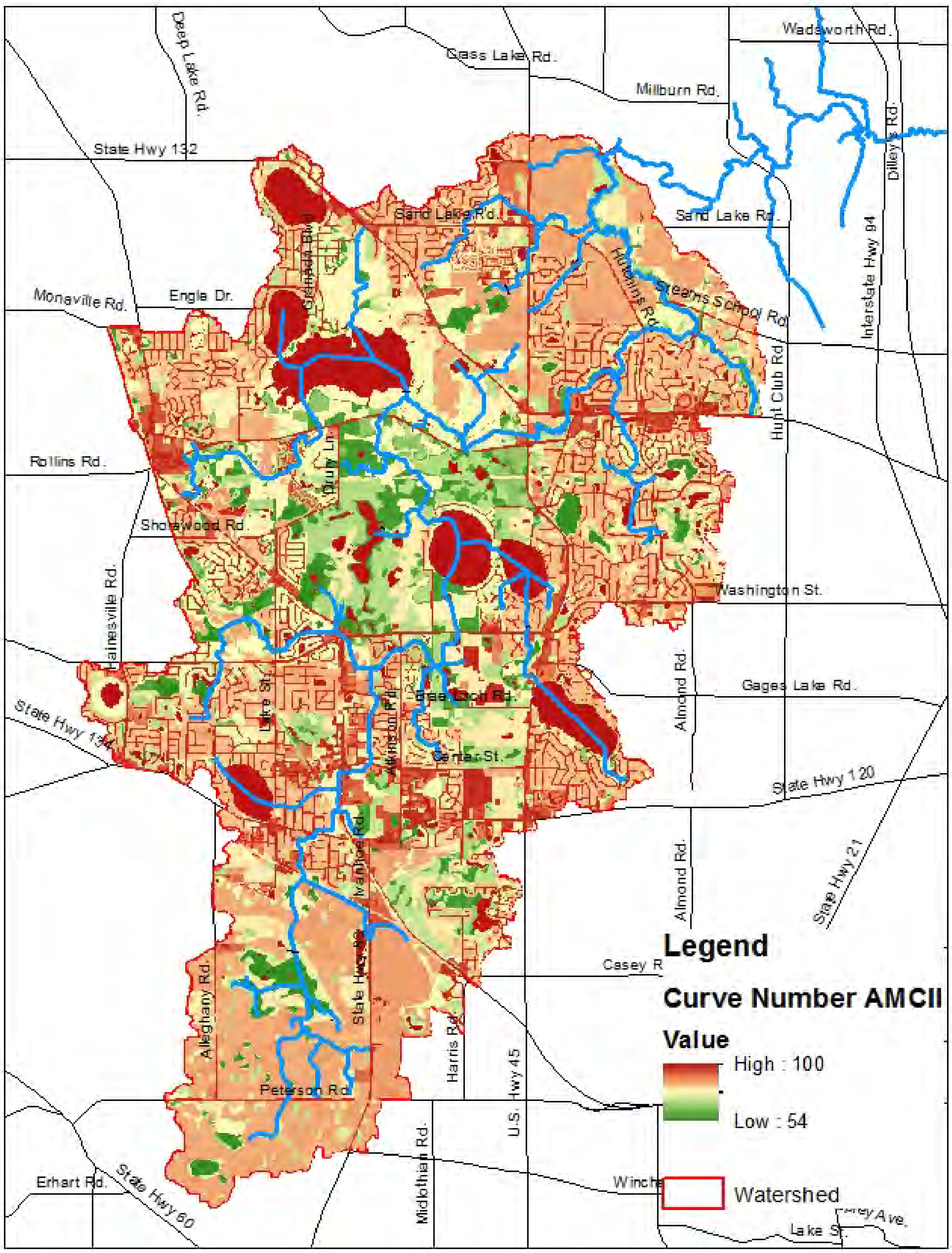


Figure 7. Mill Creek Watershed CN Values

3.2.3.4 Runoff volume calculation

The SCS CN loss model uses the empirical CN parameter to calculate runoff volumes based on landscape characteristics such as soil type, land cover, imperviousness, and land use development. Areas characterized by saturated or poorly infiltrating soils, or impervious development, have higher CN values, converting a greater portion of rainfall volume into runoff. The SCS methodology uses Equation 2 to compute stormwater runoff volume for each time step:

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Equation 2

Where:
Q = runoff volume (in.)
P = precipitation (in.)
S = storage coefficient (in.)
I_a = initial abstractions (in.)

Rainfall abstractions due to ponding and evapotranspiration can be simulated using an initial abstractions I_a parameter. The commonly used default value of I_a is estimated as 0.2 × S, where S is the storage coefficient for soil in the subbasin. S is related to CN through Equation 3:

$$S = \frac{1000}{CN} - 10$$

Equation 3

Where:
CN = curve number (dimensionless)
S = storage coefficient (in.)

Table 5 describes the input data used to develop the CN values throughout the watershed.

Table 5. Summary of curve number input Data

Variable Used to Determine CN	*Approach and Data Source of Variable for Mill Creek Subwatershed Hydrologic Modeling*
Ground cover	The 2005 Lake County Land Use\Land Cover Inventory was used to define land use. A lookup table was developed to link Land Use categories to estimated CN values. The 2005 Land Cover inventory was reviewed and updated based on known recent development.
Soil type	The Natural Resources Conservation Service (NRCS) publishes county soil surveys that include a hydrologic classification of A, B, C, or D. If a soil group's infiltration capacity is affected by a high water table, it is classified as, for instance, "A/D," meaning the drained soil has "A" infiltration characteristics, undrained "D." It was assumed that half of these soil groups (by area) are drained.
Antecedent moisture condition	Antecedent Moisture Conditions (AMC) reflect the initial soil storage capacity available for rainfall. For areas within Northeastern Illinois, it is typical to assume an AMC of II.

3.2.3.5 Runoff Hydrograph

The runoff volume produced for a subbasin is converted into a basin-specific hydrograph by using a synthetic unit hydrograph. A synthetic unit hydrograph relates the parameters of parametric unit hydrograph model to specific watershed characteristics. The Clark Unit Hydrograph method (Clark, 1945) is used for the Mill Creek subbasins.

The Clark method for developing a unit hydrograph is based on the concept of routing a time-area relationship though a linear reservoir. The two critical processes in the transformation of excess precipitation to runoff explicitly represented in this method are: 1) the movement of excess water from its origin throughout the drainage area to the watershed outlet and 2) the reduction of the magnitude of the discharge as the excess water is stored throughout the watershed.

Short-term storage of water throughout the watershed (in soil, on the surface, and in the channels) plays an important role in the transformation of precipitation excess to runoff. The linear reservoir model is a representation of the effects of this storage. HEC-HMS Technical Reference Manual (USACE, 2000) provides the continuity equation:

$$\frac{dS}{dt} = I_t - O_t$$

Equation 4

Where:
$\frac{dS}{dt}$ = time rate of change of water in storage at time *t*
I_t = average inflow to storage at time *t*
O_t = average outflow from storage at time *t*

With the linear reservoir model, storage at time *t* is related to outflow as:

$$S_t = RO_t$$

Equation 5

Where:
R = a constant linear reservoir parameter

Combining and solving Equation and Equation using a simple finite approximation yields:

$$O_t = C_A I_t - C_B O_{t-1}$$

Equation 6

Where:
C_A, C_B = routing coefficients

The routing coefficients are calculated from:

$$C_A = \frac{\Delta t}{R + 0.5\Delta t}$$

Equation 7

$$C_B = 1 - C_A$$

Equation 8

Where:
Δt = the computation time step

With Clark's model, the linear reservoir represents the aggregated impacts of all watershed storage. Thus, conceptually, the reservoir(s) may be considered to be located at each subbasin outlet or at the watershed outlet.

In addition to the lumped model of storage, the Clark model accounts for the time required for water to move to the watershed outlet (or subbasin outlets) with a linear channel model. This model routes water from remotes points to the linear reservoir with delay but without attenuation. This delay is represented implicitly with a time-area histogram. The histogram specifies the watershed area contribution to flow at the outlet as a function of time. If the area is multiplied by the unit depth and divided by the computation time step, the result is inflow (I_t) to the linear reservoir.

Clark parameter determination was based on "Equations for Estimating Synthetic Unit-Hydrograph Parameter Values for Small Watersheds in Lake County, Illinois" (USGS, 1996). The area-based equations were used. The Lake County Clark parameter equations are based on the depth of effective precipitation which varies based on the total rainfall and AMC for each rainfall event. Appendix O (Subbasin Parameters) includes a table of subbasin parameters used in the HEC-HMS model and lists the Clark coefficients for each subbasin for the 1-percent-annual-chance event with a 24-hour duration.

3.2.3.6 Runoff Routing

The runoff hydrographs calculated upstream of each reach of Mill Creek are routed downstream within HEC-HMS using a channel routing method. For Mill Creek, the channel routing methods include the Muskingham Cunge method, and the Modified Puls method.

Muskingum-Cunge routing is based on the assumption that the storage volume in a stream reach at an instant in time is a linear function of weighted inflow and outflow. The Muskingum-Cunge routing equation is:

$$O_t = C_1 I_{t-1} + C_2 I_t + C_3 O_{t-1} + C_4 (q_L \Delta x)$$

Equation 9

Where:
O_t, O_{t-1}= outflow hydrograph ordinates at time *t* and *t*-1
I_t, I_{t-1}= inflow hydrograph ordinates at time *t* and *t*-1
q_L = lateral inflow
Δx = the computation distance step
C_1, C_2, C_3, and C_4= coefficients

The Coefficients are:

$$C_1 = \frac{\frac{\Delta t}{K} + 2X}{\frac{\Delta t}{K} + 2(1 - X)}$$

Equation 10

$$C_2 = \frac{\frac{\Delta t}{K} - 2X}{\frac{\Delta t}{K} + 2(1 - X)}$$

Equation 11

$$C_3 = \frac{2(1 - X) - \frac{\Delta t}{K}}{\frac{\Delta t}{K} + 2(1 - X)}$$

Equation 12

$$C_4 = \frac{2\left(\frac{\Delta t}{K}\right)}{\frac{\Delta t}{K} + 2(1 - X)}$$

Equation 13

Where parameters *K* and *X* are:

$$K = \frac{\Delta x}{c}$$

Equation 14

$$X = \frac{1}{2}\left(1 - \frac{Q}{B S_o c \Delta x}\right)$$

Equation 15

Where:
Q = flow
B = top width of water surface
S_o = channel slope
c = wave celerity (speed)

Channel characteristics such as channel shape, reach length, roughness coefficient(s), and energy grade must be specified. HEC-GeoHMS calculates reach lengths and estimates energy slopes as computed reach slopes for input for HEC-HMS. Channel shape and roughness were determined from a combination of aerial imagery, survey data, and site photos. In the absence of better information, the shapes of some upstream reaches were approximated as small trapezoidal channels.

Modified Puls routing was selected as the channel routing methodology for reaches of Mill Creek where the floodplain storage is not uniform through the reach, using the uniform method used by the Muskinghum-Cunge methodology. The Modified Puls model is a good method for incorporating backwater effects and floodplain storage in the HEC-HMS model. Reaches where the Modified Puls method was used include the reach upstream of the Metra railroad crossing, upstream of the railroad, Center Street, the confluence with the Chesapeake Farm Tributary, Washington Street, the Fourth Lake outlet, and upstream of Route 45.

The Modified Puls method is based on the continuity equation, assuming no lateral change in flow, and with a finite difference approximation:

$I_t – O_t = S_t / \Delta t$
Where:
I = Average Inflow
O = Average Outflow
S= Storage
t = time step

The Modified Puls routing method calculates the attenuated discharge based on the input discharge-storage rating curve. For each discharge value, the difference in the total storage along the reach is computed to complete a discharge-storage rating curve. The rating curve input into the HEC-HMS model is determined using the hydraulic model completed with this analysis.

3.2.3.5 Storage Areas

Additional lake and other depression storage areas were modeled with reservoir routing in the HEC-HMS analysis. Several reservoir basins and rating curves have been based on the twelve reservoirs included in the 2008 HEC-1 hydrologic analysis which utilized available permit data from Lake County. The storage areas included in the previous analysis include Gray's Lake, Willow Lake, Gages Lake, Third and Druce Lakes, Forth Lakes, Deerpath Lake and depressional-wetland areas in subbasin V, the Forest Preserve, Rollins Savanna. Additional storage areas were added with this analysis using outlet structures based on permit data or cross section data based on the 2007 LiDAR topography (Lake County, 2011). These areas include the Countryside Landfill development, Metro Station development, Chesapeake Farm Lake, Bittersweet Golf Course Lakes, wetland areas southwest of Washington and Rt 45, and depressional storage areas along the Mill Creek floodplain. Figure 8 indicates the locations of the lakes and depressional storage areas model with reservoir routing in this analysis.

Third, Druce and Fourth Lakes have the largest impact to peak discharge values along Mill Creek. The Third Lake and Druce Lake HMS reservoir elements were updated using the hydraulic model and 2007 LiDAR (Lake County, 2011) topography as the source for the elevation-discharge-storage relationship. The two lakes were modeled as a single reservoir. Fourth Lake was added to the hydrologic model as it was previously included in the hydraulic model. Fourth Lake has been modeled as a reservoir in-line with Mill Creek based on the large low-lying connection between the lake and Mill Creek and verified based on calibration. The same elevation discharge rating curve used in the 2008 HEC-1 analysis was used for Fourth Lake, but the elevation storage relationship was updated with the 2007 LiDAR data for this analysis.

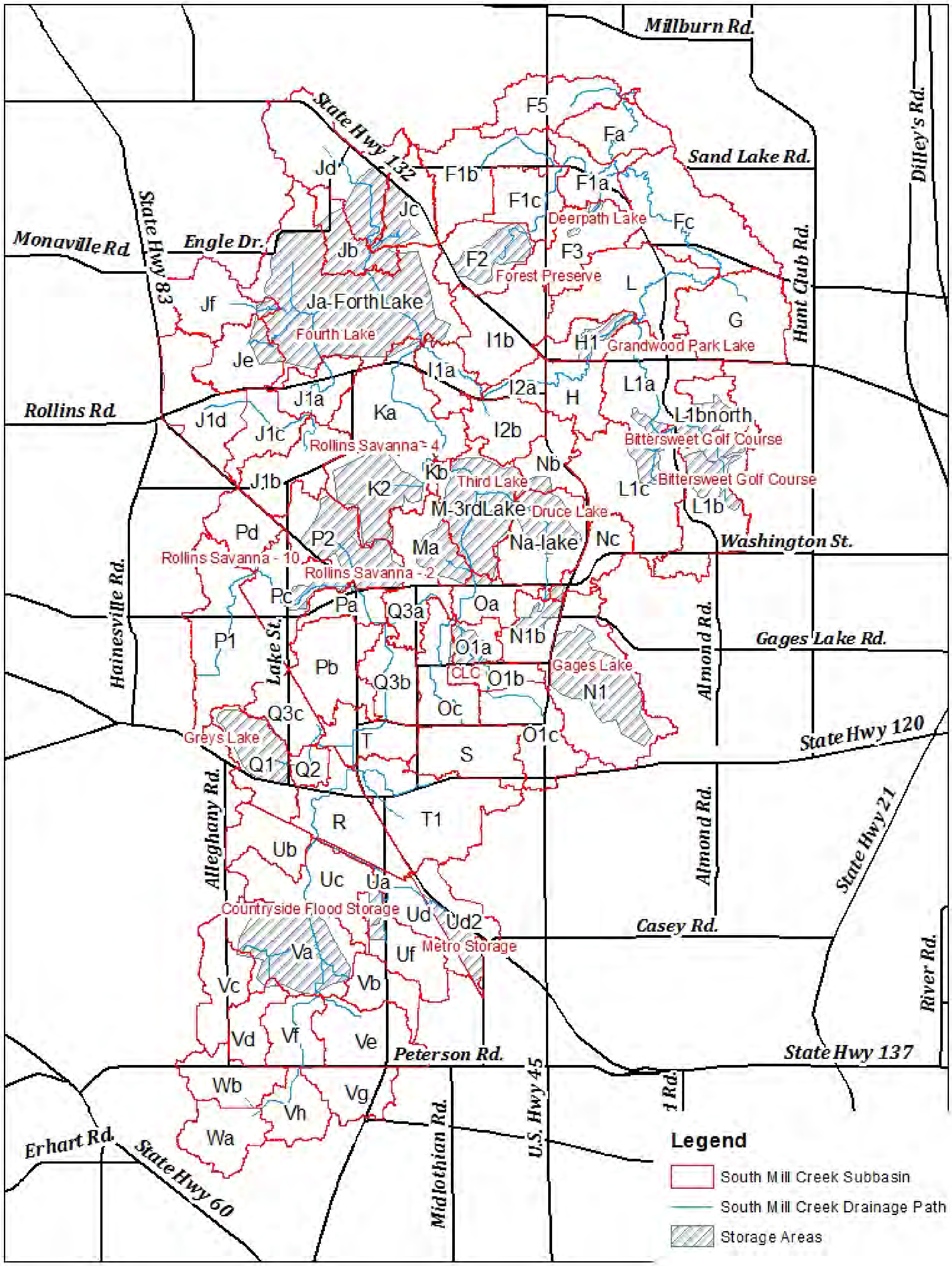


Figure 8. Lakes and depressional storage areas

Twenty-two storage areas were modeled as reservoirs in the HEC-HMS analysis.

3.2.3.6 Baseflow Conditions

Baseflow conditions for the calibration, verification and frequency analysis events were based on the North Mill Creek and Mill Creek stream gage data. For specific events the difference of the flow immediately prior to the storm event at each gage was divided evenly over the watershed area. For the frequency events, the average monthly flow was reviewed at each gage. A total discharge of 75 cfs was evenly distributed over the watershed for the base flow conditions for frequency events.

3.2.3.7 Model Overview

Figure 9 shows the schematic of the HEC-HMS rainfall runoff model for the reach of Mill Creek upstream of the North Mill Creek confluence. HMS subbasin names agree with the subbasin naming discussed previously. Reach names are based on the subbasin the reach runs through preceded by "R_". Appendix C – Hydrologic Workmap shows the drainage paths, subbasin delineation and storage areas.

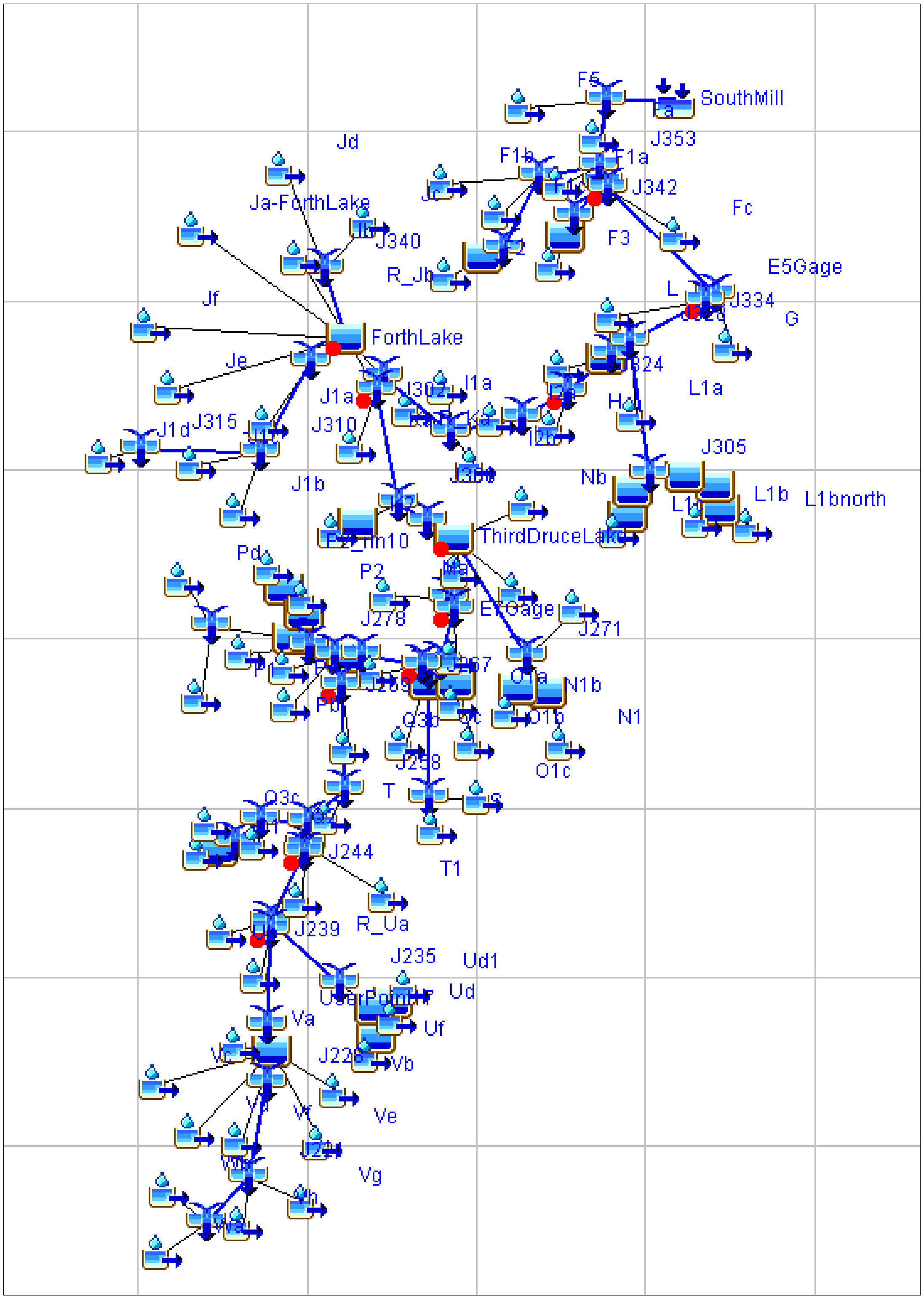


Figure 9. Schematic of the HMS Model for Mill Creek

3.3 Hydraulic Model

Hydraulic models were developed within the Hydrologic Engineering Center-River Analysis System (HEC-RAS) Version 4.1.0. The steady flow routing methodology was used within HEC-RAS.

3.3.1 Cross-sections and Hydraulic Structures

Cross section locations were developed in HEC-GeoRAS v3.1.1 (USACE, 2002). Main channel cross section data was used from two sources: 1) from the original field survey points collected for the original Tetra-Tech Study; and 2) new channel section data acquired through field survey by Thomson Surveying November 2013 (Thomson Surveying, 2013). The surveyed channel geometry was inserted into topographically generated cross-sectional data generated by using HEC-GeoRAS v3.1.1 (USACE, 2002) and a digital terrain model (DTM) based on the 2007 Countywide 2007 LiDAR topography (Lake County, 2011).

The culvert replacement project at Old Center Street was incorporated into the HEC-RAS model. Additional field survey data was performed by Thomson Surveying, Ltd for this project to include new structures, which were not present at the time of the original field survey. Additional cross sections were also surveyed for this project. Cross sections are surveyed consistent with the North American Vertical Datum, 1988 (NAVD 1988). In a few cases, information from construction plans was used to supplement survey data. Ineffective flow areas were placed at cross sections upstream and downstream of crossings, generally assuming a contraction ratio of 1:1 and an expansion ratio of 2:1. Contraction and expansion coefficients generally were increased to 0.3 and 0.5, respectively, at cross sections adjacent to structures.

3.3.2 Channel Roughness

Channel and overbank roughness characteristics were determined from photographs taken during the field surveys. The photographs were combined with information from aerial photography to assign modeled Manning's 'n' roughness coefficients along the modeled stream length. Chow (1959) was used to determine the proper Manning's coefficients for each stream channel and overbank area.

3.3.3 Discharge Input and Boundary Conditions

Steady state peak flow data was obtained from either the HEC-HMS hydrologic model or from statistical analysis on gage data as described in Section 3.2.

The 20-percent-annual-chance Des Plaines River water surface elevation of 665.79 feet (NAVD 88) was used as the downstream boundary condition for all flood events, as requested by the USACE according to the Des Plaines River Phase II study.

3.3.4 Baseflow Conditions

Baseflow conditions for the calibration, verification and frequency analysis events were based on the North Mill Creek and Mill Creek stream gage data. For specific events the difference of the flow immediately prior to the storm event at each gage was divided evenly over the watershed area. For the frequency events, the average monthly flow was reviewed at each gage. A total discharge of 75 cfs was evenly distributed over the watershed for the base flow conditions for frequency events.

3.3.5 Model Overview

Figure 10 is a schematic of the HEC-RAS model for Mill Creek. The stream channel contains 28 culverts, 15 bridges, and 4 dams. A lateral weir was added to capture the overflow of Washington Street between cross sections 80387 and 80175. After overtopping Washington Street and leaving the Mill Creek main stem system, the overflow travels northeast where it re-enters the Mill Creek main stem system downstream of Washington Street. The lateral weir is approximately 1,200 feet in length and its alignment is located as the higher ground on the north side of Washington Street. The studied stream length for Mill Creek is approximately 19 miles. Appendix D and Appendix E include the HEC-RAS data files and HEC-RAS data file name key.

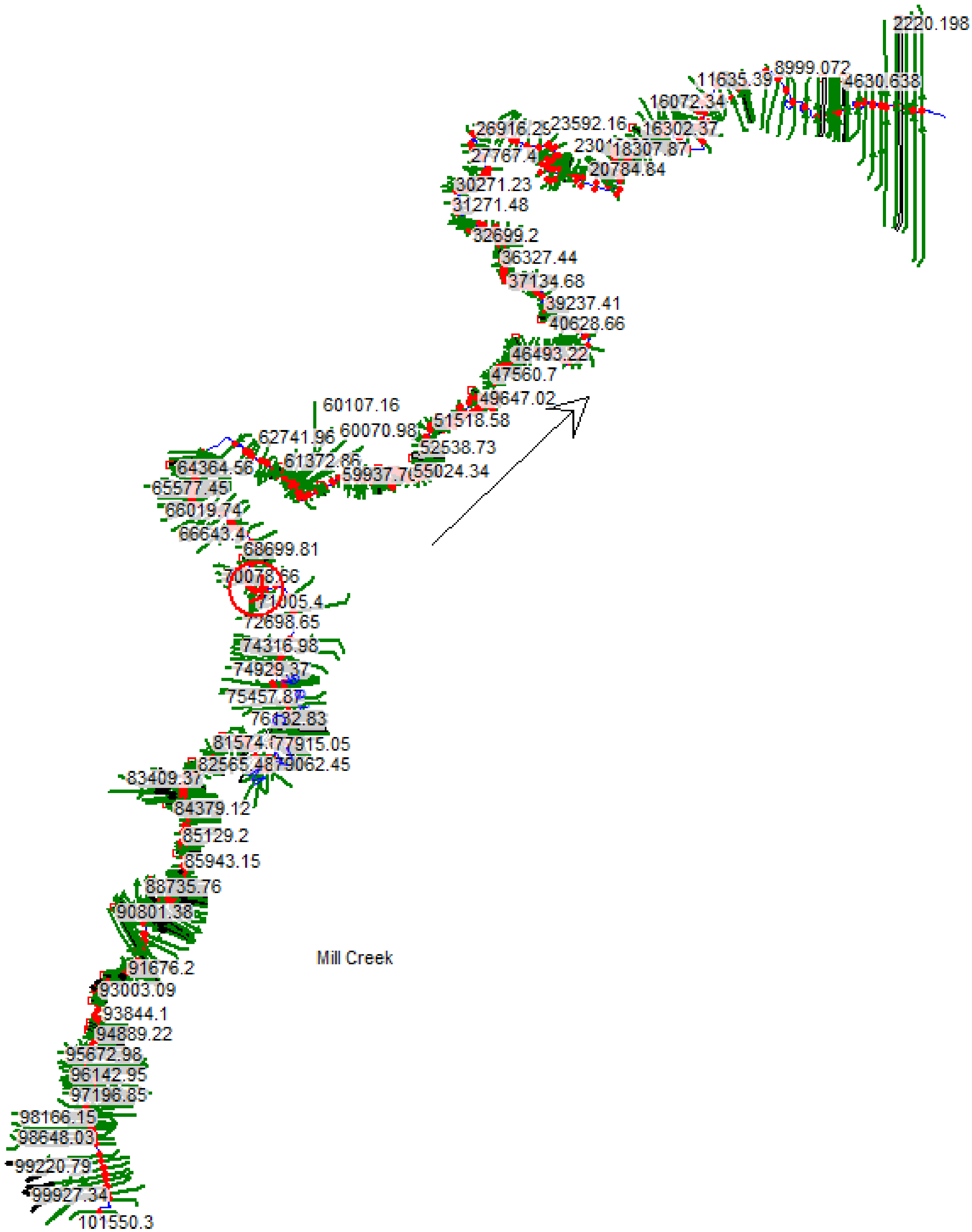


Figure 10. Schematic of HEC-RAS model for Mill Creek Watershed

SECTION 4.0
ANALYSIS

4.1 Hydrologic Analysis

Model calibration and verification for the HEC-HMS model upstream of the North Mill Creek confluence was based on available stream gage data. Recent large rainfall events in April 2013, June 2009 and June 2008 were identified as appropriate for flood event calibration. Once the rainfall runoff model was calibrated, a critical duration analysis was completed to determine the appropriate design event for floodplain analysis.

The resulting proposed 1-percent-annual-chance discharges generated for Mill Creek using regression equations, statistical analysis and/or HEC-HMS results were compared with discharge data from the effective FIS and/or gaging stations when available. Such comparisons were used to provide further analysis of the proposed peak discharge values analysis.

4.1.1 Calibration and Verification

Calibration of the HEC-HMS rainfall runoff model was completed using the June 2009 event. The 2009 event is the second largest event recorded at the USGS Mill Creek stream gage at Old Mill Creek. Based on the statistical frequency analysis at the Old Mill Creek stream gage, the June 2009 event is estimated to have between a 4- to 2-percent-annual-chance exceedance, or 25-50 year event. Data was also recorded at the USGS gage North Mill Creek near Milburn providing hydrograph input on North Mill Creek. The HEC-HMS model was extended to include the watershed downstream of the North Mill Creek stream gage and upstream of the Mill Creek at Old Mill Creek for calibration events.

The Lake County stage gage at College of Lake County, gage E-7, provided a calibration point within the watershed.

Rainfall data used in the rainfall runoff model included USGS gages at Des Plaines River near Gurnee and near Des Plaines, and daily gage data from the Third Lake, Lake Villa, Gurnee and Round Lake locations. Figure 11 summarizes the rainfall at each gage location.

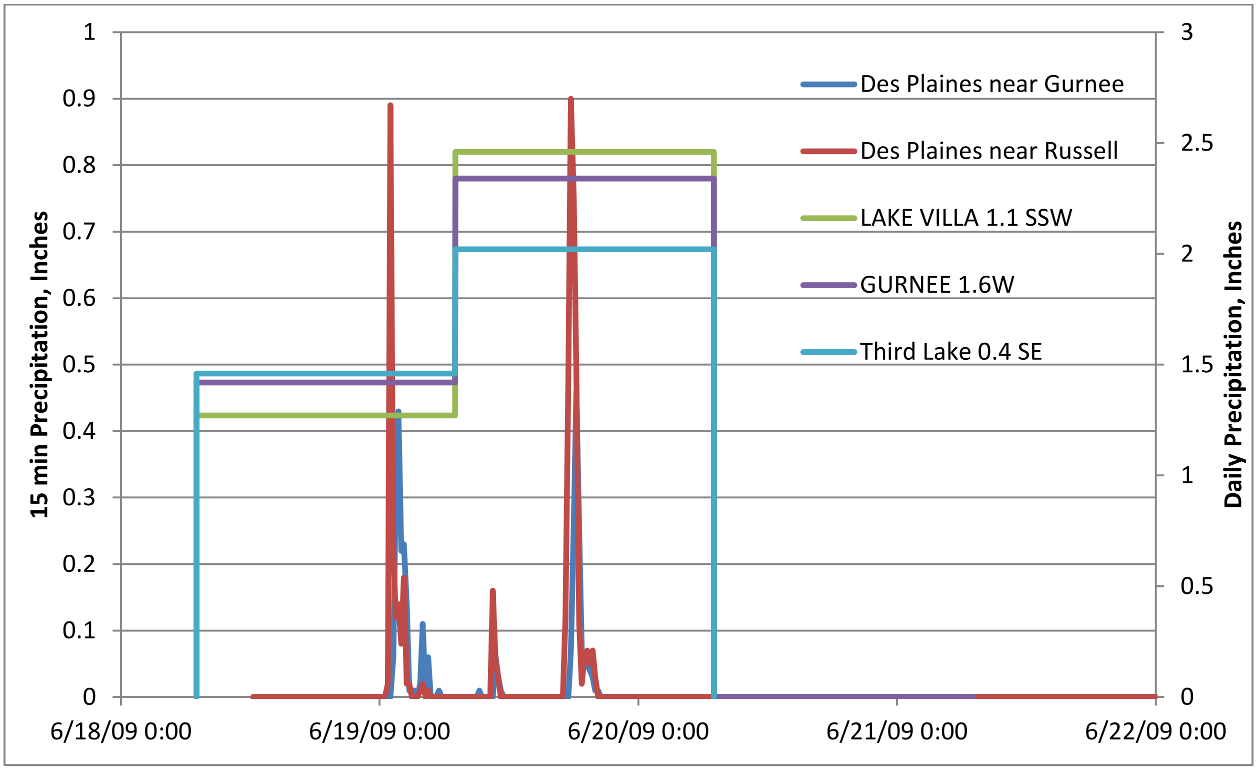


Figure 11. Rainfall hyetograph for June 2009 calibration event

During the five days prior to the rainfall event, 0.5-1.3” of rainfall were recorded at rain gages near the watershed. An antecedent moisture condition representing slightly dry conditions between the I and II conditions was used to determine curve numbers for the calibration of the model. The Clark transformation parameters were adjusted for a total event rainfall of 3.8”.

The resulting hydrographs for the watershed for the June 2009 event are shown in Figure 12. The peak discharge calculated at the Old Mill Creek gage was 1651cfs compared to the observed 1730 cfs, a difference of approximately 5%. The total volume calculated is approximately 2.5% less than the observed for the hydrograph from June 18, 2009 12:00 to June 27, 2009 00:00.

The time to peak discharge is computed to be 1 hour and 45 minutes after the observed peak discharge. Based on the observed gage data, the North Mill Creek peak discharge is approximately 32% of the observed peak discharge at Old Mill Creek stream gage.

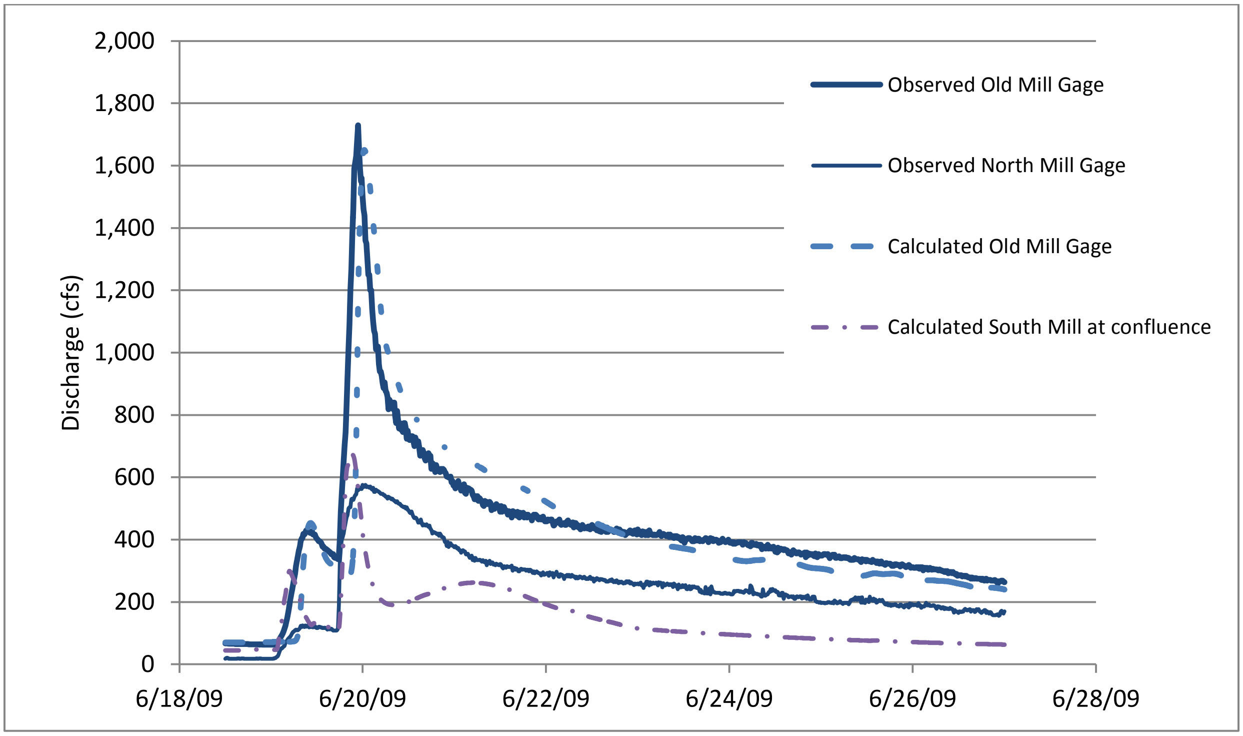


Figure 12. Rainfall hydrograph for June 2009 calibration event

The upstream reach of the watershed was evaluated based on the comparison of the timing of the discharge hydrograph from the HEC-HMS model and the Lake County E7 stage gage located near the College of Lake County at Washington Street. A comparison of the stage and discharge hydrographs is in Figure 13.

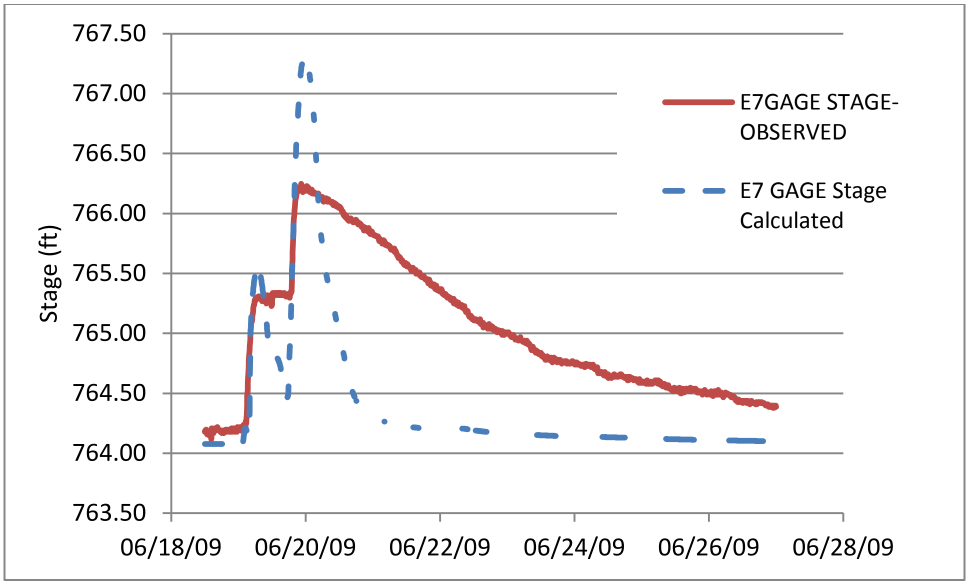


Figure 13. Rainfall hydrograph output from HEC-HMS and stage hydrograph from Lake County E7 stream gage for June 2009 calibration event

Further event verification was completed using the April 2013 and June 2008 events. The April 2013 event was chosen as it is the largest event on record at the Old Mill Creek discharge gage. Figure 14 below provides observed and computed hydrographs at Old Mill Creek for each event.

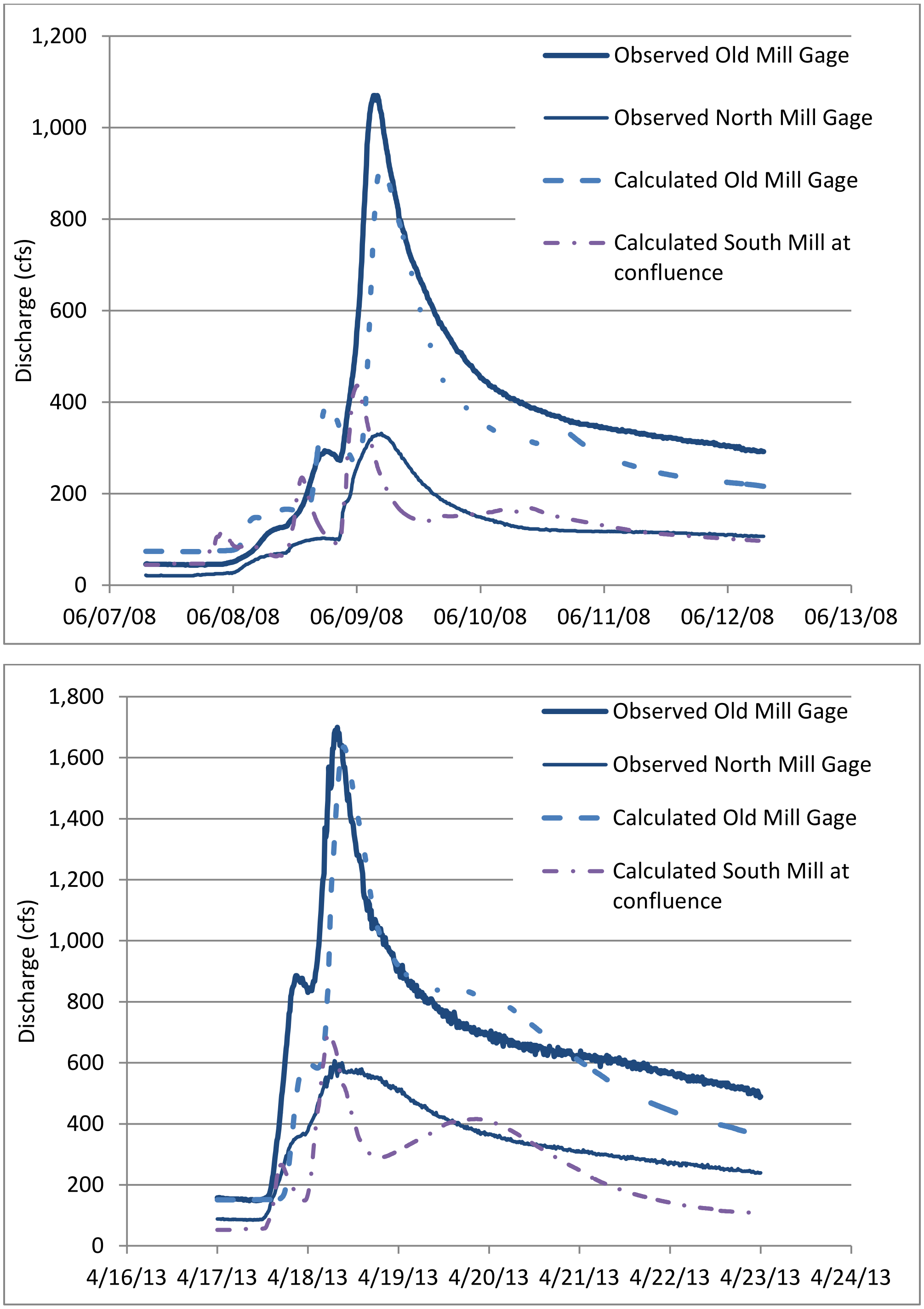


Figure 14. Observed and computed hydrographs at Old Mill Creek.

4.1.2 Critical Duration Analysis

A critical-duration analysis was performed to determine the storm duration that generally results in higher design peak flow rates for Mill Creek upstream of the confluence of North Mill Creek. A 100-year storm recurrence interval was analyzed with a range of storm durations to determine estimated flow rates in HEC-HMS. Locations for comparison were chosen from the far upstream end, the downstream end, and mid-stream; these locations are also denoted by HEC-HMS element names. The results for Mill Creek are summarized in Table 6. Hydrographs along the reach for the 24 hour 1% frequency are shown in Figure 15.

Table 6. Mill Creek critical duration analysis

Location	HMS Node	Point discharge rainfall			
		Drainage Area (sq mi)	Design Event	Rainfall inches	Peak Discharge (cfs)
State Hwy 137	J244		1% 18hr	6.11	375
			1% 24hr	6.5	396
			1% 48hr	**7.02**	**401**
			1% 72hr	7.54	390
Upstream of Chesapeak Farm Tributary	J259	6.79	1% 18hr	6.11	390
			1% 24hr	6.5	404
			1% 48hr	**7.02**	**412**
			1% 72hr	7.54	417
			1% 120hr	8.52	417
			1% 12hr	5.66	868
At Washington/E7 gage (US Third Lake	E7 gage	10.3	1% 18hr	6.11	840
			1% 24hr	6.5	865
			1% 48hr	**7.02**	**831**
			1% 72hr	7.54	799
US Forth Lake	J302	13.9	1% 18hr	6.11	636
			1% 24hr	6.5	655
			1% 48hr	7.02	663
			1% 72hr	7.54	673
			1% 120hr	**8.52**	**686**
			1% 240hr	9.56	643
At State Hwy 132- US Grandwood	J324	19.7	1% 18hr	6.11	584
			1% 24hr	6.5	611
			1% 48hr	7.02	633
			1% 72hr	7.54	652
			1% 120hr	**8.52**	**709**
			1% 240hr	9.56	713
E5 gage	E5Gage	22.8	1% 12hr	5.66	868
			1% 18hr	**6.11**	**891**
			1% 24hr	6.5	837
			1% 48hr	7.02	813
			1% 72hr	7.54	779
At confluence with North Mill	South Mill	25.8	1% 12hr	5.66	1541
			1% 18hr	**6.11**	**1628**
			1% 24hr	6.5	1533
			1% 48hr	7.02	1351

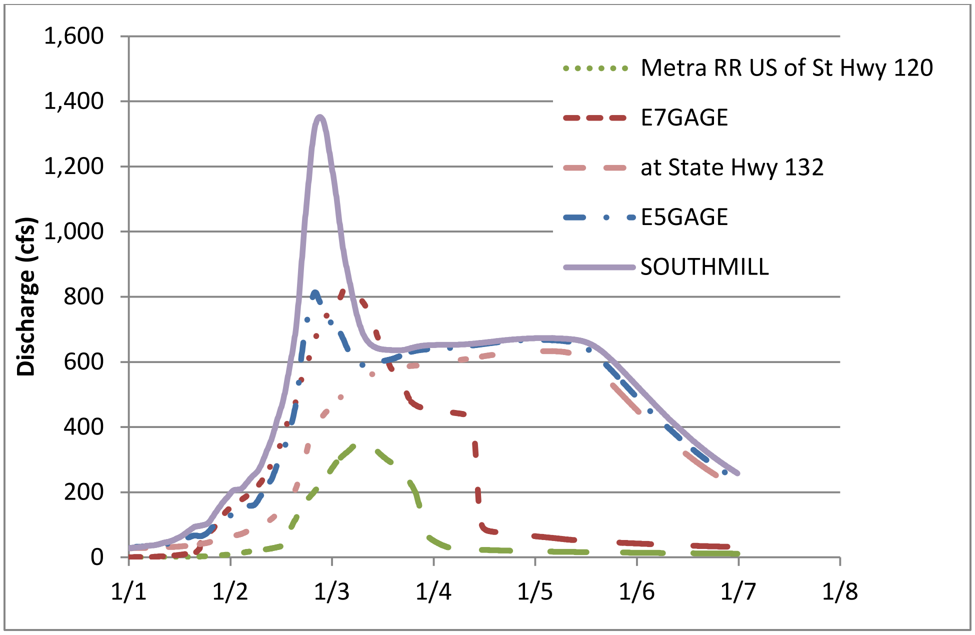


Figure15. HEC-HMS output model hydrographs for the Mill Creek Watershed 48 hour 1% annual chance critical duration analysis.

Due to the online reservoirs on Mill Creek, the critical duration varies between upstream of Third and Fourth Lake, immediately downstream of Third and Fourth Lake and the reach downstream of Grandwood Park Lake, where the peak discharge is based on the tributaries that are not routed through the storage areas. If no single storm can be identified as a critical duration for every location in the watershed it is desirable and common practice to select one duration storm event for appropriate reaches to use for comprehensive watershed planning efforts. The results of the Mill Creek analysis support selecting the 48-hour duration storm for the reach upstream of Washington Street. The 120 hour duration event will be used for the reaches just downstream of Third and Fourth Lakes. The 18 hour duration was selected for the reach downstream of Hutchins Road.

The impact of areal reduction factors on the total design rainfall was also considered where the total drainage area approached 25 square miles. However, because the hydrograph resulting in the peak discharge value is a result of the downstream tributaries, with drainage areas much smaller than the full watershed, the aerial reduction factor was not applied.

4.1.3 Peak Flow Analysis

The resulting proposed 1-percent-annual-chance discharges base the HEC-HMS model and statistical frequency analysis were plotted and compared for several locations (and therefore drainage areas) along Mill Creek. The proposed values are compared to the peak discharges values available from the Effective FIS as shown in Figure 16. The effective hydrologic peak discharge values for Mill Creek and North Mill Creek were determined using a SCS TR-20 model. Table 7 contains a list of the proposed peak discharge values for the 1% annual chance event.

The proposed discharge values on Mill Creek downstream of North Mill Creek are significantly lower than previously effective analysis downstream of North Mill Creek. Per FEMA's Guidelines and specification, statistical analysis is the most accurate methodology for peak discharge determination, followed by regression equations and rainfall runoff modeling. This analysis utilizes the 40 years of annual peak discharge records at Mill Creek at Old Mill Creek.

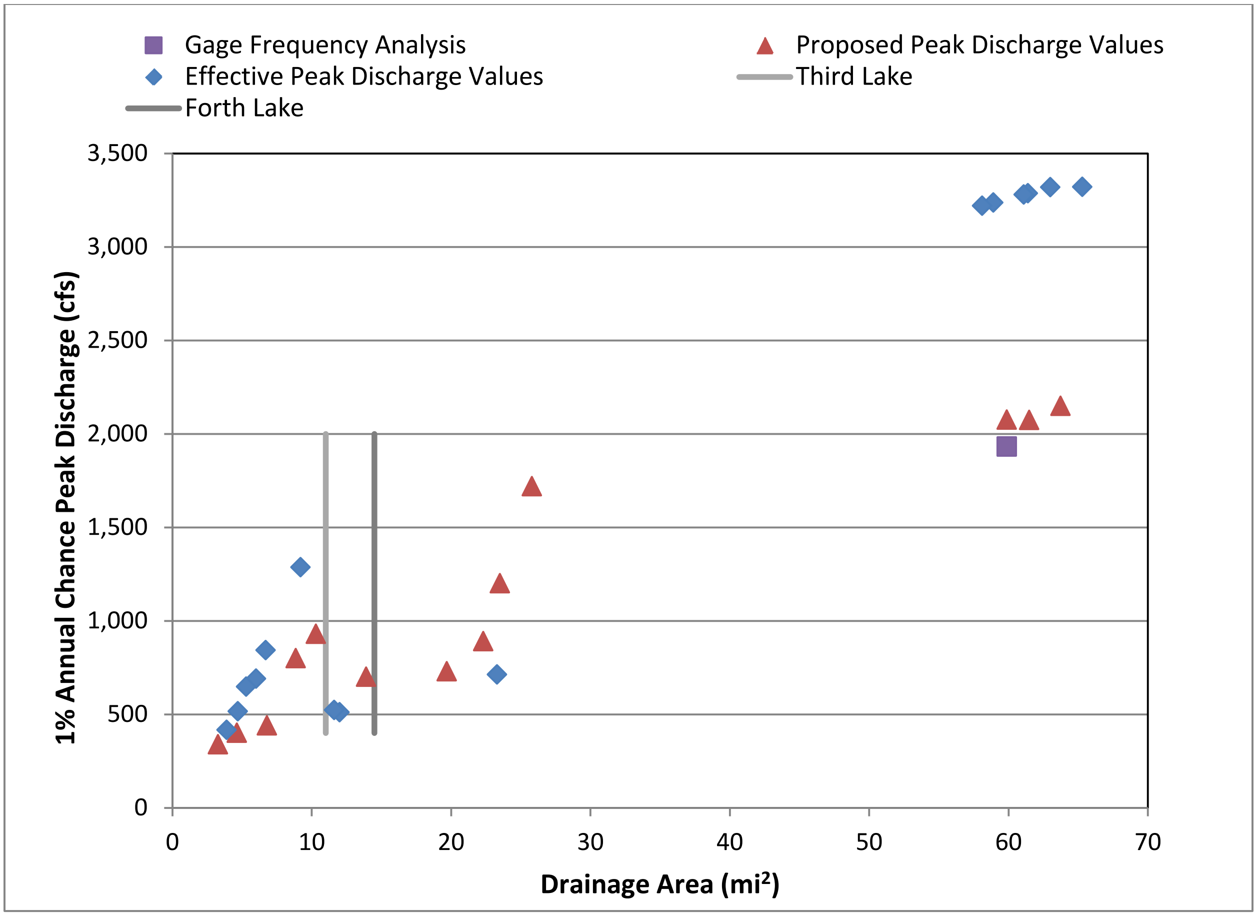


Figure 16. Mill Creek Watershed comparison of peak discharge values

Table 7. Mill Creek proposed 1% peak discharge values

	Proposed Peak Discharge Values for Annual Chance Events on Mill Creek (cfs)				
Location	*10%*	*4%*	*2%*	*1%*	*0.20%*
Metra RR US of St Hwy 120	200	250	290	350	500
RR DS of St Hwy 120	240	290	350	400	600
US unnamed tributary US of Atkinson Rd	280	330	360	410	590
US unnamed tributary DS of Atkinson Rd	430	530	610	730	1,120
US Third Lake, near Washington Street	520	620	690	830	1,490
US Fourth Lake Tributary	490	560	620	690	1,070
at State Hwy 132	470	560	620	710	950
US unnamed tributary- downstream of Hutchins Rd	490	590	680	840	1,240
Us unnamed tributary	530	700	850	1,050	1,610
US of North Mill Creek confluence	790	1,050	1,270	1,630	2,510
USGS gage Mill Creek at Old Mill Creek	1,370	1,680	1,890	2,080	2,440
At I94	1,440	1,750	1,960	2,150	2,530

4.1.4 Storage Area Floodplain Mapping

The resulting proposed 1- and 0.2-percent chance water surface elevations resulting from the HEC-HMS model have been mapped as part of this report with no FEMA FIRM Zone specifically indicated. The final proposed FEMA FIRM mapped Zone, either Zone A or Zone AE, should be further reviewed by the community prior to submittal for FIRM incorporation. Final zone designation should consider the community's needs, wetland area designation, and the source of the rating curve data. Appendix Q provides information on the Stillwater elevations for each storage area that would be mapped based on HEC-HMS water surface elevations and a table indicating the rating curve source data.

It should be noted that while the storage areas that are included in the HEC-HMS model have been identified for floodplain mapping, the downstream tributaries, which these storages areas discharge into, are not included with this analysis. For example, floodplain along the tributary downstream of the METRA Libertyville station and Countryside landfill has not been mapped as floodplain.

4.2 Hydraulic Analysis

4.2.1 Model Calibration and Verification

All models were reviewed by ISWS engineers to verify roughness values, bank stations, ineffective flow areas, hydraulic structures, boundary conditions, and hydrologic model output.

Model verification was possible for Mill Creek using high water marks and the USGS gage data. Table 8 below compares the observed stages to the simulated HEC-RAS water surface elevations for three recorded storm events. The results compared favorably for the June 2008 event at the Stearns School Road and the USGS gage at Old Mill Creek; and somewhat favorably, at the gage at Lake County Community College. The June

2009 events compared favorably at the USGS gage, and somewhat favorably at the Lake County Community College gage. Data was not available for Stearns School Road for this event. For the April 2013 event, stage data was only available at the USGS gage at Old Mill Creek; results compared favorably.

Table 8. High Water Marks vs. Simulated Event

		High Water Marks Table					
		June 2008 Event		*June 2009 Event*		*April 2013 Event*	
Location (Gage #)	*HEC-RAS Cross Section STA*	*Observed WSEL (Feet, NAVD 88)*	*RAS Simulation of this Event (Feet, NAVD88)*	*Observed WSEL (Feet, NAVD88)*	*RAS Simulation of this Event (Feet, NAVD88)*	*Observed WSEL (Feet, NAVD88)*	*RAS Simulation of this Event (Feet, NAVD 88)*
Lake County Community College (E7)	77009.58	764.8	765.72	766.2	767.07	NA	
Stearns School Road (E5)	40628.66	724.4	723.65	NA	724.60	NA	
Mill Creek at Old Mill Creek (USGS Gage #05527950)	16480	679.8	679.34	680.9	680.55	680.7	680.54
NA - not available							

Table 9, Base Flood Elevation (BFE) comparison table below compares the 1-percent-annual-chance water surface elevations of the effective FEMA cross sections to the new model values.

Table 9. Base Flood Elevation (BFE) comparison

Effective FEMA		*New Study*		*WSEL Change*
Cross Section	*WSEL(NAVD88) (Feet, NAVD 88)*	*Cross Section*	*1% Annual Chance WSEL (Feet, NAVD 88)*	*1% Annual Chance WSEL (Feet)*
A	669.2	1804.5	669.2	-0.8
B	670.4	4164	669.5	-0.9
C	672.7	4459.1	670.4	-2.3
D	674.9	10207.8	673.7	-1.2
E	677.8	10403.2	677.3	-0.7
F	682.5	16172.1	679.9	-2.8
G	687.7	18049.2	682.3	-5.4
H	688.9	18307.9	687.2	-1.7
I	689	22007.5	687.9	-1.2
J	691.1	25349.2	689.2	-1.9
K	700.5	31894.6	701.2	1.1
L	711	36139.6	711.1	1.2
M	718.5	36327.4	711.8	-1.6
N	718.5	37134.7	716.2	-1.0
O	725.5	40536.9	725.6	1.1
P	735.1	45762.6	736.65	2.3
Q	737	46029.1	737.5	1.8
R	742.3	47560.7	741.2	-0.4
S	747.8	49188.7	746.9	-0.6
T	750.9	49310	752.4	1.6
U	750.9	49793.1	752.4	1.6
V	750.9	51669.6	754.1	3.4
W	755.5	53298.3	755.7	0.3
X	760.4	56565.3	759.9	-0.5
Y	762.9	56716.8	762.0	-0.8
Z	763	62103.7	763.5	0.5
AA	763.8	64262.6	763.7	-0.1
AB	765.6	68056	765.1	-0.6
AC	765.7	70278.6	765.8	0.1
AD	765.9	74317	766.3	0.4
AE	767.2	74929.4	766.4	-0.8
AF	770.6	81147.4	771.1	1.9

Table 9. Base Flood Elevation (BFE) comparison (continued)

Effective FEMA		*New Study*		*WSEL Change*
Cross Section	*WSEL(NAVD88) (Feet, NAVD 88)*	*Cross Section*	*1% Annual Chance WSEL (Feet, NAVD 88)*	*1% Annual Chance WSEL (Feet)*
AG	771.4	81323	771.9	1.3
AH	771.6	81725.5	772.0	1.1
AI	774.5	84636.5	772.3	-1.5
AJ	775.8	86786.6	773.8	-2.0
AK	780.7	86975.2	774.4	-5.7
AL	781.8	87210.5	776.31	-4.6
AM	781.9	87797.5	778.0	-3.3
AN	781.9	90146.8	778.7	-3.0
AO	782.2	90460.5	778.9	-3.1
AP	784.2	93662.5	782.7	-1.4
AQ	786.3	98166.2	785.0	-1.5
AR	786.3	100101.1	785.1	-1.3

Significant differences in the 1-percent-annual-chance water surface elevations were encountered at lettered cross sections G, AK and AL. At cross section G (located just downstream of the dam), the new study results in a decrease of 5.4 feet in the base flood elevation. This difference may be attributed to the fact that the effective profile shows only an approximately two foot difference between the cross sections located upstream and downstream of the dam, whereas the new profile shows a difference of approximately 5 feet. At cross sections AK and AL, the new study results in a decrease of 5.7 feet and 4.6 feet, respectively, in the base flood elevation, because the culvert was replaced at Old Center Street in 2008. The less restrictive structure resulted in a lower base flood elevation upstream of the culvert.

4.2.2 Floodway and Floodplain Mapping

A floodway analysis was performed for the 1-percent-annual-chance recurrence interval event for Mill Creek. An archetypal floodway analysis used Method 4 target water surface elevation rise encroachments within HEC-RAS to establish a 0.1 foot rise in water surface. The floodway was then adjusted using specified left and right encroachments using Method 1 to meet the auxiliary floodway requirements within

Illinois concerning velocity and conveyance preservation. These auxiliary requirements are described in detail in the Illinois Department of Natural Resources, Office of Water Resources, *Floodplain Map Revision Manual*, dated March 1996. These requirements include a maximum 0.1-foot rise over the floodplain elevation; floodway volume must remain at least 90 percent of the floodplain volume; and floodway velocity cannot increase more than 10 percent of the floodplain velocity (See Appendix I, Floodway Comparison Table). Floodway information at selected cross sections is provided in Appendix J, Floodway Data Table.

Appendix H (Floodplain Comparison Workmap) shows the floodplain resulting from water surface profiles generated in this study. Also shown on this workmap is the effective FEMA 1-percent-annual-chance floodplain. The new 1-percent-annual-chance floodplain is generally similar to the effective FEMA 1-percent-annual-chance floodplain.

SECTION 5.0
SUMMARY

This analysis could be submitted to FEMA through the MT2 process to update the effective FEMA Special Flood Hazard Area (SFHA) for Mill Creek. The effective FIRM for Mill Creek has an effective Zone AE SFHA with floodway. A HEC-HMS (Version 3.5.0) hydrologic computer model and a HEC-RAS (Version 4.1) hydraulic computer model were prepared to produce a detailed study floodplain comparison workmap as shown in Appendix H (Floodplain Comparison Workmap) for the Mill Creek watershed. Floodway analysis was prepared to produce information necessary for a Physical Map Revision (PMR). Cross section data consists of main-channel field-surveyed data taken from the original report by Tetra Tech and merged with the 2007 Countywide LiDAR (Lake County, 2011) topographic dataset as overbanks. Additional cross sections and structures were field surveyed by Thomson Surveying, Ltd. in order to update the hydraulic model, see Appendix H (Floodplain Comparison Workmap) for surveyed cross-section locations and Appendix R (Thomson Field Survey Data). Appendix H also includes a comparison of FEMA's effective floodplain mapping with the 1-percent-annual-chance floodplain developed for this project.

Peak flow rates for the 10-, 4-, 2-, 1- and 0.2-percent-annual-chance flood events were established for the final submittal using an HEC-HMS v3.5 hydrologic computer modeling. For the HEC-HMS hydrologic computer model, the soil infiltration rate was estimated using the Natural Resources Conservation Service (NRCS) curve number method. The transformation method used was the Clark Unit Hydrograph. Reach routing within HEC-HMS was performed using Muskingum-Cunge methodology. The HEC-HMS output peak discharges were input into the steady HEC-RAS model. The 48-hour, 120-hour and 18–hour rainfall events were deemed to be the critical duration events for the South Mill Creek watershed. A discharge versus drainage area graph (Figure 16) was prepared to compare the 1-percent-annual-chance flood discharges produced from different methodologies and data sources.

The floodway determination was based on the State of Illinois requirements shown in the Illinois Department of Natural Resources, Office of Water Resources, *Floodplain Map*

Revision Manual, dated March 1996. These requirements include a maximum 0.1-foot rise over the floodplain elevation; floodway volume must remain at least 90 percent of the floodplain volume; and floodway velocity cannot increase more than 10 percent of the floodplain velocity (See Appendix I – Floodway Comparison Table).

The 1-percent-annual-chance flood profiles were generated as shown in Appendix G (Flood Profiles) and used to delineate a 1- and 0.2-percent-annual-chance floodplain.

All elevation data in the HEC-RAS model and shown on the floodplain map, profiles and tables reference the vertical datum of NAVD 88. See Appendix E for HEC-RAS file names. The Check-RAS program (V2.0.1 beta, 2011) was used to verify modeling parameters and input data and to check the modeling results for compliance with FEMA standards. Check-RAS data is included in the HEC-RAS data files.

SECTION 6.0
REFERENCES

Bleck Engineering Company, Inc. *South Mill Creek Watershed Hydrologic and Hydraulic Report*. Revised September 2008.

Chow, V.T. *Open Channel Hydraulics*, McGraw-Hill Book Company, NY: 1959.

Clark, C. O., 1945. *Storage and the Unit Hydrograph*. Transactions of the American Society of Civil Engineers, 110, 1419-1446, 1945.

Curtis, G. W. *Technique for Estimating Flood-Peak Discharges and Frequencies on Rural Streams in Illinois*. U.S. Geological Survey Water-Resources Investigations Report 87-4207, 1987.

Federal Emergency Management Agency (FEMA). *CHECK-RAS V2.0.1 beta*, 2011.

Federal Emergency Management Agency. 2013. *Flood Insurance Study, Lake County, Illinois, and Incorporated Areas*. Flood Insurance Study Number 17097CV001B, 2013.

Federal Insurance Administration. *Flood Insurance Study: Village of Grayslake, Lake County, Illinois.* Washington, D.C.: December 1979.

Huff, F. A., and Angel, J. R., *Rainfall Frequency Atlas of the Midwest. Illinois State Water Survey*, Champaign, Bulletin 71, 1992.

Hydrologic Engineering Center. *HEC-HMS Version: 3.5*. Institute for Water Resources, Hydrologic Engineering Center, Davis, CA: August, 2010.

Ishii, A.L., Soong, D.T., and Sharpe, J.B., 2010, Implementation and evaluation of the Streamflow Statistics (StreamStats) Web application for computing basin characteristics and flood peaks in Illinois: U.S. Geological Survey Scientific Investigations Report 2009–5197, 25 p.

Lake County Department of Information and Technology, GIS Division. *Lake County, Illinois 2007 LIDAR Derived DEM*. Contour Interval: 1 foot. November 2011 [Data collection April 16 - May 7, 2007].

Lake County Department of Information Technology, GIS Division, *2012 Lake County Aerial Photography*. Raster digital data. July 2013 [Data collection March 9, 2012 - May 13, 2013].

Soong, D. T., Ishii, A. L., Sharpe, J. B., and Avery. C. F. *Estimating Flood-Peak Discharge Magnitudes and Frequencies for Rural Streams in Illinois*, U.S. Geological Survey Science Investigations Report 2004-5103, 2004.

Thomson Surveying, Ltd. November 2013.

U.S. Army Corps of Engineers. Hydrologic Engineering Center (USACE). *HEC-GeoRAS, Version 3.1.1*. Davis, California: October 2002.

U.S. Army Corps of Engineers (USACE). *HEC-GeoHMS v10.1 toolkit for ArcGIS 10.1*

U.S. Army Corps of Engineers (USACE). *Hydrologic Modeling System HEC-HMS Technical Reference Manual, Report Number CPD-74B*, 2000.

U.S. Army Corps of Engineers (USACE). Hydrologic Engineering Center. *Hydrologic Engineering Center's River Analysis System (HEC-RAS) Computer Program, Version 4.1.0*. 2010.

Village of Grayslake, Lake County, Illinois. Letter of Map Revision Application, Mill Creek (Avon-Fremont Drainage Ditch), Revised September 2011.

Appendix A. HEC-HMS Data Files

See Attached Data Disk

Appendix B. Hydrologic GIS Data

See Attached Data Disk

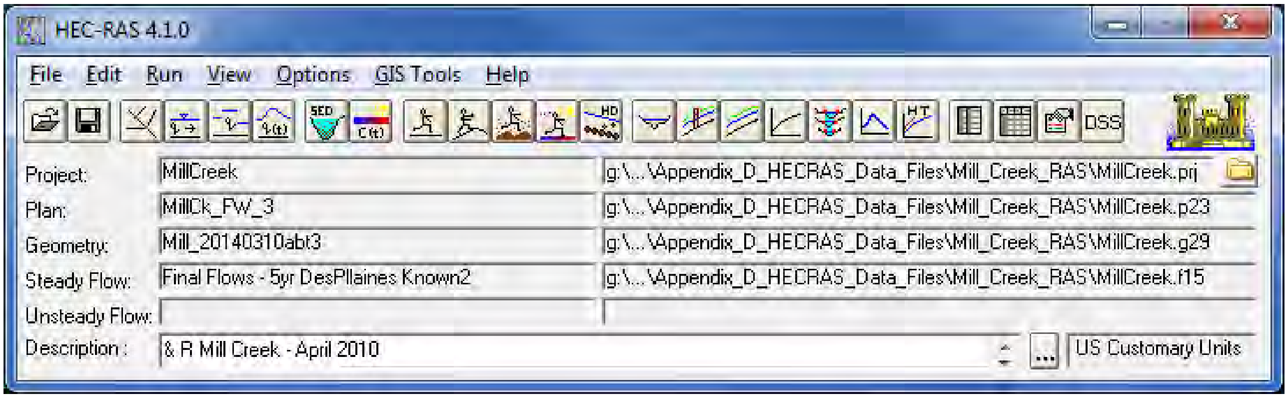
Appendix C. Hydrologic Workmap

See Attached Large Scale Map and Data Disk

Appendix D. HEC-RAS Data Files

Included on CD

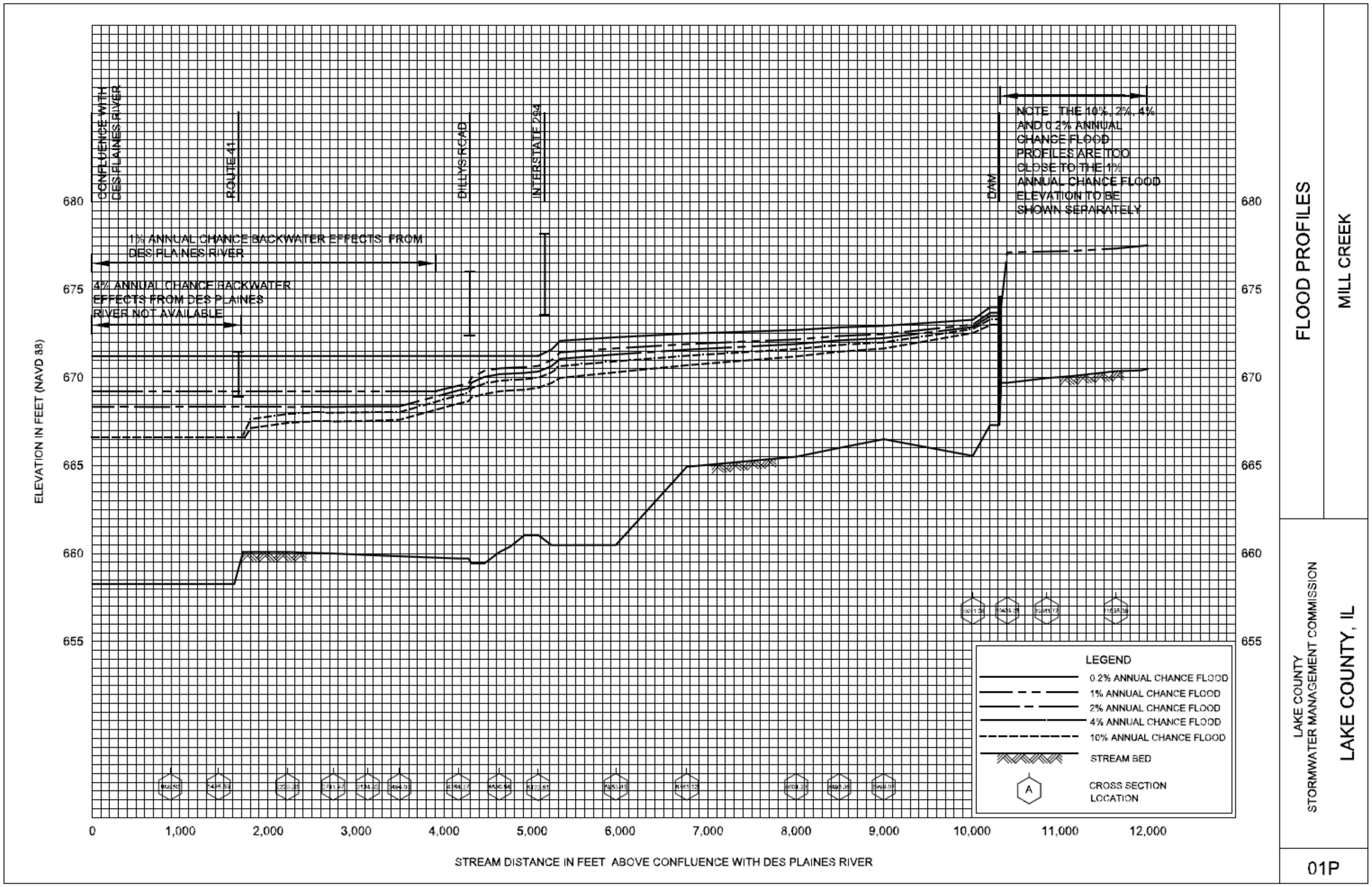
Appendix E. HEC-RAS File Name Key

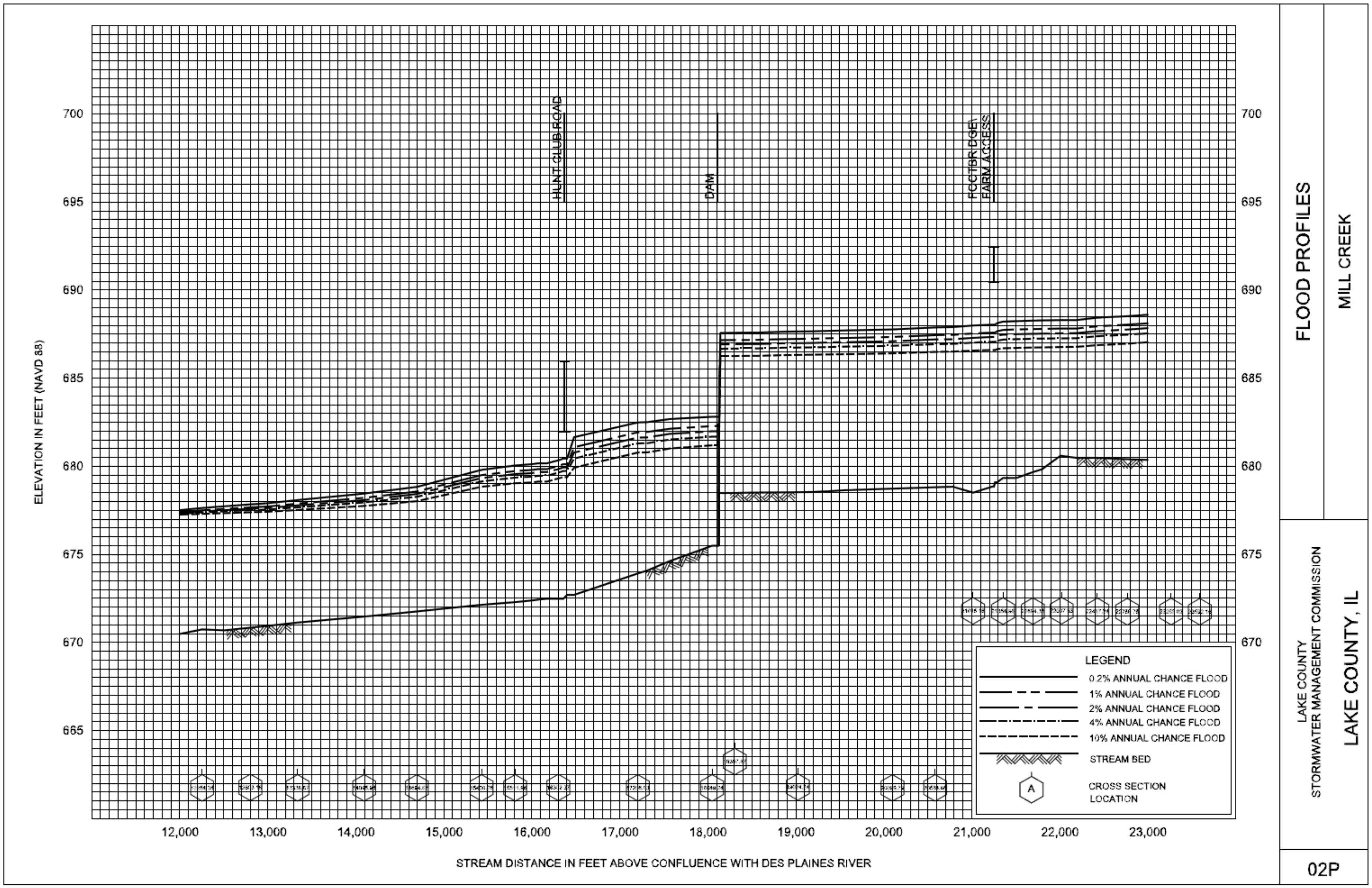


Appendix F. Hydraulic WorkMap

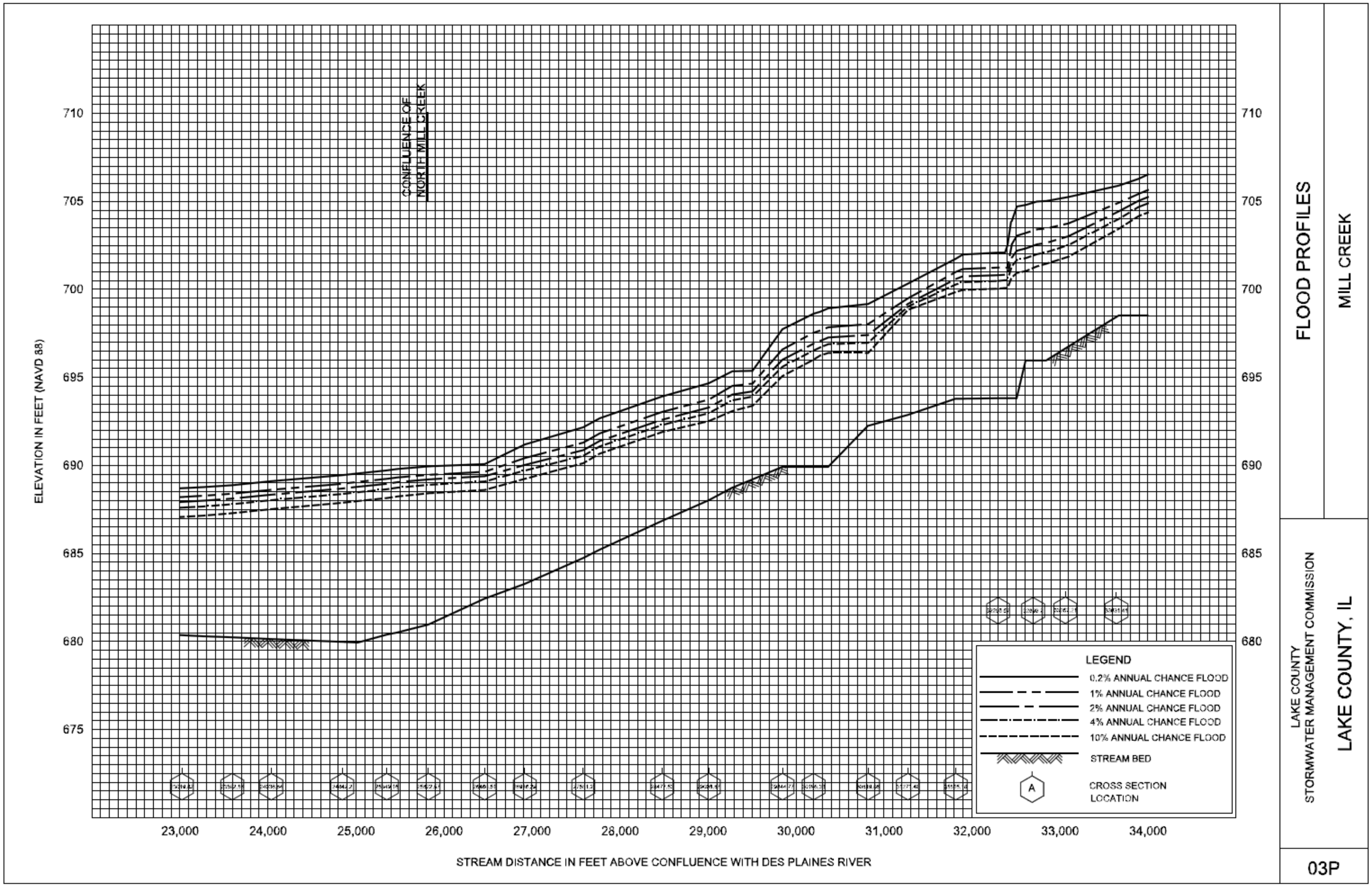
Included on CD and paper copy

Appendix G. Flood Profiles

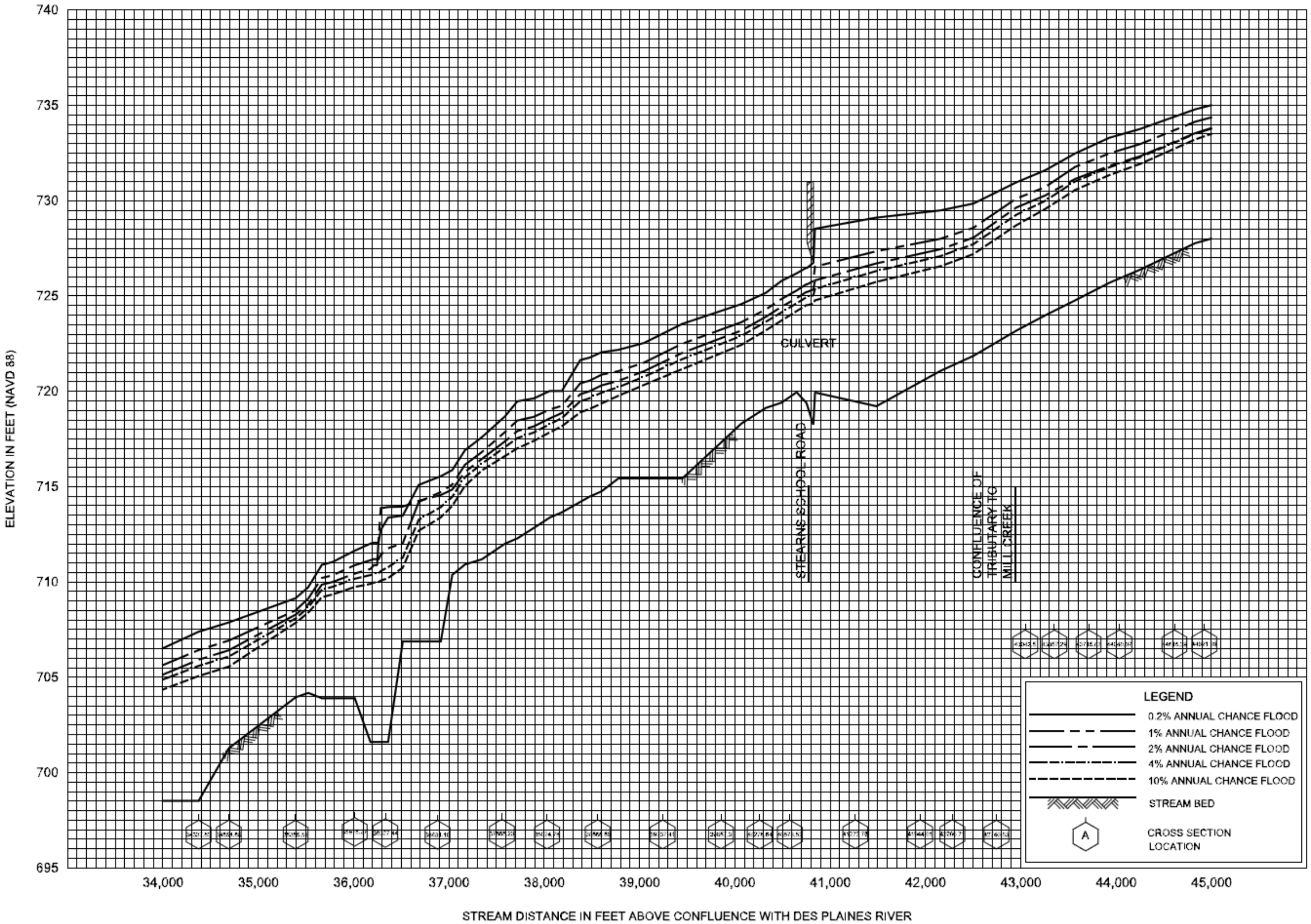




HUNT CLUB ROAD
DAM
FOOTBRIDGE/
FARM ACCESS
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH DES PLAINES RIVER
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
MILL CREEK
LAKE COUNTY
STORMWATER MANAGEMENT COMMISSION
LAKE COUNTY, IL
02P



FLOOD PROFILES
MILL CREEK
LAKE COUNTY
STORMWATER MANAGEMENT COMMISSION
LAKE COUNTY, IL
03P
CONFLUENCE OF
NORTH MILL CREEK
ELEVATION IN FEET (NAVD 88)
710
705
700
695
690
685
680
675
23,000
24,000
25,000
26,000
27,000
28,000
29,000
30,000
31,000
32,000
33,000
34,000
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH DES PLAINES RIVER
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
A
CROSS SECTION
LOCATION



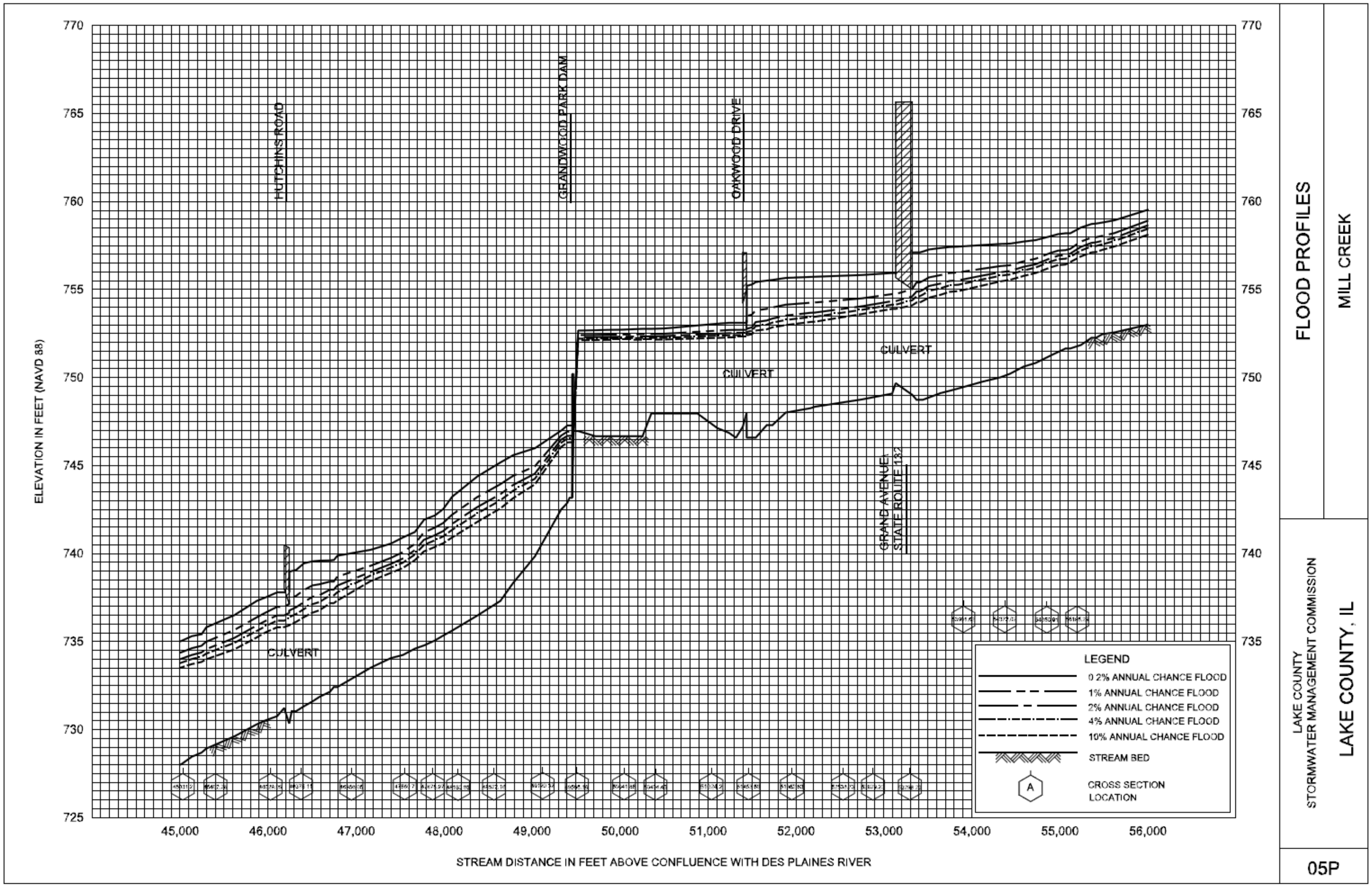
FLOOD PROFILES

MILL CREEK

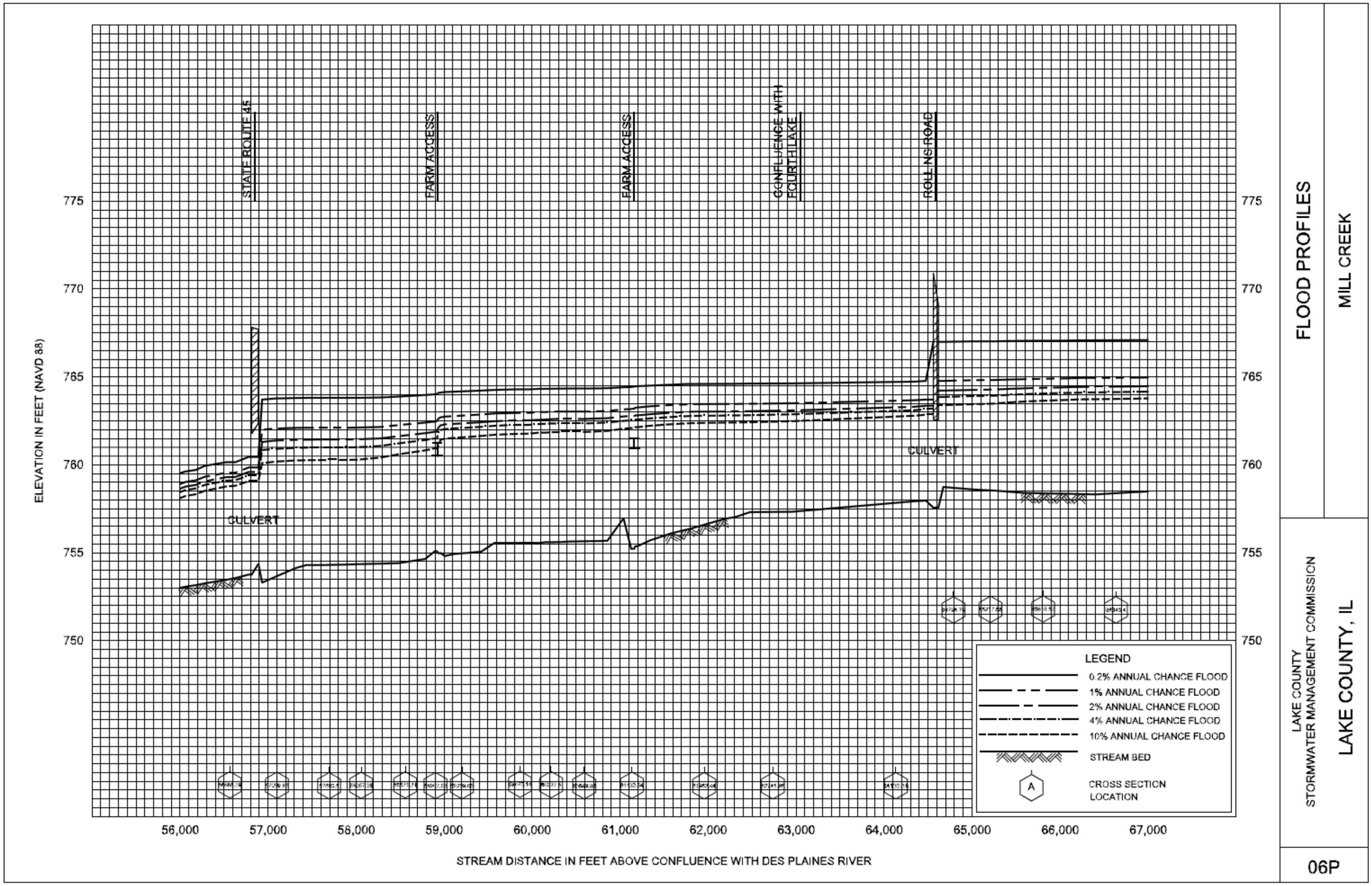
LAKE COUNTY STORMWATER MANAGEMENT COMMISSION

LAKE COUNTY, IL

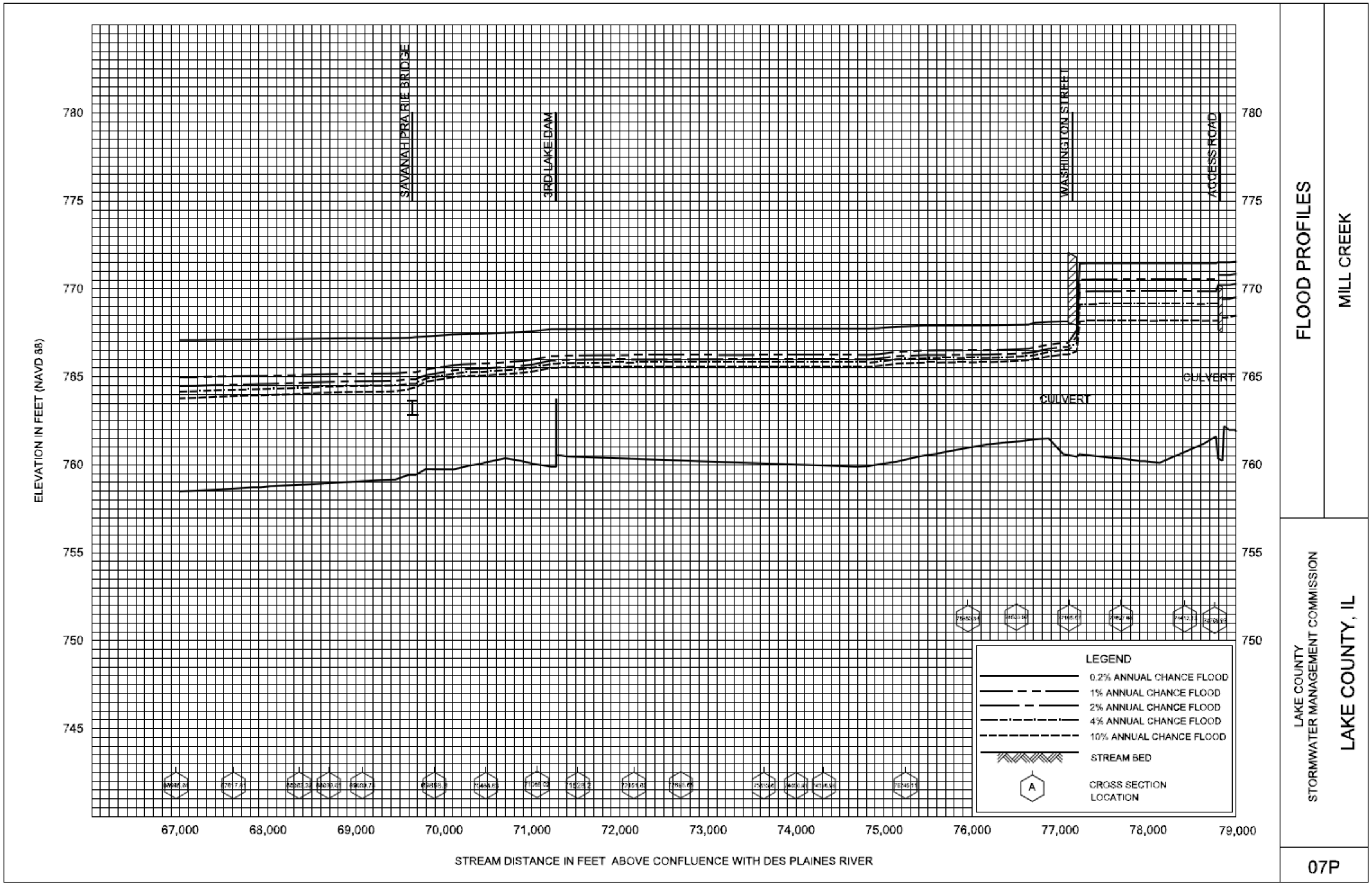
04P

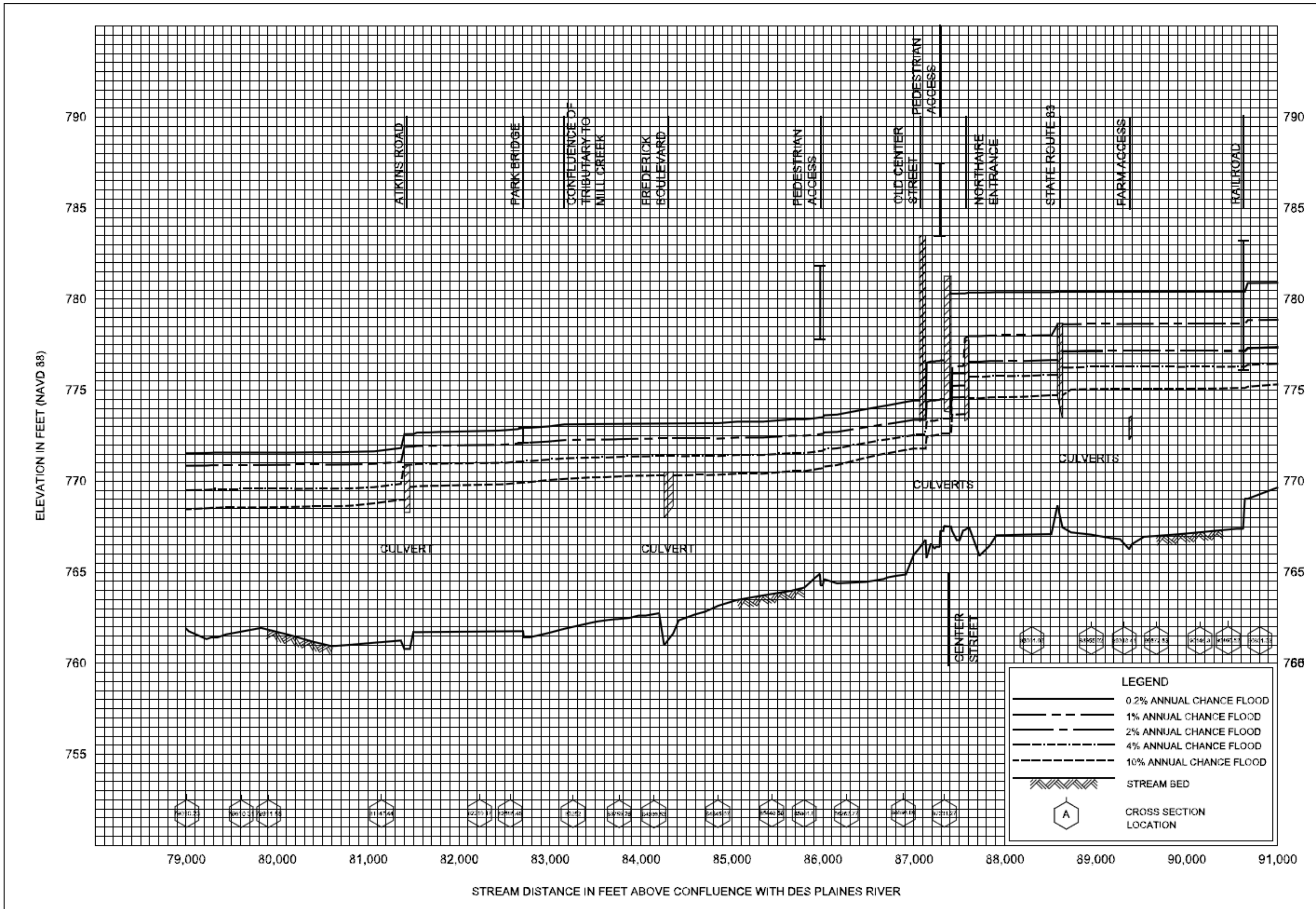


FLOOD PROFILES
MILL CREEK
LAKE COUNTY STORMWATER MANAGEMENT COMMISSION
LAKE COUNTY, IL
05P
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH DES PLAINES RIVER
HUTCHINS ROAD
GRANDWOOD PARK DAM
OAKWOOD DRIVE
GRAND AVENUE STATE ROUTE 132
CULVERT
CULVERT
CULVERT
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION



STATE ROUTE 45
FARM ACCESS
FARM ACCESS
CONFLUENCE WITH
FOURTH LAKE
ROLLINS ROAD
CULVERT
CULVERT
775
770
765
760
755
750
ELEVATION IN FEET (NAVD 88)
56,000
57,000
58,000
59,000
60,000
61,000
62,000
63,000
64,000
65,000
66,000
67,000
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH DES PLAINES RIVER
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
A
FLOOD PROFILES
MILL CREEK
LAKE COUNTY
STORMWATER MANAGEMENT COMMISSION
LAKE COUNTY, IL
06P


SAVANAH PRAIRIE BRIDGE
3RD LAKE DAM
WASHINGTON STREET
ACCESS ROAD
CULVERT
CULVERT
780
775
770
765
760
755
750
745
ELEVATION IN FEET (NAVD 88)
67,000
68,000
69,000
70,000
71,000
72,000
73,000
74,000
75,000
76,000
77,000
78,000
79,000
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH DES PLAINES RIVER
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
A
CROSS SECTION LOCATION
FLOOD PROFILES
MILL CREEK
LAKE COUNTY
STORMWATER MANAGEMENT COMMISSION
LAKE COUNTY, IL
07P



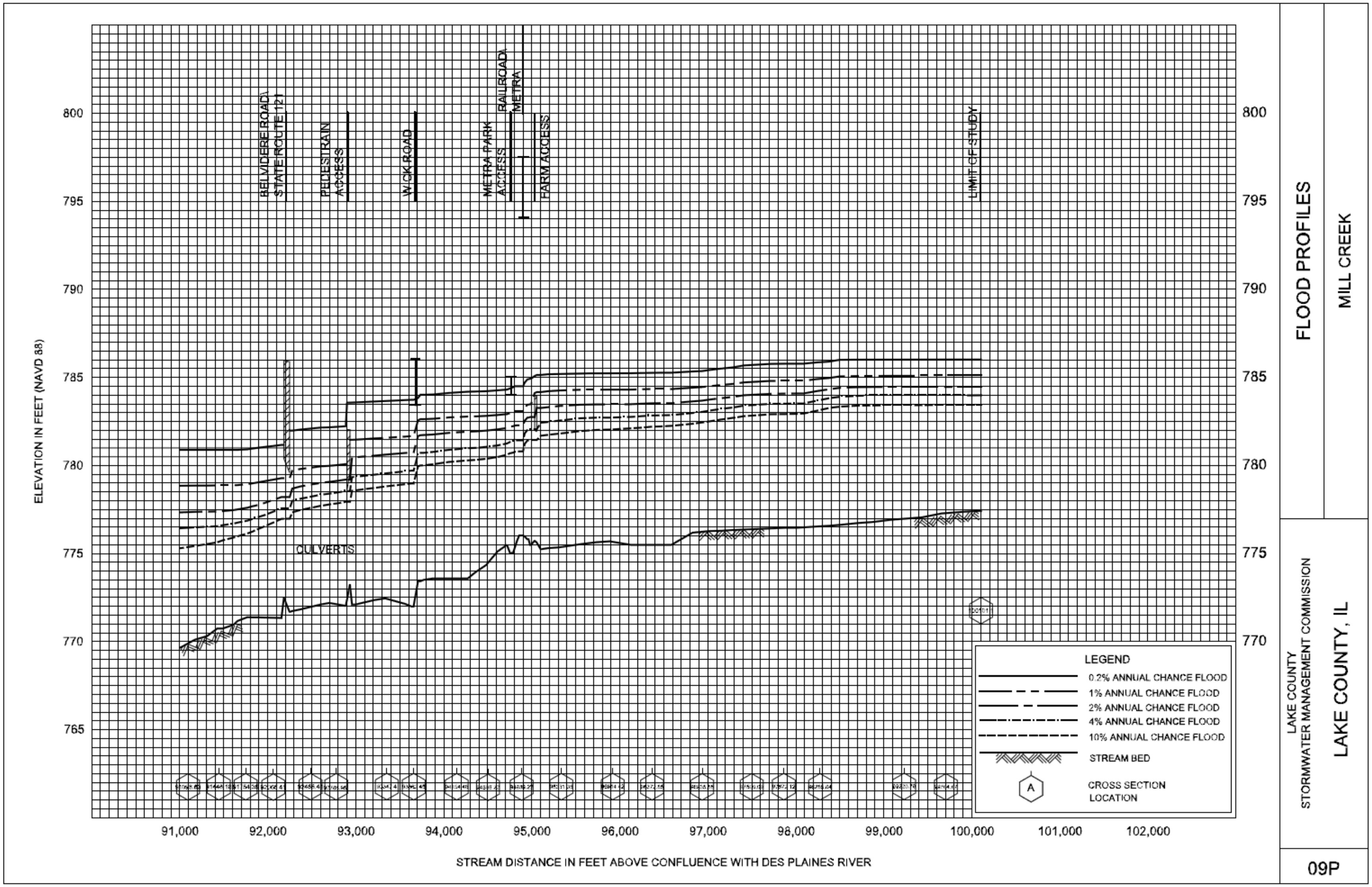
FLOOD PROFILES

MILL CREEK

LAKE COUNTY
STORMWATER MANAGEMENT COMMISSION

LAKE COUNTY, IL

08P



BELVIDERE ROAD/ STATE ROUTE 121
PEDESTRIAN ACCESS
WICK ROAD
METRA PARK ACCESS
RAILROAD/ METRA
FARM ACCESS
LIMIT OF STUDY
CULVERTS
ELEVATION IN FEET (NAVD 88)
800
795
790
785
780
775
770
765
91,000
92,000
93,000
94,000
95,000
96,000
97,000
98,000
99,000
100,000
101,000
102,000
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH DES PLAINES RIVER
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
A
CROSS SECTION LOCATION
FLOOD PROFILES
MILL CREEK
LAKE COUNTY STORMWATER MANAGEMENT COMMISSION
LAKE COUNTY, IL
09P

Appendix H. Floodplain Comparison Workmap

Included on CD and paper copy

Appendix I. Floodway Comparison Table

	Mill Creek		Illinois State Water Survey								
	3/31/2014		Note that all Output is from Steady-State Flow Model (not unsteady)								
River	Reach	River Station	W.S. Elev (ft) 100yr	W.S. Elev (ft) FW	Delta (ft)	Flow Area (sq ft) 100yr	Flow Area (sq ft) FW	Delta (%)	Vel Total (ft/s) 100yr	Vel Total (ft/s) FW	Delta (%)
Mill Creek	Mill Creek	101550.3	785.24	785.27	0.0	224.31	224.34	0.0%	1.56	1.56	0.0%
Mill Creek	Mill Creek	100742.6	785.14	785.16	0.0	1399.01	1302.12	-6.9%	0.25	0.27	8.0%
Mill Creek	Mill Creek	100574.7	785.13	785.15	0.0	2039.83	1952.11	-4.3%	0.17	0.18	5.9%
Mill Creek	Mill Creek	100315.9	785.12	785.14	0.0	1340.05	1250.23	-6.7%	0.26	0.28	7.7%
Mill Creek	Mill Creek	100101.1	785.11	785.13	0.0	2195.69	1960.56	-10.7%	0.18	0.18	0.0%
Mill Creek	Mill Creek	99927.34	785.11	785.13	0.0	4234.61	3063.58	-27.7%	0.1	0.11	10.0%
Mill Creek	Mill Creek	99704.87	785.11	785.13	0.0	3645.11	3474.75	-4.7%	0.1	0.1	0.0%
Mill Creek	Mill Creek	99443.5	785.11	785.13	0.0	4494.99	4209.15	-6.4%	0.08	0.08	0.0%
Mill Creek	Mill Creek	99220.79	785.11	785.13	0.0	4211.02	4124.82	-2.0%	0.08	0.08	0.0%
Mill Creek	Mill Creek	98863.52	785.11	785.13	0.0	4846.31	4689.96	-3.2%	0.08	0.08	0.0%
Mill Creek	Mill Creek	98648.03	785.1	785.13	0.0	2984.01	2860.6	-4.1%	0.15	0.16	6.7%
Mill Creek	Mill Creek	98498.88	785.1	785.12	0.0	2270.88	2162.05	-4.8%	0.18	0.19	5.6%
Mill Creek	Mill Creek	98285.84	785.08	785.1	0.0	1141.26	1084.68	-5.0%	0.55	0.6	9.1%
Mill Creek	Mill Creek	98166.15	784.99	785.01	0.0	172.15	172.55	0.2%	2.03	2.03	0.0%
Mill Creek	Mill Creek	98019.02	784.92	784.94	0.0	305.5	281.38	-7.9%	1.15	1.24	7.8%
Mill Creek	Mill Creek	97872.12	784.81	784.84	0.0	294.23	265.09	-9.9%	1.28	1.32	3.1%
Mill Creek	Mill Creek	97792.01	784.83	784.85	0.0	585.3	507.94	-13.2%	0.69	0.69	0.0%
Mill Creek	Mill Creek	97665.39	784.82	784.85	0.0	861.55	831.32	-3.5%	0.42	0.42	0.0%
Mill Creek	Mill Creek	97500.09	784.82	784.84	0.0	1051.84	1012.09	-3.8%	0.33	0.35	6.1%
Mill Creek	Mill Creek	97196.85	784.74	784.76	0.0	198.95	197.05	-1.0%	1.76	1.78	1.1%
Mill Creek	Mill Creek	97066.95	784.65	784.68	0.0	305.14	168.27	-44.9%	2.09	2.08	-0.5%
Mill Creek	Mill Creek	96935.16	784.59	784.62	0.0	507.12	170.26	-66.4%	2.06	2.06	0.0%
Mill Creek	Mill Creek	96800.98	784.52	784.55	0.0	549.65	170.57	-69.0%	2.06	2.05	-0.5%
Mill Creek	Mill Creek	96717.17	784.47	784.5	0.0	175.48	176.32	0.5%	1.99	1.99	0.0%
Mill Creek	Mill Creek	96612.78	784.44	784.47	0.0	268.82	223.15	-17.0%	1.58	1.57	-0.6%
Mill Creek	Mill Creek	96372.85	784.34	784.37	0.0	652.18	190.91	-70.7%	1.85	1.83	-1.1%
Mill Creek	Mill Creek	96249.55	784.36	784.4	0.0	1576.96	1494.51	-5.2%	0.38	0.39	2.6%
Mill Creek	Mill Creek	96142.95	784.36	784.39	0.0	2775.23	2694.03	-2.9%	0.3	0.31	3.3%
Mill Creek	Mill Creek	96036.05	784.35	784.38	0.0	997.77	917.06	-8.1%	0.6	0.62	3.3%
Mill Creek	Mill Creek	95914.42	784.33	784.36	0.0	737	715.44	-2.9%	0.61	0.64	4.9%
Mill Creek	Mill Creek	95672.98	784.33	784.36	0.0	2162.4	2116.01	-2.1%	0.26	0.27	3.8%
Mill Creek	Mill Creek	95521.07	784.32	784.36	0.0	2401.8	2415.53	0.6%	0.2	0.19	-5.0%
Mill Creek	Mill Creek	95331.35	784.32	784.35	0.0	1394.8	1381.34	-1.0%	0.37	0.36	-2.7%
Mill Creek	Mill Creek	95101.32	784.28	784.32	0.0	489.11	478.66	-2.1%	0.75	0.73	-2.7%
Mill Creek	Mill Creek	94969.74	784.24	784.28	0.0	379.75	372.8	-1.8%	0.95	0.94	-1.1%
Mill Creek	Mill Creek	94889.22	784.19	784.23	0.0	282.67	265.83	-6.0%	1.27	1.32	3.9%
Mill Creek	Mill Creek	94778.4	783.5	783.51	0.0	347.46	347.35	0.0%	1.01	1.01	0.0%
Mill Creek	Mill Creek	94768.15	783.5	783.51	0.0	347.86	292.2	-16.0%	1.01	1.2	18.8%
Mill Creek	Mill Creek	94750.26	783.48	783.49	0.0	235.09	234.74	-0.1%	1.49	1.49	0.0%

	Mill Creek		Illinois State Water Survey										
	3/31/2014		Note that all Output is from Steady-State Flow Model (not unsteady)										
River	Reach	River Station	W.S. Elev (ft) 100yr	W.S. Elev (ft) FW	Delta (ft)		Flow Area (sq ft) 100yr	Flow Area (sq ft) FW	Delta (%)		Vel Total (ft/s) 100yr	Vel Total (ft/s) FW	Delta (%)
Mill Creek	Mill Creek	94737.39	783.47	783.48	0.0		230.47	228.75	-0.7%		1.52	1.53	0.7%
Mill Creek	Mill Creek	94644.67	783.07	783.08	0.0		179.75	180.3	0.3%		1.95	1.94	-0.5%
Mill Creek	Mill Creek	94619.97	783.07	783.09	0.0		273.35	274.02	0.2%		1.46	1.46	0.0%
Mill Creek	Mill Creek	94596.3	783.07	783.08	0.0		336.61	270.01	-19.8%		1.31	1.48	13.0%
Mill Creek	Mill Creek	94574.22	783.03	783.04	0.0		209.96	209.35	-0.3%		1.92	1.91	-0.5%
Mill Creek	Mill Creek	94541.88	783	783.02	0.0		192.56	193.12	0.3%		2.08	2.07	-0.5%
Mill Creek	Mill Creek	94505.22	782.94	782.96	0.0		162.43	162.87	0.3%		2.46	2.46	0.0%
Mill Creek	Mill Creek	94397.86	782.89	782.91	0.0		188.77	189.37	0.3%		2.12	2.11	-0.5%
Mill Creek	Mill Creek	94267.61	782.84	782.86	0.0		212.27	212.93	0.3%		1.88	1.88	0.0%
Mill Creek	Mill Creek	94154.48	782.81	782.83	0.0		238.84	239.03	0.1%		1.67	1.67	0.0%
Mill Creek	Mill Creek	94059.08	782.8	782.82	0.0		292.4	293.28	0.3%		1.37	1.36	-0.7%
Mill Creek	Mill Creek	93844.1	782.75	782.76	0.0		253.78	254.49	0.3%		1.58	1.57	-0.6%
Mill Creek	Mill Creek	93662.45	782.67	782.69	0.0		208.82	209.54	0.3%		1.92	1.91	-0.5%
Mill Creek	Mill Creek	93559.16	782.65	782.67	0.0		250.47	251.28	0.3%		1.6	1.59	-0.6%
Mill Creek	Mill Creek	93520.88	782.65	782.67	0.0		302.68	303.83	0.4%		1.32	1.32	0.0%
Mill Creek	Mill Creek	93421.66	781.69	781.71	0.0		233.08	233.96	0.4%		1.72	1.71	-0.6%
Mill Creek	Mill Creek	93347.4	781.66	781.68	0.0		229.41	230.21	0.3%		1.74	1.74	0.0%
Mill Creek	Mill Creek	93122.59	781.59	781.61	0.0		237.63	237.58	0.0%		1.68	1.68	0.0%
Mill Creek	Mill Creek	93003.09	781.56	781.57	0.0		229.41	229.06	-0.2%		1.74	1.75	0.6%
Mill Creek	Mill Creek	92856.85	781.51	781.53	0.0		235.45	236.14	0.3%		1.7	1.69	-0.6%
Mill Creek	Mill Creek	92786.95	781.49	781.51	0.0		235.46	235.89	0.2%		1.7	1.7	0.0%
Mill Creek	Mill Creek	92744.95	781.48	781.5	0.0		238.26	238.12	-0.1%		1.68	1.68	0.0%
Mill Creek	Mill Creek	92674.01	780.1	780.11	0.0		163.93	164.39	0.3%		2.44	2.43	-0.4%
Mill Creek	Mill Creek	92590.98	780.05	780.07	0.0		181.26	181.58	0.2%		2.21	2.2	-0.5%
Mill Creek	Mill Creek	92486.41	780	780.02	0.0		192.88	193.36	0.2%		2.07	2.07	0.0%
Mill Creek	Mill Creek	92388.05	779.97	779.98	0.0		213.26	209.98	-1.5%		1.88	1.9	1.1%
Mill Creek	Mill Creek	92156.22	779.82	779.83	0.0		172.46	172.72	0.2%		2.32	2.32	0.0%
Mill Creek	Mill Creek	92065.41	779.74	779.75	0.0		153.78	154.04	0.2%		2.6	2.6	0.0%
Mill Creek	Mill Creek	91943.3	779.3	779.31	0.0		150.64	148.94	-1.1%		2.66	2.69	1.1%
Mill Creek	Mill Creek	91836.34	779.2	779.21	0.0		152.65	153.18	0.3%		2.62	2.61	-0.4%
Mill Creek	Mill Creek	91754.36	779.12	779.14	0.0		156.22	156.86	0.4%		2.56	2.55	-0.4%
Mill Creek	Mill Creek	91676.2	779.05	779.06	0.0		161.34	153.2	-5.0%		2.48	2.61	5.2%
Mill Creek	Mill Creek	91638.91	779.02	779.03	0.0		155.98	148.44	-4.8%		2.56	2.69	5.1%
Mill Creek	Mill Creek	91616.59	779.01	779.02	0.0		158.61	153.44	-3.3%		2.52	2.61	3.6%
Mill Creek	Mill Creek	91555.16	778.96	778.97	0.0		165.89	156.76	-5.5%		2.41	2.55	5.8%
Mill Creek	Mill Creek	91446.18	778.91	778.92	0.0		184.09	172.29	-6.4%		2.17	2.32	6.9%
Mill Creek	Mill Creek	91399.01	778.89	778.9	0.0		201.41	199.42	-1.0%		2.2	2.2	0.0%
Mill Creek	Mill Creek	91276.15	778.87	778.88	0.0		575.28	526.5	-8.5%		1.41	1.44	2.1%
Mill Creek	Mill Creek	91214.23	778.89	778.9	0.0		1323.96	1220.04	-7.8%		0.45	0.49	8.9%

	Mill Creek		Illinois State Water Survey								
	3/31/2014		Note that all Output is from Steady-State Flow Model (not unsteady)								
River	Reach	River Station	W.S. Elev (ft) 100yr	W.S. Elev (ft) FW	Delta (ft)	Flow Area (sq ft) 100yr	Flow Area (sq ft) FW	Delta (%)	Vel Total (ft/s) 100yr	Vel Total (ft/s) FW	Delta (%)
Mill Creek	Mill Creek	91098.63	778.88	778.89	0.0	1779.89	1656.8	-6.9%	0.33	0.35	6.1%
Mill Creek	Mill Creek	90958.8	778.88	778.89	0.0	1986.75	1898.65	-4.4%	0.3	0.31	3.3%
Mill Creek	Mill Creek	90801.38	778.87	778.88	0.0	2931.48	2826.19	-3.6%	0.26	0.26	0.0%
Mill Creek	Mill Creek	90460.52	778.85	778.86	0.0	5796.55	5599.52	-3.4%	0.69	0.68	-1.4%
Mill Creek	Mill Creek	90341.37	778.65	778.66	0.0	8260.04	7772.62	-5.9%	0.52	0.52	0.0%
Mill Creek	Mill Creek	90146.8	778.65	778.65	0.0	7663.1	7227.77	-5.7%	0.4	0.39	-2.5%
Mill Creek	Mill Creek	89876.93	778.65	778.65	0.0	7280.95	6844.12	-6.0%	0.19	0.19	0.0%
Mill Creek	Mill Creek	89672.63	778.65	778.65	0.0	5874.8	5499.57	-6.4%	0.08	0.08	0.0%
Mill Creek	Mill Creek	89318.41	778.65	778.65	0.0	6266.81	6140.14	-2.0%	0.07	0.07	0.0%
Mill Creek	Mill Creek	89056.3	778.64	778.65	0.0	5700.45	5506.25	-3.4%	0.07	0.07	0.0%
Mill Creek	Mill Creek	88955.02	778.64	778.65	0.0	4873.2	4828.16	-0.9%	0.08	0.08	0.0%
Mill Creek	Mill Creek	88735.76	778.64	778.65	0.0	2821.19	2698.63	-4.3%	0.15	0.15	0.0%
Mill Creek	Mill Creek	88516.9	778.62	778.63	0.0	1826.05	1770.44	-3.0%	0.67	0.68	1.5%
Mill Creek	Mill Creek	88301.02	778.02	778.03	0.0	472.02	430.98	-8.7%	1.19	1.2	0.8%
Mill Creek	Mill Creek	88017.56	777.99	778.01	0.0	1855.78	1793.33	-3.4%	0.78	0.82	5.1%
Mill Creek	Mill Creek	87797.5	778	778.01	0.0	3042.63	2782.09	-8.6%	0.18	0.18	0.0%
Mill Creek	Mill Creek	87695.88	778	778.01	0.0	3162.7	2903.21	-8.2%	0.16	0.16	0.0%
Mill Creek	Mill Creek	87625.05	778	778.01	0.0	2089.01	1910.32	-8.6%	0.24	0.25	4.2%
Mill Creek	Mill Creek	87510.91	777.97	777.98	0.0	460.94	450.12	-2.3%	0.89	0.91	2.2%
Mill Creek	Mill Creek	87331.27	776.32	776.34	0.0	231.9	230.81	-0.5%	1.77	1.78	0.6%
Mill Creek	Mill Creek	87293.54	776.32	776.33	0.0	284.87	277.65	-2.5%	1.44	1.48	2.8%
Mill Creek	Mill Creek	87260.03	776.31	776.33	0.0	285.37	285.15	-0.1%	1.44	1.44	0.0%
Mill Creek	Mill Creek	87210.49	776.31	776.32	0.0	347.04	348.08	0.3%	1.18	1.18	0.0%
Mill Creek	Mill Creek	87112.34	774.48	774.5	0.0	161.2	161.54	0.2%	2.54	2.54	0.0%
Mill Creek	Mill Creek	87106.64	774.5	774.52	0.0	203.13	201.93	-0.6%	2.02	2.03	0.5%
Mill Creek	Mill Creek	87100.9	774.51	774.53	0.0	254.85	254.08	-0.3%	1.61	1.61	0.0%
Mill Creek	Mill Creek	87089.3	774.51	774.53	0.0	254.49	255.18	0.3%	1.61	1.61	0.0%
Mill Creek	Mill Creek	87032.68	774.45	774.47	0.0	199.45	199.1	-0.2%	2.06	2.06	0.0%
Mill Creek	Mill Creek	87018.67	774.43	774.45	0.0	190.9	190.32	-0.3%	2.15	2.15	0.0%
Mill Creek	Mill Creek	86975.27	774.43	774.44	0.0	231.96	232.8	0.4%	1.77	1.76	-0.6%
Mill Creek	Mill Creek	86928.28	774.36	774.37	0.0	172.27	172.73	0.3%	2.38	2.37	-0.4%
Mill Creek	Mill Creek	86786.57	773.37	773.38	0.0	184.76	185.34	0.3%	2.22	2.21	-0.5%
Mill Creek	Mill Creek	86701.64	773.3	773.32	0.0	178.22	176.49	-1.0%	2.3	2.32	0.9%
Mill Creek	Mill Creek	86587.8	773.21	773.23	0.0	169.66	169.13	-0.3%	2.42	2.42	0.0%
Mill Creek	Mill Creek	86503.44	773.15	773.15	0.0	170.18	160.85	-5.5%	2.41	2.55	5.8%
Mill Creek	Mill Creek	86455.78	773.12	773.12	0.0	170.52	159.44	-6.5%	2.4	2.57	7.1%
Mill Creek	Mill Creek	86262.77	772.97	772.98	0.0	156.26	156.42	0.1%	2.62	2.62	0.0%
Mill Creek	Mill Creek	85943.15	772.71	772.72	0.0	164.54	164.84	0.2%	2.49	2.49	0.0%
Mill Creek	Mill Creek	85801.8	772.68	772.69	0.0	226.81	225.5	-0.6%	1.81	1.82	0.6%

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Mill Creek	Mill Creek	85784.63	772.6	772.62	0.0	160.31	160.6	0.2%	2.56	2.55	-0.4%
Mill Creek	Mill Creek	85750.74	772.58	772.6	0.0	175.15	175.52	0.2%	2.34	2.34	0.0%
Mill Creek	Mill Creek	85697.41	772.55	772.56	0.0	178.68	178.99	0.2%	2.29	2.29	0.0%
Mill Creek	Mill Creek	85585.45	772.49	772.5	0.0	178.11	178.26	0.1%	2.3	2.3	0.0%
Mill Creek	Mill Creek	85446.59	772.5	772.51	0.0	346.28	346.83	0.2%	1.18	1.18	0.0%
Mill Creek	Mill Creek	85129.2	772.36	772.37	0.0	179.35	179.61	0.1%	2.29	2.28	-0.4%
Mill Creek	Mill Creek	84845.07	772.4	772.41	0.0	977.49	963.82	-1.4%	0.42	0.43	2.4%
Mill Creek	Mill Creek	84636.52	772.34	772.35	0.0	1817.62	1678.65	-7.6%	1.56	1.59	1.9%
Mill Creek	Mill Creek	84496.53	772.31	772.32	0.0	2571	2343.55	-8.8%	1.16	1.25	7.8%
Mill Creek	Mill Creek	84379.12	772.34	772.35	0.0	3262.06	3087.03	-5.4%	0.15	0.16	6.7%
Mill Creek	Mill Creek	84202.94	772.34	772.35	0.0	3407.82	3170.63	-7.0%	0.13	0.14	7.7%
Mill Creek	Mill Creek	83987.05	772.34	772.35	0.0	2005.35	1867.11	-6.9%	0.21	0.22	4.8%
Mill Creek	Mill Creek	83837.91	772.33	772.34	0.0	1450.98	1417.4	-2.3%	0.29	0.29	0.0%
Mill Creek	Mill Creek	83759.25	772.33	772.34	0.0	973.65	966.11	-0.8%	0.42	0.42	0.0%
Mill Creek	Mill Creek	83658.16	772.32	772.33	0.0	924.16	926.39	0.2%	0.44	0.44	0.0%
Mill Creek	Mill Creek	83529.77	772.31	772.32	0.0	1077.64	996.26	-7.6%	0.38	0.41	7.9%
Mill Creek	Mill Creek	83512.05	772.3	772.31	0.0	1805.27	589.37	-67.4%	0.69	0.7	1.4%
Mill Creek	Mill Creek	83409.37	772.29	772.3	0.0	896.72	607.56	-32.2%	0.68	0.67	-1.5%
Mill Creek	Mill Creek	83308.99	772.28	772.29	0.0	574.31	528.48	-8.0%	0.71	0.78	9.9%
Mill Creek	Mill Creek	83252	772.29	772.3	0.0	1191.19	1108.68	-6.9%	0.34	0.37	8.8%
Mill Creek	Mill Creek	82941.84	772.26	772.27	0.0	825.81	833.86	1.0%	0.5	0.49	-2.0%
Mill Creek	Mill Creek	82767.73	772.18	772.19	0.0	675.2	678.92	0.6%	1.5	1.49	-0.7%
Mill Creek	Mill Creek	82565.48	772.12	772.13	0.0	562.22	561.61	-0.1%	1.35	1.34	-0.7%
Mill Creek	Mill Creek	82427.49	772.07	772.08	0.0	2291.23	2232.91	-2.5%	0.84	0.84	0.0%
Mill Creek	Mill Creek	82285.43	772.01	772.03	0.0	1212.06	1136.59	-6.2%	1.22	1.21	-0.8%
Mill Creek	Mill Creek	82219.17	772	772.02	0.0	605.47	588.22	-2.8%	1.21	1.24	2.5%
Mill Creek	Mill Creek	81725.46	771.97	771.98	0.0	870.23	838.42	-3.7%	0.84	0.87	3.6%
Mill Creek	Mill Creek	81574.89	771.96	771.98	0.0	2315.78	2266.04	-2.1%	0.55	0.56	1.8%
Mill Creek	Mill Creek	81455.82	771.95	771.96	0.0	1432.05	1353.25	-5.5%	0.84	0.86	2.4%
Mill Creek	Mill Creek	81323.03	771.94	771.95	0.0	979	968.37	-1.1%	0.86	0.86	0.0%
Mill Creek	Mill Creek	81284.76	771.9	771.91	0.0	495.36	492.09	-0.7%	1.49	1.5	0.7%
Mill Creek	Mill Creek	81147.44	771.07	771.07	0.0	682.9	674.46	-1.2%	1.59	1.61	1.3%
Mill Creek	Mill Creek	80852.36	770.95	770.95	0.0	470.07	438.07	-6.8%	1.6	1.69	5.6%
Mill Creek	Mill Creek	80599.68	770.92	770.92	0.0	812.09	792.51	-2.4%	0.9	0.92	2.2%
Mill Creek	Mill Creek	80387.78	770.91	770.91	0.0	1547.32	1511.08	-2.3%	0.55	0.56	1.8%
Mill Creek	Mill Creek	80175.9	770.91	770.91	0.0	2970.67	2945.64	-0.8%	0.25	0.25	0.0%
Mill Creek	Mill Creek	79911.55	770.9	770.9	0.0	1854.07	1736.89	-6.3%	0.39	0.42	7.7%
Mill Creek	Mill Creek	79610.31	770.89	770.89	0.0	1915.09	1814.6	-5.2%	0.34	0.36	5.9%
Mill Creek	Mill Creek	79228.27	770.88	770.89	0.0	3170.26	3094.4	-2.4%	0.2	0.21	5.0%

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Mill Creek	Mill Creek	79175.47	770.88	770.89	0.0		4078.42	3961.36	-2.9%		0.16	0.16	0.0%
Mill Creek	Mill Creek	79131.22	770.88	770.89	0.0		6469.58	6316.74	-2.4%		0.1	0.1	0.0%
Mill Creek	Mill Creek	79100.27	770.88	770.89	0.0		5587.31	5455.67	-2.4%		0.12	0.12	0.0%
Mill Creek	Mill Creek	79062.45	770.88	770.88	0.0		2368.4	2265.02	-4.4%		0.31	0.33	6.5%
Mill Creek	Mill Creek	79010.23	770.86	770.86	0.0		988.78	916.04	-7.4%		0.75	0.81	8.0%
Mill Creek	Mill Creek	78815.24	770.84	770.84	0.0		1012.78	918.51	-9.3%		0.74	0.81	9.5%
Mill Creek	Mill Creek	78769.97	770.85	770.85	0.0		2805.99	2653.73	-5.4%		0.27	0.28	3.7%
Mill Creek	Mill Creek	78712.13	770.8	770.8	0.0		590.21	539.46	-8.6%		1.26	1.38	9.5%
Mill Creek	Mill Creek	78650.38	770.8	770.8	0.0		3334.52	3171.1	-4.9%		0.52	0.56	7.7%
Mill Creek	Mill Creek	78557.05	770.54	770.53	0.0		784.28	707.29	-9.8%		1.02	1.09	6.9%
Mill Creek	Mill Creek	78413.13	770.54	770.53	0.0		1220.35	1117.58	-8.4%		0.61	0.67	9.8%
Mill Creek	Mill Creek	77915.05	770.54	770.52	0.0		1995.94	1881.58	-5.7%		0.37	0.4	8.1%
Mill Creek	Mill Creek	77748.71	770.54	770.52	0.0		2492.93	2316.92	-7.1%		0.3	0.32	6.7%
Mill Creek	Mill Creek	77697.68	770.54	770.52	0.0		2505.61	2338.92	-6.7%		0.3	0.32	6.7%
Mill Creek	Mill Creek	77497.35	770.54	770.52	0.0		3113.5	2970.94	-4.6%		0.24	0.25	4.2%
Mill Creek	Mill Creek	77354.13	770.54	770.52	0.0		3044.4	2936.21	-3.6%		0.25	0.25	0.0%
Mill Creek	Mill Creek	77174.32	770.54	770.52	0.0		3175.98	2867	-9.7%		0.27	0.27	0.0%
Mill Creek	Mill Creek	77105.67	770.53	770.52	0.0		2671.21	2456.98	-8.0%		0.37	0.37	0.0%
Mill Creek	Mill Creek	77009.58	770.52	770.5	0.0		1452.39	1421.54	-2.1%		0.85	0.85	0.0%
Mill Creek	Mill Creek	76822.57	766.93	766.93	0.0		717.54	669.96	-6.6%		2.07	2.06	-0.5%
Mill Creek	Mill Creek	76657.27	766.83	766.83	0.0		621.1	562.81	-9.4%		1.37	1.42	3.6%
Mill Creek	Mill Creek	76503.97	766.68	766.68	0.0		462.49	438.86	-5.1%		1.61	1.7	5.6%
Mill Creek	Mill Creek	76427.33	766.6	766.6	0.0		547.5	508.88	-7.1%		1.52	1.63	7.2%
Mill Creek	Mill Creek	76362.75	766.58	766.58	0.0		1166.05	1061.5	-9.0%		0.99	0.99	0.0%
Mill Creek	Mill Creek	76132.83	766.53	766.54	0.0		4580.99	4180.76	-8.7%		0.54	0.54	0.0%
Mill Creek	Mill Creek	75953.84	766.51	766.51	0.0		4790.54	4423.11	-7.7%		0.45	0.45	0.0%
Mill Creek	Mill Creek	75457.87	766.5	766.5	0.0		6096.58	5747.57	-5.7%		0.25	0.25	0.0%
Mill Creek	Mill Creek	75380.94	766.5	766.5	0.0		4616.83	4315.02	-6.5%		0.23	0.23	0.0%
Mill Creek	Mill Creek	75245.11	766.49	766.5	0.0		3549.01	3195.48	-10.0%		0.27	0.27	0.0%
Mill Creek	Mill Creek	74929.37	766.42	766.43	0.0		863.47	850.67	-1.5%		1.27	1.29	1.6%
Mill Creek	Mill Creek	74706.67	766.28	766.29	0.0		637.52	595.19	-6.6%		1.54	1.55	0.6%
Mill Creek	Mill Creek	74616.69	766.19	766.19	0.0		352.47	348.39	-1.2%		1.96	1.98	1.0%
Mill Creek	Mill Creek	74472.09	766.25	766.25	0.0		3880.63	3583.99	-7.6%		0.34	0.37	8.8%
Mill Creek	Mill Creek	74316.98	766.25	766.25	0.0		6445.47	6286.7	-2.5%		0.26	0.26	0.0%
Mill Creek	Mill Creek	74000.91	766.25	766.25	0.0		8231.2	8124.78	-1.3%		0.19	0.19	0.0%
Mill Creek	Mill Creek	73633.6	766.25	766.25	0.0		8715.45	8571.8	-1.6%		0.14	0.14	0.0%
Mill Creek	Mill Creek	72698.65	766.24	766.25	0.0		8377.64	8129.77	-3.0%		0.12	0.12	0.0%
Mill Creek	Mill Creek	72151.63	766.24	766.25	0.0		6306.76	6277.41	-0.5%		0.12	0.12	0.0%
Mill Creek	Mill Creek	71528.2	766.23	766.24	0.0		2341.04	2269.24	-3.1%		0.3	0.3	0.0%

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Mill Creek	Mill Creek	71179.96	766.21	766.22	0.0		1061.77	1001.89	-5.6%		0.67	0.69	3.0%
Mill Creek	Mill Creek	71115.17	766.2	766.21	0.0		793.36	783.75	-1.2%		0.87	0.88	1.1%
Mill Creek	Mill Creek	71005.4	766.18	766.19	0.0		1161.88	1057.55	-9.0%		0.67	0.69	3.0%
Mill Creek	Mill Creek	70802.66	765.98	765.99	0.0		450	422.53	-6.1%		1.53	1.63	6.5%
Mill Creek	Mill Creek	70678.16	765.9	765.92	0.0		446.43	411.86	-7.7%		1.55	1.68	8.4%
Mill Creek	Mill Creek	70484.63	765.83	765.85	0.0		504.03	478.61	-5.0%		1.37	1.44	5.1%
Mill Creek	Mill Creek	70278.55	765.76	765.78	0.0		830.27	783.06	-5.7%		1.17	1.17	0.0%
Mill Creek	Mill Creek	70205.34	765.75	765.76	0.0		1829.86	1706.89	-6.7%		0.97	0.98	1.0%
Mill Creek	Mill Creek	70078.66	765.73	765.74	0.0		2478.06	2247.41	-9.3%		0.69	0.72	4.3%
Mill Creek	Mill Creek	69994.95	765.71	765.72	0.0		2730.06	2524.66	-7.5%		0.8	0.82	2.5%
Mill Creek	Mill Creek	69898.8	765.66	765.67	0.0		547.05	515.75	-5.7%		1.26	1.34	6.3%
Mill Creek	Mill Creek	69580.3	765.41	765.43	0.0		377.55	352.15	-6.7%		1.83	1.96	7.1%
Mill Creek	Mill Creek	69463.89	765.22	765.24	0.0		400.7	390.98	-2.4%		1.72	1.76	2.3%
Mill Creek	Mill Creek	69385.38	765.26	765.28	0.0		600.92	584.6	-2.7%		1.15	1.18	2.6%
Mill Creek	Mill Creek	69236.35	765.2	765.22	0.0		696.1	662.11	-4.9%		0.99	1.04	5.1%
Mill Creek	Mill Creek	69080.73	765.19	765.2	0.0		1686.81	1525.16	-9.6%		0.52	0.55	5.8%
Mill Creek	Mill Creek	68699.81	765.18	765.19	0.0		3036.24	2744.58	-9.6%		0.23	0.25	8.7%
Mill Creek	Mill Creek	68363.32	765.14	765.15	0.0		869.68	825.81	-5.0%		0.79	0.84	6.3%
Mill Creek	Mill Creek	68055.98	765.09	765.11	0.0		954.68	891.1	-6.7%		0.72	0.77	6.9%
Mill Creek	Mill Creek	67812.81	765.06	765.08	0.0		1005.83	956.1	-4.9%		0.69	0.72	4.3%
Mill Creek	Mill Creek	67703.96	765.05	765.07	0.0		1916.37	1757.89	-8.3%		0.5	0.51	2.0%
Mill Creek	Mill Creek	67617.81	765.05	765.07	0.0		3840.95	3547.11	-7.7%		0.39	0.42	7.7%
Mill Creek	Mill Creek	67222.69	765.02	765.04	0.0		3155.76	2896.29	-8.2%		0.38	0.39	2.6%
Mill Creek	Mill Creek	66965.84	764.97	764.99	0.0		2068.3	1979.32	-4.3%		0.79	0.78	-1.3%
Mill Creek	Mill Creek	66643.4	764.96	764.97	0.0		2493.17	2339.02	-6.2%		0.3	0.32	6.7%
Mill Creek	Mill Creek	66194.4	764.94	764.96	0.0		2473.26	2326.88	-5.9%		0.28	0.3	7.1%
Mill Creek	Mill Creek	66019.74	764.94	764.95	0.0		3330.52	3049.33	-8.4%		0.25	0.25	0.0%
Mill Creek	Mill Creek	65910.96	764.92	764.93	0.0		2400	2179.22	-9.2%		0.53	0.58	9.4%
Mill Creek	Mill Creek	65816.52	764.91	764.92	0.0		1726.87	1632.76	-5.4%		0.59	0.63	6.8%
Mill Creek	Mill Creek	65684.5	764.9	764.92	0.0		2014.92	1926.77	-4.4%		0.41	0.41	0.0%
Mill Creek	Mill Creek	65577.45	764.89	764.91	0.0		4279.38	4024.22	-6.0%		0.44	0.47	6.8%
Mill Creek	Mill Creek	65384.01	764.87	764.89	0.0		1953.03	1907.15	-2.3%		0.44	0.44	0.0%
Mill Creek	Mill Creek	65217.55	764.85	764.86	0.0		1652.5	1597.67	-3.3%		0.56	0.57	1.8%
Mill Creek	Mill Creek	65033.24	764.82	764.84	0.0		2183.51	2105.15	-3.6%		0.47	0.47	0.0%
Mill Creek	Mill Creek	64909.54	764.82	764.83	0.0		2733.48	2633.95	-3.6%		0.31	0.31	0.0%
Mill Creek	Mill Creek	64796.79	764.81	764.83	0.0		2543.63	2478.77	-2.5%		0.32	0.31	-3.1%
Mill Creek	Mill Creek	64461.93	764.77	764.79	0.0		2768.66	2620.24	-5.4%		0.75	0.75	0.0%
Mill Creek	Mill Creek	64262.61	763.71	763.73	0.0		880.99	820.48	-6.9%		1.58	1.57	-0.6%
Mill Creek	Mill Creek	64132.18	763.67	763.68	0.0		1072.7	995.23	-7.2%		0.99	0.99	0.0%

	Mill Creek		Illinois State Water Survey										
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Mill Creek	Mill Creek	62741.96	763.5	763.53	0.0		2393.37	2158.48	-9.8%		0.33	0.33	0.0%
Mill Creek	Mill Creek	62264.09	763.47	763.5	0.0		2398.65	2259.47	-5.8%		0.3	0.31	3.3%
Mill Creek	Mill Creek	62103.67	763.46	763.49	0.0		2464.74	2271.38	-7.8%		0.29	0.31	6.9%
Mill Creek	Mill Creek	61962.44	763.46	763.48	0.0		2725.17	2560.5	-6.0%		0.26	0.28	7.7%
Mill Creek	Mill Creek	61598.15	763.45	763.47	0.0		2816.13	2669.79	-5.2%		0.25	0.27	8.0%
Mill Creek	Mill Creek	61372.86	763.4	763.43	0.0		840.49	785.56	-6.5%		0.84	0.9	7.1%
Mill Creek	Mill Creek	61132.34	763.33	763.35	0.0		672.28	615.97	-8.4%		1.06	1.15	8.5%
Mill Creek	Mill Creek	60983.91	763.26	763.28	0.0		595.97	549.65	-7.8%		1.25	1.36	8.8%
Mill Creek	Mill Creek	60914.55	763.17	763.19	0.0		575.89	526.21	-8.6%		1.33	1.46	9.8%
Mill Creek	Mill Creek	60827.47	763.15	763.17	0.0		658.92	602.82	-8.5%		1.08	1.18	9.3%
Mill Creek	Mill Creek	60644.46	763.06	763.08	0.0		545.42	496.8	-8.9%		1.3	1.43	10.0%
Mill Creek	Mill Creek	60599.03	763.06	763.08	0.0		1928.32	1764.3	-8.5%		1.07	1.14	6.5%
Mill Creek	Mill Creek	60578.32	763.05	763.07	0.0		2107.8	1970.57	-6.5%		0.97	1.02	5.2%
Mill Creek	Mill Creek	60444.16	763.03	763.05	0.0		3113.95	2909.47	-6.6%		0.72	0.77	6.9%
Mill Creek	Mill Creek	60370.31	763.03	763.05	0.0		3325.04	3128.1	-5.9%		0.54	0.58	7.4%
Mill Creek	Mill Creek	60222.5	763.03	763.05	0.0		4556.7	4336.37	-4.8%		0.26	0.28	7.7%
Mill Creek	Mill Creek	60107.16	763.03	763.05	0.0		10737.98	10448.03	-2.7%		0.33	0.36	9.1%
Mill Creek	Mill Creek	60070.98	763.03	763.04	0.0		8228.62	7679	-6.7%		0.39	0.42	7.7%
Mill Creek	Mill Creek	60009.45	763.02	763.04	0.0		7597.46	7022.51	-7.6%		0.41	0.43	4.9%
Mill Creek	Mill Creek	59973.93	763.01	763.03	0.0		8398.5	8126.82	-3.2%		0.5	0.53	6.0%
Mill Creek	Mill Creek	59937.76	763	763.02	0.0		4151.7	3879.55	-6.6%		0.65	0.7	7.7%
Mill Creek	Mill Creek	59870.14	763	763.02	0.0		1579.93	1433.71	-9.3%		0.46	0.5	8.7%
Mill Creek	Mill Creek	59750.65	762.96	762.97	0.0		655.42	603.27	-8.0%		1.08	1.18	9.3%
Mill Creek	Mill Creek	59611.54	762.95	762.97	0.0		1137.52	1045.91	-8.1%		0.62	0.68	9.7%
Mill Creek	Mill Creek	59360.86	762.92	762.93	0.0		794.59	742.47	-6.6%		0.89	0.96	7.9%
Mill Creek	Mill Creek	59209.08	762.86	762.88	0.0		558.81	517.87	-7.3%		1.27	1.37	7.9%
Mill Creek	Mill Creek	58902.88	762.77	762.78	0.0		556.35	506.76	-8.9%		1.28	1.4	9.4%
Mill Creek	Mill Creek	58795.22	762.74	762.75	0.0		551.99	514.74	-6.7%		1.29	1.38	7.0%
Mill Creek	Mill Creek	58747.01	762.7	762.71	0.0		493.18	472.28	-4.2%		1.54	1.61	4.5%
Mill Creek	Mill Creek	58680.01	762.46	762.46	0.0		367.95	344.83	-6.3%		2	2.14	7.0%
Mill Creek	Mill Creek	58571.21	762.4	762.4	0.0		412.44	378.31	-8.3%		1.72	1.88	9.3%
Mill Creek	Mill Creek	58271.79	762.26	762.25	0.0		446.16	417.72	-6.4%		1.59	1.7	6.9%
Mill Creek	Mill Creek	58057.35	762.15	762.16	0.0		457.81	442.16	-3.4%		1.55	1.61	3.9%
Mill Creek	Mill Creek	57805.48	762.12	762.12	0.0		850.95	782.14	-8.1%		0.83	0.91	9.6%
Mill Creek	Mill Creek	57693.5	762.11	762.11	0.0		1965.11	1896.64	-3.5%		0.56	0.56	0.0%
Mill Creek	Mill Creek	57388.87	762.11	762.11	0.0		4651.9	4407	-5.3%		0.25	0.25	0.0%
Mill Creek	Mill Creek	57218.32	762.11	762.11	0.0		3276.08	3003.24	-8.3%		0.32	0.32	0.0%
Mill Creek	Mill Creek	57099.83	762.1	762.1	0.0		2044.75	1904.41	-6.9%		0.47	0.5	6.4%
Mill Creek	Mill Creek	56866.33	762.06	762.06	0.0		907.55	842.33	-7.2%		0.78	0.84	7.7%

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Mill Creek	Mill Creek	56716.78	761.99	761.99	0.0		704.6	661.28	-6.1%		1.42	1.42	0.0%
Mill Creek	Mill Creek	56565.29	759.85	759.86	0.0		220.78	213.97	-3.1%		3.84	3.83	-0.3%
Mill Creek	Mill Creek	56412.67	759.55	759.57	0.0		236.32	234.6	-0.7%		3	3.03	1.0%
Mill Creek	Mill Creek	56311.64	759.55	759.56	0.0		565.82	522.29	-7.7%		1.25	1.36	8.8%
Mill Creek	Mill Creek	56065.97	759.32	759.32	0.0		450.3	423.5	-6.0%		1.58	1.68	6.3%
Mill Creek	Mill Creek	55964.77	759.12	759.11	0.0		300.88	296.17	-1.6%		2.36	2.4	1.7%
Mill Creek	Mill Creek	55845.48	759.02	759.02	0.0		420.18	398.7	-5.1%		1.69	1.78	5.3%
Mill Creek	Mill Creek	55408.12	758.21	758.21	0.0		259.55	257.65	-0.7%		2.74	2.76	0.7%
Mill Creek	Mill Creek	55271.67	758.05	758.05	0.0		346.57	344.94	-0.5%		2.05	2.06	0.5%
Mill Creek	Mill Creek	55195.29	757.97	757.97	0.0		437.56	401.91	-8.1%		1.62	1.77	9.3%
Mill Creek	Mill Creek	55145.15	757.95	757.95	0.0		527.52	505.75	-4.1%		1.35	1.4	3.7%
Mill Creek	Mill Creek	55024.34	757.72	757.72	0.0		343.01	334.02	-2.6%		2.07	2.13	2.9%
Mill Creek	Mill Creek	54903.21	757.31	757.31	0.0		190.25	186.14	-2.2%		3.73	3.81	2.1%
Mill Creek	Mill Creek	54850.91	757.24	757.23	0.0		362.57	343.99	-5.1%		1.96	2.06	5.1%
Mill Creek	Mill Creek	54764.98	757.21	757.21	0.0		557.49	526.7	-5.5%		1.27	1.35	6.3%
Mill Creek	Mill Creek	54675.68	757.07	757.06	0.0		374.11	353.61	-5.5%		1.9	2.01	5.8%
Mill Creek	Mill Creek	54511.41	756.75	756.74	0.0		293.41	282.4	-3.8%		2.42	2.51	3.7%
Mill Creek	Mill Creek	54372.02	756.6	756.61	0.0		416.31	396.68	-4.7%		1.71	1.79	4.7%
Mill Creek	Mill Creek	54220.36	756.38	756.4	0.0		359.91	348.67	-3.1%		1.97	2.04	3.6%
Mill Creek	Mill Creek	54107.28	756.33	756.34	0.0		528.06	496.51	-6.0%		1.34	1.43	6.7%
Mill Creek	Mill Creek	53901.62	756.18	756.2	0.0		584.27	545.66	-6.6%		1.22	1.3	6.6%
Mill Creek	Mill Creek	53631.79	755.97	755.99	0.0		541.02	503.03	-7.0%		1.31	1.41	7.6%
Mill Creek	Mill Creek	53532.61	755.94	755.95	0.0		627.48	587.31	-6.4%		1.13	1.21	7.1%
Mill Creek	Mill Creek	53430.02	755.82	755.83	0.0		441.45	423.52	-4.1%		1.61	1.68	4.3%
Mill Creek	Mill Creek	53298.28	755.69	755.7	0.0		399.59	368.64	-7.7%		1.78	1.93	8.4%
Mill Creek	Mill Creek	53228.5	755.49	755.51	0.0		260.85	249.91	-4.2%		2.72	2.84	4.4%
Mill Creek	Mill Creek	53191.27	755.37	755.4	0.0		243.76	230.33	-5.5%		2.91	3.08	5.8%
Mill Creek	Mill Creek	53156.59	755.4	755.43	0.0		396.91	376.76	-5.1%		2.03	2.02	-0.5%
Mill Creek	Mill Creek	52879.23	754.74	754.77	0.0		327.57	306.98	-6.3%		2.94	3.07	4.4%
Mill Creek	Mill Creek	52538.73	754.5	754.52	0.0		676	628.1	-7.1%		1.27	1.34	5.5%
Mill Creek	Mill Creek	51997.54	754.26	754.27	0.0		760.37	706.33	-7.1%		1.13	1.19	5.3%
Mill Creek	Mill Creek	51952.63	754.25	754.26	0.0		890.7	835.37	-6.2%		0.94	1.01	7.4%
Mill Creek	Mill Creek	51669.63	754.14	754.14	0.0		855.22	801.71	-6.3%		0.98	1.05	7.1%
Mill Creek	Mill Creek	51518.58	753.98	753.99	0.0		498.33	482.79	-3.1%		1.69	1.74	3.0%
Mill Creek	Mill Creek	51453.58	753.9	753.9	0.0		440.29	406.36	-7.7%		1.91	2.07	8.4%
Mill Creek	Mill Creek	51329.04	753.81	753.81	0.0		437.03	416.66	-4.7%		1.92	2.02	5.2%
Mill Creek	Mill Creek	51284.37	753.57	753.57	0.0		255.7	242.81	-5.0%		3.29	3.46	5.2%
Mill Creek	Mill Creek	51226	753.5	753.5	0.0		240	239.07	-0.4%		3.5	3.51	0.3%
Mill Creek	Mill Creek	51103.14	752.71	752.74	0.0		282.14	272.62	-3.4%		3.04	3.08	1.3%

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Mill Creek	Mill Creek	51024.2	752.7	752.74	0.0		436.4	417.13	-4.4%		2.14	2.25	5.1%
Mill Creek	Mill Creek	50891.75	752.66	752.7	0.0		475.5	437.06	-8.1%		1.77	1.92	8.5%
Mill Creek	Mill Creek	50665.23	752.6	752.63	0.0		463.15	467.08	0.8%		1.81	1.8	-0.6%
Mill Creek	Mill Creek	50404.43	752.52	752.56	0.0		495.52	478.93	-3.3%		1.7	1.75	2.9%
Mill Creek	Mill Creek	50282.87	752.49	752.53	0.0		576.56	536.36	-7.0%		1.49	1.57	5.4%
Mill Creek	Mill Creek	50141.68	752.47	752.51	0.0		690.09	678.47	-1.7%		1.22	1.24	1.6%
Mill Creek	Mill Creek	50041.86	752.47	752.51	0.0		936	945.04	1.0%		0.9	0.89	-1.1%
Mill Creek	Mill Creek	49793.08	752.44	752.49	0.0		855.82	844.73	-1.3%		0.98	0.99	1.0%
Mill Creek	Mill Creek	49647.02	752.44	752.48	0.0		1129.48	1133.9	0.4%		0.74	0.74	0.0%
Mill Creek	Mill Creek	49506.18	752.42	752.47	0.1		978.47	969.88	-0.9%		0.86	0.87	1.2%
Mill Creek	Mill Creek	49310.01	752.41	752.45	0.0		1044.89	1024.34	-2.0%		0.8	0.82	2.5%
Mill Creek	Mill Creek	49215	746.92	746.89	0.0		180.79	177.86	-1.6%		4.65	4.72	1.5%
Mill Creek	Mill Creek	49188.7	746.92	746.91	0.0		296.14	278.66	-5.9%		2.84	3.01	6.0%
Mill Creek	Mill Creek	49120.32	746.7	746.69	0.0		354.49	327.31	-7.7%		2.37	2.57	8.4%
Mill Creek	Mill Creek	48821.54	744.96	744.98	0.0		198.23	190.26	-4.0%		4.24	4.42	4.2%
Mill Creek	Mill Creek	48572.16	744.41	744.41	0.0		286.01	266.99	-6.7%		2.94	3.15	7.1%
Mill Creek	Mill Creek	48428.48	743.94	743.93	0.0		225.82	206.92	-8.4%		3.72	4.06	9.1%
Mill Creek	Mill Creek	48163.85	743.2	743.2	0.0		184.6	184.62	0.0%		4.55	4.55	0.0%
Mill Creek	Mill Creek	47878.97	742.2	742.21	0.0		159.81	159.5	-0.2%		5.26	5.27	0.2%
Mill Creek	Mill Creek	47777.66	741.73	741.73	0.0		176.36	159.05	-9.8%		5.56	5.57	0.2%
Mill Creek	Mill Creek	47683.72	741.47	741.48	0.0		219.02	200.78	-8.3%		5.06	5.07	0.2%
Mill Creek	Mill Creek	47560.7	741.21	741.22	0.0		229.43	219.12	-4.5%		3.75	3.83	2.1%
Mill Creek	Mill Creek	47456.16	740.54	740.54	0.0		166.73	154.97	-7.1%		5.04	5.42	7.5%
Mill Creek	Mill Creek	47320.94	740.08	740.07	0.0		226.63	210.95	-6.9%		3.71	3.98	7.3%
Mill Creek	Mill Creek	47183.36	739.75	739.77	0.0		263.76	249	-5.6%		3.18	3.37	6.0%
Mill Creek	Mill Creek	46956.05	739.31	739.33	0.0		326.88	302.76	-7.4%		2.57	2.77	7.8%
Mill Creek	Mill Creek	46576.21	738.69	738.7	0.0		403.81	368.05	-8.9%		2.16	2.28	5.6%
Mill Creek	Mill Creek	46535.63	738.4	738.41	0.0		226.46	211.3	-6.7%		3.71	3.98	7.3%
Mill Creek	Mill Creek	46493.22	738.41	738.42	0.0		280.43	264.33	-5.7%		3	3.18	6.0%
Mill Creek	Mill Creek	46375.11	738.26	738.25	0.0		439.29	395.61	-9.9%		1.97	2.12	7.6%
Mill Creek	Mill Creek	46292.08	738.19	738.19	0.0		482.6	446.94	-7.4%		1.74	1.88	8.0%
Mill Creek	Mill Creek	46194.1	737.92	737.9	0.0		291.28	265.66	-8.8%		2.88	3.16	9.7%
Mill Creek	Mill Creek	46108.36	737.6	737.58	0.0		181.25	180.34	-0.5%		4.63	4.66	0.6%
Mill Creek	Mill Creek	46057.17	737.49	737.48	0.0		202.75	201.65	-0.5%		4.14	4.17	0.7%
Mill Creek	Mill Creek	46029.09	737.42	737.4	0.0		206.73	205.33	-0.7%		4.06	4.09	0.7%
Mill Creek	Mill Creek	45890.54	736.97	736.96	0.0		255.76	232.66	-9.0%		3.58	3.68	2.8%
Mill Creek	Mill Creek	45762.55	736.65	736.63	0.0		268.34	252.77	-5.8%		3.13	3.32	6.1%
Mill Creek	Mill Creek	45658.68	736.37	736.38	0.0		278.64	256.61	-7.9%		3.01	3.27	8.6%
Mill Creek	Mill Creek	45402.78	735.65	735.68	0.0		280.11	259.62	-7.3%		3.06	3.24	5.9%

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Mill Creek	Mill Creek	45084.83	734.99	735.03	0.0	283.13	261.26	-7.7%	2.97	3.22	8.4%
Mill Creek	Mill Creek	45031.2	734.76	734.8	0.0	224.05	214.61	-4.2%	3.75	3.91	4.3%
Mill Creek	Mill Creek	44921.89	734.62	734.67	0.0	291.6	276.15	-5.3%	2.88	3.04	5.6%
Mill Creek	Mill Creek	44802.37	734.39	734.44	0.1	336.44	313.42	-6.8%	2.5	2.68	7.2%
Mill Creek	Mill Creek	44616.39	734.14	734.19	0.1	487.33	454.42	-6.8%	1.72	1.85	7.6%
Mill Creek	Mill Creek	44040.07	732.97	733.01	0.0	369.43	338.69	-8.3%	2.27	2.48	9.3%
Mill Creek	Mill Creek	43715.82	732.48	732.51	0.0	433.2	400.08	-7.6%	1.94	2.1	8.2%
Mill Creek	Mill Creek	43357.29	731.77	731.79	0.0	323.67	302.9	-6.4%	2.6	2.77	6.5%
Mill Creek	Mill Creek	43042.5	730.71	730.74	0.0	265.78	242.91	-8.6%	3.24	3.46	6.8%
Mill Creek	Mill Creek	42740.83	730.11	730.13	0.0	530.19	505.63	-4.6%	1.98	2.08	5.1%
Mill Creek	Mill Creek	42290.71	728.58	728.61	0.0	328.4	308.52	-6.1%	3.2	3.4	6.2%
Mill Creek	Mill Creek	41944.01	728	728.04	0.0	558.74	518.17	-7.3%	1.88	2.03	8.0%
Mill Creek	Mill Creek	41272.76	727.35	727.38	0.0	733.33	668.23	-8.9%	1.49	1.57	5.4%
Mill Creek	Mill Creek	40628.66	726.54	726.57	0.0	1240.44	1154.32	-6.9%	2.57	2.6	1.2%
Mill Creek	Mill Creek	40536.93	725.61	725.66	0.0	724.98	660.75	-8.9%	3.29	3.25	-1.2%
Mill Creek	Mill Creek	40436.68	725.29	725.33	0.0	452.64	421.77	-6.8%	3.02	3.11	3.0%
Mill Creek	Mill Creek	40276.64	724.84	724.87	0.0	378.19	354.61	-6.2%	2.78	2.96	6.5%
Mill Creek	Mill Creek	40113.86	724.3	724.37	0.1	380.66	364.52	-4.2%	2.76	2.88	4.3%
Mill Creek	Mill Creek	39857.3	723.63	723.71	0.1	437.93	413.04	-5.7%	2.4	2.54	5.8%
Mill Creek	Mill Creek	39237.41	722.5	722.55	0.0	466.36	439.69	-5.7%	2.25	2.39	6.2%
Mill Creek	Mill Creek	38836.78	721.51	721.56	0.0	350.1	321.4	-8.2%	3	3.27	9.0%
Mill Creek	Mill Creek	38744.46	721.06	721.1	0.0	516.42	476.17	-7.8%	2.03	2.21	8.9%
Mill Creek	Mill Creek	38566.59	720.87	720.91	0.0	657.76	626.25	-4.8%	1.6	1.68	5.0%
Mill Creek	Mill Creek	38444.06	720.56	720.62	0.1	413.9	393.36	-5.0%	2.54	2.67	5.1%
Mill Creek	Mill Creek	38344.89	720.42	720.48	0.1	475.78	442.33	-7.0%	2.21	2.37	7.2%
Mill Creek	Mill Creek	38151.04	719.24	719.27	0.0	195.63	178.4	-8.8%	5.37	5.89	9.7%
Mill Creek	Mill Creek	38024.78	719.05	719.08	0.0	417.71	383.92	-8.1%	2.59	2.73	5.4%
Mill Creek	Mill Creek	37856	718.66	718.67	0.0	422.19	392.47	-7.0%	2.49	2.68	7.6%
Mill Creek	Mill Creek	37684.82	718.47	718.48	0.0	650.21	611.46	-6.0%	1.61	1.72	6.8%
Mill Creek	Mill Creek	37555.23	717.87	717.91	0.0	314.97	289.6	-8.1%	3.33	3.63	9.0%
Mill Creek	Mill Creek	37311.34	716.81	716.86	0.1	289.86	271.35	-6.4%	3.62	3.87	6.9%
Mill Creek	Mill Creek	37134.68	716.15	716.17	0.0	356.42	336.81	-5.5%	2.95	3.12	5.8%
Mill Creek	Mill Creek	37000.93	715.11	715.1	0.0	254.46	239.19	-6.0%	4.13	4.39	6.3%
Mill Creek	Mill Creek	36881.19	714.72	714.73	0.0	400.17	375.46	-6.2%	2.62	2.8	6.9%
Mill Creek	Mill Creek	36649.82	714.2	714.2	0.0	499.8	476.95	-4.6%	2.1	2.2	4.8%
Mill Creek	Mill Creek	36480.52	712.03	712.03	0.0	134.98	135.01	0.0%	7.78	7.78	0.0%
Mill Creek	Mill Creek	36327.44	711.77	711.76	0.0	240.16	238.49	-0.7%	4.37	4.4	0.7%
Mill Creek	Mill Creek	36248.55	711.42	711.41	0.0	195.54	194.78	-0.4%	5.45	5.46	0.2%
Mill Creek	Mill Creek	36225.39	711.19	711.19	0.0	168.72	168.47	-0.1%	6.22	6.23	0.2%

	Mill Creek		Illinois State Water Survey								
	3/31/2014		Note that all Output is from Steady-State Flow Model (not unsteady)								
River	Reach	River Station	W.S. Elev (ft) 100yr	W.S. Elev (ft) FW	Delta (ft)	Flow Area (sq ft) 100yr	Flow Area (sq ft) FW	Delta (%)	Vel Total (ft/s) 100yr	Vel Total (ft/s) FW	Delta (%)
Mill Creek	Mill Creek	36210.73	711.2	711.19	0.0	189.41	189.05	-0.2%	5.54	5.55	0.2%
Mill Creek	Mill Creek	36203.09	711.18	711.17	0.0	200.11	199.75	-0.2%	5.25	5.26	0.2%
Mill Creek	Mill Creek	36175.91	711.2	711.19	0.0	513.37	512.01	-0.3%	3.46	3.47	0.3%
Mill Creek	Mill Creek	36139.55	711.14	711.13	0.0	656.15	654.29	-0.3%	3	3.01	0.3%
Mill Creek	Mill Creek	35975.27	710.88	710.87	0.0	407.56	406.26	-0.3%	2.58	2.58	0.0%
Mill Creek	Mill Creek	35743.55	710.35	710.33	0.0	433.8	429.02	-1.1%	2.42	2.45	1.2%
Mill Creek	Mill Creek	35629.9	710.21	710.2	0.0	661.85	657.05	-0.7%	1.59	1.6	0.6%
Mill Creek	Mill Creek	35487.85	709.13	709.2	0.1	245.09	259.54	5.9%	4.28	4.05	-5.4%
Mill Creek	Mill Creek	35355.51	708.51	708.6	0.1	419.93	406.13	-3.3%	2.5	2.59	3.6%
Mill Creek	Mill Creek	34654.65	706.93	706.93	0.0	512.38	486.26	-5.1%	2.05	2.16	5.4%
Mill Creek	Mill Creek	34337.63	706.43	706.44	0.0	520.97	485.27	-6.9%	2.02	2.16	6.9%
Mill Creek	Mill Creek	33852.45	705.41	705.44	0.0	368.85	344.98	-6.5%	2.85	3.04	6.7%
Mill Creek	Mill Creek	33631.41	704.92	704.94	0.0	497.44	457.01	-8.1%	2.11	2.3	9.0%
Mill Creek	Mill Creek	33057.21	703.74	703.74	0.0	906.61	864.91	-4.6%	2.65	2.83	6.8%
Mill Creek	Mill Creek	32804.84	703.45	703.46	0.0	499.07	467.76	-6.3%	2.1	2.24	6.7%
Mill Creek	Mill Creek	32699.2	703.4	703.4	0.0	634.63	584.14	-8.0%	1.65	1.8	9.1%
Mill Creek	Mill Creek	32572.59	703.2	703.2	0.0	778.96	701.24	-10.0%	2.12	2.32	9.4%
Mill Creek	Mill Creek	32470.81	703.04	703.04	0.0	1297.28	1204.45	-7.2%	2.05	2.13	3.9%
Mill Creek	Mill Creek	32424.66	702.56	702.57	0.0	420.95	394.58	-6.3%	4.04	4.15	2.7%
Mill Creek	Mill Creek	32414.17	702.28	702.28	0.0	253.03	246.53	-2.6%	6.44	6.61	2.6%
Mill Creek	Mill Creek	32403.28	701.1	701.19	0.1	182.14	186.76	2.5%	8.95	8.73	-2.5%
Mill Creek	Mill Creek	32374.71	701.22	701.3	0.1	482.93	467.23	-3.3%	5.53	5.42	-2.0%
Mill Creek	Mill Creek	32296.57	701.23	701.32	0.1	814.8	791.14	-2.9%	2.69	2.62	-2.6%
Mill Creek	Mill Creek	31894.64	701.15	701.24	0.1	1655.95	1613.1	-2.6%	0.98	1.01	3.1%
Mill Creek	Mill Creek	31815.18	700.98	701.06	0.1	978.32	924.99	-5.5%	1.67	1.76	5.4%
Mill Creek	Mill Creek	31271.48	699.48	699.47	0.0	534.64	495.79	-7.3%	3.05	3.29	7.9%
Mill Creek	Mill Creek	30819.06	698.02	698.03	0.0	722.9	716.55	-0.9%	2.25	2.27	0.9%
Mill Creek	Mill Creek	30367.76	697.84	697.83	0.0	1003.89	924.06	-8.0%	1.62	1.76	8.6%
Mill Creek	Mill Creek	30271.23	697.65	697.64	0.0	814.54	763.23	-6.3%	2	2.14	7.0%
Mill Creek	Mill Creek	30198.33	697.53	697.5	0.0	778.1	718.37	-7.7%	2.09	2.27	8.6%
Mill Creek	Mill Creek	29844.77	696.58	696.57	0.0	797.73	736.31	-7.7%	2.85	2.98	4.6%
Mill Creek	Mill Creek	29503.96	694.64	694.68	0.0	282.07	284.64	0.9%	5.78	5.73	-0.9%
Mill Creek	Mill Creek	29274.33	694.51	694.53	0.0	700.95	668.98	-4.6%	2.33	2.44	4.7%
Mill Creek	Mill Creek	29006.87	693.73	693.81	0.1	580.24	580.11	0.0%	2.81	2.81	0.0%
Mill Creek	Mill Creek	28477.53	693.03	693.09	0.1	1010.26	933.61	-7.6%	1.61	1.75	8.7%
Mill Creek	Mill Creek	27767.4	691.81	691.86	0.1	674.84	636.53	-5.7%	2.42	2.56	5.8%
Mill Creek	Mill Creek	27581.2	691.29	691.38	0.1	647.2	634.7	-1.9%	2.52	2.57	2.0%
Mill Creek	Mill Creek	26916.29	690.41	690.52	0.1	874.01	835.78	-4.4%	1.86	1.95	4.8%
Mill Creek	Mill Creek	26460.51	689.63	689.72	0.1	726.01	678.55	-6.5%	2.25	2.4	6.7%

	Mill Creek		Illinois State Water Survey										
	3/31/2014		Note that all Output is from Steady-State Flow Model (not unsteady)										
River	Reach	River Station	W.S. Elev (ft) 100yr	W.S. Elev (ft) FW	Delta (ft)		Flow Area (sq ft) 100yr	Flow Area (sq ft) FW	Delta (%)		Vel Total (ft/s) 100yr	Vel Total (ft/s) FW	Delta (%)
Mill Creek	Mill Creek	25822.57	689.46	689.55	0.1		2165.86	1978.14	-8.7%		0.96	1.05	9.4%
Mill Creek	Mill Creek	25468.96	689.31	689.41	0.1		2661.79	2460.73	-7.6%		1.14	1.13	-0.9%
Mill Creek	Mill Creek	25349.16	689.23	689.3	0.1		1481.99	1372.71	-7.4%		1.4	1.52	8.6%
Mill Creek	Mill Creek	25021.46	689.06	689.12	0.1		1718.66	1582.19	-7.9%		1.21	1.31	8.3%
Mill Creek	Mill Creek	24842.2	688.95	689.02	0.1		1643.62	1518.05	-7.6%		1.27	1.37	7.9%
Mill Creek	Mill Creek	24036.64	688.61	688.66	0.0		1493.45	1397.95	-6.4%		1.39	1.49	7.2%
Mill Creek	Mill Creek	23592.16	688.39	688.42	0.0		1626.62	1510.15	-7.2%		1.28	1.38	7.8%
Mill Creek	Mill Creek	23263.03	688.27	688.3	0.0		2054.73	1907.26	-7.2%		1.01	1.09	7.9%
Mill Creek	Mill Creek	23019.82	688.2	688.23	0.0		2291.79	2125.58	-7.3%		0.91	0.98	7.7%
Mill Creek	Mill Creek	22766.76	688.12	688.15	0.0		1832.09	1702.62	-7.1%		1.14	1.22	7.0%
Mill Creek	Mill Creek	22417.24	688.03	688.05	0.0		1584.72	1461.74	-7.8%		1.31	1.42	8.4%
Mill Creek	Mill Creek	22187.35	687.92	687.93	0.0		1020.74	934.58	-8.4%		2.04	2.23	9.3%
Mill Creek	Mill Creek	22007.53	687.92	687.93	0.0		1763.57	1681.43	-4.7%		1.18	1.24	5.1%
Mill Creek	Mill Creek	21798.28	687.9	687.91	0.0		2225.71	2099.86	-5.7%		0.93	0.99	6.5%
Mill Creek	Mill Creek	21694.36	687.89	687.9	0.0		2142.88	2084.46	-2.7%		0.97	1	3.1%
Mill Creek	Mill Creek	21506.54	687.87	687.88	0.0		2089.24	2020.9	-3.3%		1	1.03	3.0%
Mill Creek	Mill Creek	21354.98	687.84	687.85	0.0		1987.8	1875.47	-5.7%		1.23	1.27	3.3%
Mill Creek	Mill Creek	21289.48	687.68	687.7	0.0		1269.01	1258.55	-0.8%		1.99	2.01	1.0%
Mill Creek	Mill Creek	21233.03	687.62	687.63	0.0		1335.97	1288.08	-3.6%		2	2.1	5.0%
Mill Creek	Mill Creek	21015.16	687.56	687.57	0.0		1587.46	1518.52	-4.3%		1.39	1.42	2.2%
Mill Creek	Mill Creek	20784.84	687.49	687.5	0.0		1306.16	1220.04	-6.6%		1.59	1.7	6.9%
Mill Creek	Mill Creek	20584.65	687.47	687.48	0.0		1756.37	1721.09	-2.0%		1.18	1.21	2.5%
Mill Creek	Mill Creek	20099.79	687.37	687.37	0.0		1350.84	1313.92	-2.7%		1.54	1.58	2.6%
Mill Creek	Mill Creek	19546.65	687.31	687.31	0.0		2176	2152.96	-1.1%		0.96	0.97	1.0%
Mill Creek	Mill Creek	19374.94	687.29	687.29	0.0		2617.62	2613.28	-0.2%		1.01	1.01	0.0%
Mill Creek	Mill Creek	19182.79	687.25	687.25	0.0		2325.01	2319.05	-0.3%		1.39	1.39	0.0%
Mill Creek	Mill Creek	19024.24	687.22	687.22	0.0		2447.37	2433.33	-0.6%		1.34	1.35	0.7%
Mill Creek	Mill Creek	18858.11	687.22	687.21	0.0		2761.67	2652.77	-3.9%		0.75	0.78	4.0%
Mill Creek	Mill Creek	18571.14	687.18	687.17	0.0		1836.45	1696.84	-7.6%		1.13	1.23	8.8%
Mill Creek	Mill Creek	18456.76	687.17	687.17	0.0		2561.38	2537.6	-0.9%		0.81	0.82	1.2%
Mill Creek	Mill Creek	18307.87	687.17	687.16	0.0		3198.99	3192.11	-0.2%		0.65	0.65	0.0%
Mill Creek	Mill Creek	18143.03	687.16	687.15	0.0		3215.3	3212.25	-0.1%		0.65	0.65	0.0%
Mill Creek	Mill Creek	18049.24	682.31	682.35	0.0		1982.96	1955.57	-1.4%		1.05	1.06	1.0%
Mill Creek	Mill Creek	17567.72	682.17	682.21	0.0		1856.74	1858.48	0.1%		1.14	1.14	0.0%
Mill Creek	Mill Creek	17313.54	681.99	682.03	0.0		1391.7	1353.85	-2.7%		1.49	1.54	3.4%
Mill Creek	Mill Creek	17206.03	681.98	682.01	0.0		2042.25	1872.94	-8.3%		1.02	1.11	8.8%
Mill Creek	Mill Creek	16480.37	681.16	681.21	0.1		1433.24	1464.13	2.2%		3.38	3.34	-1.2%
Mill Creek	Mill Creek	16302.37	680.18	680.27	0.1		889.91	947.43	6.5%		4.38	4.27	-2.5%
Mill Creek	Mill Creek	16172.07	679.94	680.01	0.1		1995.99	1926.68	-3.5%		3.18	3.41	7.2%

	Mill Creek		Illinois State Water Survey								
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River	Reach	River Station	W.S. Elev (ft) 100yr	W.S. Elev (ft) FW	Delta (ft)	Flow Area (sq ft) 100yr	Flow Area (sq ft) FW	Delta (%)	Vel Total (ft/s) 100yr	Vel Total (ft/s) FW	Delta (%)
Mill Creek	Mill Creek	16072.34	679.88	679.98	0.1	2486.38	2454.36	-1.3%	1.85	1.82	-1.6%
Mill Creek	Mill Creek	15998.1	679.77	679.88	0.1	2705.55	2680.63	-0.9%	1.55	1.49	-3.9%
Mill Creek	Mill Creek	15811.96	679.75	679.85	0.1	2315.85	2242.86	-3.2%	1	1.02	2.0%
Mill Creek	Mill Creek	15430.26	679.51	679.63	0.1	1258.65	1256.85	-0.1%	1.71	1.71	0.0%
Mill Creek	Mill Creek	14694.67	678.62	678.71	0.1	1196.03	1112.19	-7.0%	1.8	1.93	7.2%
Mill Creek	Mill Creek	14095.96	678.29	678.36	0.1	1783.52	1663.15	-6.7%	1.21	1.29	6.6%
Mill Creek	Mill Creek	13338.87	677.99	678.04	0.0	2083.33	1918.88	-7.9%	1.03	1.12	8.7%
Mill Creek	Mill Creek	12999.11	677.82	677.85	0.0	2484.99	2252.72	-9.3%	1.11	1.2	8.1%
Mill Creek	Mill Creek	12803.18	677.78	677.81	0.0	2012.51	1882.84	-6.4%	1.07	1.14	6.5%
Mill Creek	Mill Creek	12508.11	677.69	677.72	0.0	1666.72	1545.49	-7.3%	1.29	1.39	7.8%
Mill Creek	Mill Creek	12254.36	677.62	677.65	0.0	1904.67	1760.92	-7.5%	1.13	1.22	8.0%
Mill Creek	Mill Creek	11916.85	677.51	677.53	0.0	1960.19	1842.69	-6.0%	1.1	1.17	6.4%
Mill Creek	Mill Creek	11635.39	677.42	677.43	0.0	2142.55	1973.18	-7.9%	1	1.09	9.0%
Mill Creek	Mill Creek	11133.65	677.33	677.33	0.0	2703.82	2472.02	-8.6%	0.8	0.87	8.7%
Mill Creek	Mill Creek	10851.77	677.32	677.32	0.0	4919.19	4691.99	-4.6%	0.44	0.46	4.5%
Mill Creek	Mill Creek	10403.23	677.29	677.3	0.0	5048.66	4674.53	-7.4%	0.69	0.69	0.0%
Mill Creek	Mill Creek	10207.76	673.67	673.72	0.1	2022.56	1938.45	-4.2%	1.5	1.54	2.7%
Mill Creek	Mill Creek	10011.28	673.01	673.09	0.1	951.68	957.74	0.6%	3.55	3.49	-1.7%
Mill Creek	Mill Creek	8999.072	672.48	672.49	0.0	2350.2	2145.22	-8.7%	0.91	1	9.9%
Mill Creek	Mill Creek	8493.349	672.36	672.37	0.0	3161.97	2943.9	-6.9%	0.68	0.73	7.4%
Mill Creek	Mill Creek	8004.228	672.18	672.18	0.0	2454.88	2354.06	-4.1%	0.88	0.91	3.4%
Mill Creek	Mill Creek	6761.118	671.9	671.91	0.0	2895.46	2671.4	-7.7%	0.74	0.8	8.1%
Mill Creek	Mill Creek	5953.809	671.65	671.66	0.0	2616.97	2481.28	-5.2%	1.08	1.08	0.0%
Mill Creek	Mill Creek	5322.43	671.43	671.43	0.0	2772.45	2724.19	-1.7%	1.2	1.22	1.7%
Mill Creek	Mill Creek	4917.034	670.58	670.59	0.0	3227.11	3053.06	-5.4%	2.09	2.09	0.0%
Mill Creek	Mill Creek	4758.031	670.55	670.56	0.0	3275.67	3037.96	-7.3%	1.45	1.44	-0.7%
Mill Creek	Mill Creek	4630.638	670.52	670.53	0.0	3194.87	2879.03	-9.9%	1.19	1.18	-0.8%
Mill Creek	Mill Creek	4459.073	670.38	670.38	0.0	2813.34	2670.06	-5.1%	1.65	1.73	4.8%
Mill Creek	Mill Creek	4164.273	669.54	669.55	0.0	2877.22	2619.72	-8.9%	3.48	3.47	-0.3%
Mill Creek	Mill Creek	3494.03	668.65	668.67	0.0	2341.24	2142.56	-8.5%	2.22	2.19	-1.4%
Mill Creek	Mill Creek	3134.321	668.71	668.72	0.0	4902.55	4605.91	-6.1%	0.44	0.47	6.8%
Mill Creek	Mill Creek	2741.965	668.68	668.69	0.0	7124.05	6427.38	-9.8%	0.34	0.34	0.0%
Mill Creek	Mill Creek	2423.823	668.66	668.68	0.0	9072.66	8585.27	-5.4%	0.34	0.34	0.0%
Mill Creek	Mill Creek	2220.198	668.6	668.62	0.0	10937.97	10490.65	-4.1%	0.66	0.67	1.5%
Mill Creek	Mill Creek	1804.534	668.31	668.33	0.0	14409.08	14226.66	-1.3%	2.73	2.55	-6.6%
Mill Creek	Mill Creek	1435.503	666.03	666.11	0.1	17025.02	17425.45	2.4%	4.37	4.28	-2.1%
Mill Creek	Mill Creek	1162.479	665.82	665.92	0.1	18644.81	19265.72	3.3%	1.75	1.69	-3.4%
Mill Creek	Mill Creek	888.4987	665.79	665.89	0.1	22402.54	23071.86	3.0%	0.6	0.58	-3.3%

Appendix J. Floodway Data Table

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	888.4987	888	7121.07	23071.86	0.58	669.2	665.79	665.89	0.1
Mill Creek	1162.479	1162	6414.81	19265.72	1.69	669.2	665.82	665.92	0.1
Mill Creek	1435.503	1436	5786.62	17425.45	4.28	669.2	666.03	666.11	0.1
Mill Creek	1804.534	1805	3973.53	14226.66	2.55	669.2	668.31	668.33	0.0
Mill Creek	2220.198	2220	3424.03	10490.65	0.67	669.2	668.6	668.62	0.0
Mill Creek	2423.823	2424	2549.64	8585.27	0.34	669.2	668.66	668.68	0.0
Mill Creek	2741.965	2742	2156.95	6427.38	0.34	669.2	668.68	668.69	0.0
Mill Creek	3134.321	3134	1832.48	4605.91	0.47	669.2	668.71	668.72	0.0
Mill Creek	3494.03	3494	1049.89	2142.56	2.19	669.2	668.65	668.67	0.0
Mill Creek	4164.273	4164	992.23	2619.72	3.47	669.54	669.54	669.55	0.0
Mill Creek	4459.073	4459	906.83	2670.06	1.73	670.38	670.38	670.38	0.0
Mill Creek	4630.638	4631	950.59	2879.03	1.18	670.52	670.52	670.53	0.0
Mill Creek	4758.031	4758	973.9	3037.96	1.44	670.55	670.55	670.56	0.0
Mill Creek	4917.034	4917	1007.6	3053.06	2.09	670.58	670.58	670.59	0.0
Mill Creek	5322.43	5322	943.96	2724.19	1.22	671.43	671.43	671.43	0.0
Mill Creek	5953.809	5954	820.52	2481.28	1.08	671.65	671.65	671.66	0.0
Mill Creek	6761.118	6761	904	2671.4	0.8	671.9	671.9	671.91	0.0
Mill Creek	8004.228	8004	915.32	2354.06	0.91	672.18	672.18	672.18	0.0
Mill Creek	8493.349	8493	1203.47	2943.9	0.73	672.36	672.36	672.37	0.0
Mill Creek	8999.072	8999	1290.79	2145.22	1	672.48	672.48	672.49	0.0
Mill Creek	10011.28	10011	717.45	957.74	3.49	673.01	673.01	673.09	0.1
Mill Creek	10207.76	10208	791.65	1938.45	1.54	673.67	673.67	673.72	0.1
Mill Creek	10403.23	10403	1316.76	4674.53	0.69	677.29	677.29	677.3	0.0
Mill Creek	10851.77	10852	1294.64	4691.99	0.46	677.32	677.32	677.32	0.0
Mill Creek	11133.65	11134	720.52	2472.02	0.87	677.33	677.33	677.33	0.0
Mill Creek	11635.39	11635	570.91	1973.18	1.09	677.42	677.42	677.43	0.0
Mill Creek	11916.85	11917	567.72	1842.69	1.17	677.51	677.51	677.53	0.0
Mill Creek	12254.36	12254	480.2	1760.92	1.22	677.62	677.62	677.65	0.0
Mill Creek	12508.11	12508	377.88	1545.49	1.39	677.69	677.69	677.72	0.0
Mill Creek	12803.18	12803	443.9	1882.84	1.14	677.78	677.78	677.81	0.0
Mill Creek	12999.11	12999	758.61	2252.72	1.2	677.82	677.82	677.85	0.0
Mill Creek	13338.87	13339	621.62	1918.88	1.12	677.99	677.99	678.04	0.0
Mill Creek	14095.96	14096	502.65	1663.15	1.29	678.29	678.29	678.36	0.1

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	14694.67	14695	367.34	1112.19	1.93	678.62	678.62	678.71	0.1
Mill Creek	15430.26	15430	408.36	1256.85	1.71	679.51	679.51	679.63	0.1
Mill Creek	15811.96	15812	635.4	2242.86	1.02	679.75	679.75	679.85	0.1
Mill Creek	15998.1	15998	955.36	2680.63	1.49	679.77	679.77	679.88	0.1
Mill Creek	16072.34	16072	976.1	2454.36	1.82	679.88	679.88	679.98	0.1
Mill Creek	16172.07	16172	948.14	1926.68	3.41	679.94	679.94	680.01	0.1
Mill Creek	16302.37	16302	618.82	947.43	4.27	680.18	680.18	680.27	0.1
Mill Creek	16480.37	16480	641.79	1464.13	3.34	681.16	681.16	681.21	0.1
Mill Creek	17206.03	17206	395.45	1872.94	1.11	681.98	681.98	682.01	0.0
Mill Creek	17313.54	17314	402.02	1353.85	1.54	681.99	681.99	682.03	0.0
Mill Creek	17567.72	17568	484.55	1858.48	1.14	682.17	682.17	682.21	0.0
Mill Creek	18049.24	18049	579.1	1955.57	1.06	682.31	682.31	682.35	0.0
Mill Creek	18143.03	18143	674.75	3212.25	0.65	687.16	687.16	687.15	0.0
Mill Creek	18307.87	18308	669.95	3192.11	0.65	687.17	687.17	687.16	0.0
Mill Creek	18456.76	18457	525.88	2537.6	0.82	687.17	687.17	687.17	0.0
Mill Creek	18571.14	18571	312.86	1696.84	1.23	687.18	687.18	687.17	0.0
Mill Creek	18858.11	18858	514.49	2652.77	0.78	687.22	687.22	687.21	0.0
Mill Creek	19024.24	19024	494.62	2433.33	1.35	687.22	687.22	687.22	0.0
Mill Creek	19182.79	19183	511.8	2319.05	1.39	687.25	687.25	687.25	0.0
Mill Creek	19374.94	19375	516.49	2613.28	1.01	687.29	687.29	687.29	0.0
Mill Creek	19546.65	19547	402.11	2152.96	0.97	687.31	687.31	687.31	0.0
Mill Creek	20099.79	20100	223.79	1313.92	1.58	687.37	687.37	687.37	0.0
Mill Creek	20584.65	20585	303.02	1721.09	1.21	687.47	687.47	687.48	0.0
Mill Creek	20784.84	20785	221.3	1220.04	1.7	687.49	687.49	687.5	0.0
Mill Creek	21015.16	21015	260.6	1518.52	1.42	687.56	687.56	687.57	0.0
Mill Creek	21233.03	21233	236.67	1288.08	2.1	687.62	687.62	687.63	0.0
Mill Creek	21289.48	21289	254.27	1258.55	2.01	687.68	687.68	687.7	0.0
Mill Creek	21354.98	21355	382.76	1875.47	1.27	687.84	687.84	687.85	0.0
Mill Creek	21506.54	21507	343.2	2020.9	1.03	687.87	687.87	687.88	0.0
Mill Creek	21694.36	21694	376.7	2084.46	1	687.89	687.89	687.9	0.0
Mill Creek	21798.28	21798	378.01	2099.86	0.99	687.9	687.9	687.91	0.0
Mill Creek	22007.53	22008	289.36	1681.43	1.24	687.92	687.92	687.93	0.0
Mill Creek	22187.35	22187	168.09	934.58	2.23	687.92	687.92	687.93	0.0
Mill Creek	22417.24	22417	309.92	1461.74	1.42	688.03	688.03	688.05	0.0
Mill Creek	22766.76	22767	540.96	1702.62	1.22	688.12	688.12	688.15	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	23019.82	23020	489.23	2125.58	0.98	688.2	688.2	688.23	0.0
Mill Creek	23263.03	23263	500.02	1907.26	1.09	688.27	688.27	688.3	0.0
Mill Creek	23592.16	23592	341.85	1510.15	1.38	688.39	688.39	688.42	0.0
Mill Creek	24036.64	24037	333.1	1397.95	1.49	688.61	688.61	688.66	0.0
Mill Creek	24842.2	24842	389.72	1518.05	1.37	688.95	688.95	689.02	0.1
Mill Creek	25021.46	25021	330	1582.19	1.31	689.06	689.06	689.12	0.1
Mill Creek	25349.16	25349	380.68	1372.71	1.52	689.23	689.23	689.3	0.1
Mill Creek	25468.96	25469	698.18	2460.73	1.13	689.31	689.31	689.41	0.1
Mill Creek	25822.57	25823	529.03	1978.14	1.05	689.46	689.46	689.55	0.1
Mill Creek	26460.51	26461	248.44	678.55	2.4	689.63	689.63	689.72	0.1
Mill Creek	26916.29	26916	272.47	835.78	1.95	690.41	690.41	690.52	0.1
Mill Creek	27581.2	27581	239.42	634.7	2.57	691.29	691.29	691.38	0.1
Mill Creek	27767.4	27767	256.08	636.53	2.56	691.81	691.81	691.86	0.1
Mill Creek	28477.53	28478	300.59	933.61	1.75	693.03	693.03	693.09	0.1
Mill Creek	29006.87	29007	266.11	580.11	2.81	693.73	693.73	693.81	0.1
Mill Creek	29274.33	29274	221.35	668.98	2.44	694.51	694.51	694.53	0.0
Mill Creek	29503.96	29504	108.86	284.64	5.73	694.64	694.64	694.68	0.0
Mill Creek	29844.77	29845	349	736.31	2.98	696.58	696.58	696.57	0.0
Mill Creek	30198.33	30198	226.31	718.37	2.27	697.53	697.53	697.5	0.0
Mill Creek	30271.23	30271	249.47	763.23	2.14	697.65	697.65	697.64	0.0
Mill Creek	30367.76	30368	217.88	924.06	1.76	697.84	697.84	697.83	0.0
Mill Creek	30819.06	30819	278.07	716.55	2.27	698.02	698.02	698.03	0.0
Mill Creek	31271.48	31271	268.86	495.79	3.29	699.48	699.48	699.47	0.0
Mill Creek	31815.18	31815	253.38	924.99	1.76	700.98	700.98	701.06	0.1
Mill Creek	31894.64	31895	336.96	1613.1	1.01	701.15	701.15	701.24	0.1
Mill Creek	32296.57	32297	278.34	791.14	2.62	701.23	701.23	701.32	0.1
Mill Creek	32374.71	32375	194.18	467.23	5.42	701.22	701.22	701.3	0.1
Mill Creek	32403.28	32403	54.84	186.76	8.73	701.1	701.1	701.19	0.1
Mill Creek	32414.17	32414	45.45	246.53	6.61	702.28	702.28	702.28	0.0
Mill Creek	32424.66	32425	116.58	394.58	4.15	702.56	702.56	702.57	0.0
Mill Creek	32470.81	32471	272.51	1204.45	2.13	703.04	703.04	703.04	0.0
Mill Creek	32572.59	32573	158.7	701.24	2.32	703.2	703.2	703.2	0.0
Mill Creek	32699.2	32699	163.92	584.14	1.8	703.4	703.4	703.4	0.0
Mill Creek	32804.84	32805	146.13	467.76	2.24	703.45	703.45	703.46	0.0
Mill Creek	33057.21	33057	273.52	864.91	2.83	703.74	703.74	703.74	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
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Mill Creek	33631.41	33631	234.3	457.01	2.3	704.92	704.92	704.94	0.0
Mill Creek	33852.45	33852	126.82	344.98	3.04	705.41	705.41	705.44	0.0
Mill Creek	34337.63	34338	155.86	485.27	2.16	706.43	706.43	706.44	0.0
Mill Creek	34654.65	34655	224.71	486.26	2.16	706.93	706.93	706.93	0.0
Mill Creek	35355.51	35356	215.28	406.13	2.59	708.51	708.51	708.6	0.1
Mill Creek	35487.85	35488	209.9	259.54	4.05	709.13	709.13	709.2	0.1
Mill Creek	35629.9	35630	337.73	657.05	1.6	710.21	710.21	710.2	0.0
Mill Creek	35743.55	35744	224.5	429.02	2.45	710.35	710.35	710.33	0.0
Mill Creek	35975.27	35975	120.89	406.26	2.58	710.88	710.88	710.87	0.0
Mill Creek	36139.55	36140	194.89	654.29	3.01	711.14	711.14	711.13	0.0
Mill Creek	36175.91	36176	150.06	512.01	3.47	711.2	711.2	711.19	0.0
Mill Creek	36203.09	36203	39.76	199.75	5.26	711.18	711.18	711.17	0.0
Mill Creek	36210.73	36211	32.16	189.05	5.55	711.2	711.2	711.19	0.0
Mill Creek	36225.39	36225	26.2	168.47	6.23	711.19	711.19	711.19	0.0
Mill Creek	36248.55	36249	66.51	194.78	5.46	711.42	711.42	711.41	0.0
Mill Creek	36327.44	36327	136.99	238.49	4.4	711.77	711.77	711.76	0.0
Mill Creek	36480.52	36481	58.29	135.01	7.78	712.03	712.03	712.03	0.0
Mill Creek	36649.82	36650	241.54	476.95	2.2	714.2	714.2	714.2	0.0
Mill Creek	36881.19	36881	188.7	375.46	2.8	714.72	714.72	714.73	0.0
Mill Creek	37000.93	37001	146.86	239.19	4.39	715.11	715.11	715.1	0.0
Mill Creek	37134.68	37135	154.14	336.81	3.12	716.15	716.15	716.17	0.0
Mill Creek	37311.34	37311	130.95	271.35	3.87	716.81	716.81	716.86	0.1
Mill Creek	37555.23	37555	82.7	289.6	3.63	717.87	717.87	717.91	0.0
Mill Creek	37684.82	37685	222.75	611.46	1.72	718.47	718.47	718.48	0.0
Mill Creek	37856	37856	152.51	392.47	2.68	718.66	718.66	718.67	0.0
Mill Creek	38024.78	38025	191.37	383.92	2.73	719.05	719.05	719.08	0.0
Mill Creek	38151.04	38151	45	178.4	5.89	719.24	719.24	719.27	0.0
Mill Creek	38344.89	38345	128.77	442.33	2.37	720.42	720.42	720.48	0.1
Mill Creek	38444.06	38444	124.49	393.36	2.67	720.56	720.56	720.62	0.1
Mill Creek	38566.59	38567	242.15	626.25	1.68	720.87	720.87	720.91	0.0
Mill Creek	38744.46	38744	179	476.17	2.21	721.06	721.06	721.1	0.0
Mill Creek	38836.78	38837	121.67	321.4	3.27	721.51	721.51	721.56	0.0
Mill Creek	39237.41	39237	154.81	439.69	2.39	722.5	722.5	722.55	0.0
Mill Creek	39857.3	39857	179.14	413.04	2.54	723.63	723.63	723.71	0.1
Mill Creek	40113.86	40114	134.56	364.52	2.88	724.3	724.3	724.37	0.1

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
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Mill Creek	40276.64	40277	143.26	354.61	2.96	724.84	724.84	724.87	0.0
Mill Creek	40436.68	40437	139.64	421.77	3.11	725.29	725.29	725.33	0.0
Mill Creek	40536.93	40537	287.03	660.75	3.25	725.61	725.61	725.66	0.0
Mill Creek	40628.66	40629	370.21	1154.32	2.6	726.54	726.54	726.57	0.0
Mill Creek	41272.76	41273	221.81	668.23	1.57	727.35	727.35	727.38	0.0
Mill Creek	41944.01	41944	179.92	518.17	2.03	728	728	728.04	0.0
Mill Creek	42290.71	42291	165.02	308.52	3.4	728.58	728.58	728.61	0.0
Mill Creek	42740.83	42741	210.13	505.63	2.08	730.11	730.11	730.13	0.0
Mill Creek	43042.5	43043	169.02	242.91	3.46	730.71	730.71	730.74	0.0
Mill Creek	43357.29	43357	128.67	302.9	2.77	731.77	731.77	731.79	0.0
Mill Creek	43715.82	43716	158.8	400.08	2.1	732.48	732.48	732.51	0.0
Mill Creek	44040.07	44040	209.32	338.69	2.48	732.97	732.97	733.01	0.0
Mill Creek	44616.39	44616	194.15	454.42	1.85	734.14	734.14	734.19	0.1
Mill Creek	44802.37	44802	128.09	313.42	2.68	734.39	734.39	734.44	0.1
Mill Creek	44921.89	44922	134.12	276.15	3.04	734.62	734.62	734.67	0.0
Mill Creek	45031.2	45031	69.09	214.61	3.91	734.76	734.76	734.8	0.0
Mill Creek	45084.83	45085	101.71	261.26	3.22	734.99	734.99	735.03	0.0
Mill Creek	45402.78	45403	89.75	259.62	3.24	735.65	735.65	735.68	0.0
Mill Creek	45658.68	45659	104.55	256.61	3.27	736.37	736.37	736.38	0.0
Mill Creek	45762.55	45763	133.22	252.77	3.32	736.65	736.65	736.63	0.0
Mill Creek	45890.54	45891	92.85	232.66	3.68	736.97	736.97	736.96	0.0
Mill Creek	46029.09	46029	66.87	205.33	4.09	737.42	737.42	737.4	0.0
Mill Creek	46057.17	46057	59.16	201.65	4.17	737.49	737.49	737.48	0.0
Mill Creek	46108.36	46108	40.6	180.34	4.66	737.6	737.6	737.58	0.0
Mill Creek	46194.1	46194	153.08	265.66	3.16	737.92	737.92	737.9	0.0
Mill Creek	46292.08	46292	249.37	446.94	1.88	738.19	738.19	738.19	0.0
Mill Creek	46375.11	46375	276.76	395.61	2.12	738.26	738.26	738.25	0.0
Mill Creek	46493.22	46493	85.37	264.33	3.18	738.41	738.41	738.42	0.0
Mill Creek	46535.63	46536	86.64	211.3	3.98	738.4	738.4	738.41	0.0
Mill Creek	46576.21	46576	188.67	368.05	2.28	738.69	738.69	738.7	0.0
Mill Creek	46956.05	46956	116.03	302.76	2.77	739.31	739.31	739.33	0.0
Mill Creek	47183.36	47183	87.57	249	3.37	739.75	739.75	739.77	0.0
Mill Creek	47320.94	47321	135.43	210.95	3.98	740.08	740.08	740.07	0.0
Mill Creek	47456.16	47456	65.43	154.97	5.42	740.54	740.54	740.54	0.0
Mill Creek	47560.7	47561	77.79	219.12	3.83	741.21	741.21	741.22	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
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Mill Creek	47683.72	47684	94.53	200.78	5.07	741.47	741.47	741.48	0.0
Mill Creek	47777.66	47778	56.87	159.05	5.57	741.73	741.73	741.73	0.0
Mill Creek	47878.97	47879	36.17	159.5	5.27	742.2	742.2	742.21	0.0
Mill Creek	48163.85	48164	41.67	184.62	4.55	743.2	743.2	743.2	0.0
Mill Creek	48428.48	48428	64	206.92	4.06	743.94	743.94	743.93	0.0
Mill Creek	48572.16	48572	101.6	266.99	3.15	744.41	744.41	744.41	0.0
Mill Creek	48821.54	48822	157.57	190.26	4.42	744.96	744.96	744.98	0.0
Mill Creek	49120.32	49120	184.06	327.31	2.57	746.7	746.7	746.69	0.0
Mill Creek	49188.7	49189	124.96	278.66	3.01	746.92	746.92	746.91	0.0
Mill Creek	49215	49215	96.73	177.86	4.72	746.92	746.92	746.89	0.0
Mill Creek	49310.01	49310	370.01	1024.34	0.82	752.41	752.41	752.45	0.0
Mill Creek	49506.18	49506	329.04	969.88	0.87	752.42	752.42	752.47	0.1
Mill Creek	49647.02	49647	392.16	1133.9	0.74	752.44	752.44	752.48	0.0
Mill Creek	49793.08	49793	284.07	844.73	0.99	752.44	752.44	752.49	0.0
Mill Creek	50041.86	50042	317.26	945.04	0.89	752.47	752.47	752.51	0.0
Mill Creek	50141.68	50142	232.97	678.47	1.24	752.47	752.47	752.51	0.0
Mill Creek	50282.87	50283	207.24	536.36	1.57	752.49	752.49	752.53	0.0
Mill Creek	50404.43	50404	154	478.93	1.75	752.52	752.52	752.56	0.0
Mill Creek	50665.23	50665	150.44	467.08	1.8	752.6	752.6	752.63	0.0
Mill Creek	50891.75	50892	145.59	437.06	1.92	752.66	752.66	752.7	0.0
Mill Creek	51024.2	51024	136.33	417.13	2.25	752.7	752.7	752.74	0.0
Mill Creek	51103.14	51103	65.71	272.62	3.08	752.71	752.71	752.74	0.0
Mill Creek	51226	51226	61.51	239.07	3.51	753.5	753.5	753.5	0.0
Mill Creek	51284.37	51284	77.15	242.81	3.46	753.57	753.57	753.57	0.0
Mill Creek	51329.04	51329	111.62	416.66	2.02	753.81	753.81	753.81	0.0
Mill Creek	51453.58	51454	129.24	406.36	2.07	753.9	753.9	753.9	0.0
Mill Creek	51518.58	51519	174.69	482.79	1.74	753.98	753.98	753.99	0.0
Mill Creek	51669.63	51670	301	801.71	1.05	754.14	754.14	754.14	0.0
Mill Creek	51952.63	51953	355.09	835.37	1.01	754.25	754.25	754.26	0.0
Mill Creek	51997.54	51998	334.38	706.33	1.19	754.26	754.26	754.27	0.0
Mill Creek	52538.73	52539	298.21	628.1	1.34	754.5	754.5	754.52	0.0
Mill Creek	52879.23	52879	181.91	306.98	3.07	754.74	754.74	754.77	0.0
Mill Creek	53156.59	53157	142.66	376.76	2.02	755.4	755.4	755.43	0.0
Mill Creek	53191.27	53191	61.68	230.33	3.08	755.37	755.37	755.4	0.0
Mill Creek	53228.5	53229	73.27	249.91	2.84	755.49	755.49	755.51	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	53298.28	53298	105	368.64	1.93	755.69	755.69	755.7	0.0
Mill Creek	53430.02	53430	164.86	423.52	1.68	755.82	755.82	755.83	0.0
Mill Creek	53532.61	53533	235.38	587.31	1.21	755.94	755.94	755.95	0.0
Mill Creek	53631.79	53632	225	503.03	1.41	755.97	755.97	755.99	0.0
Mill Creek	53901.62	53902	259.93	545.66	1.3	756.18	756.18	756.2	0.0
Mill Creek	54107.28	54107	228.81	496.51	1.43	756.33	756.33	756.34	0.0
Mill Creek	54220.36	54220	153.65	348.67	2.04	756.38	756.38	756.4	0.0
Mill Creek	54372.02	54372	153.07	396.68	1.79	756.6	756.6	756.61	0.0
Mill Creek	54511.41	54511	124.93	282.4	2.51	756.75	756.75	756.74	0.0
Mill Creek	54675.68	54676	151.71	353.61	2.01	757.07	757.07	757.06	0.0
Mill Creek	54764.98	54765	192.03	526.7	1.35	757.21	757.21	757.21	0.0
Mill Creek	54850.91	54851	282.52	343.99	2.06	757.24	757.24	757.23	0.0
Mill Creek	54903.21	54903	99.52	186.14	3.81	757.31	757.31	757.31	0.0
Mill Creek	55024.34	55024	159.04	334.02	2.13	757.72	757.72	757.72	0.0
Mill Creek	55145.15	55145	212.57	505.75	1.4	757.95	757.95	757.95	0.0
Mill Creek	55195.29	55195	180.53	401.91	1.77	757.97	757.97	757.97	0.0
Mill Creek	55271.67	55272	156.36	344.94	2.06	758.05	758.05	758.05	0.0
Mill Creek	55408.12	55408	189.29	257.65	2.76	758.21	758.21	758.21	0.0
Mill Creek	55845.48	55845	133.79	398.7	1.78	759.02	759.02	759.02	0.0
Mill Creek	55964.77	55965	130.08	296.17	2.4	759.12	759.12	759.11	0.0
Mill Creek	56065.97	56066	218.92	423.5	1.68	759.32	759.32	759.32	0.0
Mill Creek	56311.64	56312	163.47	522.29	1.36	759.55	759.55	759.56	0.0
Mill Creek	56412.67	56413	90.15	234.6	3.03	759.55	759.55	759.57	0.0
Mill Creek	56565.29	56565	98.61	213.97	3.83	759.85	759.85	759.86	0.0
Mill Creek	56716.78	56717	158.95	661.28	1.42	761.99	761.99	761.99	0.0
Mill Creek	56866.33	56866	174.84	842.33	0.84	762.06	762.06	762.06	0.0
Mill Creek	57099.83	57100	530.83	1904.41	0.5	762.1	762.1	762.1	0.0
Mill Creek	57218.32	57218	812.25	3003.24	0.32	762.11	762.11	762.11	0.0
Mill Creek	57388.87	57389	1017.03	4407	0.25	762.11	762.11	762.11	0.0
Mill Creek	57693.5	57694	613.03	1896.64	0.56	762.11	762.11	762.11	0.0
Mill Creek	57805.48	57805	218.75	782.14	0.91	762.12	762.12	762.12	0.0
Mill Creek	58057.35	58057	122.92	442.16	1.61	762.15	762.15	762.16	0.0
Mill Creek	58271.79	58272	97.69	417.72	1.7	762.26	762.26	762.25	0.0
Mill Creek	58571.21	58571	97.27	378.31	1.88	762.4	762.4	762.4	0.0
Mill Creek	58680.01	58680	98.44	344.83	2.14	762.46	762.46	762.46	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	58747.01	58747	130.57	472.28	1.61	762.7	762.7	762.71	0.0
Mill Creek	58795.22	58795	121	514.74	1.38	762.74	762.74	762.75	0.0
Mill Creek	58902.88	58903	121.54	506.76	1.4	762.77	762.77	762.78	0.0
Mill Creek	59209.08	59209	128.93	517.87	1.37	762.86	762.86	762.88	0.0
Mill Creek	59360.86	59361	194.97	742.47	0.96	762.92	762.92	762.93	0.0
Mill Creek	59611.54	59612	274.93	1045.91	0.68	762.95	762.95	762.97	0.0
Mill Creek	59750.65	59751	182.73	603.27	1.18	762.96	762.96	762.97	0.0
Mill Creek	59870.14	59870	386	1433.71	0.5	763	763	763.02	0.0
Mill Creek	59937.76	59938	1176	3879.55	0.7	763	763	763.02	0.0
Mill Creek	59973.93	59974	2427.25	8126.82	0.53	763.01	763.01	763.03	0.0
Mill Creek	60009.45	60009	2075.82	7022.51	0.43	763.02	763.02	763.04	0.0
Mill Creek	60070.98	60071	2198	7679	0.42	763.03	763.03	763.04	0.0
Mill Creek	60107.16	60107	3055	10448.03	0.36	763.03	763.03	763.05	0.0
Mill Creek	60222.5	60223	1061.24	4336.37	0.28	763.03	763.03	763.05	0.0
Mill Creek	60370.31	60370	902	3128.1	0.58	763.03	763.03	763.05	0.0
Mill Creek	60444.16	60444	833	2909.47	0.77	763.03	763.03	763.05	0.0
Mill Creek	60578.32	60578	621.42	1970.57	1.02	763.05	763.05	763.07	0.0
Mill Creek	60599.03	60599	610	1764.3	1.14	763.06	763.06	763.08	0.0
Mill Creek	60644.46	60644	154.99	496.8	1.43	763.06	763.06	763.08	0.0
Mill Creek	60827.47	60827	176	602.82	1.18	763.15	763.15	763.17	0.0
Mill Creek	60914.55	60915	160	526.21	1.46	763.17	763.17	763.19	0.0
Mill Creek	60983.91	60984	168.72	549.65	1.36	763.26	763.26	763.28	0.0
Mill Creek	61132.34	61132	166.79	615.97	1.15	763.33	763.33	763.35	0.0
Mill Creek	61372.86	61373	274	785.56	0.9	763.4	763.4	763.43	0.0
Mill Creek	61598.15	61598	900	2669.79	0.27	763.45	763.45	763.47	0.0
Mill Creek	61962.44	61962	946	2560.5	0.28	763.46	763.46	763.48	0.0
Mill Creek	62103.67	62104	831.25	2271.38	0.31	763.46	763.46	763.49	0.0
Mill Creek	62264.09	62264	819.54	2259.47	0.31	763.47	763.47	763.5	0.0
Mill Creek	62741.96	62742	845.22	2158.48	0.33	763.5	763.5	763.53	0.0
Mill Creek	64132.18	64132	365	995.23	0.99	763.67	763.67	763.68	0.0
Mill Creek	64262.61	64263	309	820.48	1.57	763.71	763.71	763.73	0.0
Mill Creek	64461.93	64462	878.18	2620.24	0.75	764.77	764.77	764.79	0.0
Mill Creek	64796.79	64797	938.64	2478.77	0.31	764.81	764.81	764.83	0.0
Mill Creek	64909.54	64910	1279.8	2633.95	0.31	764.82	764.82	764.83	0.0
Mill Creek	65033.24	65033	1109.7	2105.15	0.47	764.82	764.82	764.84	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
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Mill Creek	65217.55	65218	964.65	1597.67	0.57	764.85	764.85	764.86	0.0
Mill Creek	65384.01	65384	946.83	1907.15	0.44	764.87	764.87	764.89	0.0
Mill Creek	65577.45	65577	1465.88	4024.22	0.47	764.89	764.89	764.91	0.0
Mill Creek	65684.5	65685	750.34	1926.77	0.41	764.9	764.9	764.92	0.0
Mill Creek	65816.52	65817	639.68	1632.76	0.63	764.91	764.91	764.92	0.0
Mill Creek	65910.96	65911	808.66	2179.22	0.58	764.92	764.92	764.93	0.0
Mill Creek	66019.74	66020	1003.94	3049.33	0.25	764.94	764.94	764.95	0.0
Mill Creek	66194.4	66194	851.57	2326.88	0.3	764.94	764.94	764.96	0.0
Mill Creek	66643.4	66643	959.86	2339.02	0.32	764.96	764.96	764.97	0.0
Mill Creek	66965.84	66966	1084.82	1979.32	0.78	764.97	764.97	764.99	0.0
Mill Creek	67222.69	67223	1373.65	2896.29	0.39	765.02	765.02	765.04	0.0
Mill Creek	67617.81	67618	1327	3547.11	0.42	765.05	765.05	765.07	0.0
Mill Creek	67703.96	67704	745	1757.89	0.51	765.05	765.05	765.07	0.0
Mill Creek	67812.81	67813	296	956.1	0.72	765.06	765.06	765.08	0.0
Mill Creek	68055.98	68056	273	891.1	0.77	765.09	765.09	765.11	0.0
Mill Creek	68363.32	68363	254	825.81	0.84	765.14	765.14	765.15	0.0
Mill Creek	68699.81	68700	842.96	2744.58	0.25	765.18	765.18	765.19	0.0
Mill Creek	69080.73	69081	511.03	1525.16	0.55	765.19	765.19	765.2	0.0
Mill Creek	69236.35	69236	270	662.11	1.04	765.2	765.2	765.22	0.0
Mill Creek	69385.38	69385	308.11	584.6	1.18	765.26	765.26	765.28	0.0
Mill Creek	69463.89	69464	305.61	390.98	1.76	765.22	765.22	765.24	0.0
Mill Creek	69580.3	69580	140	352.15	1.96	765.41	765.41	765.43	0.0
Mill Creek	69898.8	69899	180	515.75	1.34	765.66	765.66	765.67	0.0
Mill Creek	69994.95	69995	996.43	2524.66	0.82	765.71	765.71	765.72	0.0
Mill Creek	70078.66	70079	838.52	2247.41	0.72	765.73	765.73	765.74	0.0
Mill Creek	70205.34	70205	734.03	1706.89	0.98	765.75	765.75	765.76	0.0
Mill Creek	70278.55	70279	408.62	783.06	1.17	765.76	765.76	765.78	0.0
Mill Creek	70484.63	70485	129.52	478.61	1.44	765.83	765.83	765.85	0.0
Mill Creek	70678.16	70678	128.64	411.86	1.68	765.9	765.9	765.92	0.0
Mill Creek	70802.66	70803	173.68	422.53	1.63	765.98	765.98	765.99	0.0
Mill Creek	71005.4	71005	403.88	1057.55	0.69	766.18	766.18	766.19	0.0
Mill Creek	71115.17	71115	295	783.75	0.88	766.2	766.2	766.21	0.0
Mill Creek	71179.96	71180	431.28	1001.89	0.69	766.21	766.21	766.22	0.0
Mill Creek	71528.2	71528	883.31	2269.24	0.3	766.23	766.23	766.24	0.0
Mill Creek	72151.63	72152	1885	6277.41	0.12	766.24	766.24	766.25	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
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Mill Creek	72698.65	72699	2510	8129.77	0.12	766.24	766.24	766.25	0.0
Mill Creek	73633.6	73634	2590	8571.8	0.14	766.25	766.25	766.25	0.0
Mill Creek	74000.91	74001	2445	8124.78	0.19	766.25	766.25	766.25	0.0
Mill Creek	74316.98	74317	1880	6286.7	0.26	766.25	766.25	766.25	0.0
Mill Creek	74472.09	74472	1050	3583.99	0.37	766.25	766.25	766.25	0.0
Mill Creek	74616.69	74617	224.27	348.39	1.98	766.19	766.19	766.19	0.0
Mill Creek	74706.67	74707	389.91	595.19	1.55	766.28	766.28	766.29	0.0
Mill Creek	74929.37	74929	546.57	850.67	1.29	766.42	766.42	766.43	0.0
Mill Creek	75245.11	75245	1319.94	3195.48	0.27	766.49	766.49	766.5	0.0
Mill Creek	75380.94	75381	2128.82	4315.02	0.23	766.5	766.5	766.5	0.0
Mill Creek	75457.87	75458	2661.93	5747.57	0.25	766.5	766.5	766.5	0.0
Mill Creek	75953.84	75954	2320	4423.11	0.45	766.51	766.51	766.51	0.0
Mill Creek	76132.83	76133	2115	4180.76	0.54	766.53	766.53	766.54	0.0
Mill Creek	76362.75	76363	723.97	1061.5	0.99	766.58	766.58	766.58	0.0
Mill Creek	76427.33	76427	235.62	508.88	1.63	766.6	766.6	766.6	0.0
Mill Creek	76503.97	76504	178	438.86	1.7	766.68	766.68	766.68	0.0
Mill Creek	76657.27	76657	224.5	562.81	1.42	766.83	766.83	766.83	0.0
Mill Creek	76822.57	76823	315.64	669.96	2.06	766.93	766.93	766.93	0.0
Mill Creek	77009.58	77010	419.81	1421.54	0.85	770.52	770.52	770.5	0.0
Mill Creek	77105.67	77106	581.87	2456.98	0.37	770.53	770.53	770.52	0.0
Mill Creek	77174.32	77174	572.39	2867	0.27	770.54	770.54	770.52	0.0
Mill Creek	77354.13	77354	527.44	2936.21	0.25	770.54	770.54	770.52	0.0
Mill Creek	77497.35	77497	674.19	2970.94	0.25	770.54	770.54	770.52	0.0
Mill Creek	77697.68	77698	798.27	2338.92	0.32	770.54	770.54	770.52	0.0
Mill Creek	77748.71	77749	779.66	2316.92	0.32	770.54	770.54	770.52	0.0
Mill Creek	77915.05	77915	199.64	1881.58	0.4	770.54	770.54	770.52	0.0
Mill Creek	78413.13	78413	142.75	1117.58	0.67	770.54	770.54	770.53	0.0
Mill Creek	78557.05	78557	89.01	707.29	1.09	770.54	770.54	770.53	0.0
Mill Creek	78650.38	78650	744.13	3171.1	0.56	770.8	770.8	770.8	0.0
Mill Creek	78712.13	78712	132.73	539.46	1.38	770.8	770.8	770.8	0.0
Mill Creek	78769.97	78770	586.57	2653.73	0.28	770.85	770.85	770.85	0.0
Mill Creek	78815.24	78815	185.9	918.51	0.81	770.84	770.84	770.84	0.0
Mill Creek	79010.23	79010	164.05	916.04	0.81	770.86	770.86	770.86	0.0
Mill Creek	79062.45	79062	739.35	2265.02	0.33	770.88	770.88	770.88	0.0
Mill Creek	79100.27	79100	1258.48	5455.67	0.12	770.88	770.88	770.89	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
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Mill Creek	79131.22	79131	1467.03	6316.74	0.1	770.88	770.88	770.89	0.0
Mill Creek	79175.47	79175	802.36	3961.36	0.16	770.88	770.88	770.89	0.0
Mill Creek	79228.27	79228	603.8	3094.4	0.21	770.88	770.88	770.89	0.0
Mill Creek	79610.31	79610	354.98	1814.6	0.36	770.89	770.89	770.89	0.0
Mill Creek	79911.55	79912	353.14	1736.89	0.42	770.9	770.9	770.9	0.0
Mill Creek	80175.9	80176	631.32	2945.64	0.25	770.91	770.91	770.91	0.0
Mill Creek	80387.78	80388	440	1511.08	0.56	770.91	770.91	770.91	0.0
Mill Creek	80599.68	80600	310.46	792.51	0.92	770.92	770.92	770.92	0.0
Mill Creek	80852.36	80852	131.71	438.07	1.69	770.95	770.95	770.95	0.0
Mill Creek	81147.44	81147	251.89	674.46	1.61	771.07	771.07	771.07	0.0
Mill Creek	81284.76	81285	94.2	492.09	1.5	771.9	771.9	771.91	0.0
Mill Creek	81323.03	81323	195.52	968.37	0.86	771.94	771.94	771.95	0.0
Mill Creek	81455.82	81456	246.95	1353.25	0.86	771.95	771.95	771.96	0.0
Mill Creek	81574.89	81575	390.63	2266.04	0.56	771.96	771.96	771.98	0.0
Mill Creek	81725.46	81725	141.13	838.42	0.87	771.97	771.97	771.98	0.0
Mill Creek	82219.17	82219	161.6	588.22	1.24	772	772	772.02	0.0
Mill Creek	82285.43	82285	332.59	1136.59	1.21	772.01	772.01	772.03	0.0
Mill Creek	82427.49	82427	581.29	2232.91	0.84	772.07	772.07	772.08	0.0
Mill Creek	82565.48	82565	308.76	561.61	1.34	772.12	772.12	772.13	0.0
Mill Creek	82767.73	82768	552.15	678.92	1.49	772.18	772.18	772.19	0.0
Mill Creek	82941.84	82942	657.03	833.86	0.49	772.26	772.26	772.27	0.0
Mill Creek	83252	83252	542.93	1108.68	0.37	772.29	772.29	772.3	0.0
Mill Creek	83308.99	83309	248.02	528.48	0.78	772.28	772.28	772.29	0.0
Mill Creek	83409.37	83409	463.47	607.56	0.67	772.29	772.29	772.3	0.0
Mill Creek	83512.05	83512	569.55	589.37	0.7	772.3	772.3	772.31	0.0
Mill Creek	83529.77	83530	789.49	996.26	0.41	772.31	772.31	772.32	0.0
Mill Creek	83658.16	83658	304.5	926.39	0.44	772.32	772.32	772.33	0.0
Mill Creek	83759.25	83759	304.69	966.11	0.42	772.33	772.33	772.34	0.0
Mill Creek	83837.91	83838	479.93	1417.4	0.29	772.33	772.33	772.34	0.0
Mill Creek	83987.05	83987	545.07	1867.11	0.22	772.34	772.34	772.35	0.0
Mill Creek	84202.94	84203	783.72	3170.63	0.14	772.34	772.34	772.35	0.0
Mill Creek	84379.12	84379	830.8	3087.03	0.16	772.34	772.34	772.35	0.0
Mill Creek	84496.53	84497	698.32	2343.55	1.25	772.31	772.31	772.32	0.0
Mill Creek	84636.52	84637	622.04	1678.65	1.59	772.34	772.34	772.35	0.0
Mill Creek	84845.07	84845	130.95	963.82	0.43	772.4	772.4	772.41	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	85129.2	85129	33.1	179.61	2.28	772.36	772.36	772.37	0.0
Mill Creek	85446.59	85447	58.19	346.83	1.18	772.5	772.5	772.51	0.0
Mill Creek	85585.45	85585	29.81	178.26	2.3	772.49	772.49	772.5	0.0
Mill Creek	85697.41	85697	34.77	178.99	2.29	772.55	772.55	772.56	0.0
Mill Creek	85750.74	85751	33.21	175.52	2.34	772.58	772.58	772.6	0.0
Mill Creek	85784.63	85785	32.55	160.6	2.55	772.6	772.6	772.62	0.0
Mill Creek	85801.8	85802	42.19	225.5	1.82	772.68	772.68	772.69	0.0
Mill Creek	85943.15	85943	31.57	164.84	2.49	772.71	772.71	772.72	0.0
Mill Creek	86262.77	86263	33.7	156.42	2.62	772.97	772.97	772.98	0.0
Mill Creek	86455.78	86456	25.53	159.44	2.57	773.12	773.12	773.12	0.0
Mill Creek	86503.44	86503	27.26	160.85	2.55	773.15	773.15	773.15	0.0
Mill Creek	86587.8	86588	32.36	169.13	2.42	773.21	773.21	773.23	0.0
Mill Creek	86701.64	86702	32.29	176.49	2.32	773.3	773.3	773.32	0.0
Mill Creek	86786.57	86787	38.51	185.34	2.21	773.37	773.37	773.38	0.0
Mill Creek	86928.28	86928	32.24	172.73	2.37	774.36	774.36	774.37	0.0
Mill Creek	86975.27	86975	50.32	232.8	1.76	774.43	774.43	774.44	0.0
Mill Creek	87018.67	87019	40.69	190.32	2.15	774.43	774.43	774.45	0.0
Mill Creek	87032.68	87033	39.28	199.1	2.06	774.45	774.45	774.47	0.0
Mill Creek	87089.3	87089	44.99	255.18	1.61	774.51	774.51	774.53	0.0
Mill Creek	87100.9	87101	43.33	254.08	1.61	774.51	774.51	774.53	0.0
Mill Creek	87106.64	87107	38.61	201.93	2.03	774.5	774.5	774.52	0.0
Mill Creek	87112.34	87112	30.3	161.54	2.54	774.48	774.48	774.5	0.0
Mill Creek	87210.49	87210	65.27	348.08	1.18	776.31	776.31	776.32	0.0
Mill Creek	87260.03	87260	50.16	285.15	1.44	776.31	776.31	776.33	0.0
Mill Creek	87293.54	87294	46.05	277.65	1.48	776.32	776.32	776.33	0.0
Mill Creek	87331.27	87331	40.86	230.81	1.78	776.32	776.32	776.34	0.0
Mill Creek	87510.91	87511	168.16	450.12	0.91	777.97	777.97	777.98	0.0
Mill Creek	87625.05	87625	430.65	1910.32	0.25	778	778	778.01	0.0
Mill Creek	87695.88	87696	653.52	2903.21	0.16	778	778	778.01	0.0
Mill Creek	87797.5	87798	820.73	2782.09	0.18	778	778	778.01	0.0
Mill Creek	88017.56	88018	887.41	1793.33	0.82	777.99	777.99	778.01	0.0
Mill Creek	88301.02	88301	185.92	430.98	1.2	778.02	778.02	778.03	0.0
Mill Creek	88516.9	88517	415.68	1770.44	0.68	778.62	778.62	778.63	0.0
Mill Creek	88735.76	88736	439	2698.63	0.15	778.64	778.64	778.65	0.0
Mill Creek	88955.02	88955	866.96	4828.16	0.08	778.64	778.64	778.65	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	89056.3	89056	982.18	5506.25	0.07	778.64	778.64	778.65	0.0
Mill Creek	89318.41	89318	1200	6140.14	0.07	778.65	778.65	778.65	0.0
Mill Creek	89672.63	89673	1419.55	5499.57	0.08	778.65	778.65	778.65	0.0
Mill Creek	89876.93	89877	1977	6844.12	0.19	778.65	778.65	778.65	0.0
Mill Creek	90146.8	90147	2066.83	7227.77	0.39	778.65	778.65	778.65	0.0
Mill Creek	90341.37	90341	1909	7772.62	0.52	778.65	778.65	778.66	0.0
Mill Creek	90460.52	90461	1519.12	5599.52	0.68	778.85	778.85	778.86	0.0
Mill Creek	90801.38	90801	1383.08	2826.19	0.26	778.87	778.87	778.88	0.0
Mill Creek	90958.8	90959	530.62	1898.65	0.31	778.88	778.88	778.89	0.0
Mill Creek	91098.63	91099	493.26	1656.8	0.35	778.88	778.88	778.89	0.0
Mill Creek	91214.23	91214	504.97	1220.04	0.49	778.89	778.89	778.9	0.0
Mill Creek	91276.15	91276	228.14	526.5	1.44	778.87	778.87	778.88	0.0
Mill Creek	91399.01	91399	87.89	199.42	2.2	778.89	778.89	778.9	0.0
Mill Creek	91446.18	91446	30.25	172.29	2.32	778.91	778.91	778.92	0.0
Mill Creek	91555.16	91555	27.26	156.76	2.55	778.96	778.96	778.97	0.0
Mill Creek	91616.59	91617	28.84	153.44	2.61	779.01	779.01	779.02	0.0
Mill Creek	91638.91	91639	26.57	148.44	2.69	779.02	779.02	779.03	0.0
Mill Creek	91676.2	91676	28.07	153.2	2.61	779.05	779.05	779.06	0.0
Mill Creek	91754.36	91754	36.13	156.86	2.55	779.12	779.12	779.14	0.0
Mill Creek	91836.34	91836	35.89	153.18	2.61	779.2	779.2	779.21	0.0
Mill Creek	91943.3	91943	31.71	148.94	2.69	779.3	779.3	779.31	0.0
Mill Creek	92065.41	92065	30.43	154.04	2.6	779.74	779.74	779.75	0.0
Mill Creek	92156.22	92156	35.91	172.72	2.32	779.82	779.82	779.83	0.0
Mill Creek	92388.05	92388	41.82	209.98	1.9	779.97	779.97	779.98	0.0
Mill Creek	92486.41	92486	37.46	193.36	2.07	780	780	780.02	0.0
Mill Creek	92590.98	92591	35.55	181.58	2.2	780.05	780.05	780.07	0.0
Mill Creek	92674.01	92674	32.82	164.39	2.43	780.1	780.1	780.11	0.0
Mill Creek	92744.95	92745	42.61	238.12	1.68	781.48	781.48	781.5	0.0
Mill Creek	92786.95	92787	43.06	235.89	1.7	781.49	781.49	781.51	0.0
Mill Creek	92856.85	92857	44.13	236.14	1.69	781.51	781.51	781.53	0.0
Mill Creek	93003.09	93003	39.91	229.06	1.75	781.56	781.56	781.57	0.0
Mill Creek	93122.59	93123	41.98	237.58	1.68	781.59	781.59	781.61	0.0
Mill Creek	93347.4	93347	41.37	230.21	1.74	781.66	781.66	781.68	0.0
Mill Creek	93421.66	93422	42.1	233.96	1.71	781.69	781.69	781.71	0.0
Mill Creek	93520.88	93521	60.38	303.83	1.32	782.65	782.65	782.67	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	93559.16	93559	49.68	251.28	1.59	782.65	782.65	782.67	0.0
Mill Creek	93662.45	93662	41.01	209.54	1.91	782.67	782.67	782.69	0.0
Mill Creek	93844.1	93844	47.04	254.49	1.57	782.75	782.75	782.76	0.0
Mill Creek	94059.08	94059	53.3	293.28	1.36	782.8	782.8	782.82	0.0
Mill Creek	94154.48	94154	46.54	239.03	1.67	782.81	782.81	782.83	0.0
Mill Creek	94267.61	94268	42.54	212.93	1.88	782.84	782.84	782.86	0.0
Mill Creek	94397.86	94398	43.92	189.37	2.11	782.89	782.89	782.91	0.0
Mill Creek	94505.22	94505	33.9	162.87	2.46	782.94	782.94	782.96	0.0
Mill Creek	94541.88	94542	38.8	193.12	2.07	783	783	783.02	0.0
Mill Creek	94574.22	94574	44.31	209.35	1.91	783.03	783.03	783.04	0.0
Mill Creek	94596.3	94596	51.62	270.01	1.48	783.07	783.07	783.08	0.0
Mill Creek	94619.97	94620	66.5	274.02	1.46	783.07	783.07	783.09	0.0
Mill Creek	94644.67	94645	44.65	180.3	1.94	783.07	783.07	783.08	0.0
Mill Creek	94737.39	94737	43.5	228.75	1.53	783.47	783.47	783.48	0.0
Mill Creek	94750.26	94750	47.5	234.74	1.49	783.48	783.48	783.49	0.0
Mill Creek	94768.15	94768	51	292.2	1.2	783.5	783.5	783.51	0.0
Mill Creek	94778.4	94778	49.81	347.35	1.01	783.5	783.5	783.51	0.0
Mill Creek	94889.22	94889	170.35	265.83	1.32	784.19	784.19	784.23	0.0
Mill Creek	94969.74	94970	248.72	372.8	0.94	784.24	784.24	784.28	0.0
Mill Creek	95101.32	95101	318.58	478.66	0.73	784.28	784.28	784.32	0.0
Mill Creek	95331.35	95331	849.91	1381.34	0.36	784.32	784.32	784.35	0.0
Mill Creek	95521.07	95521	1218.95	2415.53	0.19	784.32	784.32	784.36	0.0
Mill Creek	95672.98	95673	1139.3	2116.01	0.27	784.33	784.33	784.36	0.0
Mill Creek	95914.42	95914	474.85	715.44	0.64	784.33	784.33	784.36	0.0
Mill Creek	96036.05	96036	561.75	917.06	0.62	784.35	784.35	784.38	0.0
Mill Creek	96142.95	96143	1072.08	2694.03	0.31	784.36	784.36	784.39	0.0
Mill Creek	96249.55	96250	756.98	1494.51	0.39	784.36	784.36	784.4	0.0
Mill Creek	96372.85	96373	39.95	190.91	1.83	784.34	784.34	784.37	0.0
Mill Creek	96612.78	96613	89.03	223.15	1.57	784.44	784.44	784.47	0.0
Mill Creek	96717.17	96717	40	176.32	1.99	784.47	784.47	784.5	0.0
Mill Creek	96800.98	96801	37.09	170.57	2.05	784.52	784.52	784.55	0.0
Mill Creek	96935.16	96935	34.94	170.26	2.06	784.59	784.59	784.62	0.0
Mill Creek	97066.95	97067	34.35	168.27	2.08	784.65	784.65	784.68	0.0
Mill Creek	97196.85	97197	47.82	197.05	1.78	784.74	784.74	784.76	0.0
Mill Creek	97500.09	97500	262.73	1012.09	0.35	784.82	784.82	784.84	0.0

FLOODING SOURCE			FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
FLOODING SOURCE	CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Creek	97665.39	97665	284.5	831.32	0.42	784.82	784.82	784.85	0.0
Mill Creek	97792.01	97792	192.47	507.94	0.69	784.83	784.83	784.85	0.0
Mill Creek	97872.12	97872	158.7	265.09	1.32	784.81	784.81	784.84	0.0
Mill Creek	98019.02	98019	101.31	281.38	1.24	784.92	784.92	784.94	0.0
Mill Creek	98166.15	98166	37.48	172.55	2.03	784.99	784.99	785.01	0.0
Mill Creek	98285.84	98286	1137.99	1084.68	0.6	785.08	785.08	785.1	0.0
Mill Creek	98498.88	98499	1107.89	2162.05	0.19	785.1	785.1	785.12	0.0
Mill Creek	98648.03	98648	1546.45	2860.6	0.16	785.1	785.1	785.13	0.0
Mill Creek	98863.52	98864	2330	4689.96	0.08	785.11	785.11	785.13	0.0
Mill Creek	99220.79	99221	2004	4124.82	0.08	785.11	785.11	785.13	0.0
Mill Creek	99443.5	99444	1829.42	4209.15	0.08	785.11	785.11	785.13	0.0
Mill Creek	99704.87	99705	1292.31	3474.75	0.1	785.11	785.11	785.13	0.0
Mill Creek	99927.34	99927	1106.33	3063.58	0.11	785.11	785.11	785.13	0.0
Mill Creek	100101.1	100101	737.74	1960.56	0.18	785.11	785.11	785.13	0.0
Mill Creek	100315.9	100316	521.21	1250.23	0.28	785.12	785.12	785.14	0.0
Mill Creek	100574.7	100575	1002.25	1952.11	0.18	785.13	785.13	785.15	0.0
Mill Creek	100742.6	100743	915.09	1302.12	0.27	785.14	785.14	785.16	0.0
Mill Creek	101550.3	101550	358.64	224.34	1.56	785.24	785.24	785.27	0.0

Appendix K. Discharge Certification Form

Mill Creek Floodplain Study April 1, 2014

New Hydrology / Flow Approval Checklist

Narrative

x	Project Description
x	General Location Map
x	Analysis Methods
x	Rainfall Amounts
x	Rainfall Distributions
	Sensitivity Analysis
x	Calibration
	Documentation of Restrictive Road Crossings
	Signed & Sealed by PE

Maps and Schematics

x	Include Subbasins & Names
x	Include Other Significant Points
x	Aerial Photography
x	Topography
x	Land Use
x	Soils
x	Floodplain/Floodway
x	Model Schematic

Supporting Calculations

X	Curve numbers
X	Lag Time/TC
X	Rating Curves
X	Routing Parameters

Models

X	Hydrologic - Electronic
X	Hydraulic - Electronic
X	Floodway Definition
	Structure - Specific

Summary Tables

X	Subbasin and Section IDs
X	General Hydrology Results
	Sensitivity Analysis
X	General Hydraulic Results
X	Floodway Definition

Discharge Certification Form for Mill Creek Hydrologic Analysis 4/2014

Applicant Information

Agency/Firm:	Illinois State Water Survey	Date:	4/2014
submitted by:	Amanda Flegel	Phone:	217-300-3468
Address:	2204 Griffith Drive, Champaign, Illinois 61820		
Applicant/Property Owner			

Hydrologic Information

Community/Communities Affected:	Lake County, Village of Grayslake, Village of Third Lake, Village of Old Mill Creek, the Village of Wadsworth, and Unincorporated Lake County.
County:	Lake County
Quadrangle Name(s):	
Stream Name:	Mill Creek
Flood Insurance Study and Map Panel:	Lake County panels, 0043, 0044, 0061, 0062, 0063, 0131, 0132, 0133, 0134, 0151
Model Calibration (yes or no):	Yes
Study Models:	HEC-HMS 3.5

*Locations should be based on physical landmarks, such as "1000 ft. upstream of Main Street" Please attach a map showing location with identifiers.

Page 1

Discharge Certification Locations

**Additional frequency events are detailed in the report

Section Name	Identifying Landmark	Legal Description (Sec.,Twp., Range)	Drainage Area (sq. miles)	Certified Discharges		Other Frequencies	
				100-year (cfs)	10-year (cfs)	Frequency (Years)	Flow (cfs)
1	Metra Railroad US of St Hwy 120	S35, T45N, R10E	3.28	350	200	**	**
2	RR DS of St Hwy 120	S35, T45N, R10E	4.63	400	240	**	**
3	US unnamed tributary US of Atkinson Rd	S26, T45N, R10E	6.79	410	280	**	**
4	US unnamed tributary DS of Atkinson Rd	S25, T45N, R10E	8.86	730	430	**	**
5	US Third Lake, near Washington Street	S24, T45N, R10E	10.3	830	520	**	**
6	US Forth Lake Tributary	S12, T45N, R10E	13.9	690	490	**	**
7	at State Hwy 132	S7, T45N, R11E	19.7	710	470	**	**
8	US unnamed tributary- downstream of Hutchins Rd	S8, T45N, R11E	22.3	840	490	**	**
9	US unnamed tributary	S6, T45N, R11E	23.5	1,050	530	**	**
10	US of North Mill Creek confluence	S31, T46N, R11E	25.8	1,630	790	**	**
11	USGS gage Mill Creek at Old Mill Creek	S32, T46N, R11E	59.88	2,080	1,370	**	**
12	At I94	S33, T46N, R11E	63.73	2,150	1,440	**	**

*Locations should be based on physical landmarks, such as "1000 ft. upstream of Main Street" Please attach a map showing location with identifiers.

Appendix L. PeakFQ Output File

```
1
 Program PeakFq          U. S. GEOLOGICAL SURVEY           Seq.000.000
 Ver. 5.2          Annual peak flow frequency analysis      Run Date / Time
 11/01/2007         following Bulletin 17-B Guidelines       11/04/2013 10:35

                     --- PROCESSING OPTIONS ---

                   Plot option         = None
                   Basin char output   = None
                   Print option        = Yes
                   Debug print         = No
                   Input peaks listing = Long
                   Input peaks format  = WATSTORE peak file

                   Input files used:
                     peaks (ascii)  - C:\DOCUMENTS AND
SETTINGS\AFLEGEL.UOFI\DESKTOP\PEAKFQ\MILLCRK_OLDMILLCRK_PEAKQPL
                     specifications - PKFQWPSF.TMP
                   Output file(s):
                     main - C:\DOCUMENTS AND SETTINGS\AFLEGEL.UOFI\DESKTOP\PEAKFQ\MILLCRK_OLDMILLCRK_PEAKQPL

1
 Program PeakFq          U. S. GEOLOGICAL SURVEY           Seq.001.001
 Ver. 5.2          Annual peak flow frequency analysis      Run Date / Time
 11/01/2007         following Bulletin 17-B Guidelines       11/04/2013 10:35

          Station - 05527950  MILL CREEK AT OLD MILL CREEK, IL


                 I N P U T   D A T A   S U M M A R Y

           Number of peaks in record          =      40
           Peaks not used in analysis         =       1
           Systematic peaks in analysis       =      39
           Historic peaks in analysis         =       0
           Years of historic record           =       0
           Generalized skew                   =  -0.400
              Standard error                  =   0.550
              Mean Square error               =   0.303
           Skew option                        =  WEIGHTED
           Gage base discharge                =     0.0
           User supplied high outlier threshold =   --
           User supplied low outlier criterion  =   --
           Plotting position parameter        =    0.00
```

```
********* NOTICE -- Preliminary machine computations.      *********
********* User responsible for assessment and interpretation. *********

**WCF109W-PEAKS WITH MINUS-FLAGGED DISCHARGES WERE BYPASSED.     1
**WCF113W-NUMBER OF SYSTEMATIC PEAKS HAS BEEN REDUCED TO NSYS =   39
  WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.            0.0
  WCF198I-LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED.     1      86.8
  WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.    3277.7
  WCF002J-CALCS COMPLETED. RETURN CODE =  2
1

 Program PeakFq        U. S. GEOLOGICAL SURVEY          Seq.001.002
 Ver. 5.2         Annual peak flow frequency analysis      Run Date / Time
 11/01/2007        following Bulletin 17-B Guidelines       11/04/2013 10:35

        Station - 05527950  MILL CREEK AT OLD MILL CREEK, IL

      ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

              FLOOD BASE              LOGARITHMIC
           ---------------------  -------------------------------
                 EXCEEDANCE           STANDARD
            DISCHARGE PROBABILITY    MEAN    DEVIATION    SKEW
           -------------------------------------------------------
SYSTEMATIC RECORD      0.0    1.0000    2.7640     0.3091    -1.148
BULL.17B ESTIMATE     86.8    0.9744    2.7773     0.2818    -0.703

  ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

   ANNUAL                     'EXPECTED   95-PCT CONFIDENCE LIMITS
 EXCEEDANCE    BULL.17B    SYSTEMATIC PROBABILITY'  FOR BULL. 17B ESTIMATES
 PROBABILITY    ESTIMATE     RECORD    ESTIMATE      LOWER       UPPER

   0.9950       --        44.3       --        --        --
   0.9900       --        63.2       --        --        --
   0.9500      183.9      150.0      173.7      131.8      235.1
   0.9000      252.1      223.6      243.9      191.5      311.3
   0.8000      358.7      343.1      353.2      287.9      430.3
   0.6667      484.7      485.6      481.8      402.1      575.1
   0.5000      645.8      663.5      645.8      543.8      771.3
   0.4292      721.3      744.0      722.7      608.0      867.7
   0.2000     1044.0     1061.0     1055.0      868.2     1309.0
   0.1000     1290.0     1268.0     1314.0     1055.0     1671.0
   0.0400     1572.0     1469.0     1616.0     1260.0     2106.0
   0.0200     1760.0     1582.0     1823.0     1394.0     2408.0
```

0.0100	1931.0	1671.0	2014.0	1512.0	2688.0
0.0050	2086.0	1741.0	2191.0	1618.0	2948.0
0.0020	2270.0	1811.0	2404.0	1743.0	3263.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.003
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 11/04/2013 10:35

Station - 05527950 MILL CREEK AT OLD MILL CREEK, IL

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1960	-778.0	H	1994	988.0	
1962	439.0		1995	696.0	
1963	70.0		1996	1020.0	
1964	120.0		1997	1000.0	
1965	423.0		1998	609.0	
1966	500.0		1999	1160.0	
1967	395.0		2000	1060.0	
1968	146.0		2001	405.0	
1969	720.0		2002	581.0	
1970	744.0		2003	138.0	
1971	583.0		2004	831.0	
1972	921.0		2005	436.0	
1973	510.0		2006	465.0	
1974	840.0		2007	770.0	
1975	319.0		2008	1070.0	
1976	1050.0		2009	1730.0	
1990	486.0		2010	963.0	
1991	931.0		2011	958.0	
1992	336.0		2012	316.0	
1993	1090.0		2013	1700.0	

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization

H 7 Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.004
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 11/04/2013 10:35

Station - 05527950 MILL CREEK AT OLD MILL CREEK, IL

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
2009	1730.0	0.0250	0.0250
2013	1700.0	0.0500	0.0500
1999	1160.0	0.0750	0.0750
1993	1090.0	0.1000	0.1000
2008	1070.0	0.1250	0.1250
2000	1060.0	0.1500	0.1500
1976	1050.0	0.1750	0.1750
1996	1020.0	0.2000	0.2000
1997	1000.0	0.2250	0.2250
1994	988.0	0.2500	0.2500
2010	963.0	0.2750	0.2750
2011	958.0	0.3000	0.3000
1991	931.0	0.3250	0.3250
1972	921.0	0.3500	0.3500
1974	840.0	0.3750	0.3750
2004	831.0	0.4000	0.4000
2007	770.0	0.4250	0.4250
1970	744.0	0.4500	0.4500
1969	720.0	0.4750	0.4750
1995	696.0	0.5000	0.5000
1998	609.0	0.5250	0.5250
1971	583.0	0.5500	0.5500
2002	581.0	0.5750	0.5750
1973	510.0	0.6000	0.6000
1966	500.0	0.6250	0.6250
1990	486.0	0.6500	0.6500
2006	465.0	0.6750	0.6750
1962	439.0	0.7000	0.7000

2005	436.0	0.7250	0.7250
1965	423.0	0.7500	0.7500
2001	405.0	0.7750	0.7750
1967	395.0	0.8000	0.8000
1992	336.0	0.8250	0.8250
1975	319.0	0.8500	0.8500
2012	316.0	0.8750	0.8750
1968	146.0	0.9000	0.9000
2003	138.0	0.9250	0.9250
1964	120.0	0.9500	0.9500
1963	70.0	0.9750	0.9750
1960	-778.0	--	--

1

End PeakFQ analysis.

Stations processed : 1

Number of errors : 0

Stations skipped : 0

Station years : 40

Data records may have been ignored for the stations listed below.

(Card type must be Y, Z, N, H, I, 2, 3, 4, or *.)

(2, 4, and * records are ignored.)

For the station below, the following records were ignored:

FINISHED PROCESSING STATION: 05527950 USGS MILL CREEK AT OLD MILL CREEK,

Appendix M. StreamStats Output Summary

Location	Drainage Area (sq.mi.)	Channel Slope (ft/mi)	Percent Open Water	Regression Equation/ StreamStat (cfs)				
				10%	4%	2%	1%	0.20%
USGS gage Mill Creek at Old Mill Creek	59.88	7.44	6.51	1,300	1,600	1,820	2,020	2,490
Approximately 0.5 Miles downstream of the Mill Creek at Old Mill Creek gage	61.48	7.34	6.38	1,330	1,630	1,860	2,060	2,540
At I94	63.73	7.30	6.21	1,370	1,680	1,920	2,130	2,620

Summary table for StreamStat results used in statistical peak discharge frequency analysis on Mill Creek downstream of North Mill Creek

Appendix N. Curve Number Lookup Table

Runoff Curve Numbers for land use and soil type combinations used in this analysis.

LULC05	Land Use	A	B	C	D
1111	Single Family detached	61	75	83	87
1112	Townhouse and Duplexes	77	85	90	92
1113	Age Restricted Single Family detached	61	75	83	87
1114	Age Restricted Townhouse and Duplexes	89	92	94	95
1115	Condominium	77	85	90	92
1116	Age Restricted Condominium	77	85	90	92
1120	Farmhouse	59	74	82	86
1131	Apartments	77	85	90	92
1132	Age Restricted Apartments	77	85	90	92
1133	Income Restricted Apartments	77	85	90	92
1141	Mobile Home	77	85	90	92
1142	Age Restricted Mobile Home	77	85	90	92
1210	Shopping Malls	89	92	94	95
1220	Office Campus/Research Park	89	92	94	95
1230	Single Structure Office	89	92	94	95
1240	Commercial Mix	89	92	94	95
1250	Cultural, Entertainment	49	69	79	84
1260	Hotel/Motel	61	75	83	87
1270	Auto Dealerships, Recreational Vehicle Dealerships, Boat dealerships, and Truck Dealerships	89	92	94	95
1310	Medical and Health Care Facilities	77	85	90	92
1320	Educational Facilities	68	79	86	89
1340	Governmental Administration and Services	68	79	86	89
1350	Prison and Correctional Facilities	-	-	-	-
1360	Religious Facilities	68	79	86	89
1380	Cemeteries	49	69	79	84
1390	Other Institutional	49	69	79	84
1410	Mineral Extraction	-	-	-	-
1420	Manufacturing and Processing	81	88	91	93
1430	Warehousing/Distribution Center and Wholesale	81	88	91	93
1440	Industrial Park	-	-	-	-
1521	Public Roadway	98	98	98	98
1522	Interstate and Toll Way	-	-	-	-
1523	Private Roadway	98	98	98	98
1524	Rights-of-way Occupied by Transportation Related Uses	-	-	-	-
1525	Right-of-way Occupied by Non-Transportation	-	-	-	-
1526	Bus Facility	89	92	94	95
1529	Temporary code for non-road uses located in Rights-Of-Way	-	-	-	-
1530	Airport Transportation	-	-	-	-

LULC05	Land Use	A	B	C	D
1540	Automobile Parking	98	98	98	98
1550	Communication	81	88	91	93
1560	Utilities and Waste Facilities	68	79	86	89
1570	Regulated Landfills	68	79	86	89
1581	Railroad Right-of-Way with tracks present including trackside vegetation.	49	69	79	84
1592	Commuter and Transit Rail Stations	81	88	91	93
1593	Other Railroad Related Facilities such as rail yards, storage yards, and maintenance facilities				
2110	Cropland	67	78	85	89
2120	Equestrian Cropland				
2200	Orchards, Vineyards, Nurseries and Horticultural Areas	49	69	79	84
2300	Farm Buildings and Associated Land				
2310	Non Equestrian Facilities	59	74	82	86
2320	Equestrian Facilities	68	79	86	89
2410	Pasture				
2420	Agricultural lands managed for grazing	49	69	79	84
3110	Parks, Arboretums, and Botanical Gardens	49	69	79	84
3120	Golf Courses	49	69	79	84
3130	Other Open Space	49	69	79	84
3140	Groomed Subdivision and Commercial Set Asides	49	69	79	84
3150	Recreational Trails	72	82	87	89
3210	Parks, Arboretums, Botanical Gardens, and Forest Preserves	35	56	70	77
3230	Subdivision and Commercial Conservation Set Asides	35	56	70	77
3300	Primarily Stormwater Management	35	56	70	77
4110	Forest Lands	43	65	76	82
4120	Wetlands	30	58	71	78
4130	Wetlands/Agricultural	30	58	71	78
4140	Grasslands	49	69	79	84
4150	Indeterminate Vegetation	35	56	70	77
4160	Beach	100	100	100	100
4210	Residential - Under Development	49	69	79	84
4220	Non-Residential - Under Development	49	69	79	84
4300	Other Vacant Land Available for Redevelopment	49	69	79	84
5100	Rivers, Streams, and Canals	100	100	100	100
5200	Lakes, Reservoirs, and Lagoons	100	100	100	100
5300	Lake Michigan	100	100	100	100
9999	UNCLASSIFIED				

Appendix O. Subbasin Parameters

Subbasin	Area (sq miles)	CN AMC II	Main Channel Length LFP length (miles)	Main Channel Slope LFP Slp1085ftmi (ft/mi)	Depth Effect Precip 1%,18hr (in)	1997 Lake County Tc&R Area Based Eq Tc (hr)	R (hr)
F1a	0.24	81.19	1.03	51.36	4.00	1.38	2.21
F1b	0.47	87.39	1.94	43.72	4.67	1.14	1.94
F1c	0.26	86.67	1.30	47.84	4.59	0.73	1.42
F2	0.34	76.15	1.30	30.23	3.49	3.02	4.59
F3	0.36	85.66	1.40	45.08	4.48	0.96	1.75
F5	0.33	88.95	1.74	52.94	4.84	0.80	1.43
Fa	0.27	84.10	1.49	34.08	4.31	0.99	1.96
Fc	0.65	79.62	3.01	19.82	3.84	2.20	4.15
G	0.53	85.25	1.69	25.16	4.43	1.07	2.27
H	0.23	80.85	1.04	18.72	3.97	0.80	2.13
H1	0.16	87.47	1.29	26.82	4.67	0.45	1.22
I1a	0.20	74.26	1.45	5.93	3.30	1.66	5.22
I1b	0.45	82.13	1.61	11.97	4.10	1.69	3.92
I2a	0.11	73.79	0.78	15.63	3.26	1.37	3.43
I2b	0.25	75.11	1.07	22.03	3.39	0.78	2.18
J1a	0.21	83.32	1.28	19.87	4.23	0.85	2.11
J1b	0.33	78.24	1.54	14.87	3.70	1.07	2.87
J1c	0.23	78.02	1.29	3.64	3.68	1.26	4.84
J1d	0.44	82.32	1.49	8.99	4.12	1.02	3.11
Ja-ForthLake	1.27	81.33	2.62	10.27	4.02	2.42	5.35
Jb	0.22	75.70	1.16	27.93	3.45	0.90	2.18
Jc	0.26	86.35	1.50	35.74	4.55	0.75	1.57
Jd	0.63	84.39	1.97	16.79	4.34	1.19	2.79
Je	0.27	82.16	1.49	35.79	4.11	0.89	1.86
Jf	0.30	82.74	1.37	31.76	4.17	1.00	2.06
K2	0.46	75.33	1.52	14.23	3.41	1.08	3.07
Ka	0.57	68.95	1.89	12.25	2.79	5.77	10.27
L	0.58	84.14	2.23	23.47	4.31	1.16	2.48
L1a	0.51	86.67	1.67	14.27	4.59	0.97	2.48
L1b	0.52	83.15	2.24	17.35	4.21	1.19	2.79

Subbasin	Area	CN AMC II	Main Channel Length	Main Channel Slope	Depth Effect Precip	1997 Lake County Tc&R Area Based Eq	
			LFP length	LFP Slp1085ftmi		Tc	R
	(sq miles)		(miles)	(ft/mi)	1%,18hr (in)	(hr)	(hr)
L1bnorth	0.22	83.15	2.24	17.35	4.21	0.73	1.99
L1c	0.64	84.97	1.67	20.16	4.40	1.23	2.68
M-3rdLake	0.44	86.15	1.57	1.33	4.53	0.89	4.85
Ma	0.27	77.88	1.20	12.97	3.66	1.84	4.21
N1	0.77	89.12	2.29	3.10	4.86	1.09	4.17
N1b	0.21	78.00	0.65	30.85	3.68	0.86	1.98
Na-lake	0.44	86.17	1.42	7.89	4.53	0.94	2.93
Nb	0.22	81.95	1.38	15.62	4.08	0.71	2.07
Nc	0.20	86.83	1.25	18.30	4.60	0.55	1.58
O1a	0.16	80.25	0.88	17.25	3.91	0.71	2.03
O1b	0.10	79.00	0.32	23.50	3.78	0.89	2.14
O1c	0.36	88.31	1.81	16.62	4.77	0.65	1.80
Oa	0.18	87.46	0.82	20.33	4.67	0.49	1.40
Oc	0.31	83.27	1.68	18.80	4.22	0.85	2.16
P1	0.65	82.82	2.09	10.55	4.17	1.39	3.61
P2	0.21	82.48	1.40	14.87	4.14	0.53	1.73
P2_rln	0.28	82.48	1.40	14.87	4.14	0.49	1.73
Pa	0.15	85.30	1.20	16.48	4.44	0.43	1.40
Pb	0.41	86.91	1.76	8.71	4.61	0.80	2.54
Pc	0.37	79.85	1.73	3.53	3.87	1.15	4.58
Pd	0.23	81.96	1.30	27.56	4.08	0.64	1.63
Q1	0.34	88.51	0.91	9.96	4.79	0.70	2.19
Q2	0.08	87.02	0.68	-11.63	4.62	0.35	1.27
Q3a	0.19	81.99	1.27	4.02	4.09	0.62	2.84
Q3b	0.24	84.52	1.20	25.20	4.35	0.72	1.75
Q3c	0.21	88.96	1.02	6.08	4.84	0.48	1.97
R	0.40	84.31	2.11	20.14	4.33	0.94	2.25
S	0.34	86.88	1.07	37.44	4.61	0.68	1.47
T	0.25	86.51	0.82	28.42	4.57	0.54	1.38
T1	0.64	82.31	2.01	24.01	4.12	1.22	2.60
Ub	0.23	81.68	1.09	34.45	4.06	0.92	1.92
Uc	0.48	77.16	1.65	29.20	3.59	9.06	9.22
Ud	0.18	82.62	1.57	11.65	4.15	0.71	2.22
Ud1	0.25	82.62	1.57	11.65	4.15	0.86	2.52

Subbasin	Area (sq miles)	CN AMC II	Main Channel Length LFP length (miles)	Main Channel Slope LFP Slp1085ftmi (ft/mi)	Depth Effect Precip 1%,18hr (in)	1997 Lake County Tc&R Area Based Eq Tc (hr)	R (hr)
Uf	0.29	84.85	1.41	25.93	4.39	1.52	2.77
Va	0.57	81.14	1.29	18.88	4.00	2.25	4.17
Vb	0.20	81.90	1.32	46.07	4.08	2.13	2.96
Vc	0.29	80.92	1.28	38.65	3.98	2.96	3.93
Vd	0.18	77.97	1.12	31.15	3.67	2.62	3.98
Ve	0.37	83.34	1.55	27.06	4.23	1.70	3.02
Vf	0.23	77.71	1.14	31.45	3.65	3.88	5.14
Vg	0.23	82.79	1.17	15.59	4.17	1.64	3.46
Vh	0.22	79.20	0.88	44.10	3.80	3.39	4.18
Wa	0.27	76.22	0.98	24.16	3.50	4.47	6.24
Wb	0.26	79.61	1.00	25.80	3.84	4.14	5.56

Appendix P. August 26, 2013 Meeting Agenda

STORMWATER MANAGEMENT COMMISSION

MEETING AGENDA

Mill Creek Floodplain Study Kick-Off Meeting
August 26, 2013
10:30am

- Introduction

- Past Studies & Data
  1. Village of Grayslake's LOMR Application for Mill Creek (Avon-Fremont Drainage Ditch) report by Baxter & Woodman, dated September 2011
  2. Independent Technical Review: Mill Creek LOMR Application of Grayslake study (letter) by Christopher B. Burke Engineering, Ltd., dated October 17, 2011
  3. Review Comments of Mill Creek, re-submitted by Lake County Stormwater Management Commission (LCSMC), consulting done by Tetra Tech and Bleck Engineering Company, Inc., by USACE-LRC, dated February 11, 2008
  4. South Mill Creek Watershed Hydrologic and Hydraulic Report by Bleck Engineering Company, Inc., dated February 14, 2007, revised modeling April 2008 and revised report September 2008
  5. South Mill Creek Watershed Hydrologic and Hydraulic Report by Bleck Engineering Company, Inc., dated February 14, 2007
  6. Mill Creek Watershed Study ITR Report by Bleck Engineering Company, Inc., dated February 1, 2007
  7. Mill Creek Watershed Study Report by Tetra Tech EMI, dated January 29, 2004
  8. Mill Creek Watershed Full Build-out/Future Conditions Hydrologic and Hydraulic Conditions report by Tetra Tech EMI, dated September 29, 2003
  9. Mill Creek Cross Section and Floodplain Mapping Report by Spaceco Inc., dated November 13, 2002
  10. The Lake County Geographic Information System.

- Changed Conditions Maps & Permits

- Project Timeline

- Questions

U:\Floodplain Studies\Mill\kickoff\MEETING AGENDA.doc

Appendix Q. Storage Area Mapping Information

				Stillwater Elevation Table (Feet, NAVD 88)				
Storage Area	HMS Project Subbasin	Effect. Zone	Crit. Duration	10%	4%	2%	1%	0.2%
Countryside Landfill- north flood storage	Ud	None	18hr	794.34	794.94	795.2	795.47	796.43
Countryside Landfill- south pond	Ud	None	18hr	795.13	796.03	796.84	797.86	798.78
Metro storage area	Ud1	Zone A	18hr	796.33	796.65	796.93	797.34	798.41
Gray's Lake		Zone A	120hr	788.02	788.3	788.56	788.91	789.84
Chesapeake Farm Lake	Pc	Zone A	18hr	768.77	769.36	769.85	770.4	770.91
Rollins Savanna storage in P2_roln10	P2-rln10	Zone A	18hr	772.33	772.65	772.94	773.4	774.28
Rollins Savanna storage in P2_roln2	P2-rln2	None	18hr	771.81	771.82	771.85	771.88	771.97
CLC- Willow Lake	O1a	Zone A	120hr	769.74	770.2	770.64	771.2	771.65
Gages Lake	N1	Zone A	120hr	780.35	780.58	780.76	780.98	781.16
Depressional storage near Washington and US 45	N1b	Zone A	18hr	768.78	769.5	769.9	770.57	772.15
Druce Lake	Na-Lake	Zone AE	120hr	765.55	766.03	766.48	767.09	768.49
Rollins Savanna storage	K	Zone A	120hr	774.86	775.12	775.32	775.61	776.16
Fourth Lake	Ja-ForthLake	Zone AE	120hr	762.39	762.73	762.98	763.32	764.66
Lake Miltmore	Ja-ForthLake	Zone AE	120hr	762.39	762.73	762.98	763.32	764.66
Bittersweet Golf Course L1c-RT23	L1c	none	24hr	763.77	764.35	764.52	764.21	764.97
Bittersweet Golf Course L1c-RT28	L1c	None	48hr	761.49	762.62	763.58	764.47	764.83
Bittersweet Golf Course L1b-RT14	L1c	None	48hr	761.16	762.08	762.33	762.34	762.93
Bittersweet Golf Course L1b-RT10	L1b	Zone A	48hr	762.06	762.23	762.28	762.38	762.67
Bittersweet Golf Course L1b-RT9	L1b	Zone A	18hr	761.23	761.82	762.25	762.7	763.32
Forest Preserve storage	F2	None	18hr	760.66	760.73	760.77	760.82	760.92
Deerpath Lake	F3	None	18hr	732.59	733.23	733.76	734.11	734.43

Storage Area	HMS Project Subbasin	Effective FIRM	Proposed FIRM	Proposed Zone notes
Countryside Landfill-north flood storage	Ud	None	Zone A	The outlet data is based on permit information. 2007 LiDAR data used for volume calculation is within 1' accuracy. The resulting BFE determination is over 1' different than the permit data.
Countryside Landfill-south pond	Ud	None	Zone A	The outlet data is based on permit information. 2007 LiDAR data used for volume calculation is within 1' accuracy. The resulting BFE determination is over 1' different than the permit data.
Countryside Landfill	Ud	Zone A	remove	The effective Zone A is now located on high ground.
Metro storage area	Ud1	Zone A	Zone A	Outlet data is based on permit information and the resulting proposed BFE is within 1' of the permit data. 2007 LiDAR data used for volume calculation is within 1' accuracy.
Gray's Lake		Zone A	Zone AE	The outlet data is based on the 2008 HEC-1 rating curves. The proposed BFE is 0.7' above the structure outlet elevation based on Gray's Lake provided data.
Chesapeake Farm Lake	Pc	Zone A	Zone A	The outlet data is based on permit information. 2007 LiDAR data used for volume calculation is within 1' accuracy.
Rollins Savanna storage in P2_roln10	P2-rln10	Zone A	Zone AE	The outlet data is based on the 2008 HEC-1 rating curves. The flow path between storage areas was mapped as inundated.

Storage Area	HMS Project Subbasin	Effective FIRM	Proposed FIRM	Proposed Zone notes
Rollins Savanna storage in P2_roln2	P2-rln2	None	Zone AE	The outlet data is based on the 2008 HEC-1 rating curves. The flow path between storage areas was mapped as inundated.
CLC- Willow Lake	O1a	Zone A	Zone AE	The outlet data is based on the 2008 HEC-1 rating curves. The proposed results are within 1' of the design 1% water surface elevation.
Gages Lake	N1	Zone A	Zone AE	The outlet data is based on the 2008 HEC-1 rating curves. The proposed BFE agrees well with recent condo development design 1% water surface elevation.
Depressional storage near Washington and US 45	N1b	Zone A	Zone A	Outlet data is based on permit information from the medical building to the north. 2007 LiDAR data used for volume calculation is within 1' accuracy. The resulting proposed floodplain agrees well with the wetland area. Consideration should be given to how to map the south wetland area.
Druce Lake	Na-Lake	Zone AE	Zone AE	Druce Lake modeled as a single reservoir with Third Lake. Proposed BFE is approximately 1' greater than the effective BFE.
Rollins Savanna storage	K	Zone A	Zone A	The outlet data is based on the 2008 HEC-1 rating curves. The source data for these rating curves was not validated by ISWS.
Fourth Lake	Ja-ForthLake	Zone AE	Zone AE	Significant changes were made to the volume of Forth Lake based on the 2007 LiDAR data. The rating curve was based on the 2008 HEC1 model. The lake was modeled as inline with the stream. Proposed BFE is within 1' of the effective BFE.
Lake Miltmore	Ja-ForthLake	Zone AE	Zone AE	Lake Miltmore was modeled as a single reservoir with Forth Lake. Proposed BFE is within 1' of the effective BFE.

Storage Area	HMS Project Subbasin	Effective FIRM	Proposed FIRM	Proposed Zone notes
Bittersweet Golf Course L1c-RT23	L1c	None	Zone A	Storage area volume based on 2007 LiDAR data. Rating curve based on permit structures and overland flow elevation from 2007 LiDAR. Proposed results are within 1' of the design water surface elevations.
Bittersweet Golf Course L1c-RT28	L1c	None	Zone A	Storage area volume based on 2007 LiDAR data. Rating curve based on permit structures and overland flow elevation from 2007 LiDAR. Proposed results are within 1' of the design water surface elevations.
Bittersweet Golf Course L1b-RT14	L1c	None	Zone A	Storage area volume based on 2007 LiDAR data. Rating curve based on permit structures and overland flow elevation from 2007 LiDAR. Proposed results are greater than 1' of the design water surface elevations.
Bittersweet Golf Course L1b-RT10	L1b	Zone A	Zone A	Storage area volume based on 2007 LiDAR data. Rating curve based on permit structures and overland flow elevation from 2007 LiDAR. Proposed results are within 1' of the design water surface elevations.
Bittersweet Golf Course L1b-RT9	L1b	Zone A	Zone A	Storage area volume based on 2007 LiDAR data. Rating curve based on permit structures and overland flow elevation from 2007 LiDAR. Proposed results are greater than 1' of the design water surface elevations.
Forest Preserve storage	F2	None	Zone AE	The outlet data is based on the 2008 HEC-1 rating curves. The proposed BFE is within 1' of the HEC1 resulting BFE.
Deerpath Lake	F3	None	Zone A	The outlet data is based on the 2008 HEC-1 rating curves. The resulting BFE does not inundate the south lake. These should be modeled as separate reservoirs to map the lake area.

Appendix R. Thomson Field Survey Data

Thomson Survey (Fall of 2013)		
Field-Surveyed Cross Sections		Structures
30271	64262	Grandwood Park Dam
31894	64461	Farm Access (STA 58714)
32414	69385	Farm Access (STA 60951)
32572	69463	Rollins Rd
33852	69580	Rollins Savanna Prairie Bridge (STA 69439)
35743	76822	Washington St
36222	77009	METRA Railway Bridge
36480	85697	
38744	85750	
49188	85801	
58571	86786	
58680	86975	
58747	87018	
58795	87089	
58902	94505	
60827	94574	
60914	94750	
60983		

Appendix S. Independent Technical Review (ITR) Response

Drainage Area Review Comments by watershed
with ISWS response (3/31/2014)
Bleck Engineering
Mill Creek ITR

A: OK

B: There is ~362-ac upstream of Wadsworth Road and a defined channel system downstream of the Wadsworth Road that is not modeled (present in LC streams layer). The majority of the flow enters the stream near I94. Don't have structure data or survey cross-sections for tributary, therefore, left as single sub-basin. In future should model channel and establish profile.

- A hydraulic model of the tributary was not completed. The 2014 ISWS proposed HEC-HMS model was not extended downstream of North Mill Creek, so the subbasin is not included in the proposed rainfall runoff model.

C: Northern portion (~53-ac) of C moved into B watershed (it goes east not south).

There is a defined channel between Wadsworth Road and stream that is not modeled (present in LC streams layer). Don't have structure data or survey cross-sections so just combined hydrographs for flow rate into stream. In future should model channel.

On-line impoundment at B/C divide not surveyed or modeled. In future should model channel and establish profile.

- The 2014 ISWS proposed HEC-HMS model was not extended downstream of North Mill Creek, so the subbasin is not included in the proposed rainfall runoff model.
- Joanna mentioned this at the kick-off meeting; we mentioned that it wasn't necessary to obtain additional cross sections or model it in HEC-RAS unless Lake County wanted it.

D: There is a large storage area upstream of Hunt Club Road and then a defined channel from Hunt Club Road, across Sand Lake Road and into stream (present in LC streams layer). No survey data (for pond, structures or cross-sections) available therefore left as LARGE sub-basin. In future should model channel and establish profile.

- The HEC-HMS model was not extended downstream of North Mill Creek, so the subbasin is not included in the proposed rainfall runoff model.

E: Small channel to stream not modeled. No directly adjacent structures. No revision necessary.

F: There are 3 large defined channels entering stream (present in the LC streams layer). This sub-basin is WAY TOO large. Used SMC permit data to break this area out into 6 sub-basins. In future should model channels and establish profiles.

52-ac area in SE corner should go into G and not F. Modified.

The following Permits have been issued:

- ***F1***
- ***F2***
- ***F3***
- ***F4***
- ***F5***

- The 2014 ISWS proposed HEC-HMS model subbasins were based on HEC-GeoHMS automated delineation using the LiDAR data available. The area was further subdivided such that two tributaries downstream of Stearns School Road are specifically modeled in the HEC-HMS rainfall runoff model. The additional permit data was not specifically included in the HMS model. The Deerpath Subdivision storage area was included based on the previous HEC-1 model, with an extended rating curve.

- Hydraulic modeling for the tributaries was not completed.

G: Added 52-ac from F (on NE of stream)

Added additional acreage from F south of Stearns School Road (west of Stream)

- The 2014 ISWS proposed HEC-HMS model subbasins were based on HEC-GeoHMS automated delineation using the LiDAR data available. This subbasin represents the area drained by the unnamed tributary.

H: Broke into 2 sub-basins with Grand Avenue as drainage divide.

Reshaped at Grand and Route 45

H/L SE border appears to be based on subdivision plan (development under construction per aerial). Let delineation alone (varies slightly from topo)

Modified NW corner of new H1 (original H)

- The 2014 ISWS proposed HEC-HMS model subbasins were based on HEC-GeoHMS automated delineation using the LiDAR data available. The area defined by these subbasins were generally unchanged.

I: I/L border north of Grand is cut through swale and not ridgeline (ridgeline cuts through depressional area as well, revised.

Broke into 2 sub-basins with wetland storage area inflow point as drainage divide

SW corner of I (south of Rollins) goes into K

? connection of floodplain between large overbank area and smaller overbank area closer to 45 in I1 (overtopping between 62 and 64. Will likely overtop currently modeled BFE 763.4). Should obtain additional survey data and revise.

Floodplain shading should include area north of Grand based on current floodplain.

Structure at Grand Ave should be added (lateral flow) to verify level pool (further break out new I1).

- The 2014 ISWS proposed HEC-HMS model subbasins were based on HEC-GeoHMS automated delineation using the LiDAR data available. The area defined by these subbasins was further subdivided.

J: J/K border doesn't match previous Cambridge North Study, revised (see K1)

Stream upstream of Fourth Lake not included. This data is available in the Cambridge North file. In future should update hydrology, model channels and establish profiles for Cambridge and Fourth Lake tributaries, J1 (this area delineated for future use but not added to HEC-1 model).

- The 2014 ISWS proposed HEC-HMS model subbasins were revised to agree with the Autumn Ridge subbasin delineations. The subbasin also agreed with the Cambridge North Study, per Lake County review, due to the use of the LiDAR data. Several separate subbasins were identified north, south and west of Forth Lake and tributary routing is modeled into Forth Lake from the north and south. A single storage area was used to represent the Forth Lake, Miltmore Lake and the wetland area.

K: Removed portion of K and direct into J1.

Broke out remaining K into K and K2 and P2 per Rollins Savanah permit file.

- The 2014 ISWS proposed HEC-HMS model subbasins were based on the LiDAR data, and there were small changes to the drainage areas.

L: Broke out into L1 and L.

Significant amount of depressional storage not modeled (such as large areas upstream Almond and 4 areas west of Almond). Riverine profile not established (appears to be down roadways). Significant inflow point is just downstream of H1. In future should update hydrology, model channels and establish profiles within L1.

- The 2014 ISWS proposed HEC-HMS model subbasins were further subdivided. The tributary downstream of Grandwood Lake is modeled in the HEC-HMS rainfall runoff model. The wetland/storage areas surrounding the Bittersweet Golf Course were incorporated in the hydrologic model based on design plan data. The storage areas were included in the model as 5 separate reservoirs.
- Hydraulic modeling of the tributary was not completed and risk along the flow path to Mill Creek is not identified.

M: Contains Third Lake.

Northern limits of M broken out into I2 per Rollins Savanah permit file.

- The 2014 ISWS proposed HEC-HMS model subbasin was further subdivided and there were small changes to the drainage area based on the LiDAR data.

N: Originally contained Gages Lake unattenuated and Druce Lake. Broke out Gages Lake into N1 per permit file and explicitly modeled. Druce Lake modeled as off-line storage in unsteady flow HEC-RAS.

Floodplain from Druce Lake should be shown to extend into Third Lake Development (Third Lake Commons or something – McClure site).

- The 2014 ISWS proposed HEC-HMS model subbasin was further subdivided and there were small changes to the drainage area based on the LiDAR data. Druce Lake was modeled as part of Third Lake as the small weir dividing the storage areas was damaged/removed per field inspection and based on the wide connection between the two.

O: Willow Lake not originally modeled or mapped as FP. Broke out O1 per CLC permit file.

- The 2014 ISWS proposed HEC-HMS model subbasin was further subdivided. The permit data was used to define the drain area to Willow Lake.

P: Significant unnamed tributary not studied. Topography file missing portion of the watershed. Some additional information in the Squaw topography (but contour data not complete south of Washington).

Large storage area not attenuated (drained by tile upstream of tracks). In future should update hydrology, model channel and establish profiles for P1 (this area delineated for future use, not currently explicitly modeled).

- The 2014 ISWS proposed HEC-HMS model subbasin was further subdivided to include routing of the Chesapeak Landing tributary. Storage areas in the Rollins Savanah were incorporated per the previous study, but additional storage was modeled along the Chesapeak Lake and at the confluence.

Q: Inappropriate subbasin and inflow point into Mill Creek. Original Grays Lake rating curve wrong.

Broke down into 3 sub-basins (Q1, Q2, Q3).

Grays Lake rating curve revised per information obtained from Baxter & Woodman on behalf of the Village.

- The 2014 ISWS proposed HEC-HMS model subbasin were revised based on the LiDAR data. The Grey's Lake rating curve was not revised since the 2008 HEC-1 model. Drainage routing from Grey's Lake to Mill Creek also based on HEC-1 model.

R: Modified with new Q1, Q2 boundaries

- The 2014 ISWS proposed HEC-HMS model subbasin included small drainage area revisions based on the LiDAR data.

S: Minor boundary adjustments to better match topography.

College Trail Lake in (CT Subd. pre 93) not modeled.

- The 2014 ISWS proposed HEC-HMS model subbasin were further subdivided and portions were labeled as subbasin 'O' based on incorporating drainage paths for tributaries to Mill Creek.

T: Adjusted overall boundaries to better match topography

Broke out into T, T1 and T2 to assist in calibration effort at 3 mainstem crossings). In future should update hydrology, model channel and establish profiles for T1.

- The 2014 ISWS proposed HEC-HMS model did identify the appropriate input of increase flow from T1 but did not specifically model the tributary include routing of the tributary in the hydrologic model.

U: Countryside Landfill not included. In future this area should be updated per permit file.

- The 2014 ISWS proposed HEC-HMS model did incorporate the storage areas identified as part of the Countryside Landfill and the Metro storage permit files.

V: Large headwater depression added to HEC-1 model. Up most cross-sections omitted from hydraulics model (location etc. not practical for unsteady flow)

- The 2014 ISWS proposed HEC-HMS model included the storage area as modeled in the HEC-1 model.

Appendix J – Flood Audit Questionnaire

STORMWATER MANAGEMENT COMMISSION

June 5, 2013

Dear :

The Lake County Stormwater Management Commission is currently updating its countywide flood problem areas inventory for the Mill Creek Watershed as a part of the development of the watershed plan. We are requesting your assistance with this update via this letter, which provides the following information about the inventory update:

- background on the flood problem areas inventory;
- the need for an update;
- what information is requested; and
- the local benefits of an updated inventory

Background

The Lake County Stormwater Management Commission (SMC) conducted an inventory to identify flood problem areas in Lake County in 1995. More than 300 flood damage areas located throughout the county were inventoried. Flood problem areas were identified primarily from a combination of flood damage reports and anecdotal information provided by communities, homeowner associations and elected officials.

SMC used the flood problem areas inventory to develop a draft countywide flood hazard mitigation plan (FHMP) in 1999, and incorporated its flood mitigation recommendations into the County's All Hazard Mitigation plan. A few examples of flood mitigation projects undertaken by SMC and others in recent years include:

- SMC's buyout program for repetitively flood damaged structures at Sturm Subdivision, Williams Park, Gurnee, and several other communities;
- Site-specific flood mitigation planning for Gurnee, North Chicago, Diamond Lake Drain, and the Pekara Subdivision; and
- Various drainage improvement and flood storage projects funded by communities, the county, SMC and the state.

Need for update

Since the flood problem areas inventory is now more than 10 years old, and a number of mitigation projects have been undertaken in the interim period, the inventory needs to be updated to reflect changes in flood damage risk so that it is appropriately addressed by the Mill Creek Watershed and Flood Mitigation Plan. SMC needs your community's help in updating the inventory. To that end, we request that a representative of your community determine if there are any flood problem areas in your community that should be added to the inventory or updated in the inventory. There are two worksheets attached to this document: a New Flood Problem area worksheet to add a flood problem area not previously inventoried and a Flood Problem Area Inventory Update sheet to reflect any changes that may have occurred in a location previously delineated as a flood problem area. (Copy these sheets if you need more than one.) If a written description is not adequate to describe the problem, we ask that you send a map outlining the affected area. A flood problem area is defined as follows:

Flood Problem Area:

A "flood problem area" is composed of one or more structures in a geographical area that are damaged by the same primary source/cause of flooding. (There may be secondary sources/causes that affect an area also. Please also note these under the "type of flooding" section if they are known.) Road flooding that results in damage to infrastructure, loss of critical access or is a threat to safety should also be included within or as a flood problem area. Known health and safety hazards such as septic failure, secondary sanitary sewer backup, erosion, water pollution from hazardous materials etc. should also be described on the worksheet. Areas that only have "nuisance" flooding should not be included in the inventory. "Nuisance" flooding includes yard or open space flooding alone, where there is no resulting damage to a structure, loss of access, or loss of septic or utilities.

Information request

Please designate the most flood-knowledgeable person or persons in your community to fill out the information requested for the update. Within the scope of this update, SMC would like to clarify whether any areas need to be added to the inventory; primary and secondary sources or causes of flooding; the boundaries of the flood damage area; the approximate frequency of flooding at these sites; and what if any flood mitigation activities have occurred to reduce flood damage in these flood problem areas. In addition to providing a completed flood problem areas worksheet, we request you send a map depicting the affected area.

Local benefits

An update of the local flood problem areas in the inventory will increase your opportunities for reducing flood damage in your community. SMC uses the updated flood problem inventory for evaluating priority locations for future flood mitigation projects in Lake County.

In addition to reducing flood damage in known flood problem areas, the updated inventory will be useful to community Enforcement Officers in making determinations about adequate downstream capacity in proximity to flood problem areas when issuing Watershed Development Permits. In this way, the updated flood problem area inventory will help in making sure that flood damage at existing sites is not exacerbated by nearby development projects, and will hopefully prevent flood damage as a consequence of future development.

Many thanks for your assistance in updating the inventory. ***Please return*** your worksheet(s) with a corresponding community map(s) to SMC by ***July 12, 2013***. If you have any questions about the inventory, contact Andrea Cline at 847-377-7710.

Sincerely,

Andrea L. Cline

Andrea Cline
Water Resource Professional

Attachments

New Flood Problem Areas (FPA) Inventory

DATE		**COMMUNITY**			
CONTACT NAME		**TITLE**		**PHONE**	

PROBLEM AREA DESCRIPTION

Location Name: (subdivision name, street intersection, etc.)		**Property owner:** (if known)	

Is Property located in:

Drainage District ☐Yes ☐No Name of Drainage District:

Park District ☐Yes ☐No Name of Park District:

Problem Description (Damage-Causing or Nuisance)

What do you feel was the cause of the flooding? Check all that apply.

☐Storm sewer back up ☐Sanitary sewer backup

☐Sump pump failure/power failure ☐Saturated plug or standpipe

☐Standing water next to house ☐Other:

☐ Depressional ☐ Poor Drainage

☐Overbank flooding from Dutch Gap, Hastings Creek or North Mill Creek.

Has the flooding resulted in: Sewer Backup ☐Yes ☐No Septic Failure ☐Yes ☐No

DAMAGE POTENTIAL / KNOWN DAMAGE LEVEL (During a 100-Year Flood)

Number & Type of Buildings (indicate building use if not residential):

Critical Facilities (include names of police or fire stations, schools, water sanitary treatment facilities, public utility providers and nursing homes):

New Flood Problem Areas (FPA) Inventory

Street, Highways, Bridges with damage or loss of access:

HISTORICAL FLOOD DAMAGE (Confidential Information)

Month/Yr.	Depth	Frequency of Occurrence	# Bldgs.	$ Damage	Other

Other known damage level (such as flooding damages to basements, 1st floor, garage/outbuilding, crawl space, septic systems, utilities, roadway, erosion, limited access, etc.):

PLANS FOR THE AREA

Flood Control Projects

Community/Neighborhood Plans

OTHER HAZARDS (e.g. , soil constraints, hazardous materials in area or upstream, erosion)

OTHER DATA SOURCES (persons or studies where other information may be found)

Flood Problem Areas (FPA) Inventory Update

LAKE COUNTY FLOOD HAZARD MITIGATION PLAN

Date:_____________ Community: ______________________ FPA #: ____________

INSTRUCTION	FLOOD PROBLEM AREA* UPDATE INFORMATION
Subdivision name, street intersection etc.	**Location name:**
If the flood damage location is different than the area mapped, please mark the map with the correct approximate boundary of the FPA, describe and provide reason for change.	**Location description:**
If the primary type or cause of flood damage is incorrect as shown on the map, please update to reflect whether it is caused by overbank flooding, located in depressional area, local drainage system is insufficient, sanitary sewer backup or septic failure.	**Type of flooding:** **Flood source (if known):**
Number of buildings damaged. Indicate building use if not single-family residence.	**Buildings damaged at this site:** **Building use:**
Names of streets where flooding results in road damage or loss of access.	**Streets flooded:**
Indicate whether flooding damages basement, 1st floor, garage/outbuilding, crawl space, septic system, utilities, roadway, causes erosion, or limits access.	**Known damage level:**
Include names of police or fire stations, schools, water or sanitary treatment facilities or other public utility providers, and nursing homes in FPA.	**Critical facilities:**
Approximately how often does the FPA flood: ≥annually; 2-5 years; 6-10 years; 11-50 years; or 51+ years.	**Frequency of occurrence:**

Flood Problem Areas (FPA) Inventory Update

INSTRUCTION	FLOOD PROBLEM AREA* UPDATE INFORMATION
What if any measures have been taken to mitigate the level of flood damage to this FPA. Please provide the year and funding source(s) for the mitigation project or activity and describe its level of flood protection.	**Flood damage mitigation:** **What has been done -** **When -** **Funding source(s) -** **Level of protection -**
Name, position, address, email, phone, fax etc. of the person completing this form.	**Contact information:**
In your opinion, should this FPA be eliminated from the inventory because the site does not match the definition of a flood problem area as described below. Please explain why. Any other notes.	**Notes:**

*** Flood Problem Area:**
A "flood problem area" is composed of one or more structures in a geographical area that are damaged by the same primary source/cause of flooding. (There may be secondary sources/causes that affect an area also. Please note these under the "type of flooding" section if they are known.) Road flooding that results in damage to infrastructure, loss of critical access or is a threat to safety should also be included within or as a flood problem area.
Known health and safety hazards such as septic failure, secondary sanitary sewer backup, erosion, water pollution from hazardous materials etc. should also be described for a flood problem area in the "known damage level" section.

Areas that only have "nuisance" flooding should not be included in the inventory. "Nuisance" flooding includes yard or open space flooding alone, where it does not result in damage to a structure, loss of access, or loss of septic or utilities.

STORMWATER MANAGEMENT COMMISSION

June 11, 2013

«BILLTONAME»
«BILLTOADDRESS»
«BILLTOCITY», «BILLTOSTATE» «BILLTOZIP»

Dear Property Owner(s):

The Lake County Stormwater Management Commission (SMC) is developing a watershed management plan for the Mill Creek watershed. As part of the watershed planning process, SMC is trying to identify those structures in the watershed that are at risk of flooding so that the watershed plan can recommend reasonable solutions to reduce flood damage.

You own a property in the Mill Creek watershed in a neighborhood that was previously reported as a potential flood problem area. Therefore, we are requesting that you provide us with additional information regarding the flood history of your property by way of the attached questionnaire. We would appreciate it if you would complete the questionnaire and return it to our office. If you have not experienced flooding on your property, please let us know by answering questions 1 and 7-14 of the questionnaire. The collective information received from the questionnaires will be summarized (without any address specific data) in the flood damage section of the watershed assessment and action plan.

Completing the attached questionnaire and taking flood protection steps are voluntary. You are under no obligation to participate in this program. The requested information will help us develop a useful and cost-effective watershed improvement plan that properly addresses flood damage, and will help us provide you with flood damage reduction technical assistance if you so desire such assistance.

If you have any questions about the watershed plan or this questionnaire, feel free to call Andrea Cline of the Lake County Stormwater Management Commission at 847-377-7710.

Sincerely,

Andrea L. Cline

Andrea Cline
Water Resource Specialist

Attachment

MILL CREEK FLOOD PROTECTION QUESTIONNAIRE

		Building Type
Name:	☐	Single Family Home
Property Address:	☐	Multi-Family Home
Property Identification Number(s) PIN, if known:	☐	Commercial

Mailing Address (if different than above):						Phone:		
City:	State	Zip	E-Mail:					
1.	Has your home or property ever been flooded or had a water problem?			☐ Yes		☐ No		
If "yes" please complete this entire questionnaire.			**If "no", please complete questions 7-14.**					
2.	In what years did it flood?							
3.	Where did you get water and how deep did it get?							
	☐ In basement:	Depth	☐ In crawl space:	Depth				
	☐ Over first floor:	Depth	☐ In yard only					
	☐ Water kept out of house or building by sewer valve or other protective measure							
4.	Have you sandbagged or taken other temporary measures to protect your property, home or other buildings from flooding?							
	☐ Sandbagged(in which years):		☐ Other :					
5	What do you feel was the cause of your flooding? Check all that affect your building or property.							
	☐ Storm sewer back up		☐ Sanitary sewer backup					
	☐ Sump pump failure/power failure		☐ Saturated plug or standpipe					
	☐ Standing water next to house		☐ Other:					
	Overbank flooding from Mill Creek							
6.	Have you installed any flood protection measures on your property?							
	☐ Sump pump		☐ Backup power system/generator					
	☐ Overhead sewers or sewer backup valve		☐ Sewer plug or standpipe					
	☐ Waterproofed walls		☐ Moved things out of the basement					
	☐ Regraded yard to keep water away from building		☐ Other:					
7.	How long have you owned the building, or when did you move into the building?							
8	What type of foundation does your building have?		☐ Slab	☐ Crawlspace	☐ Basement			
	If you have a basement, is the basement:		☐ Finished	☐ Unfinished				
9.	What is your water supply?	☐ Private Well	☐ Public Water Supply					
10	How is your sewage treated?	☐ Private Septic System	☐ Commercial Septic	☐ Public Sanitary System				
11.	Does the building have footing drains?	☐ Yes	☐ No	If Yes (Check applicable items)				
	Location of discharge:	☐ Into the sanitary sewer service line		☐ Into storm sewer sump pump				
		☐ Into sanitary sewer ejector pump		☐ Don't know				
		☐ Other:						
12.	Do you have Flood Insurance?			☐ Yes	☐ No			
13.	Do you have a sewer/basement flood rider to your homeowner's insurance?			☐ Yes	☐ No			
14.	**If you have flood damage and you would be interested in having the Lake County SMC perform a flood survey for your home please return to: LCSMC, 500 Winchester Rd., Libertyville, IL 60048** ☐ Yes ☐ No							
Additional Comments								

Cline, Andrea L.

From: Hertel, Darcy L.
Sent: Wednesday, June 12, 2013 2:34 PM
Subject: Mill Creek Flood Problem Area Inventory Questionnaire
Attachments: Mill Creek Fillable Questionnaire.pdf

Dear Mill Creek Watershed Stakeholders,

The Lake County Stormwater Management Commission (SMC) is developing a watershed management plan for the Mill Creek watershed. As part of the watershed planning process, SMC is trying to identify those structures in the watershed that are at risk of flooding so that the watershed plan can recommend reasonable solutions to reduce flood damage.

If you own a property in the Mill Creek watershed, we are requesting that you provide us with information regarding the flood history of your property by way of the attached questionnaire. We would appreciate it if you would complete the questionnaire by either filling out the form electronically and emailing it to acline@lakecountyil.gov, or you can choose to print and mail it to our office at 500 Winchester, Libertyville, IL 60048. If you have not experienced flooding on your property, please let us know by answering questions 1 and 7-14 of the questionnaire. The collective information received from the questionnaires will be summarized (without any address specific data) in the flood damage section of the watershed assessment and action plan.

Completing the attached questionnaire and taking flood protection steps are voluntary. You are under no obligation to participate in this program. The requested information will help us develop a useful and cost-effective watershed improvement plan that properly addresses flood damage, and will help us provide you with flood damage reduction technical assistance if you so desire such assistance.

If you have any questions about the watershed plan or this questionnaire, feel free to call Andrea Cline of the Lake County Stormwater Management Commission at 847-377-7710 or email at acline@lakecountyil.gov.

Andrea

Andrea Cline
Lake County Stormwater Management Commission
500 W Winchester Road Suite 201
Libertyville IL 60048
847-377-7710

Appendix K – Existing and Potential Flood Storage Methods

Existing Flood Storage

Existing flood storage is defined as existing or created depressional areas that are presently storing, or potentially could store stormwater runoff to decrease flooding in the watershed. Besides flood protection, flood storage areas can be used for the mitigation of wetland losses (wetland restoration), channel protection, and water quality protection. The criteria used to identify existing storage locations are summarized below.

Existing Flood Storage Areas Criteria:

- Includes all existing open water (streams and lakes), wetlands, detention basins, and 100- year floodplains,
- Excludes parcels less than 1/3 acre, transportation, and building footprints,
- Storage calculated assuming 2 feet of storage volume at each location,
- Minimum storage size of 1 acre-foot to qualify as a site

ARCGIS was used to perform the analysis and develop the spatial mapping deliverables and statistics to identify existing flood storage locations. The locations identified in Chapter 5 ranges from one acre-foot to over 2,000 acre-feet of storage. There are 694 storage areas encompassing 6,250 acres (30% of the watershed) and the estimated potential to store 12,500 acre-feet of water.

Regional Flood Storage

A watershed scale analysis utilizing ARCGIS was performed to identify regional storage locations and potential regional storage locations.

Regional storage locations were delineated using ARCGIS and the following criteria:

- Depressional areas in the watershed, delineated using ARCGIS spatial analysis
- Open space and undeveloped land use, open space includes agricultural, forest, grassland, public/private open space and small water parcels.
- Not classified as large named lakes or large wetland complex
- Location with at least 100-acres of tributary drainage area
- Regional flood storage location must be over 5-acres in total area

Potential storage locations are a subset of the regional storage locations that exclude all of the Lake County Wetland Inventory mapped wetlands. At these sites flood storage could potentially be enhanced or created with the construction of berms and moderate grading and excavation.

- Depressional areas in the watershed, delineated using ARCGIS spatial analysis

- Open space and undeveloped land use, open space includes agricultural, forest, grassland, public/private open space and small water parcels.
- Not classified as large named lakes or large wetland complex
- Location with at least 100-acres of tributary drainage area
- Regional flood storage location must be over 5-acres in total area
- Not mapped as Lake County Wetland Inventory sites

Appendix L – Potential Wetland Restoration Site Methodology

8-12-13 *Revised by GW*

Mill Creek Watershed Plan: GIS Query Protocol and Proposed Ranking System for Potential Wetland Restoration Sites

Baseline GIS Query for Identifying Potential Restoration Sites is "Drained Hydric Soil" (Hydric – LCWI layer) ≥5 acres on "Open" or Partially Open" Parcels. This query yields a total of 60 potential restoration sites.

Applying the ranking system below results in: 3 High Potential, 25 Moderate Potential and 32 Low Potential.

Proposed Restoration Site Ranking System

Criterion	Category	Points
1 Size	5-10 acres 11-20 acres > 20 acres	1 2 3
2. Ownership	Private Public 1 (e.g., municipal, park district, township) Public 2 (e.g., LCFPD, Conserve Lake County)	1 2 3
3. Proximity to Existing Wetlands	Not Connected to Wetlands Connected to Wetland/Farmed Wetland Connected to Designated ADID Wetland	0 1 2
4. Proximity to FEMA 100-yr Floodplain	> 100 feet from FEMA 100-yr floodplain Within 100 feet of FEMA 100-yr floodplain Connected to FEMA 100-yr floodplain	0 1 2
5. Proximity to SMC-Documented Flood Problem Area (FPA)	> 1000 feet from FPA ≤ 1000 ≥ 100 feet of FPA < 100 feet from FPA	0 1 2

Ranking (total points): **2-4 Low Potential**
5-8 Moderate Potential
9-12 High Potential

Appendix M – Cost Assumptions for BMPs

Best Management Practice Cost Assumptions

The following assumptions were used to determine total costs as listed in Chapter 7, Section 7.2:

1. Basin wide residential practices include a combination of rain barrels and rain gardens. Assumes an average treatment area of 0.25 acres. Each treatment area assumes two 60 gallon rain barrels and one rain garden or infiltration trench. Assumed costs are $160.00 for rain barrels and $3,500 for each rain garden or infiltration trench.

2. Cost estimates for blind inlets are based on NRCS cost-share rates and assume construction and material costs of $3,000/inlet. Each inlet assumes treatment of 50 acres.

3. Porous/Permeable pavement/infiltration basin retrofits assume an average material cost of $9/square foot and an average construction cost of $3.75/square foot.

4. Costs for filter and riparian buffer strips are calculated at $3,000/ac, assuming a minimum width of 50 feet. Costs are generated using NRCS cost-share rates and professional judgment and include land preparation, materials and seeding.

5. Costs for cover crops and nutrient management are based on NRCS cost-share rates and are assumed to cost $70/ac on average.

6. Costs for riffles and grade control structures are based on professional judgment and field experience and total $8,000 - $14,000 per individual structure.

7. Costs for streambank stabilization or lake bank stabilization are based on professional judgment and experience and are assumed at $85/ft.

8. Wetland creation assumes all materials, engineering and dirt work or excavation costs of $20,000/acre.

9. Wetland restoration assumes a cost of $10,000/acre.

10. Costs for detention basins are based on site conditions and professional judgment/experience and range from $20,000-$65,000 each.

11. Grassed waterways assume a cost of $3,000/acre based on typical NRCS cost-share rates and professional judgment.

12. Water and sediment control basin costs are based on NRCS cost-share rates and professional experience and assume an average of $4,000/basin.

13. Costs for terraces are based on professional experience and NRCS cost-share rates and assume a cost of $500 for every five acres of treatment.

14. Equestrian BMPs can include a combination of costs for multiple practices and are based on a combination of NRCS cost-share rates and professional experience and judgment. Costs assume $15,000-$20,000 per detention basin/runoff control, $6,000 for each diversion, and $8,000 for a gutter system.

15. The cost to establish a training and inspection program for septic pumpers is estimated to cost $50,000.

16. In the absence of a solid foundation for estimating costs for problem discharge locations, hydrologic impediments, and detention basin retrofits, a flat rate of $20,000 is used for each problem discharge location and hydrologic impediment and $10,000 to retrofit one detention basin.

Flood Problem Area Mitigation Cost Assumptions

The following assumptions were used to determine total costs as listed in Chapters 5 and 7.

A concept level cost estimate was developed for each of the proposed concept level mitigation measures. The costs were based on culvert length, storm water pipe length, number of storm water inlets, swale excavation, asphalt pavement area, curb & gutter length, stream restoration, and demolition & mobilization. A 40% contingency was also included to cover any undetermined construction costs, and to many of the unknown configuration of the existing storm water systems. Table 1 below shows the unit costs used for the unit cost used to develop the total project costs for each of the proposed mitigation measures.

Table 1 Mitigation Measure Unit Costs

Item	Unit Cost	Unit
Culvert	$250	LF
Storm Water Pipe	$150	LF
Storm Water Inlet	$5,500	EACH
Swale Grading	$10	CY
Asphalt Pavement	$25	SY
Curb & Gutter	$25	LF

Stream Restoration	$350	LF
Demolition/Mobilization	25%	n/a
Contingency	40%	n/a
Engineering Design	12%	n/a
Surveying	3%	n/a
Geotechnical	3%	n/a

To develop the concept level total project cost estimates, many assumptions were made because of the lack of information about the existing storm water system configuration (i.e. pipe alignment, size of pipes, length of pipes, etc.). The lengths and areas needed for the project cost calculations were measured using ArcMap and GIS data provided by Lake County SMC. Below describes the assumptions made to develop the project cost estimates:

Swales

- Proposed swales are 2' flat bottom, 3' deep, 3:1 side slopes.
- Lengths were measured the length of the road that was being flooded.

Storm Pipes

- Length included the distance to connect the proposed inlets and also the distance to the next intersection. It was assumed that an existing curb inlet would be at the next intersection.

Curb & Gutter

- 15' of new curb & gutter for each proposed inlet.

Appendix N – Potential Funding Sources

Potential Funding Sources for Watershed Projects/Programs

The following list of potential funding sources is compiled from a variety of sources. Funding and program availability are contingent upon federal, state, and local budgets and appropriations for the budget year in which funding is being sought, so changes may have occurred that are not reflected in the list. Contact the program representative for updates or changes to program details.

The ***Catalog of Federal Domestic Assistance (CFDA)*** is the single best place to search all federal funding sources. The catalog should be available at local libraries and can also be accessed on the CFDA website on-line at: http://www.cfda.gov. The website lists all federal funding programs available, including those for conservation. Federal agency websites will provide more detailed information about federal programs and provide information on other opportunities for assistance. All organizations applying for federal funding must have a Data Universal Numbering System (DUNS) identification number.

There are a number of ***Federal Tax Incentives for Conservation*** for owners of environmentally sensitive land that has been donated for conservation purposes, or has been placed in a conservation easement, or simply managed for conservation. Individuals, organizations, and others are all eligible. Information can be found at www.gpoaccess.gov/cfr, www.irs.gov/, www.ailt.org/irs.htm, and http://www/irs.gov/pub/irs-drop/n-04-41.pdf. You can also contact the Illinois EPA, 1021 North Grand Avenue East, P.O. Box 19276, Springfield, Illinois, 62794-9276. Phone: 217-782-3397.

U.S. Environmental Protection Agency (USEPA) issues federal environmental regulations, enforces federal environmental law, and manages a number of grant programs.

• **Water Quality Cooperative Agreements** assist public or nonprofit organizations in developing, implementing, and demonstrating innovative that reduce wastewater related pollution. Primarily meant to fund exemplary projects, e.g., new BMPs, that increase and transfer knowledge. Not to be used for land acquisition and development.
Eligibility: States, public agencies, and nonprofit organizations.
Assistance: $10,000 to $500,000 with no local match requirement, although match offers are considered during evaluation.
Website: http://www.epa.gov/owm/wqca/2004.htm
Contact: USEPA Region 5, 77 W. Jackson Blvd. Chicago, IL 60604. Phone: 312-353-4378.

• **Wetland Program Development Grants** support strengthening state comprehensive wetland programs, developing a comprehensive wetland monitoring and assessment program, improving the effectiveness of compensatory mitigation, and refining the protection of vulnerable wetlands and aquatic resources.
Eligibility: States, local governments, public agencies, and interstate agencies.
Assistance: $50,000 to $420,000 grants with 25 percent local match requirement.
Website: http://www.epa.gov/owow/wetlands/ grantguidelines/.
Contact: US EPA Region 5, 77 West Jackson Blvd., Chicago, IL, 60604. Phone: 312-886-0241 Email: garra.catherine@epa.gov.

• **Assessment and Watershed Protection Program Grants** help to develop innovative approaches to watershed protection, make a contribution to the body of restoration and management techniques, and transfer knowledge. Application of established techniques may be funded if doing so would contribute to the general understanding of an environmental problem.
Eligibility: States, local governments, public agencies, nonprofit organizations, individuals.
Assistance: $5,000 to $80,000 with no local match requirement, although match offers are considered during evaluation as 10 percent of the ranking.
Website: http://www.epa.gov/owow/funding.html.
Contact: USEPA Offi ce of Wetlands, Oceans, and Watersheds, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20460. Phone: 202-566-1211, 202-566-1206.

• **Targeted Watersheds Grants Program (formerly Watershed Initiative)** funds projects that demonstrate innovative approaches to watershed restoration with an emphasis on inter-organizational collaboration, market-based techniques, and demonstrable environmental improvement. Does not support activities directly required under the Clean Water Act.
Eligibility: Any public entity, but must be nominated by the state.
Assistance: $600,000 to $900,000 with 25 percent local match required.
Website: http://www.epa.gov/owow/watershed/initiative/.
Contact: USEPA Region 5, 77 W. Jackson Blvd. Chicago, IL 60604. Phone: 312-886-7742. Email: thomas.paul@epa.gov.

• **State Wetlands Protection Grants** support development of new wetland protection, management, and restoration programs or refine existing programs. Grants can finance monitoring, assessment, and river corridor restoration.
Eligibility: State governments, local governments, and special districts.
Assistance: Federal–local cost share at 75 percent federal funding.
Website: http://www.epa.gov/region5/business/fsswpg.htm.
Contact: USEPA Region 5, Water Division, 77 W. Jackson Blvd. Chicago, IL 60604. Phone: 312-886-0241.

• The **USEPA Guidebook for Financial Tools** is used for identifying conservation funding source options
Eligibility: anyone can access the guidebook.
Assistance: informational only.
Website: http://www.epa.gov/efinpage or http://cfpub.epa.gov/fedfund/
Contact: see website.

• **USEPA Catalog of Funding Sources for Watershed Protection** is useful for identifying programs that will protect both urban and rural watersheds
Eligibility: anyone can access the guidebook.
Assistance: informational only.
Website: http://www.epa.gov/owow/funding.html, http://www.epa.gov/owow/watershed/ or http://wwwepa.gov/owow/funding/html, http://www.epa.gov/owow/watershed/ or http://cfpub.epa.gov/fedfund/.
Contact: see websites.

• The **Brownfields Assessment, Revolving Loan Fund, and Cleanup Grants** are for the re-use and remediation of brownfield sites throughout Illinois.
Eligibility: local governments, private not-for-profit (501C3) groups, and others.
Assistance: $2 to $3 million annually. Cleanup grants require 25% cost-share, grants range from under $15,000 to over $50,000.
Website: http://www.epa.gov/brownfields/
Contact: Call 312-886-7576 or 301-589-5318.

• The **Environmental Education Grants Program** funds environmental education activities such as curricula design or dissemination, designing or demonstrating educational field methods for the public, and training educators.
Eligibility: Educational organizations, private not-for profit groups, and local governments.
Assistance: Minimum of 25% matching funds or in kind services required. Awards of $25,000 or less are granted by regional offices.
Website: http://www.epa.gov/enviroed/grants.html
Contact: Call 312-353-5282 or visit the website for most current information and deadlines.

• The **Environmental Justice Grant Programs** include community-based approaches for environmental protection.
Eligibility: Educational organizations, private not-for profit groups.
Assistance: No match is required. Up to $15,000 per non-superfund site, other project grants variable up to $100,000.
Website: http://www.epa.gov.
Contact: Call 312-886-5993 or 1-800-962-6215.

• **Smart Growth Technical Assistance Opportunities** assist local communities develop in an environmentally friendly, sustainable manner.
Eligibility: Local governments, private not-for-profit groups, and others.
Assistance: In-kind contributions with assistance preferred.
Website: http:/www.epa.gov/smartgrowth/techasst.htm/.
Contact: Call 202-566-2853.

• The **Priority Lake and Watershed Implementation Program** provides funding to implement protection/restoration practices that improve water quality.
Eligibility: Local governments, private not-for-profit groups. Priority given to publicly-owned and accessed lakes.
Assistance: Funding up to 100%, projects range up to $40,000.
Website: http://www.epa.gov/smartgrowth/techasst.htm/.
Contact: 217-782-3362.

• **Five Star Restoration Challenge Grants** bring together citizen groups, corporations, youth groups and students, landowners, and government agencies to undertake projects that restore streambanks and wetlands. Projects must include a strong wetland or riparian restoration component, and should also include education, outreach, and community stewardship. Jointly administered by the National Fish and Wildlife Foundation, the National Association of Counties, and the Wildlife Habitat Council, and mainly funded by USEPA.
Eligibility: Requires at least five or more partnering organizations.
Assistance: $5,000 to $20,000 with a 1 to 1 match requirement.
Website: http://www/nfwf.org/programs/5-star-rfp.htm, http://www.epa.gov/owow/wetlands/restore/5star/.
Contact: USEPA Wetlands Division, Room 6105 (4502T), 1200 Pennsylvania Avenue, NW, Washington, DC. Email: price.myra@epa.gov.

Illinois Environmental Protection Agency (IL EPA) administers state and federal environmental programs and regulations.

• **Clean Water Act Section 319 Grants** provide funding for implementing corrective and preventative best management practices on a watershed scale, for the demonstration of innovative BMPs on a sub-watershed scale, and the development of information and education non point source pollution control programs. Administered by Illinois EPA.
Eligibility: State and local governments, nonprofits, individuals, businesses.
Assistance: Federal cost share at 60 percent maximum.
Website: http://www.epa.state.il.us/water/financialassistance/non-point.html.
Contact: Illinois EPA, 1021 North Grand Avenue East, P.O. Box 19276, Springfield, Illinois, 62794-9276. Phone: 217-782-3397.

• **Clean Water State Revolving Loan Funds (SRF)**, initially designed for wastewater treatment plant upgrades, supports watershed and non-point source control measures. These can include projects such as agricultural and urban runoff control, wet weather flow control including stormwater and sewer overflows, buffers, wetland protection, habitat restoration, and community-based comprehensive watershed management. Currently IEPA targets SRF funding to point source pollution control, i.e., upgrading wastewater infrastructure, but recently there has been approximately 20% set aside for nonpoint source control green infrastructure projects.
Eligibility: State and local governments, nonprofits, individuals, businesses.
Assistance: Funds projects at 100 percent at a national average interest rate of 2.2 percent, subject to change.
Website: http://www.epa.gov/owmitnet/cwfinance/cwsrf/.
Contact: Illinois EPA, 1021 North Grand Avenue East, P.O. Box 19276, Springfield, Illinois, 62794-9276. Phone: 217-782-3397.

• The **Illinois Clean Lakes Program** grant program supports lake owners' interest and commitment to long-term, comprehensive lake management. Detailed diagnostic/feasibility studies scientifically document the causes, sources and magnitude of lake impairment (Phase I). Data generated from these monitoring studies are used to recommend lake protection/restoration practices for future implementation (Phase II).
Eligibility: Lake owners, local units of government, private not-for-profit (501C3) groups.
Assistance: up to $75,000 for Phase 1, 40% match required; up to $300,000 for Phase II study costs with 50 percent local match required. Available for publicly owned lakes larger than 6 acres with public access.
Website: http://www.epa.state.il.us/water/conservation-2000/iclp.html.
Contact: IEPA Bureau of Water – Surface Water Section, Des Plaines Monitoring and Assessment Unit, 9511 West Harrison, Des Plaines, IL 60016. Phone: 847-294-4000. State contact: 217-782-3362.

• The **Lake Education Assistance Program** supports educational programs on inland lakes and lake watersheds.
Eligibility: local governments, educational organizations, and private not-for-profit groups.
Assistance: Maximum funding of $500 is reimbursed after completion.
Website: http://www.epa.state.il.us/water/conservation-2000/leap/index.html.
Contact: 217-782-3362.

•The **Streambank Cleanup and Lakeshore Enhancement (SCALE)** program provides funds to assist groups that have established a recurring stream or lakeshore cleanup. Funds can be used for safety attire, litter bags, event promotion, logistical needs and dumpster or landfill fees.

Eligibility: organizations that have an established streambank or lakeshore cleanup including environmental groups, soil and water conservation districts, park districts and nonprofit organizations.
Assistance: Ranges from $500 to $3,500.
Website: http://www.epa.state.il.us/water/watershed/scale.html.
Contact: 217-782-3362.

•The **Illinois Green Infrastructure Grant (IGIG)** program is available to assist in the implementation of green infrastructure management practices to control stormwater runoff for water quality protection. Funds are limited to the implementation of projects to install best management practices and are awarded based on three categories: Combined Sewer Overflow Rehabilitation, Stormwater Retention and Infiltration, and Green Infrastructure Small Projects.
Eligibility: Any entity that has legal status to accept funds from the state, including state and local government units, nonprofit organizations, citizen and environmental groups, individuals and businesses.
Assistance: Annually $5 million. Typical grant range: Combined Sewer Overflow Rehabilitation $300,000-$3,000,000 (total available $3 million); Stormwater Retention and Infiltration $100,000-$750,000 (total available $1.8 million); and Green Infrastructure Small Projects $15,000-$75,000 (total available $200,000).
Website: http://www.epa.state.il.us/water/financial-assistance/igig.html.
Contact: 217-782-3362.

• The **Volunteer Lake Management Program** (VLMP), administered by the Illinois EPA, serves as an educational program for Illinois citizens to learn about lake ecosystems and utilizes the time and talents of citizen volunteers to gather fundamental information on inland lakes.
Eligibility: Lake owners.
Assistance: technical assistance only.
Website:h t t p : / / w w w / e p a . s t a t e . i l . u s / w a t e r /conservation-2000/vlmp.html.
Contact: Holly Hudson, Chicago Metropolitan Agency for Planning, 233 South Wacker, Suite 800, Willis Tower, Chicago, IL 60606. email: hlhudson@cmap.org.

U.S. Army Corps of Engineers (USACE) Civil Works programs involve the planning, design, construction management, operation and maintenance of water resource management and restoration projects to meet flood and storm damage reduction, navigation, environmental restoration, hydropower, recreation and other water related goals.

• **Flood Hazard Mitigation and Riverine Ecosystem Restoration Program ("Challenge 21")** focuses on non-structural, sustainable approach to flood protection, including watershed-based planning, wetland conservation, relocation of buildings out of the floodplain, riparian corridor restoration, and pre-disaster mitigation planning. Funding has not yet been authorized.
Eligibility: Local governments; study area must be within a floodplain.
Assistance: Federal cost share at 50 percent for studies and 65 percent for project implementation. Maximum federal allocation is $30 million.
Website: Information is available at http://www.saw.usace.army.mil/floodplain/Challenge%2021.htm.
Contact: For information, contact USACE (Headquarters) Planning Division, 20 Massachusetts Avenue NW, Washington, DC 20314. Phone: 202-761-4750.

• **Continuing Authorities Program** allows the Corps to respond quickly to water resources problems. Some of the legislative authorities of the program include Aquatic Ecosystem Restoration (Section 206), Environmental Dredging (Section 312), and Environmental Restoration (Section 1135). See website for full listing.
Eligibility: Local public entities are eligible for studies, planning engineering, construction, and administration.
Assistance: Federal–local cost share percentages vary depending on the program. Up to $5 million federal assistance provided.
Website: The USACE Vicksburg District provides an overview of the Continuing Authorities Program at http://www.mvk.usace.army.mil/Offices/pp/Projects/Small_Projects_Program/basics.htm.
Contact: USACE Chicago District, 111 N. Canal St, Suite 600, Chicago, IL 60606. Phone: 312-846-5498.

Federal Emergency Management Agency (FEMA) manages a number of programs that assist communities in disaster planning and hazard mitigation.

• **Flood Mitigation Assistance (FMA)** helps states and communities identify and implement measures to reduce the risk of flood damage to structures insured under the National Flood Insurance Program (NFIP). Awards planning grants to assist development of Flood Mitigation Plans and project grants for projects that reduce flood losses, such as elevation, relocation,

demolition, acquisition of insured structures and property, flood proofing, and minor structural projects that reduce the risk of flood to insured structures.
Eligibility: State agencies, NFIP communities, qualified local organizations, Tribal governments.
Assistance: Federal cost share maximum of 75 percent.
Website: http://www.fema.gov/fi ma/fma.shtm
Contact: FEMA Region 5, 536 South Clark St., Chicago, IL 60605. Phone: 312-408-5500.

• **Hazard Mitigation Grant Program (HMGP)** implements long-term hazard mitigation measures following a major disaster declaration and, in Illinois, for post-disaster floodplain building buy-outs, elevation, relocation, retrofit, and demolition on public and private land.
Eligibility: State and local governments, qualified nonprofit organizations, Tribal governments.
Assistance: Federal cost share maximum of 75 percent.
Website: http://www.fema.gov/fi ma/hmgp/
Contact: Mr. Ron Davis, Illinois Emergency Management Agency, 110 East Adams Street, Springfield, IL 62701-1109. Phone: 217-782-8719. E-mail: RDavis@iema.state.il.us.

• **Pre-Disaster Mitigation Program (formerly Project Impact)** implements the pre-disaster mitigation program for states and communities to reduce risk to the population, the costs and disruption caused by severe property damage and the cost to all taxpayers of Federal disaster relief efforts. Eligible projects include: acquisition, relocation, elevation, and strengthening of structures, development of standards to protect structures from disaster damage, and drainage improvement projects.
Eligibility: State and local governments, universities, Tribal governments.
Assistance: Federal cost share maximum of 75 percent with a $3 million cap.
Website: http://www.fema.gov/fi ma/pdm.shtm.
Contact: FEMA Region 5, 536 South Clark St., Chicago, IL 60605. Phone: 312-408-5500.

• **National Flood Insurance, Increased Cost of Compliance Program** provides flood insurance policyholders with flood damaged homes and businesses in high-risk areas, also known as Special Flood Hazard Areas, with assistance to help pay the costs to bring their home or business into compliance with their community's floodplain ordinance, including building elevation, relocation, demolition, or floodproofing.
Eligibility: flood insurance policy holders.
Assistance: Federal assistance up to $30,000.
Website: http://www.fema.gov/nfi p/icc.shtm.
Contact: FEMA Region 5, 536 South Clark St., Chicago, IL 60605. Phone: 800-427-4661.

U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS), the successor agency to the Soil Conservation Service, partners with state conservationist offices and provides funding and technical assistance to landowners to promote soil and water conservation.

• **Environmental Quality Incentives Program (EQIP)** provides incentive payments and cost-shares to implement conservation practices.
Eligibility: Non-federal landowners engaged in farming or ranching.
Assistance: Federal share maximum of 75 percent, $450,000 aggregate cap on EQIP contracts. Beginning farmers and ranchers, as well as limited resource producers, may qualify for a 90 percent cost-share.
Website: http://www.il.nrcs.usda.gov/programs/eqip/.
Contact: 500 C Street, SW Washington, D.C. 20472. Phone: (202) 566-1600. State: 217.353.6600. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• **Conservation Reserve Program (CRP)** offers annual rental payments, incentive payments for certain activities, and cost-share assistance to remove highly erodible cropland or sensitive acres from crop production. Program encourages farmers to plant long term resource conserving vegetative covers to improve soil, water, and wildlife resources. Eligible practices include riparian buffers along streams, ditches, lakes, wetlands, and ponds, grass or contour filter strips, and windbreaks. Funds also may be used to retire agricultural floodplain land. Program is administered by the Farm Service Agency.
Eligibility: Non-federal landowners engaged in farming or ranching.

Assistance: Farmers receive compensation, based on agricultural rent, for retiring sensitive land over a multiyear contract, usually 10-15 years.
Website: http://www.nrcs.usda.gov/programs/crp/.
Contact: USDA Farm Service Agency, 1400 Independence Ave, SW Washington, DC 20250-0506 Phone: 800-457-3642. State office: 217-353-6600. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• **Emergency Watershed Protection Program (EWP)** provides assistance to reduce hazards to life and property in watersheds from erosion and flooding due to severe natural events. May be used to establish vegetative cover, open restricted channels, repair diversions and levees, and purchase floodplain easements on flooded land in non-urban areas.
Eligibility: Public and private landowners with a project sponsor, i.e., a state or local government or special government district. Applications must be submitted within 60 days of disaster or 10 days in an emergency.
Assistance: Up to 75 percent federal cost-share for projects.
Website: http://www.nrcs.usda.gov/programs/ewp/.
Contact: USDA, NRCS, Financial Assistance Programs Division, 14th and Independence Ave., SW, Room 6103A-S, Washington, DC 20250. Phone: 202-690-0793. State: 217.353.6600. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• **Soil and Water Conservation Assistance** program provides cost share and incentive payments to farmers and ranchers to voluntarily address threats to soil, water, and related natural resources, including grazing land, wetlands, and wildlife habitat. Requires a conservation plan and certification of eligible conservation practices by state conservationist.
Eligibility: Farmers and ranchers who own or control land.
Assistance: 5 to 10 year contracts with NRCS, 75 percent federal cost share, $50,000 maximum benefit.
Website: http://www.nrcs.usda.gov/programs/swca/.
Contact: USDA, NRCS, 14th and Independence Avenue, SW, Washington, DC 20250. Phone: 202-720-1873. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• **Watershed Protection and Flood Prevention Program (PL 83-566)** includes the Watershed Surveys and Planning program as well as the Watershed Operations program. The latter provides funding for installing conservation practices in small watersheds for flood prevention, erosion and sediment control, water quality, habitat enhancement, wetland creation and restoration.
Eligibility: Sponsorship by a state/local government or special government district, watershed less than 250,000 acres.
Assistance: Project grants.
Website: http://www.nrcs.usda.gov/programs/watershed/index.html#Watershed_ops.
Contact: USDA, NRCS, 14th and Independence Avenue, SW, Washington, DC 20250. Phone: 202-720-8770. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• **Wetland Reserve Program** provides funds to purchase permanent or 30-year easements and restoration agreement, or assist in a cost-share agreement with landowners, to restore wetlands and floodplain habitat on private land.
Eligibility: Individual landowners who have owned land for at least one year. Eligible lands must be restorable, contribute significantly to wetland functions and values, and be suitable for wildlife habitat.
Assistance: Permanent easement purchased by USDA with 100 percent of restoration funded by federal government; thirty year easement purchased by USDA with 75 percent of restoration funded federally; or restoration cost-share only with USDA contributing 75 percent of cost.
Website: http://www.nrcs.usda.gov/programs/wrp/.
Contact: USDA, NRCS, 14th and Independence Avenue, SW, Washington, DC 20250. Phone: 202-720-1062. State contact: 217-353-6600. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha

County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• **Wildlife Habitat Incentives Program (WHIP)** provides funding and technical assistance for private landowners to develop and improve fish and wildlife habitat.
Eligibility: Private lands and some federal, state, and local government lands.
Assistance: Cost-share agreements up to 75% depending on landowner commitment, increased assistance for agreements longer than 15 years.
Website: http://www.nrcs.usda.gov/programs/farmbill/index.html
Contact: USDA NRCS, 14th and Independence Avenue, SW, Washington, DC 20250. Phone: 202-720-1062. State contact: 217.353.6600. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• The **Streambank Stabilization Restoration Program,** administered by the Soil and Water Conservation District, goals are to develop and demonstrate vegetative, stone structure and other low-cost bio-engineering techniques for stabilizing streambanks and to encourage the adoption of low-cost streambank stabilization practices by making available financial incentives, technical assistance and educational information to landowners with critically eroding streambanks.
Eligibility: All landowners and project sites (rural and urban) in each Illinois county.
Assistance: check with the Lake/McHenry County SWCD for details.
Website: http://www.lakeswcd.org/.
Contact: Lake/McHenry County Soil and Water Conservation District, 1648 S. Eastwood Drive Woodstock, IL 60098 Phone: 815/338-0099

• The **Conservation Security Program (CSP)** promotes the conservation of soil, water, air, energy, plant and animal life located on working lands.
Eligibility: Individuals, organizations, and others. Contact administrator for details.
Assistance: check with the county-based USDA Service Centers for application deadlines and most current information. In-kind services or operations are required.
Website: http://www.nrcs.usda.gov/programs/farmbill/index.html.
Contact: USDA, NRCS, 14th and Independence Avenue, SW, Washington, DC 20250. Phone: 202-720-1062. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

• The **Farm and Ranch Lands Protection Program (FRPP)** is intended to permanently preserve prime farmland or protect lands with historical and archeological resources.
Eligibility: local units of government, private not-for-profit (501C3) groups, educational institutions, and others.
Assistance: matching and in-kind match required. Check website for details.
Website: http://www.nrcs.usda.gov/programs/farmbill/index.
Contact: USDA, NRCS, 14th and Independence Avenue, SW, Washington, DC 20250. Phone: 202-720-1062. In Lake County, contact Erika Turner, Acting District Conservation, McHenry County Woodstock Field Office, 1648 S. Eastwood Drive, Woodstock IL 60098. Email: erika.turner@il.usda.gov. Phone: 815-338-0099 ext. 3. In Kenosha County, contact Brandi Richter, District Conservationist, Union Grove Service Center, 1012 Vine Street, Union Grove WI 53182-1047. Phone: 262-878-1243.

United States Department of Agriculture, Forest Service (USDA-FS) manages programs that promote forestry and natural enhancement of urban areas through urban forestry programs.

• **Urban and Community Forest Challenge Cost-Share Grant Program** helps establish and support urban and community forests and forestry activities.
Eligibility: local governments, educational organizations, individuals, and others.
Assistance: Non-federal match of 50% required
Website: http://www.fs.fed.us/ucf/.
Contact: USDA, Forest Service 1400 Independence Ave., SW, Washington, D.C., 20250-0003. Phone (202)205-8333

United States Department of Energy (USDOE) compiles and distributes a list of monthly funding opportunities relating to energy and the environment. Go to http://www.eere.energy.gov/ and click on financial opportunities.

U.S. Department of the Interior, Fish and Wildlife Service (USFWS) manages programs to protect wildlife and habitat by means such as issuing rules for hunters and anglers, administering the Endangered Species Act, and awarding grants for environmental restoration.

• **Challenge Cost Share Program** provides grants for conservation practices, ecosystem protection, and enhancement of wildlife and plant habitat.
Eligibility: Individuals, businesses, federal, state, and local governments, universities, and non-profit organizations.
Assistance: Grants at 50 percent local match. Average award is about $7,800.
Website: See Catalog of Federal Domestic Assistance (15.642), http://www.cfda.gov.
Contact: USFWS National Wildlife Refuge System, 4401 N. Fairfax Drive, Suite 670, Arlington, VA 22203. Phone: 703-358-1744

• **Private Stewardship Program** provides cost share funding for conservation practices by private landowners or community groups that benefit threatened, endangered, and at-risk species.
Eligibility: Individuals, businesses, private nonprofit organizations, local or county governments. Cooperating private landowners must be identified in proposals.
Assistance: Project grants at 10 percent local match. Average award about $70,000.
Website: http://endangered.fws.gov/grants/private_stewardship/index.html.
Contact: USFWS Region 3, One Federal Drive, Fort Snelling, MN 55111-4056. Phone: 612-713-5343.

• **Partners for Fish and Wildlife Programs** assist private landowners in restoring habitat in accordance with USFWS goals, including, for example, restoration of wetland hydrology, use of prescribed burns, and planting with native vegetation. Wetlands are the primary focus of the program in Illinois. Landowners enter into at least a 10-15 year agreement to refrain from returning the land to its former use or otherwise nullifying the restoration. Eligible projects include restoration or enhancement of transient waterfowl habitat, improve water quality, flood protection, and groundwater recharge.
Eligibility: Non-state and non-federal landowners, individuals, local government, and non-government organizations.
Assistance: Project grants at 50-60 percent local cost share with matching or in-kind services preferred, but not required.
Website: http://ecos.fws.gov/partners/.
Contact: USFWS, Branch of Habitat Restoration, Room 400, 4401 N. Fairfax Blvd., Arlington VA 2220 Phone: (703) 358-2201
USFWS Region 3 Office, 2651 Coolidge Rd, East Lansing, MI 48823. Phone: (517) 351-8470.

• **Northeastern Illinois Wetlands Conservation Account** is intended for restoration, enhancement, and/or replacement of wetland functions and values which have been degraded or destroyed as a result of activities conducted in violation of the Clean Water Act or the Rivers and Harbors Act. Also funds activities that promote understanding, appreciation, and stewardship of wetlands.
Eligibility: Governmental agencies, non-profit conservation organizations, and private home owner associations.
Assistance: Project grants up to $150,000. Matching funds preferred but not required.
Website: http://www.fws.gov/midwest/chicago/neiwca2004rfp.htm.
Contact: USFS Chicago Illinois Field Office, 1250 South Grove Ave., Suite 103, Barrington, Illinois 60010.
Phone: 847-381-2253.

National Park Service (NPS) manages the nation's system of national parks, historic sites, etc. and serves as a conduit for some recreation-related conservation funding.

• **Land and Water Conservation Fund (LWCF)** provides funds to states and localities for park and recreational land planning, acquisition, and development. Public access must be granted in perpetuity. Funds are awarded through the Illinois Department of Natural Resources, which also manages a similar program, using state funding, called the Open Space Lands Acquisition and Development (OSLAD) Program. Points are generally awarded for applications that place natural resources in protection.
Eligibility: Local government agencies with authority to develop land for parks.
Assistance: Up to $750,000 for acquisition projects, with 50 percent match required.
Website: http://dnr.state.il.us/ocd/newoslad1.htm.
Contact: Illinois DNR, One Natural Resources Way, Springfield, IL 62702. Phone: 217-782-6302.

• **Challenge Cost-Share Program (CCSP)** provides matching funds for a variety of projects relating to conservation, natural area enhancement, and recreation, but tends to fund projects on or near lands managed by the National Park Service.
Eligibility: State and local governments, private nonprofit organizations.
Assistance: Up to $30,000 with 50 percent match.
Website: http://www.nps.gov/ncrc/programs/ccsp/index.htm.
Contact: National Center for Recreation and Conservation, NPS, 1849 C Street NW (Org. Code 2220), Washington, DC 20240. Phone: 202-354-6912.

U.S. Department of Transportation (DOT) regulates the federally mandated metropolitan planning process and administers federal transportation funding.

• **Transportation Enhancement Program (TEA-21)** funds projects that may include, among others, control technologies to prevent polluted highway runoff from reaching surface water bodies, scenic easements, pedestrian and bicycle trails, and wetland mitigation efforts including mitigation banking, wetland preservation and restoration, wetland planning, and natural habitats. Projects must relate to surface transportation and fall into one of twelve eligible categories. Funding is disbursed through State of Illinois.
Eligibility: Local government units with taxing authority.
Assistance: 80 percent federal share of project costs in general, 50 percent for acquisition. Awards up to $2 million.
Website: http://www.fhwa.dot.gov/environment/te/overview.htm (Federal), http://www.dot.il.gov/opp/itep.html (Illinois).
Contact: Illinois DOT, 2300 S. Dirksen Pkwy., Springfield, IL 62764. Phone: 217-782-7820.

Illinois Department of Natural Resources (IDNR)

• **Partners for Conservation (Conservation 2000)** supports nine conservation programs across three state agencies and provides financial and technical support to groups (ecosystem partners) which seek to maintain and enhance ecological and economic conditions in key watersheds of Illinois.
Eligibility: Varies by program. Eligible projects include habitat protection or improvement, technical assistance, and education.
Assistance: Project grants, varies by program.
Website: http://dnr.state.il.us/orep/c2000/.
Contact: IDNR Region 2, 2050 W. Stearns Road, Bartlett, IL 60103. Phone: 847-608-3100.

• **Conservation Reserve Enhancement Program (CREP)** cooperative effort between landowners, state, local and federal agencies designed to enhance the Illinois River by protecting water quality and land in the Illinois River Watershed. Landowners who take environmentally sensitive land out of agricultural production in the Illinois River Watershed will receive financial incentives, cost-share incentives and technical assistance for establishing long-term, resource conserving covers. Supported practices include: tree planting, habitat, wetlands, filter strips, and buffers. Terms may be 15, 30, or 50 years or permanent.
Eligibility: Individuals, corporations, non-governmental organizations.
Assistance: varies by practice and type of land.
Website: http://www.ilcrep.org.
Contact: IDNR Region 2, 2050 W. Stearns Road, Bartlett, IL 60103. Phone: 847-608-3100. State: 217.785.8287.

• **Urban Flood Control Assistance** involves initial study process and determination of appropriate flood control solutions. Funding depends on General Assembly appropriations for tributary studies and project feasibility investigations, focused on structural flood control solutions.
Eligibility: Local sponsorship, positive net benefit formally shown by benefit-cost analysis, membership in good standing in National Flood Insurance Program.
Assistance: Varies with appropriation.
Website: http://dnr.state.il.us/owr/OWR_programs.htm.
Contact: IDNR Office of Water Resources, One Natural Resources Way, 2nd Floor, Springfield, Illinois 62702-1271. Phone: (217) 782-4637.

• ***Small Projects Fund*** provides direct assistance to rural and small urban communities statewide to reduce stormwater related flood damages by alleviating localized, significant drainage and flood problems.
Eligibility: Local government sponsorship, membership in good standing in National Flood Insurance Program.
Assistance: Maximum of $100,000 per locality.

Website: http://dnr.state.il.us/owr/OWR_programs.htm.
Contact: IDNR Office of Water Resources, One Natural Resources Way, 2nd Floor, Springfield, Illinois 62702-1271. Phone: (217) 782-4637.

• The **Illinois Habitat Fund** The Illinois Habitat Fund is one of three programs funded through the purchase of a State Habitat Stamp. For the Illinois Habitat Fund Grant Program, eligible projects are limited to those seeking to preserve, protect, acquire or manage habitat (all wetlands, woodlands, grasslands, and agricultural lands, natural or altered) in Illinois that have the potential to support populations of wildlife in any or all phases of their life cycles.
Eligibility: not-for-profit organization or government agency that has the expertise, equipment, adequate staff/workforce and permission from the landowner (if applicable) to develop and/or manage habitat..
Assistance: projects designed to protect, preserve, acquire, or manage habitat. Contact program administrator for assistance amounts.
Website: http://www.dnr.state.il.us/grants/Special_Funds/WildGrant.htm.
Contact: Vera Bojic, RiverWatch Coordinator, 618-468-4870 or vbojic@lc.edu.

• The **Open Space Lands Acquisition and Development** (OSLAD) Program is a state-financed grant program that provides funding assistance to local government agencies for acquisition and/or development of land for public parks and open space.

The federal **Land & Water Conservation Fund program** (known as both LWCF and LAWCON) is a similar program with similar objectives.
Eligibility: Local governments having statutory authority to acquire and develop land for public park purposes.
Assistance: Under both programs, funding assistance up to 50% of approved project costs can be obtained. Grant awards up to $750,000 are available for acquisition projects, while development/renovation projects are limited to a $400,000 grant maximum.
Website: http://dnr.state.il.us/ocd/newoslad1.htm.
Contact: IDNR Office of Office of Architecture, Engineering and Grants, One Natural Resources Way, 2nd Floor, Springfield, Illinois 62702-1271. Phone: 217/782-6302.

• The Division of Wildlife or Resource Protection and Stewardship **Trees, Shrubs and Seedlings at No Cost program** is intended to encourage landowners to reforest land, increase wildlife, and control erosion.
Eligibility: individuals; landowner must have an approved management / conservation plan.
Assistance: Seedlings provided at no charge. Shipping costs paid by grantee.
Contact: IDNR 217-785-2361.

• The **Forestry Assistance Grant Programs** are intended to create or enhance landowner or local forestry programs.
Eligibility: Local governments, individuals, and others.
Assistance: varies by program; 50% cost share grants and reimbursement up to $5,000.
Website: http://dnr.state.il.us/conservation/forestry/.
Contact: 217-782-2361.

• **Schoolyard Habitat Action Grants** support enhancement of wildlife habitat, with emphasis on youth involvement and education.
Eligibility*:* Educational organizations and others. Project must involve a trained Project WILD educator or facilitator.
Assistance: Maximum funding to $600.
Website: http://dnr.state.il.us/lands/education/CLASSRM/grants.htm.
Contact: 217-524-4126.

• **Illinois Biodiversity Field Trip Grants & Free Educational Materials** supports field trips for students to visit natural areas, natural history museums, and other natural resource related activities. Conservation education materials, including lesson plans, can be used separately.
Eligibility: Educational organizations and others.
Assistance: funding for field trips up to $500 per class, per project.
Website: http://dnr.state.il.us/lands/education/CLASSRM/grants.htm.
Contact: 217-524-4126.

Illinois Department of Agriculture (IDA)

• **Streambank Stabilization & Restoration Program (SSRP)** is designed to support naturalized stream bank stabilization practices in rural and urban communities. 10 year program term.
Eligibility: All organizations and individuals.
Assistance: 25% match required.
Website: http://www.agr.state.il.us/environment/conserv.
Contact: 217-782-6297, 800-864-7311, or contact the local Soil & Water Conservation District that serves your county.

• **Sustainable Agriculture Grant (Conservation 2000) Program** supports projects include those that carry out research, education, and on-farm demonstration projects that support sustainable agriculture, conserve soil, protect the environment, and maintain profitability.
Eligibility: Individuals, corporations, local governments. Landowner must have an approved management/conservation plan.
Assistance: Grants awarded up to $10,000 per individual; $50,000 per unit of government, or other eligible organization. 60% cost-share; 10 year term.
Website: http://www.agr.state.il.us/Environment/conserv.
Contact: 217-782-6297, 800-864-7311, or contact the local Soil & Water Conservation District that services your county.

Illinois State Board of Education (ISBE)

• Useful website to search for educational grants at http://www.isbe.state.il.us/grants/default.htm.

State of Illinois Tax Incentives for Conservation *are a*vailable for organizations and individuals. See http://dnr.state.il.us/OREP/C2000/Incentives.htm for details.

• Real Property Conservation Rights Act (765 ILCS 120/1et seq.): if land is qualified by having a conservation easement, it may be assessed at 8 1/3 fair market value.

• Illinois Natural Areas Preservation Act (525 ILCS 30/1et.seq)/17 Ill Adm. Code: if land is qualified by being designated as an Illinois Nature Preserve, it may be assessed at $1/year in perpetuity.

• Preferential Assessment of Farmland (Property Tax Code, Sec. 1-60 (Definitions.) Sec. 10-110 et seq.: if qualified, assessments are based on Cropland as 33 1/3% of the agricultural economic value; Permanent Pasture as 1/3 of its value of cropland; other farmland at 1/6 of its value as cropland; and wasteland without a contributory value to farmland at zero.

• Open Space Assessment (Illinois Property Tax Code Sections 10-155): a lower use evaluation is used for land in open space; 10 acre minimum area.

• Preferential Assessment of Common Areas (Illinois Property Tax Code Sections 10-35): Purpose is to encourage open space in residential developments; if qualifying, assessment is reduced to $1/year.

• Non-Clear Cut Assessment (P.A. 91-907, Property Tax Code Sec. 10-153): land is valued at 1/12th of its productivity index equalized assessed value as cropland if it is within 15 yards of waters listed by IDNR as navigable and has not been clear cut of trees; incentive is not applicable in jurisdictions with populations greater than 500,000.

• Other tax incentives may also apply. Contact IDNR regarding the Real Property Conservation Rights Act and the Illinois Natural Areas Preservation Act at 217-785-8774. Contact your local township or county assessor to determine eligibility under other incentives.

Lake County

• **Lake County SMC Watershed Management Board (WMB)** Fund Eligibility: Watershed Management Board members in good standing with the National Flood Insurance Program and comply with SMC policies.
Assistance: Cost-share at least 50% with funds or in-kind services or a combination of both. Approximately $100,000 to $150,000 is available each year for planning, engineering analysis, alternate solution evaluation, design, capital construction, maintenance and repairs projects.

Website: http://www.co.lake.il.us/smc/projects/wmb/.
Contact: Lake County Stormwater Management Commission, 500 W Winchester Road, Libertyville, Illinois, 60048. For information on WMB program contact Christine Gaynes at 847.377.7706 or cgaynes@lakecountyil.gov

Other Sources

Project funding sources that could potentially qualify as federal/state matching funds may come from a variety of local government, private, or community trusts or foundations that support initiatives reflecting organizational policies. Eligibility criteria are as varied as the donors. Most of these sources require a Not-For-Profit (501c3,*c4, etc.) corporate status.

• The ***Illinois Clean Energy Community Foundation*** supports projects that enhance natural areas, increase renewable energy, or improve energy efficiency. Can be used to purchase land.
Eligibility: private not-for-profit organizations, educational organizations, local governments.
Assistance: call for details, which change year to year.
Website: http://www.illinoiscleanenergy.org.
Contact: Illinois Clean Energy Foundation, 312-372-5191.

• The ***Illinois Conservation and Climate Initiative*** *(ICCI)* is a joint project of the State of Illinois and the Delta Institute that allows farmers and landowners to earn greenhouse gas emissions credits when they use conservation tillage, plant grasses and trees, or capture methane with manure digesters. Program term runs through 2010.
Eligibility: individuals and corporations.
Assistance: contact the Delta Institute for details.
Website: http://www.illinoisclimate.org.
Contact: The Delta Institute, 312-554-1909.

• ***Riverwatch*** is a volunteer-driven effort to collect stream data from Illinois streams and submit the data to the Illinois Natural History Survey. This former IDNR program is now being administered by The National Great Rivers Research & Education Center.
Eligibility: all Illinois streams.
Assistance: monitoring training, forms, and kits.
Website: http://ngrrec.org/river_watch.htm.
Contact: Nate Keener, RiverWatch Coordinator, (618) 468-2782 or nkeener@lc.edu.

• ***Habitat Restoration Funds for Northeastern Illinois River Watersheds*** supports wetland restoration and aquatic wildlife habitat projects.
Eligibility: individuals, all organizations, educational organizations, local governments.
Assistance: 25% cost share.
Website: http://www.lakeswcd.org.
Contact: Lake County SWCD, 100 N. Atkinson Road, Suite 102-A, Grayslake, IL 60030-7805. Phone: 847-223-1056. E-Mail: lcswcd@sbcglobal.net.

• The ***National Fish and Wildlife Foundation General Matching and Special Grant Programs*** supports habitat restoration and protection on private lands.
Eligibility: varies.
Assistance: Sample grant sizes in Illinois range from $3,000 to over $100,000.
Website: http://www.nfwf.org.
Contact: 202-857-0166.

• **Five Star Restoration Challenge Grants** bring together citizen groups, corporations, youth groups and students, landowners, and government agencies to undertake projects that restore streambanks and wetlands. Projects must include a strong wetland or riparian restoration component, and should also include education, outreach, and community stewardship. Jointly administered by the National Fish and Wildlife Foundation, the National Association of Counties, and the Wildlife Habitat Council, and mainly funded by USEPA.
Eligibility: Requires at least five or more partnering organizations.
Assistance: $5,000 to $20,000 with a 1 to 1 match requirement.
Website: http://www/nfwf.org/programs/5-star-rfp.htm, http://www.epa.gov/owow/wetlands/restore/5star/.

Contact: USEPA Wetlands Division, Room 6105 (4502T), 1200 Pennsylvania Avenue, NW, Washington, DC. Email: price.myra@epa.gov.

• The ***Trust for Public Lands (TPL)*** works with local organizations to conserve lands for a variety of uses, to include farms, ranches, natural lands and lands of historic importance.
Eligibility: local government, private not-for-profit organizations, educational organizations, and others.
Assistance: technical and informational assistance to identify lands to be protected and assist in financing and land transactions.
Website: http://www.tpl.org. Click on local programs-North Central Region.
Contact: 312-427-1979 & 314-436-7255.

Reference Sources

Several grant search engines and organizations exist to help identify funding sources. Fees for services or products may be charged by these organizations. When searching, be sure to clarify whether charges will be incurred. For "do-it-your-selfers," local grant data collection centers are available throughout Illinois.

• ***Resources for Global Sustainability (***RGS) publishes a yearly catalog called "Environmental Grantmaking Foundations". P.O. Box 3665, Cary, NC 27519. Phone: 1-800-724-1857. http://www.environmentalgrants.com.

• ***Environmental Grantmaker's Association*** Provides a list of environmental grant foundations. http://www.ega.org.

• ***Minnesota Office of Environmental Assistance*** http://www.nextstep.state.mn.us/

• ***The Foundation Center*** 79 Fifth Street, New York, New York 10003. Phone: 212-620-4230. http://www.fdncenter.org.

• ***Sonoran Institute*** Look for Conservation Assistance Tools (CAT) at http://www.sonoran.org.

• ***Illinois Department of Natural Resources*** IDNR has a very comprehensive grant search engine at: http://dnr.state.il.us/orep/c2000/grants/

• ***The Donor's Forum of Chicago*** 208 S. LaSalle St., Suite 735, Chicago, IL 60604. Phone: 312-578-0175. http://www.donorsforum.org. E-mail: info@donorsforum.org

• ***Metropolitan Association for Philanthropy*** 1320 Olive Street St. Louis, MO. http://www.mapstl.org. Phone: 314-621-6220.

• ***eCivis Grants Network*** Assistance for local governments to improve their grants success through expert grant research, information, grant training, and technology. eCivis, Inc. 3452 E. Foothill Blvd, Floor 9, Pasadena, CA 91107. Phone: 877-232-4847. Email info@ecivis.com.