Sauk River

Watershed Restoration and Protection Strategy Report

March 2015

Sauk River Watershed District

Minnesota Pollution Control Agency

CLEAN WATER LAND & LEGACY AMENDMENT

wq-ws4-08a

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Disclaimer:
The science, analysis and strategy development described in this report began before accountability provisions were added to the Clean Water Legacy Act in 2013; thus, this report does not address all of its elements. When this watershed is revisited, according to the 10-year cycle, the information will be updated according to the required elements of a Watershed Restoration and Protection Strategy Report.

Key Terms

Assessment Unit Identifier (AUID): The unique water body identifier for each river reach comprised of the USGS eight-digit HUC plus a three-character code unique within each HUC.

Aquatic life impairment: The presence and vitality of aquatic life is indicative of the overall water quality of a stream. A stream is considered impaired for impacts to aquatic life if the fish Index of Biotic Integrity (IBI), macroinvertebrate IBI, dissolved oxygen, turbidity, or certain chemical standards are not met.

Aquatic recreation impairment: Streams are considered impaired for impacts to aquatic recreation if fecal bacteria standards are not met. Lakes are considered impaired for impacts to aquatic recreation if total phosphorus, chlorophyll-a, or Secchi disc depth standards are not met.

Hydrologic Unit Code (HUC): A Hydrologic Unit Code (HUC) is assigned by the USGS for each watershed. HUCs are organized in a nested hierarchy by size. For example, the Minnesota River Basin is assigned a HUC-4 of 0702 and the Pomme de Terre River Watershed is assigned a HUC-8 of 07020002.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses including: aquatic life, aquatic recreation, and aquatic consumption.

Index of Biotic integrity (IBI): A method for describing water quality using characteristics of aquatic communities, such as the types of fish and invertebrates found in the waterbody. It is expressed as a numerical value between 0 (lowest quality) to 100 (highest quality).

Protection: This term is used to characterize actions taken in watersheds of waters not known to be impaired to maintain conditions and beneficial uses of the waterbodies.

Restoration: This term is used to characterize actions taken in watersheds of impaired waters to improve conditions, eventually to meet water quality standards and achieve beneficial uses of the waterbodies.

Source (or Pollutant Source): This term is distinguished from 'stressor' to mean only those actions, places or entities that deliver/discharge pollutants (e.g., sediment, phosphorus, nitrogen, pathogens).

Stressor (or Biological Stressor): This is a broad term that includes both pollutant sources and non- pollutant sources or factors (e.g., altered hydrology, dams preventing fish passage) that adversely impact aquatic life.

Total Maximum Daily Load (TMDL): A calculation of the maximum amount of a pollutant that may be introduced into a surface water and still ensure that applicable water quality standards for that water are met. A TMDL is the sum of the wasteload allocation for point sources, a load allocation for nonpoint sources and natural background, an allocation for future growth (i.e., reserve capacity), and a margin of safety as defined in the Code of Federal Regulations.

What is the Watershed Restoration and Protection Strategy (WRAPS) Report?

The State of Minnesota has adopted a "watershed approach" to address the state's 81 "major" watersheds (denoted by 8-digit hydrologic unit code or HUC). This watershed approach incorporates **water quality assessment, watershed analysis, civic engagement, planning**, **implementation**, and **measurement of results** into a 10-year cycle that addresses both restoration and protection.

As part of the watershed approach, waters not meeting state standards are still listed as impaired and Total Maximum Daily Load (TMDL) studies are performed, as they have been in the past, but in addition the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to help state agencies, local governments and other watershed stakeholders determine how to best proceed with restoring and protecting lakes and streams. This report summarizes past assessment and diagnostic work and outlines ways to prioritize actions and strategies for continued implementation.

Purpose	• Support local working groups and jointly develop scientifically-supported restoration and protection strategies to be used for subsequent implementation planning
	• Summarize Watershed Approach work done to date including the following reports:
	  • *Sauk River Watershed Monitoring and Assessment*
	  • *Sauk River Watershed Biotic Stressor Identification*
	  • *Sauk River, HSPF Modeling of the Sauk River, Sauk Lake Watershed Total Maximum Daily Load and Sauk Lake -North Bay*
	  • *Osakis Lake Area Excess Nutrient TMDL*
	  • *Turbidity TMDL Assessment for Stony, Un-named and Getchell Creeks*
	  • *Lower Sauk River, Mill Creek and Pearl Lake TMDL*

Scope	• Impacts to aquatic recreation and impacts to aquatic life in streams • Impacts to aquatic recreation in lakes • Create strategies for restoration and protection of watershed resources
Audience	• Local working and interest groups (Watershed District, local governments, SWCDs, etc.) • State agencies (MPCA, DNR, BWSR, etc.) • Local interest groups (lake associations, Friends of the Sauk River)

1. Watershed Background & Description

The Sauk River Watershed (070102020) lies in the heart of rural central Minnesota, encompassing a complex system of integrated lakes and streams. Located in the North Central Hardwoods Ecoregion, the Sauk River Watershed transitions from a more forested landscape (North) in to a highly concentrated agricultural landscape in the south.

The Sauk River Watershed covers a large land area, over 1,040 square miles. The Sauk River originates from Osakis Lake, near the city of Osakis and flows southeasterly 134.9 river miles (DNR, 2011) to the city of St. Cloud, where it joins the Mississippi River. The watershed, like the Sauk River, extends in a northwest to southeast direction (Figure 1).

The Sauk River Watershed covers over 667,513 acres across portions of five counties including Douglas, Meeker, Pope, Stearns, and Todd counties (Table 1). The watershed is about 75 miles in length with some areas being up to 30 miles in width. The river drops approximately 340 feet in elevation from Osakis Lake to the Mississippi River.

Table 1: Sauk River Watershed District Area by County

	Douglas	Pope	Meeker	Stearns	Todd	Total
Area (acres)	58,962	31,881	9,300	429,868	137,304	667,315
Area (sq. mi.)	92.1	49.8	14.5	671.7	214.5	1042.6
Percent of watershed	8.8	4.8	1.4	64.4	20.6	100

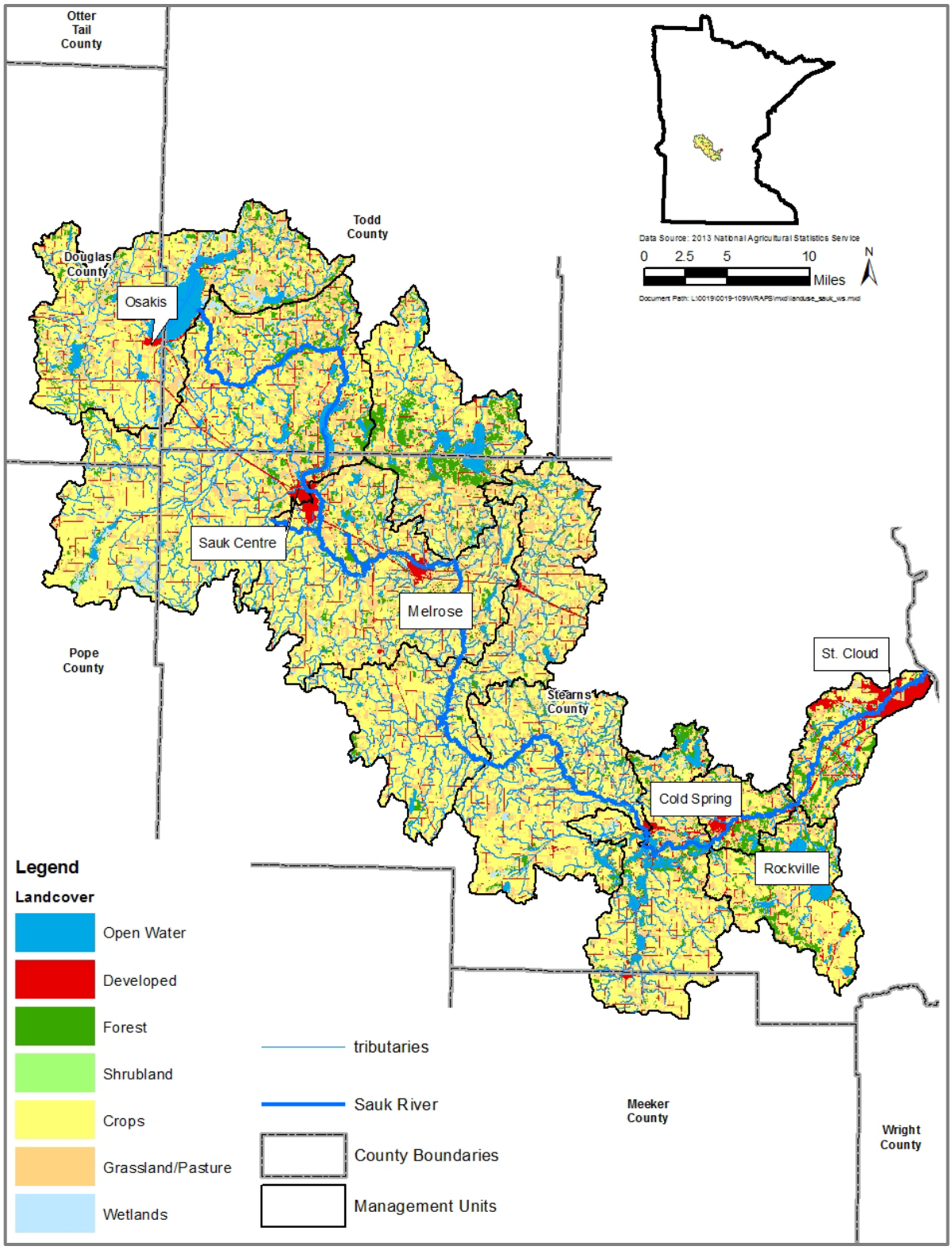
Source: District legal boundary provided by Todd County GIS.

The Sauk River Watershed headwaters are primarily agricultural with wetland areas and spotted with forested areas. Moving downstream to the middle Sauk River region, wetland and forested areas become scarce and row crop with artificial drainage begins to dominate the landscape. Livestock numbers also increase considerably, approximately 1500 registered feedlots, with many feedlots located near or adjacent to creeks or drainage ditches (Figure 2). The lower stretch of the River becomes progressively urbanized as it meanders through several small municipalities and eventually through the city of St. Cloud where it converges with the Mississippi River. Table 2 lists the general land use type found within the Sauk River Watershed broken down by percent.

Table 2: Percent of Sauk River watershed by land cover.

Landuse	Acres	Percent Total
Grains and Other Crops	82,579	12%
Urban/Roads	41,749	6%
Corn and Soybeans	284,884	43%
Hay and Pasture	17,009	3%
Grassland	60,918	9%
Wetlands and Open Water	105,421	16%
Forest and Shrubland	74,655	11%
Total	**667,215**	**100%**

Source: 2013 National Agricultural Statistics (NASS) GIS land cover.



Agricultural

Figure 1: Land Cover (NASS, 2013) within the Sauk River Watershed

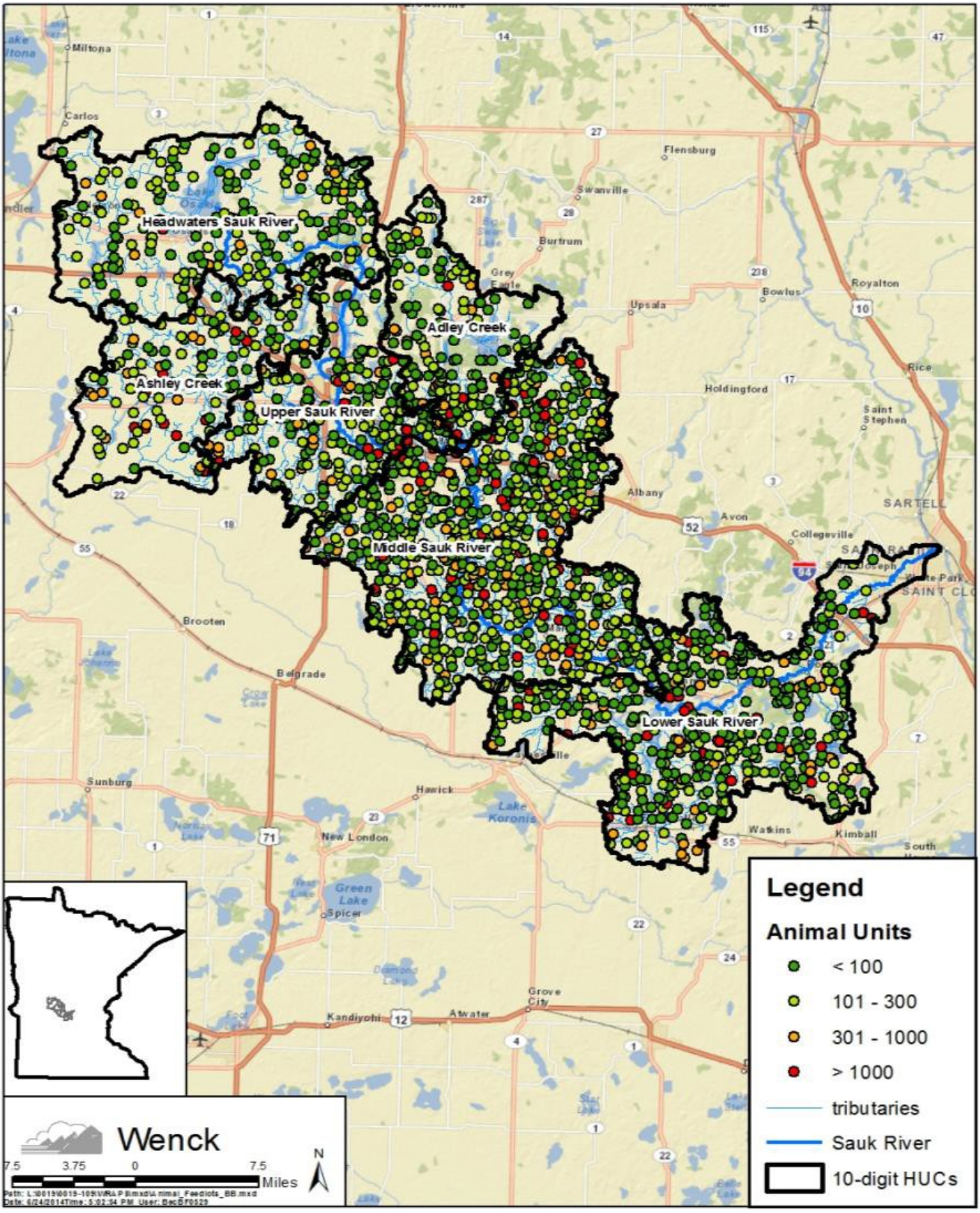


Figure 2: Feedlots within the Sauk River Watershed

Within the Sauk River Watershed there are 586 intermittent and perennial streams. The Minnesota Department of Natural Resources (DNR) estimates a total of 1,682 miles of stream length in the watershed. In addition, there are numerous ephemeral streams that appear only after snow melt and storm events and reflect many additional miles of watercourse flows. Collectively, these streams flow into the Sauk River.

Some of the major tributaries to the Sauk River include: Ashley, Hoboken, Adley, Getchell, Stoney, and Mill (Table 3). These larger tributaries generally carry the largest volumes of water to the river and consequently carry more sediments and nutrients into the Sauk River. Most of the remaining streams are unnamed.

Table 3: Major streams in the Sauk River watershed

Stream	*Length (mi)*	*Watershed Area (mi2)*
Sauk River	134.9*	1,043
Adley Creek	4.8	89
Ashley Creek	27.5	113
Getchell Creek	16.1	67
Hoboken Creek	10.5	28
Stoney Creek	11.1	26
Mill Creek	11.1	48

*DNR Watershed assessment health report, 2011

In addition to streams and rivers, lakes are important resources to the SRWD and its people. Lakes in the District support a high quality of life for area residents and provide thousands of people with a range of recreational opportunities. Many of the lakes, especially the larger ones, have been popular destinations for decades. There are 371 established lake basins in the Sauk River Watershed. According to the DNR's Bulletin 25, one of the initial inventories of lakes, there are 243 public water basins in the watershed. These lakes cover approximately 35,700 acres (DNR, 1968).

The largest lake in the watershed is Osakis Lake, which is located in Douglas and Todd counties and has an area of 6,768 acres. Its size supports multiple recreational activities and an active tourism base for the area. The second largest lake, Sauk Lake (2,111 acres), is located in Todd and Stearns counties.

These counties share two other large lakes, Big Birch (2,085 acres) and Little Birch (793 acres). Other major lakes (over 500 acres) in the watershed include Smith Lake in Douglas County; Pearl, Grand, Big Fish, Cedar Island, Sauk River Chain of Lakes of Stearns County, and Maple and Fairy lakes in Todd County.

The population of the watershed is approximately 65,000 people and the watershed contains the larger cities of Waite Park, St. Cloud, St. Joseph, Cold Spring and Sauk Centre. There are numerous smaller communities throughout the watershed. The municipalities located throughout the watershed have wastewater treatment facilities (WWTF) that discharge to the Sauk River or its tributaries.

The Sauk River Watershed has a diverse social and economic pattern from the rural areas south and west of Osakis to the urbanized St. Cloud region. Within the watershed there is also an extreme diversity of natural resources from riverine to recreational lakes, prairie potholes to sand plains, native prairie to hardwood forests. As a result, there is a wide range of resource management and protection needs, with waters ranging from pristine to impaired waters. The conditions of these lakes and streams including associated pollutant sources are detailed in the following sections.

Additional Sauk River Watershed Resources

Sauk River Watershed District website – past studies, monitoring data, civic engagement, overall watershed management plan: http://www.srwdmn.org/

Past MPCA studies including assessment, TMDLs, and implementation in the Sauk River Watershed can be found at: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/sauk-river.html

Minnesota DNR Watershed Assessment Mapbook for the Sauk River Watershed: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/wsmb16.pdf

Natural Resources Conservation Service's (NRCS) Rapid Watershed Assessment:

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/mn/technical/dma/rwa/?cid=nrcs142p2_023591

Stearns County Surface Water Assessment 2009-2010:

http://stearns.server306.com/files/1047.pdf

2. Watershed Conditions

The Sauk River (HUC8 -07010202) Watershed is a medium-sized watershed encompassing five lake-rich counties in west central Minnesota. The Sauk River Watershed has a total area of 667,513 acres (270,513 hectares). The Sauk River Watershed is comprised of 32 sub-watersheds classified as 12 digit HUC watersheds.

A total of 371 established lake basins and 586 perennial and ephemeral streams are located in the Sauk River Watershed. The effects of past land use changes such as water quantity management, loss of natural land cover and open space, alterations within floodplains, land conversion from cropland to development, and other alterations to the environment have contributed to noticeable changes in water quality and quantity. Despite past improvements to point source discharges and conservation efforts taken to improve water quality, both point and nonpoint sources of pollution continue to impact surface water quality in the watershed.

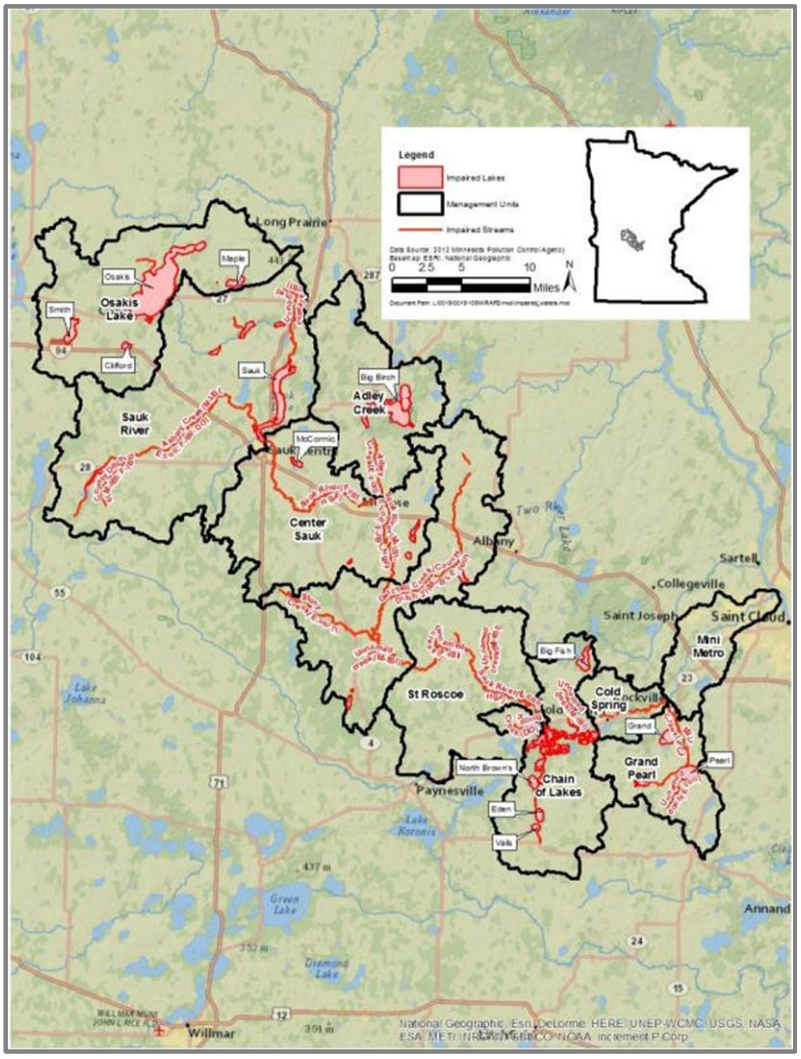


Figure 3: Stream and river impairments in the Sauk River Watershed

To help surface waters recover, nonpoint conservation best management practices (BMP) such as stormwater retention and diversion, feedlot abatements, shoreland restoration, septic system upgrades and vegetative buffers have been implemented in the Sauk River Watershed from 1994 to 2014. Continued efforts are needed to achieve water quality standards in impaired water bodies and protect other water resources from becoming impaired.

Of the 371 lakes in the watershed, 58 were monitored by the Sauk River Watershed District (SRWD) as part of Clean Water Partnership (CWP) projects and Surface Water Assessment Grants (SWAG). These lakes were monitored for impairments to aquatic recreation. Thirty-one of these lakes were found to be impaired for excessive nutrients and 27 assessed as meeting water quality standards. Of the 586 stream reaches, 42 were assessed for aquatic recreations and/or aquatic life. Fourteen streams reaches were assessed as impaired for aquatic recreation and 20

assessed as non-supporting of aquatic life and eight as supportive to aquatic life. The Sauk River is listed for impairments in five reaches of the river as shown in Figure 3.

Within the Sauk River Watershed there are 28 county and judicial ditch systems that drain relatively large areas. There are also many miles of private ditch networks in the watershed and hundreds of miles of buried tile systems. Agricultural ditching has been identified as a potential cause of fish and invertebrate impairments due to the prevalence of public and private drainage systems. The runoff volume, sediment load and nutrients carried by these conveyances are delivered to downstream waters.

Data collected on the main stem of the Sauk River in 2011 shows a threefold increase in total phosphorus (TP) concentrations from the outlet of Osakis Lake on the upstream end of the River to the mouth where it converges with the Mississippi River. Data shows that starting at New Munich, TP values generally double those observed in minimally impacted streams in the Central Region. The TP values at most monitoring locations exceed the MPCA's proposed stream standard of 100µg/L (0.1 mg/L) for the central region of Minnesota. The water quality observed in the Sauk River affects not only the residents of the watershed, but public water supplies for urbanized areas (St. Cloud and Minneapolis) downstream after the Sauk River converges with the Mississippi River.

The increased phosphorus concentrations recorded for the water bodies monitored throughout the watershed are a direct reflection of the various land uses found in the watershed. Intensive row crop agriculture, along with livestock production, directly influences the amount of nutrients applied to area fields. Direct access of cattle to the Sauk River and its tributaries is causing damage, loss of habitat, increased nutrient concentrations, and increased fine sediment transport that is filling coarse substrate used by fish and macroinvertebrates. Residential and urban landscapes also increase already excessive nutrient levels through wastewater discharge, lawn and gardening maintenance activities, and pet waste washing into the waterways. The accumulations of nutrients from differing land uses are causing excessive nutrient levels in lakes and streams (Sauk River Watershed Stressor Identification, August 2012).

Excess sediment being transported down the streams and ditches is also a main stressor to biology within the Sauk River Watershed. The excess amount of fine material being transported downstream is settling out and filling in pools, smothering rock riffles and causing a general degradation of in-stream habitat (Sauk River Watershed Stressor Identification, August 2012). Ditching is also a main stressor to the stream health. Changes in the delivery and rate of water through the ditch system are causing increased peak flows and reduced base flows in area streams (Sauk River Watershed Stressor Identification, August 2012). Many of the ditches in the watershed do not have adequate buffering and fine material is being transported through bank failures and row crop farming that is occurring next to the ditches.

2.1 Condition Status

Water quality and biological monitoring in the Sauk River Watershed has been conducted for several decades with the goal of assessing water quality and aquatic life. The Sauk River Watershed was part of the MPCA's Intensive Water Monitoring (IWM) in 2008. The data collected for area TMDL studies, SWAG projects, and historic data were used in addition to the IWM data to assess and identify stream reaches that lacked a healthy population of fisheries and macroinvertebrates, as well as lakes that do not support swimming and aquatic recreation.

The result of the 2008 IWM was the discovery and listing of numerous streams in the Sauk River Watershed as "impaired" for aquatic life and others for being non-supportive of aquatic recreation. Streams that are not listed as impaired are either not yet assessed (lacking monitoring data), have over 50% of the stream channelized, or are identified as having good to exceptional biological integrity based on current data. Streams not listed as impaired will be subject to protection efforts. Information regarding protection efforts is discussed in Section 2.4.

The SWAG data and historic data determined that the majority of the recreational developed lakes within the Sauk River Watershed are impaired and are non-supportive to swimming. Lakes not assessed and those meeting state standards will be subject to protections efforts, which are discussed in Section 2.4.

Some of the water bodies in the Sauk River Watershed are impaired for mercury; however, this report addresses impairments to aquatic recreation and aquatic life in the lakes and streams of the Sauk River Watershed. Impairments for aquatic consumption (human consumption) are not addressed in this report but may be found in the *Minnesota Statewide Mercury TMDL*: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired- waters-and-tmdls/tmdl-projects/special-projects/statewide-mercury-tmdl-pollutant-reduction- plan.html

Streams

Stream conditions throughout the Sauk River Watershed were assessed using a range of parameters including fish and invertebrate index of biotic integrity (IBI), *E. coli* bacteria, turbidity, and dissolved oxygen. Monitoring data for each assessed stream was compared to state water quality standards. Stream conditions and assessment data are summarized in the Sauk River Watershed Monitoring and Assessment Report (MPCA, 2011).

Within the Sauk River Watershed there are 84 stream Assessment Unit Identifiers (AUID). Thirty-nine of these AUIDs were assessed as part of the 2008 MPCA IWM program (Figure 4). The IWM results showed that only eight streams were considered fully supporting of aquatic life and only 11 of aquatic recreation. Twenty-six of these streams were not assessed for aquatic biology due to the excessive channelization of the stream. Table 4 lists the 45 stream reaches that have been assessed in the Sauk River Watershed (MPCA and SRWD data). The assessed streams are organized in the table by HUC-10 subwatersheds and presented in a north to south arrangement. The assessment indicated whether the stream reach is supportive or impaired for aquatic life and recreation.

Table 4: Assessment status of stream reaches in the Sauk River Watershed

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life					Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	pH	Dissolved Oxygen	Turbidity/TSS	Bacteria
Headwaters Sauk River	552	Crooked Lake	Unnamed Cr to Lk Osakis	Sup	Imp	Sup	NA	Sup	Imp
	673	Sauk River	Juergens Lk to Sauk Lk	Imp	Imp	Sup	Imp	Sup	Sup
	592	Unnamed Creek	Headwaters to Sauk R	Imp	Imp	IF	IF	IF	NA
	666	Unnamed ditch	Unnamed Cr to Sauk Lk	Imp	Imp	IF	IF	IF	NA
	589	Boss Creek	Headwaters to Osakis Lake	IF	IF	IF	IF	IF	IF
	904	Unnamed Creek	Steven Lk to Faille Lk	NA	NA	NA	Imp	NA	Sup
	667	Sauk River	Headwaters to Guernsey	Sup	Sup	Sup	Sup	Sup	NA
	669	Sauk River	Guernsey Lk to Little Sauk	IF	IF	Sup	Sup	Sup	Sup
	671	Sauk River	Little Sauk Lk to Juergens Lk	IF	IF	Sup	IF	Sup	Sup
Adley Creek	527	Adley Creek	Sylvia Lk to Sauk R	NA	NA	NA	IF	IF	Imp
	601	Prairie Creek	Head water to Little Birch Lake	NA	NA	NA	Sup	Sup	Sup
	535	Fish Creek	Goose Lk to Big Birch Lk	Sup	Sup	NA	IF	Sup	IF
	570	Trout Creek	Headwaters to Prairie	NA	NA	IF	IF	IF	IF
Ashley Creek	503	Ashley Creek	Headwaters to Sauk Lk	Imp	Imp	Sup	Imp	IF	Imp
Ashley Creek	521	County Ditch 6	Unnamed Cr to Ashley Cr	Imp	Imp	IF	IF	IF	IF
	578	Silver Creek	Union Lk to Ashley Creek	NA	NA	NA	Sup	IF	IF
	522	Hoboken Creek	Headwaters to Sauk Lake	IF	IF	Sup	IF	IF	Sup
Upper Sauk River	506	Sauk River	Melrose Dam to Adley Cr	Imp	IF	IF	IF	IF	NA
	507	Sauk River	Sauk Lk to Melrose Dam	Imp	Sup	IF	IF	NA	Sup
Middle Sauk River	562	Getchell Creek (Cty	Unnamed Cr to Sauk R	Sup	Imp	Sup	Sup	Sup	Imp
	505	Sauk River	Adley Cr to Getchell Cr	Imp	Imp	Sup	IF	Sup	Imp
	508	Sauk River	Getchell Cr to State Hwy	Sup	Sup	IF	IF	Sup	Imp
	541	Stoney Creek	Headwaters (Unnamed lk 73- 0261-00) to Sauk	NA	NA	IF	IF	Sup	Imp
	542	Unnamed Creek	Unnamed Cr to Sauk R	IF	IF	IF	IF	IF	Imp
	554	Unnamed Creek	Unnamed Cr to Sauk R	Sup	Imp	IF	IF	IF	NA
	556	Unnamed Creek	Headwaters to Sauk R	Imp	Imp	IF	IF	IF	NA

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Aquatic Life					Aq Rec
				Fish Index of Biotic Integrity	Macroinvertebrate Index of Biotic Integrity	pH	Dissolved Oxygen	Turbidity/TSS	Bacteria
	598	Unnamed Creek	Unnamed Cr to Schneider	Sup	Imp	IF	IF	IF	NA
	615	Unnamed Creek	Unnamed Cr to Getchell Cr	NA	NA	NA	IF	IF	Imp
	660	Unnamed Creek	Unnamed Cr to Sauk R	Imp	Imp	IF	IF	IF	NA
	662	Unnamed Creek	Unnamed Cr to Unnamed	Imp	Sup	IF	IF	IF	NA
Lower Sauk River	545	Eden Lake Outlet	Headwaters (Eden Lk 73- 0150-00) to	Imp	Imp	Sup	Sup	Sup	Imp
	520	Sauk River	Cold Spring WWTP to Mill	Imp	Imp	IF	IF	Sup	Sup
	550	Unnamed Creek	Unnamed Cr to Vails (Mud) Lk	IF	IF	NA	IF	IF	Imp
	616	Unnamed Creek	Unnamed Cr to Schneider	IF	IF	NA	Imp	IF	IF
	663	Unnamed creek	Unnamed Cr to Unnamed	NA	Imp	IF	IF	IF	NA
	567	Unnamed creek (Cold Spring Creek)	T123 R30W S15, west line to Sauk R	IF	IF	IF	IF	IF	Imp
	665	Unnamed ditch	Headwaters to Pearl Lk	IF	IF	IF	IF	IF	Imp
Lower Sauk River	674	Mill Creek	Headwaters (Goodners Lk 73-0076-00) to	Imp	Imp	IF	IF	Sup	Imp
	550	Luxemburg Creek	Headwaters to Eden Lake	NA	NA	NA	Sup	IF	IF
	565	Kinzer Creek	Unnamed Lk to Knaus Lake	IF	IF	IF	Imp	Sup	Sup
	575	Kolling Creek	Unnamed Creek to Becker Lk	IF	IF	IF	Imp	Sup	Sup
	606	Ploofs Creek	Headwaters to Grand Lake	NA	NA	IF	IF	IF	IF
	676	Mill Creek	Pearl Lk to Sauk R	NA	NA	IF	Sup	Sup	Imp
	501	Sauk River	Mill Creek to Mississippi	Sup	Sup	Sup	Sup	Sup	Sup
	545	Tib to North	Headwaters to Browns Lk	Imp	Imp	Sup	Sup	Sup	Imp

Sup = found to meet the water quality standard, Imp = does not meet the water quality standard and therefore, is impaired, IF = the data collected was insufficient to make a finding, NA = not assessed

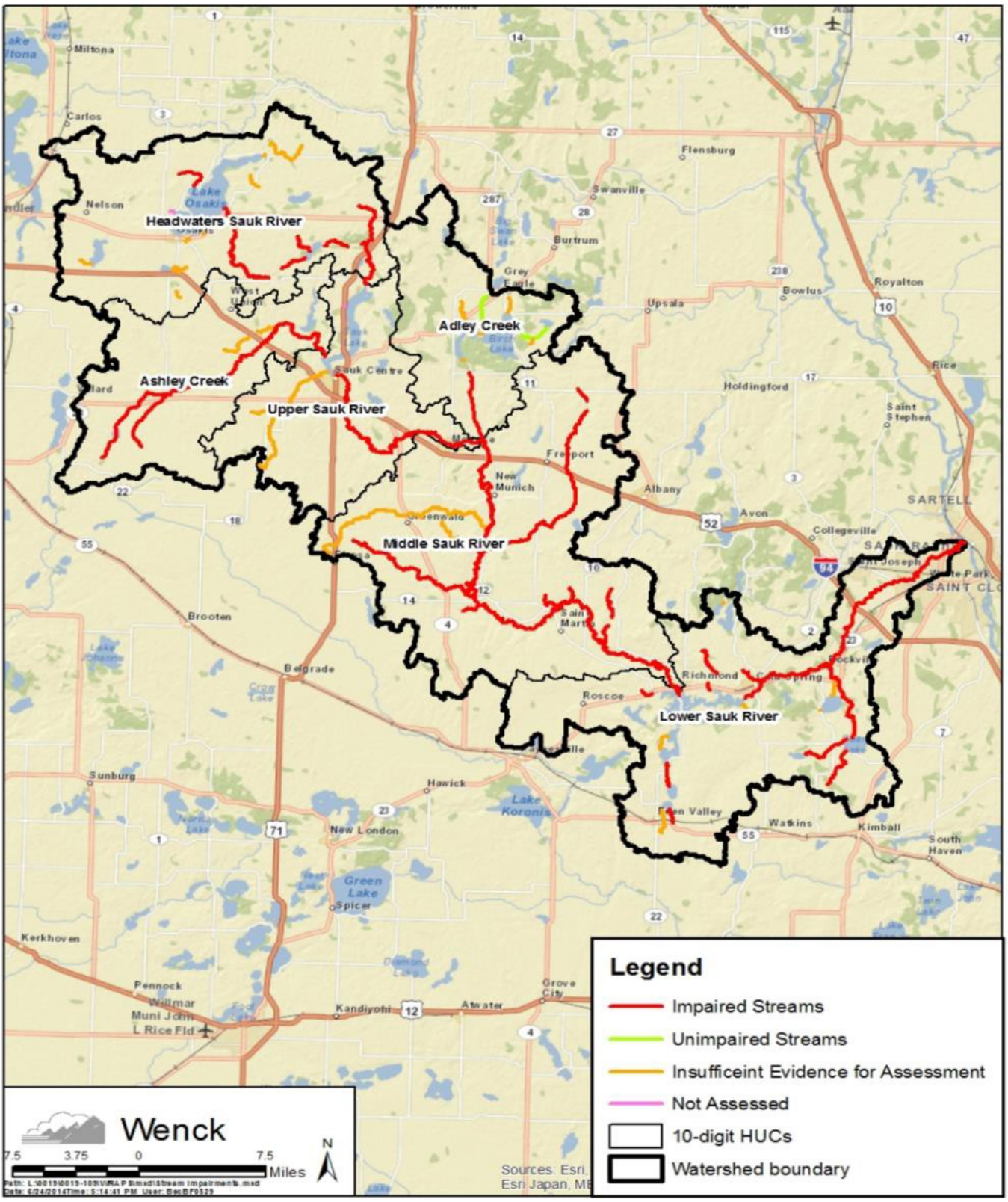


Figure 4: Stream impairments in the Sauk River Watershed

Lakes

The 371 lakes greater than 10 acres that were identified in the Sauk River Watershed by the DNR are classified as class 2B waters, for which aquatic life and recreation are the protected beneficial uses. Fifty-eight of these lakes have been assessed and compared to the state water quality standards (Table 5). Thirty-one of the 58 lakes have been listed as impaired (Table 5) and 27 of these lakes currently meet water quality standards and need to be protected. The 313 lakes not currently assessed have been categorized as "at risk" as there is a need to protect them from future degradation.

The 58 lakes assessed in the Sauk River Watershed were monitored for three primary parameters, total phosphorus, chlorophyll-a and transparency (Secchi) to compare with aquatic recreation-based state standards. Additional parameters such as ortho-phosphorus, dissolved oxygen and temperature were monitored to determine internal loading potential.

The lakes within the Sauk River Watershed are divided into several different categories in terms of activities and can be broken down into three categories as per the MPCA Lakes Protocol; either impaired lakes, assessed and not impaired lakes and not assessed lakes. Table 5 lists the 58 lakes that have been assessed within the Sauk River Watershed. The lakes are listed by HUC10 subwatersheds and arranged from north to south.

Table 5: Assessed Lakes in the Sauk River Watershed

HUC-10 Subwatershed	Lake ID	Lake	Aquatic Recreation
Headwater Sauk River	21-0003-00	Clifford Lake	Imp
	21-0016-00	Smith Lake	Imp
	77-0163-00	Juergens Lake	Imp
	77-0164-00	Little Sauk Lake	Imp
	77-0181-00	Maple Lake	Imp
	77-0182-00	Guernsey Lake	Imp
	77-0195-00	Faille Lake	Imp
	77-0215-00	Osakis Lake	Imp
	77-0201-00	Little Osakis lake	Sup*
Ashley Creek	61-0029-00	Westport Lake	Imp
	770180-00	William lake	Sup
	77-0154-00	Fairy Lake	Sup
	77-0149-01	Long Lake (mainbasin)	Sup
Upper Sauk River	73-0273-00	McCormic Lake	Imp
	77-0151-00	Mud Lake	Sup
	77-0150-01	Sauk Lake (North Bay)	Imp
	77-0150-02	Sauk Lake (South Bay)	Imp
	77-0149-00	Long Lake-Higgins	Sup
	73-0255-00	Cedar lake	Sup

HUC-10 Subwatershed	Lake ID	Lake	Aquatic Recreation
Adley Creek	77-0095-00	Fuller/Hennessey Lake	Sup*
	77-0089-00	Little Birch Lake	Sup
	77-0084-00	Big Birch lake	Sup*
	73-0233-00	Kings Lake	Sup
	73-0231-00	Long Lake	Sup*
Adley Creek	73-0226-00	Cedar Lake	Sup
	73-0249-00	Sylvia Lake	Sup
	73-0183-00	St. Anna Lake	Sup*
Middle Sauk River	73-0233-00	Kings Lake	Sup
	73-0199-00	Sand Lake	Imp
	73-0208-00	Uhlenkolts Lake	Imp
	73-0215-00	Maria Lake	Imp
	73-0244-00	Ellering Lake	Imp
	730241-00	Black Oak lake	Sup*
Lower Sauk River	73-0037-00	Pearl Lake	Imp
	73-0076-00	Goodners Lake	Imp
	73-0082-00	Schneider Lake	Imp
	73-0083-00	Great Northern LK	Imp
	73-0086-00	Knaus Lake	Imp
	73-0087-00	Krays lake	Imp
	73-0088-00	Bolfing Lake	Imp
	73-0089-00	Zumwalde Lake	Imp
	73-0133-01	Cedara Island (main Bay)	Imp
	73-0133-03	Cedar Island (Koetter Lake)	Imp
	73-0139-00	Long Lake	Imp
	73-0147-00	North Brown's Lake	Imp
	73-0150-00	Eden Lake	Imp
	73-0151-00	Vails Lake	Imp
	73-0157-00	Horseshoe Lake	Imp
	73-159-00	Big Lake	Sup
	73-106-00	Big Fish lake	Sup
	73-0107-00	Long Lake	Sup
	73-0132-00	Thein lake	Sup
	73-0051-00	Pleasant Lake	Sup
	73-0057-00	Rausch Lake	Sup
	73-0035-00	School Section Lake	Sup
	73-0055-00	Grand Lake	Sup
	73-0038-00	Camelian Lake	Sup
	73-0156-00	Becker Lake	Sup

Sup = meets the water quality standard, Imp = does not meet the water quality standard therefore, is impaired, IF = the data collected was insufficient to make a finding, NA = not assessed and * indicates borderline impairment

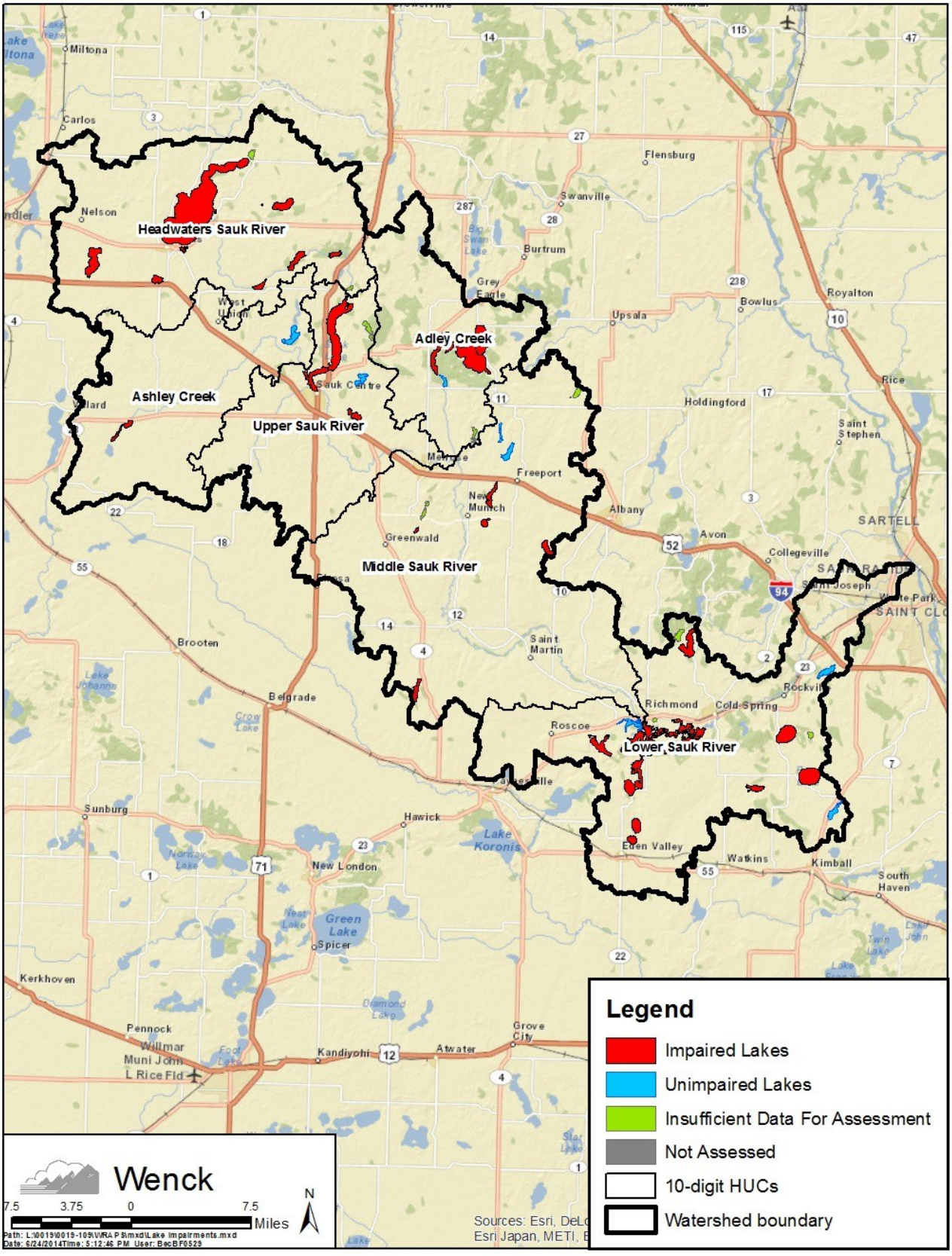


Figure 5: Lake Impairments in the Sauk River Watershed

2.2 Water Quality Trends

The SRWD has actively sampled the watershed since 1995 and as such has compiled an extensive data set. Several lakes, such as Osakis Lake, and streams (i.e., Stoney Creek) have 15 plus years of monitoring data while others have an average of five years of data. In 2008, an intensive monitoring program was conducted on the Sauk River Watershed by the MPCA which included biological monitoring. A complete listing of all lakes and streams within the watershed including those without sufficient data for assessments may be found in the MPCA Sauk River Watershed Lakes Report: http://www.pca.state.mn.us/index.php/water/water- types-and-programs/surface-water/lakes/lakewater-quality/lake-water-quality.html.

The Sauk River monitoring station located on County Road 111, on the outskirts of Richmond, is the most downstream site on the Sauk River with at least 10 years of water quality and flow monitoring data. However, it is difficult to determine a long term trend at this site due to the influence from the large wetland complex located upstream of this monitoring station. In general, the Sauk River has seen a measureable decline in TP concentrations since the 1980's, specifically since the 1991 1mg/L effluent limit issued to the WWTFs within the Sauk River Watershed. The TP concentrations have dropped from an average of 450ug/L to an average of 150-175ug/L during low flows (150-420cfs) and 200-400 during high flows (450-1350cfs). However, the TP and total suspended solids (TSS) concentrations still exceed the proposed state water quality standards for streams within the North Central Hardwood Forest Ecoregion.

Within the Sauk River Watershed, the Horseshoe Chain of Lakes has the most extensive dataset.

In the early 1980's, the Minnesota Pollution Control Agency MPCA conducted a biological study on the Sauk River and the chain of lakes, which ultimately played a role in the establishment of the SRWD (1986) and the enforcement of the 1mg/L phosphorus effluent limit for WWTF within the Sauk River Watershed. In 1992, Water Resource and Management Inc. (WRM) completed a diagnostic study on the Sauk River Chain of Lakes (a.k.a Horseshoe Chain of Lakes) (Table 6). The results of the diagnostic study showed a measureable reduction in TP concentrations in Horseshoe Lake (Table 7) since the 1980's which was attributed to the phosphorus control limits. Since the diagnostic study, there have been significant efforts by the SRWD and the five county SWCDs, NRCS and county agencies to address nonpoint sources to reduce sediment and nutrient loading to the Sauk River Chain of Lakes. Monitoring data shows a fluctuation in the summer average TP concentrations in Horseshoe Lake during wet and dry years. Overall TP levels have improved throughout the monitoring history; however, Horseshoe Lake is still impaired for excessive nutrients.

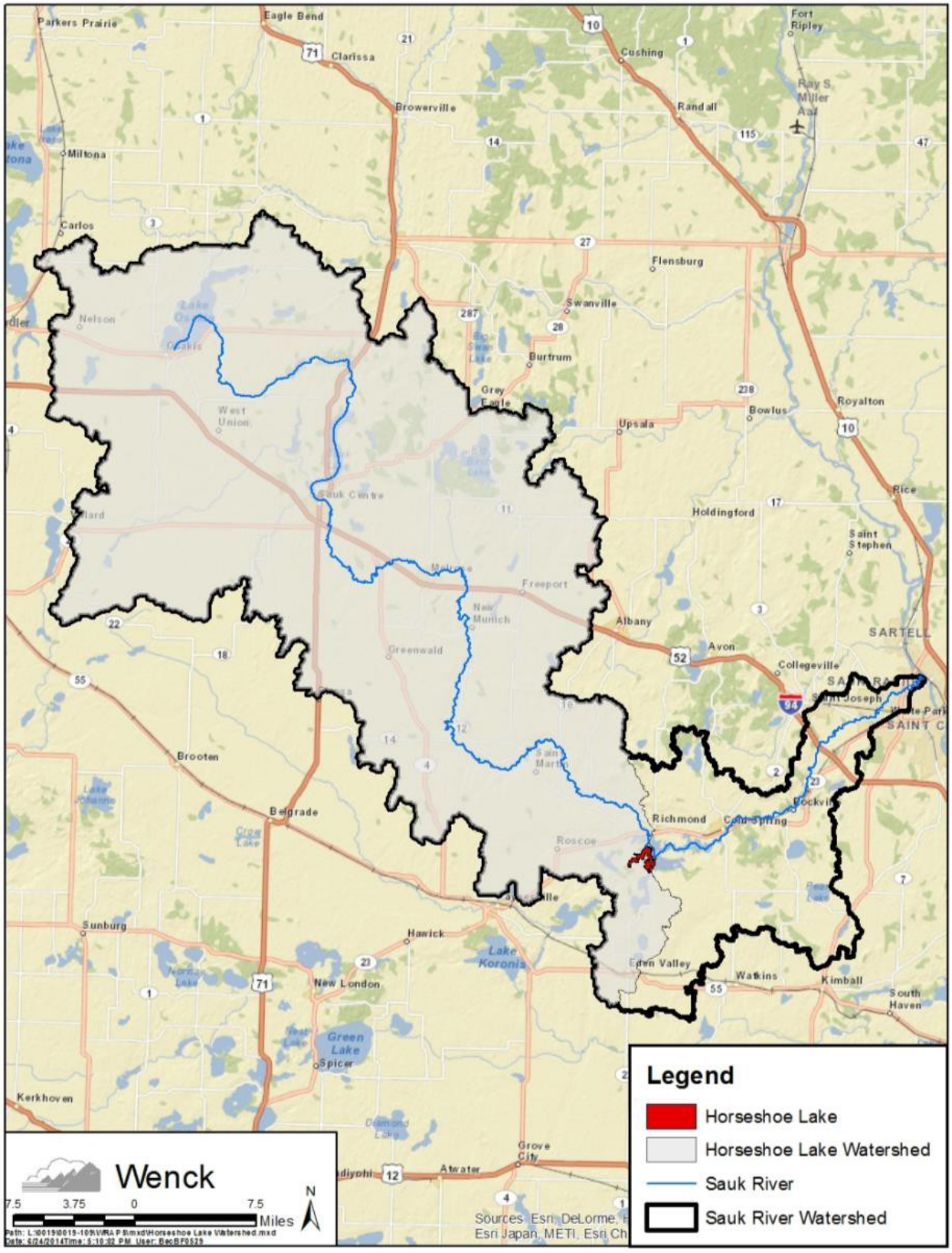


Figure 6: Horseshoe Lake Watershed

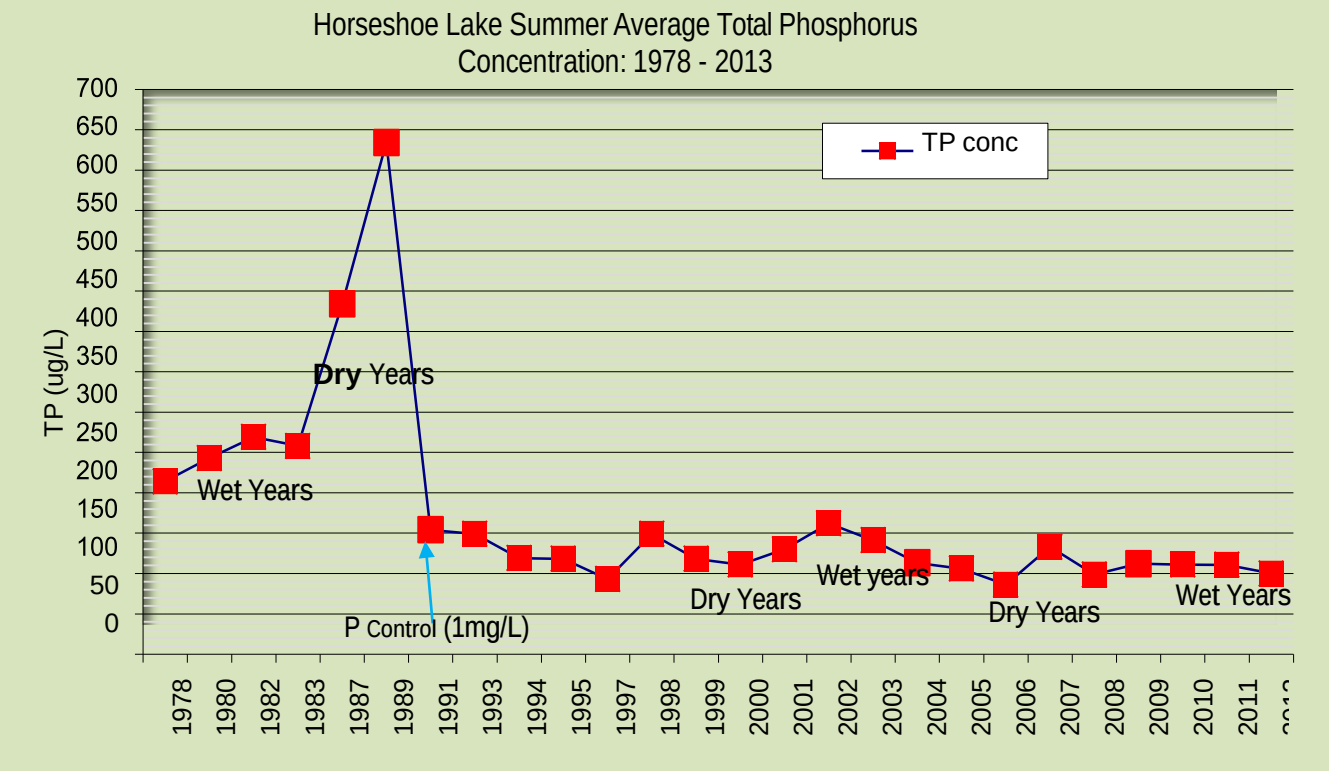


Figure 7: Water Quality Trend for Total Phosphorus in Horseshoe Lake – of the Sauk River Chain of Lakes

Water Chemistry data were analyzed for trends using the Seasonal Kendall Test for Trends by the MPCA (MPCA, 2011) for the long term period of record (1953-present) and near term period of record (1995-present) of lakes in the Sauk River Watershed (Table 6). There were significant decreases in the TP and significant increases in nitrite/nitrates and chlorides during the long term period of record (Table 6).

Table 6: Assessed Lakes in the Sauk River Watershed

Parameter	Historical Trend (1953-2009)	Recent Trend (1995-2009)
Total Suspended Solids	no trend	no trend
Biochemical Oxygen Demand	no trend	no trend
Total Phosphorus	-41%	no trend
Nitrite/ Nitrate	+439%	no trend
Unionized Ammonia	no trend	no trend
Chloride	+752%	no trend
pH	no trend	no trend

A designation of "no trend" means that a statistically significant trend has not been found; this may simply be the result of insufficient data. Ranges for annual and total changes are 90%confidence intervals. *Source – MPCA, 2011*

In addition to state and local government efforts, a citizen lake monitoring program (CLMP) and citizen stream monitoring program (CSMP) occurs throughout the watershed. The CLMP water quality trends analysis indicate improving conditions for lakes observed (Table 7). Additional data available on lakes to make determinations on the long term water quality trends varies within the watershed. For specific trending information on select lakes see the MPCA's Assessment Report of Selected Lakes within the Sauk River Watershed (July 2010) and the MPCA's EQuIS database.

Table 7: CLMP Data Water Clarity Trends

Sauk HUC 07010202	CSMP (Transparency Tube)	CLMP (Secchi Disk)
number of sites w/ increasing trend	3	16
number of sites w/ decreasing trend	0	3
number of sites w/ no trend	6	16

Source – MPCA, 2011

2.3 Stressors and Sources

Stressors of Biologically-Impaired Stream Reaches

In order to develop appropriate strategies for restoring or protecting water bodies, the stressors and/or sources impacting or threatening them must be identified and evaluated. Biological stressor identification is done for streams with either fish or macroinvertabrate biota impairments, and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors (e.g., altered hydrology, fish passage, habitat) (Table 8). Pollutant source assessments are done where a biological stressor ID process identifies a pollutant as a stressor as well as for the typical pollutant impairment listings (e.g., dissolved oxygen). Section 3 provides further detail on stressors and pollutant sources.

Table 8: Primary stressors to aquatic life in biologically-impaired reaches in the Sauk River Watershed

SRWD Management Units	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor						
					Dissolved Oxygen	Bedded Sediment	Phosphorus	Altered Hydrology	Habitat	Connectivity	Turbidity
Lake Osakis	638	Unnamed Cr	"Unnamed lk (77-0168-00) to Little Lk Osakis"	Fish and Invertebrate IBI	X	X	X	X	X		
Sauk Lake	502	Sauk River	Headwaters (Lk Osakis) to Sauk Lk	Fish IBI	X	X	X	X	X	X	X
Sauk Lake	503	Ashley Creek	Headwaters to Sauk Lake	Fish IBI	X	X	X	X	X	X	X
	522	Hoboken Cr	Headwaters to Sauk Lk	Fish and Invertebrate IBI	X	X	X	X	X	X	X

SRWD Management Units	AUID (Last 3 digits)	Stream	Reach Description	Biological Impairment	Primary Stressor						
					Dissolved Oxygen	Bedded Sediment	Phosphorus	Altered Hydrology	Habitat	Connectivity	Turbidity
	540	County Ditch 44	Headwaters to Sauk Lk	Fish and Invertebrate IBI	X	X	X	X	X	X	X
	613	Unnamed Cr	Unnamed cr to Silver Cr	Fish and Invertebrate IBI	X	X	X	X	X	X	X
Sauk Lake	666	Unnamed ditch	Unnamed cr to Sauk Lk	Fish and Invertebrate IBI	X	X	X	X	X	X	X
	673	Sauk River	Juergens Lk to Sauk Lk	Fish IBI	X	X	X	X	X	X	X
Center Sauk	505	Sauk River	Adley Cr to Getchell Cr	Fish and Invertebrate IBI		X	X	X	X	X	
	506	Sauk River	Melrose Dam to Adley Cr	Fish IBI		X	X	X	X	X	
	507	Sauk River	Sauk Lk to Melrose Dam	Fish and Invertebrate IBI		X	X	X	X	X	
GUS Plus	541	Stoney Cr	Headwaters(unnamed Lk 73- 0261-00) to Sauk R	Invertebrate IBI		X	X	X	X		X
	598	Unnamed Cr	Unnamed ditch to unnamed Cr	Fish and Invertebrate IBI		X	X	X	X		X
	655	Unnamed Cr	Unnamed cr to Stony Cr	Fish and Invertebrate IBI		X	X	X	X		X
St. Roscoe	556	Unnamed Cr	Unnamed cr to Sauk R	Fish and Invertebrate IBI		X	X	X			
	662	Unnamed Cr	Unnamed Cr to Sauk R	Fish and Invertebrate IBI		X	X	X			
Chain of Lakes	545	Eden Lk Outlet	Headwaters (Eden Lk 73-0150- 00) to Browns Lk	Fish and Invertebrate IBI	X		X	X			
Cold Spring	520	Sauk River	Cold Spring WWTP to Mill Cr	Fish IBI	X	X	X	X			
Grand Pearl	674	Mill Creek	Headwaters (Goodners Lk 73- 0076-00) to Pearl Lk	Fish and Invertebrate IBI	X		X	X			

Pollutant Sources

Point and nonpoint sources of pollution have been identified through previous TMDL processes, which are outlined in Table 9 and Table 10. The watershed also contains over 50 Concentrated Animal Feeding Operations (CAFOs). Although each watershed is unique, land use is similar throughout the watershed, which results in common pollutant sources in most streams or lakes. Section 3 uses the pollution source assessment to identify possible implementation steps and timelines for impaired and un-impaired stream reaches and lakes.

Table 9: Point Sources in the Sauk River Watershed

HUC-10 Subwatershed	Point Source			Pollutant reduction needed beyond current permit conditions/limits?	Notes
	Name	Permit #	Type		
Headwaters Sauk River (0701020201)	Osakis WWTP	MN0020028	Municipal wastewater	Yes (TP)	Allocated TP as part of the Osakis Lake Area TMDL study (2013)
Upper Sauk River (0701020203)	Sauk Centre WWTP	MN0024821	Municipal wastewater	Yes (TP)	Pending approval for the SRCL TMDL study (2014)
Middle Sauk River (0701020205)	Melrose WWTP	MN0020290	Municipal stormwater	Yes (TP)	Pending approval for the SRCL TMDL study (2014)
	Freeport WWTP	MNG580019	Municipal wastewater	Yes (TP)	Pending approval for the SRCL TMDL study (2014)
	New Munich WWTP	MN0025631	Municipal wastewater	Yes (TP)	Pending approval for the SRCL TMDL study (2014)
	GEMS (Greenwald, Elrose, Miere Grove and Spring Hill) WWTP	MNG580205	Municipal wastewater	Yes (TP)	Discharges to CD9 and to Lake Ellering
Lower Sauk River (0701020206)	St. Martin WWTP	MN0024783	Municipal wastewater	Yes (TP)	Pending approval for the SRCL TMDL study (2014)
	Richmond WWTP	MN0024597	Municipal wastewater	Yes (TP)	Pending approval for the SRCL TMDL study (2014)
	Lake Henry WWTP	MN0020885	Municipal wastewater	Yes (TP)	Pending approval for the SRCL TMDL study (2014)
	Cold Spring	MN0023094	Municipal wastewater	NO	Discharges to Sauk River

Table 10: Nonpoint Sources in the Sauk River Watershed Watershed. Relative magnitudes of contributing sources are indicated

HUC-10 Subwater-shed	Stream/Reach (AUID) or Lake (ID)	Pollutant	Pollutant Sources													
			Fertilizer & manure run-off	Livestock in riparian areas	Failing septic systems	Wildlife	Groundwater	Upland soil erosion	Internal TP Sediment Release	Aquatic Vegetation	Upstream Lakes	Rough Fish	WWTP Discharge	In-stream Algal production	Field Erosion	Bank Erosion
Headwaters Sauk River (0701020201)	Lake Osakis (77-0215)	TP	●		O				O		O					
	Smith Lake (21-0016)	TP	●													
	Faille Lake (77-0195)	TP	O						O		●					
Upper Sauk River (0701020203)	Sauk Lake (77-0150-02)	TP	●				O		O							
Middle Sauk River (0701020205)	Getchell Creek (562)	TSS													●	O
	Un-named Creek (542)	TSS													●	O
	Stoney Creek (541)	TSS													●	O
Lower Sauk River (0701020206)	Pearl Lake (07-0037)	TP	●		O				●							
	Mill Creek (537)	*E. coli*	●	●	O	O										

Key: ● = High O = Moderate O = Low

2.4 TMDL Summary

Total Maximum Daily Load (TMDL) studies have been conducted in the Sauk River Watershed that include the Lake Osakis Excess Nutrient TMDL (Wenck Associates, 2013), the Turbidity TMDL Assessment for Stony, Unnamed, and Getchell Creeks (Wenck, 2010), the Pearl Lake Nutrients and Mill Creek Bacteria TMDLs (Barr, 2012), and the Sauk Lake-North Bay Excess Nutrients TMDL (MPCA, 2013). A TMDL study was conducted on the Sauk River Chain of Lakes (EOR 2014) and is pending final approval. Sauk Lake-South Bay is also undergoing a TMDL study and should receive final approval in 2015. In 2014, Wenck Associates completed a TMDL study on a series of small lakes (Maple, Little Sauk, Guernsey, Juergens, Westport, Sand, Henry, Uhlenkolts and McCormick) for nutrients impairments and three streams (Ashley Creek, Adley Creek, Stoney) and the Sauk River for bacteria impairments. This multi-resource TMDL is pending review and final approval. These documents contain allocation load reductions for six stream and 17 lake impairments, which are summarized in Table 11 and Table 12 of this report.

Additionally, Section 3 of this report prioritizes watersheds into protection and restoration areas using pollutant loading analysis, which also outlines strategies for watershed loading reductions. There are an additional 22 water bodies listed on the 2014 303d list that do not have a completed TMDL study due to lack of available funding.

Table 11: Allocation summary for all completed lake TMDLs in the Sauk River Watershed

			Allocations (lbs/year)										
			Wasteload Allocation			Load Allocation					MOS	RC	
HUC-10	Lake (ID)	Pollutant	WWTFs	Construction & Industrial Stormwater	MS4 Communities	Watershed Load	Internal Load	Upstream Lakes	Groundwater	Atmosphere	Margin of Safety	Reserve Capacity	Percent Reduction
Headwaters Sauk River (0701020201)	Lake Osakis (77-0215)	TP	--	107	--	6,520	365	1,678	--	1,499	535	--	41%
	Smith Lake (21-0016)	TP	--	27	--	1,318	0	--	--	132	89	--	35%
	Faille Lake (77-0195)	TP	--	14	--	322	23	480	--	19	45	--	70%
Upper Sauk River (0701020203)	Sauk Lake (77-0150-02)	TP		15.2		7,068	301	--	116	69	541	--	40%
Lower Sauk River (0701020205)	Pearl Lake (07-0037)	TP	--	--	--	648	640	--	--	51	71	--	25%

Table 12: Allocation summary for all completed lake TMDLs in the Sauk River Watershed

HUC-10	Stream/Reach (AUID)	Pollutant	Flow Zone	***E. coli* Allocations (billions organisms/day) Sediment Allocations (tons/year)**				Percent Reduction
				Wasteload Allocation		Load Allocation	MOS	
				WWTFs	Regulated Stormwater (CSW/ISW/MS4)	Watershed Load	Margin of Safety	
Middle Sauk River (0701020205)	Getchell (562)	TSS	Very High	--	0.473*	27.48	1.46	0%
			High	--	0.147*	7.25	0.28	26%
			Mid	--	0.074*	2.54	0.16	0%
			Low	--	0.05*	1.08	0.04	0%
			Dry	--	0.038*	0.39	0.02	0%
	Un-named (542)	TSS	Very High	--	0.036	2.32	0.07	95%
			High	--	0.016	1.05	0.01	65%
			Mid	--	0.012	0.73	<0.01	44%
			Low	--	0.01	0.67	<0.01	39%
			Dry	--	0.01	0.65	<0.01	7%
	Stony (541)	*TSS*	Very High		0.099	6.32	0.16	89%
			High		0.027	1.68	0.07	45%
			Mid		0.017	1.08	0.03	35%
			Low		0.006	0.33	0.07	66%
			Dry		0	0.00	0.00	0%
Middle Sauk River (0701020206)	Mill Creek (537)	*E. coli*	Very High	--	--	158	40	59%
			High	--	--	54.8	37.8	68%
			Mid	--	--	29.2	12.0	61%
			Low	--	--	8.51	7.39	84%
			Dry	--	--	1.06	4.51	93%

* Construction Stormwater and Permitted discharger wasteload allocations were combined in TMDL report

2.5 Protection Considerations

Within the Sauk River Watershed there are several impaired water resources and many non-impaired resources. The watershed is also home to several outstanding resources such as wildlife management areas, state forest and preservation areas owned by The Nature Conservancy. These areas provide critical habitat for many species and support various recreational activities.

For the past 40 plus years, local and state efforts have focused on restoring lakes and streams not meeting state water quality standards. However, there are also numerous water bodies, that although currently may meet water quality standards, are threatened by decreased water quality, residential development, increased flooding impacts and invasive species. The SRWD, county SWCDs, NRCS, lake associations and state agencies have been working collaboratively to monitor and assess the biodiversity and ecology of the watershed in a watershed-wide approach (MPCA, 2008).

Moving forward, protection efforts by these entities and other organizations, such as the Friends of the Sauk River, will become increasingly important to protect current water quality conditions and prevent further degradation. Table 13 identifies a preliminary list of protection efforts for the non-impaired water resources within the Sauk River Watershed.

Public awareness is the key factor in protecting and restoring the water resources of the Sauk River Watershed. The SRWD and local agencies continue to pool resources to circulate information to the residents of the watershed. These expanded education efforts use a variety of social media to reach residents of all demographics and have become an important factor in civic engagement efforts. The SRWD, county SWCD and NRCS, and local environmental groups continue to work together to improve the overall level of understanding and awareness to citizens of the watershed approach using the available technology, such as interactive websites and Facebook.

Information access and availability is also important as part of the effort to protect water resources. The SRWD has developed several databases to make data retrieval more efficient. The SRWD's monitoring data will be made available for residents to use on its website and it is currently developing an interactive web-based mapping tool for public use.

Table 13: Protection strategies for non-impaired resources

Parameter	Description	Responsible Party
Septic System Loading	Conduct county-wide septic system inventories and work with watershed residents to address non-compliant or substandard septic system. Support rules and ordinances developed in DWSMA regarding septic systems	MPCA, County Planning and Zoning and SRWD
Groundwater Priority areas	Promote adoption of more protective groundwater BMPs and support protection rules and ordinance in the DWSMA for public water supply areas.	SRWD, Municipalities, MDH, county agencies
Wetlands	Promote wetland restoration and protection by collaborating with federal, state and local agencies to provide technical assistance and financial incentives for landowner participation.	DNR, USFWS, SWCD, SRWD
Stormwater	Promote the revision of land use ordinances to include maximum parking ratio, efficient parking lanes, and grassed over-flow lots. Promote the construction of runoff storage infiltration basins for existing lots that need retrofitting or additional space. Promote the construction, use and maintenance of grit chambers and other filtration systems. Promote early street sweeping and other stormwater BMPs.	Municipalities, county agencies, SRWD
Aquatic invasive species	Develop a plan to assess the presence and density of invasive species within the watershed and develop a plan to prevent the spread of AIS that threatened water resources	DNR, Lake Associations, SRWD
Erosion	Collaborate efforts with County SWCDs/ NRCS, MDA and Environmental Services to work with producers to implement BMPs to address field erosion and/or steam bank erosion. Pursue funding to encourage participation in BMP implementation.	SWCDs, NRCS, SRWD, MDA, county agencies
Agriculture	Collaborate efforts with County SWCDs/ NRCS, MDA and Environmental Services to work with producers to implement BMPs to address agriculture runoff. Promote gridded soil testing to reduce over application of fertilizers, Promote new innovative programs to increase landowner participation.	SWCDs, NRCS, SRWD, MDA, county agencies
Drainage Management	Explore opportunities to provide assistance to landowners within drainage areas to minimize flow volume and agricultural runoff to private and public drainage ditches to reduce impact to receiving waterbodies. Promote the incorporation of BMPs in storm water conveyance systems	SRWD, SWCD, NRCS and municipalities
Riparian / Shoreland	Promote adoption of more protective riparian/shoreland management standards at state and local levels to protect critical habitat and geological sensitive areas. Pursue funding to provide technical and financial incentives to restore riparian areas to a stable state.	DNR, County agencies, SRWD
Civic Engagement/ public outreach	Promote and participate in civic engagement and public outreach efforts. Encourage collaboration and coordination among state and local agencies, conservation groups, special interests groups and residents to strengthen watershed protection efforts. Identify barriers to participation in existing programs and identify strategies to overcome the barriers	State and local agencies, Conservation Groups, lake associations, SRWD
Ordinance/rules	Promote the development and adoption of ordinance and rules to protect water resources from degradation. Work with townships, municipalities and other local agencies to develop protection ordinances and rules that are feasible and enforceable.	State and local agencies, Townships. Municipalities, Conservation Groups, lake associations, SRWD

3. Prioritizing and Implementing Restoration and Protections Strategies

The Clean Water Legacy Act (CWLA) requires that WRAPS reports summarize priority areas for targeting actions to improve water quality, identify point sources and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of such prioritization and strategy development. Because much of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed it is imperative to create social capital (trust, networks and positive relationships) with those who will be needed to voluntarily implement BMPs. Thus, effective ongoing civic engagement is fully a part of the overall plan for moving forward.

The broad restoration and protection strategies presented in this WRAPS report are intended to be further refined and applied by the SRWD and local partners as part of targeted activities for specific subwatersheds. A variety of planning tools will be used to develop more detailed strategies. These restoration and protection efforts will be incorporated in local water plans, the SRWD's comprehensive management plan and applications for state and federal grant funds.

3.1 Targeting of Geographic Areas

A wide variety of tools were available to target geographic areas that are in need of restoration or protection.

Since the three pollutants of primary concern in the Sauk River Watershed are the TP, bacteria, and suspended solids (turbidity), a specific set of tools was used to assess the pollutant loading throughout the entire Sauk River Watershed (Figure 8, Figure 9, Figure 10). The tools that were used in this WRAP report are:

Hydrological Simulation Program – Fortran (HSPF)

- Sediment Load
- TP Load

Watershed Bacteria Production by Source Method

- Bacteria

In addition to the tools used to target protection and restoration areas on a major basin scale (i.e., Sauk River Watershed) others were used on a finer scale in the TMDL process to target specific pollutant loading sources in each impaired watershed. The source assessment and reduction strategies derived from these focused tools are summarized in Table 14. These tools include:

- The Revised Universal Soil Loss Equation (RUSLE)
- Watershed Bacteria Production by Source Method
- In-Lake Nutrient Response Model (BATHTUB)
- Stream Power Index Using Light Detection and Ranging (LiDAR)

The 8-digit HUC area of the Sauk River Watershed is approximately 1,040 square miles and large enough that it can be difficult to manage as a whole. In 2003, the SRWD subdivided the watershed into 10 smaller water management units (MUs) to manage water quality and quantity more efficiently. The 10 MU were established based on population, terrain characteristics, land cover, and drainage patterns in the watershed. The MUs were delineated using GIS mapping and data available in 2003, but may be adjusted somewhat with current Lidar data. While there are similarities between the MUs, each faces a unique set of management issues affecting water resources in the drainage area. Each MU's specific needs are guided by the water quality, hydrologic and hydraulic data collected during the past 25 years as well as scientific studies and modeling efforts.

In 2014, the SRWD completed a watershed-wide HSPF model to target priority 12 digit HUCs within each MU. The Sauk River HSPF model was used to complete a pollutant source assessment for the Sauk River Watershed and to evaluate potential pollutant load reductions to surface waters under multiple resource management scenarios. Model results will be shared with local agencies to develop a collaborative and targeted effort towards water resource protection and restoration.

The following three figures are products of the HSPF modelling. In Figure 8, the model breaks down *E. coli* bacteria production on a sub-watershed basis within the Sauk River Watershed. The areas in dark red indicate the most significant source areas of bacteria production. A few possible sources of this production include riparian pastures, surface applied manure, human sewage, or feedlots without runoff controls. Possible practices to incorporate in these areas might be riparian pasture management, manure management, or feedlot runoff protection.

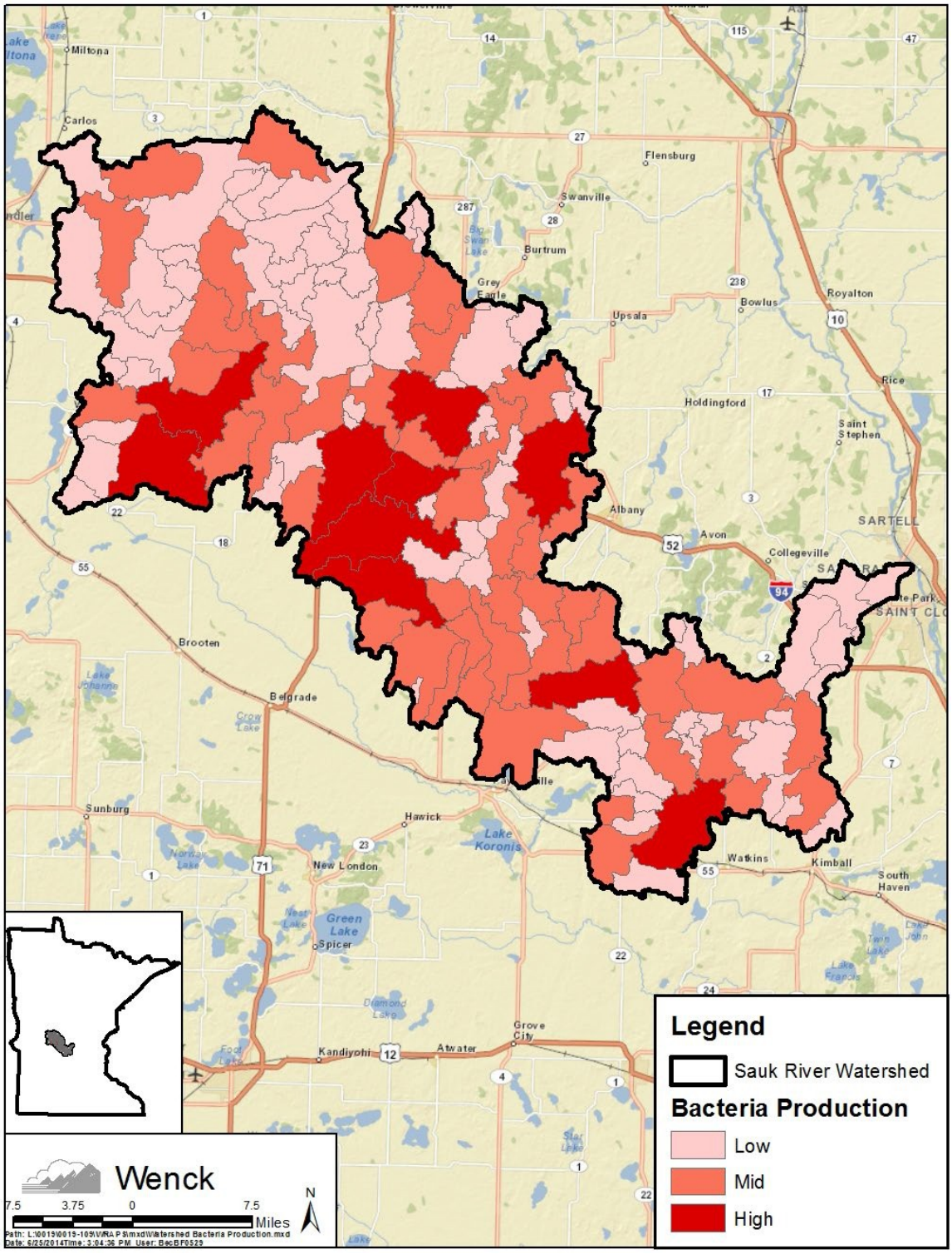


Figure 8: Bacteria production by subwatershed in the Sauk River Watershed

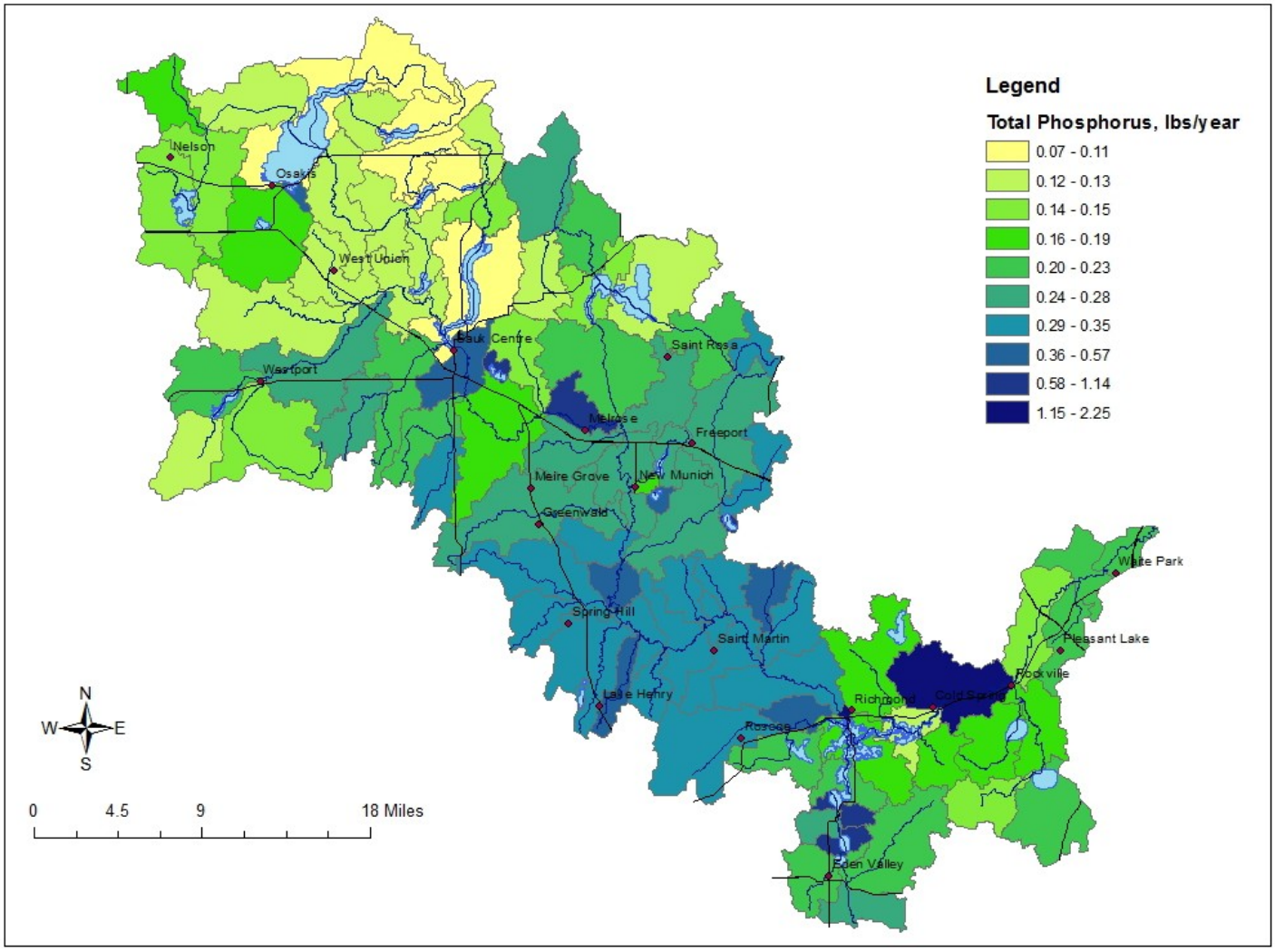


Figure 9: Total phosphorus loading in the Sauk River subwatershed

In Figure 9, the darkest blue areas indicate the most significant sub-watershed level contributors to phosphorus loading. Sources for phosphorus loading include failing septic systems, runoff from agriculture, runoff from fertilized grass lawns, soil erosion, and numerous other areas. The BMPs for these areas might include infiltration basins, improved erosion control, upgrading of septic systems, natural vegetation buffers, iron sand filters, phosphorus- free fertilizers, or stormwater retention.

See also the Minnesota Department of Agriculture (MDA) handbook for more information on nutrient management (http://www.eorinc.com/documents/AG-BMPHandbookforMN_09_2012.pdf).

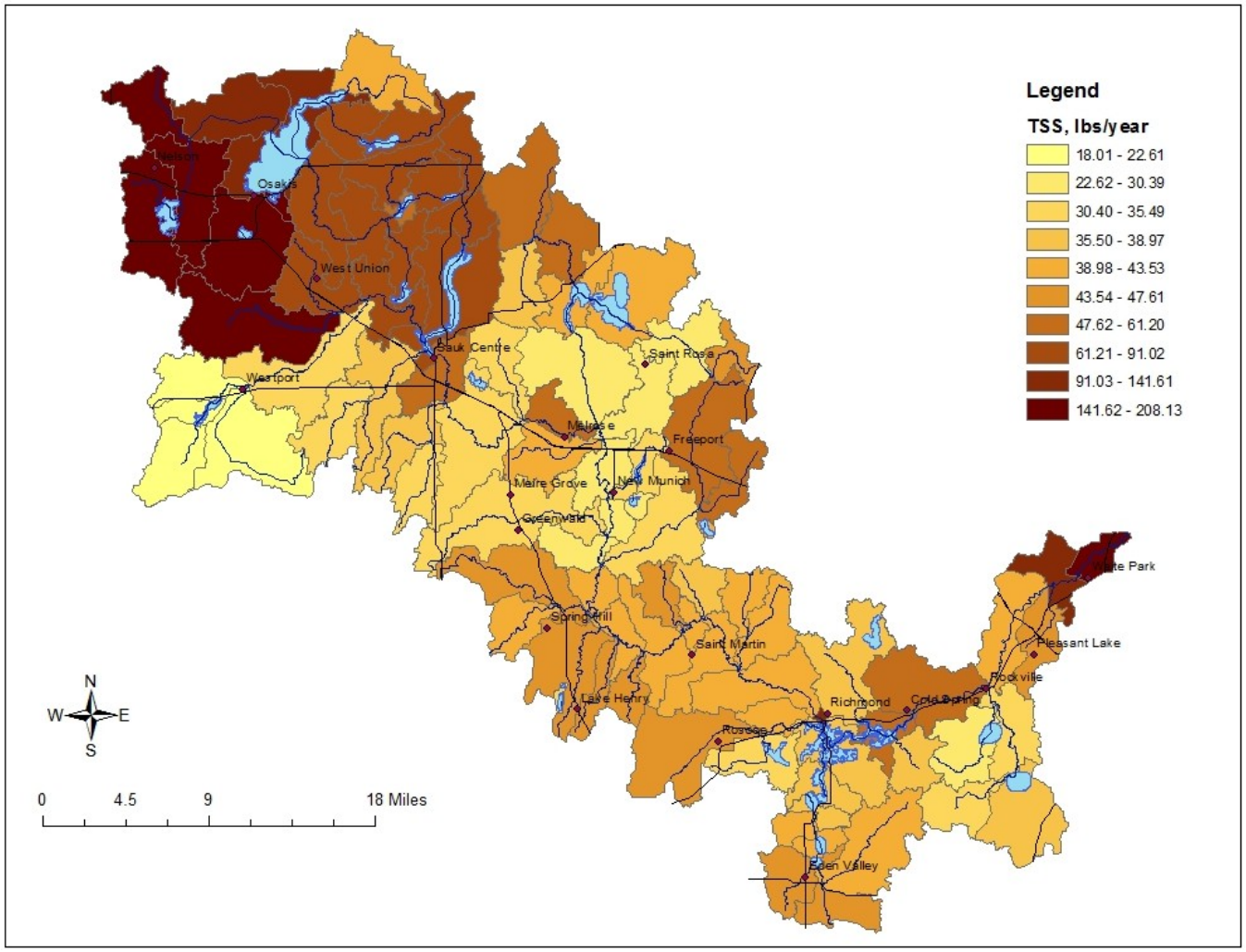


Figure 10: Sediment loading in the Sauk River by subwatershed

Figure 10 above depicts a breakdown of sediment loading concentrations on a sub-watershed basis. Sediment loading contributes to turbidity (often identified as TSS) in surface waters, and the sediment often carries with it nutrients such as phosphorus, or bacteria such as *E. coli*. Concentrated runoff and exposed soils are key contributors to sediment loading, and BMPs to address sediment transport often include native vegetation buffers, "multiple tiered" practices that retain or distribute runoff volumes, and basic erosion control practices.

See the MDA Handbook for more information on agricultural BMP (http://www.eorinc.com/documents/AG-BMPHandbookforMN_09_2012.pdf).

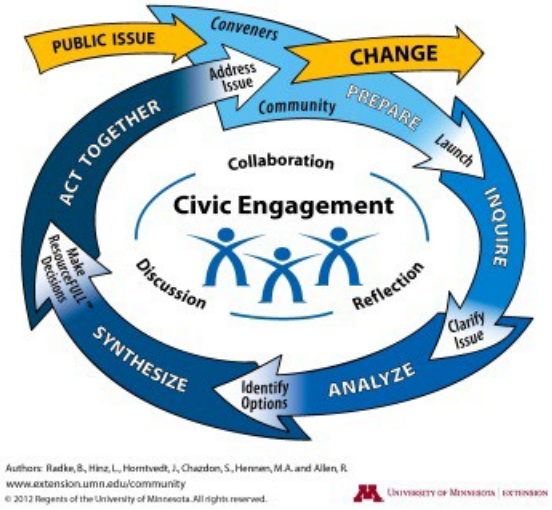
Table 14: Tools for prioritizing and targeting watershed restoration efforts

Tool	Description	How can the tool be used?	Notes	Analysis Scale
Hydrological Simulation Program – FORTRAN (HSPF) Model	Simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land. Typically used in large watersheds (greater than 100 square miles).	Incorporates watershed-scale and nonpoint source models into a basin-scale analysis framework. Addresses runoff and constituent loading from pervious land surfaces, runoff and constituent loading from impervious land surfaces, and flow of water and transport/ transformation of chemical constituents in stream reaches.	Local or other partners can work with MPCA HSPF modelers to evaluate at the watershed scale: 1) the efficacy of different kinds or adoption rates of BMPs, and 2) effects of proposed or hypothetical land use changes.	Impaired watershed Scale
Watershed Bacteria Production by Source	Uses literature rates and available data/estimates of all known bacteria sources in the watershed to calculate total watershed bacteria production. Bacteria sources for this assessment include: wildlife (primarily birds and deer), feedlot and livestock, total septic systems and estimated failure rates, wastewater treatment facility effluent, and pet populations for urban areas.	This tool helps estimate the total amount of bacteria produced in a given watershed or subwatershed. On a large watershed scale, results are helpful in identifying subwatersheds with higher rates of bacteria production to focus monitoring efforts and potential BMPs.	Bacteria production analysis was originally developed to aid TMDL source assessment for the Ann River and Snake River Watershed *E. coli* impaired reaches. This analysis was extended to include all Snake River sub-watersheds (non-impaired reaches) for use in the WRAPS report.	Impaired watershed Scale

Tool	Description	How can the tool be used?	Notes	Analysis Scale
Revised Universal Loss Equation	RUSLE predicts the long term average annual rate of erosion on a field slope based on rainfall pattern, soil type, topography, land use and management practices.	This model provides an assessment of existing soil loss from upland sources and the potential to assess sediment loading through the application of BMPs	It is important to note that model results represent the maximum amount of soil loss that could be expected under existing conditions and have not been calibrated to field observations or observed /monitored data.	Subwatershed Scale
BATHTUB Model	Simulates average total phosphorus, chlorophyll-a and Secchi depth for deep and shallow lakes.	The tool can be used to estimate changes in water quality based on changes in external and internal nutrient loading.	The models can be used for future lake planning to assess changes in land use and nutrient loads.	Individual Lake Scale
Terrain Analysis	Terrain analysis using Light Detection and Ranging (LiDAR) data or Stream Power Index (SPI) in a geographic information system (GIS) to identify and prioritize geographic areas that may be contributing disproportionate sediment and nutrient loads to adjacent water bodies.	General mapping and analysis of elevation/terrain. These data have been used for: erosion analysis, water storage and flow analysis, siting and design of BMPs, wetland mapping, and flood control mapping. A specific application of the data set is to delineate small catchments. The stream power index analysis can identify and prioritize geographic areas that may be contributing sediment by means of stream bank erosion.	SPI focused on areas near (<500 feet) the main-stem channel and major tributary channels since flow erosion from these areas are more likely to effectively deliver sediment to the impaired reach. LiDAR data is available on the MN Geospatial Information website for most counties.	Impaired Watershed Scale

3.2 Civic Engagement

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term "public participation" in that civic engagement encompasses a higher, more interactive level of involvement. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." A resourceFULL decision is one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: http://www1.extension.umn.edu/community/civic-engagement/



As a part of this WRAPS process, a public comment period on the draft WRAPS was held from January 20, 2015, to February 19, 2015. Comments that were received were addressed with changes to the draft document.

Accomplishments and Future Plans

The SRWD has a vigorous, ongoing education and outreach program. Other local organizations within the watershed have been successfully interacting and engaging with citizens throughout the watershed, such as the Central Minnesota Water Education Alliance (CMWEA). Watershed District staff collaborates with CMWEA and other local groups and organizations to expand its ability to inform the public on various water quality topics.

One example of this collaboration is the annual water festivals. Each year, seven water festivals are held throughout the Sauk River Watershed. These water festivals are hosted by local SWCDs, lake associations, municipalities, county agencies, private businesses and the SRWD. Presenters for each event are very diverse, such as the DNR, county public works, well drillers, master gardeners and the Minnesota Science Museum to name a few. The purpose of the festivals is to teach fourth grade students about water: 1) what it is and how it fits into the hydrologic cycle; 2) its importance to all life; 3) how it relates to other natural resources; and 4) how human activities affect water quality and quantity. Students attend numerous learning stations, play games, interact with hands-on activities, make giant bubbles and participate in many other fun events, all while learning about our most valuable resource – *water!*

The SRWD Citizen Advisory Committee (CAC) is also a diverse group of participants. The CAC is made up of interested landowners, lake association members, SWCDs Board Supervisors and staff, and county commissioners. The CAC meets quarterly to discuss activities and issues within the watershed. The CAC's discussions and recommendations are presented the SRWD Board of Managers to aide in decisions for projects and funding.

An innovative approach to educating the youth of the Sauk River Watershed has been established by the SRWD. Offering hands-on activities provides students of all age's opportunities to learn about water quality in the classroom as well as the outdoors. Outdoor classroom sessions, and classroom visits with the Districts "Education Kits" are a few examples of the SRWD efforts to involve the youth in protecting water quality. Outdoor activities have proven to be the most effective in creating memorable moments for area students. Students have pointed out to SRWD staff what they remember from their previous outings while attending another class at the next grade level.

Information has been shared with the adult community through workshops and various forms of media on the importance of protecting water quality. Information regarding rain gardens, shoreland restoration, septic maintenance and stormwater has been presented at community education classes, mass mailings and through local newspapers. Brochures and pamphlets on specific topics were handed out at the local county fairs and other public events, such as the "Family Fun Night" in Sauk Centre. Additional activities include the following:

- The SRWD staff presented at lake association meetings throughout the Sauk River Watershed. Shoreland restoration, stormwater retention and rain gardens were topics of discussion as well as the ongoing TMDL studies.
- Rain garden demonstration sites were installed in the cities of Cold Spring and Rockville as part of a "Rain Garden Initiative", which was designed to give residents hands on experience to see firsthand how stormwater runoff can be retained and support a flower garden. In addition, shoreland maintenance workshops, such as prescribed burns, were held at two demonstration sites (installed in previous years) to explain how restoration projects need to be burned to remove old growth and to rejuvenate plant species.
- The SRWD has worked with Minnesota Extension and Central Minnesota Water Education Alliance to encourage the general public to participate in "Backyard BMPs" by presenting at community education classes.

- Staff from the SRWD attended annual Irrigators Association conferences held in Sauk Centre, Prairie Lakes Coop conferences and MN Dairy Association annual meeting. Display boards were set up at each conference to encourage producers to protect groundwater and surface waters as part of their farming practices
- The SRWD created an Educational Catalog and 750 copies were distributed to schools showcasing programs, materials, and activities available as resources to area schools. There are 73 public and private schools in the District. In 2013 the SRWD had direct, in-class room programming with 53 out of the 73 schools (72% of the District's schools participate). These in-class sessions give schools the opportunity to provide environmental education opportunities that many school districts are not able to afford on their own. The SRWD staff provides teachers with lesson plans, materials, and other interactive information.
- To recognize citizens within the Sauk River Watershed who have demonstrated outstanding stewardship efforts, the SRWD established the R.I.V.E.R. award. The award stands for Residents Improving Valuable Environmental Resources. Each year the Board of Managers selects a recipient based on the BMP project and its benefits to water quality. The SRWD has a "Wall of Fame" displaying the award winners. Press releases are also submitted to the local media outlets for each R.I.V.E.R. award recipient.
- A summer tour is held each year in the Sauk River Watershed to give local decision makers, legislators and the general public an opportunity to learn about conservation projects the SRWD has completed as well as water quality concerns that need to be addressed.

The SRWD Board and staff participate annually in Legislative Days at the Capitol. The Board of Managers and the Administrator meet with legislators and distribute information about the SRWD's programs and activities conducted to all eleven legislators that have jurisdiction within the District.

Thelen Consulting was contracted by the SRWD to help the District increase its public relations and to improve public awareness of the Sauk River and its water quality concerns. Thelen Consulting developed the SRWD campaign concept "wave makers" and has been approved by the SRWD's Board. The next step is to determine campaign participants and budget.

The SRWD also collaborates with two local radio stations (KASM and KEYL) to host air time once a month to discuss important water quality topics as an effort to reach a larger audience. Each session is held for approximately 30 minutes. Staff discussed surface and groundwater concerns and how pollutants from runoff impact our water resources. Available financial assistance is also discussed. Periodically local

agencies, such as the Stearns and Todd County Soil and Water Conservation Districts, present on these radio stations to inform the public of their conservation program and practices as well as upcoming events.

Future Activities:

The SRWD staff is working on the new website which will have interactive maps and information to better serve the public. Staff will continue these efforts and will work to enhance public relations through other social media such as Facebook and a watershed district blog.

Education and public outreach is a core function of the District. The SRWD's 3rd generation Comprehensive Management Plan (2014-2023) will expand its current Education and Outreach Program to continue to raise awareness of the District, what it does and what it can do.

Additional emphasis will be placed on:

- Providing education for decision-makers, developers and real estate agents about water resource issues;
- Partnering with other agencies such as the county SWCDs to provide targeted education for producers focused on the value of undertaking BMPs such as manure management, livestock exclusion, etc.;
- Developing and conveying information about the economic value of BMPs; and
- Continuing and expanding relationships with lake associations, sportsman's groups, and other groups with an interest in preserving and improving water quality.

Public Outreach Partners:

- Stearns, Todd, Douglas, Pope and Meeker County SWCDs and NRCS
- Stearns County Environmental Services
- Todd County Planning and Zoning
- Doulas County Land and Resource Management
- Minnesota Extension Service
- CMWEA
- Friends of the Sauk River

- Osakis, Big Sauk Lake, Big Birch, Little Birch, Sauk River Chain of Lakes Associations
- Osakis Sportsmen's Club
- Pheasants Forever – Stearns County Chapter
- Ducks Unlimited
- DNR
- St. Cloud State University
- Cities of Sauk Centre, Melrose, Freeport, Richmond, Cold Spring, Rockville, and St. Cloud

Partner activities:

Over 60% of the Sauk River Watershed is located in Stearns County. The Stearns County SWCD is very active in the watershed conducting education and outreach activities. The Stearns SWCD is involved in field tours and demonstrations, one-on-one landowner visits and hosts its annual "Breakfast on the Farm" which brings producers together to discuss conservation and protection of our natural resources. This event helps increase agricultural awareness and spread a positive message about food and fiber producers to the general public.

The Stearns SWCD also oversees two innovative programs that are focused in the Sauk River Watershed. The first program is the Conservation Marketplace Midwest (CMM). This program works with area residents to install conservation BMPS to benefit water quality and receive financial benefits as well. The mission of the CMM is to "create measurable ecological and social uplift by establishing new economic opportunities to advance conservation efforts." This program provides a market-based system that connects buyers and generators of ecosystem service credits.

In 2013, the middle Sauk River Region was selected by the state to host a pilot project for the new Minnesota Ag Water Quality Certification Program. The Stearns County SWCD is working with state agencies to test-run this new program in "dairy country," also known as the heart of Stearns County's agricultural industry.

The Stearns County SWCD is coordinating a Discovery Farm research project in collaboration with the MDA and the SRWD. Discovery Farms is a farmer-led effort to gather field scale water quality information from different types of farming systems, in landscapes all across Minnesota. The mission of the Discovery Farms program is to gather water quality information under real-world conditions. The goal is to provide practical, credible, site-specific information to enable better farm management.

Todd County makes up the northern portion of the Sauk River Watershed. The county planning and zoning and SWCD staff have been active in lake association meetings discussing lakeshore concerns, annual feedlot meetings and township meeting promoting cost share programs and SWCD services and newsletters. Extra efforts were made to reach out to the Amish community to discuss conservation efforts on their farms and animal waste management near water bodies. Todd County SWCD hosts its annual youth education event for students in 4th through 6th grade. The event is held on a local farm to give students hands-on experience in soil and water conservation.

The upper northeast corner of the watershed is located in Douglas County. The Douglas County SWCD, NRCS and Land and Resource Department are very active in lake protection efforts. Each year, these agencies and the Douglas County Coalition of Lake Associations host the "Awake the Lake" education event to build awareness for water quality concerns and emerging issues. The group also hosts its annual Kids Groundwater Fest, an interactive education event for fourth and fifth graders to learn about the importance of clean water.

The Pope County portion of the Sauk River Watershed is heavily agricultural and has several large livestock operations. The Pope County SWCD and NRCS have been active in addressing nutrient runoff concerns and groundwater concerns through several cost share programs and education efforts. The Pope SWCD operates the Rosholt Research Farm near the city of West Port to conduct soil and water research. Information gathered here, such as fertilizer application rate BMPs, is shared with local producers and organizations. The SWCD also offers nitrate testing clinics to local residents to help monitor and protect local drinking water supplies. Pope County SWCD is also active in school education programs, such as the annual water-fest for area fourth graders to learn about water conservation and protection.

Meeker County is the smallest (1.4%) and southern-most portion of the watershed; however, it has a very active agricultural community and includes a portion of the City of Eden Valley. The Meeker County SWCD and NRCS have been active in educating local producers about conservation practices and their long term benefits for water quality.

Friends of the Sauk River is a nonprofit organization whose mission is to improve, protect, and promote enjoyment the natural resources of the Sauk River Watershed. The Friends of the Sauk River actively participates in area water festivals and have adopted a portion of the Sauk River in the St. Cloud area for clean-up. The group hosts area paddling events to promote these resources.

The CMWEA is a coalition of central Minnesota cities, counties and other organizations that provide educational outreach to promote water quality stewardship. The CMWEA develops and implements educational programs that encourage local residents to protect water resources. The Rain barrel initiative is one example of the education programs developed by CMWEA.

Future plans:

Throughout the planning process for the Sauk River Watershed District's third Generation Comprehensive Management Plan, local agencies and organizations were brought to the table to determine roles and responsibilities of each group to achieve the goals and objectives of the 10 year Plan. The new Plan focuses on the need to address the load allocations of current TMDLs and future TMDL allocations. In addition, the local partners will be teaming up to keep the local citizens engaged and informed in this WRAPS implementation process. Additional training may be required for District staff and local organization staff members to provide strong leadership in civic governance.

3.3 Restoration & Protection Strategies

The CWLA requires that the WRAPS report summarize priority areas for targeting actions to improve water quality, identify point sources and identify nonpoint sources of pollution with sufficient specificity to prioritize and geographically locate watershed restoration and protection actions. In addition, the CWLA requires including an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources.

This section of the report provides the results of such prioritization and strategy development. Because much of the nonpoint source strategies outlined in this section rely on voluntary implementation by landowners, land users and residents of the watershed it is imperative to create social capital (trust, networks and positive relationships) with those who will be needed to voluntarily implement best management practices. Thus, effective ongoing civic engagement is fully a part of the overall plan for moving forward.

The Sauk River HSPF modeling efforts completed in 2014 will assist the SRWD and local partners to prioritize targeted areas to protect and restore water resources. The HSPF model evaluated potential pollutant load reductions to surface waters under multiple management scenarios.

The SRWD, SWCDS and other local agencies will use this information to target future conservation BMP efforts. Examples of these protection and restoration strategies are described below.

Protection Strategy Examples:

Within the Sauk River Watershed, all new development, industrial, and construction project proposals will be designed to maintain or improve upon existing hydrologic conditions and pollutant loadings and fully comply with the SRWD and local government authorities, National Pollutant Discharge Elimination System (NPDES), and anti-degradation requirements. Rural residential, commercial, industrial, and urban development projects will be reviewed with respect to water treatment requirements to protect the environment. As redevelopment occurs, areas with little or no treatment, including street or highway reconstruction, will be evaluated for inclusion of erosion control or stormwater BMPs. The SRWD will work in partnership with the local communities and developers to manage pollutant loads and volume reduction on development and redevelopment projects.

The agricultural land drainage networks within the Sauk River Watershed will undergo an evaluation for the purpose of nutrient reduction in runoff. This assessment will explore the feasibility of reducing the velocity of flow in agricultural drains and ditches to allow particulate nutrients an opportunity to settle out. The use of nutrient traps or settling basins along drains will be explored to determine their effectiveness in reducing nutrient loading. This activity will include a review of the feasibility of acquiring marginal land and constructing new wetlands, or restoring existing wetland areas that could serve as natural filters for drainage water.

Restoration Strategy Examples

Areas within the watershed with high numbers of livestock operations will be evaluated. Landowners having drainage from confined livestock areas will be encouraged to direct runoff to retention basins, grassed buffer strips, constructed wetlands, or other recommended nutrient-reduction feature. Manure accumulated in confined holding areas should be regularly removed and applied to crop or pasture lands during appropriate seasons and at appropriate agronomic rates. Other “manure management” planning, such as specifying nutrient rate limits, setback distances to surface waters, and use of designed facilities and techniques for storing and transport of manure may be utilized. Livestock producers will be encouraged through enhanced incentives, education, and (when required) regulations to implement measures to protect riparian areas and waterways, such as managing livestock access in riparian areas and providing off-site watering structures. Agriculture extension programs, as well as other partnership programs, will be used to help agricultural producers assess the environmental risk of their operations. The programs will also be used to provide advice on how to prevent the contamination of groundwater and surface water.

The SRWD will develop additional strategies that promote and support annual soil testing to provide agricultural producers with the tools necessary to make sound agronomic, economic, and environmental decisions. Consider incentives for agricultural producers to conduct soil testing and manure testing. Work with the local SWCD and NRCS offices to enhance education on the economic and environmental benefits of soil and manure testing.

Develop a focused educational campaign to provide guidance to homeowners on how to properly maintain septic systems and how to recognize when they are failing. Encourage the local governing agencies to conduct mandatory inspection of private sewage treatment systems at the time of sale. The sale of the property would be conditional on a properly functioning system. Explore funding options to recover the costs of conducting an ongoing comprehensive septic system field inspection program and maintaining a septic system database

Incentive program

The SRWD is committed to water quality and has taken many steps to improve the water quality of the lakes and streams within the Sauk River Watershed. The SRWD's incentive program was set up in 1995 to allow watershed residents/landowners to receive a financial benefit by participating in resource conservation and enhancement efforts. By "sharing the cost", landowners can undertake projects they could not afford to do on their own. The District's incentive program offers cost share funding (grant dollars) and State Revolving Loan Funds (SRF) low interest loans for conservation BMP projects implemented within the SRWD.

Landowners have the option to utilize both funding programs for their project when monies are available. Funds for the incentive program are attained through grant programs offered by the MPCA, Environmental Protection Agency (EPA), the Board of Water and Soil Resources (BWSR) and designated foundations and organizations. Cost share funds are eligible for various types of BMPs. Loan funds are available for individual sewage treatment systems (ISTS). Implementing BMPs is a voluntary effort; thus, offering cost share dollars is an incentive for landowners to make environmental improvements without having to carry the full financial burden on their own.

Emerging issues

Within the Sauk River Watershed there are several emerging issues that can have an impact on water resources. An example of this is the influx of aquatic invasive species (AIS). Curly leaf pondweed and carp infestations are a concern for many lakes within the Sauk River Watershed. The SRWD has worked with the Sauk Lake Association and the City of Sauk Centre for more than 20 years to address the pondweed issue and more recently the carp population. For approximately 20 years, the SRWD has also facilitated a weed

harvesting program using mechanical methods to remove pondweed from Sauk Lake and the lake association has contracted carp removal to reduce bottom mixing which causes phosphorus release from the bottom sediment. The Sauk Lake North Bay TMDL concludes that internal loading is a source of nutrients from decaying vegetation and low oxygen levels. Approximately 70% reduction in internal loading is needed for the lake to achieve state water quality standards.

Endocrine disrupters are another emerging issue that has been identified in surface and groundwater. Endocrine disruptors have potential to affect aquatic species populations and alter communities, change behavior, and even affect human health. The SRWD is working with staff from St. Cloud State University and the University of Minnesota to conduct further research on this issue.

Technology

Technology has improved the ability to assess and predict water quality and quantity using GIS mapping, watershed models and field instruments. In 2005-2006, the SRWD partnered with the Stearns County SWCD to attain LIDAR data for Stearns County. LiDAR data was mapped statewide in partnership between state, federal, county and city governments and academic institutions in Minnesota, and funded by the Clean Water Fund of the Land and Legacy Amendment (Minnesota's elevation mapping project). In 2010, LIDAR data became available for the entire watershed. Using the LIDAR data, GIS mapping and HSPF modeling technology, the SRWD and its project partners are able to target and prioritize implementation efforts to maximize available funding sources.

Example of a protection project

Big Fish Lake, located near Richmond, Minnesota, is one of the pristine lakes in the Sauk River Watershed. In 1999-2001, the SRWD and Stearns County Environmental Services conducted a diagnostic study on Big Fish and Long Lake to assess the current land uses and identify possible nutrient sources. A protection plan was developed to prevent these lakes from becoming impaired. The study showed that groundwater has a direct influence on Big Fish Lake's water quality and quantity. 70% of the shoreline area around Big Fish Lake and 50% of the shoreline around Long Lake has very high sensitivity to groundwater contamination. The research indicated that priority emphasis should be on groundwater quality protection measures. A septic system survey was completed by Stearns County and the non-compliant systems are in the process of being addressed.

Example of a restoration project

Big Birch Lake experienced decreasing water clarity, and increased areas of submerged aquatic vegetation since the early 1970's. The 1994 Diagnostic Study reported a decline in transparency, with the northeast basin being impacted more severely than the main basin. The Big Birch Lake Watershed Management Project developed strong partnerships with local, state and federal agencies as well as citizen organizations and individuals.

The BMP implementation efforts within the Big Birch Lake Watershed such as septic system upgrades, feedlot abatements, buffer strips, wetland restoration have dramatically decreased the in-lake TP concentration by 32+% since the 1994 Diagnostic Study. Local volunteers recorded noticeable improvements in transparency and overall water quality. Area residents have commented to the SRWD regarding the positive changes they have seen in Big Birch Lake's water quality

Continued education regarding lawn maintenance, manure management, septic system maintenance and shoreland protection is ongoing for the residents of Big Birch Lake. As new owners move in, they are provided with educational material by the lake association on how they can enjoy the lake surroundings while minimizing their water quality impacts.

3.3.1 Protection and Restoration Strategy using smaller scale management districts.

The SRWD's second generation comprehensive watershed management plan (2003-2013) subdivided the District into 10 subdrainage areas, or MU reflecting the varied terrain, land cover, and drainage patterns in the watershed. While there are similarities between many of the subdrainage areas, for example, land cover across the watershed is primarily corn-soybean production, each drainage area faces a unique set of management issues affecting water resources.

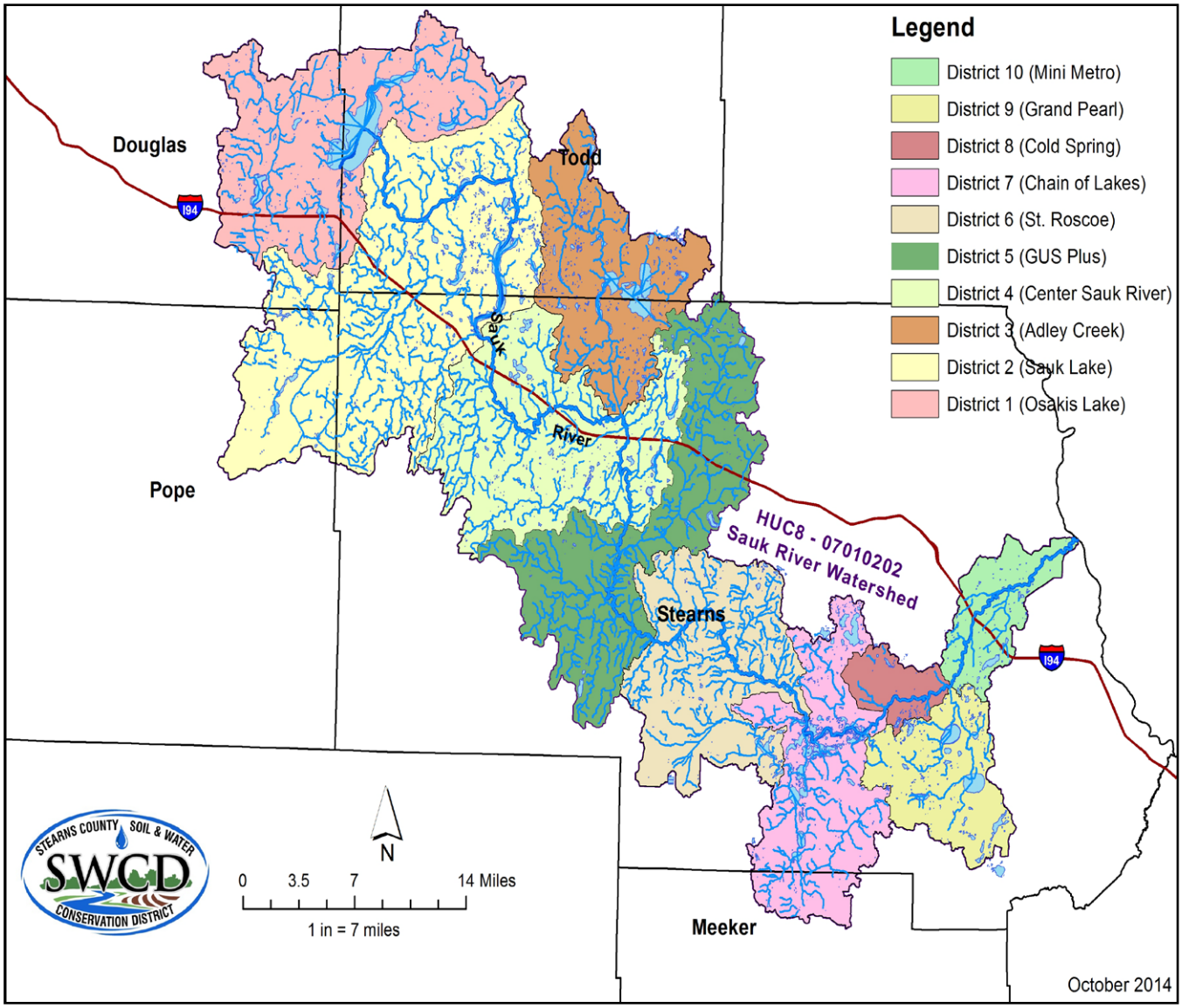
Under the authority of Minn. Stat. § 103D.729, the District has the ability to establish these MUs into Water Management District. This statute enables the District to levy taxes within the Management Unit to pay for programs and projects within that special taxing district. This funding mechanism will be implemented as part of the District's Third Generation Comprehensive Watershed Management Plan (2014-2023).

Table 15 below identifies the 10 MUs, which are shown in Figure 11. The MUs range in size from just over 22 square miles to over 230 square miles. Some of the MUs are rich with water resources – lakes, streams, and wetlands; others, less so.

Table 15: Management Units in the Sauk River Watershed District

Management Unit (MU) Name	MU number	Area (sq mi)
Osakis Lake	1	138.5
Sauk Lake	2	232.2
Adley Creek	3	88.9
Center Sauk	4	136.7
GUS Plus	5	135.1
St. Roscoe	6	107.8
Chain of Lakes	7	94.5
Grand Pearl	8	43.6
Cold Spring	9	22.2
Mini Metro	10	43.3

Figure 11: Sauk River Watershed District 10 Water Management Units



3.3.2 Targeting reduction within Water Management units using subwatershed (HUC12) modeling.

In 2012, a hydrologic and water-quality model of the Sauk River Watershed was developed with HSPF for the MPCA (RESPEC, 2012). In 2013 the SRWD contracted with RESPEC to further enhance this model down to a subwatershed scale, HUC12 (Table 17). The HSPF subwatershed model was calibrated using water-quality monitoring data and meteorological records of the 15-year timespan from 1995 to 2009, incorporating both point and nonpoint source loads.

The 2013-14, HSPF model conducted a pollutant source assessment for the Sauk River Watershed and evaluate potential pollutant load reductions to surface waters under multiple resource management scenarios. Scenarios included resource management changes that could have a positive impact on water quality, as well as options that could potentially be adopted by landowners and municipalities. The model data was analyzed to determine changes to both agricultural and urban areas. Adoption rates were viewed that varied from "achievable" to "aggressive" as well as cumulative results of combining both urban and agricultural changes.

Table 16 shows the reduction potential for each subwatershed under the cumulative (urban and agriculture) aggressive scenario for TP, TN and TSS. Further breakdown of the subwatersheds can be found in the *Sauk River Watershed Pollutant Source Assessment and Evaluation of Resource Management Scenarios* (RESPEC, 2014) report found in appendices.

The SRWD and local partners will utilize the model data to target reduction on a subwatershed basis within each MU.

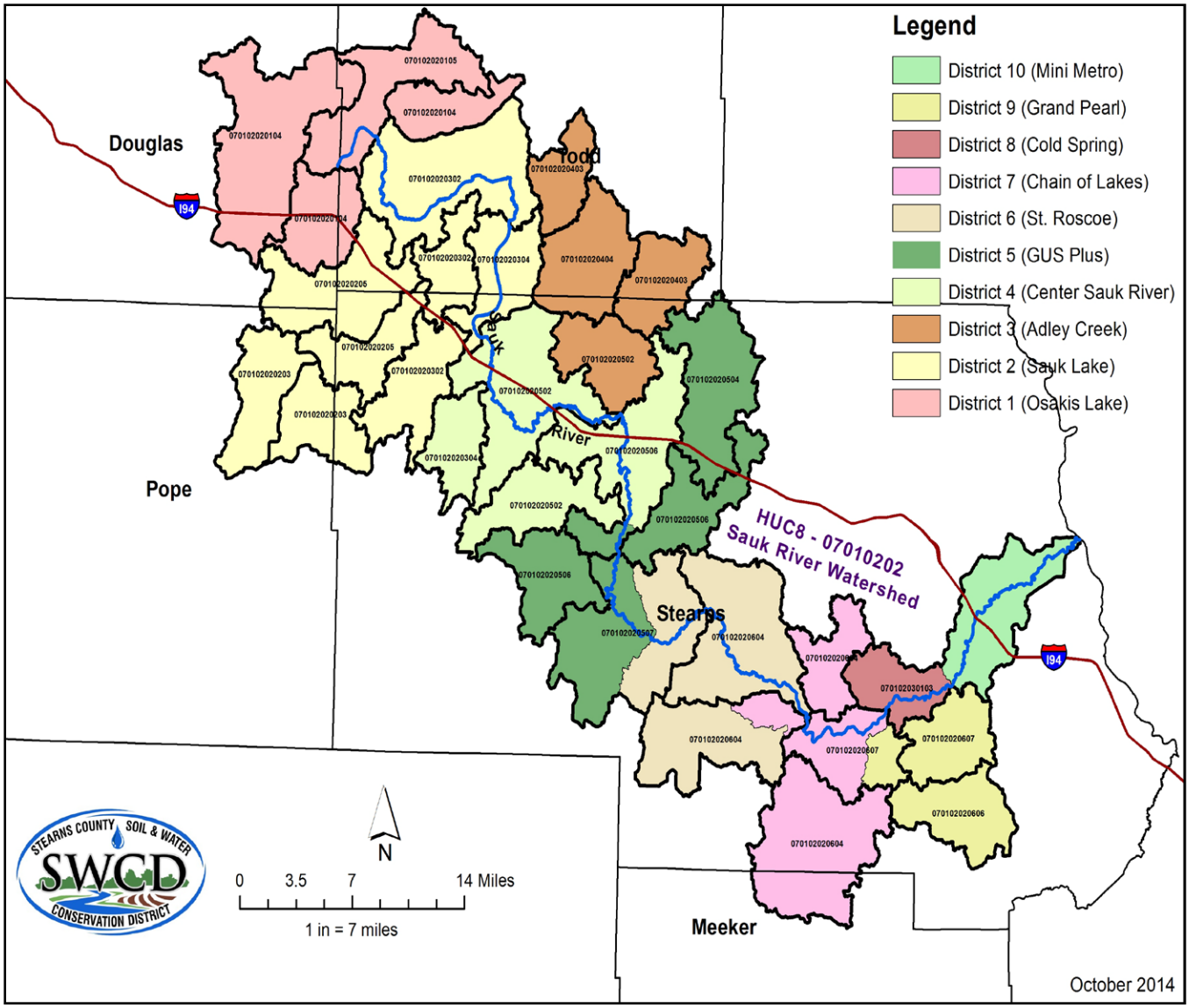
Table 16: Reductions under the Cumulative Aggressive Scenario

Management Unit		Cumulative Aggressive - Reductions						
		Runoff (in/yr)	TN (lbs/ac/yr)	TP (lbs/ac/yr)	TSS (tons/ac/yr)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
1	Osakis Lake	0.11	2.37	0.1	0:02	2.09	0.09	34.07
2	Sauk Lake	0.09	2.61	0.11	0.02	2.46	0.11	37.65
3	Centre-Sauk River	0.12	2.62	0.15	0.02	2.03	0.12	28.73
4	Adley Creek	0.66	5.71	0.38	0.03	3.67	0.24	35.41
5	GUS Plus	0.15	5.34	0.27	0.02	4.03	0..21	34.42
6	Saint Roscoe	0.15	5.57	0.15	0.02	4.43	0.12	37.46
7	Chain of Lakes	0.21	4.91	0..17	0.03	3.88	0.13	42.34
8	Grand Pearl	0.11	3.75	0.12	0.02	3.52	0.12	33.78
9	Cold Spring	2.1	11.82	2:21	0.04	5.2	1.04	33.58
10	Mini Metro	1.96	4.43	0.42	0.07	2.19	0.23	81.54

Table 17: Sauk River Watershed Management Units with 12 Digit Hydrologic Unit Codes (HUC12)

WMU #	Water Management Unit Name	HUC-12 NAME	12 Digit BUC
1	Osakis Lake	Clifford Lake	070102020102
		Osakis Lake	070102020104
		Boss Creek	070102020103
		Crooked Lake Ditch	070102020101
2	Sauk Lake	County Ditch No 3	070102020202
		Sauk Lake	070102020302
		Hoboken Creek	070102020301
		Middle Ashley' Creek	070102020203
		Little Sauk Lake-Sauk River	070102020105
		Lower Ashley Creek	070102020205
		Silver Creek	070102020204
		Upper Ashley Creek	070102020201
3	Adley Creek	Trout Creek	070102020401
		Little Birch Lake	070102020403
		Big Birch Lake	070102020402
		Adley Creek	070102020404
4	Centre Sauk	City of New Munich-Sauk River	070102020).0.2
		Moliter Lake	070102020303
		County Ditch No 44	070102020501
		City of Melrose-Sauk River	070102020304
5	GUS Plus	Lake Henry-Sauk River	70102020506
		Lower Getchell Creek	070102020504
		Stony Creek	070102020505
		Upper Getchell Creek	070102020503
6	St. Roscoe	Kolling Creek	070102020601
		Backes Lake-Sauk River	070102020507
7	Chain of Lakes	Big Fish Lake	070102020603
		Cedar Island Lake-Sauk River	070102020604
		Long Lake .	070102020602
8	Grand Pearl	Mill Creek '	070102020606
		Pearl Lake	070102020605
9	Cold Spring	Sauk River	070102020607
10	Mini Metro	Sauk River	070102020607

Figure 12: Sauk River Watershed 12 Digit Hydrologic Unit Codes (HUC12) within the Management Units



The small scale management tools, MUs and HUC12 (Figure 12) model data, were used to generate the strategy and action plan shown in Table 18. The MUs are HUC12s are prioritized in Table 18 based on protection and restoration needs. The timeline shown in Table 18 reflects the time to achieve the 10 year milestones. This timeframe also coincides with the priority efforts in the SRWD's 10 year Comprehensive Management Plan. Landowner participation and available funding are important factors in achieving each milestone.

Table 18: Strategies and actions proposed for the Sauk River Watershed

HUC-10 Subwatershed	Waterbody and Location: Waterbody	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions	Water Quality: Goals / Targets	Strategies (see key below)	Estimated Scale of Adoption Needed	Sauk River Watershed District	SWCD	County	City	NRCS	MPCA	DNR	Lake Association	Timeline reflects meeting the 10 year milestone*	Interim 10 year Milestones
All	Unimpaired Streams	**All**	Suspended Solids	Varies Average TSS loading range from 18-208 lbs/yr - highest loading found in MU 1,2,5, 9 and10 (Figure 11)	90% of samples ≤25 NTU Watershed ranges from 46mg/L to 120mg/L	Septic System Compliance	Sauk River Watershed Wide With emphasis on MUs 1, 2 5, 9 and 10									2018-2028	lity reduce y 10-
						Feedlot Management		•	•	•							
						Crop and Manure Management		•	•			•					
						Soil Health		•	•			•					
						Streambank Restoration		•	•					•			
						Internal TP Release Reduction											
						Shoreline Protection		•	•	•				•	•		
						Wetland Restoration											
						Roadside Erosion Control			•	•							
						City Stormwater Management		•	•	•	•						
						Channel Restoration		•	•					•			
						NPDES Compliance		•									
						Public Outreach		•									
			E. coli	Bacteria production varies in the watershed, ranging from low to high. Highest bacteria production found in MUs 2, 3, 4, 6, 7 and 8 (Figure 9)	Geometric Mean ≤ 126 org/100 mL Watershed ranges from 3 to > 2600mg/L	Septic System Compliance	Sauk River Watershed Wide With emphasis on MUs 2,3, 4,6,7 and 8.	•		•						2018-2028	Maintain 2014 water quality reduce eve 90% otic rules
						Feedlot Management			•	•		•					
						Crop and Manure Management			•		•						
						Streambank Restoration											
						Internal TP Release Reduction											
						Shoreline Protection		•	•	•				•			
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance							•				
						Public Outreach		•									
			Biologic habitat	Varies	Varies	Septic System Compliance	Sauk River Watershed Wide									2018-2028	nditions abitat along three tributaries to the Sauk River.
						Feedlot Management											
						Crop and Manure Management											
						Streambank Restoration											
						Internal TP Release Reduction											
						Shoreline Protection		•	•	•				•	•		
						Wetland Restoration		•	•	•				•			
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration		•	•					•			
						NPDES Compliance											
						Public Outreach		•									
All	Unimpaired	**All**	Nutrients	Varies	Varies	Septic System Compliance	Sauk River	•		•							Maintain 2014 water quality

HUC-10 Subwatershed	Waterbody and Location (ID)	Waterbody and Location Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Strategies (see key below)	Estimated Scale of Adoption Needed	Sauk River Watershed District	SWCD	County	City	NRCS	MPCA	DNR	Lake Association	Timeline	Interim 10 year Milestones
	Lakes			Lakes that are not impaired in the Sauk River watershed have an average TP concentration of <40ug/L. These lakes have smaller watersheds. i.e. Big Fish Lake, Big Birch, Little Birch Lake & Lake Sylvia	Summer average Of 40ug/L or less for deep lakes and 60ug/L or less for shallow lakes.	Feedlot Management	Watershed Wide MUs 3, 7 and 9 include the majority of the lakes not impaired for nutrients.	•	•			•					greater
						Crop and Manure		•	•			•					
						Streambank Restoration		•	•				•				
						Internal TP Release Reduction		•	•	•				•	•		
						Shoreline Protection		•	•	•				•	•		
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									
All	Impaired Lakes without TMDLs	**All**	Nutrients	Within the Sauk River watershed there are several lakes that are impaired that are pending an approved TMDL. These lakes are located in MU 1 ,2, 4, 5 and 6	Summer average Of 40ug/L or less for deep lakes and 60ug/L or less for shallow lakes	Septic System Compliance	Impaired lakes pending an approved TMDL are located in MU1(070102020103) MU2(070102020105 & 070102020201), MU4 (070102020302 & 070102020304), MU5 (070102020502 & 070102020504) and 6 (070102020506). Efforts will focus in the listed HUC12 subwatersheds.	•		•						2016-2026	
						Feedlot Management		•	•			•					Reduce TP concentrations by 10% or greater in 10 years.
						Crop and Manure		•	•			•					
						Streambank Restoration		•	•				•				
						Internal TP Release Reduction		•	•	•				•	•		
						Shoreline Protection		•	•	•				•	•		
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									
All	Impaired Streams without TMDLs	**All**	Suspended Solids	Within the Sauk River watershed there are few streams that are impaired for turbidity that are pending a TMDL study. Most of these streams are located in MU 1 and 10	90% of samples ≤25 NTU	Septic System Compliance	Impaired streams are located in the following subwatersheds (HUC12) 070102020102, 010702020101 and 070102020607									2016-2026	
						Feedlot Management		•	•	•							
						Crop and Manure		•	•			•					
						Streambank Restoration		•	•					•			
						Internal TP Release Reduction											
						Shoreline Protection		•	•	•				•	•		
						Wetland Restoration											
						Roadside Erosion Control			•	•							
						City Stormwater Management		•	•	•	•						
						Channel Restoration		•	•					•			
						NPDES Compliance		•									
						Public Outreach		•									
All	Impaired Streams	**All**	*E. coli*		Geometric Mean ≤ 126 org/ 100 mL	Septic System Compliance		•		•							Reduce E.coli levels by 10- 15% or greater in 10 years.
						Feedlot Management			•	•		•					

HUC-10 Subwatershed	Waterbody and Location: Waterbody	Waterbody and Location: Location and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions	Water Quality: Goals / Targets	Strategies (see key below)	Estimated Scale of Adoption Needed	Sauk River Watershed District	SWCD	County	City	NRCS	MPCA	DNR	Lake Association	Timeline	Interim 10 year Milestones
				Within the Sauk River watershed there are several streams that are impaired for Ecoli, including sections of the Sauk River. These streams are located in MU 1, 2, 3, 4, 5, 6, 8 and 9. TMDL study is pending approval		Crop and Manure Management	Streams Impaired for Ecoli, including sections of the Sauk River are located in MU1(070102020101) MU2(070102020203) MU3(070102020404) MU4(070102020505 & 0701020200502) MU5(070102020504 & 070102020506) MU6(070102020507) MU8 070102020606) MU9(070102020607)		•		•					2016-2026	
						Streambank Restoration											
						Internal TP Release Reduction											
						Shoreline Protection		•	•	•				•			
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance							•				
						Public Outreach		•									
			Biologic habitat	There are several streams with Fish and Invertebrate impairments. These streams still require a TMDL study. More data needed	Varies	Septic System Compliance	Sauk River Watershed Wide									2018-2028	Address biologic habitat in the next 10 years as funding becomes available.
						Feedlot Management											
						Crop and Manure Management											
						Streambank Restoration											
						Internal TP Release Reduction											
						Shoreline Protection		•	•	•				•	•		
						Wetland Restoration		•	•	•				•			
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration		•	•					•			
						NPDES Compliance											
						Public Outreach		•									
Headwaters Sauk River (0701020201)	Lake Osakis (77-0215)	Todd, Douglas	TP	Osakis Lake exceeds state standards for TP with a summer average ranging from 45-65 µg/L for years 2001-2013	Summer TP Mean ≤ 40 µg/L	Septic System Compliance	Contributing Watershed of MU1: 070102020101, 070102020104, 070102020103, 070102020102	•		•						2014-2024	Reduce TP concentrations by 10% or great in the next 10 years. TMDL has been approved and focus will be on the subwatershed 070102020101 for the first 10 years.
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					
						Streambank Restoration		•	•				•				
						Internal TP Release Reduction											
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									
	Smith Lake (21-0016)	Douglas	TP		Summer TP Mean ≤ 40 µg/L	Septic System Compliance	Contributing Watershed	•		•						2015-2025	
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					

HUC-10 Subwatershed	Waterbody and Location (ID)	Waterbody and Location **Location** and Upstream Influence Counties	Parameter (incl. non-pollutant stressors)	Water Quality Current Conditions	Water Quality Goals / Targets	Strategies (see key below)	Estimated Scale of Adoption Needed	Sauk River Watershed District	SWCD	County	City	NRCS	MPCA	DNR	Lake Association	Timeline	Interim 10 year Milestones
				Smith Lake exceeds state standards for TP with a summer average of 49 µg/L		Streambank Restoration	Contributing Watershed of MU1: 070102020101	•	•				•				Reduce TP concentrations by 10% or great in the next 10 years. TMDL has been approved and focus will be on the subwatershed 070102020101 for the first 10 years.
						Internal TP Release Reduction											
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									
	Faille Lake (77-0195)	Todd, Douglas	TP	Faille Lake exceeds state standards for TP with a summer average of 173 µg/L	Summer TP Mean ≤ 60 µg/L	Septic System Compliance	Contributing Watershed of MU1: 070102020102	•		•						2016-2026	Reduce TP concentrations by 10% or great in the next 10 years. TMDL has been approved and focus will be on the subwatershed 070102020102 for the first 10 years.
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					
						Streambank Restoration		•	•				•				
						Internal TP Release Reduction											
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									
Upper Sauk River (0701020203)	Sauk Lake (north bay) (77-0150-02)	Douglas, Pope, Stearns, Todd	TP	Sauk Lake – North Bay exceeds state standards for TP with a summer average of 61 µg/L	Summer TP Mean ≤ 40 µg/L	Septic System Compliance	Contributing Watershed of MU1 and MU2: 070102020101, 070102020104, 070102020103, 070102020102, 070102020105, 070102020105, 070102020302	•		•						2015-2025	Reduce TP concentrations by 10% or great in the next 10 years. TMDL has been approved and focus will be on the subwatershed 070102020105 for the first 10 years.
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					
						Streambank Restoration		•	•				•				
						Internal TP Release Reduction											
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									
Middle Sauk River (0701020205)	Getchell Creek (562)	Stearns	Suspended Solids	Getchell Creek exceeds turbidity standards	Very High: 0% Reduction High: 26% Reduction Mid: 0% Reduction Low: 0% Reduction	Septic System Compliance	Contributing Watershed										
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					
						Streambank Restoration		•	•					•			

HUC-10 Subwatershed	Waterbody and Location (ID)	Location and Upstream Influence	Parameter (incl. non-pollutant stressors)	Water Quality: Current Conditions	Water Quality: Goals / Targets	Strategies (see key below)	Estimated Scale of Adoption Needed	Sauk River Watershed District	SWCD	County	City	NRCS	MPCA	DNR	Lake Association	Timeline	Interim 10 year Milestones
				10% of samples ≥ 25 NTU	Dry: 0% Reduction	Internal TP Release Reduction	MU5, subwatersheds 070102020503, 070102020504									2016-2026	Reduce TSS concentrations by 10% or great in the next 10 years. TMDL has been approved and focus will be on the subwatershed 070102020503 and 070102020504.
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration		•	•					•			
						NPDES Compliance											
						Public Outreach		•									
	Un-named Creek (542)	Stearns	Suspended Solids	Unnamed Creek exceeds turbidity standards 10% of samples ≥ 25 NTU	Very High: 95% Reduction High: 65% Reduction	Septic System Compliance	Contributing Watershed MU5, subwatershed 070102020506									2016-2026	Reduce TSS concentrations by 10% or great in the next 10 years.
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					
						Streambank Restoration		•	•					•			
						Internal TP Release Reduction											
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration		•	•					•			
						NPDES Compliance											
						Public Outreach		•									
	Stony Creek (541)	Stearns	Suspended Solids	Stoney Creek exceeds turbidity standards 10% of samples ≥ 25 NTU		Septic System Compliance	Contributing Watershed MU5, subwatershed 070102020505									2016-2026	Reduce TSS concentrations by 10% or great in the next 10 years.
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					
						Streambank Restoration		•	•					•			
						Internal TP Release Reduction											
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration		•	•					•			
						NPDES Compliance											
						Public Outreach		•									
Lower Sauk River (0701020206)	Pearl Lake (07-0037)	Stearns	TP	Pearl Lake exceeds state TP standards with a summer average of /L 43 µg/L	Summer TP Mean ≤ 60 µg/L	Septic System Compliance	Contributing Watershed of MU8: 070102020605									2015-2027	Reduce TP concentrations by 10% or great in the next 10 years. TMDL has been approved. Focus will be on subwatershed 070102020605 for the next 10 years.
						Feedlot Management											
						Crop and Manure Management			•		•						
						Streambank Restoration											
						Internal TP Release Reduction		•	•				•				
						Shoreline Protection											

HUC-10 Subwatershed	Waterbody and Location		Parameter (incl. non-pollutant stressors)	Water Quality		Strategies (see key below)	Estimated Scale of Adoption Needed	Sauk River Watershed District	SWCD	County	City	NRCS	MPCA	DNR	Lake Association	Timeline	Interim 10 year Milestones
	Waterbody (ID)	**Location** and Upstream Influence Counties		Current Conditions	Goals / Targets												
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									
	Mill Creek (537)	Stearns	Mill Creek is impaired for *E. Coli. Exceeding the*	Very High: 384org/day[1] High: 171org/day[1] Mid:73.8org/day[1] Low: 53.1org/day[1] Dry: 14.8 org/day[1]	Very High: 59% Reduction High: 68% Reduction Mid: 61% Reduction Low: 84% Reduction Dry: 93% Reduction	Septic System Compliance	Contributing Watershed MU8: Subwatersheds 070102020605 070102020606	•		•						2015-2027	Reduce E.Coli levels by 10% or great in the next 10 years. TMDL has been approved. Focus will be on subwatersheds 070102020605 and 070102020606 for the next 10 years. Achieve 90% compliance with state septic rules
						Feedlot Management		•	•			•					
						Crop and Manure Management		•	•			•					
						Streambank Restoration											
						Internal TP Release Reduction											
						Shoreline Protection											
						Wetland Restoration											
						Roadside Erosion Control											
						City Stormwater Management											
						Channel Restoration											
						NPDES Compliance											
						Public Outreach		•									

Key: Red rows = impaired waters requiring restoration; = unimpaired waters requiring protection

[1]Bacteria existing condition load units given in organisms per day

*Timeline reflects the time to achieve the 10 year milestone as addressed in the SRWD"s 10 year Comprehensive Management Plan.

Table 19: Key for Strategies Column

Strategy	Practices (NRCS Code)
Nonpoint Source	
Livestock, pasture and feedlot management	Managed/restricted area fencing (382 and 472), pasture runoff controls, buffers (322/390), heavy use protection-stream crossing areas, alternative watering sources, rotational grazing
Cropland and manure management	Chemical addition to manure, spreading in sensitive areas, soil P testing, nutrient management (590), conservation and reduced tilling methods (329, 345 and 346), sediment and water control structures and basins (350), cover crops (340), grassed waterways, lined waterways and channels, manure runoff control, manure storage facilities (313)
Soil Health	Soil health management planning, cover crops and crop rotation to improve soil health and sustainability.
Septic Systems	Imminent threat to public health and safety (ITPHS) upgrades, septic upgrades in shoreline areas
Streambank restoration	Streambank stabilization (580), re-meanders, habitat improvement
Internal P release (lakes)	Chemical addition to lake sediment to immobilize Phosphorus release from sediment
Shoreline protection	Shoreline protection (580), natural plantings, setbacks
Wetland restorations	Restore degraded and impacted wetlands that may be P source (651)
Roadside erosion control	Flow/erosion control basins near crossings to reduce sediment/flow (638)
Dam/Culvert management	Assess culverts/dams for sizing, retention, fish passage and hydrologic function
Channel Restoration	Stabilize the bed or bottom of a channel for sediment transport or deposition (584)
City Stormwater management	Controlling the quantity and quality of stormwater runoff to minimize erosion and sedimentation (570)
Forestry management	Timber stand improvement (666), early habitat succession (647)
Public Outreach and Civic Engagement	Conduct local public awareness activities through targeted community interaction. Citizens participate in order to improve conditions.
Point Source	
NPDES point source compliance	All NPDES-permitted sources shall comply with conditions of their permits, which are written to be consistent with any assigned wasteload allocations

4. Monitoring Plan

The SRWD will take the lead in monitoring and tracking of the effectiveness of activities implemented to reduce nutrient loading in the watershed. Future monitoring of water quality in lakes and stream within the Sauk River Watershed is necessary to enable assessment of whether progress is being made towards achievement of TMDL goals. Monitoring is also important to improve upon the current understanding of the lake dynamics. A better understanding of the linkages between load sources and lake response will reduce uncertainties associated with model predictions, and allow refinement of load allocations to various sources. This type of effectiveness monitoring is critical in the adaptive management approach. Results of the monitoring identify progress toward benchmarks as well as shape the next course of action for implementation.

4.1 Lake Monitoring

Citizen volunteers will monitor surface water quality and aesthetic conditions biweekly and submit their data to the MPCA's Citizen Lake Monitoring Program. Depending on available funding, each year the SRWD will monitor four to six lakes in the Sauk River Watershed to determine water quality status and compare to historic data.

Lakes in the Sauk River Watershed are monitored bi-monthly 8 times per season (once in May and September, twice in June, July, and August) for chlorophyll-*a*, TP, ortho-phosphorus, total Kjeldahl nitrogen (TKN), temperature, dissolved oxygen, pH, conductivity, and Secchi disk transparency. For lakes indicating thermocline or oxycline conditions, bottom samples are collected and analyzed for ortho-phosphorus and TP. Dissolved oxygen and temperature profiles are completed on all lakes during each sample event. Scheduled in-lake monitoring will continue as implementation activities are installed across the watersheds. These monitoring activities should continue until water quality goals are met.

4.2 Stream and Bacteria Monitoring

River and stream monitoring in the Sauk River Watershed has been conducted largely by the SRWD, with assistance from the MPCA. Stream monitoring will continue throughout the watershed at the established monitoring stations. Sampling should occur bi-monthly from snowmelt through September. As BMPs are implemented throughout the watershed it is also suggested that monitoring take place in those subwatersheds to track progress towards the TMDL. Data collected will build upon the current dataset and track changes based on implementation progress.

Flow monitoring should be done monthly at established sites. Flow data will be used to determine water volume and annual loading. Electronic data loggers should be maintained to capture water elevations to be converted to flow/discharge.

4.3 Biological Monitoring

The MPCA and the DNR will continue to conduct macroinvertabrate and macrophyte as well as fish surveys as allowed by their regular schedule. By continuing to monitor water quality and biota scores in the listed streams determine whether or not habitat restoration measures are required to bring the stream into compliance. Sampling should be conducted by the MPCA, the DNR, or other agencies every five to 10 years during the summer season at each established location until compliance is observed for at least two consecutive assessments.

Currently fish surveys are conducted every 5 years and macrophyte surveys are conducted as staffing and funding allow on a 10-year rotation.

Tracking the implementation of BMPs while continuing to monitor the biological conditions in the watershed will help local stakeholders and public agencies understand the effectiveness of the WRAPS document. If biota scores remain below the confidence intervals, further encouragement of the use of BMPs across the watershed through education and incentives will be a priority.

5. References and Further Information

Barr Engineering, Inc. 2012. Mill Creek and Pearl Lake Nutrients. September 2011.

Minnesota Department of Natural Resources. An Inventory of Minnesota Lakes: Bulletin No. 25.

Minnesota Pollution Control Agency. 2013.Sauk Lake Excess Nutrients TMDL . November 2013. Report wq-iw8-40e.

Minnesota Pollution Control Agency. 2012. Sauk River Watershed Stressor ID Report. August 2012. Report # wq-iw8-38n.

Minnesota Pollution Control Agency. 2011. Sauk River Watershed Monitoring and Assessment Report. September 2011. Report wq-ws3-07010202b

Wenck Associates, Inc. 2010. Getchel, Unnamed, and Stoney Turbidity TMDL. June 2010. Report wq-iw8-27e.

Wenck Associates, Inc. 2013 Lake Osakis Excess Nutrients TMDL. May 2013.

Sauk River Watershed Reports

All Sauk River Watershed reports referenced in this watershed report are available at the Sauk River Watershed webpage: http://www.pca.state.mn.us/enzqde1