Red Lake River

Watershed Restoration and Protection Strategy Report

November 2019

MINNESOTA POLLUTION CONTROL AGENCY

RMB Environmental Laboratories, Inc.

Red Lake Watershed District • Dedicated to Water Management •

CLEAN WATER LAND & LEGACY AMENDMENT

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Project Partners

Minnesota Pollution Control Agency

Red Lake Watershed District

Minnesota Department of Natural Resources

RMB Environmental Laboratories

Pennington County Soil and Water Conservation District

Red Lake County Soil and Water Conservation District

West Polk County Soil and Water Conservation District

Emmons and Olivier Resources

Minnesota Board of Water and Soil Resources

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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/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.

Dissolved Oxygen (DO): DO is the amount of oxygen that is available in the water. DO concentrations are measured in mg/L, in-situ, using DO sensors.

Escherichia Coli (*E. coli*) Bacteria: *E. coli* is a bacterium that is commonly found in the gut of warm-blooded animals. Excess *E. coli* increases the risk of bacterial infections during aquatic recreation.

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 Red River of the North Basin is assigned a HUC-4 of 0902 and the Red Lake River Watershed is assigned a HUC-8 of 09020303.

Impairment: Water bodies are listed as impaired if water quality standards are not met for designated uses that include: 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: Restoration actions are taken in watersheds of impaired waters to improve conditions so that water quality standards are eventually met and beneficial uses of the waterbodies are achieved.

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): "Stressor" is a broad term that includes both pollutant sources and non-pollutant factors (e.g., altered hydrology, fish passage barriers) that adversely affect aquatic life.

Total Maximum Daily Load (TMDL): A TMDL is 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.

Total Suspended Solids (TSS): TSS is a quantification of organic and inorganic solids that are suspended in water. Those solids may be soil particles (sand, silt, clay), plant matter, animal matter, and wastes.

Executive Summary

The Red Lake River (USGS Hydrologic Unit Code 09020303), in northwest Minnesota, begins at the outlet of Lower Red Lake and flows west to the Red River of the North. The Red Lake River Watershed receives drainage from three other major subwatersheds: Upper and Lower Red Lakes, Thief River, and Clearwater River. It flows through the cities of Thief River Falls, St. Hilaire, Red Lake Falls, Crookston, Fisher, and East Grand Forks. It is the source of drinking water for the cities of Thief River Falls and East Grand Forks.

A formal water quality assessment was conducted in 2014 and the results of that assessment were applied to the draft 2016 and 2018 Lists of Impaired Waters. Tables in Section 2 of this report list the waters that are included on the 2018 303(d) List of Impaired Waters, and the current water quality conditions of all streams that met data requirements. The Red Lake River Watershed Total Maximum Daily Load (TMDL) Report addressed 31 impairments of aquatic life and/or recreation that have been found within 19 reaches of the Red Lake River and its tributaries. Turbidity and/or total suspended solids (TSS) impairments were found in six reaches of the Red Lake River between the Pennington County Ditch 96 confluence and the Red River of the North. Impairments due to chronically high concentrations of Escherichia coli *(E. coli)* bacteria have been found along six reaches of Red Lake River tributaries. Impairments due to low dissolved oxygen (DO) levels have been addressed for two tributaries of the Red Lake River. Low index of biotic integrity (IBI) scores have resulted in macroinvertebrate IBI (M-IBI) impairments for seven reaches and fish IBI (F-IBI) impairments for ten reaches along tributaries of the Red Lake River. TMDLs were calculated for reaches that were impaired by quantifiable pollutants (TSS and *E. coli* impairments). Load reduction recommendations were calculated where concurrent flow and sampling data had been collected.

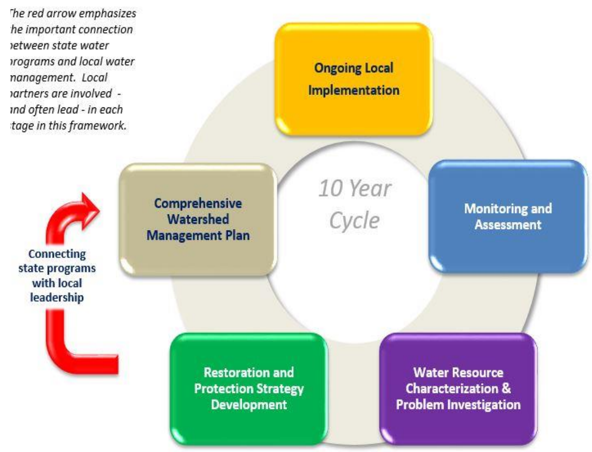
The causes of water quality impairments and threats to other, unimpaired streams, have been investigated and summarized in Section 2 of this report. Protection considerations were contemplated and compiled for unimpaired waters throughout the watershed.

Multiple tools are available for prioritizing and targeting restoration and protection projects. Assessment statistics helped identify and prioritize nearly restored and nearly impaired streams. Spatial analysis of the watershed identified areas that could be contributing pollutants at relatively high rates. Tools like the Soil and Water Assessment Tool (SWAT) model, Hydrological Simulation Program – Fortran (HSPF) model, HSPF-Scenario Application Manager (SAM) tool, stream power index (SPI), and Prioritize Target and Measure Application (PTMApp) have been used to identify areas where implementation of best management practices (BMPs) and other projects should be targeted within the Red Lake River Watershed. The sources of water quality problems were also investigated through direct measurements like longitudinal sampling, a fluvial geomorphology study, and microbial source tracking. Stressor identification (SID) found that insufficient base flow was the most common stressor for aquatic biology and cause of low DO levels within impaired Red Lake River tributaries, and it exacerbated the effects of other stressors.

Strategies were recommended for reducing nonpoint contributions of TSS from the landscape and in stream/ditch channels. Strategies for addressing sources of *E. coli* pollution have been described. Recommendations were also provided for strategies that could improve DO levels, base flows, aquatic habitat, and the quality of aquatic life. This report also includes information about future monitoring plans, cost estimation, and civic engagement strategies.

Efforts were made to inform and involve the public throughout the Red Lake River WRAPS project. Recent civic engagement efforts and plans are described in this document. There is currently excellent cooperation among agencies for project implementation and monitoring. Local organizations are cooperating to implement projects through the Red Lake River One Watershed One Plan (1W1P). Water chemistry and stage/flow data will be regularly collected throughout the watershed by local and state organizations to assess current conditions and track progress.

What is the WRAPS Report?



Minnesota has adopted a watershed approach to address the state's 80 major watersheds. 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, the Minnesota Pollution Control Agency (MPCA) developed a process to identify and address threats to water quality in each of these major watersheds. This process is called Watershed Restoration and Protection Strategy (WRAPS) development. WRAPS reports have two roles: impaired waters have strategies for restoration, and waters that are not impaired have strategies for protection.

Waters not meeting state standards are listed as impaired and TMDL studies are developed for them. TMDLs are incorporated into WRAPS. In addition, the watershed approach process facilitates a more cost-effective and comprehensive characterization of multiple water bodies and overall watershed health, including both protection and restoration efforts. A key aspect of this effort is to develop and utilize watershed-scale models and other tools to identify strategies for addressing point and nonpoint source pollution that will cumulatively achieve water quality targets. For nonpoint source pollution, this report informs local planning efforts, but ultimately the local partners decide what work will be included in their local plans. This report also serves as the basis for addressing the U.S. Environmental Protection Agency's (EPA) Nine Minimum Elements of watershed plans, to help qualify applicants for eligibility for Clean Water Act Section 319 implementation funds.

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:
    - *Red Lake River Watershed Monitoring and Assessment*
    - *Red Lake River Watershed Biotic Stressor Identification*
    - *Red Lake River watershed Fluvial Geomorphology Report*
    - *Red Lake River Watershed One Watershed One Plan*
    - *Red Lake River Watershed Total Maximum Daily Load*

Scope

- Impacts to aquatic recreation
- Impacts to aquatic life in streams

Audience

- Local working groups (SWCDs, Watershed Districts, etc.)
- State agencies (MPCA, DNR, BWSR, etc.)
- Local leaders and decision makers
- Concerned and motivated citizens

The watershed-based strategy recognizes the connectivity of the watershed better than the former reach-by-reach system. An impairment may extend over multiple assessment units. Impairments for different parameters may be linked by common stressors and/or pollutants. The stakeholder process is also helped through this strategy. Not only is there an increased emphasis on civic engagement, but the process also avoids the redundancy that could occur when addressing TMDLs with a reach-by-reach strategy. The watershed-based, comprehensive implementation plan will be more useful and effective because it will address pollutant sources and stressors throughout the watershed. It will also reduce the complexity of incorporating TMDL implementation plans into watershed management plans.

The Red Lake River WRAPS process was conducted in close coordination with the Red Lake River 1W1P process. A significant amount of information and goals are shared among the 1W1P, TMDL, and WRAPS documents. The majority of the content of the Red Lake River WRAPS Report is organized within four sections.

1. Watershed Background and Description

This section provides a description of the watershed to familiarize the reader with watershed features and issues. It also contains some information about the history of the watershed and findings of previous water quality studies.

2. Watershed Conditions

This section includes detailed water quality assessment results from the 2014 assessment (2004 through 2014 data). Water quality trends were also calculated and some strong trends were revealed. The current impaired waters are identified and TMDL summaries are included in this section. This section provides guidance for addressing stressors and sources of pollutant sources for all subwatersheds, regardless of impairment status. The results of investigative monitoring efforts are also described.

3. Prioritizing and Implementing Restoration and Protection

This is, arguably, the most important section of the report. In recent years, multiple water quality models have been used to identify the areas of the watershed that are contributing the most significant quantities of pollutants. SPI modeling and Minnesota Department of Natural Resources (DNR) Pollutant Source Identification analysis pinpointed locations that are need of repair or protection. A geomorphological assessment of the watershed provided recommendations for implementation efforts throughout much of the watershed. State and local staff collaborated to compile lists of potential projects that could be completed to address water quality restoration and protection needs. The lists of projects are organized into tables for the entire watershed and for each HUC-10 subwatershed.

4. Monitoring Plan

This section provides a detailed summary of monitoring site locations (flow, water quality, etc.). It also provides a description of data collection goals.

1. Watershed Background & Description

The Red Lake River Watershed is a 909,024-acre HUC-8 watershed in northwestern Minnesota. The watershed covers portions of Beltrami, Clearwater, Marshall, Pennington, Polk and Red Lake counties and flows through (or near) the cities of Thief River Falls, St. Hilaire, Red Lake Falls, Crookston, Fisher, and East Grand Forks. The watershed falls within the jurisdiction of multiple LGUs, including the respective local counties and SWCDs, the Red Lake Watershed District (RLWD), and the Red Lake Nation.

The characteristics of the watershed change from its eastern origins to its western extent. The Red Lake River begins in the peatlands of the Northern Minnesota Wetlands ecoregion, and then flows through the till plains, beach ridges and lake plains of the Lake Agassiz Plain ecoregion. Prior to settlement, the majority of the land was covered by either prairie or wetland. Today, the majority of land is being used for the production of cultivated crops.

The Red Lake River flows through lake modified glacial till in the eastern, upstream portion of the watershed. Near St. Hilaire, the glacial till deposits change to shoreline and near-shore glacial sediment. The near-shore sediments are moderately to well-sorted silt, clay, and sand that were deposited in the shallow water of Glacial Lake Agassiz. The shoreline sediments consist of sand and silt with gravel ridges. As the river flows south to Red Lake Falls and west to the Black River confluence, fine sand soil types become more prevalent. From the Black River confluence to where the Red Lake River turns directions and flows directly west (near Gentilly), the glacial deposits are from wave-eroded, low-relief glacial sediment. These areas are made up of clay to slightly pebbly soils. Near Crookston, there is a shift to finer soil particles (clay, loam, very fine sandy loam, and silty clay loam) (DNR 2016).

Additional Red Lake River Watershed Resources

USDA Natural Resources Conservation Service (NRCS) Rapid Watershed Assessment for the Red Lake River Watershed: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022515.pdf

DNR Watershed Health Assessment Framework; Red Lake River Watershed Report Card: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/ReportCard_Major_63.pdf

DNR Watershed Context Report: http://files.dnr.state.mn.us/natural_resources/water/watersheds/tool/watersheds/context_report_major_63.pdf

Red Lake River WRAPS Information: http://www.rlwdwatersheds.org/1449384-wrap-info

General information about the Red Lake River (document, previous studies, photos, contacts, links): http://www.rlwdwatersheds.org/rl-watershed-info

Red Lake River One Watershed One Plan

http://www.westpolkswcd.com/uploads/3/4/8/5/34855804/red_lake_river_1w1p_report_amended_march_2019.pdf

1.1 Land Use

The predominant land use in the Red Lake River is agriculture, as shown in Table 1-1 and Figure 1-1. The prevalence of cultivated land is more intense in the western part of the watershed than it is in the eastern part of the watershed. The river receives stormwater runoff from the six towns and cities through which it flows. According to the Red Lake River Watershed Monitoring and Assessment Report, 71.1% of the streams in the Red Lake River watershed have been modified. This statistic may be somewhat inflated because it includes channels that are a part of drainage systems that were constructed where natural channels did not exist. Prior to settlement, the eastern portion of the watershed was dominated by wetlands and the western portion of the watershed was mostly prairie.

Soybeans and grains (barley and wheat) are grown throughout the watershed (Figure 1-2). Sugar beets are grown on many fields throughout the western portion of the watershed for the American Crystal Sugar agricultural cooperative to supply the sugar factories in Crookston and East Grand Forks.

Table 1-1. Red Lake River Watershed land use and land cover.

Red Lake River Watershed Land Use Summary		
National Land Cover Database Category	**Pre-Settlement***	**Percent of Watershed - 2011****
Developed, Open Space		4.08%
Developed, Low Intensity		0.88%
Developed, Medium Intensity		0.17%
Developed, High Intensity		0.05%
Barren Land		0.02%
Shrub/Scrub	14.80%	0.10%
Grassland/Herbaceous	46.69%	0.63%
Deciduous Forest	9.57%	3.68%
Evergreen Forest		0.13%
Mixed Forest	0.91%	0.03%
Pasture/Hay		5.34%
Cultivated Crops		60.63%
Woody Wetlands	4.80%	9.98%
Emergent Herbaceous Wetlands	23.11%	12.96%
Open Water	0.12%	1.32%

*Land use categories are named differently in the DNR presettlement data and the NLCD data. Presettlement values were placed into the categories that seemed most appropriate. The *Natural Vegetation of Minnesota* document from the DNR was used as guidance.
**2011 National Land Cover Database

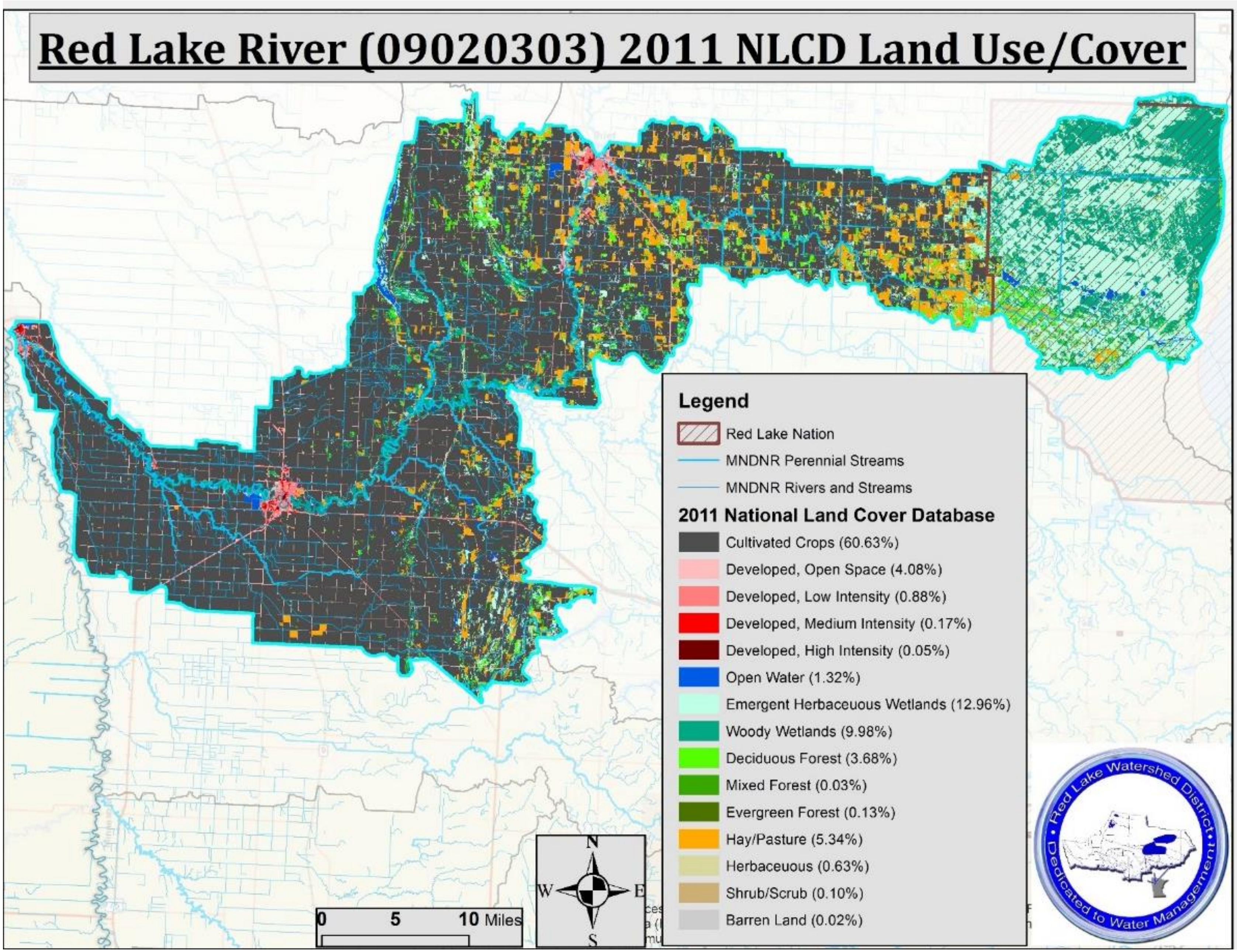


Figure 1-1. Red Lake River Land Cover (2011 National Land Cover Database).

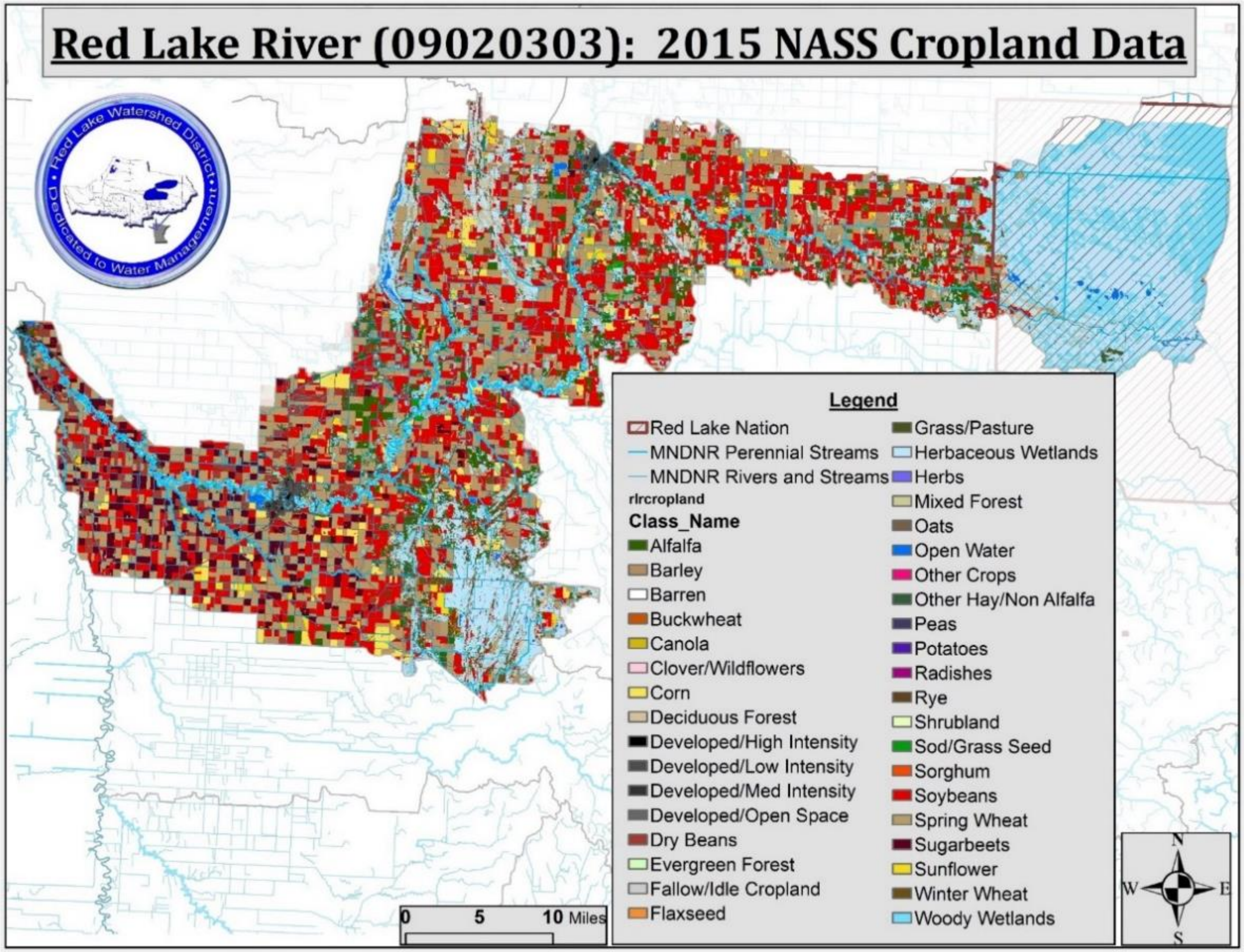


Figure 1-2. 2015 United States Department of Agriculture, National Agricultural Statistics Service Cropland Data.

1.2 Streams

The Red Lake River begins at the United State Army Corps of Engineers (USACE) dam at the outlet of Lower Red Lake within the Red Lake Nation. The dam is located at the pour point of the 1,263,678-acre Upper and Lower Red Lakes Major (HUC-8) Watershed. The Red Lake River then flows west to the city of Thief River Falls where it is joined by the 624,422-acre Thief River HUC-8 major watershed. The Red Lake River then flows south to Red Lake Falls, where it is joined by the 886,600-acre Clearwater River HUC-8 major watershed. The Red Lake River then flows south and west through the cities of Crookston and Fisher to the city of East Grand Forks where it flows into the Red River of the North. Other significant streams that flow into the Red Lake River, include Cyr Creek, Black River, Gentilly River, and Burnham Creek. Along its path, the river also receives drainage from many county and judicial ditches. Rivers, streams, ditches, and their respective AUIDs are shown in Figure 1-4.

A portion of the Red Lake River between a concrete weir water control structure within the Red Lake Reservation and Pennington County Ditch 39 was channelized by the USACE to address flooding and water supply issues. Downstream of the channelized reach, the natural channel features a pattern of riffles and pools. As the river nears Thief River Falls, the channel deepens as it enters the area influenced by the Thief River Falls reservoir. The Thief River Falls reservoir is created by a large dam in the city of Thief River Falls (Figure 1-3). Rapids and pools are found downstream of the Thief River Falls dam. High bluffs are found along the river near Red Lake Falls and its confluence with the Clearwater River. Downstream of the Black River, the water in the Red Lake River becomes cloudier and the gradient decreases as it enters the Lake Agassiz Plain ecoregion. A reservoir remains in the city of Crookston, upstream of the retrofitted dam. The river becomes deeper and more sediment laden as it flows west from Crookston to its confluence with the Red River in East Grand Forks.

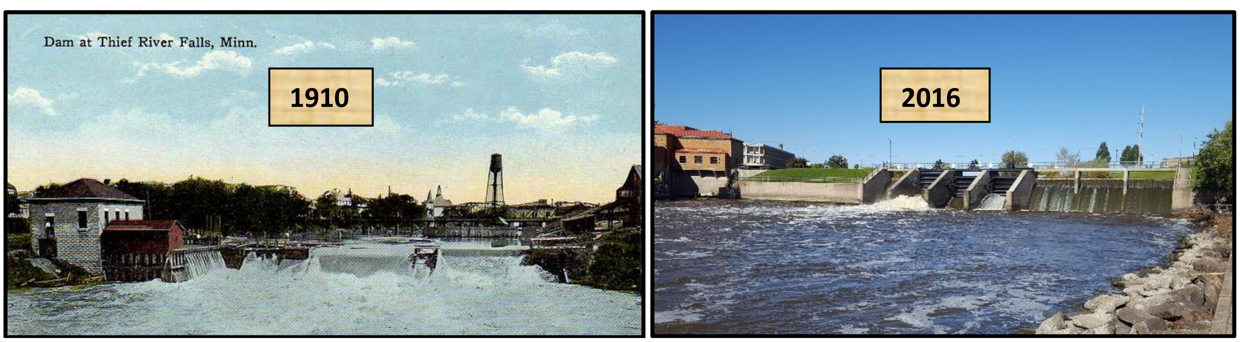


Figure 1-3. Historical and current images of the Thief River Falls Dam.

The Red Lake River provides opportunities for recreation. Boat and kayak accesses are found throughout the Red Lake River corridor. Local entities have organized to add and improve accesses and trails along the river (Red Lake River Corridor Enhancement Joint Powers Board). Upstream of Thief River Falls, there are multiple accesses and a high-quality fishery along the reach, despite the presence of the Thief River Falls Dam (a barrier to fish passage). The fishery between Thief River Falls and Crookston improved after the Crookston Dam was replaced with rock rapids in 2005 and sheet piling was removed from the Otter Tail Power Dam upstream of Crookston in 2006. The Red Lake River is utilized for all types of aquatic recreation within the Thief River Falls reservoir (swimming, tubing, and fishing). Campgrounds are located near the Red Lake River in Thief River Falls, Red Lake Falls, Huot, and Crookston. Ice fishing on the Red Lake River is popular within the cities of Thief River Falls and Crookston.

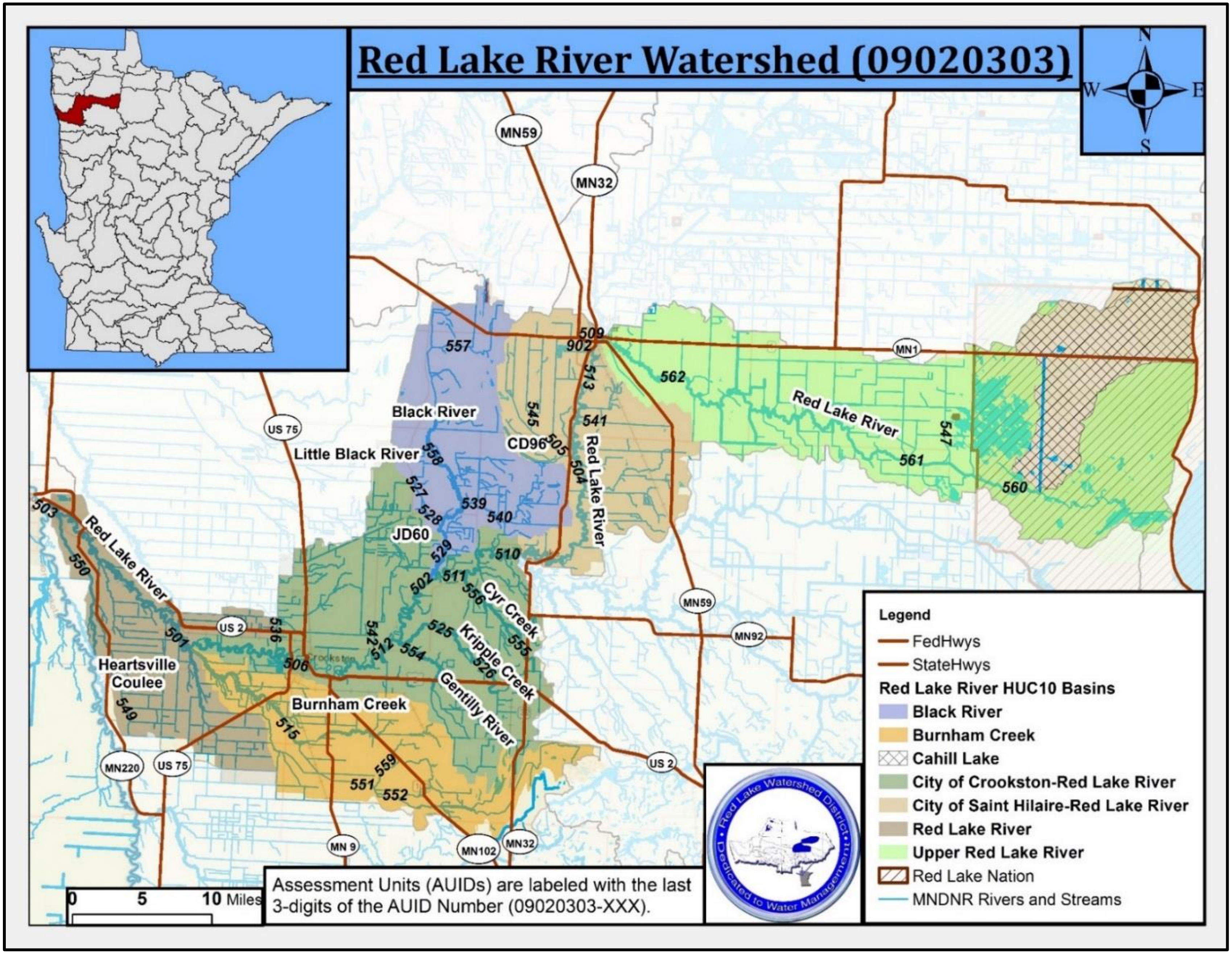


Figure 1-4. Red Lake River Watershed map, with subwatersheds.

1.3 Subwatersheds

The Red Lake River HUC - 8 major watershed encompasses seven HUC-10 subwatersheds, shown in Figure 1-5. The direct and total drainage areas of the impaired AUIDs within the Red Lake River Watershed are listed in Table 1-2. In addition to the drainage area of the Red Lake River major Watershed, the Upper/Lower Red Lakes, Thief River, and Clearwater River major watersheds contribute to the total drainage areas for impairments along the Red Lake River. The direct drainage areas of the impaired AUIDs are shown in Figure 1-6.

Table 1-2. Total and Direct Drainage Areas of Impaired AUIDs, Derived from USGS StreamStats.

AUID 09020303-XXX	Waterbody	Description	Total Drainage Area (mi²)	Direct Drainage Area (mi²)	Percent of the 1420.35 mi² Red Lake River Major Sub-Watershed	Upstream AUID 09020303-XXX	Monitored Tributary 09020303-XXX	Downstream AUID 0902030X-XXX
501	Red Lake River	Burnham Creek to Heartsville Coulee	5653.50	90.45	6.37%	506	515	3-503
502	Red Lake River	Black River to Gentilly River	5210.96	16.90	1.19%	511	529	3-512
503	Red Lake River	Heartsville Coulee to Red River	5685.96	2.70	0.19%	501	550	1-504
504	Red Lake River	Pennington CD96 to Clearwater River	3642.52	62.10	4.37%	513	505	3-510
505	Pennington CD96	Headwaters to Red Lake River	41.55	29.16	2.05%	--	545	3-504
506	Red Lake River	Polk CD99 to Burnham Creek	5413.34	66.76	4.70%	512	--	3-501
512	Red Lake River	Gentilly River to Polk CD99	5346.58	24.65	1.74%	502	542	3-506
515	Burnham Creek	Polk CD15 to Red Lake River	149.71	76.45	5.38%	551	--	3-501
525	Kripple Creek	Unnamed Creek to Gentilly River	32.91	32.45	2.28%	526	--	3-554
526	Kripple Creek	Unnamed Ditch to Unnamed Creek	0.46	0.46	0.03%	--	--	3-525
528	Little Black River	Channelized portion to the Black River	24.66	3.99	0.28%	527	--	3-529
529	Black River	Little Black River to Red Lake River	144.87	9.37	0.66%	558	528	3-502
542	Judicial Ditch 60	Lateral Ditch 4 to Red Lake River	43.30	43.30	3.05%	--	--	3-512
545	Br5 Pennington CD96	Br2 Pennington CD96 to Pennington CD96 Main Stem	12.39	12.39	0.87%	--	--	3-505
547	Pennington CD43	Unnamed Ditch to Red Lake River	24.36	24.36	1.72%	--	--	3-561
550	Heartsville Coulee	Polk CD115 to Red Lake River	37.29	14.59	1.03%	549	--	3-503
551	Burnham Creek	Polk CD106 to Polk CD15	73.26	15.18	1.07%	552	559	3-515
554	Gentilly River	Polk CD140 to Red Lake River	67.70	41.70	2.94%	553	524	3-512
556	Cyr Creek	County Road 14 to Red Lake River	24.88	19.00	1.34%	555	--	3-511
558	Black River	-96.4328 48.0146 (channelized reach) to Little Black River	110.84	29.27	2.06%	557	539	3-529

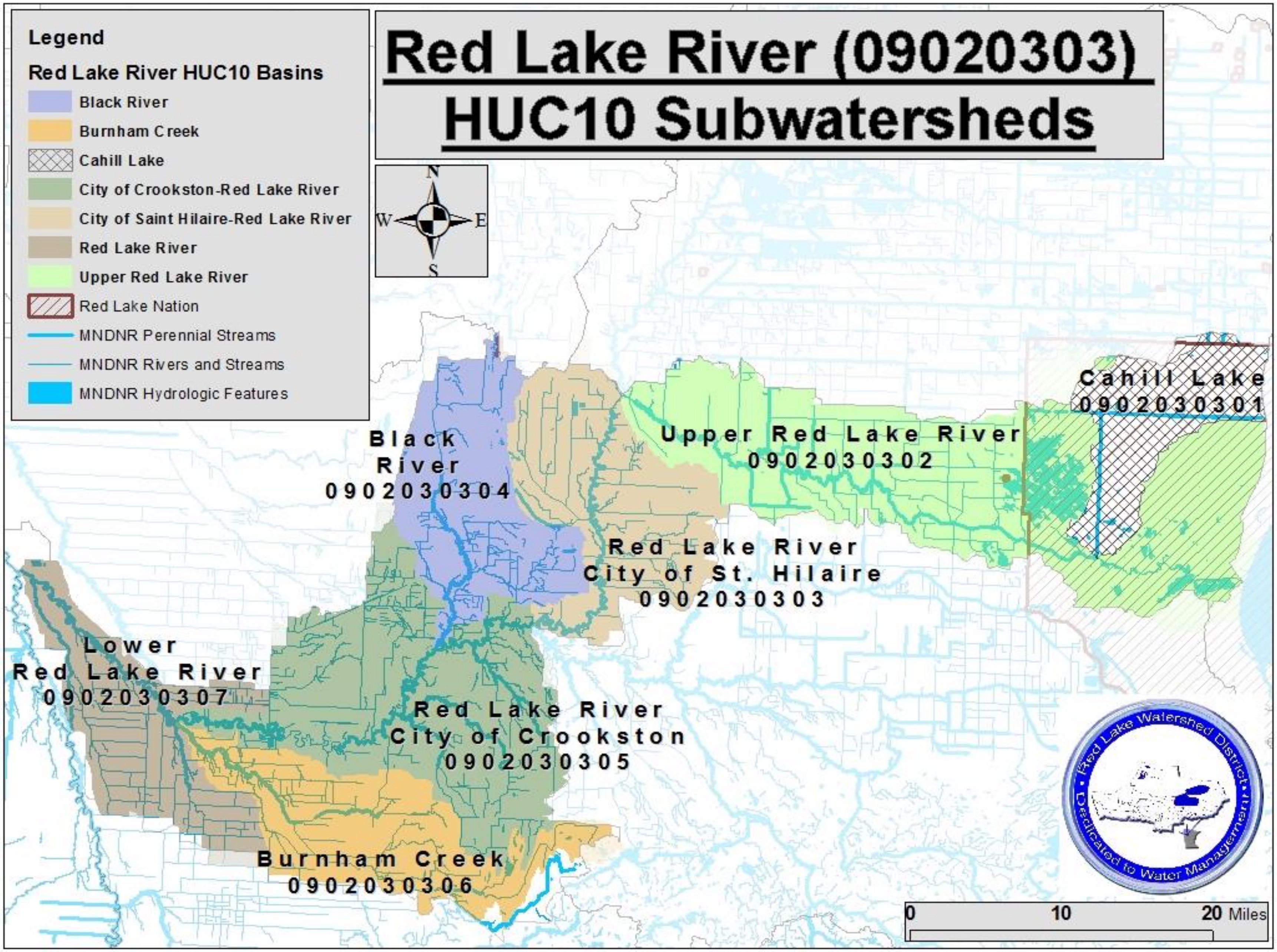


Figure 1-5. 2016 Red Lake River Watershed Subwatersheds.

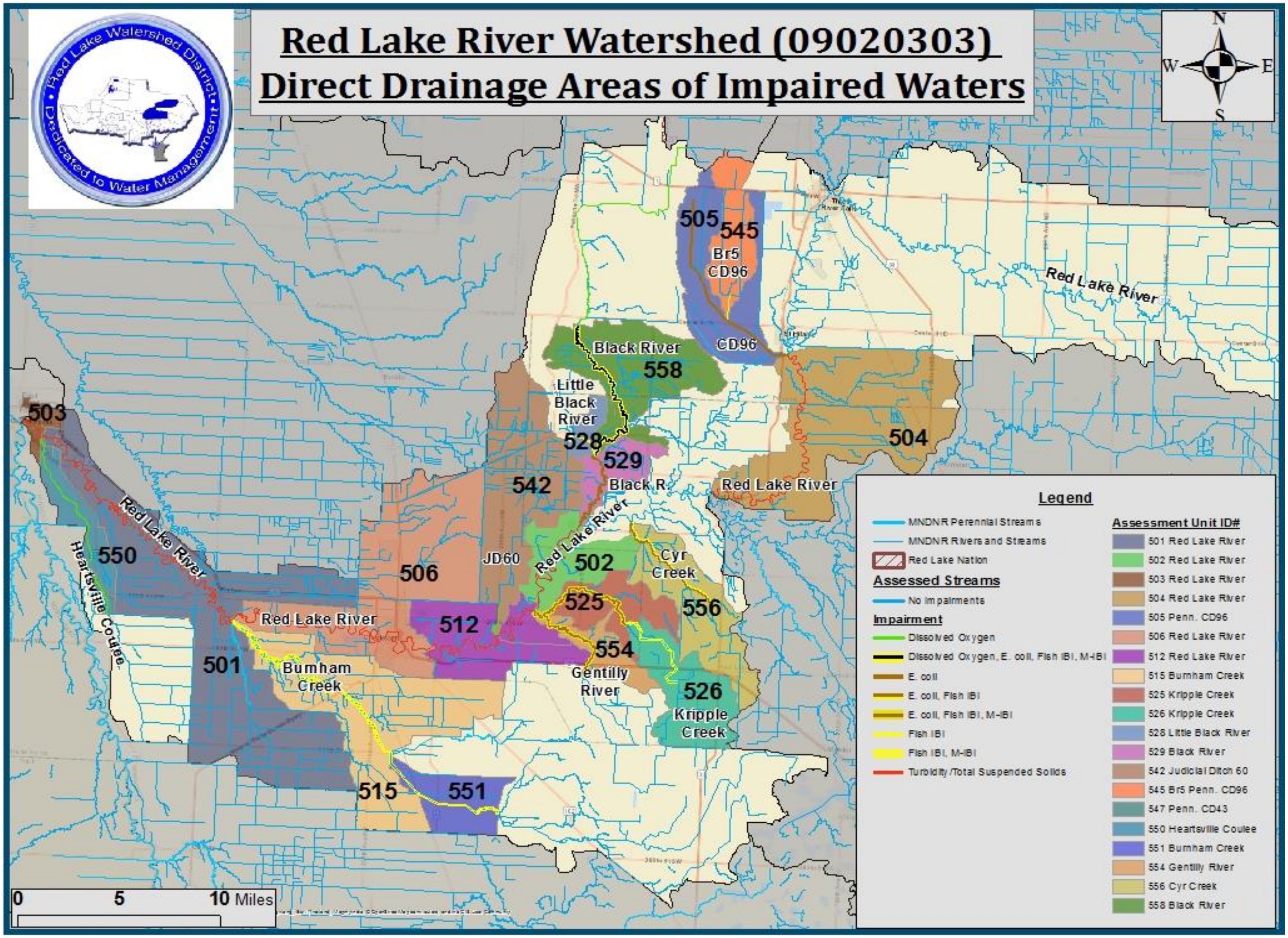


Figure 1-6. Direct drainage areas of impaired waters in the Red Lake River Watershed.

1.4 Impoundments

Flood control impoundments are significant and influential features of the Red Lake River Watershed. Future construction of new impoundments is likely as LGUs work to meet distributed retention goals, and seek to reduce peak flows and flood damage. Flood control impoundments are one way of retaining water in the Red River basin to prevent or lessen flooding. The 1998 Red River Basin Flood Damage Reduction Work Group Mediation Agreement identifies goals for flood damage reduction in the Red River Basin as well as natural resource management strategies for protection of water quality and wildlife habitat. Locations of impoundments are shown in Figure 1-7.

Good Lake Impoundment

The Good Lake Impoundment is a cooperative effort between the Red Lake Band of Chippewa Indians and the RLWD. The impoundment lies entirely within the Red Lake Indian Reservation, approximately 30 miles east of Thief River Falls. The multi-purpose project provides wetland habitat, floodwater retention, and potential irrigation water supply. Spring storage capacity is 11,300 acre-feet, which is equal to 2.6 inches of runoff from the 73 square-mile drainage area. The project intercepts overland flows to reduce flooding on 4,000 acres of private land immediately west of the project.

Goose Lake Swamp

The Goose Lake Swamp is located two miles north of Dorothy. Aerial photos reveal that the pool represents the natural headwaters of the Little Black River. Water is pooled upstream of an outlet structure at the southeastern end of the swamp. Drainage into the Little Black River was rerouted via a ditch that parallels the eastern edge of the swamp. The swamp and surrounding prairie lands make up the Pembina Wildlife Management Area. Wildlife habitat is the primary purpose of this pool.

Shirrick Dam

The Shirrick Dam was constructed on the Black River in 1984 in Section 35 of Wylie Township in Red Lake County, approximately six miles northwest of Red Lake Falls. The primary purpose of the impoundment is to provide flood relief on the Red Lake River and the Red River of the North by controlling the flow contribution from the Black River. The reservoir has the capacity to detain up to 4,800 acre-feet of water. The Shirrick Dam is an on-channel impoundment. The outlet structure is a barrier to fish passage and negatively affects upstream fish communities.

Thief River Falls Reservoir

The Thief River Falls Dam creates a reservoir within the city of Thief River Falls. The city of Thief River Falls draws its drinking water from the Red Lake River at a location near the dam. More detailed information regarding impacts to drinking water sources from upstream within the Thief River watershed, can be found in the Thief River Watershed TMDL and the Thief River WRAPS, both dated March 2019. The dam is also used to generate hydroelectric power. The quality of fish populations in upstream waters is good, despite the fish passage barrier that is created by the Thief River Falls Dam.

US Corps of Engineers Control Dam at the Lower Red Lake Outlet

In 1931, the Indian Service (now Bureau of Indian Affairs) constructed the Red Lake River dam for the reported "purpose of lake regulation and flood control below the lake."

Louisville/Parnell Impoundment

The Louisville/Parnell Impoundment (and Wetland Bank Project) is located in Section 13 of Parnell Township (Polk County) and Section 18 of Louisville Township (Red Lake County). The project is located in the headwaters of Judicial Ditch 60 (JD 60). The project controls break out flows from Lateral 2 of Judicial Ditch 60. The project provides 400 ac-ft. of floodwater retention and created 37 acres of wetlands.

Parnell Impoundment

The Parnell impoundment can discharge water to the Red Lake River watershed, through JD 60, or the Grand Marais Creek Watershed. The project reduces flooding on downstream agricultural lands and urban areas by retaining up to 4,000 ac-ft. of floodwater.

SCS/NRCS Dams

The Soil Conservation Service (SCS/NRCS) constructed small dams on tributaries to larger rivers and drainage ways. These multipurpose dams were constructed for the purpose of stabilizing outlets, reducing erosion and siltation, flood retention, and wildlife habitat. They were built with earthen embankments. Permanent pools are created by fixed-crest outlet structures that have no drawdown capabilities. Some of the small NRCS dams are located on ephemeral drainage ways and create no fish passage issues along impaired reaches. The Baird-Beyer dam on the Little Black River; however, is an on-channel impoundment that is a fish passage barrier for an impaired reach (09020303-528). The dams are accomplishing the goal of stabilizing outlets of drainage ways and reducing erosion at the location of the dam and some distance upstream. The following dams are located on tributaries of the Red Lake River:

- Latundresse Dam
- Odney Flaat Dam (Burnham Creek)
- BR-6 Impoundment (Polk CD 140, Gentilly Creek headwaters)
- Seeger Dam
- Baird-Beyer Dam (Little Black River)
- Thibert Dam

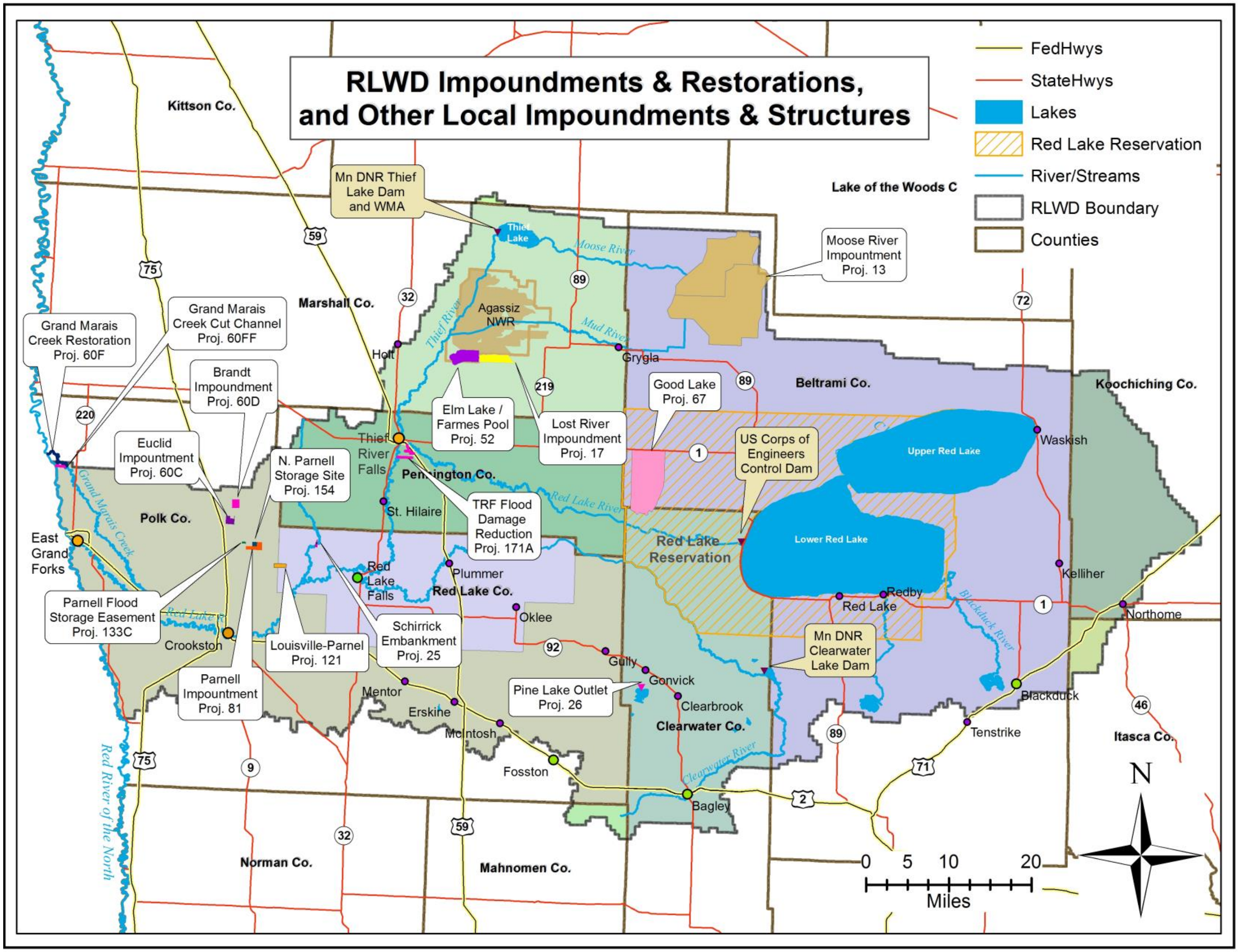


Figure 1-7. Locations of impoundments within the Red Lake River Watershed and the RLW.

2. Watershed Condition

Rivers, streams, and ditches have been formally assessed within the Red Lake River HUC8 Major Watershed. The only two waterbodies that have been given the name "lake" within the Red Lake River Watershed are the Good Lake impoundment and the Goose Lake swamp. Neither have been formally assessed. Neither are used for swimming or boating.

Some of the waterbodies in the Red Lake River Watershed are impaired by mercury; however, this report does not cover toxic pollutants. For more information on mercury impairments see the statewide mercury TMDL at: 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.

2.1 Condition Status

The Red Lake River Watershed TMDL addressed 31 impairments of aquatic life and/or recreation that have been found within 19 reaches of the Red Lake River and its tributaries. Turbidity and/or TSS impairments were found in six reaches of the Red Lake River between the Pennington County Ditch 96 confluence and the Red River of the North. Impairments due to chronically high concentrations of *E. coli* bacteria have been found along six reaches of Red Lake River tributaries. Impairments due to low DO levels have been identified in four reaches along tributaries of the Red Lake River. Low IBI scores have resulted in M-IBI impairments for 7 reaches, and F-IBI impairments for 10 reaches, along tributaries of the Red Lake River.

The cities of Thief River Falls and East Grand Forks draw their drinking water from the Red Lake River. Impaired reaches of the Red Lake River drain to the location of the East Grand Forks raw water intake. In addition to excess sediment in the river, city staff in both Thief River Falls and East Grand Forks have expressed concern over elevated levels of total organic carbon (TOC) in the river. Drinking water source assessments have been completed for each of the cities by the Minnesota Department of Health. More detailed information regarding impacts to drinking water sources from upstream within the Thief River Watershed, can be found in the Thief River Watershed TMDL and the Thief River WRAPS, both dated March 2019.

The impaired waterbodies within the Red Lake River Watershed are identified in Table 2-1. The locations of those impairments are displayed in Figure 2-3.

The oldest Red Lake River water quality records in the state's EQuIS water quality database were collected in 1953. Data collection efforts were minimal until the late 1990s (Figure 2-1). The intensity of monitoring efforts has increased in the last two decades. Increased awareness of the importance of monitoring data collection, monitoring methods, water quality standards, and assessment results have motivated multiple, productive, local monitoring programs (LGUs and volunteers). The RLWD monitors more than 60 sites within its jurisdiction. SWCDs collect monthly samples. Volunteer monitoring by River Watch programs at schools generates a significant amount of water quality data. State agencies have allocated funding for intensive studies, load monitoring, and supplemental condition monitoring. The scope of monitoring efforts has expanded to include continuous water quality monitoring with deployed loggers, increased local stage/flow monitoring, and MPCA biological monitoring. Additional information about current monitoring efforts can be found in the monitoring plan in Section 4 of this report.

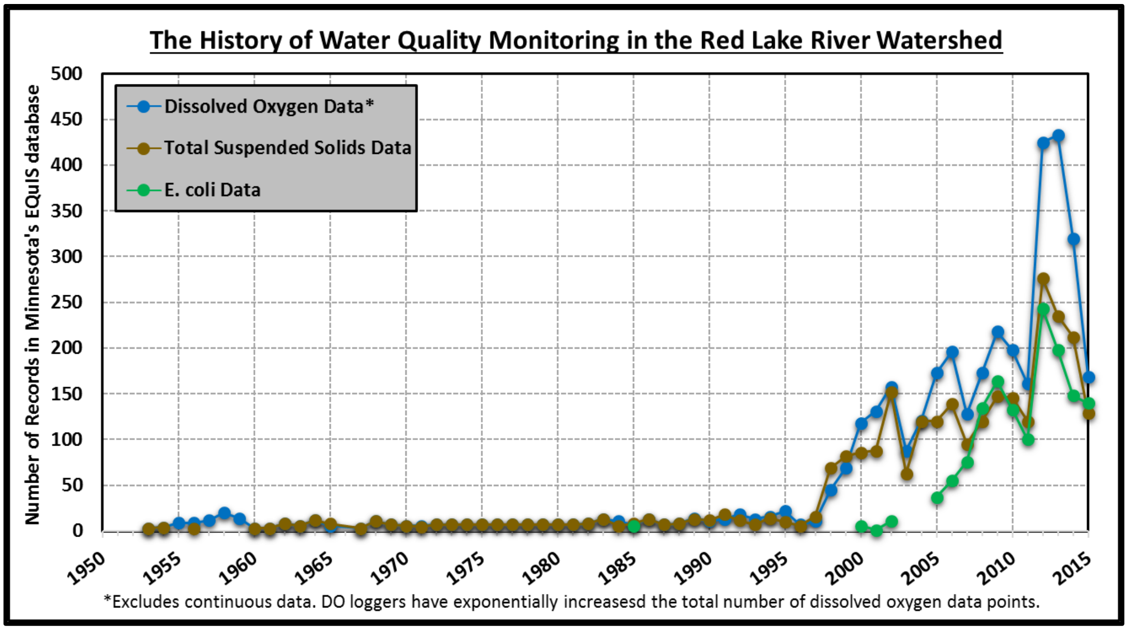


Figure 2-1. Historical quantification of water quality monitoring data collection.

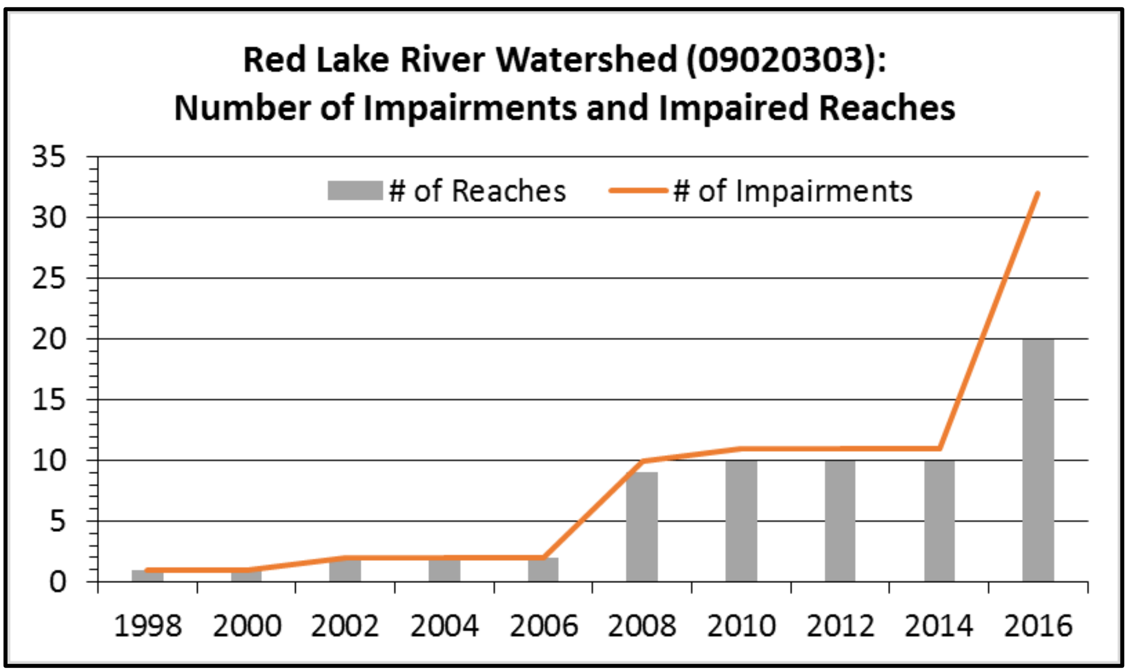


Figure 2-2. Changes in the number of impairments and impaired reaches over time.

The number of impaired reaches doubled during the 2014 assessment (Figure 2-2). A summary of assessment results is shown in Table 2-2. Also, the number of individual impairments more than doubled. An increase in data collected, rather than a decrease in water quality, is primarily responsible for the increase in known impairments.

- The 2014 assessment was the first time that the MPCA used IBI data to assess conditions in the Red Lake River Watershed.

- The 2014 assessment was the first time that many sites had sufficient data for *E. coli* bacteria assessments. The transition from fecal coliform to *E. coli* as the aquatic recreation water quality standard was too recent in 2009 (the last time the Red Lake River Watershed was formally assessed prior to 2014) and many reaches had insufficient data.
- Five reaches were split during the 2014 assessment so that Tiered Aquatic Life Use (TALU) standards could be applied properly. In most cases, a channelized portion of the reach was separated from a natural-channel portion. Local monitoring efforts have increased in order to attain sufficient data from as many of those new assessment units as possible and prepare for the 2024 assessment.

Table 2-1. Impaired Waterways of the Red Lake River Watershed on the 2018 303(d) List of Impaired Waters.

Red Lake River Watershed (09020303) Rivers, Streams, and Ditches on the 2018 303 (d) list of Impaired Waters					
HUC 10 Subwatershed	**Waterbody Name and Reach**	**Use Class**	**Assessment Unit ID**	**Impairment**	**Year Listed**
Upper Red Lake River 0902030302	**County Ditch 43** Unnamed Ditch to Red Lake River	2B, 3C	547	Aquatic Life- Aquatic Macroinvertebrate Bioassessment	2016
				Aquatic Life- Fishes Bioassessment	2016
	Red Lake River Clearwater/Pennington County Line to CD39	1C, 2Bd, 3C	561	Aquatic Consumption- Mercury	1998
	Red Lake River CD39 to Thief River	1C, 2Bd, 3C	562	Aquatic Consumption- Mercury	1998
Red lake River City of St. Hilaire 0902030303	**Red Lake River** Pennington CD96 to Clearwater River	1C, 2Bd, 3C	504	Aquatic Consumption- Mercury	1998
				Aquatic Life- Turbidity (& TSS)*	2008
	Pennington CD96 Headwaters to Red Lake River	2B, 3C	505	Aquatic Recreation- *E. Coli*	2016
	Red Lake River Thief River to Thief River Falls Dam	1C, 2Bd, 3C	509	Aquatic Consumption- Mercury	1998
	Red Lake River Thief River Falls Dam to Pennington CD96	1C, 2Bd, 3C	513	Aquatic Consumption- Mercury	1998
	Unnamed Ditch (Branch 5, Pennington CD96) (Br2 CD96 to CD96 Main Stem)	2B, 3C	545	Aquatic Life- Fishes Bioassessment	2016
Black River 0902030304	**Little Black River** Unnamed Ditch (Channelized Portion) to Black River	2B, 3C	528	Aquatic Life- Fishes Bioassessment	2016
	Black River Little Black River to Red Lake River	2B, 3C	529	Aquatic Recreation- *E. Coli*	2016
	Black River -96.4328 48.0146 to Little Black River	2Bg, 3C	558	Aquatic Life- Aquatic Macroinvertebrate Bioassessment	2016
				Aquatic Life- Fishes Bioassessment	2016
				Aquatic Life- Dissolved Oxygen	2008
				Aquatic Recreation- *E. Coli*	2016
Red Lake River City of Crookston 0902030305	**Red Lake River** Black River to Gentilly River	1C, 2Bd, 3C	502	Aquatic Consumption- Mercury	1998
				Aquatic Life- Turbidity (& TSS)*	2008
	Red Lake River CD99 to Burnham Creek	1C, 2Bd, 3C	506	Aquatic Consumption- Mercury	1998
				Aquatic Life- Turbidity (& TSS)*	2008
	Red Lake River Clearwater River to Cyr Creek	1C, 2Bd, 3C	510	Aquatic Consumption- Mercury	1998
	Red Lake River Cyr Creek to Black River	1C, 2Bd, 3C	511	Aquatic Consumption- Mercury	1998

Red Lake River Watershed (09020303) Rivers, Streams, and Ditches on the 2018 303 (d) list of Impaired Waters					
HUC 10 Subwatershed	**Waterbody Name and Reach**	**Use Class**	**Assessment Unit ID**	**Impairment**	**Year Listed**
Red Lake River City of Crookston 0902030305 (continued)	**Red Lake River** Gentilly River to CD 99	1C, 2Bd, 3C	512	Aquatic Consumption- Mercury	1998
				Aquatic Life- Turbidity*	2009
	Kripple Creek Unnamed Creek to Gentilly River	2B, 3C	525	Aquatic Life- Aquatic Macroinvertebrate Bioassessment	2016
				Aquatic Life- Fishes Bioassessment	2016
				Aquatic Recreation- *E. Coli*	2016
	Kripple Creek (CD66) Unnamed Ditch to Unnamed Creek	2B, 3C	526	Aquatic Life- Aquatic Macroinvertebrate Bioassessment	2016
				Aquatic Life-Fishes Bioassessment	2016
	JD 60 Lateral Ditch 4 to Red Lake River	2B, 3C	542	Aquatic Life- Dissolved Oxygen	2016
	Gentilly River CD140 to Red Lake River	2C	554	Aquatic Life- Aquatic Macroinvertebrate Bioassessment	2016
				Aquatic Life- Fishes Bioassessment	2016
				Aquatic Recreation- *E. Coli*	2016
	Cyr Creek County Road 14 to Red Lake River	2Bg, 3C	556	Aquatic Life-Fishes Bioassessment	2016
				Aquatic Recreation- *E. Coli*	2016
Burnham Creek 0902030306	**Burnham Creek** Polk CD15 to Red Lake River	2C	515	Aquatic Life- Aquatic Macroinvertebrate Bioassessment	2016
				Aquatic Life- Fishes Bioassessment	2016
	Burnham Creek CD106 to Polk CD15	2C	551	Aquatic Life- Aquatic Macroinvertebrate Bioassessment	2016
				Aquatic Life- Fishes Bioassessment	2016
Lower Red Lake River 0902030307	**Red Lake River** Burnham Creek to Unnamed Creek (Heartsville Coulee	1C, 2Bd, 3C	501	Aquatic Consumption- Mercury	1998
				Aquatic Life - Turbidity (& TSS)*	1998
	Red Lake River Unnamed Creek (Heartsville Coulee) to Red River	1C, 2Bd, 3C	503	Aquatic Consumption- Mercury	1998
				Aquatic Life- Turbidity (& TSS)*	2002
	Unnamed Ditch (Heartsville Coulee)	2B, 3C	550	Aquatic Life- Dissolved Oxygen	2016

* The Red Lake River Watershed was assessed using newly adopted TSS standards in 2015. Some turbidity impairments were delisted where TSS standards were met. Turbidity impairments remain listed for those reaches that fail to meet the TSS standards or have insufficient data to prove compliance with the TSS standards.

**Mercury impairments have been addressed by a state-wide Mercury TMDL that was approved by the EPA in 2007: https://www.pca.state.mn.us/sites/default/files/wq-iw4-01b.pdf

***Impairment has been recategorized from a Category 5 to Category 4C.

Use Classes: 1C- Domestic Consumption (requires heavy treatment)

2B-Aquatic Life and Recreation-Warm and Cool Water Habitat (lakes and streams)
2Bd-Aquatic Life and Recreation-Warm and Cool Water Habitats (also protected for drinking water)
2Bg-Aquatic Life and Recreation-General Warm Water Habitat (lakes and streams)
2C-Aquatic Life and Recreation-Indigenous aquatic live and their habitats (streams)
2D-Aquatic Life and Recreation-Wetlands
3C-Industrial Consumption (heavy treatment)

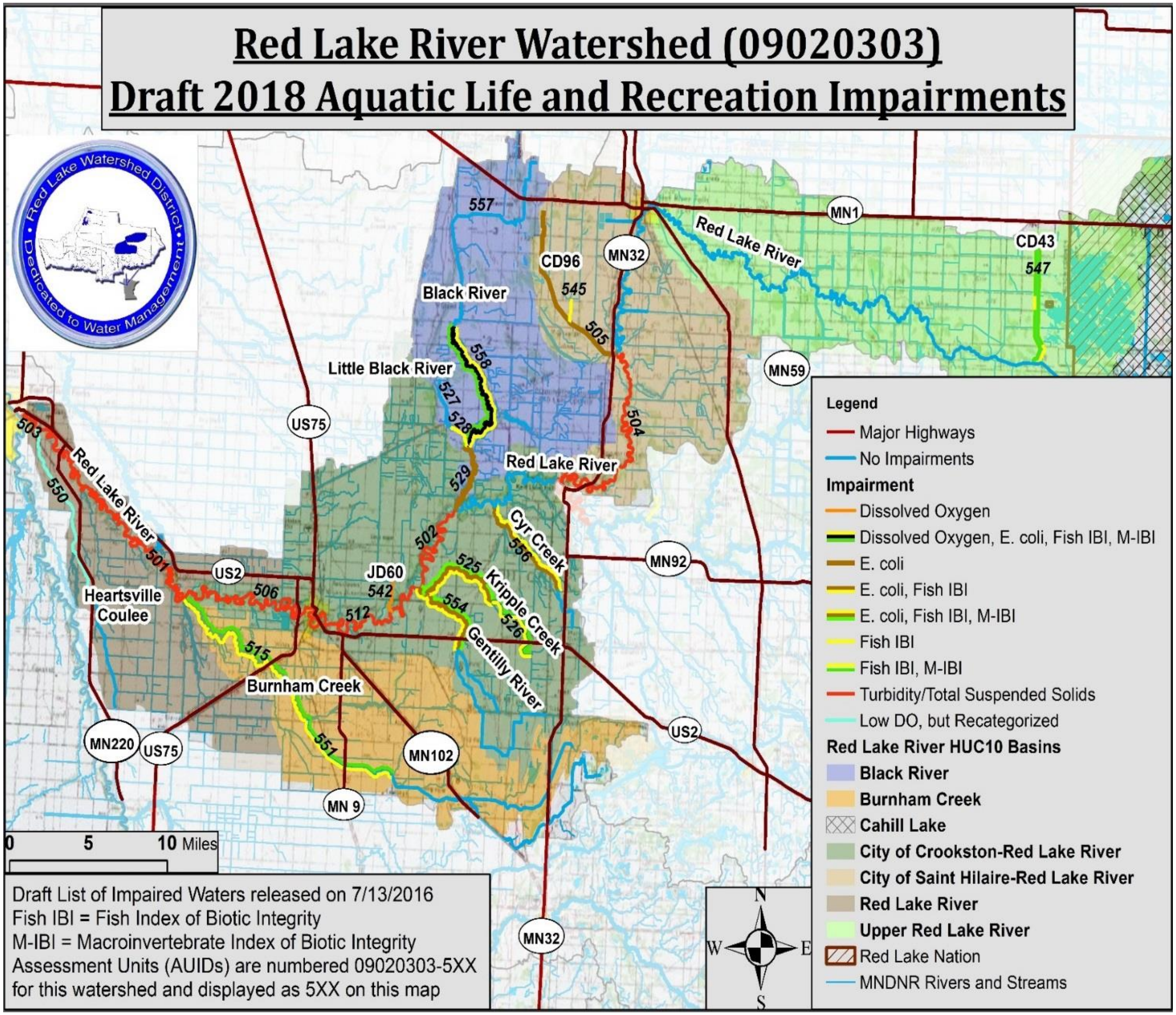


Figure 2-3. Map of the 2018 Red Lake River Watershed Aquatic Life and Recreation Impairments.

Table 2-2. Assessment status of stream reaches in the Red Lake River Watershed, presented (mostly) from north to south.

Current Water Quality Conditions in the Red Lake River Watershed (2004-2014 Data)																	
HUC-10 Subwatershed	AUID	Stream	Reach Description	Segment Length (Miles)	# of Days with Water Chemistry Data*	Aquatic Life						River Eutrophication					Aq Rec
						Fish IBI	Macroinvertebrate IBI	pH	Un-ionized Ammonia	Dissolved Oxygen	Turbidity/ TSS	Total Phosphorus	Biochemical Oxygen Demand	Chlorophyll-a	DO Fluctuation	River Eutrophication	*E. coli* Bacteria
Red Lake River 0902030307	501	Red Lake River	Burnham Creek to Unnamed Creek	30.83	341	Sup	Sup	Sup	Sup	Sup	Imp	PI	IF	Sup	IF	IF	Sup
	503	Red Lake River	Unnamed Creek to Red River	1.87	130	Sup	Sup	Sup	Sup	Sup	Imp	Sup	Sup	IF	IF	Sup	Sup
	549	RLWD Ditch 12	Headwaters to CD115	7.27	2	PI	PI	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
	550	Heartsville Coulee	CD115 to Red Lake River	11.39	186*	IF	IF	Sup	Sup	Imp	Sup	PI	IF	IF	Sup	IF	Sup
Burnham Creek 0902030306	515	Burnham Creek	Polk CD15 to Red Lake River	20.35	239*	Imp	Imp	Sup	Sup	Sup	Sup	PI	IF	IF	Sup	IF	Sup
	551	Burnham Creek	CD 106 to Polk CD 15	7.53	21*	Imp	Imp	IF	IF	IF	IF	IF	IF	IF	Sup	IF	IF
	552	Burnham Creek	Br1 CD72 to CD106	15.88	2	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
	559	CD106	Headwaters to Burnham Creek	5.79	1	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF

Current Water Quality Conditions in the Red Lake River Watershed (2004-2014 Data)																	
HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Segment Length (Miles)	# of Days with Water Chemistry Data*	Aquatic Life						River Eutrophication					Aq Rec
						Fish IBI	Macroinvertebrate IBI	pH	Un-ionized Ammonia	Dissolved Oxygen	Turbidity/ TSS	Total Phosphorus	Biochemical Oxygen Demand	Chlorophyll-a	DO Fluctuation	River Eutrophication	*E. coli* Bacteria
Red Lake River 0902030305	502	Red Lake River	Black River to Gentilly River	9.91	88	Sup	Sup	Sup	Sup	Sup	Imp	Sup	IF	IF	IF	Sup	Sup
	506	Red Lake River	Crookston Dam to Burnham Creek 2	25.05	112	Sup	Sup	Sup	Sup	Sup	Imp	Sup	IF	IF	IF	Sup	Sup
	510	Red Lake River	Clearwater River to Cyr Creek	8.16	0	Sup	Sup	IF	IF	IF	PI	IF	IF	IF	IF	IF	IF
	511	Red Lake River	Cyr Creek to Black River	4.64	0	Sup	Sup	IF	IF	IF	PI	IF	IF	IF	IF	IF	IF
	512	Red Lake River	Gentilly River to Crookston Dam	11.77	35	Sup	Sup	Sup	IF	IF	Imp	IF	IF	IF	IF	IF	IF
	525	Kripple Creek	Unnamed Creek to Gentilly River	9.28	682*	Imp	Imp	Sup	Sup	Sup	Sup	PI	IF	IF	Sup	IF	Imp
	526	Kripple Creek (CD66)	Unnamed ditch to Unnamed Creek	5.91	16*	Imp	Imp	IF	IF	IF	IF	IF	IF	IF	Sup	IF	IF
	536	CD1	CD60 to Red Lake River	2.06	70*	IF	IF	Sup	Sup	PI	IF	IF	IF	IF	Sup	IF	IF
	542	JD60	Lateral Ditch 4 to Red Lake River	1.87	126*	IF	IF	IF	Sup	Imp	Sup	PI	IF	IF	Sup	IF	IF
	546	JD60	CD147 to Unnamed Ditch	2.67	3	PI	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
	554	Gentilly River	CD140 to Red Lake River	8.51	207*	Imp	Imp	Sup	Sup	PI	Sup	Sup	IF	IF	Sup	IF	Imp
	555	Cyr Creek	Headwaters to County Road 14	2.82	1	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
	556	Cyr Creek	County Road 14 to Red Lake River	8.99	144*	Imp	IF	Sup	Sup	PI	Sup	PI	IF	IF	Sup	IF	Imp

Current Water Quality Conditions in the Red Lake River Watershed (2004-2014 Data)																	
						Aquatic Life						River Eutrophication					Aq Rec
HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Segment Length (Miles)	# of Days with Water Chemistry Data*	Fish IBI	Macroinvertebrate IBI	pH	Un-ionized Ammonia	Dissolved Oxygen	Turbidity/ TSS	Total Phosphorus	Biochemical Oxygen Demand	Chlorophyll-a	DO Fluctuation	River Eutrophication	*E. coli* Bacteria
Black River 0902030304	527	Little Black River (Channelized)	Headwaters to the non-channelized Portion	3.14	5	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
	528	Little Black River	Channelized portion to Black River	2.17	21*	Imp	IF	IF	IF	PI	IF	IF	IF	IF	Sup	IF	PI**
	529	Black River	Little Black River to Red Lake River	8.45	257*	Sup	Sup	Sup	Sup	Sup	Sup	PI	IF	IF	PI	PI	Imp
	539	Browns Creek	Unnamed Ditch to Black River	1.36	16	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF	PI
	540	Browns Creek	Unnamed Ditch to Unnamed Ditch	2.87	22	IF	IF	Sup	Sup	IF	Sup	PI	IF	IF	IF	IF	IF
	557	Black River (Channelized)	Headwaters to -96.4328 48.0146	15.82	57	Sup	Sup	Sup	Sup	PI**	Sup	Sup	IF	IF	PI	Sup	Sup
	558	Black River	-96.4328 48.0146 to Little Black River	14.21	79*	Imp	Imp	Sup	Sup	Imp	Sup	PI	IF	IF	Sup	IF	Imp
Red Lake River 0902030303	504	Red Lake River	CD 96 to Clearwater River	20.88	165	Sup	Sup	Sup	Sup	Sup	Imp	Sup	IF	IF	IF	IF	Sup
	505	Pennington CD 96	Headwaters to Red Lake River	10.72	172*	Sup	Sup	Sup	Sup	PI	Sup	Sup	IF	Sup	PI	Sup	Imp
	509	Red Lake River	Thief River to Thief River Falls Dam	0.86	105	IF	IF	Sup	Sup	IF	Sup	Sup	IF	IF	IF	Sup	Sup
	513	Red Lake River	Thief River Falls Dam to CD 96	13.66	125	Sup	Sup	Sup	Sup	Sup	Sup	Sup	IF	IF	IF	Sup	Sup
	541	Pennington CD 21	Unnamed Creek to Red Lake River	1.52	29	IF	IF	Sup	PI	PI	Sup	PI	IF	IF	IF	IF	PI
	545	Br5 Pennington CD 96	BR 2 CD 96 to CD96 main stem	1.32	18*	Imp	Sup	IF	IF	PI	IF	IF	IF	IF	Sup	IF	IF
	902	Pennington CD 70	T154 R43W S31 to Red Lake River	2.03	61	IF	IF	Sup	Sup	PI	Sup	PI	IF	IF	IF	IF	Sup

Current Water Quality Conditions in the Red Lake River Watershed (2004-2014 Data)

HUC-10 Subwatershed	AUID (Last 3 digits)	Stream	Reach Description	Segment Length (Miles)	# of Days with Water Chemistry Data*	Aquatic Life						River Eutrophication					Aq Rec
						Fish IBI	Macroinvertebrate IBI	pH	Un-ionized Ammonia	Dissolved Oxygen	Turbidity/ TSS	Total Phosphorus	Biochemical Oxygen Demand	Chlorophyll-a	DO Fluctuation	River Eutrophication	*E. coli* Bacteria
Red Lake River 0902030302	547	Pennington CD 43	Unnamed Ditch to Red Lake River	7.3	14*	Imp	Imp	IF	IF	PI	IF	IF	IF	IF	PI	IF	IF
	560	Red Lake River	Headwaters to Clearwater/Pennington County Line	17.93	77	Sup	IF	Sup	Sup	Sup	Sup	Sup	IF	IF	IF	Sup	Sup
	561	Red Lake River	Clearwater/Pennington County Line to CD39	22.23	237*	Sup	Sup	Sup	Sup	PI	Sup (30)	Sup	IF	IF	Sup	Sup	Sup
	562	Red Lake River	Thief River to Thief River Falls Dam	26.36	235*	Sup	Sup	PI	Sup	Sup	Sup (30)	Sup	IF	IF	Sup	Sup	Sup
Cahill Lake (Unnamed Ditch) 0902030301	543	Unnamed Ditch	Unnamed Ditch to Red Lake River	9.96	0	Sup	PI	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF

IF	**I**nsu**f**ficient data. Either there is no data, or the data doesn't meet minimum requirements for an assessment.
Imp	**Imp**aired. The reach is officially listed as impaired for this parameter and 2004-2014 data supports that listing.
PI	**P**otentially **I**mpaired reach in need of protection efforts. 2004-2014 data provides evidence that the reach is too frequently violating the standard for this specific parameter, but the reach has not been listed as impaired. Decisions to list, or not to list, are based upon professional judgement in addition to statistics. The poor results may have been connected with low flows; water quality conditions may have changed; the reach may be of limited resource value; or good IBI scores may indicate that water chemistry deficiencies are not harming aquatic life. There also may be insufficient data on a reach, but interpolation of upstream and downstream impairments suggests that in-between waters would also be impaired, or the reach is trending toward impairment.
Sup	**Sup**porting. Current data indicates that the reach is meeting the standard for this parameter and supports the respective designated use.

*Includes both discrete and continuous data

**Poor water quality has been discovered in more recently collected data

Total Suspended Solids: Six reaches in the Red Lake River Watershed are impaired by TSS. These same reaches were previously considered impaired under the turbidity 25 NTU standard. Existing turbidity impairments in the Black River and Burnham Creek are no longer considered to be impaired when utilizing the TSS standard. Excess TSS was found to be a stressor of aquatic life in the SID Report.

In 2005 through 2014 data, the exceedance rate of the TSS standard in the Red Lake River at the Fisher monitoring site (S000-031) was 55.3%. The average flow weighted mean concentration (FWMC) based on Watershed Pollutant Load Monitoring Network (WPLMN) data near Fisher is 96 mg/L for the years 2007 through 2016. The highest recorded TSS concentration at this location during this period was 866 mg/L on April 27, 2013. The impairment is less severe within upstream reaches (Figure 2-5). The average FWMC for TSS, based on WPLMN data at Red Lake Falls, decreases to 30 mg/L (years 2012 through 2016). Further upstream at High Landing the FWMC decreases even further to 10 mg/L (2015 and 2016). The Red Lake River exceeded expectations for aquatic biology throughout the watershed, while also exceeding the 65 mg/L TSS standard in at least 5 of the river's 13 main-channel reaches.

The impaired reach that is closest to being restored and meeting its applied TSS standard is the Red Lake River that begins upstream of Crookston at CD 99 and ends at Burnham Creek (09020303-506). That reach exceeded the 65 mg/L standard in less than 14% of samples. The unimpaired reach within the watershed that is in the most danger of becoming impaired is the Black River between the Little Black River and the Red Lake River (09020303-529) that exceeded the 65 mg/L TSS standard in 8.9% of eligible samples. The "cleanest" streams in the watershed are the multiple reaches that have not exceeded the TSS standards that have been applied to them:

- Red Lake River, Thief River to Thief River Falls Dam, 09020303-509, 30 mg/L standard
- Browns Creek, 09020303-540, 65 mg/L standard
- Judicial Ditch 60, Lateral Ditch 4 to Red Lake River, 09020303-542, 65 mg/L
- Heartsville Coulee, CD 115 to Red Lake River, 09020303-550, 65 mg/L standard
- Cyr Creek, CR 14 to Red Lake River, 09020303-556, 65 mg/L standard
- Black River, -96.4328 48.0146 to Little Black R, 09020303-558, 65 mg/L standard

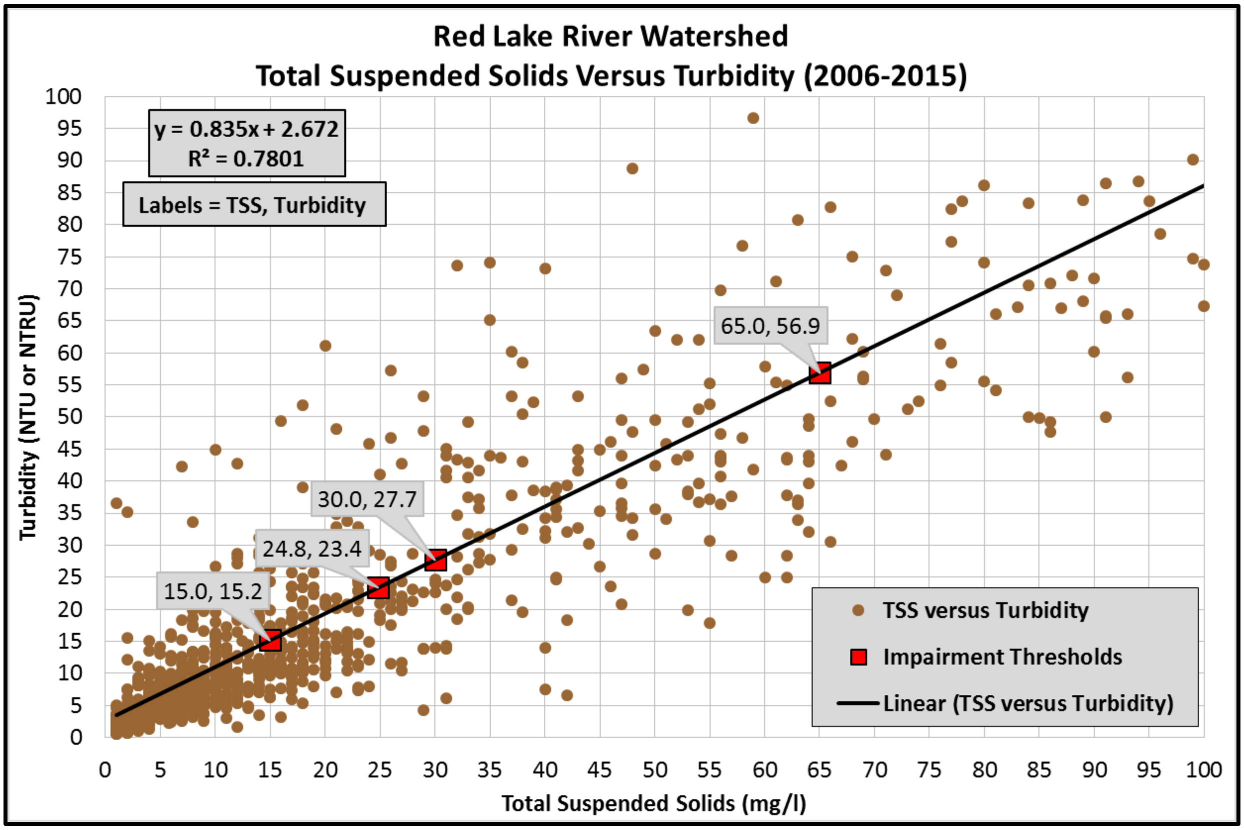


Figure 2-4. A comparison of TSS and turbidity values within the Red River (09020303) watershed. The data source was all data collected in the years 2006 through 2015 that was stored in the EQuIS database in early 2016.

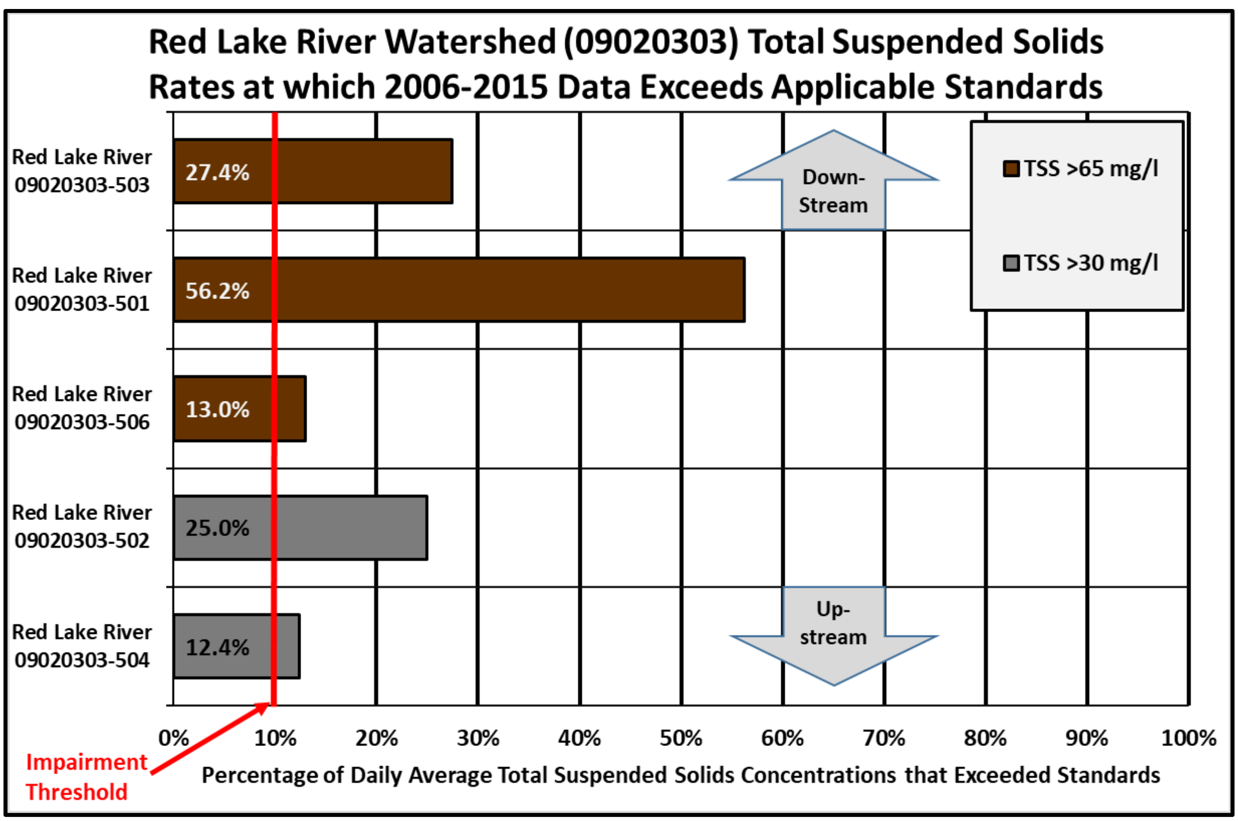


Figure 2-5. Rates at which the TSS standard is exceeded in impaired reaches of the Red Lake River.

Dissolved Oxygen: The headwaters portion of the Red Lake River (0902030302), upstream of its confluence with the Thief River (09020304), was considered to be impaired by low DO on previous impaired waters lists. That reach was split into three sections during the most recent assessment: the portion within the Red Lake Indian Reservation (09020303-560), the channelized portion (09020303-561), and the natural portion near Thief River Falls (09020303-562). Deployments of DO loggers and intensive discrete measurements found that DO improves from upstream to downstream within the channelized reach. That data collection effort also found that the natural portion of the Red Lake River upstream of Thief River Falls is meeting the DO standard. All of the sites that were assessed for aquatic life along that headwaters-to-Thief-River reach met standards. Therefore, the MPCA concluded that the Red Lake River appears to be adequately supporting aquatic life, despite deficient DO levels within the channelized portion. DO impairments have been found in Red Lake River tributaries where stagnant water is a common occurrence (Figure 2-6). Frequent low DO levels have been recorded in other reaches, but they were not listed as impaired because direct connections with zero-flow conditions (e.g. 09020303-541) were identified during the 2014 assessment.

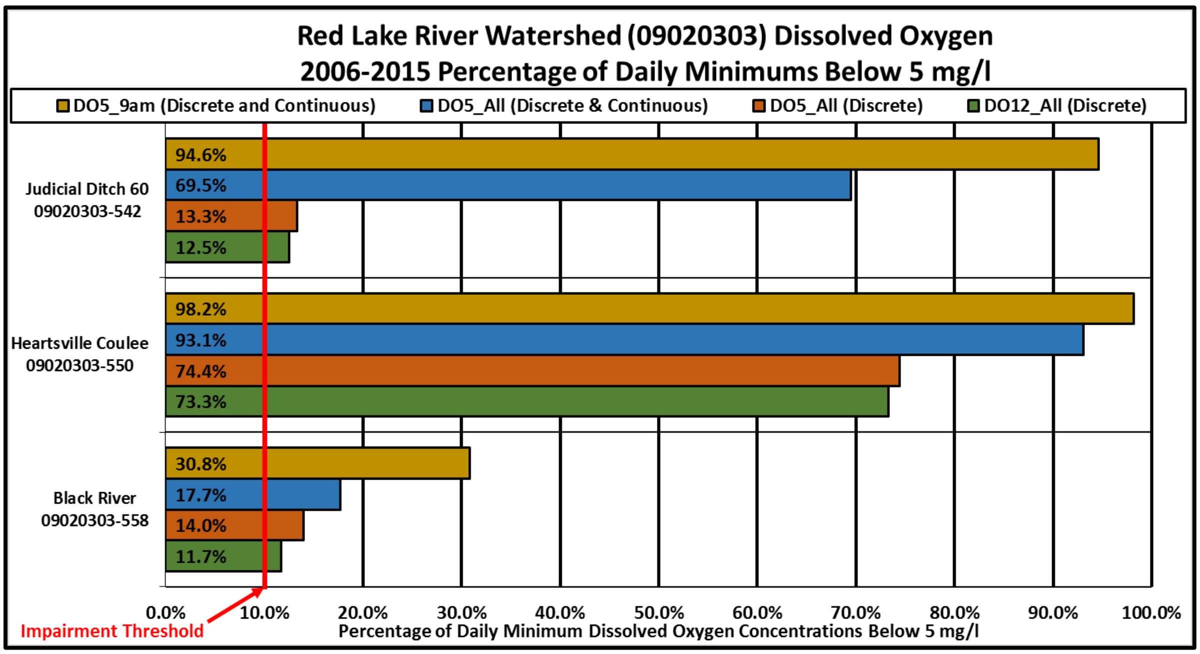


Figure 2-6. Relative severity of DO impairments, based on 2006-2015 data.

Most of the main channel of the Red Lake River downstream of Thief River Falls has had excellent DO concentrations. Downstream of Thief River Falls, DO loggers have only been deployed within tributaries. Of those tributaries, Kripple Creek at 180th Avenue exhibited the lowest frequency of low, pre-9:00 a.m. daily minimum DO readings only dropping below the standard 3.3% of the time. The impaired reach that is closest to being restored is Judicial Ditch 60 (09020303-542). That reach violated the DO standard in 11.4% of the 2004 through 2014 discrete DO readings collected in the months of May through September. The unimpaired reach that is in the most danger of becoming impaired based upon discrete data is the Gentilly River. Continuous monitoring data with frequently low DO readings have been recorded in some reaches that were not listed as impaired. Some, but not all, of these reaches had a high frequency of low DO readings that was explained by a lack of flow. Because of frequent low DO, due to low flow or other, more ambiguous causes, additional monitoring is recommended for these reaches:

- Pennington County Ditch 96 (09020303-505)
- Burnham Creek (09020303-515 and 09020303-551)
- Little Black River (09020303-527 and 09020303-528)
- Black River (09020303-529 and 09020303-558)
- Polk County Ditch 1 (09020303-536)
- Pennington County Ditch 21 (09020303-541)
- Channelized portion of the Red Lake River (09020303-561 and 09020303-562)

After an examination of the DO-impaired reach of Heartsville Coulee, the MPCA decided to re-categorize the impairment to Class 4C, because the impairment is caused by naturally low gradients influenced by wetlands and a diversion structure, creating low flow/stagnant conditions. A Class4C impairment does not require a TMDL to be completed.

***E. coli* Bacteria:** Regular sampling for *E. coli* bacteria did not begin until 2005. Due to the requirement of five samples per calendar month, most reaches had insufficient data for an assessment when the watershed was assessed in 2009 (only four years of data). The watershed was most recently assessed in 2014. A number of new *E. coli* impairments were identified during the 2014 assessment (Table 2-3).

Table 2-3. *E. coli*-impaired waters, severity of impairments, and the months in which they are impaired.

2006-2015 Monthly Geometric Mean *E. coli* Concentrations (MPN/100mL) and Exceedances in Impaired Reaches of the Red Lake River Watershed						
Stream Name	**AUID**	**May**	**June**	**July**	**August**	**September**
Pennington County Ditch 96	09020302-505	46.8	110.6	**264.1**	61	99.7
Kripple Creek	09020303-525	94.8	**245.3**	**136.4**	**437.9**	**169.6**
Little Black River	09020303-527	*12.8**	*31**	**194.9**	*62.5**	*161.6**
Black River	09020303-529	66.7	**246.8**	**150.2**	42	**137.4**
Gentilly River	09020303-554	21.5	**150.2**	**140.7**	**186**	72
Cyr Creek	09020303-556	100.5	**291.3**	**269**	113.3	926.9
Black River	09020303-558	11.3	89.6	**141.8**	110.7	24.8
*Italics and ** = Insufficient data for an official assessment of this month						
Water quality standard for monthly geometric mean *E. coli* = 126 MPN/100mL						

The impaired reach that is the closest to being restored is the natural portion of the Black River upstream of the Little Black River confluence (09020303-558) with a maximum monthly geomean of 153 MPN/100 mL. The portion of the Red Lake River that is in most danger of becoming impaired is the reach between CD 96 and the Clearwater River (09020303-504) due to a June *E. coli* geometric mean of 121.3 MPN/100 mL. The reaches of the Red Lake River with the lowest concentrations of *E. coli* have been the three reaches upstream of Thief River Falls (09020303-560, 09020303-561, and 09020303-

562). One reach, Pennington County Ditch 21, greatly exceeded the *E. coli* standards, but was not listed because the exceedances occurred on days during which there was no flow in the ditch.

Index of Biotic Integrity: The first formal assessment of fish and macroinvertebrate communities in the Red Lake River Watershed by the MPCA was completed in 2014. Prior to the 2014 assessment, two reports with fish sampling results from the Red Lake River Watershed had been published by the DNR (Red River Basin Stream Survey Report, Red Lake River Watershed, 2004) and the EPA (Development of IBI Expectations for the Lake Agassiz Plain Ecoregion 1998). Sampling was conducted in 2012 by the MPCA in preparation for the 2014 assessment. That year was exceptionally dry and IBI scores suffered due to a lack of water and flow. IBI assessment results from sites throughout the watershed are shown in Figures 2-7 and 2-8.

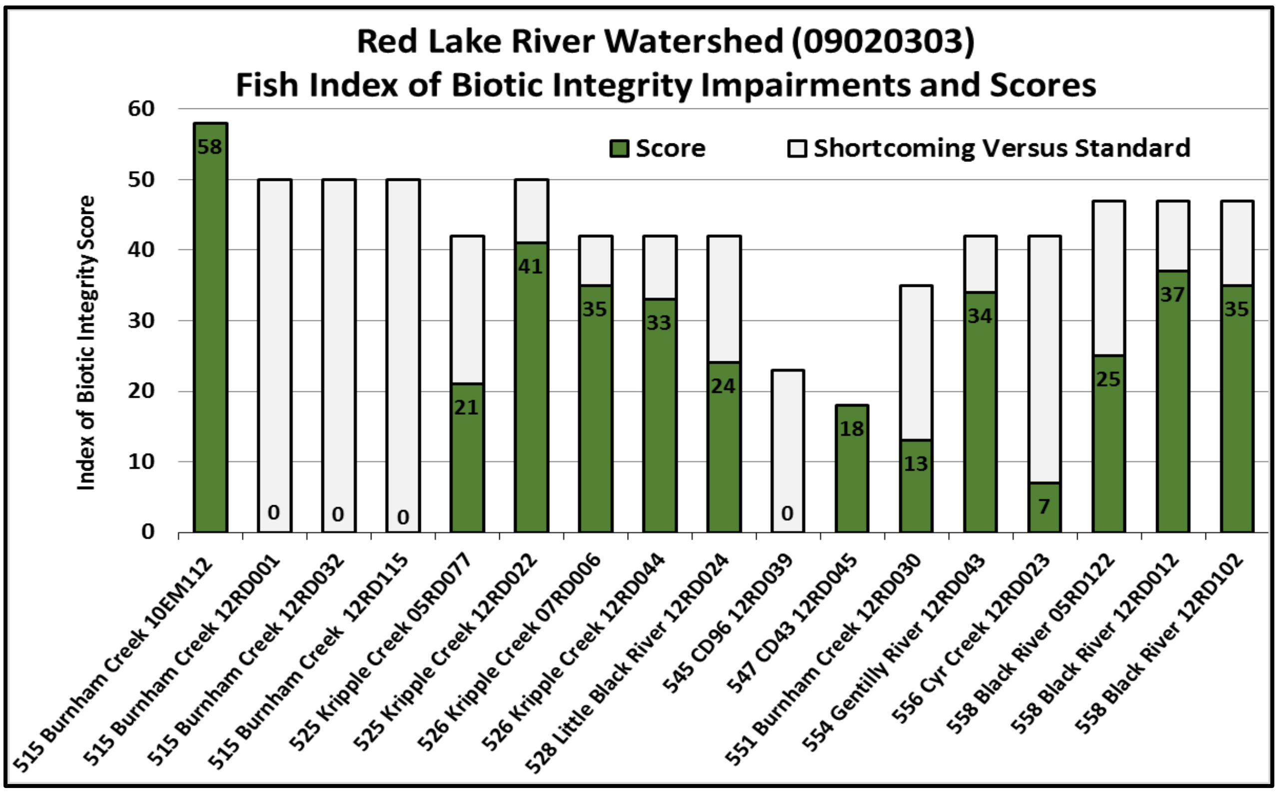


Figure 2-7. Fish IBI scores on impaired reaches and expectations of applied standards.

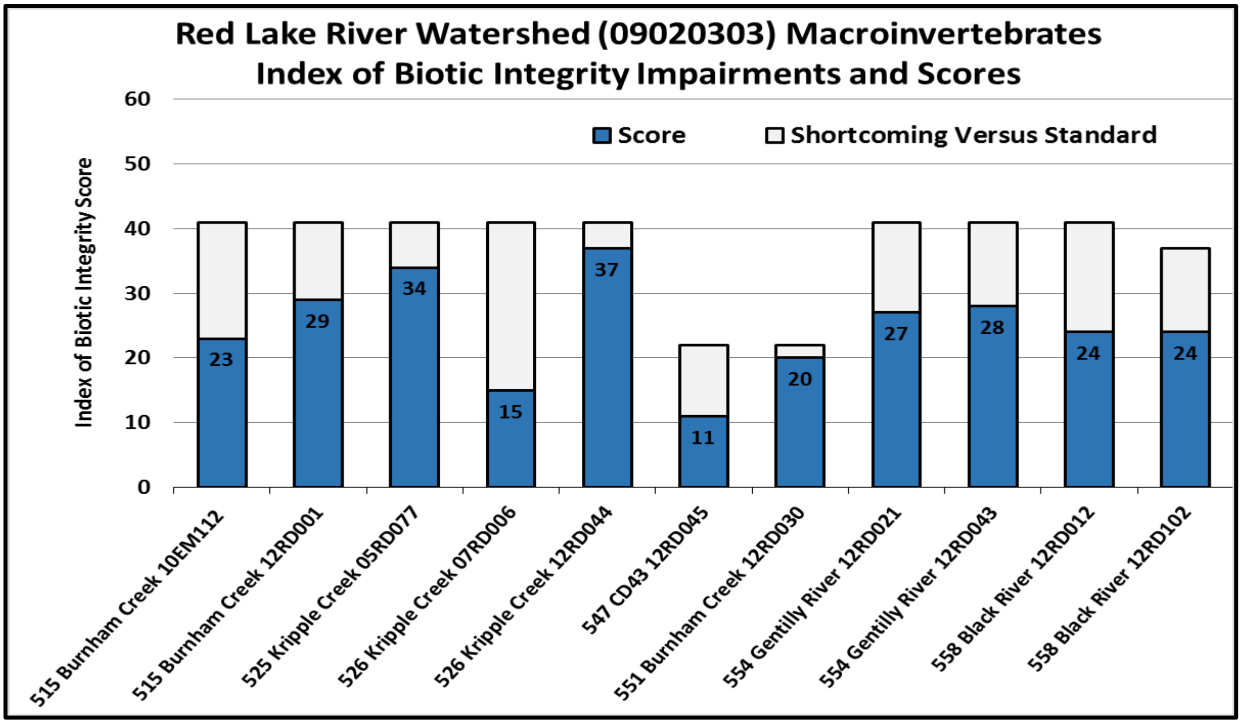


Figure 2-8. Macroinvertebrate IBI scores on impaired reaches and expectations of applied standards.

Locations of IBI assessments along with corresponding DNR Watershed Health Assessment Framework (WHAF) catchment IBI health score are shown in Figures 2-9 and 2-10.

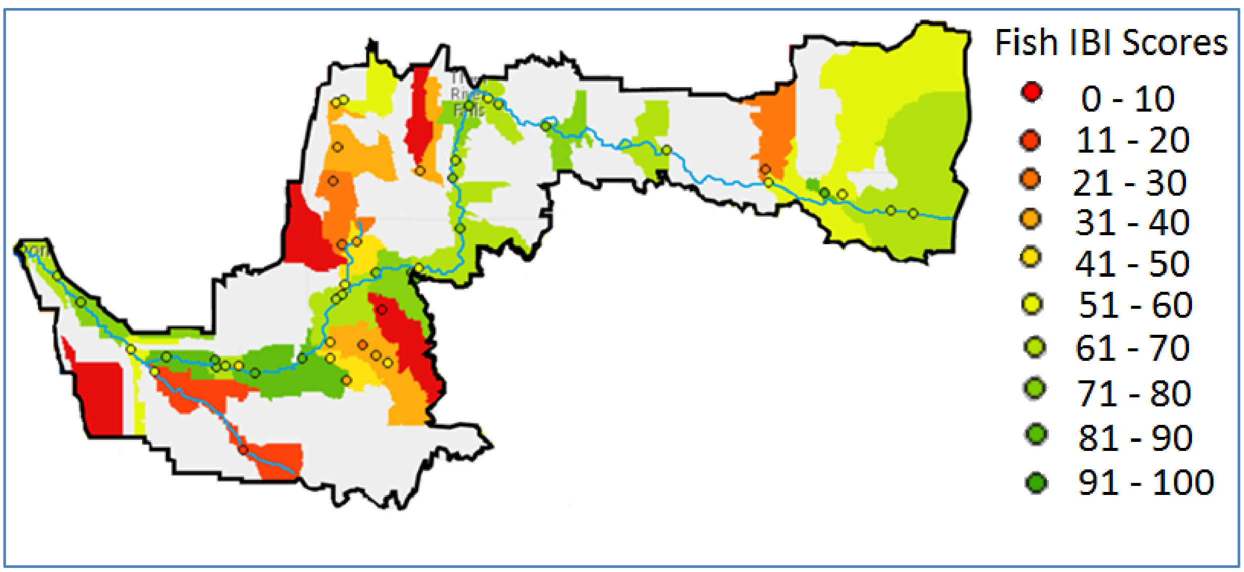


Figure 2-9. Fish IBI assessment locations with scores and DNR catchment IBI health score.

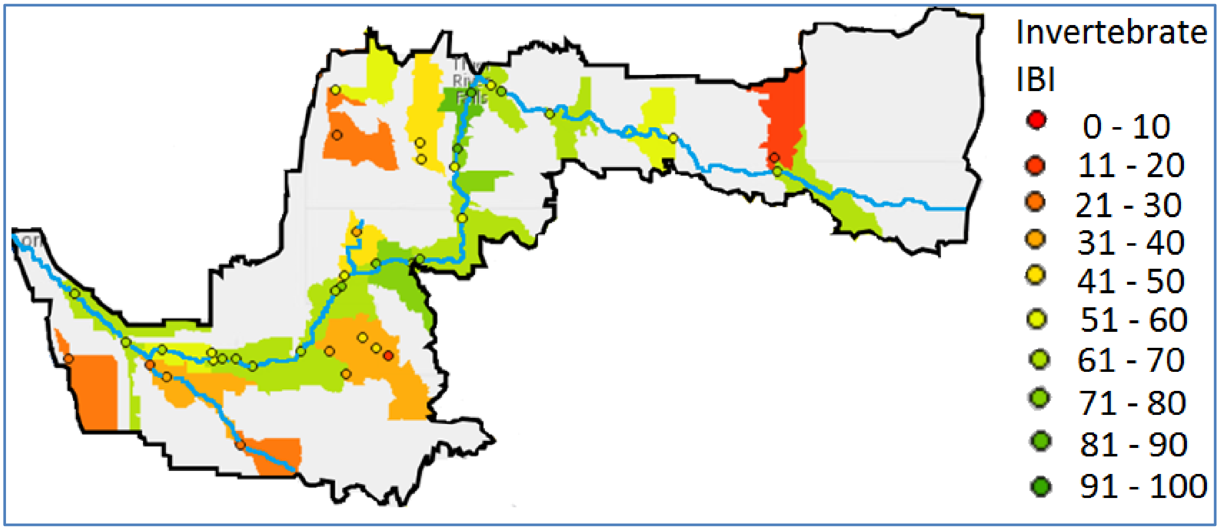


Figure 2-10. Macroinvertebrate IBI assessment locations with scores and DNR catchment IBI health score.

The downstream reaches of the Gentilly River (09020303-554) and Kripple Creek (09020303-526) are the portions of streams that are closest to meeting F-IBI standards, and should be a high priority for restoration efforts. Kripple Creek is also a reach that is very close to meeting the M-IBI standards. The lower portion of the Black River (09020303-529) is a reach that is in the greatest danger of becoming impaired, as it only exceeded the F-IBI impairment threshold by three points. The Red Lake River in Crookston failed to exceed the F-IBI impairment threshold, but the 09020303-506 reach as a whole is not impaired due to better scores at other stations along the reach. RLWD Ditch 12 (09020303-549) is the unimpaired reach that had the lowest M-IBI score relative to its applied standard. It fell 33 points short of meeting standards. However, biological sampling occurred immediately after construction within the ditch and all habitat had been removed. The highest F-IBI score that was recorded along the main channel of the Red Lake River was found near the confluence with Polk County Ditch 1. Ironically, this score was recorded less than 5.7 miles downstream of the Red Lake River site within Crookston that failed to reach the impairment threshold. The best M-IBI score in the watershed (83 points) was recorded in the Red Lake River near St. Hilaire (Site 05RD171 along AUID 09020303-513).

2.2 Water Quality Trends

The Mann-Kendall test was used to identify statistical trends in TSS, DO, TP, and *E. coli* at long-term monitoring sites within the Red Lake River Watershed. Monitoring sites with at least 10 years of monitoring data were targeted for the analysis. The Mann-Kendall test is a non-parametric test for identifying trends in time series data. The data values are evaluated as an ordered time series. Each data value is compared to all subsequent data values. An Excel spreadsheet was created to calculate Mann-Kendall statistic - S, the variance of S - VAR(S), normalized test statistic – Z, and the probability associated with the normalized test statistic – f(z) values for each period of time. In Tables 2-4 through 2-14, the trend is shown to be decreasing if the Z value is negative and computed probability is greater than 90%. The trend is shown as an increasing if the Z value is positive and the computed probability is greater than 90%. A series of data points that produce a probability of significance that is greater than 99% is shown as a strong trend. For each site, or group of sites, a particularly interesting trend is called out and shown in a graph in Figures 2-10 through 2-21.

Aggregation of all monitoring data indicated significant improvements for DO, but increasing concentrations of TP and *E. coli*. The results of the watershed-wide test could be influenced by changes in monitoring patterns. Data collection on tributaries of the Red Lake River has been expanded. Those tributaries generally have lower TSS concentrations, but higher *E. coli* concentrations than the main channel of the Red Lake River.

Increasing trends in *E. coli* concentrations may be due to increased sampling efforts along impaired tributaries. Other possible causes are discussed in Section 2.3.2. TSS concentrations have been trending upward at multiple sites. The upward trend in the Red Lake River at Fisher (S000-031, Table 2-7) may be partially influenced by load monitoring programs that target sampling during runoff events. DO levels appear to be improving at multiple sites.

Table 2-4. Water quality trends for all of the data collected within the Red Lake River Watershed.

Recent Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River Watershed - All Sites	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1992-2014	1992-2014	1992-2014	2000-2014
Annual Average	X	↑+ (green)	↑+ (red)	↑+ (red)
Summer (May - Sept.)	X	↑ (green)	↑+ (red)	↑+ (red)
April	X	X	↑ (red)	↑ (red)
May	X	↑+ (green)	↑ (red)	X
June	X	X	↑+ (red)	↑ (red)
July	↓ (green)	↑ (green)	X	↑ (red)
August	X	X	X	↑ (red)
September	↓ (green)	↑ (green)	X	X
October	↓+ (green)	X	X	↑ (red)
X = No Trend				
↑ (green) = Upward Trend (Getting Better)				
↓ (green) = Downward Trend (Improvement)				
↑+ (green) = Strong Upward Trend (Getting Significantly Better)				
↓+ (green) = Strong Downward Trend (Getting Significantly Better)				
↑+ (red) = Strong Upward Trend (Getting Significantly Worse)				
↑ (red) = Upward Trend (Getting Worse)				

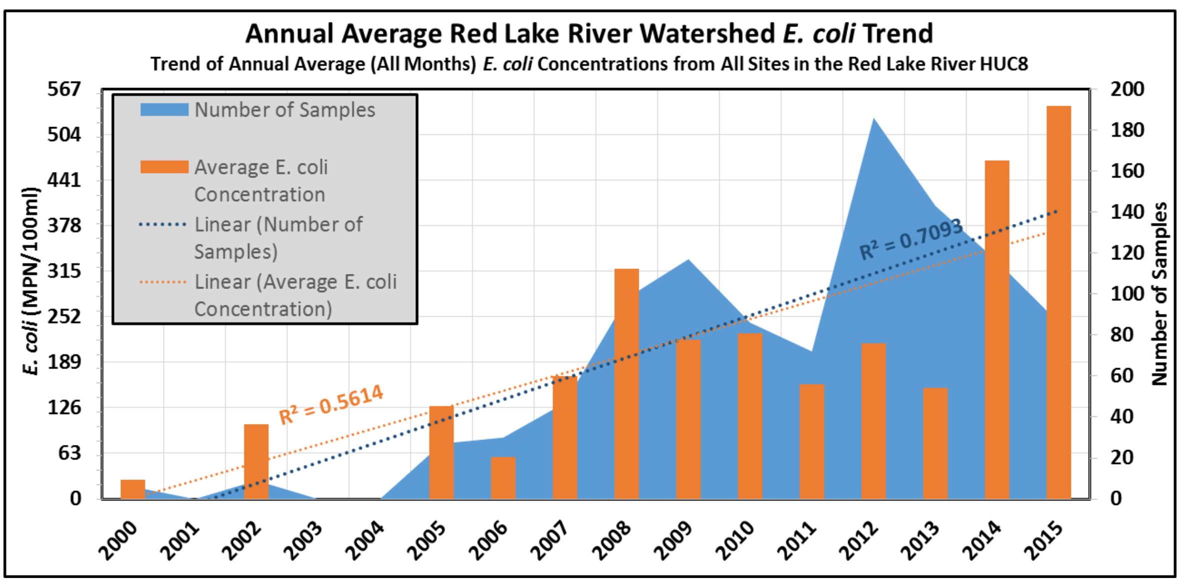


Figure 2-11. Upward trends in average *E. coli* concentrations and sample collection efforts.

Table 2-5. Historical Water quality trends in the Red Lake River in the city of East Grand Forks.

Historical Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River in East Grand Forks S002-963, S000-013	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1953-2015	1953-2015	1958-2015	1985-2015
Annual (All Months)	↑ + (red)	↑	↓ +	X
Summer (May - Sept.)	X	↑ +	↓ +	X
April	X	↑ +	↓	X
May	X	↑	↓ +	X
June	X	X	↓	X
July	X	↑ +	↓	X
August	X	↑ +	↓ +	X
September	X	X	↓	X
October	X	↑	↓ +	X
X = No Trend				
↑ = Upward Trend (Getting Better)				
↓ = Downward Trend (Improvement)				
↑ + (red) = Strong Upward Trend (Getting Significantly Worse)				
↑ + = Strong Upward Trend (Getting Significantly Better)				
↓ + = Strong Downward Trend (Getting Significantly Better)				

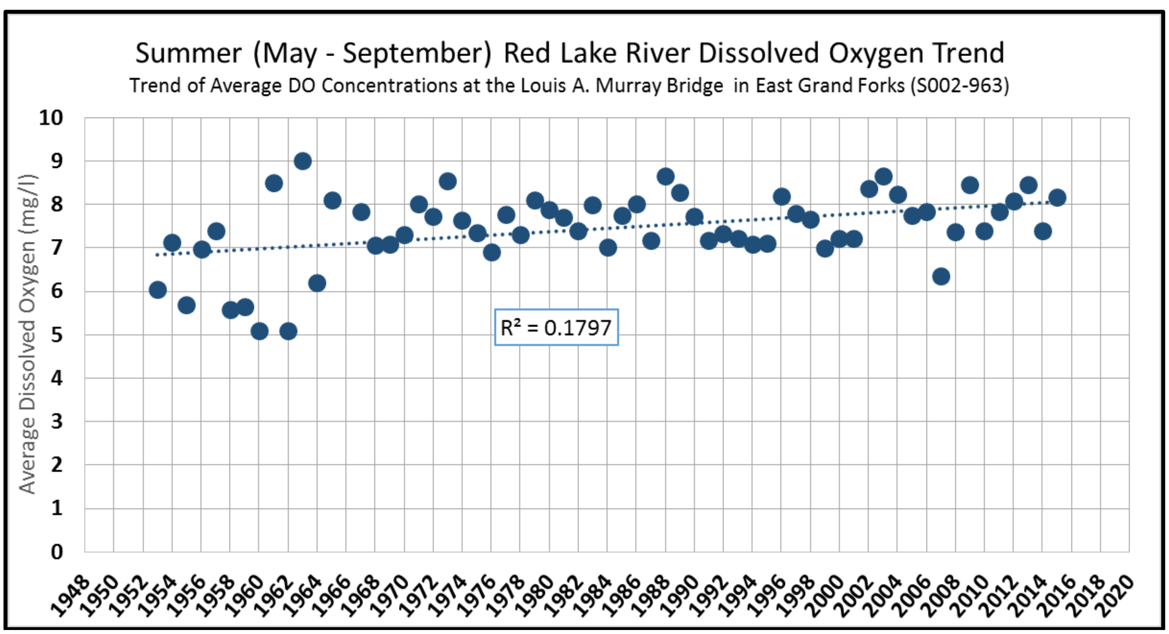


Figure 2-12. Summer DO trend in the Red Lake River at the Murray Bridge in East Grand Forks.

Table 2-6. Recent Water quality trends in the Red Lake River in the city of East Grand Forks.

Recent Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River in East Grand Forks **S002-963, S000-013**	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1992-2014	1992-2014	1992-2014	2000-2014
Annual (All Months)	↑ (red)	↓ (red)	X	X
Summer (May - Sept.)	X	↑ (green)	X	X
April	X	X	X	X
May	X	X	X	X
June	X	X	X	X
July	X	↑ (green)	X	X
August	X	X	↓ (green)	X
September	X	↑ (green)	↓ (green)	X
October	↓ (green)	X	↓ (green)	X
X = No Trend				
↑ (green) = Upward Trend (Getting Better)				
↓ (green) = Downward Trend (Improvement)				
↑ (red) = Upward Trend (Getting Worse)				
↓ (red) = Downward Trend (Getting Worse)				
↑ + (green) = Strong Upward Trend (Getting Significantly Better)				
↓ + (green) = Strong Downward Trend (Getting Significantly Better)				

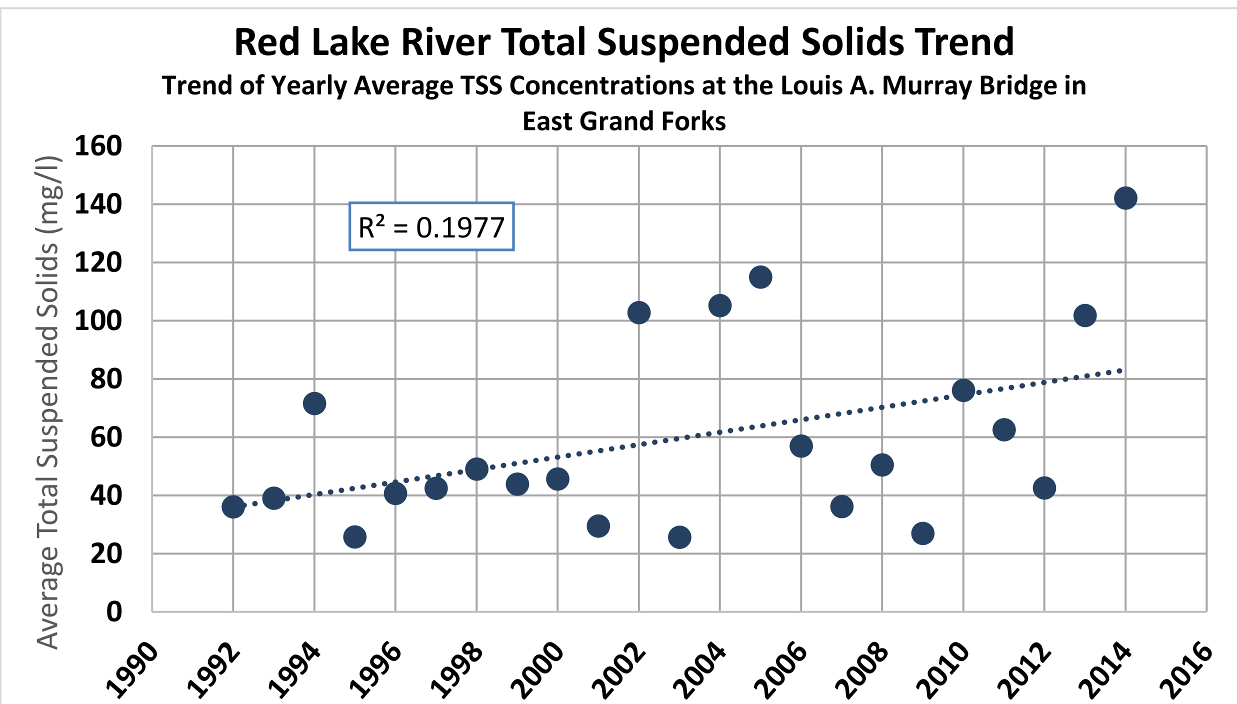


Figure 2-13. Trend of Red Lake River TSS at the Murray Bridge in East Grand Forks.

Table 2-7. Water quality trends in the Red Lake River at Fisher.

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River at Fisher **S000-031**	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1992-2014	1992-2014	1992-2014	2000-2013
Annual (All Months)	↑ (red, +)	X	↑ (red)	X
Summer (May - Sept.)	↑ (red)	↑ (green)	X	X
April	X	X	X	X
May	↑ (red)	X	X	X
June	X	↑ (green)	↓ (green)	↓ (green)
July	X	↑ (green)	X	X
August	X	X	↓ (green)	X
September	X	↑ (green)	X	X
October	X	X	↓ (green)	X
X = No Trend				
↑ (green) = Upward Trend (Getting Better)				
↓ (green) = Downward Trend (Improvement)				
↑ (red) = Upward Trend (Getting Worse)				
↓ (red) = Downward Trend (Getting Worse)				
↑ (red, +) = Strong Upward Trend (Getting Significantly Worse)				

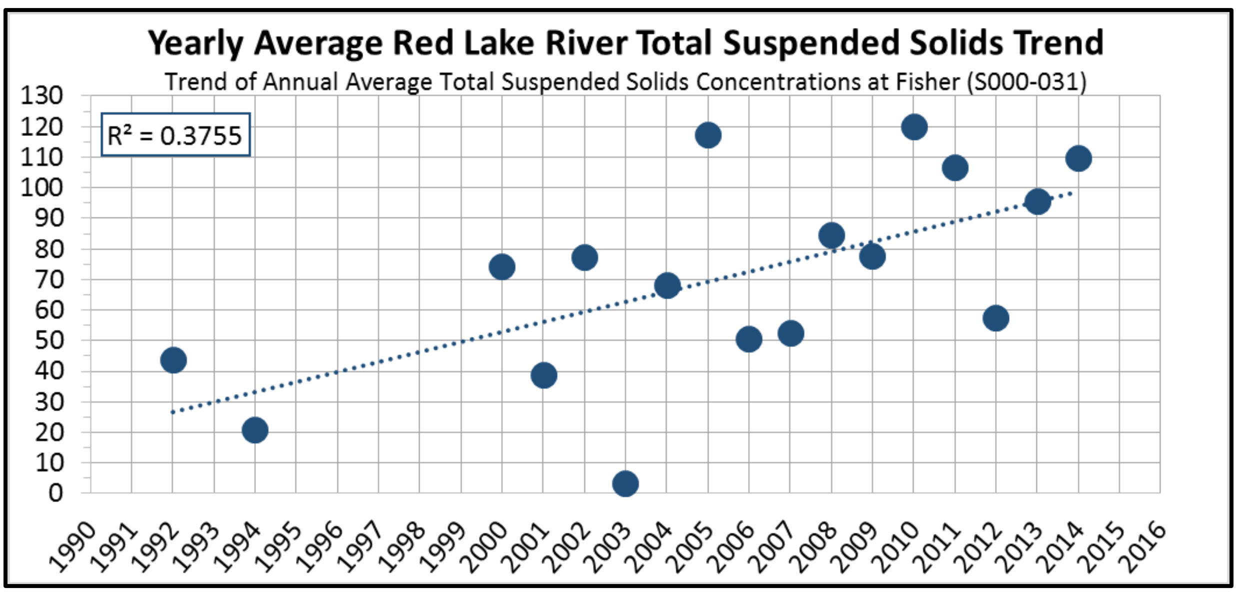


Figure 2-14. Trend of yearly average Red Lake River TSS at Fisher.

Table 2-8. Water Quality Trends in the Red Lake River at Crookston (S002-080).

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River Crookston Site S002-080/05079000	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1994-2014	1997-2014	1992-2014	2005-2014
Annual Average	X	X	X	X
April	↓ (green)	X	↓ (green)	X
May	X	↑ (green)	X	X
June	X	X	X	↑ (red)
July	X	X	X	↑ (red)
August	X	X	X	X
September	X	↑+ (green)	X	X
October	X	X	↓ (green)	X
November - March	↑ (red)	X	X	X
X = No Trend				
↑ (green) = Upward Trend (Getting Better)				
↓ (green) = Downward Trend (Improvement)				
↑+ (green) = Strong Upward Trend (Getting Significantly Better)				
↑ (red) = Upward Trend (Getting Worse)				

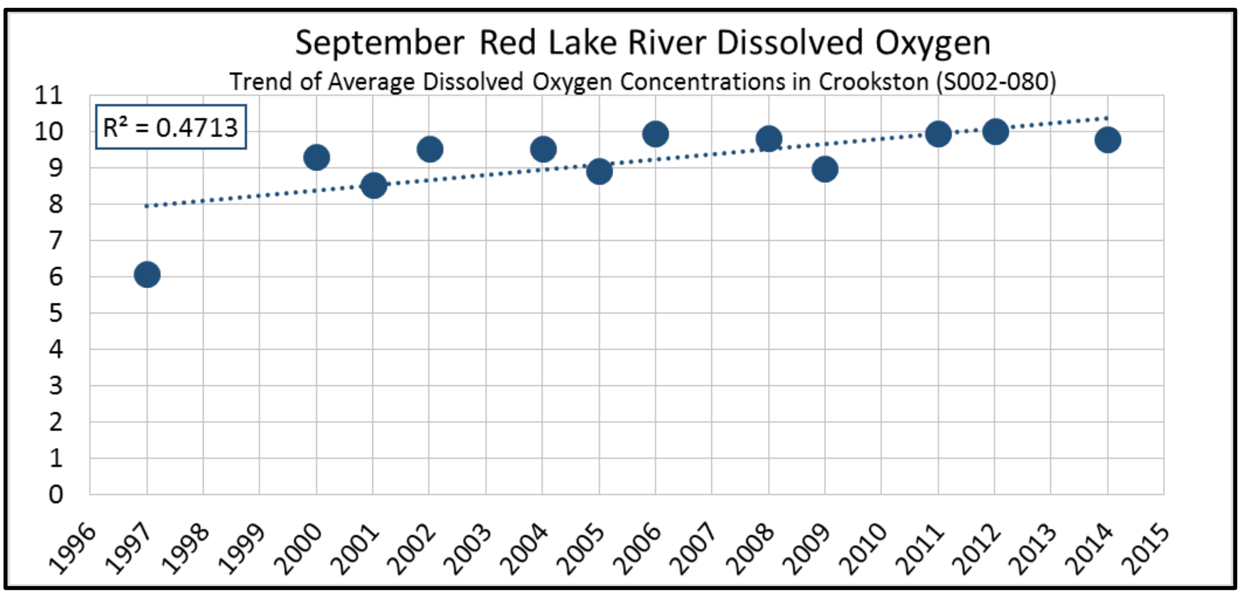


Figure 2-15. Trend in September DO readings in the Red Lake River at Crookston.

Table 2-9. Water quality trends in the Red Lake River at the CSAH 3 crossing near Huot.

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River at Huot (CSAH 3): Sites S002-976 and S003-173	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1998-2015	1998-2015	1998-2015	2005-2015
All Months	X	⬆ (green)	X	⬆ (red)
Summer (May - Sept.)	X	⬆+ (green)	X	⬆ (red)
April	X	X	X	X
May	⬆ (red)	X	⬆ (red)	⬆ (red)
June	X	⬆ (green)	X	X
July	⬆ (red)	⬆+ (green)	⬇ (green)	X
August	X	⬆ (green)	X	X
September	X	⬆ (green)	X	X
October	⬇ (green)	⬆ (green)	X	X
X = No Trend				
⬆ (red) = Upward Trend (Getting Worse)				
⬆ (green) = Upward Trend (Getting Better)				
⬇ (green) = Downward Trend (Improvement)				
⬆+ (green) = Strong Upward Trend (Getting Significantly Worse)				

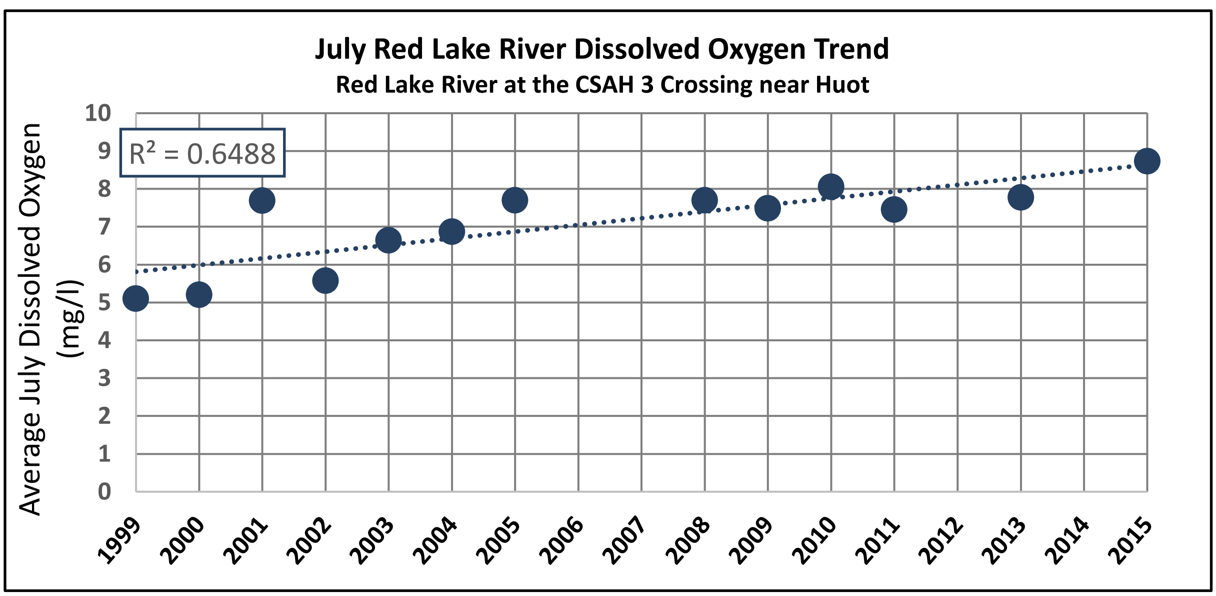


Figure 2-16. Trend in July DO concentrations in the Red Lake River near Huot.

Table 2-10. Water quality trends in the Red Lake River in the city of Thief River Falls.

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River In Thief River Falls S002-076, S002-324, S006-225	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1994-2014	1992-2014	1992-2014	2005-2014
Annual (All Months)	X	X	X	X
Summer (May - Sept.)	X	X	X	red ↑
April	X	X	X	X
May	green ↓	red ↓	X	X
June	X	X	red ↑	X
July	green ↓	red ↓	X	red ↑ +
August	X	X	X	X
September	X	X	green ↓	X
October	green ↓ +	red ↓ +	X	X
X = No Trend				
red ↑ + = Strong Upward Trend (Getting Significantly Worse)				
red ↑ = Upward Trend (Getting Worse)				
red ↓ + = Strong Downward Trend (Getting Significantly Worse)				
green ↓ = Downward Trend (Improvement)				
green ↓ + = Strong Downward Trend (Getting Significantly Better)				

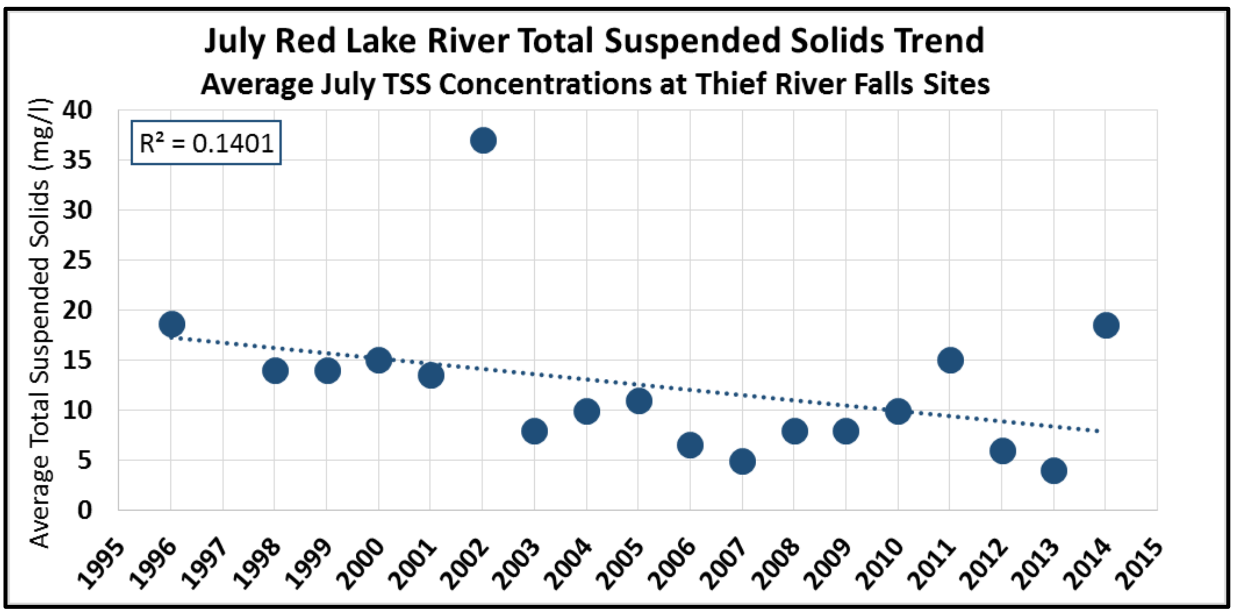


Figure 2-17. Trend in July TSS in the Red Lake River at Thief River Falls.

Table 2-11. Water quality trends in the Red Lake River at the CSAH 219 Bridge in Highlanding.

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Red Lake River at Highlanding (CSAH 219) S002-077	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1992-2014	1990-2015	1992-2014	2000-2014
Annual (All Months)	X	↓ (red)	↑ (red)	X
Summer (May - Sept.)	X	X	X	X
April	X	X	X	X
May	X	X	X	X
June	↑ (red)	X	X	↑ (red)
July	X	X	X	X
August	X	X	X	X
September	X	X	X	X
October	↓+ (green)	↓ (red)	↓ (green)	X
X = No Trend				
↑ (green) = Upward Trend (Getting Better)				
↓ (green) = Downward Trend (Improvement)				
↑ (red) = Upward Trend (Getting Worse)				
↓ (red) = Downward Trend (Getting Worse)				
↓+ (green) = Strong Downward Trend (Getting Significantly Better)				

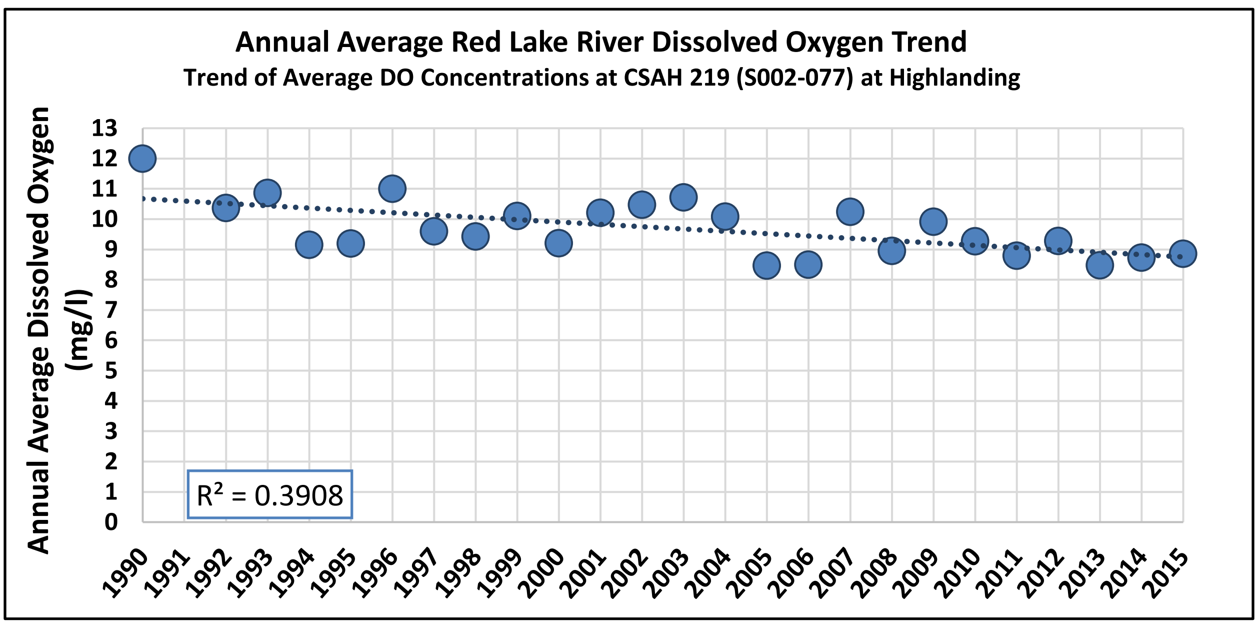


Figure 2-18. Trend in annual average DO in the Red Lake River at Highlanding.

Table 2-12. Water quality trends near the downstream end of the Burnham Creek Watershed.

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
(Lower) Burnham Creek At 270th Ave SW, 320th Ave SW, & 270th St. SW Site S002-972, S007-058, S002-081	Total Suspended Solids	Dissolved Oxygen	Total Phosphorus	E. coli
Years	1999-2015	1992-2014	1992-2014	2005-2014
Annual (All Months)	X	X	X	X
Summer (May - Sept.)	X	X	X	X
April	↓	X	X	X
May	↑	X	X	X
June	X	X	X	X
July	↓	X	X	↑
August	X	X	X	↓
September	X	X	↓	↓
October	↓	X	X	X
X = No Trend				
↑ = Upward Trend (Getting Worse)				
↓ = Downward Trend (Improvement)				

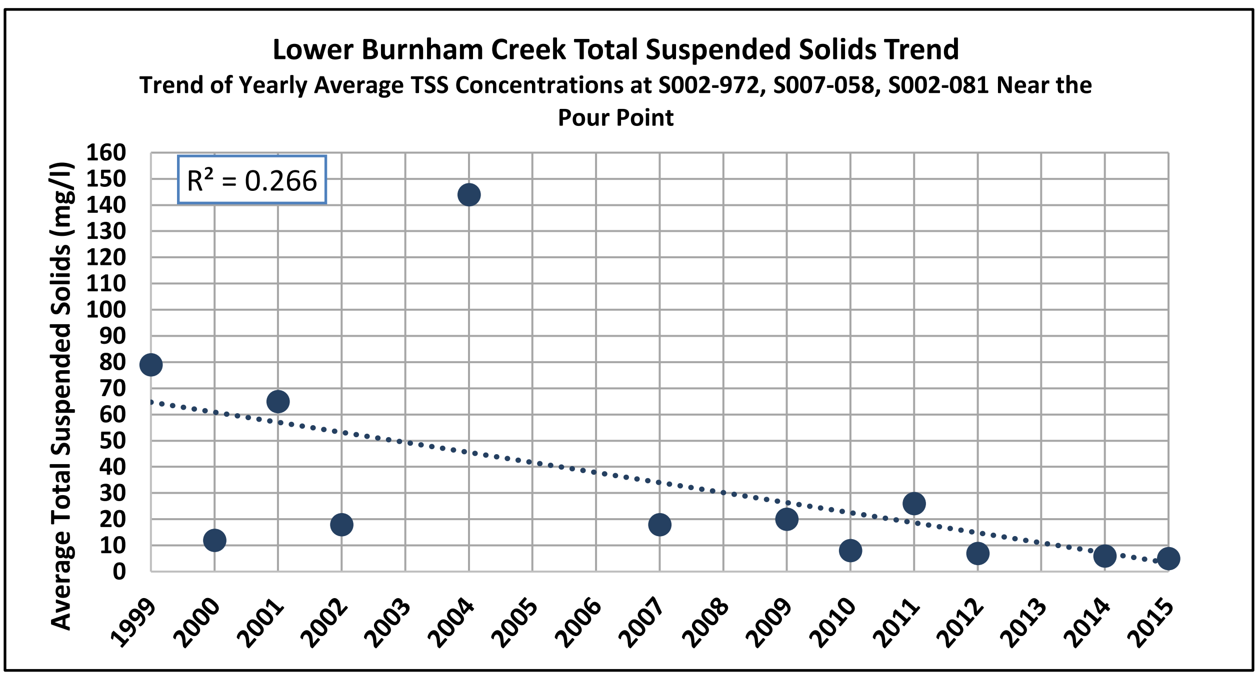


Figure 2-19. Trend in yearly average TSS in lower Burnham Creek.

Table 2-13. Water quality trends in the Gentilly River at CSAH 11.

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Gentilly River at CSAH 11 **S004-058**	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	2005-2014	2005-2014	2005-2014	2005-2015
Annual (All Months)	X	↑ (green)	X	X
Summer (May - Sept.)	X	X	↑ (red)	↑ (red)
April	X	X	X	X
May	X	X	↑ (red)	X
June	X	X	↑ (red)	X
July	X	X	X	X
August	X	X	↑ (red)	X
September	X	↓ (red)	X	X
October	X	X	X	X
X = No Trend				
↑ (green) = Upward Trend (Getting Better)				
↓ (green) = Downward Trend (Improvement)				
↑ (red) = Upward Trend (Getting Worse)				
↓ (red) = Downward Trend (Getting Worse)				
↓ (green, +) = Strong Downward Trend (Getting Significantly Better)				

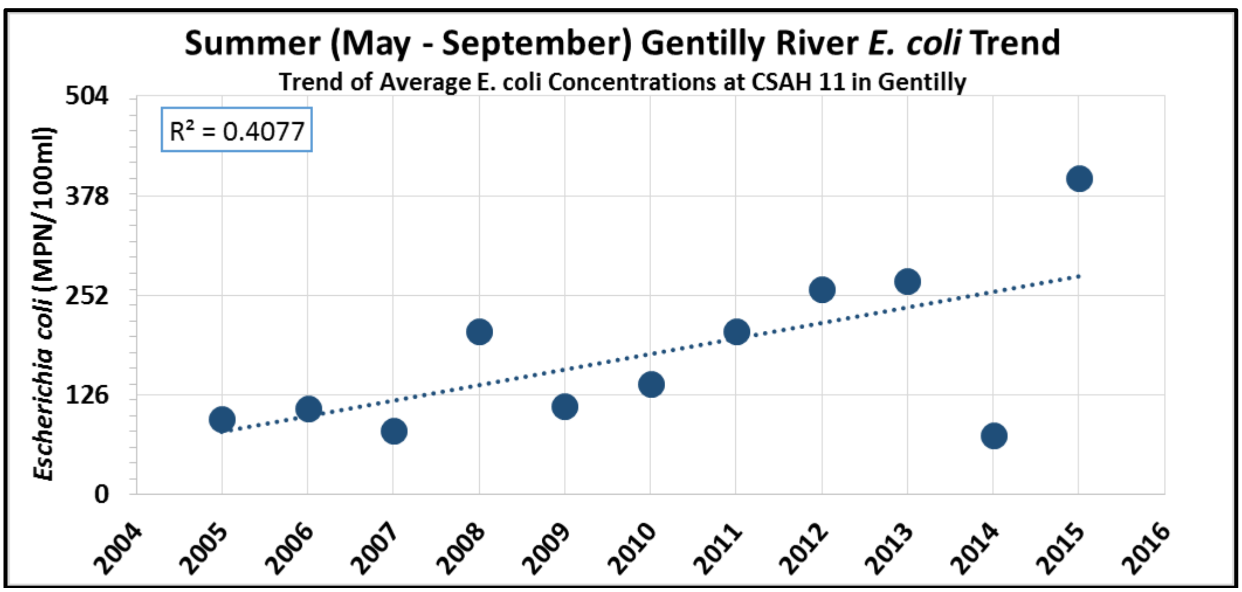


Figure 2-20. Trend in summer *E. coli* concentrations in the Gentilly River.

Table 2-14. Water quality trends in the Black River at CSAH 18 (S002-132).

Trends of Seasonal Averages Using Seasonal Mann-Kendall Analysis				
Black River at CSAH 18 Site S002-132	**Total Suspended Solids**	**Dissolved Oxygen**	**Total Phosphorus**	**E. coli**
Years	1992-2014	1992-2014	1992-2014	2005-2015
Open Water (Apr. - Oct.)	X	X	Upward Trend (Getting Worse)	Strong Upward Trend (+)
April	X	X	X	X
May	X	X	X	X
June	X	Upward Trend (Getting Better)	Upward Trend (Getting Worse)	Strong Upward Trend (+)
July	X	X	X	Upward Trend (Getting Worse)
August	X	X	X	X
September	X	X	X	X
October	X	Upward Trend (Getting Better)	X	X
November - March	X	X	X	X

X = No Trend
(green arrow) = Upward Trend (Getting Better)
(red arrow with +) = Strong Upward Trend (Getting Significantly Worse)
(red arrow) = Upward Trend (Getting Worse)

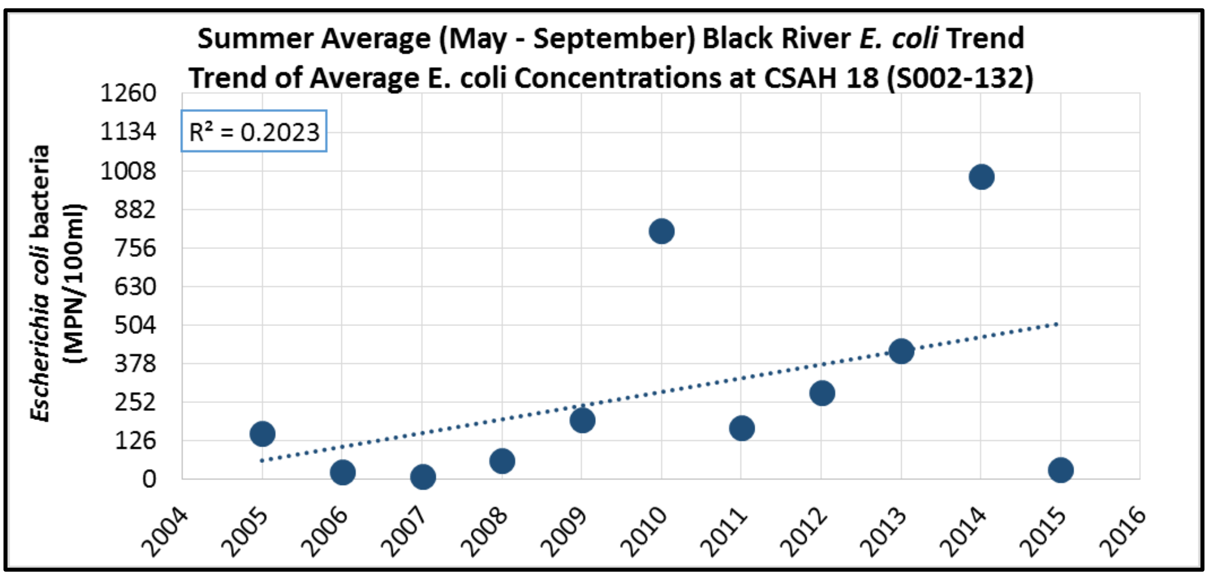


Figure 2-21. Trend in summer average *E. coli* concentrations in the Black River.

2.3 Stressors and Sources

In order to develop appropriate strategies for restoring or protecting waterbodies, the stressors and/or sources influencing or threatening them must be identified and evaluated. Biological SID is done for streams with either fish or macroinvertebrate biota impairments, and encompasses both evaluation of pollutants and non-pollutant-related factors as potential stressors (e.g. altered hydrology, fish passage, habitat). Pollutant source assessments are done where a biological SID process identifies a pollutant as a stressor, as well as for the typical pollutant impairment listings. Table 2-19 lists the impaired waterways and which stressors and pollutant sources are contributing to those impairments. Section 2.3 provides further detail on locations of stressors and pollutant sources. Section 3.3 provides information about what will be done to address the impairments. Known pollutant sources for unimpaired reaches have also been identified for this WRAPS document.

Nonpoint sources of pollution are the dominant source of pollutants in the watershed. The relative contributions of point and nonpoint sources are shown in Figure 2-22. Current knowledge of nonpoint pollutant sources for impaired reaches and reaches in need of protection is shown in Table 2-16.

The wastewater treatment facilities (WWTFs) that discharge into the Red Lake River are listed in Table 2-15. Figure 2-24 displays the relatively small amount of pollution that is contributed by point source WWTFs within the watershed. Average annual TSS, TP, and nitrogen (N) loads were estimated by the Red Lake River HSPF model. Average annual TSS loads from WWTFs were calculated from permitted concentrations and discharge records. No permitted TP or N concentrations were found, but WWTFs have been required to monitor concentrations. Average concentrations from the most recent year of monitoring (typically 2015) were used, along with discharge duration records to calculate annual TP and N loads. The total point source loads were subtracted from the total annual loads to calculate the estimated annual nonpoint loads. The WWTF for the City of Crookston was not included in the annual point source loading estimates in Figure 2-20 because the facility has not discharged for many years. Even though the Crookston WWTF is permitted to discharge, the WWTF is operated currently as infiltrations basins with primary treatment prior to infiltration.

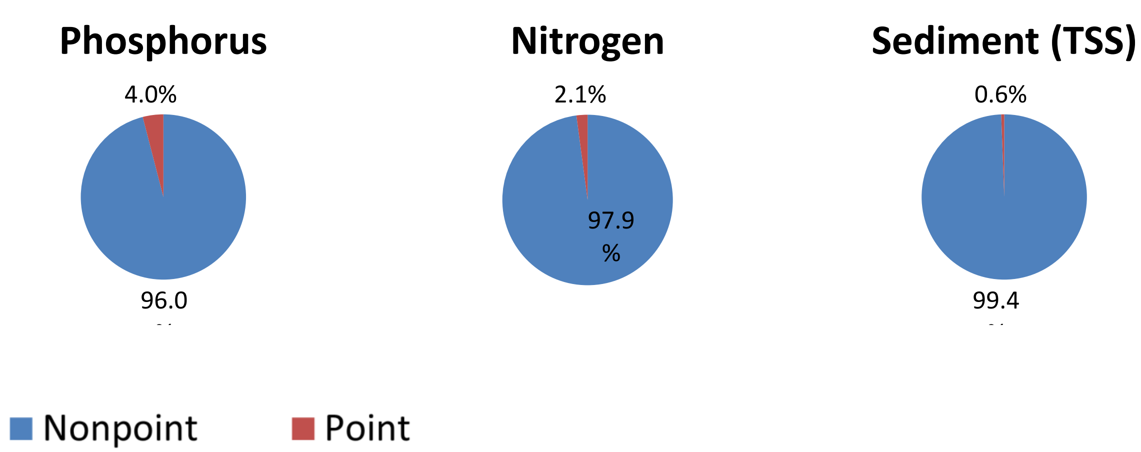


Figure 2-22. Overall breakdown of nonpoint source vs. point source pollution in Red Lake River Watershed.

Table 2-15. Point Sources in the Red Lake River Watershed and downstream affected reaches.

Red Lake River Wastewater Treatment Facilities and Reaches Impaired			Wastewater Treatment Facility Discharge Monitoring Stations						
HUC 10	Affected Reaches		Thief River Falls MN0021431	St. Hilaire MN0024741	7 Clans Casino MN0063452	Red Lake Falls MNG580161	American Crystal Sugar MN0001929	Crookston MN0021423	Fisher MNG580170
0902030303	09020303-504	CD96 to Clearwater River	X	X	X				
0902030305	09020303-502	Black River to Gentilly River	X	X	X	X			
0902030305	09020303-512	Gentilly River to CD99	X	X	X	X			
0902030305	09020303-506	CD99 to Burnham Creek	X	X	X	X			
0902030307	09020303-501	Burnham Creek to Heartsville Coulee	X	X	X	X	X	X	X
0902030307	09020303-503	Heartsville Coulee to Red River	X	X	X	X	X	X	X

Table 2-16. Nonpoint Sources in the Red Lake River Watershed. Relative magnitudes of contributing sources are indicated.

HUC-10 Subwatershed	Stream/Reach (AUID)	Pollutant	Pollutant Sources: Inadequate Riparian Buffers**	Upland Erosion	Stormwater	Wastewater Treatment Facilities	Wind Erosion	Streambank Erosion	Natural Background	Livestock along Streams	Birds (e.g. Cliff Swallows)	Waterfowl	Failing Septic Systems
Upper Red Lake River 0902030302	Red Lake River (560, 561, 562)	TSS	⭘	●	⭘		○	○					
		E. coli			○				○	⭘	⭘		
	Penn. CD 43 (547)	TSS	⭘										
Red Lake River City of St. Hilaire 0902030303	Red Lake River (504)	TSS	●	●	●	⭘	⭘	⭘					
		E. coli			⭘	⭘			○		●		
	Penn. CD 96 (505)	*E. coli*							○	○	●	○	○
	Br5 Penn. CD 96 (545)	TSS	○	○									
Black River 0902030304	Little Black River (528)	TSS	⭘	⭘									
		E. coli							○	●	○	●	
	Black River (529)	TSS	○	⭘				●					
		E. coli							○	⭘			⭘
	Black River (557)	TSS	○	○				○					
		E. coli							○		○	○	
	Black River (558)	TSS	○	⭘				○					
		E. coli							○	●		○	
Red Lake River City of Crookston 0902030305	Red Lake River (502)	TSS	●	●	⭘	⭘	●	⭘					
		E. coli			○	○			○	○	○	○	○
	Red Lake River (506)	TSS	●	●	●	⭘	⭘	⭘					
	Red Lake River (512)	TSS	●	●	●	⭘	⭘	⭘					
	Kripple Creek (525)	TSS	●	●			⭘	○					
		E. coli		●					○	⭘	⭘		●
	Kripple Creek (526)	TSS	⭘										
		E. coli							○	●	○		⭘
	Judicial Ditch 60 (542)	TSS	○	○				○					
	Gentilly River (554)	TSS	○	○									
		E. coli							○	○	○	○	
	Cyr Creek (556)	TSS	⭘					⭘					
		E. coli							○	○	○		
Burnham Creek 0902030306	Burnham Creek (515)	TSS	●	●			⭘	⭘					
		E. coli							○		○		
	Burnham Creek (551)	TSS	●	●			⭘						
Lower Red Lake River 0902030307	Red Lake River (501)	TSS	●	●	●	○	●	●					
	Red Lake River (503)	TSS	○	⭘	●	○	○	●					
	Heartsville Coulee (550)	TSS	○		⭘		○						
		E. coli			○				○		○	○	

Key: ● = High ⭘ = Moderate ○ = Low Blank = Absent or Undiscovered

**The SID Report was completed prior to the compliance deadlines for the Buffer Law. However, the RLWD currently has a lower compliance rate than the state as a whole.

2.3.1 Total Suspended Solids

Identification and reduction of sediment sources and erosion problems is an ongoing effort within the Red Lake River Watershed. Sources have been identified by water quality models, spatial analysis, examination of aerial photos, windshield surveys, the WRAPS process, stream channel stability assessments, and public surveys. There are six reaches within the watershed that are impaired by TSS. Sources of sediment are described within the TMDL document and this section. Information about the locations of erosion problems can be found in Section 3.1. LGUs can use the information in Sections 2.5, 3.1, and 3.3 of this report to plan targeted, prioritized projects that will have measurable results.

Load duration curves (Figure 2-23) show that most of the exceedances of the TSS water quality standard coincide with high and very high flows. This indicates that nonpoint sources of sediment are the primary source of excess sediment.

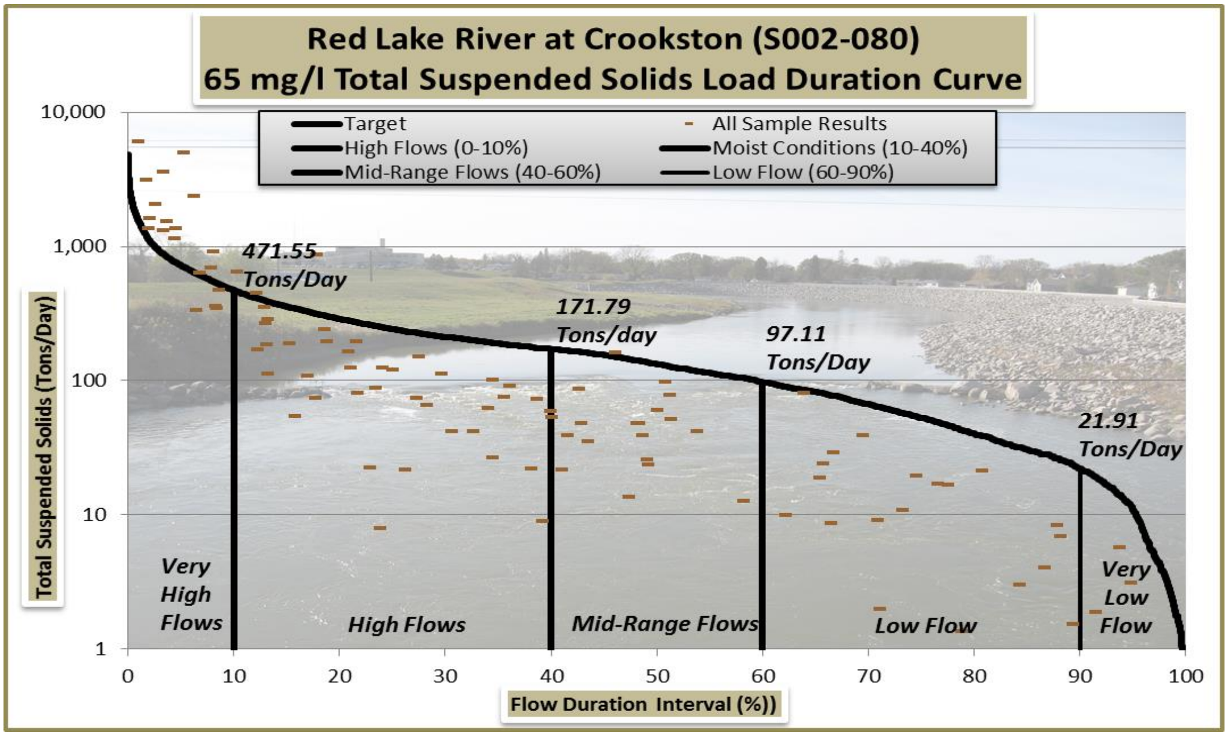


Figure 2-23. Load duration curve example (Red Lake River at Crookston).

Multiple nonpoint sources are contributing to excess TSS concentrations in the Red Lake River. Overland erosion, streambank erosion, wind erosion, and stormwater runoff all contribute to TSS concentrations and loads. Each of these categories of sources have been investigated and documented to some extent. Water quality models have been developed as a means of identifying the areas of the watershed that are contributing the most sediment, particularly from overland erosion. The results of a fluvial geomorphology study that was conducted by the DNR can help target erosion prevention efforts along the river channels. Longitudinal sampling has provided insight into the locations of sediment sources.

Efforts to reduce erosion and TSS concentration along rivers, streams, and ditches that are currently meeting water quality standards are also important for improving conditions for aquatic life, preventing degradation, and preventing future impairments. Since TSS is also commonly associated with phosphorus, a reduction in TSS should help dramatically lower phosphorus loads of the Red Lake River Watershed, benefitting downstream Lake Winnipeg (NRS 2014)

Based upon assessment statistics, a number of streams are in danger of becoming impaired in the future due to frequently high TSS concentrations (high single-digit percentages). Excess sediment is also described as a stressor of aquatic life for several reaches by the Red Lake River Watershed SID Report.

Table 2-22 shows the six reaches that are most in need of protection to avoid future TSS impairments. The SID Report identified high levels of suspended sediment as a possible contributing stressor for six AUIDs on four streams:

- Burnham Creek (09020303-515 and 09020303-551)
- Kripple Creek (09020303-525 and 09020303-526)
- Gentilly River (09020303-554)
- Black River (09020303-558)

This section includes explanations of sediment sources in the Red Lake River Watershed:

Construction and Industrial Stormwater

Turbidity and TSS impairments along the Red Lake River have been identified at monitoring sites in Red Lake County and Polk County. According to publicly available information, the annual percentage of land area under construction has been 0.021% in Polk County and .005% in Red Lake County.

According to publicly available facility information, there are somewhere between 375 and 394.34 acres of permitted industrial activity within the 909,024-acre Red Lake River Watershed. That acreage represents 0.04% of the watershed. The facility information for one 19.34-acre parcel is incomplete and does not list the acres of industrial activity, but the percentage of the watershed covered by industrial activity rounds to 0.04% with or without that parcel.

The combined area covered by permitted construction and industrial activity is between .045% and .061% of the Red Lake River Watershed.

Regulated Municipal Separate Storm Sewer Systems

A municipal separate storm sewer system (MS4) is a conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains, etc.). It is owned or operated by a public entity (which can include cities, townships, counties, military bases, hospitals, prison complexes, highway departments, universities, etc.) that has jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes. It is designed or used for collecting or conveying stormwater and discharges to waters of the United States. It is not a combined sewer. It also is not part of a publicly owned treatment works. The Red Lake River TMDL also accounted for the acreage under the Minnesota Department of Transportation (MnDOT) right of way (ROW) that lies within the urbanized portion of impaired AUIDs in wasteload calculations.

When the U.S. Census is completed every ten years, MS4s with a population greater than 5,000 based on the latest U.S. Census and that have been assigned a wasteload allocation (WLA) in an approved TMDL are required to obtain coverage under the MS4 permit. There are only two current MS4 in the Red Lake River Watershed, the City of East Grand Forks (Permit #MS400088) and the MnDOT ROW.

East Grand Forks is located at the downstream end of an impaired reach (AUID -503). East Grand Forks Storm Water Prevention Plan (SWPP), Stormwater Ordinance and public outreach can be found on their website. A significant current and historical problem in the city, is mud being deposited on the road from the hauling of sugar beets to the processing plant. The mud deposition is caused by wet conditions and the clay soil of the Red River Valley sticking to the tires of beet hauling tucks and causes muddy, slippery road conditions. This has increased the amount of sediment that enters the stormwater system. City staff demonstrated the problem to RLWD staff in May of 2009 by running a lift station near the processing plant that discharged dark-colored water with a TSS concentration of 720 mg/L. This issue has not been addressed to date.

The city of Crookston, population 7,804 (2016), is located along a reach of the Red Lake River that is impaired by high TSS (AUID – 512). Stormwater contributions have been studied within the city of Crookston (2011). Some of the general findings of the study are applicable to other cities along the Red Lake River. The Crookston Stormwater Management Study identified areas of the city that were contributing to the turbidity impairment in the Red Lake River. Six areas were sampled over the course of the summer of 2011, with the highest sample for turbidity occurring in the industrial park at 447 NTU. The study recommended a variety of structural and nonstructural (such as public education and moving of city's snow dumping site) practices to address stormwater concerns in the city. After EPA approval of the Red Lake River Watershed TMDL (public noticed in conjunction with this report), the City of Crookston will be required to obtain coverage under the MS4 permit as they will be assigned a WLA in the TMDL.

Stormwater from the city of Thief River Falls, population 8,796 (2016), is upstream of the TSS impaired reach AUID – 504 (the impairment starts just south of St. Hilaire). However, the Red Lake River is not impaired as it flows through the city of Thief River Falls and sampling data shows that the city's reservoir has the net effect of removing sediment from the river. The 90th percentile TSS concentration and assessment statistics are better (lower concentration and lower rate of exceedance) within the reservoir and where the river begins to flow out of the city than they are in the Red Lake River or Thief River upstream of the city. The city's stormwater flows into the Thief River within the influence of the reservoir. Even though there is a net improvement in water quality (regarding TSS concentrations) as water flows through Thief River Falls, there still are notable sources of TSS and other pollutants that have been identified and should be addressed through voluntary practices and cooperation among local entities. The Pennington County SWCD, with the assistance of a consultant, completed a stormwater study for the City of Thief River Falls. The *Thief River Falls Water Quality Study* (2017) identified optimal locations throughout the city where stormwater BMPs could be targeted to deliver measurable water quality benefits. Thief River Falls is not proposed to receive a WLA in the draft Red Lake River TMDL and thus will not be required to obtain coverage under the MS4 permit.

Wastewater Treatment Facilities

Six WWTFs discharge into the Red Lake River (Table 2-15 and Figure 2-24). Compared to other sources of sediment in the Red Lake River, WWTF discharge is not a significant contributor from an annual load perspective. Between 2006 and 2015, WWTFs annually contributed an average total of 173.7 tons of sediment to the Red Lake River, combined. That amount is less than one tenth of a percent of the total estimated current annual load in the Red Lake River at Fisher. Discharge records from the St. Hilaire WWTF reveal no occasions in which that facility has exceeded 30 mg/L. Although it is permitted to do so, the Crookston WWTF has not discharged to the Red Lake River since 1997 thanks to the use of tertiary treatment and rapid infiltration basins. The permitted TSS concentrations for the facilities along the Red

Lake River are less than or equal to the 65 mg/L water quality standard that is applied to the Red Lake River in AUIDs 501, 503, 506, and 512.

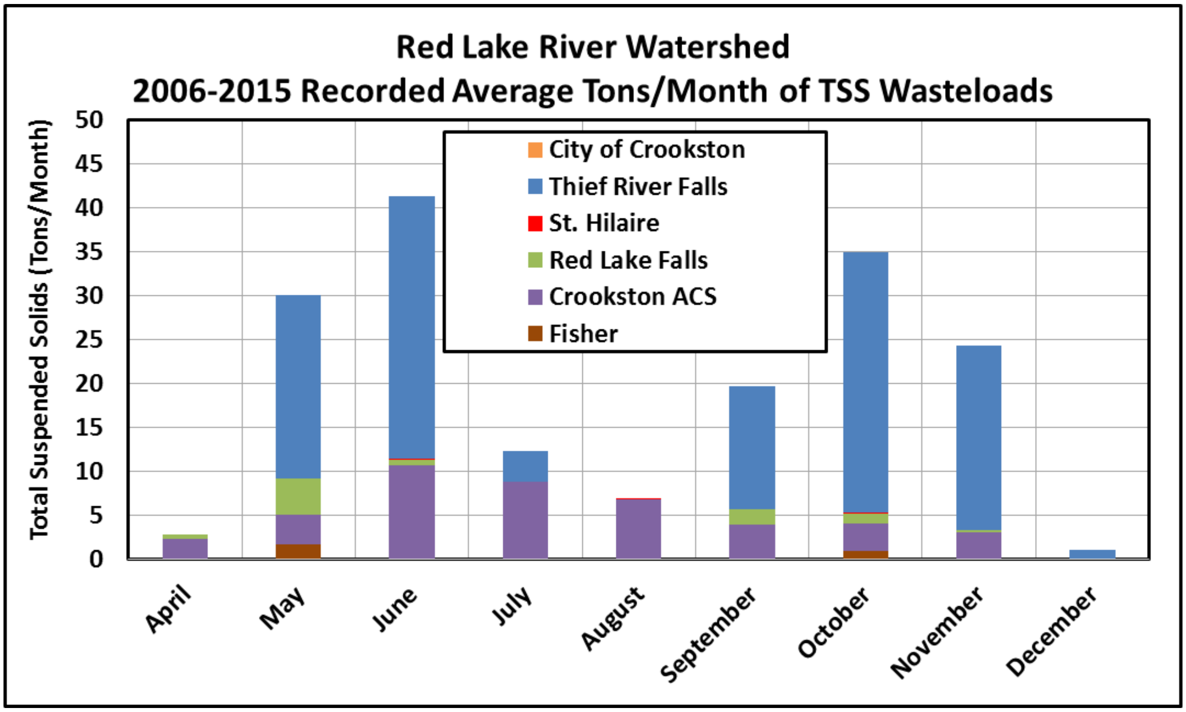


Figure 2-24. Relative wastewater contributions from cities along the Red Lake River.

It is still possible for the Red Lake River to be affected by wastewater contributions in some situations. During very low flows, WLAs can account for a large percentage of the total load allocation at the Fisher gage on the Red Lake River. Discharges that occur when flows at the gage (USGS 05080000) are lower than 200 cfs could have a significant effect upon water quality in the river. Discharge with a TSS concentration greater than 30 mg/L from the Thief River Falls WWTF, St. Hilaire WWTF, or Red Lake Falls WWTF could negatively affect TSS concentrations in the portion of the Red Lake River AUIDs 504 and 502 that are required to meet a 30 mg/L TSS standard. The reported TSS concentration in Red Lake Falls WWTF effluent is often lower than 30 mg/L, but has occasionally exceeded that level. Concentrations in Thief River Falls WWTF discharge have also occasionally exceed the 30 mg/L standard.

Drainage

For over the last century, an effort has been made to increase the rate at which water is shed off the land by creating ditch networks and or straightening natural reaches in the area. Much of this ditching (channelization) occurred in the early 1900s through various state/county projects in an effort to create conditions which would better suit the agricultural land use practices of the area. In more recent years, installation of drain-tiles has become a common practice to even further increase the drainage rate of the area. Although these projects accomplish their initial goal of draining water from the upstream land more quickly, many of the streams in the watershed have become hydrologically unstable and thus prone to bank failure (MPCA 2016).

The report, *Red Lake River Watershed Farm to Stream Tile Drainage Water Quality Study* (2009), looked at the effects of tile drainage within the watershed. The report looked both at water quality and water quantity with respect to tile drainage. Key findings from the report:

- With conventional agriculture, there seems to be a water quality trade-off when using tile drainage. Lowered sediment and phosphorus concentrations, but nitrate concentrations are increased.
- Tile drainage in the Red River Basin reduces peak flows from an individual field relative to surface drained fields during runoff events.
- The duration of flow from tile is much longer than the duration of flow from surface drainage.
- Tile drainage in the Red River Basin increases the total volume of runoff in the long-term relative to surface drained fields.
- Antecedent conditions have a significant role on the influence of tile drainage during a runoff event. A rainfall event will have a varying effect upon runoff due to varying levels of initial soil moisture, rainfall amount, rainfall intensity, and rainfall duration.
- The results pertain only to tile drainage systems with similar soils and topography in Red River Basin **that do not have surface inlets.**
- A major recommendation of this study would be the complete conversion of wild rice paddies to main line tile drainage as it provided significant water quality benefits.

Until recently, no permits were required for private drainage projects within the RLWD. The RLWD started requiring permits for the installation of subsurface tile drainage within the Red Lake River Watershed in September 2015. This change in management was prompted by multiple concerns about tile drainage management and installation. Tiling permits have a set of conditions placed upon them to reduce the effect of erosion at the outlet of the systems.

Stream and Ditch Bank Erosion

Typical of the Red River Basin/Lake Agassiz Plain ecoregion in general, most of the reaches within this watershed are relatively low gradient in nature as the area has a poorly defined floodplain. To exemplify this point, at its origin at Lower Red Lake in Clearwater County, the Red Lake River has an elevation of approximately 1,181 feet above sea level. The outlet elevation near East Grand Forks is 348 feet lower at approximately 833 feet. Since the Red Lake River flows about 192 miles from its source to its confluence with the Red River, its average gradient is only 1.8 feet/mile (MPCA 2016) . Because of this low gradient, the streams are not efficient at transporting large amounts of water rapidly. With changes in the hydrology this has increased flow velocity of outside bends in the river's meanders, often resulting in severe bank erosion.

The report *Streambank Stabilization Challenges in the Glacial Lake Agassiz Sediments of the Red River Basin in North Dakota* (Rush, 2007) outlines the issues of stream bank erosion in the Red River Basin, which includes Red Lake River Watershed.

This relatively young river network cuts evermore sinuous channels through glaciolacustrine strata, such as the Sherack and Brenna Formations that formed some of the richest agricultural land in the world. These strata beneath the rivers and agricultural lands are layers of highly plastic, fat clays deposited within the ancient lake. The clays shrink and swell in reaction to the region's extreme climatic swings and are subject to slope failure where they are unconfined along the river meanders. Although these slope failure naturally occur in the Red River Valley, their frequency and severity has been exacerbated by clearing of riparian vegetation, development of riverside land, and changes in basin-wide hydrology.Several factors individually and cumulatively affect river bank instability including properties of the sediment, topographic slope, hydrology and the presence of vegetation.

The report states that many of the clays and silty-clay soils of the basin have little strength when wet and unconfined. Because of this natural feature, the removal of deep-rooted vegetation also has a significant effect on stream bank erosion. The importance of deep-rooted vegetation for the prevention of mass wasting and slumping riverbanks is evident along the lower reaches of the Red Lake River, where vegetation has been removed (lawns, agriculture, etc.) and the banks are experiencing mass wasting (sloughing).

The report concludes that hydrology is a critical factor of slope stability and identifies changes in hydrology from residential development as one source. The report also states:

"*increased drainage of agricultural land during the last 50 years and record precipitation during the past decade have led to frequent and significant flooding in the valley. The precipitation and flooding, especially during frost-free months, has drastically increased groundwater levels and soil moisture. These changes in discharge and flooding have caused the river channels to downcut and widen as they adjust to new flow regimes. The combined effect of the above factors has been a rapid increase in the number of slope failures across the Red River Valley.* This effect has been noted in the Red Lake River Watershed as channel incision has created situations where floodwaters do not have immediate access to a floodplain. This creates instability because high velocity floodwaters are confined to the stream channel and not allowed to dissipate energy over a larger area.

Figure 2-25. Photos of eroding bluffs along the Red Lake River near Red Lake Falls.

Eroding streambanks along the Red Lake River (Figure 2-25) have been documented with georeferenced photos. An erosion site inventory identified and ranked 63 notable erosion problems that were identified during the 2007 Red Lake River Rendezvous canoe tour. Eroding river and stream banks were documented during the fluvial geomorphology study. Inventoried Red Lake River reaches and tributaries include:

- The entirety of the Red Lake River AUIDs 09020303-501 and 09020303-503 between Burnham Creek and the Red River of the North.
- A portion of Red Lake River AUID 09020303-506 from a point half-way between Crookston and Fisher (47.784183, -96.726945, in alignment with 310th Ave SW).
- A portion of the Red Lake River AUID 09020303-512 from CSAH 11 to the former location of the Otter Tail Power Dam (47.773091, -96.527230).
- The Red Lake River between Hwy 32 and Old Crossing Treaty Park (AUIDs 09020303-504, 09020303-510, 09020303-511, and 09020303-502)
- 6.3 miles of the Red Lake River downstream of the southern edge of Thief River Falls (48.092769/-96.186071 to 48.040046/-96.210036)
- Red Lake River Forsberg Park (185th Ave NE) to Finsbury Park (in Thief River Falls)
- Red Lake River from approximately 240th Ave to the Smiley (CSAH 7) Bridge.
- Red Lake River downstream of Highlanding (CSAH 24 crossing) to approximately 280th Ave NE
- Red Lake River from the River Valley (CSAH 3) access to the Highlanding (CSAH 219) access.
- Black River, downstream of CSAH 18

A fluvial geomorphology study was completed for the Red Lake River Watershed. Bank Erosion Hazard Index (BEHI) ratings were conducted along reaches of the Red Lake River and its tributaries in 2012. Full geomorphic assessments were conducted on representative reaches along the Red Lake River and a tributary in 2012. Follow-up work was completed in 2013. The Pfankuch stability ratings were stable along the Red Lake River. Excess upland and bank erosion problems were still identified. Erosion rates were highest along TSS-impaired reaches (Table 2-17). High, steep banks are very susceptible to gully erosion. Much of the Red Lake River channel between Thief River Falls and the Clearwater River is incised. Development of the land adjacent to the Red Lake River within Thief River Falls is widespread and the buffer condition varies greatly.

Table 2-17. BANCS Model erosion estimates from the Red Lake River Fluvial Geomorphology Study

Red Lake River Watershed Fluvial Geomorphology Study BANCS Model Erosion Estimates from 2012 Reconnaissance Reaches								
River	Reconnaissance Reach	AUID(s)	Impaired by TSS?	Length (miles)	Erosion Volume (yds^3/yr)	Erosion Mass (tons/yr)	Erosion Rate (tons/mile/yr)	Pfankuch Stability Rating
Red Lake River	CSAH 3 to CSAH 219	09020303-561	No	3.4	33.3	43.3	12.7	Stable
Red Lake River	110th St. NE to 280th Ave NE	09020303-561	No	4.7	45.5	59.2	12.6	Stable
Red Lake River	East of 230th Ave NE to CSAH 7	09020303-562	No	7.6	177.3	230.6	30.3	Stable
Red Lake River	Forsberg Park to Finsbury Park	09020303-562	No	6.2	218.4	283.9	45.8	Stable
Red Lake River	Mark Blvd to Hwy 32/CR7	09020303-513	No	3.8	1545.2	2008.7	528.6	Stable
Red Lake River	Hwy 32 to Sportsman's Park near Red Lake Falls.	09020303-504	Yes	4.9	6144.3	7987.6	1630.1	Stable
Red Lake River	Sportsman's Park to 200th St. SW	09020303-510 09020303-511 09020303-502	Yes (502), 510 and 511 are unknown	6.2	6456.6	8393.6	1353.8	Stable
Red Lake River	CSAH 11 to 220th Ave SW (Otter Tail Power Dam)	09020303-512	Unknown	4.4	3038.1	3949.5	897.6	Stable
Black River	CSAH 18 to the Red Lake River	09020303-529	No	0.95	238.4	309.9	326.2	Unstable

The outlets of multiple public drainage systems along the Red Lake River are also unstable and contributing to the sediment loads in the Red Lake River. Eroding outlets have been identified in some counties within the Red Lake River Watershed.

An example of an unstable ditch outlet is the outlet of JD60 (AUID 09020303-542), downstream of CSAH 11. Major headcutting and slope failure is occurring downstream of the CSAH 11 crossing and the downstream end of the culvert is significantly perched. MPCA and RLWD staff visited with the landowner and learned that he would be in favor of a potential grade stabilization project there. Another notable, rapidly eroding portion of a ditch system is the lower 1.25 miles of Polk County Ditch 1, between Highway 2 and the Red Lake River. Velocities are very high along this reach during runoff events. New, massive slumps have been observed in recent years. A new home has recently been built dangerously close to the unstable ditch bank.

Implementation of the provisions of the State of Minnesota’s 2015 Buffer Law will be very beneficial to water quality conditions throughout the watershed. Modeling results indicate that improved buffers will significantly improve water quality. Nearly the entire length of the Red Lake River has been traversed by water quality professionals and the relationship between buffer quality and erosion is evident. Although buffers will not stop all erosion, the most severe erosion problems occur where there is no perennial vegetation buffer. Trees and deep-rooted vegetation stabilize banks and provide surface protection. Slumping typically occurs where there is no woody and deep-rooted vegetation. The next step would be to encourage voluntary improvement of the quality of vegetation along buffers (more woody and native vegetation). Ditches and public waters will be inspected for buffer compliance under the law. Figure 2-26 indicates the level of compliance with the Buffer Law as of January 2019.

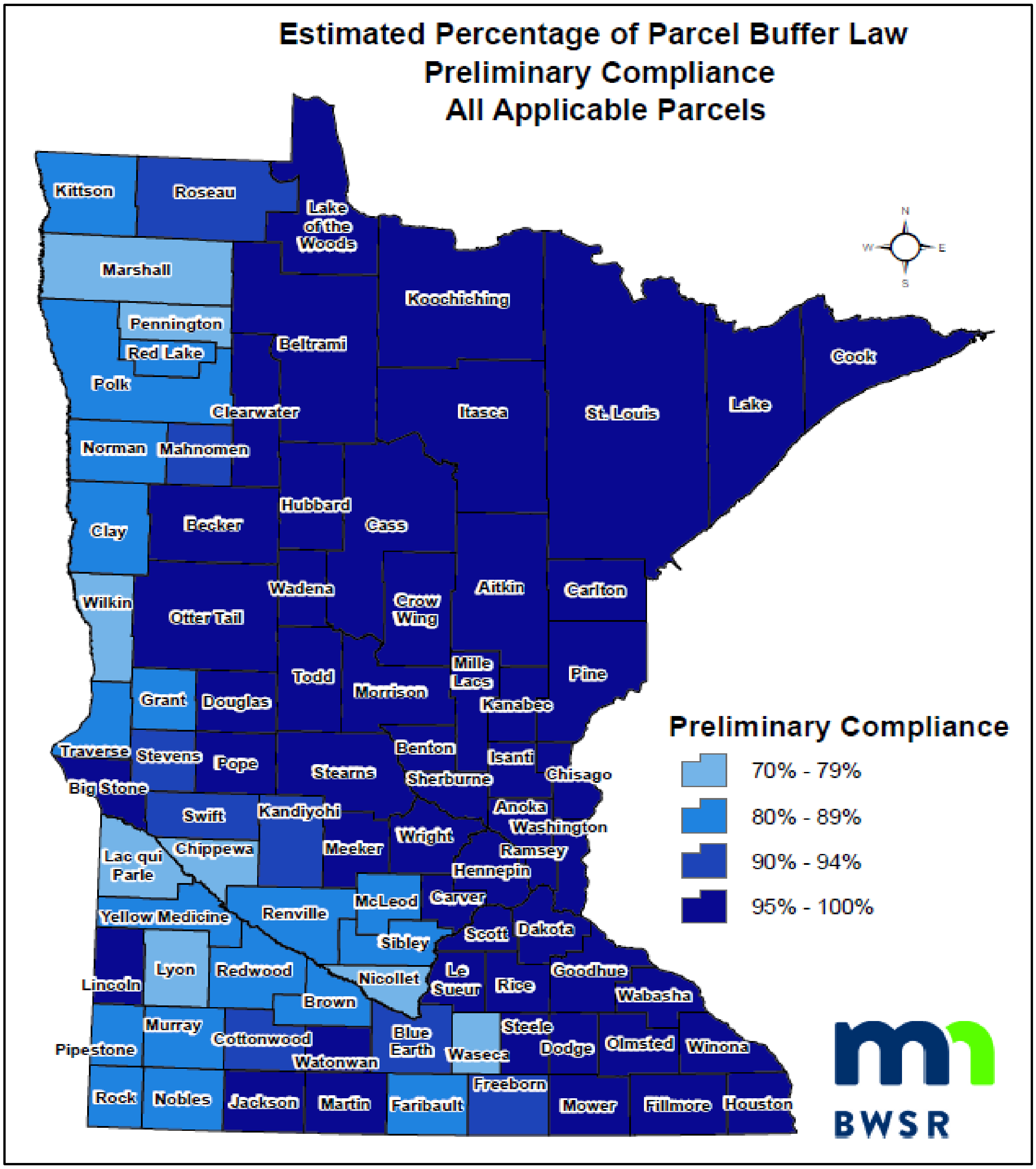


Figure 2-26. Buffer Law Compliance 2019.

Upland Sediment Sources

Overland erosion has been documented in many forms. Gully erosion is occurring within cultivated fields. The outlets of ditches are unstable and actively eroding. Gully erosion of private field ditch outlets has been documented in the watershed. Side water inlets and other BMPS need to be implemented to prevent future gully formation. SPI layers have been created to identify all flow paths that are highly susceptible to erosion. Section 3.1.3 provides addition discussion and outputs of the SPI done in the Red Lake River Watershed. During windshield surveys, individual erosion sites like the one in Figure 2-27 were documented with georeferenced photographs by the RLWD.

Figure 2-27. Large gully in the Burnham Creek Watershed.

Figure 1-1 land use map shows the prevalence of agricultural land in the watershed – land that is susceptible to overland erosion. Soil erodibility is related to the integrated effects of rainfall, runoff and infiltration on soil loss and is commonly called the soil erodibility factor (K), which represents the effect of soil properties and soil profile characteristics on soil loss and take into account soil texture, structure, permeability, and organic matter content. K was developed by the NRCS for use in estimating soil losses with the Universal Soil Loss Equation (USLE). Values of K range from 0.02 (lowest erodibility) to 0.69 (highest erodibility). In general, the higher the K value the greater the susceptibility of the soil to rill and sheet erosion by rainfall. Figure 2-28 provides a condensed scale of K showing low, medium and high soil erodibility in the Red Lake River Watershed.

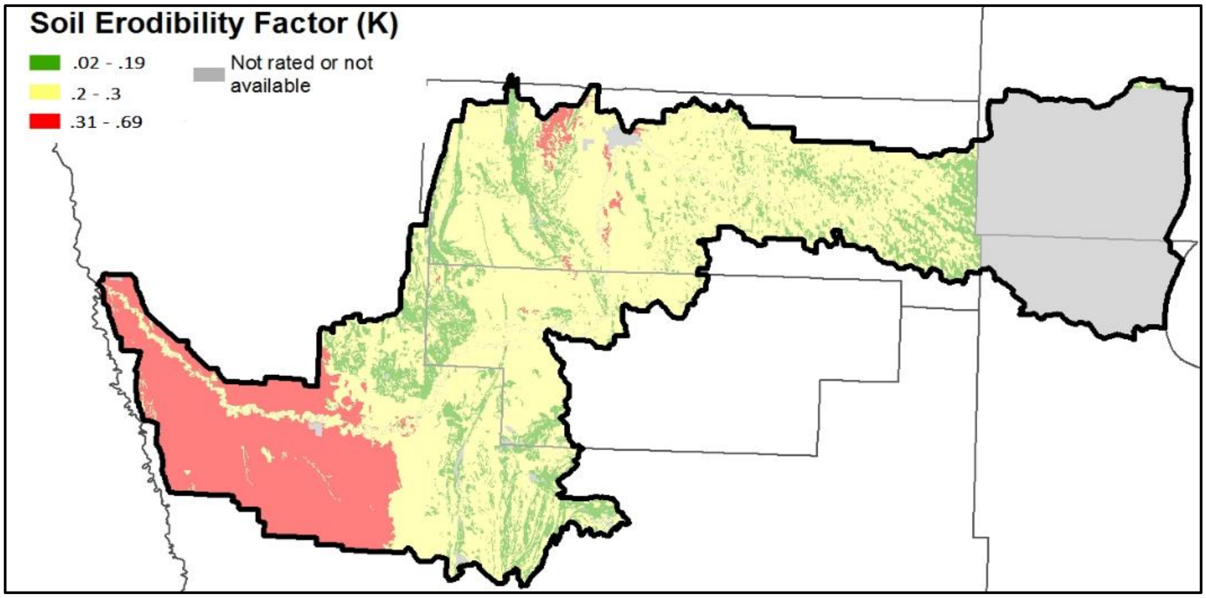


Figure 2-28. Red Lake River Watershed Soil Erodibility Factor (K).

Stormwater

Stormwater contributions have been studied within the city of Crookston. Some of the general findings of the study are applicable to other cities along the Red Lake River. The Crookston Stormwater Management Study identified areas of the city that were contributing to the turbidity impairment of the Red Lake River. Stormwater drainage from the Crookston industrial park had consistently high turbidity levels (up to 447 NTRU). Another discovery that was made by the study was that the city's snow dumping site was located next to the river. In recent years, ice storms have preceded winter snowfall events. The sand and salt that is spread on roads and icy parking lots is plowed into piles along with snow throughout the winter. Multiple situations have been identified in which cities or businesses have piled snow next to a river or ditch. Figure 2-29 shows how a melting mixture of sand and snow along a parking lot in Thief River Falls is directly polluting a ditch that flows into the Red Lake River.

A plume of sediment entering the Red Lake River from Pennington County Ditch 70 was traced upstream to the Digi-Key Electronics parking lot in the spring of 2016. Sampling of accessible stormwater outlets and modeling of stormwater runoff has been completed for the City of Thief River Falls. The Pennington SWCD, with assistance from Houston Engineering, Inc., completed the *Thief River Falls Water Quality Study* in 2017. The study identified optimal locations throughout the city where stormwater BMPs could be targeted to deliver measurable water quality benefits.

Stormwater retention ponds are not as common in cities along the Red Lake River as they are in metropolitan areas. New ponds were constructed to capture runoff from the parking lots of large shopping centers constructed in the cities of Thief River Falls and Crookston. A pond was recently constructed along Greenwood Street in Thief River Falls during the construction of a new bridge over the Red Lake River.

Figure 2-29. Spring parking lot runoff from melting sediment-laden snow piles along Pennington County Ditch 70 in the city of Thief River Falls.

Wind Erosion

Wind erosion is a notable source of sediment in the Red Lake River Watershed, particularly in the spring and early summer. Figure 2-31 shows the Wind Erodiblity Group for the Red Lake River Watershed. Soils assigned group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. Many areas of the watershed are naturally susceptible to wind erosion.

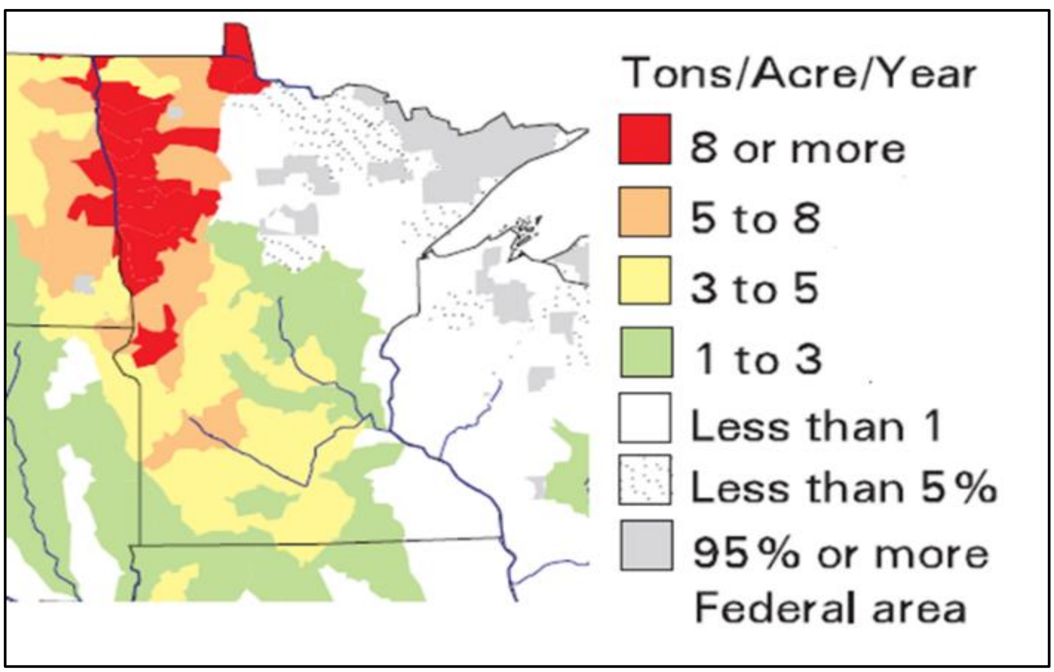


Figure 2-30. Average Annual Soil Erosion by Wind (NRCS 2000).

The University of Minnesota Extension Service collected soil samples from six field ditches across western Minnesota to gain an understanding of how much soil was being deposited in ditches. It found, on average, 9.1 tons of soil per acre of road ditch with a range of 2.6 to 32.6 tons/acre (DeJong-Hughes 2014). UMN Extension Service determined that five factors highly influence wind erosion in the Red River Valley:

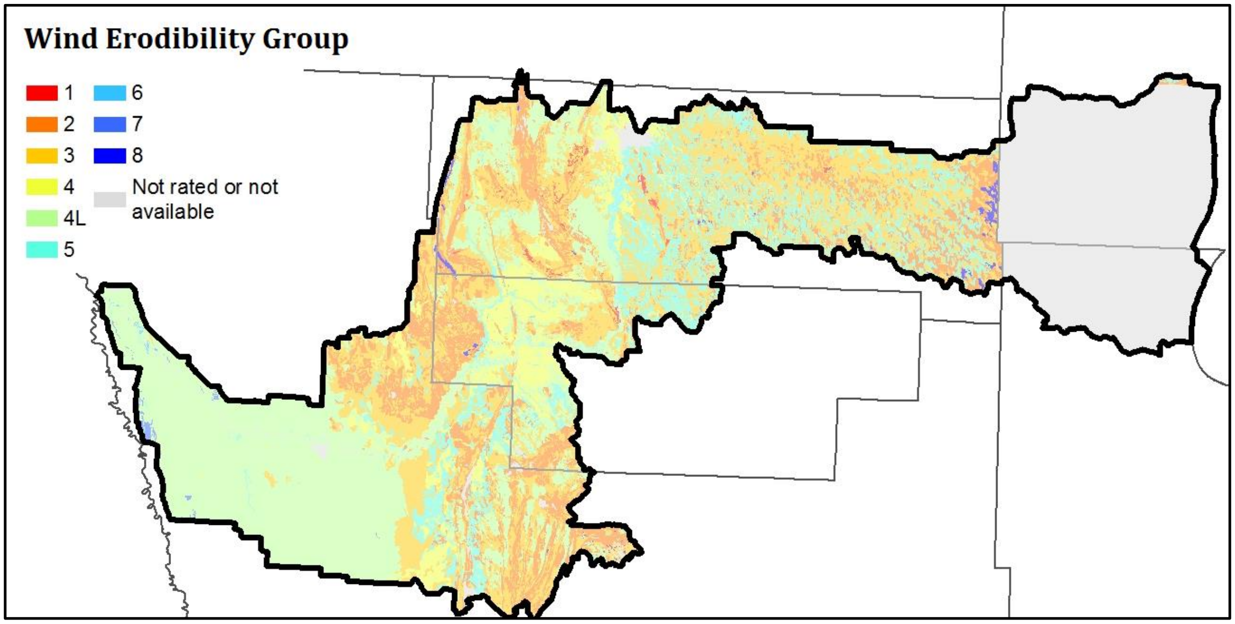


Figure 2-31. Wind Erodibility Groups.1 is the most susceptible to wind erosion and 8 is the least.

1. *The relatively flat topography allowing wind to pick up speed and intensity*. In the Red Lake River Watershed, tree rows and windbreaks are dying and being removed (Figure 2-32). This has the effect of increasing the amount of fetch on fields and leading to exacerbated wind erosion. According to Marshall County SWCD staff, small root systems, chemicals, and fungus issues are contributing to this problem. Some species of trees are reaching the end of their life cycles and are being removed (Chinese elms). Hybrid poplar trees only last about 20 years because they grow too fast and then break.


Figure 2-32. Photo of a field windbreak that is in the process of being removed.

2. *Aggressive tillage breaks apart soil aggregates allowing for lighter individual soil particles, which can be moved by the wind.* Besides tillage, a farming practice called "ground rolling" for soybean fields has effected soil aggregates. Soybean fields are compacted and smoothed with heavy rollers after planting to prevent damage to harvesting equipment. Rolling pushes rocks into the ground and breaks up clumps of dirt that might damage equipment that is set close to the ground. According to an article from the University of Minnesota Extension Service (Dejong-Hughes 2016), rolling crushes surface soil aggregates, leaves the field smooth and loosens residue from the soil, reducing the soil conservation benefits of less tillage. Figure 2-33 shows the effect from ground rolling when the weather turns dry and windy.

Figure 2-33. April 2015 wind erosion from a recently rolled field near St. Hilaire.

3. *Lack of residue and vegetative cover which could have provided a physical barrier to protect against wind erosion.*
4. *Rowed crops provide little soil protection until the crop has canopied. Short season crops, after fall tillage, leave soil unprotected for six to nine months of the year.*
5. *The natural carbonates minerals of the soils in the Red River Valley make the soil particularly vulnerable to wind erosion. Sand and silt are usually deposited short distances from the field, and clay particles become suspended in the air and are transported greater distances.*

Tillage transects surveys, also referred to as Crop Residue Management Surveys, have been conducted in Minnesota agricultural counties, on a somewhat irregular intervals, from 1989 to 2007. The surveys were used to track cropland use, conservation cropping systems, cover crop adoption and residue cover by county. Historical data for the time period 1989 to 2007 for the counties of the Red Lake River Watershed can be found at the Minnesota Tillage Transect Survey Data Center.

More recently BWSR has developed a process to systematically and unbiasedly collect tillage data utilizing remote sensing methods. Satellite imagery from Landsat 8 (an American satellite) and Sentinel 2 (European satellite) was calibrated using ground-truthed data for crop residue cover and cover crops. A simple regression model was used to calibrate and validate satellite surface reflectance data for crop residue cover. Pixel resolution ranges from 2 to 30 meters, depending on the satellite. Percent residue was then averaged for all land uses to an entire HUC-12 level. Individual field data is not available with this process.

Because the percent residue is averaged for all land uses, and not just cropped fields, comparisons to pervious tillage transect surveys residue cover is extremely limited. For example, previously if an area had 30% residue cover this was considered conservation tillage (limited or no till); whereas with the current process a 30% residue would indicate a significant amount of tillage had occurred within the area.

2017 was the first year this process was used in the Red Lake River Watershed. Figure 2-34 depicts the data that was collected May 6, 2017 through May 13, 2017. The eastern half of the watershed was not analyzed because the satellite did not fly directly overhead, and the lower end of the watershed had too much cloud cover to collect data during the data collection window. While Figure 2-34 would indicate there is an excessive amount of tillage occurring in the Red Lake River Watershed, the reader is cautioned in making judgements on only one year of information. There are a number of variables that impact a farmer's decision on tillage, so it is important to look at long-term trends when evaluating overall tillage methods in an area.

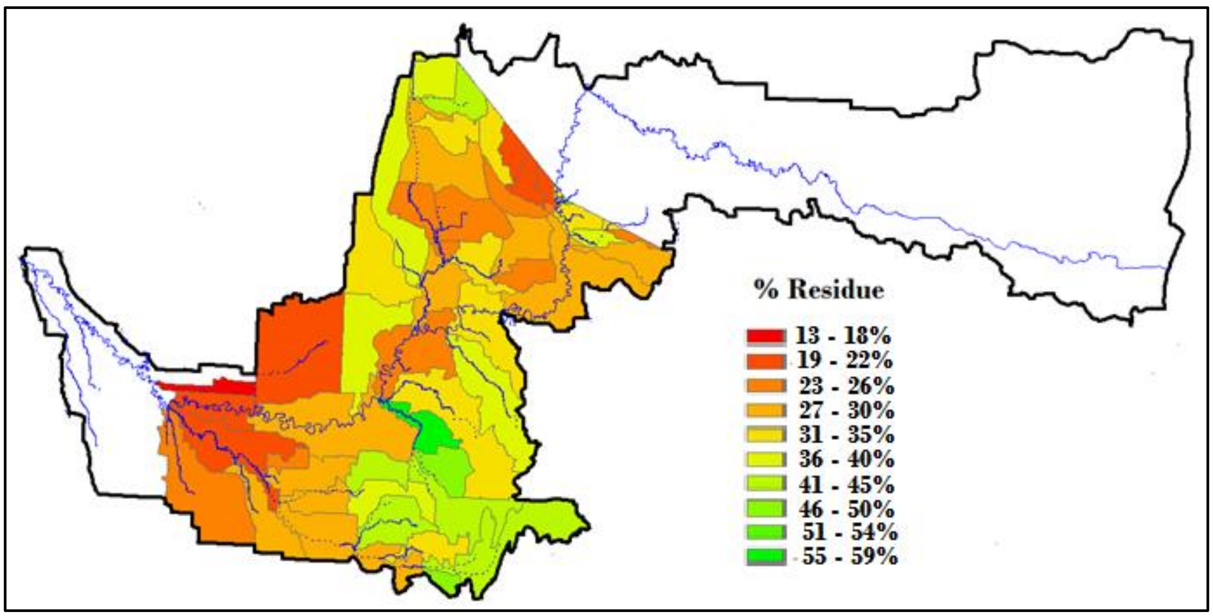


Figure 2-34. Crop Residue Based on Remote Sensing 2017.

2.3.2 *E. coli*

Permitted

There are no WWTFs or MS4s within the drainage area of any reach in the Red Lake River Watershed that is impaired by *E. coli* bacteria.

Feedlots

Manure contains high concentrations of bacteria that can runoff into streams when not properly managed. Of the 66 feedlots (locations shown in Figure 2-35) in the Red Lake River Watershed, there is one active NPDES permitted operation, which is considered a Concentrated Animal Feeding Operations (CAFOs). The MPCA currently uses the federal definition of a CAFO in its regulation of animal feedlots. In Minnesota, the following types of livestock facilities are issued, and must operate under, a NPDES Permit: a) all federally defined CAFOs, some of which are under 1000 animal units (AUs) in size; and b) all CAFOs and non-CAFOs, which have 1000 or more AUs. These feedlots must be designed to totally contain runoff, and manure management planning requirements are more stringent than for smaller feedlots. In accordance with the state of Minnesota's agreement with EPA, CAFOs with state-issued General NPDES Permits must be inspected twice during every five-year permitting cycle, and CAFOs with state issued Individual NPDES Permits are inspected annually.

Data indicate that there are 16 feedlots located in shoreland (within 1,000 feet of a lake or 300 feet of a river/stream). Of the 16 feedlots in shoreland, 15 facilities have open lots. Feedlot sites are considered a potential source of bacteria to Red Lake River Watershed. Local impacts to water resources in the Red

Lake River Watershed could in some cases be significant, as demonstrated in one case in the watershed. Permitted feedlots, however, are a source of *E. coli* along with non-permitted livestock operations in most of the impaired reaches in the Red Lake River Watershed. There is a high density of feedlots along AUIDs 558 and 529 of the Black River. The watersheds of the other streams that are impaired by *E. coli* bacteria each contain at least one feedlot operation. Longitudinal sampling in the Little Black River, Kripple Creek and Gentilly River has shown that a single livestock operation can greatly increase *E. coli* concentrations in these small rivers.

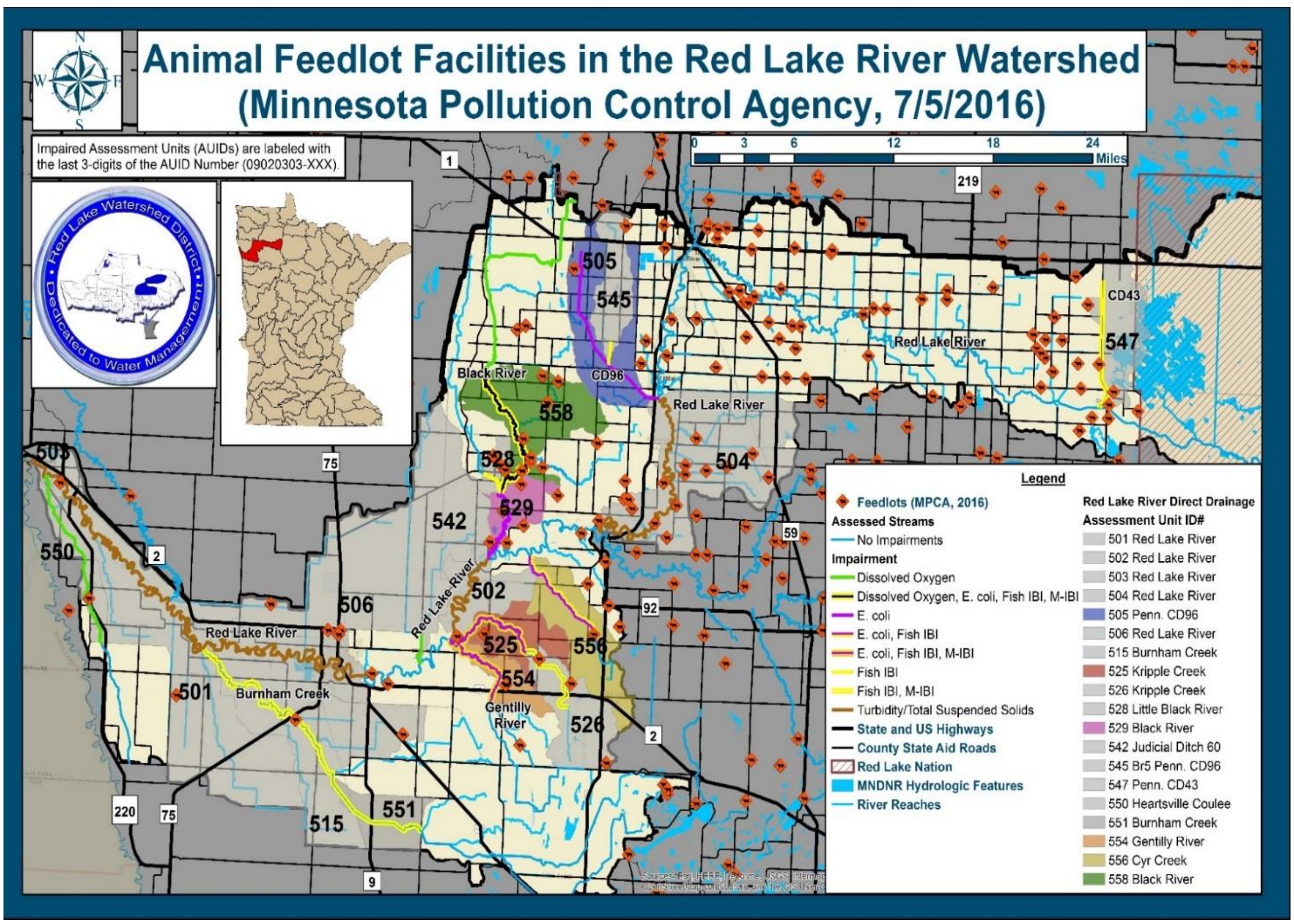


Figure 2-35. Map of feedlot locations throughout the Red Lake River Watershed based on GIS data published by the MPCA on July 5, 2016.

Wildlife

There are sources of natural background bacteria in the tributaries of the Red Lake River that are not going to be eliminated by BMPs, but only minimally contribute to *E. coli* levels in rivers. Warm-blooded wild animals in the watershed contribute to *E. coli* concentrations in watercourses. In natural settings, wildlife is scattered, and such a small fraction of wild animal waste is "deposited" in waterways that natural background sources are not enough to cause an impairment. The average minimum monthly (May through September) geometric mean *E. coli* concentration in unimpaired streams in data collected from 2004 through 2014 was just 24.2 MPN/100mL.

There are; however, situations in which wildlife sources of bacteria can become a source of excess bacteria. Concentrated populations of animals near a waterway (Figure 2-36) can contribute enough *E. coli* bacteria to create an impaired condition. Birds and waterfowl congregate at locations that provide favorable habitat and food. Birds have been proven to be a source of *E. coli* in some of the impaired streams in the Red Lake River through Microbial Source Tracking analysis and observations made during sampling. Cliff swallow communities under bridges (and inside box culverts are a significant source of fecal bacteria from birds. The nests are built above the water and are heavily concentrated (Figure 2-36). Swallows can be numerous in flocks that reside under a bridge and they swarm over the water when disturbed (e.g., when someone is sampling at the site). Their droppings fall with regularity into the water that is being sampled. Flocks of waterfowl congregating in wetlands or in stream/ditch channels can cause high *E. coli* concentrations in downstream waters in some circumstances. High *E. coli* concentrations in the Gentilly River were tracked upstream to the BR-6 impoundment. The primary monitoring site, on AUID 527, of the Little Black River was located at the outlet of the Goose Lake swamp. However, it is important to note that not all wetlands are sources of excess *E. coli* bacteria. Water flowing out of a restored wetland in the headwaters of Kripple Creek during a runoff event had an *E. coli* concentration that was safely below the 126 MPN/100mLstandard.

Figure 2-36. Cliff swallow nests under a bridge.

Very high concentrations of *E. coli* bacteria have been found in Pennington County Ditch 21 at the CSAH 17 crossing. An inspection of the site found that many pigeons have been roosting under the bridge. The surface of the water was covered with scum and feathers (Figure 2-37). When the water is stagnant, high concentrations of bird waste can accumulate in water that is pooled under the bridge. Longitudinal sampling revealed that water quality problems are unique to that particular crossing, especially during low flows. Figure 2-38 shows the relative difference between the CSAH 17 crossing and the rest of the ditch crossings. Figure 2-39 shows how the stagnant water and pollutant inputs from the roosting birds has negatively affected DO concentrations at the site. The bridge was replaced with box culverts in the fall of 2017. No exceedances of the 126 MPN/100mL *E. coli* standard were recorded in 2018.

Figure 2-37. Roosting areas, stagnant water, scum, and feathers under the CSAH 17 Bridge over Pennington County Ditch 21.

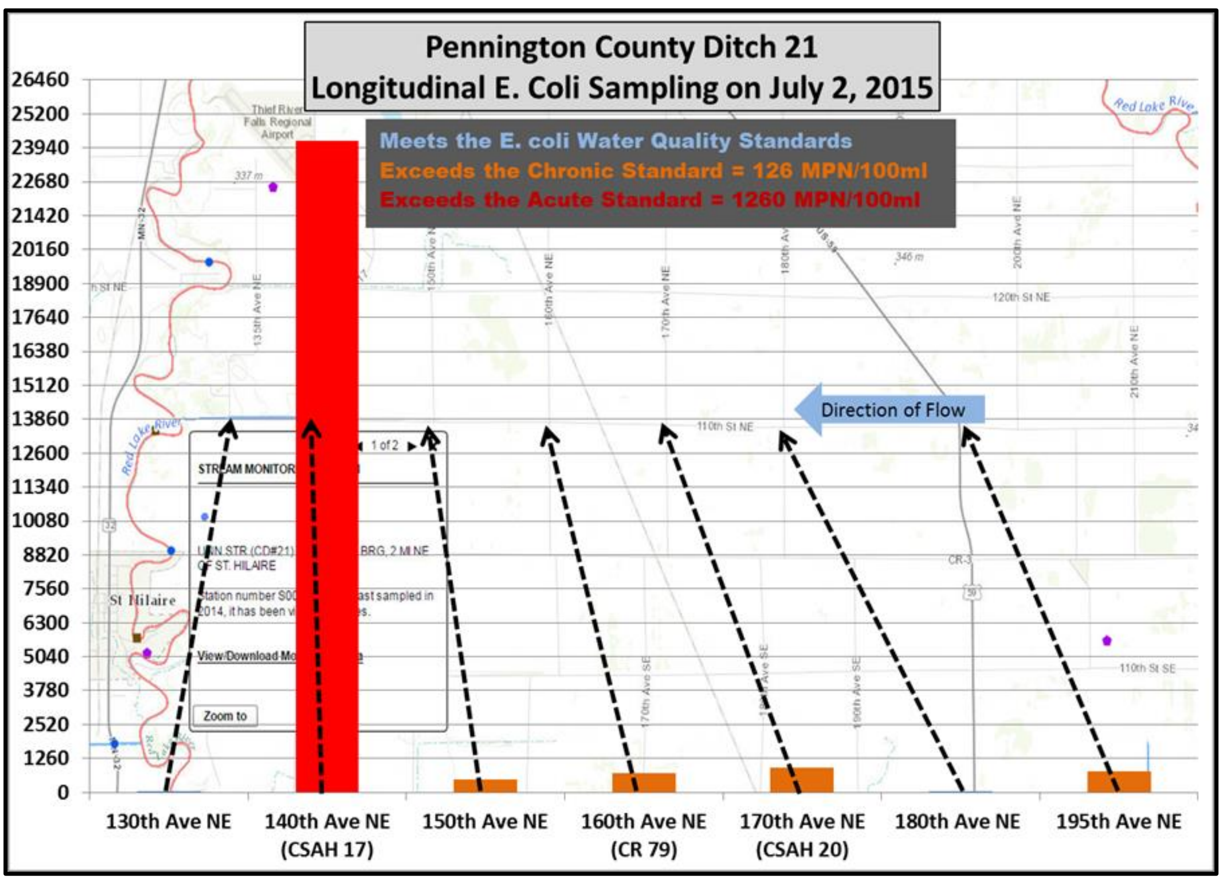


Figure 2-38. Longitudinal *E. coli* concentrations along Pennington County Ditch 21 on July 2, 2015.

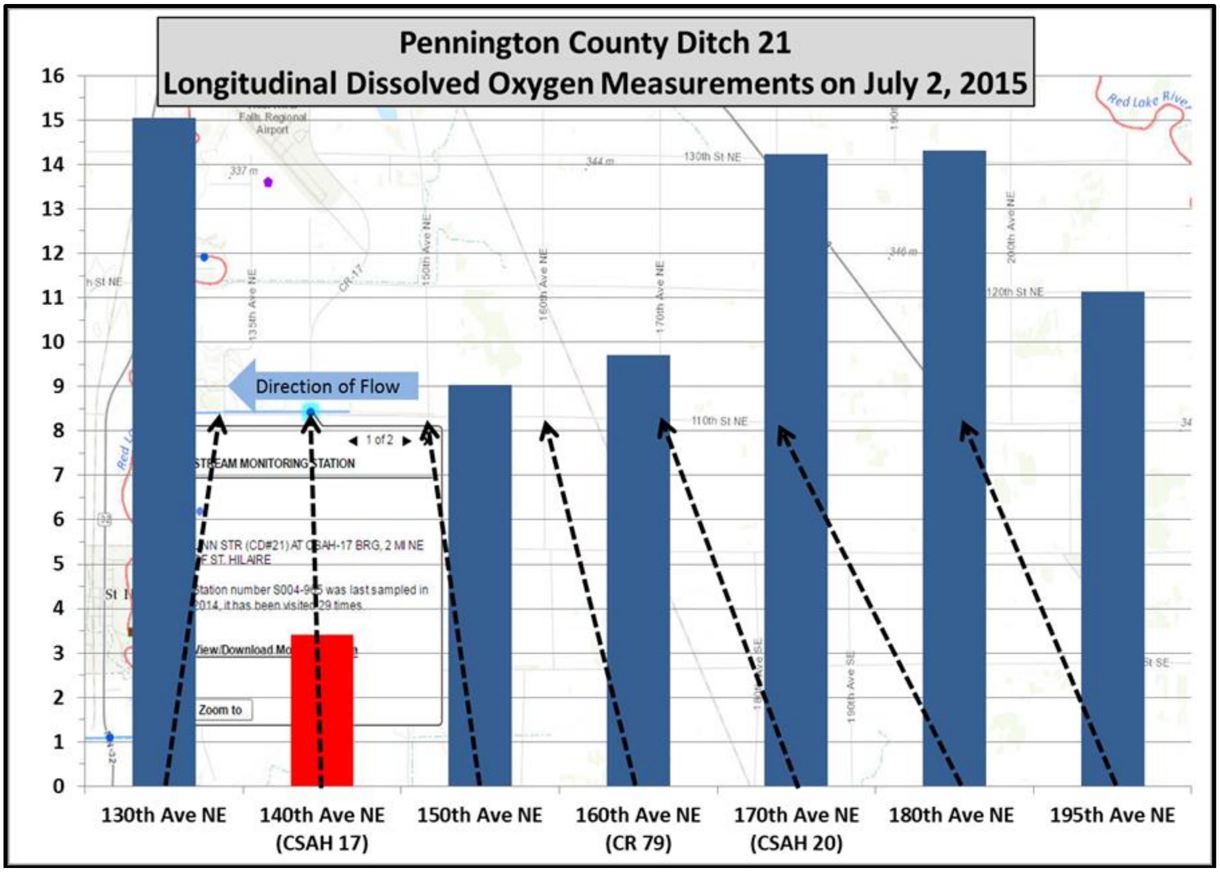


Figure 2-39. Longitudinal DO profile of Pennington County Ditch 21 on July 2, 2015.

Livestock on pasture

Livestock access to rivers and streams (Figure 2-40) and/or poorly managed pastures near streams is a common source of excess *E. coli* in rivers and streams. A visual assessment of the watershed through windshield surveys and examination of aerial photos identified numerous areas where livestock have been concentrated along or near rivers and streams. Significant increases in *E. coli* bacteria concentrations were found downstream of livestock operations during longitudinal sampling efforts. Longitudinal sampling (Section 3.1.5) has identified specific locations where concentrations increase downstream of a livestock operation.

Figure 2-40. Cattle along the Red Lake River.

Failing Septic Systems

Septic systems that are not maintained or failing can contribute excess bacteria. The MPCA collects data yearly from LGUs on subsurface sewage treatment systems (SSTS). Estimations are made on the number of: total SSTS systems, the number of compliant systems, number of systems failing to protect ground water (failing), and the number of imminent public health threats (IPHT) which may include straight pipes. Data is reported only to the county level, or to the township level if the township has elected jurisdiction, so data specific to the Red Lake River Watershed is not available. However, using overall county data could indicate potential SSTS compliance percentage within the watershed. Figure 2-41 provides countywide estimates for SSTS compliance for counties in the Red Lake River Watershed.

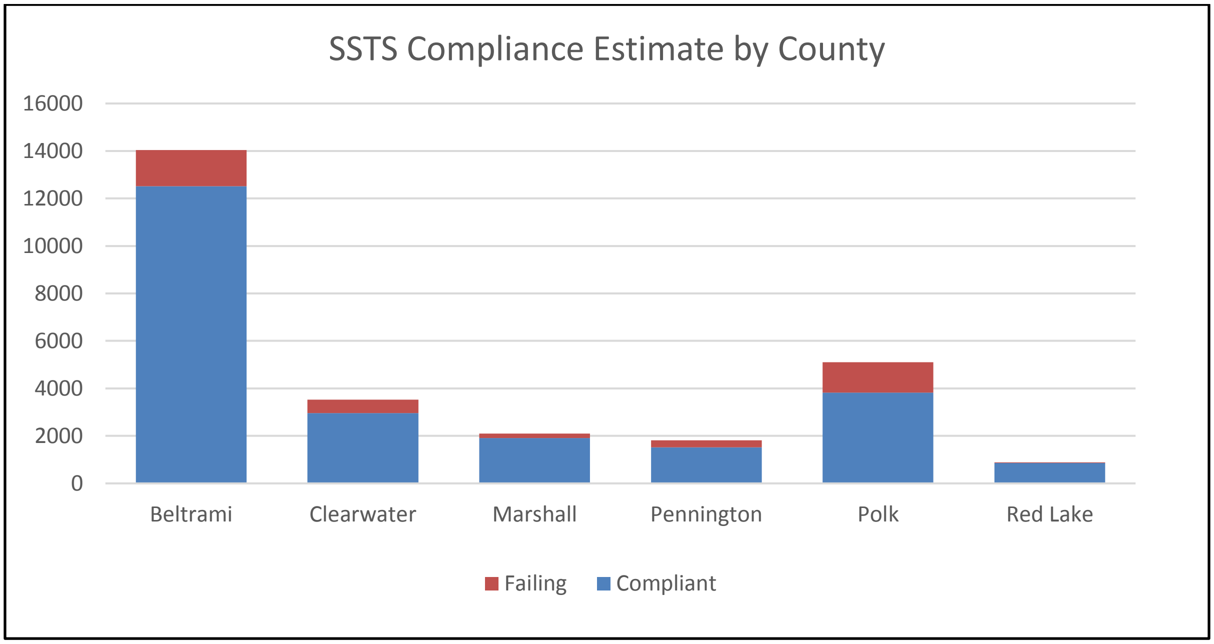


Figure 2-41. SSTS Compliance Estimates by County.

On average, the six counties in the Red Lake River Watershed inspect 0.1% to 2.7%% of the SSTS yearly within their respective counties. Only Beltrami and Red Lake counties within the Red Lake River Watershed, have a “Point of Sale” inspection requirement within their local ordinance indicating that a SSTS compliance inspection is required at property transfer. Even though there is potentially a significant number of failing systems in the Red Lake River Watershed, they are unlikely to contribute substantial amounts of pollutants and stressors to the total annual loads in the Red lake River Watershed, when compared to other sources. However, the impacts of failing SSTS on water quality may be pronounced in areas with high concentrations of failing SSTS or at times of low precipitation and/or flow. Such was the case discovered while sampling in the Chief’s Coulee Drainage near Thief River Falls. High *E. coli* concentrations were traced back to noncompliant SSTS within the drainage area. A watershed-wide SSTS inventory with compliance inspections would help quantify the potential impact SSTS have on the Red Lake River Watershed. Progress on replacing failing and IPHT systems is occurring within the six counties. Since 2002, on average 105 systems are replaced or repaired each year within the six counties.

Undersewered/unsewered Communities

"Undersewered/unsewered community" is defined as a cluster of five or more houses or businesses that are each situated on one-acre lots or less that have inadequate wastewater treatment. This may range from a community having failing individual systems to small cities with inadequate collection and treatment infrastructure. An inventory of these communities located in the Red Lake River Watershed was conducted in 2008 and updated in 2015 (Figure 2-42). Currently there are six identified areas designated as undersewered/unsewered community and are at various stages of becoming "sewered". Continued local support is needed to ensure the completion of the projects.

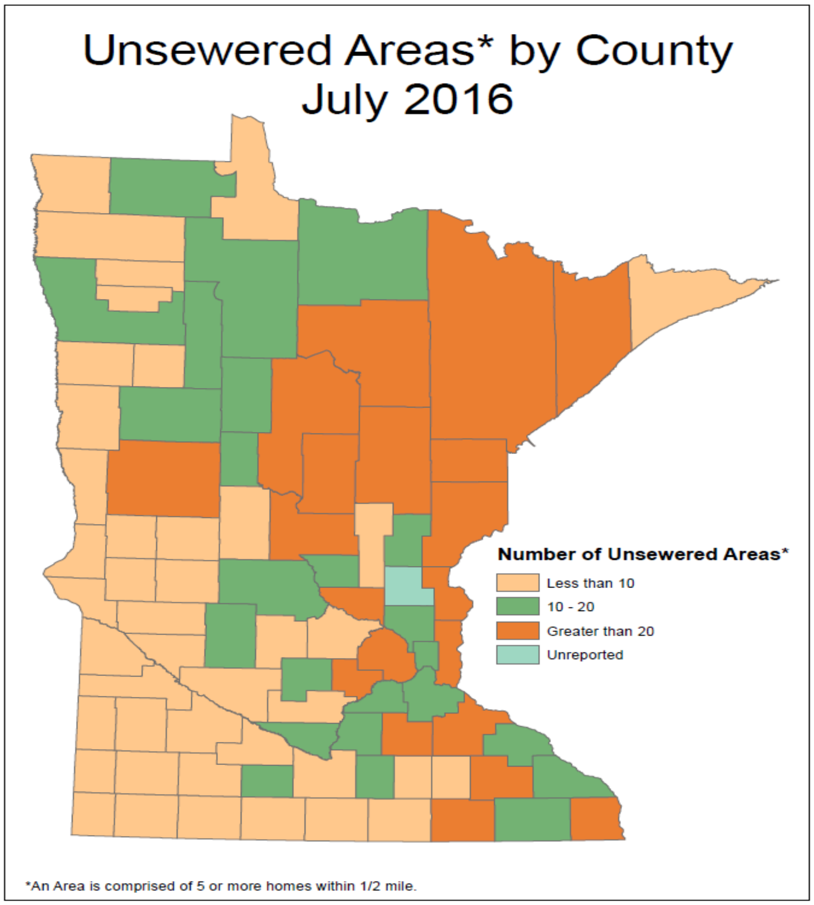


Figure 2-42. Unsewered areas by county.

Microbial Source Tracking

Microbial Source Tracking samples were collected from the Black River, Gentilly River, and Kripple Creek on July 15, 2014. Microbial source tracking is a method for identifying the type of animal that is the source of fecal coliform and *E. coli* pollution. The samples were analyzed by a lab in Florida (Source Molecular) that specializes in this testing. *E. coli* samples were also collected and sent to RMB Environmental Laboratories in Detroit Lakes to obtain the total concentration of *E. coli* bacteria at the time of sampling. Past data was used as a guide for the timing of sample collection. The results of the tests (Table 2-18) can aid in source identification and assist with prioritizing and targeting implementation actions.

Table 2-18. Results of Microbial Source Tracking analysis conducted within the Red Lake River Watershed.

Date	Site Name	S-Code	*E. coli* (MPN/100ml)	Analysis Requested	Quantification	DNA Analytical Results	Contributing to Fecal Pollution?
7/15/2014	Black River at CSAH 18	S002-132	69.1	Bird Fecal ID	---	Absent	---
				Cow Bacteroidetes ID	---	Absent	---
				Human Bacteroidetes ID 1	<LOQ	Trace	Potential
				Human Bacteroidetes ID 2	<LOD	Absent	
8/26/2014	Black River at CSAH 18	S002-132	73.8	Bird Fecal ID	Non-detect	Absent	Negative
				Human Bacteroidetes ID 1	Non-detect	Absent	Negative
				Human Bacteroidetes ID 2	Non-detect	Absent	Negative
				Ruminant Fecal ID	---	Absent	---
6/18/2014	Red Lake River at Sportsman's Bridge (CSAH 13)	S003-172	157.6	Bird Fecal ID	<LOQ	Trace	Potential
				Cow Bacteroidetes ID	---	Absent	---
				Human Bacteroidetes ID 1	---	Absent	---
				Human Bacteroidetes ID 2	---	Absent	---
6/24/2014	Red Lake River at Sportsman's Bridge (CSAH 13)	S003-172	27.2	Bird Fecal ID	<LOQ	Trace	Potential
				Cow Bacteroidetes ID	---	Absent	---
				Human Bacteroidetes ID 1	---	Absent	---
				Human Bacteroidetes ID 2	---	Absent	---
7/15/2014	Gentilly River at CSAH 11	S004-058	67.7	Bird Fecal ID	---	Absent	---
				Cow Bacteroidetes ID	---	Absent	---
				Human Bacteroidetes ID 1	<LOD	Absent	Negative
				Human Bacteroidetes ID 2	<LOD	Absent	Negative
8/26/2014	Gentilly River at CSAH 11	S004-058	77.1	Bird Fecal ID	Non-detect	Absent	Negative
			77.1	Human Bacteroidetes ID 1	Non-detect	Absent	Negative
			77.1	Human Bacteroidetes ID 2	Non-detect	Absent	Negative
			77.1	Ruminant Fecal ID	---	Absent	---
7/15/2014	Kripple Creek at 180th Ave SW	S004-835	86	Bird Fecal ID	---	Absent	---
			86	Cow Bacteroidetes ID	---	Absent	---
			86	Human Bacteroidetes ID 1	7.59E+02	Present	Potential
			86	Human Bacteroidetes ID 2	<LOD	Absent	
8/26/2014	Kripple Creek at 180th Ave SW	S004-835	292	Bird Fecal ID	<LOQ	Trace	Potential
				Human Bacteroidetes ID 1	<LOQ	Trace	Potential
				Human Bacteroidetes ID 2	Non-detect	Absent	
				Ruminant Fecal ID		Absent	

<LOD = Below the Limit of Detection (<10 copy numbers per reaction)

<LLOQ = Below the Limit of Quantification

An examination of the watershed and monitoring data reveals two probable sources of *E. coli* along the Little Black River (AUIDs 527 and 528). High *E. coli* concentrations have been found within Goose Lake and are almost certainly created by waterfowl in the pool. A livestock operation along the Little Black River seems to be a source of excess *E. coli* in the AUID 528 reach of the Little Black River. A series of samples were collected in July and August at sites that bracketed the livestock operation. The majority of *E. coli* concentrations at the upstream (CR 3, S008-116) crossing have been low enough to meet the State's water quality standard, but the majority of samples at the lower site (CR 102, S008-111) have exceeded the 126 MPN/100ml chronic water quality standard. There was insufficient data for an assessment of AUID 528 as of the end of the 2015 monitoring season, but the monthly geomeans are high for June, July, and August with the two to three samples/month that have been collected. A site-by-site analysis shows that monthly geometric mean concentrations are higher at CR 102 (S008-111) than CR 3 (S008-116), as shown in Figure 2-43. Unless BMPs are implemented, AUID 528 will likely be listed as impaired after the next assessment.

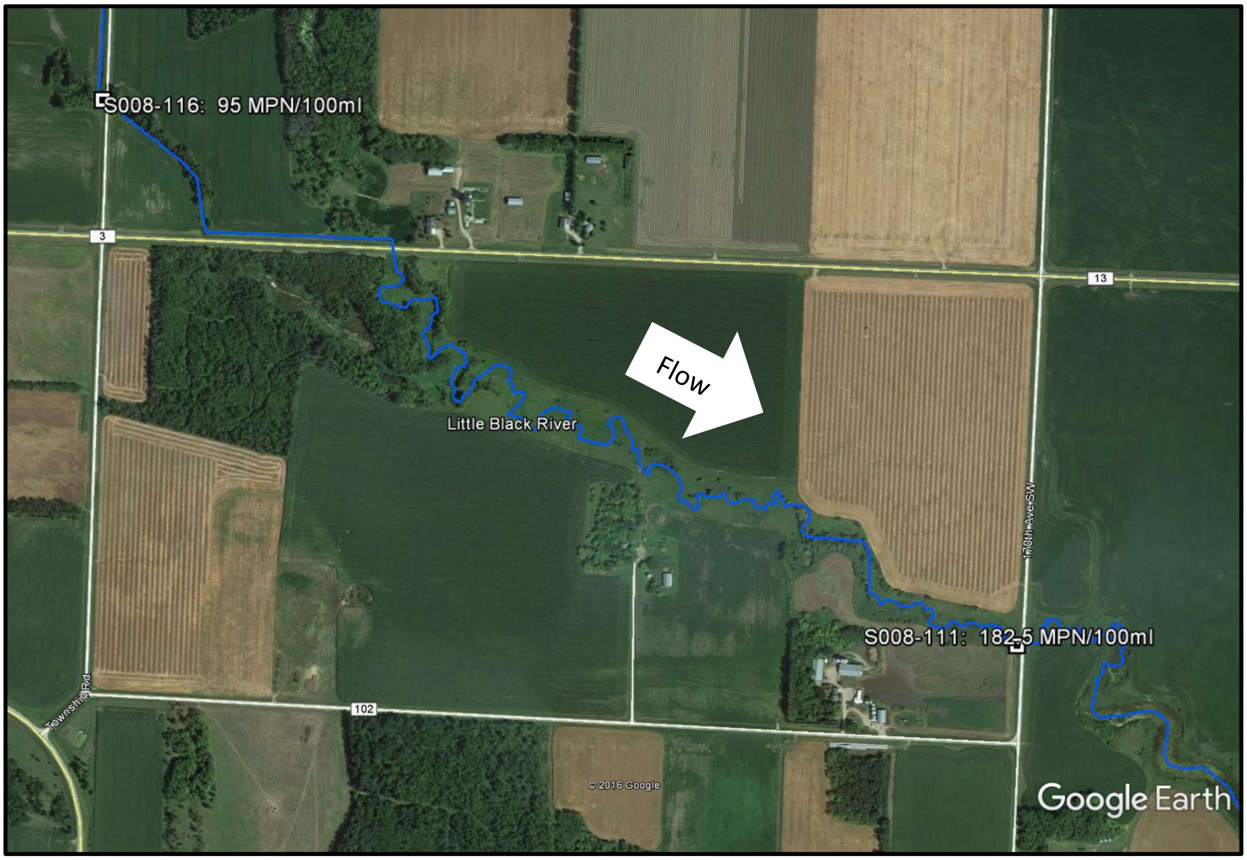


Figure 2-3. Geometric mean *E. coli* concentrations for the month of July along the Little Black River.

Pennington County SWCD and RLWD staff began monitoring a drainage system within the northern part of Thief River Falls called Chief's Coulee. This drainage system flows into the Red Lake River downstream of the Thief River confluence, near the southern edge of Chief Red Robe Park. The sampling effort found extremely high concentrations of *E. coli* and other pollutants at the Dewey Avenue crossing of Chief's Coulee. The location of the pollutant source(s) was narrowed down to an area between Dewey Avenue and Atlantic Avenue. On a day in which septic water was discovered at the Dewey Avenue crossing, city, SWCD, and RLWD staff inspected the area between the two streets to find the source. Multiple problems were identified. The worst problem was seepage from a home's septic system. The other was a sump pump that was discharging polluted water from the "basement" of a grain elevator. The home with the leaking septic system has been hooked up to the city's sanitary sewer. The sump pump from the grain elevator; however, still appears to be in operation. *E. coli* concentrations remain high, but they are not as extreme as they were before the septic seepage problem was fixed. The Pennington SWCD began working on a septic system inventory of the Chief's Coulee drainage area in 2016 and several failing, "public health threat," systems have already been discovered.

2.3.3 Stressors of Biologically-Impaired Stream Reaches

The Red Lake River Watershed SID Report and the Red Lake River TMDL provide detailed descriptions of the stressors that have been found to be negatively affecting fish and macroinvertebrates throughout the watershed. The most pervasive stressor was a lack of base flow. Fish passage and low DO were also significant stressors. In most cases, the influence of those stressors is exacerbated by low flows. No evidence was found that connected low DO problems with any pollutants that have been sampled in the reaches. Low DO readings were directly connected to low flow on most impaired streams in the Red Lake River Watershed.

In-stream habitat needs improvement in many reaches of the Red Lake River. According to information found in the Red Lake River Watershed Monitoring and Assessment Report, 71.1% of the stream channels in the Red Lake River Watershed have been modified Figure 2-44.

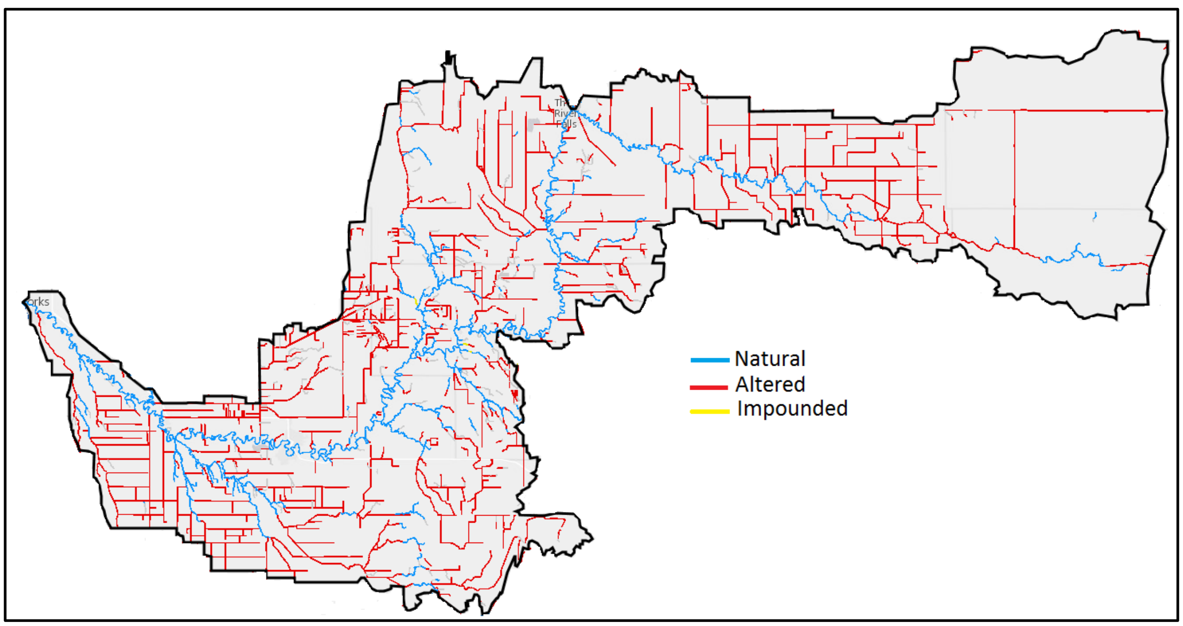


Figure 2-44. Altered water courses in the Red Lake River Watershed.

This number could be inflated because it included ditches that were constructed where streams did not previously exist. Those newly created drainage channels are still acting as stressors. They are working to drain the land more quickly, which reduces retention. Decreased water retention across the landscape reduces the amount of water that can seep into streams and maintain base flows in the late summer months.

Stressors of aquatic life are summarized in Table 2-19.

Table 2-19. Summary of aquatic life stressors and sources of pollutants.

HUC-10 Subwatershed	AUID (Last 3 Digits)	River/Stream/Ditch Name	Reach Description	Impaired by Poor Fish Index of Biological Integrity?	Impaired by Poor Macroinvertebrate Index of Biological Integrity?	Primary Stressors				
						Insufficient Base Flow	Low Dissolved Oxygen (Due to Low Flow)	Fish Passage Barriers	Insufficient In-Stream Habitat	Excess Sedimentation
Upper Red Lake River 0902030302	547	Pennington Co. Ditch 43	Unnamed Ditch to Red Lake River	F-IBI	M-IBI	●	●		●	
Red Lake River City of St. Hilaire 0902030303	545	Br 5, Penn. Co. Ditch 96	BR 2 CD 96 to CD 96 Main Stem	F-IBI		●	●			
Black River 0902030304	528	Little Black River	Unnamed Ditch to Black River	F-IBI		●	●	●	●	●
	558	Black River	-96.4328 48.0146 to Little Black River	F-IBI	M-IBI	●	●	●	●	●
Red Lake River City of Crookston 0902030305	525	Kripple Creek	Unnamed Creek to Gentilly River	F-IBI	M-IBI	●				●
	526	Kripple Creek	Unnamed Ditch to Unnamed Creek	F-IBI	M-IBI	●			●	
	554	Gentilly River	CD 140 to Red Lake River	F-IBI	M-IBI	●	●		●	●
	556	Cyr Creek	CR 14 to Red Lake River	F-IBI		●	●			
Burnham Creek 0902030306	551	Burnham Creek	CD 106 to Polk CD 15	F-IBI	M-IBI	●	●		●	●
	515	Burnham Creek	Polk CD 15 to Red Lake River	F-IBI	M-IBI	●	●		●	●

2.4 TMDL Summary

The Red Lake River Watershed TMDL is the only TMDL report that has been completed for the Red Lake River Watershed. Its development was a product of the Red Lake River WRAPS project. It addresses:

- 6 TSS impairments
- 6 *E. coli* impairments
- 2 DO impairments
- 10 F-IBI impairments
- 7 M-IBI impairments

Sediment reductions will be required for the Red Lake River to meet TSS standards. The load allocations and recommended load reductions for TSS are summarized in Table 2-20.

E. coli concentrations will also need to be reduced in tributaries of the Red Lake River. The load allocations and recommended load reductions for *E. coli* are summarized in Table 2-21.

Current loads were calculated for sampling events that coincided with flow records.

The TMDL report summarizes the considerable amount of data analysis that was conducted to determine the causes of IBI and DO impairments. No connections between DO/IBI impairments and pollutant loading were identified. Investigation of data and physical characteristics found that those impairments have been influenced more by low flow, fish passage barriers, and in-stream habitat than any potential pollutant of concern. Recategorizing these impairments will be proposed where appropriate. TMDL establishment sites were chosen for each impaired AUID at frequently-monitored sites that are nearest to the poor point of the reach. Due to the limited number of Red Lake River crossings, some of the TSS TMDL establishment sites are located in mid-reach locations. Most of the tributaries are monitored regularly at crossings that are near the pour points of those subwatersheds.

Table 2-20. Allocation summary for TSS TMDLs in the Red Lake River Watershed.

Red Lake River Watershed ● Total Suspended Solids ● Total Maximum Daily Loads ● Tons/Day													
					Allocations								
Stream (AUID)	Pollutant (Standard)	Units	Season or Flow Conditions	Loading Capacity	Wasteload Allocation	Margin of Safety	Reserve Capacity	NPDES MS4	MnDOT ROW WLA	Const. & Ind. Stormwater	Load Allocation	Current Daily Load	Percent Reduction Needed
Red Lake River (09020303-503)	Total Suspended Solids (65 mg/l)	Tons/ Day	Very High	946.62	7.03	94.66	47.33	3.18	0.80	0.18	793.44	1020.83	**22.3%**
			High	346.01	7.03	34.60	17.30	1.14	0.29	0.07	285.58	726.02	**60.7%**
			Mid	200.90	7.03	20.09	10.05	0.65	0.17	0.04	162.87	161.26	0.0%
			Low	125.39	7.03	12.54	6.27	0.40	0.10	0.03	99.03	91.34	0.0%
			Very Low	40.97	7.03	4.10	2.05	0.11	0.03	0.01	27.64	27.74	0.4%
Red Lake River (09020303-501)	Total Suspended Solids (65 mg/l)	Tons/ Day	Very High	916.63	7.03	91.66	45.83	2.63	--	0.17	769.31	3340.14	**77.0%**
			High	298.01	7.03	29.80	14.90	0.84	--	0.06	245.38	544.68	**54.9%**
			Mid	182.31	7.03	18.23	9.12	0.51	--	0.03	147.39	168.29	**12.4%**
			Low	79.23	7.03	7.92	3.96	0.21	--	0.01	60.10	82.23	**26.9%**
			Very Low	28.57	7.03	2.86	1.43	0.06	--	0.01	17.18	15.02	0.0%
Red Lake River (09020303-506)	Total Suspended Solids (65 mg/l)	Tons/ Day	Very High	722.23	3.33	72.22	36.11	2.55	--	0.14	607.88	1453.91	**58.2%**
			High	241.92	3.33	24.19	12.10	0.85	--	0.05	201.40	170.55	0.0%
			Mid	132.35	3.33	13.24	6.62	0.46	--	0.03	108.67	53.45	0.0%
			Low	52.59	3.33	5.26	2.63	0.17	--	0.01	41.19	24.05	0.0%
			Very Low	11.04	3.33	1.10	0.55	0.03	--	0.00	6.03	4.40	0.0%
Red Lake River (09020303-512)	Total Suspended Solids (65 mg/l)	Tons/ Day	Very High	843.51	3.33	84.35	42.18	--	--	0.16	713.49	Not Known	Not Known
			High	319.49	3.33	31.95	15.97	--	--	0.06	268.18	Not Known	Not Known
			Mid	189.04	3.33	18.90	9.45	--	--	0.04	157.32	Not Known	Not Known
			Low	116.06	3.33	11.61	5.80	--	--	0.02	95.30	Not Known	Not Known
			Very Low	37.03	3.33	3.70	1.85	--	--	0.01	28.14	Not Known	Not Known
Red Lake River (09020303-502)	Total Suspended Solids (30 mg/l)	Tons/ Day	Very High	376.95	3.33	37.70	18.85	--	--	0.05	317.02	1395.93	**77.3%**
			High	145.14	3.33	14.51	7.26	--	--	0.02	120.02	137.42	**12.7%**
			Mid	86.05	3.33	8.61	4.30	--	--	0.01	69.80	36.31	0.0%
			Low	52.93	3.33	5.29	2.65	--	--	0.01	41.65	23.21	0.0%
			Very Low	16.87	3.33	1.69	0.84	--	--	0.00	11.01	3.88	0.0%
Red Lake River (09020303-504)	Total Suspended Solids (30 mg/l)	Tons/ Day	Very High	225.00	2.86	22.50	11.25	--	--	0.03	188.36	714.94	**73.7%**
			High	93.85	2.86	9.39	4.69	--	--	0.01	76.90	105.60	**27.2%**
			Mid	35.49	2.86	3.55	1.77	--	--	0.01	27.30	21.19	0.0%
			Low	12.77	2.86	1.28	0.64	--	--	0.00	7.99	3.41	0.0%
			Very Low	0.00	0.00	0.00	0.00	--	--	0.00	0.00	0.00	0.0%

Table 2-21. Allocation summary for *E. coli* TMDLs in the Red Lake River Watershed.

Red Lake River Watershed ● *Escherichia Coli* Bacteria ● Total Maximum Daily Loads										
					Allocations					
Stream (AUID)	Pollutant (Standard)	Units	Season or Flow Conditions	Loading Capacity	Wasteload Allocation	Margin of Safety	Reserve Capacity	Load Allocation	Current Daily Load	Percent Reduction Needed
Penn. CD96 (09020303-505)	*E. coli*, 126 MPN/100mL	Billions of Orgs/Day	Very High	225.12	0.00	22.51	0.00	202.61	136.98	0.0%
			High	26.84	0.00	2.68	0.00	24.16	26.82	**9.9%**
			No Flow	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
Kripple Creek (09020303-525)	*E. coli*, 126 MPN/100mL	Billions of Orgs/Day	Very High	93.54	0.00	9.35	0.00	84.19	141.65	**40.6%**
			High	23.59	0.00	2.36	0.00	21.23	25.69	**17.4%**
			Mid	11.47	0.00	1.15	0.00	10.32	11.18	**7.7%**
			Low	4.46	0.00	0.45	0.00	4.01	6.43	**37.7%**
			Very Low	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
Black River (09020303-529)	*E. coli*, 126 MPN/100mL	Billions of Orgs/Day	Very High	502.70	0.00	50.27	0.00	452.43	19686.94	**97.7%**
			High	18.91	0.00	1.89	0.00	17.02	38.00	**55.2%**
			No Flow (Mid, Low, and Very Low)	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
Gentilly River (09020303-554)	*E. coli*, 126 MPN/100mL	Billions of Orgs/Day	Very High	222.05	0.00	22.20	0.00	199.85	83.68	0.0%
			High	53.33	0.00	5.33	0.00	48.00	51.74	**7.2%**
			Mid	31.17	0.00	3.12	0.00	28.05	25.13	0.0%
			Low	21.38	0.00	2.14	0.00	19.24	7.76	0.0%
			Very Low	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
Cyr Creek (09020303-556)	*E. coli*, 126 MPN/100mL	Billions of Orgs/Day	Very High	239.57	0.00	23.96	0.00	215.61	283.20	**23.9%**
			High	48.01	0.00	4.80	0.00	43.21	43.79	**1.3%**
			Mid	3.87	0.00	0.39	0.00	3.48	1.49	0.0%
			No Flow (Low and Very Low)	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
Black River (09020303-558)	*E. coli*, 126 MPN/100mL	Billions of Orgs/Day	Very High	365.88	0.00	36.59	0.00	329.29	205.89	0.0%
			High	87.22	0.00	8.72	0.00	78.50	68.17	0.0%
			Mid	27.31	0.00	27.31	0.00	24.58	29.90	**17.8%**
			Low	7.73	0.00	7.73	0.00	6.96	2.58	0.0%
			Very Low	0.43	0.00	0.43	0.00	0.39	0.01	0.0%

2.5 Protection Considerations

There are reaches of rivers, streams and ditches within the Red Lake River Watershed that are meeting water quality standards. Even those reaches with impairments are not violating the water quality standards for every parameter. The TMDL establishes restoration needs and strategies for impaired waters. This section focuses on concerns and strategies for:

- Waters that, according to assessment statistics, are most in danger of becoming impaired.
- Waters that are not impaired, but opportunities for water quality improvement have been identified.
- Unimpaired water quality characteristics of waters that are impaired for one or more parameters.

During the process of developing the Red Lake River 1W1P, assessment statistics (e.g. exceedance rates) were used to categorize waters. Highest priority was given to impaired streams that were closest to meeting water quality standards (exceeded impairment thresholds by the smallest margins). The group of watercourses with the second highest priority for water quality improvement projects includes waters that are not formally listed as impaired but are closest to the impairment threshold. Actions should be taken to improve water quality in those reaches, or at least prevent conditions from getting worse. To rank and identify priority waters, waterways were ranked by:

- The rates at which they have violated DO and TSS standards (2004 through 2014)
- Maximum monthly geometric mean *E. coli* concentrations (2004 through 2014)
- Margins by which they either surmounted or fell short of IBI impairment thresholds (2004 through 2014)

Waters that had the highest exceedance rates or concentrations of pollutants, without being impaired, and waters that just barely met IBI standards were categorized as waters that have a high priority for protection projects. For example, the lower reach of the Black River (09020303-529) has exceeded the 65 mg/L TSS standard in 8.9% of samples, which is relatively close to the 10% impairment threshold. Therefore, it has been prioritized as a reach that is in need of projects that will reduce erosion and keep this reach from becoming impaired in future assessments. The waters and respective parameters are listed in Table 2-22. The waters are ranked based on the number of parameters in need of protection (count) and the average of the relative rankings for the parameter (count/average). The numerical rankings in each parameter's column are based upon the proximity to impairment. Reaches that are most in danger of becoming impaired for a particular parameter were ranked "1," for example.

Table 2-22. Ranked table of waters that are most in need of protection projects in order to avoid future impairments.

Protect High-Quality Unimpaired Waters at Greatest Risk of Becoming Impaired (Ranking based on proximity to impairment thresholds in 2004-2014 assessment statistics)									
Stream	**AUID**	**HUC10**	**TSS**	***E. coli***	**DO**	**F-IBI**	**M-IBI**	***Count***	***Count/Avg***
Black River	557	Black River	2	2		3	2	4	1.778
Black River	529	Black River	1			2	5	3	1.125
Red Lake River	561	Upper Red Lake River			1			1	1.000
Red Lake River	504	Red Lake R. – City of St. Hilaire		1				1	1.000
CD 53 (RLWD Ditch 12)	549	Lower Red Lake River					1	1	1.000
Red Lake River	506	Red Lake R. – City of Crookston				1	4	2	0.800
Red Lake River	562	Upper Red Lake River				4	3	2	0.571
Burnham Creek	515	Burnham Creek	3	4				2	0.571
Gentilly River	554	Red Lake R. – City of Crookston			2			1	0.500
Red Lake River	502	Red Lake R. – City of Crookston		3				1	0.333
Cyr Creek	556	Red Lake R. – City of Crookston			3			1	0.333
Polk County Ditch 1	536	Red Lake R. – City of Crookston			4			1	0.250
Penn. County Ditch 96	505	Red Lake R. – City of St. Hilaire	4					1	0.250
Kripple Creek	525	Red Lake R. – City of Crookston	5					1	0.200
Red Lake River	501	Lower Red Lake River				5		1	0.200

2.5.1. Aquatic Invasive Species Plans

Discoveries of aquatic invasive species (AIS) have occurred in neighboring watersheds and in Upper Red Lake. The presence of these species can have negative effects upon native aquatic life, water chemistry, and aquatic recreation. Water quality monitoring activities are also affected by the presence of AIS due to decontamination requirements. The counties along the Red Lake River (Polk, Red Lake, and Pennington) have received funding and have been implementing plans to combat the spread of AIS.

In 2014, a county tax bill was passed that provides funds for AIS prevention. Each year, Minnesota counties will receive funding to support AIS prevention programs.

County board representatives designate a LGU within each county to serve as their AIS program coordinator. The designated LGU works closely with local, state and federal governments, as well as nonprofit and private organizations, to develop and implement AIS prevention programs. Individual counties make decisions on how funds are to be used.

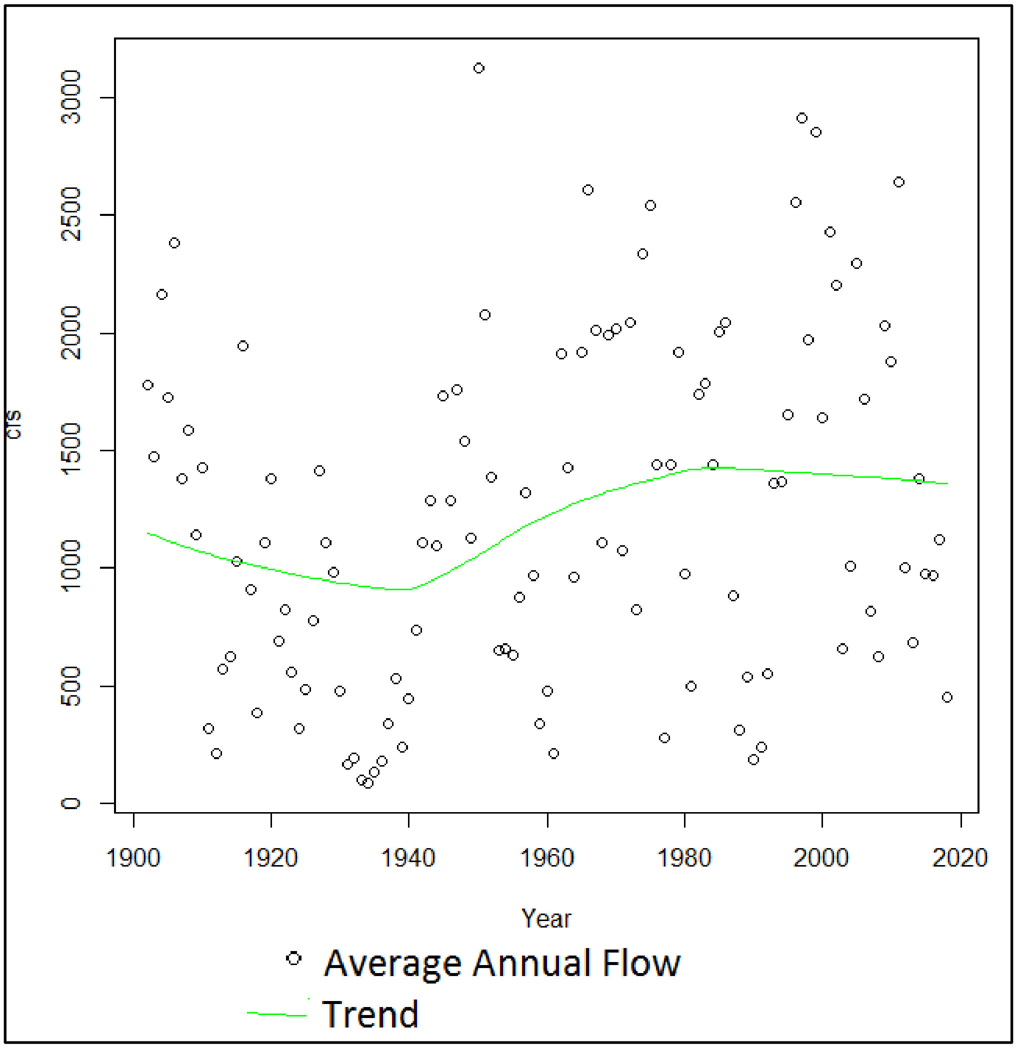
As of December 2016, AIS had not been identified within the Red Lake River Watershed. Zebra mussels (Dreissena polymorpha) are slowly working their way north, hopping from lake to lake and flowing with the currents of the Red River of the North. Zebra mussels have been found in the Red River of the North in Grand Forks, so there is some concern about future infestations in the Red Lake River. The city is concerned that the zebra mussels would clog municipal water intakes. In March of 2019, the DNR confirmed that zebra mussel veligers were found in Upper Red Lake, upstream of the Red Lake River. Established AIS populations and newly discovered AIS in neighboring watersheds are cause for concern. An established population of Eurasian Watermilfoil (Myriophyllum spicatum) is found in Union Lake just south of Erskine, in the Sandhill River Watershed. In the summer of 2016, starry stonewort (Nitellopsis obtusa) was identified in Turtle Lake, south of Bemidji, Minnesota. It was also discovered in a bay on the eastern edge of Upper Red Lake near the town of Waskish, Minnesota.

Education, prevention, and early detection are some of the key strategies in keeping AIS out of the Red Lake Watershed. Efforts from county AIS program coordinators are helping to push the “Clean, Drain, Dry” movement. They are flooding the markets with educational materials, hiring summer interns to help inspect watercrafts, purchasing decontamination stations, advertising on billboards, and distributing other educational materials.

2.5.2. Distributed Retention

Higher rates of flow within rivers results in greater erosive power. The highest TSS concentrations have occurred during the highest rates of flow. One way to decrease stream bank erosion within the Red Lake River is moderation of flows. Storing water temporarily can also improve infiltration. Increased infiltration and storage of water can also help improve base flows that are fed by seepage from groundwater and wetlands. A distributed detention study (HDR 2013) has been completed. The study involved a rigorous modeling effort that used HEC-HMS (Hydrologic Modeling System from the Hydrologic Engineering Center of the U.S. Army Corps of Engineers). The study investigated spatial and temporal relationships relative to watershed discharge and Red River Valley flooding, as well as contributing watershed areas most greatly contributing to flooding. This study investigated opportunities and potential hydrologic effects of new distributed detention basins to supplement the existing detention facilities within the entire RLWD. In total, 15 off-channel and tributary sites were identified and proposed. A RLWD peak flow reduction goal of 35%, during a flooding event similar to the 1997 flood, at Crookston was identified. A long term USGS stream gauge monitoring site is located at Crookston. Historical flows records date back to 1901, the longest in the Red Lake River Watershed. Annual flows have been highly variable throughout the period of record. Trend analysis on the flow has shown overall there has been a .46% per year increase in flow during this time period. While there is has been an overall increase, the Dust Bowl years had a significant effect on the flow of the Red Lake River Watershed (Figure 2-45).

Figure 2-45. Average Annual Flows at Crookston since 1901.



2.5.3. Nutrient Reduction Plans

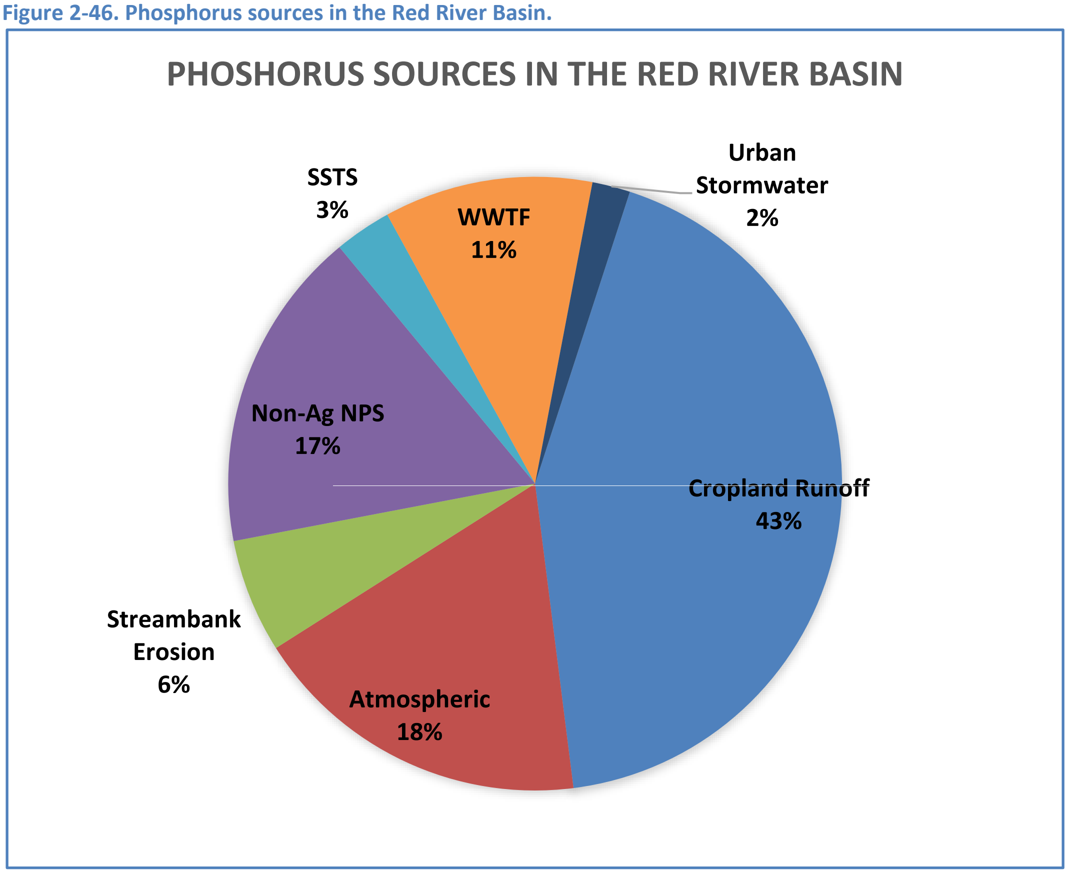
The State of Minnesota Nutrient Reduction Strategy was developed to guide the state in reducing excess nutrients in waters so that in-state and downstream water quality goals are ultimately met. An interagency coordination team representing 11 agencies developed the draft NRS. Public input was sought and used by the interagency coordination team to produce the final NRS. The Lake Winnipeg Basin, which includes the Red Lake River Watershed, requires a 10% reduction of phosphorus and a 13% reduction in N relative to the 2003 conditions. These provisional goals were based on the 2003 Lake Winnipeg Action Plan. The reduction goals are expected to change with the completion of new Lake Winnipeg strategies. The NRS is being updated in 2019-2020.

The NRS estimated (derived from SPARROW modeling) the 2003 phosphorus load for the Red Lake River Watershed at 86.2 metric tons (MT) and the N load at 1,689.6 MT. A 4.3% reduction in phosphorus throughout the Lake Winnipeg basin has already been achieved. With these reductions, the additional needed phosphorus reduction to achieve NRS goals from the Red Lake River Watershed is 5.2 metric tons. N reductions in the basin have yet to be achieved so the required N reductions for the Red Lake River Watershed remain at 169.0 MT.

Data from the WPLMN station at Fischer indicates that the average (2007 through 2016) yearly loading of phosphorus is 188.6 MT and N is 1,943.2 MT. It should be noted that this site includes loads from the Clearwater River Watershed (643.9 MT of N and 44.2 MT of phosphorus based on WPLMN data) and the Thief River Watershed (435.9 MT of N and 25.4 MT of phosphorus based on WPLMN data), which enter the Red Lake River Watershed upstream of the monitoring station at Fischer.

Nonpoint phosphorus sources in the Red River Basin contribute 84% of the load and are made up of cropland runoff 43%, atmospheric deposition 18%, streambank erosion 6% and non-agricultural rural runoff 17%. Phosphorus contributions from point sources total 16%, and are made up of domestic/industrial wastewater 11%, urban stormwater 2% and Individual sewage treatment systems 3% (RRBC 2015) (Figure2-46).

Figure 2-46. Phosphorus sources in the Red River Basin.



The main source of N in the Red River Basin is agricultural land (Figure 4-48). Cropland groundwater, cropland drainage and cropland runoff account for 69% of the N during an average precipitation year. During a wet year these three sources account for a significantly higher amount at 76% of the N. Other sources of N, in an average precipitation year, include: feedlot <1%, urban nonpoint 1%, point sources 2%, SSTS 2%, forest areas 10%, and atmospheric deposition 16% (MPCA 2013).

The Red River Basin Commission (RRBC), working with the International Red River Board (IRRB), have recognized that to achieve water quality goals in Lake Winnipeg there is a need to return to the conditions that existed in 1990 in Lake Winnipeg. This will require further reductions than identified in the NRS, as the Red River of the North Watershed contributes 10% to 15% of the water that flows into Lake Winnipeg but contributes about 60% of the phosphorus load to the lake. Phosphorus reductions needed to meet proposed the Lake Winnipeg objective could be as high as a 50% reduction in current average annual load

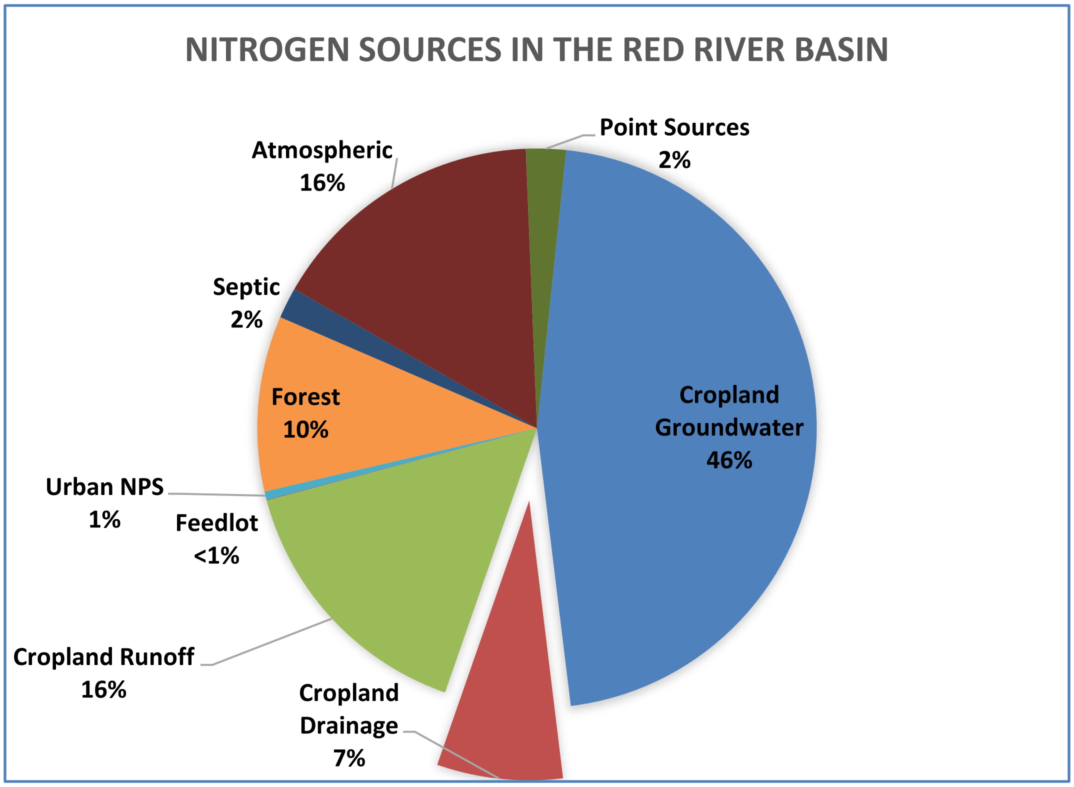


Figure 2-47. Nitrogen sources in the Red River Basin.

The RRBC and IRRB are developing a nutrient reduction strategy that encompasses the three jurisdictions that make up the Basin - Minnesota, North Dakota, and Manitoba. The proposed effort will bring together citizens, local units of government, and state and federal interests to put together a comprehensive plan to address water quality issues within the basin, focusing on sediment and nutrients. The RRBC will partner with agricultural interests and local units of government to hold community conversations to build a nutrient reduction strategy that meets the intent of each individual jurisdiction, as well as the Red River Basin as a whole, with unique nutrient reduction allocations by major watershed.

Implementation in Minnesota of the soon to be developed basin strategy will be guided by the NRS. Communication between those working on Minnesota's NRS and those working on the basin strategy has ensured compatibility between the two efforts. Communication and coordination will continue as the strategies are implemented within the basin.

3. Prioritizing and Implementing Restoration and Protection

This section includes comprehensive lists of strategies that will be used to restore impaired waters and protect waters that are currently meeting water quality standards.

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 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 most 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 implementation strategies, including associated scales of adoption and timelines, provided in this section are the result of watershed modeling efforts and professional judgment based on what is known at this time and, thus, should be considered approximate. Furthermore, many strategies are predicated on securing funding through grants and other sources. As such, the proposed strategies outlined are subject to adaptive management—an iterative approach of implementation, evaluation and course correction.

The 1W1P process places the highest priority for the implementation of water quality improvement projects upon impaired reaches that are closest to meeting water quality standards (Table 3-1). These are the reaches that can, theoretically, be most easily restored.

Table 3-1. Ranked list of the impaired waters that are closest to meeting State water quality standards and should be high priority targets for implementation projects.

Restore Impaired Waters that are Closest to Meeting State Water Quality Standards (Ranking based on proximity to impairment thresholds in 2004-2014 assessment statistics)									
Stream	**AUID**	**HUC10**	**TSS**	***E. coli***	**DO**	**F-IBI**	**M-IBI**	***Count***	***Count/Avg***
Black River	558	Black River		1	2			2	1.333
Judicial Ditch 60	542	Red Lake River-City of Crookston			1			1	1.000
Red Lake River	504	Red Lake River-City of St. Hilaire	1					1	1.000
Gentilly River	554	Red Lake River-City of Crookston		2		3		2	0.800
Burnham Creek	515	Burnham Creek				1	4	2	0.800
Kripple Creek	526	Red Lake River-City of Crookston				4	1	2	0.800
Red Lake River	506	Red Lake River-City of Crookston	2					1	0.500
Burnham Creek	551	Burnham Creek					2	1	0.500
Penn. County Ditch 43	547	Upper Red Lake River				2		1	0.500
Kripple Creek	525	Red Lake River-City of Crookston				5	3	2	0.500
Penn. County Ditch 96	505	Red Lake River-City of St. Hilaire		3				1	0.333
Red Lake River	502	Red Lake River-City of Crookston	3					1	0.333
Red Lake River	503	Lower Red Lake River	4					1	0.250
Black River	529	Black River		4				1	0.250
Red Lake River	501	Lower Red Lake River	5					1	0.200

3.1 Targeting of Geographic Areas

Several tools and practical operations were used to rank and identify areas of the Red Lake River Watershed that are in need of projects to reduce nonpoint source pollution:

- SWAT model
- HSPF
- SPI terrain analysis
- PTMApp
- Longitudinal Sampling

In addition to the tools described in this section, other efforts have been undertaken to help identify critical areas for targeted implementation efforts. Windshield reconnaissance, in-stream (kayak) reconnaissance, examination of aerial photos, and ditch inspections are some of the on-the-ground methods that were used to identify erosion problems. Rivers were prioritized for restoration or protection during the 1W1P process based upon their proximity to water quality standards.

Pennington County, Red Lake County, and West Polk SWCDs are in the process of conducting ditch inventories that will prioritize ditches for BMP implementation based upon the magnitude of need for side water inlets and buffers.

A DNR Hydrologist created "potential water quality impact site" shapefiles in which potential sources of pollutants and other notable features in the Red Lake River Watershed are marked. Four categories of features were marked: erosion, livestock, blockages, and drainage.

3.1.1 Prioritize, Target, and Measure Application

The International Water Institute and Houston Engineering have developed a tool that can be used to prioritize, target, and measure simulated water quality improvements. The Prioritize, Target, and Measure Application (PTMApp) is a desktop and web application which can be used by practitioners to provide the technical bridge between the general description of the types of strategies in a local water plan and the identification of implementable on-the-ground BMPs and Conservation Practices (CPs).

PTMApp can be used in a workshop environment by SWCDs, watershed districts, county local water planning, agency staff and decision-makers to PRIORITIZE resources and the issues impacting them, TARGET specific fields to place CPs and BMPs, and MEASURE water quality improvement by tracking the expected nutrient and sediment load reductions delivered to priority resources. The tool enables practitioners to build prioritized and targeted implementation scenarios, measure the cost-effectiveness of the scenario for improving water quality, and report the results to pursue funds for project implementation.

It breaks the drainage areas into relatively small units. The model can estimate sediment and nutrient loss from each of those small units (Figure 3-1). Cost information has been incorporated into the application so that projects can be targeted to achieve the greatest amount of pollutant reduction for each dollar spent. It is best suited to the targeting of practices that reduce pollution from overland runoff because it does not account for in-channel processes. The Red Lake River 1W1P document includes maps that show pollutant reduction estimates and cost effectiveness for each of five categories of BMPs (Figure 3-2 through Figure 3-4):

- Protection BMPs (stream bed/channel stabilization, critical area planting, streambank and shoreline protection, tree/shrub establishment)
- Source protection (conservation tillage, nutrient management, rotational grazing) – Figure 3-4
- Storage BMPs (drainage water management, stormwater retention, water/sediment control basins, wetland restoration)
- Filtration (conservation cover, cover crop, filter strips, grassed waterway) – Figures 3-2 and 3-3
- Infiltration (two-stage ditch design)

Web and desktop versions of the tool are available http://ptmapp.rrbdin.org/.

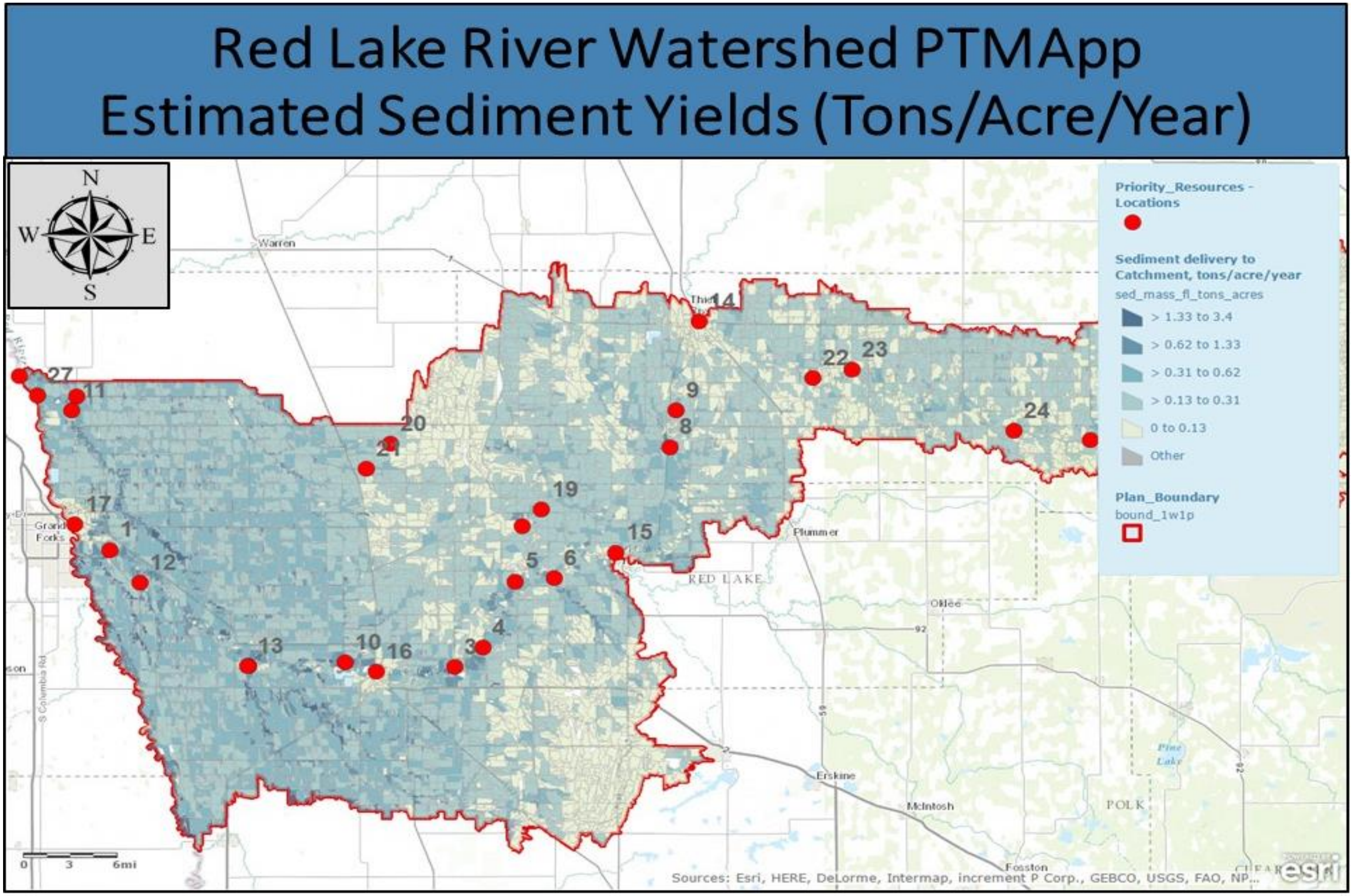


Figure 3-1. Sediment Yields (tons/acre/year) in the Red Lake River Watershed as estimated by the Red Lake River planning area PTMApp.

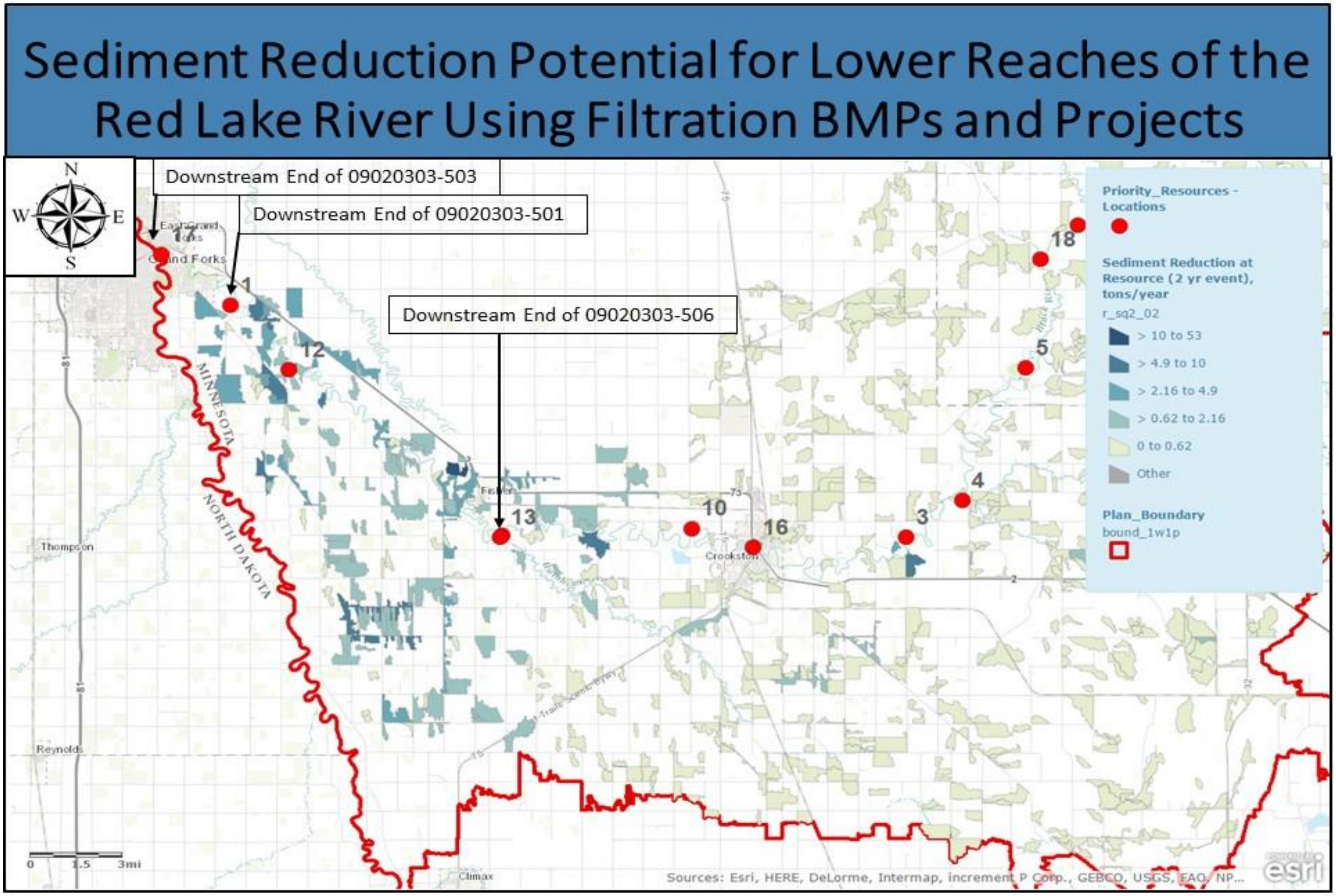


Figure 3-2. PTMApp-generated sediment reduction potential for lower reaches of the Red Lake River using filtration BMPs.

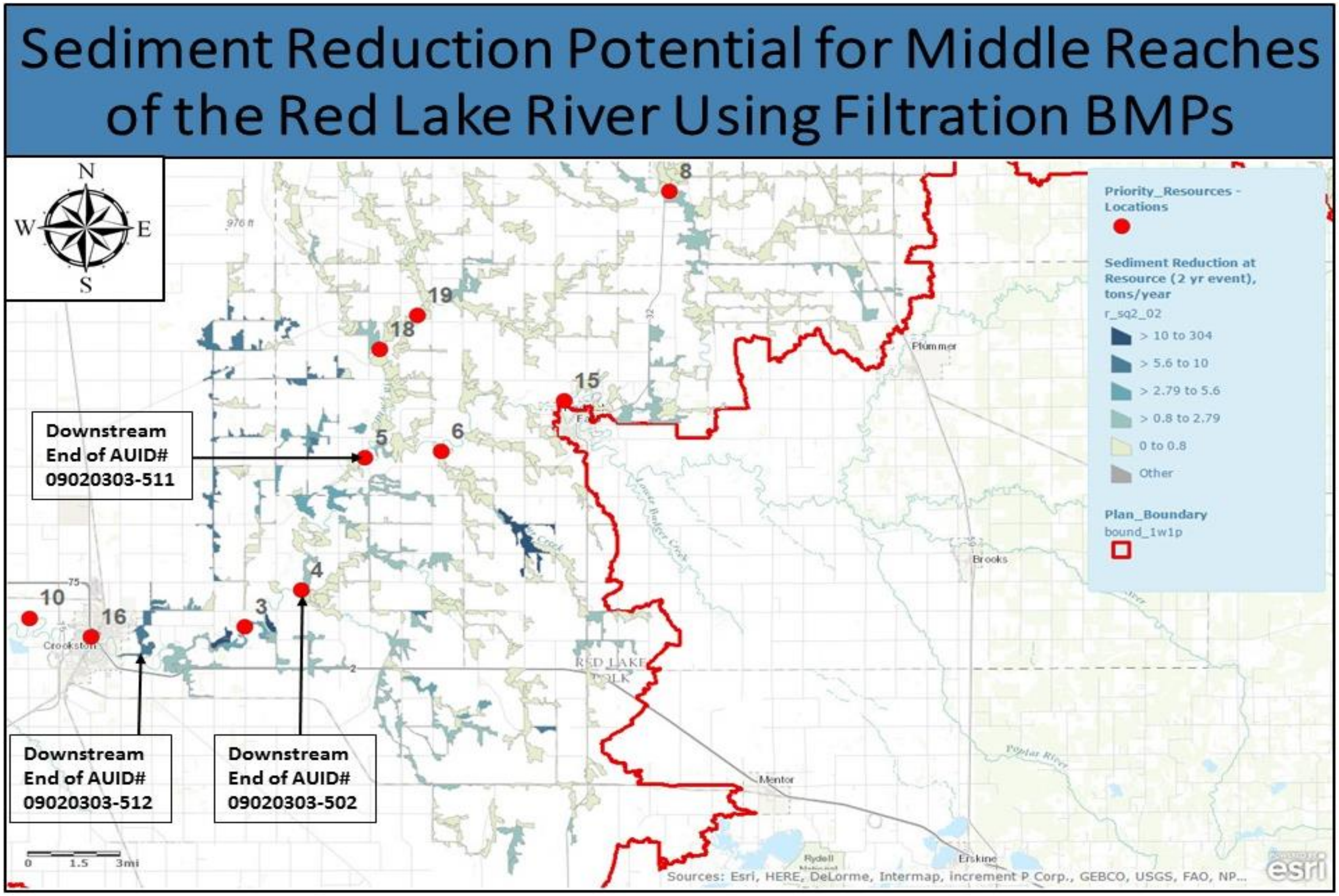


Figure 3-3. PTMApp-generated sediment reduction potential for the middle reaches of the Red Lake River using filtration BMPs.

Sediment Reduction Potential for Red Lake River Reach 09020303-504 Using Protection BMPs and Projects

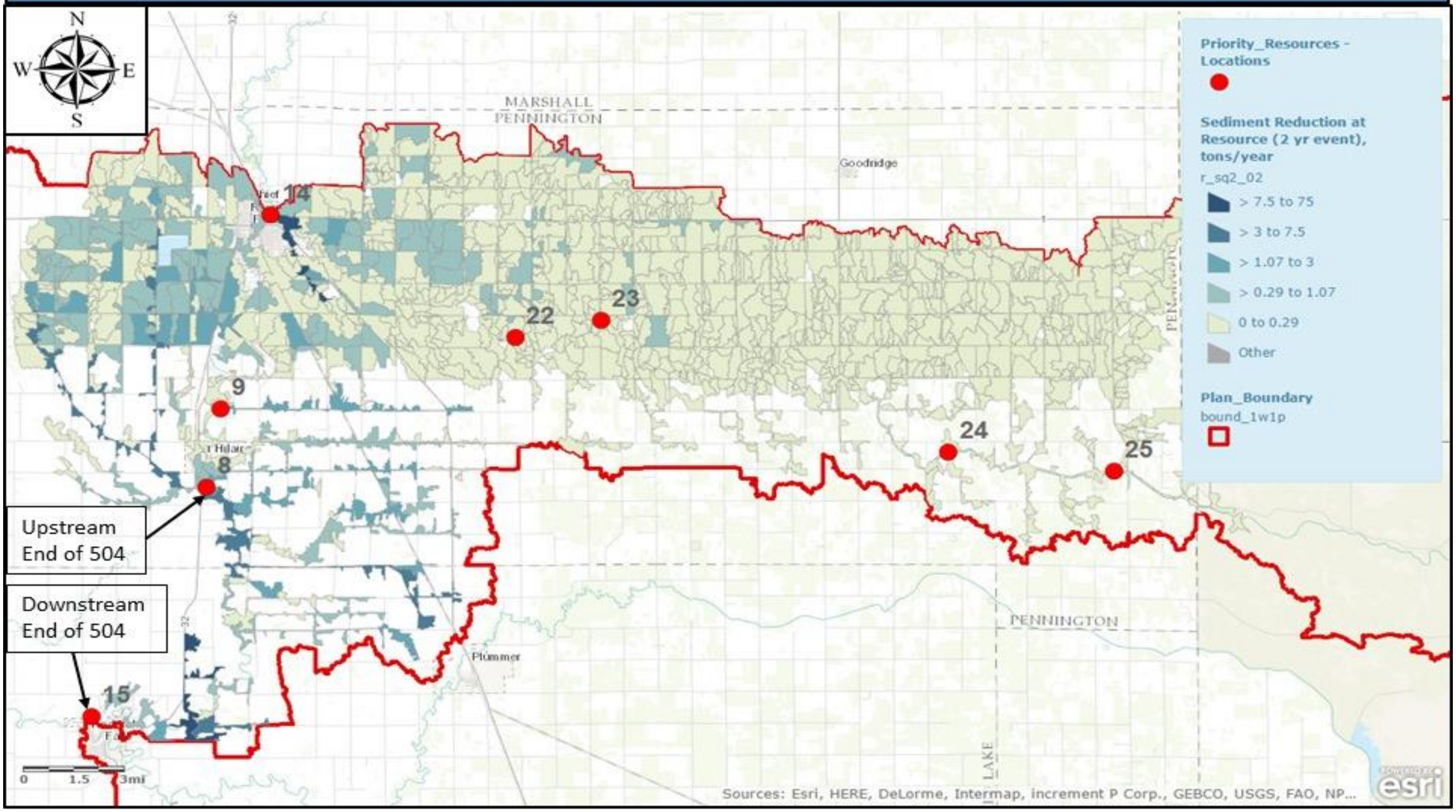


Figure 3-4. Sediment reduction potential for AUID 09020303-504 using protection BMPs, as simulated by PTMApp.

3.1.2 Hydrological Simulation Program – FORTRAN (HSPF) Model

A HSPF model of the Red Lake River was developed by the RESPEC consulting firm. The HSPF model incorporates watershed-scale and nonpoint source models into a basin-scale analysis framework. It 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. It provides a simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants from pervious and impervious land. It typically used in large watersheds (greater than 100 square miles).

The HSPF-SAM tool is an interface for the extraction of information from an existing HSPF model. The tool can be used to create strategies tables that quantify the BMPs that are needed in order to achieve pollutant reduction goals. The suitability of BMPs can be estimated on the HUC-12 scale. It is most effective when used in tandem with local scale GIS targeting (PTMApp or ACPF) and local resource manager knowledge. Before HSPF-SAM can be used for a watershed, someone familiar with the HSPF model must complete a Processing Application Translator for HSPF (PATH) process for the watershed. A consultant has updated the Red Lake River HSPF model, completed the PATH process, and created an HSPF-SAM for the watershed in 2017. The revised model has an extended, simulated period of 1995 through 2016. The HSPF-SAM application makes the HSPF modeling results accessible to LGUs and provides tools for targeting BMP implementation.

Figure 3-5 shows the relative contributions to simulated annual loads from different sources. The majority of modeled erosion comes from in-stream erosion and cultivated fields Figure 3-6 shows the relative erosion rates (sediment yields) from sub-basins in the Red Lake River watershed. The map highlights the Polk CD 1 and Lower Burnham Creek subwatersheds as areas that have the highest sediment yields. . Figure 3-7 shows how the TSS yield from developed land is relatively high.

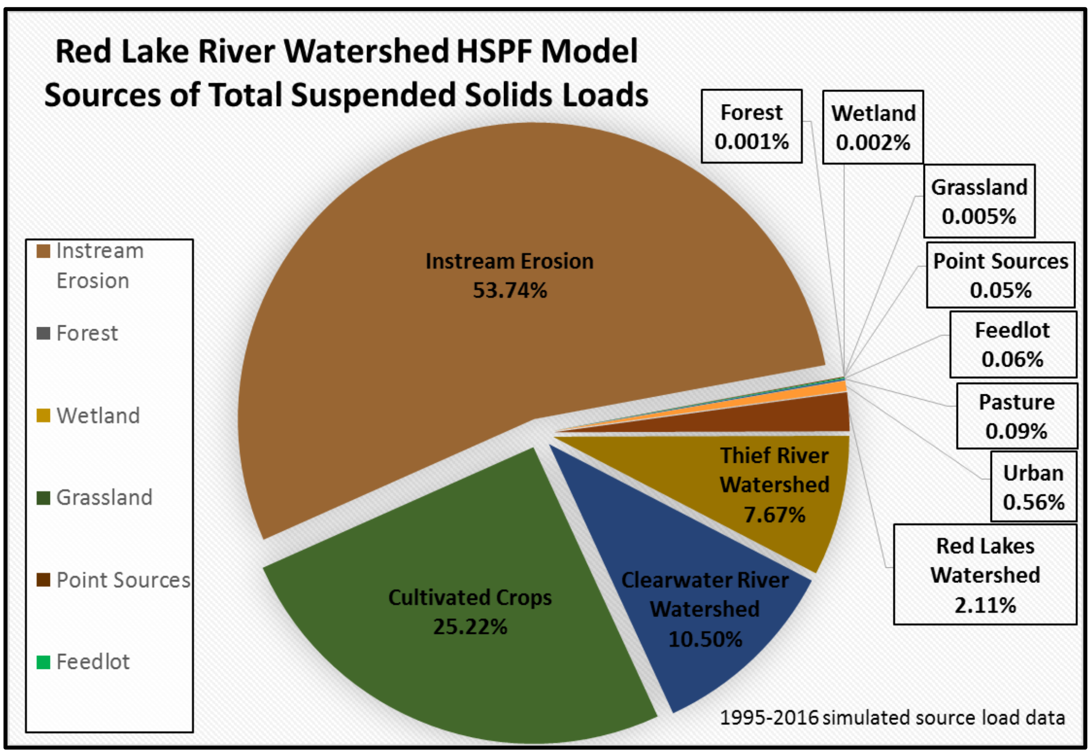


Figure 3-5. Proportions of 1995-2016 HSPF-simulated TSS loads attributed to categories of sources.

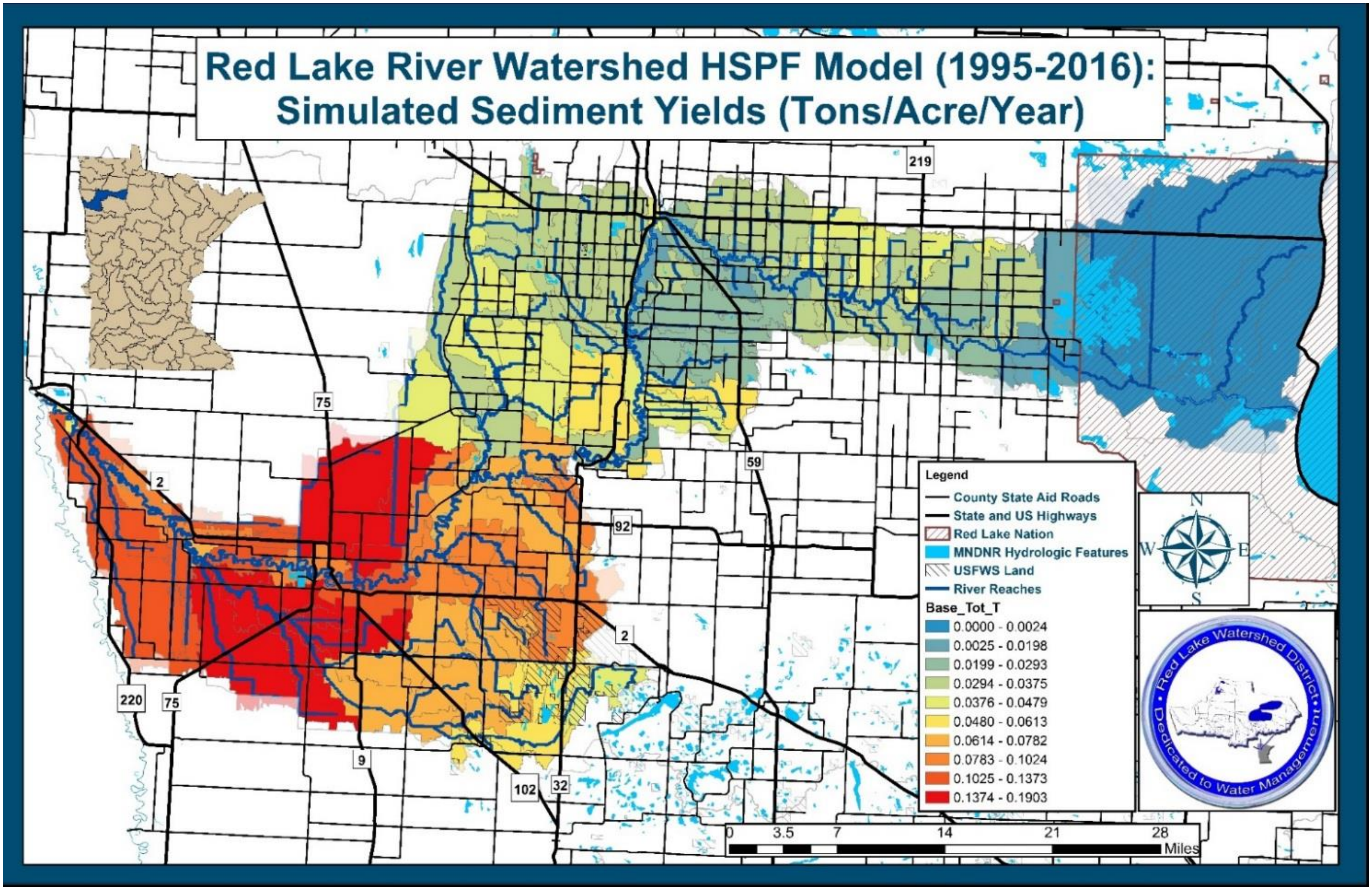


Figure 3-6. HSPF-Modeled 1995-2016 Total Suspended Sediment Yields for the Red Lake River Watershed.

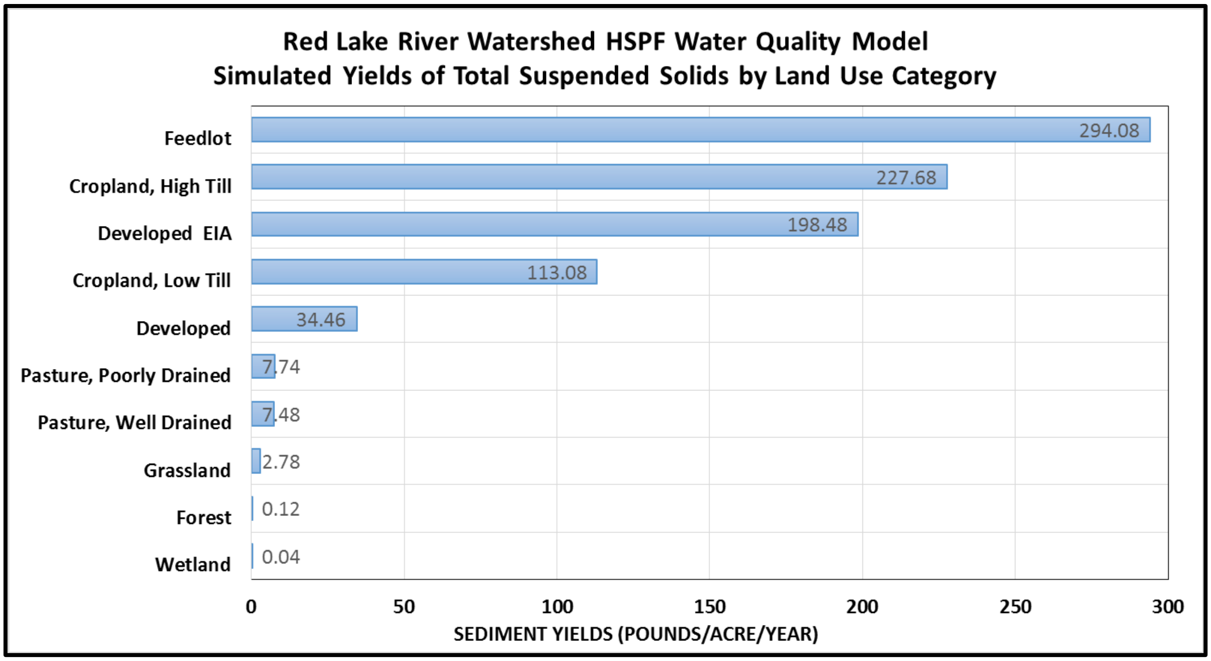


Figure 3-7. TSS yields by land use category, as simulated by the 1995-2016 HSPF Model.

3.1.3 Terrain Analysis and Stream Power Index (SPI)

RLWD staff used SPI analysis of the Red Lake River Watershed to identify points on the landscape where flow accumulation and erosive power create a risk of gully erosion. An intensive and detailed culvert inventory was used to hydro-correct LiDAR data prior to the analysis. Field reconnaissance was used to verify the results of the analysis. The files are available on the RLWD website: http://www.redlakewatershed.org/downloads.html.

Figures 3-8, 3-9, 3-10, and 3-11 show the analysis results from the direct drainage areas of impaired reaches of the Red Lake River. Additional subwatershed maps can be found in the Red Lake River WRAPS. Channels and flow paths highlighted in red are more susceptible to erosion than the other 98% of flow paths in the watershed. Not all of the highlighted flow paths are actively eroding. Some of them are currently adequately protected. It is important to make sure that those areas remain protected in the future. SPI layers can be used in conjunction with PTMApp and the DNR's potential water quality impact site layers to assist in the planning of projects. The SPI analysis is sufficiently detailed to plan projects on individual fields.

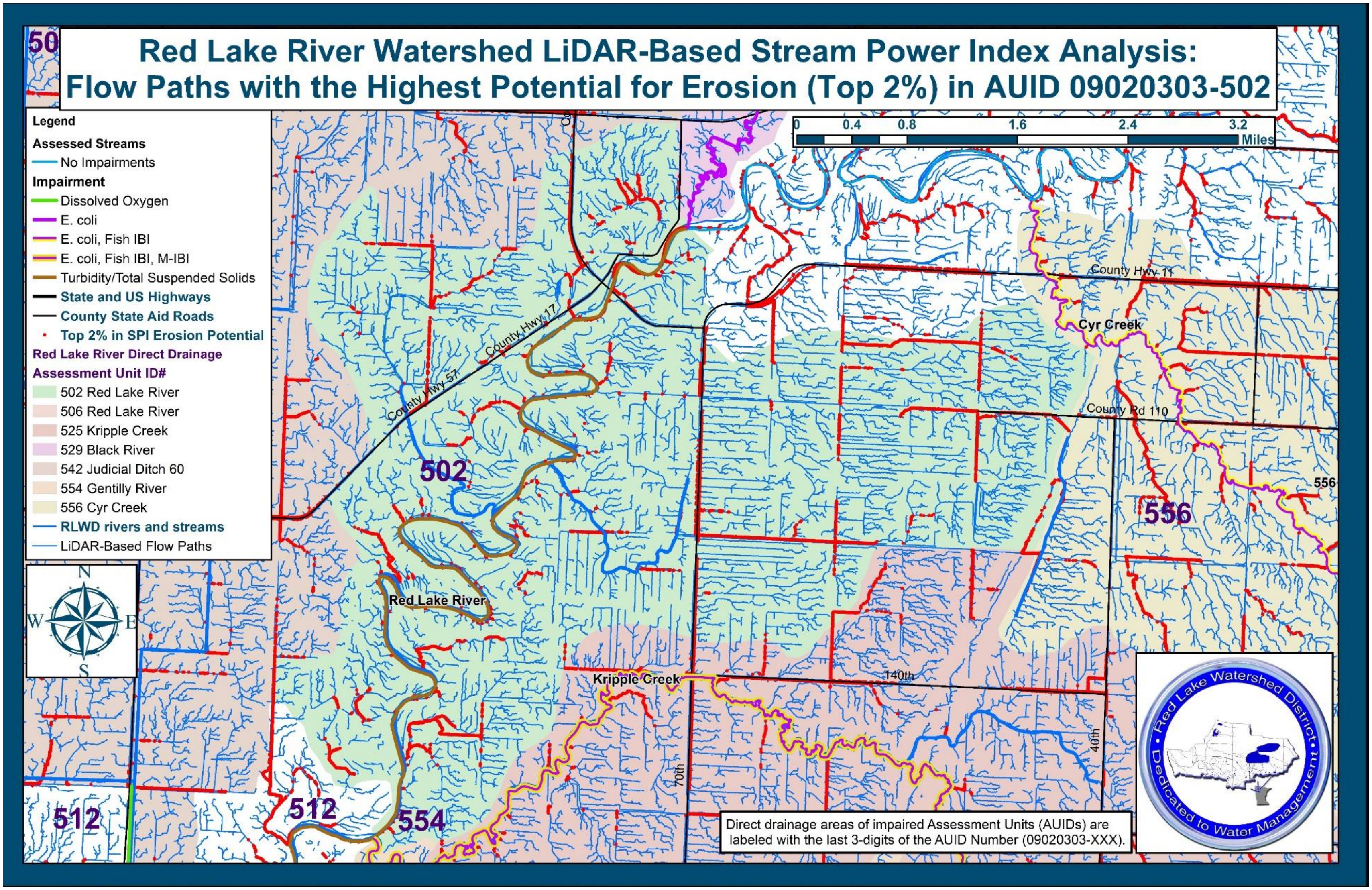


Figure 3-6. Red Lake River Watershed Stream Power Index Analysis for the direct drainage area of AUID 09020303-502.

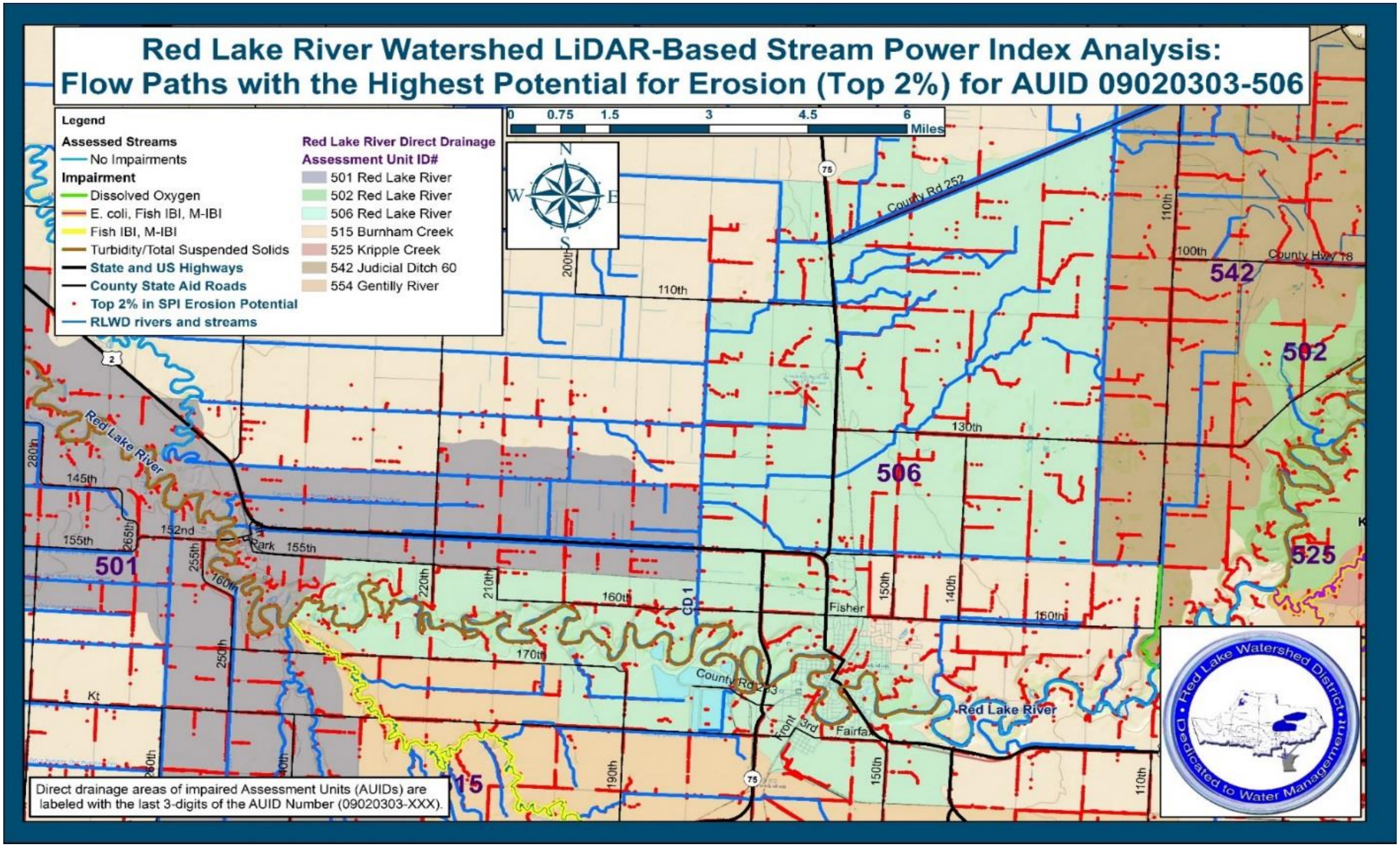


Figure 3-7. Red Lake River Watershed SPI Analysis: direct drainage area of AUID 09020303-506 and eastern 09020303-501.

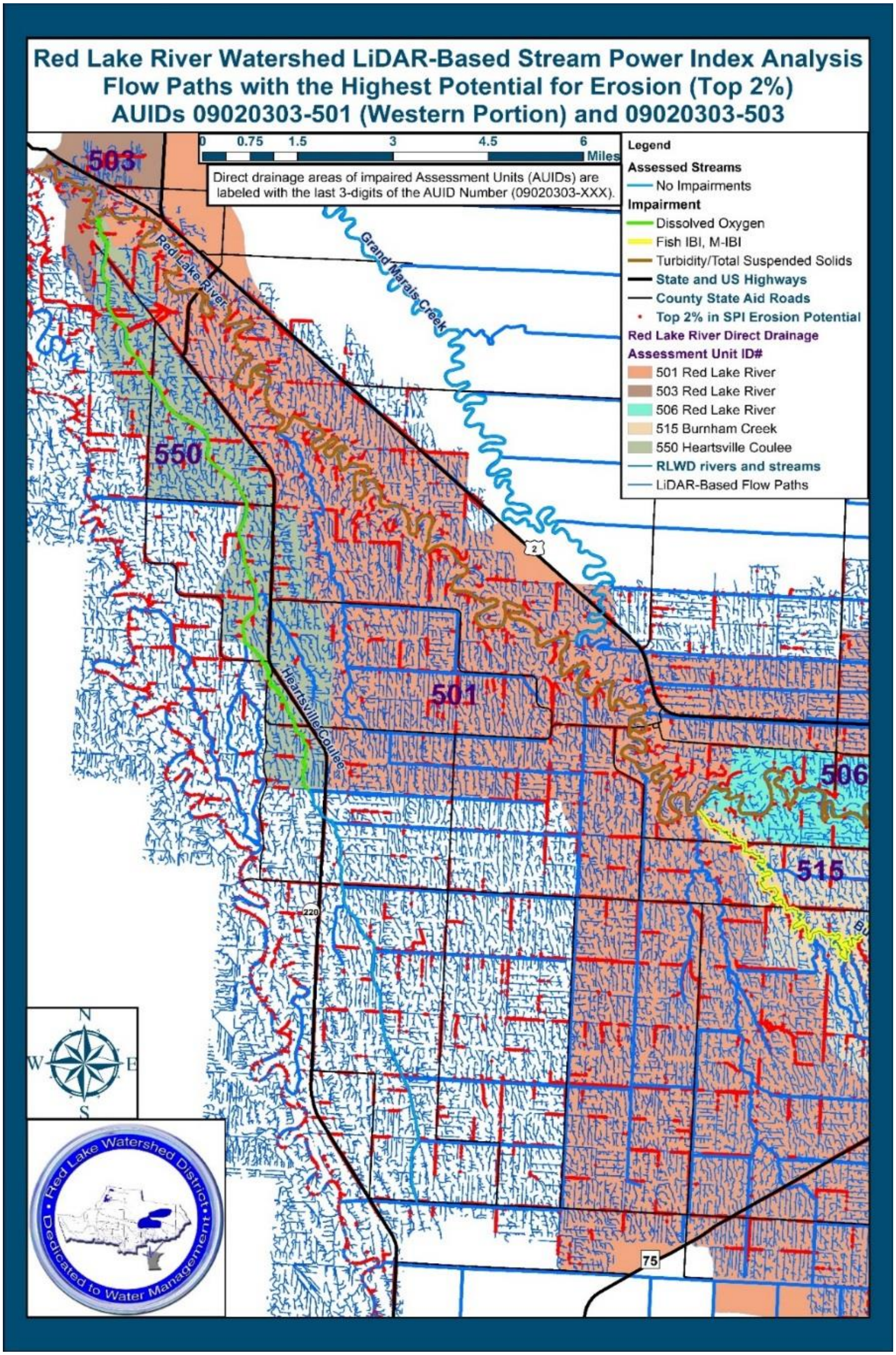
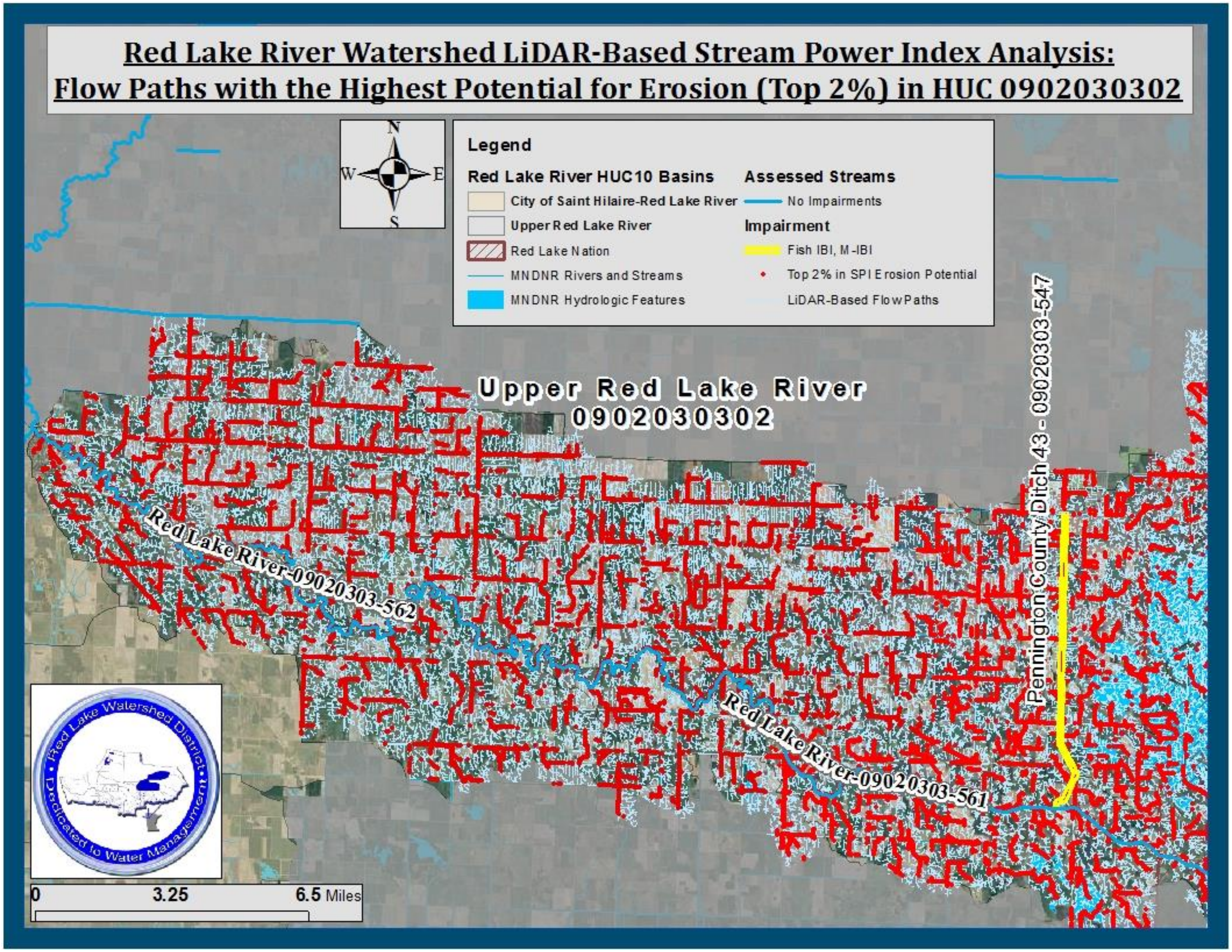


Figure 3-8. Red Lake River Watershed SPI Analysis for the direct drainage area of AUIDs 09020303-501 and 09020303-503.

Figure 3-9. Red Lake River Watershed SPI Analysis for the 0902030302 subwatershed: AUIDs 09020303-561 and 09020303-562.



3.1.4 SWAT Model

Prior to the HSPF model and PTMApp development, nearly every major watershed within the Red River Basin was modeled using the SWAT model. The results of these models have been used to target projects and estimate benefits of BMP implementation. The map in from the Red Lake River SWAT model report shows the sub-basins that are contributing the most sediment per acre (sediment yield). According to the map in Figure 3-12, the Red Lake Falls area and outlets of major Polk County drainage systems should be targeted for implementation projects.

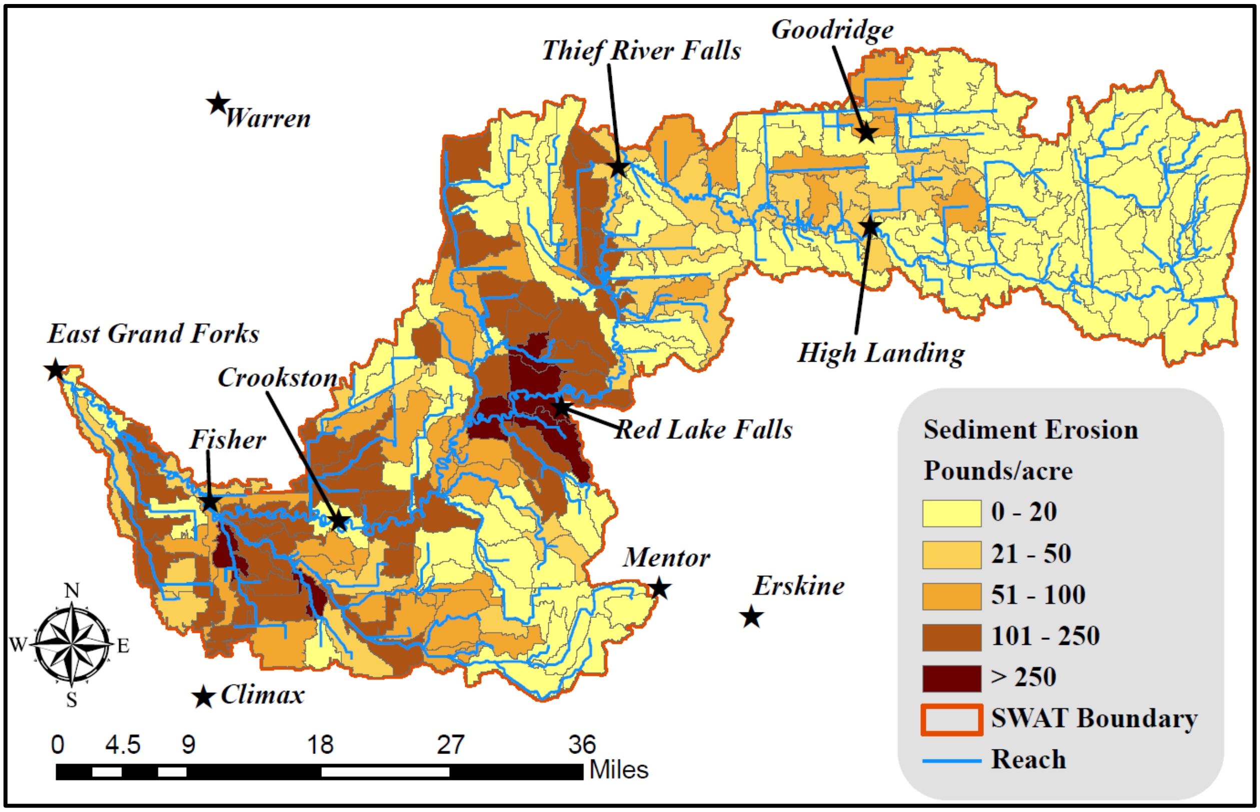


Figure 3-10. Sediment yield map from the Red Lake River SWAT model.

3.1.5 Longitudinal Water Quality Sampling

The collection of longitudinal water quality samples is a method for directly measuring how water quality changes within a river, stream, or ditch as it flows past potential pollutant sources, especially during runoff events. This has been completed within the Red Lake River Watershed along the Red Lake River and these tributaries:

- Lower Red Lake River
- Burnham Creek
- Gentilly River
- Kripple Creek
- Black River

Red Lake River

Longitudinal samples were collected along the main channel of the Red Lake River from Murray Bridge in East Grand Forks upstream to the CSAH 3 crossing near Huot on May 23, 2013, during a runoff event that resulted from significant rainfall events on May 19 through May 21 of 2013. Figure 3-13 shows how TSS concentrations greatly increased downstream of Crookston.

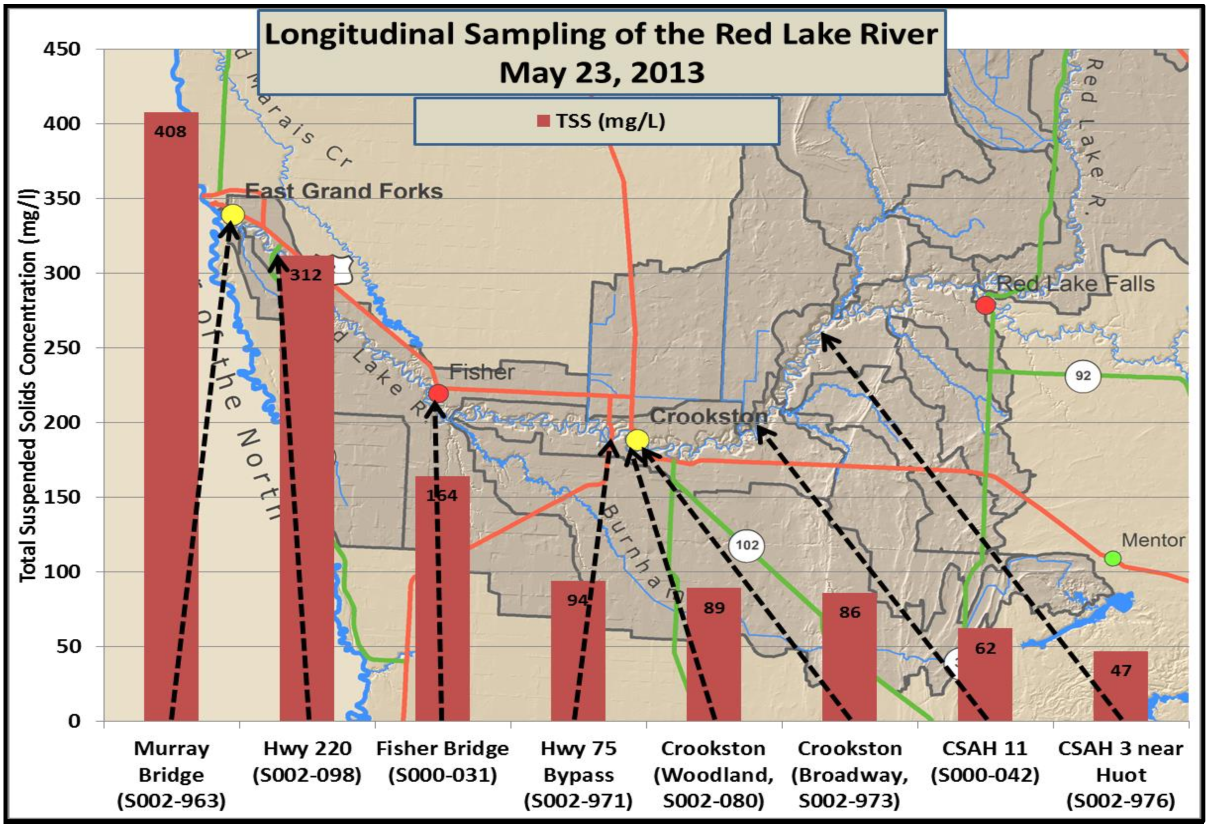


Figure 3-11. May 23, 2013 longitudinal sampling along the Red Lake River.

Burnham Creek

Longitudinal sampling was conducted along Burnham Creek during a runoff event (Figures 3-14 and 3-15). The lower half of Burnham Creek was sampled during a rain event on May 21, 2013 and sampling continued upstream the next day. Turbidity (397.1 FNU) and TSS (264 mg/L) levels were very high on the lower end of the watershed, but gradually improved upstream and were very low (0.4 FNU) at Highway 32 (flowing out of Glacial Ridge NWR). Turbidity increased from 9.1 FNU to 44.2 through the Spring Gravel Dam washout area downstream of Highway 102 (to 180th Ave). Turbidity then increased significantly to 81.9 at the next crossing (190th Ave). Therefore, the planned Burnham Creek grade stabilization and restoration projects are well needed in order to address some sources of sediment and turbidity. Turbidity was very low (4.4 FNU) in CD 106 where it flows into Burnham Creek (see right photo in Figure 3-14).

Figure 3-12. Photos of Burnham Creek during a runoff event.

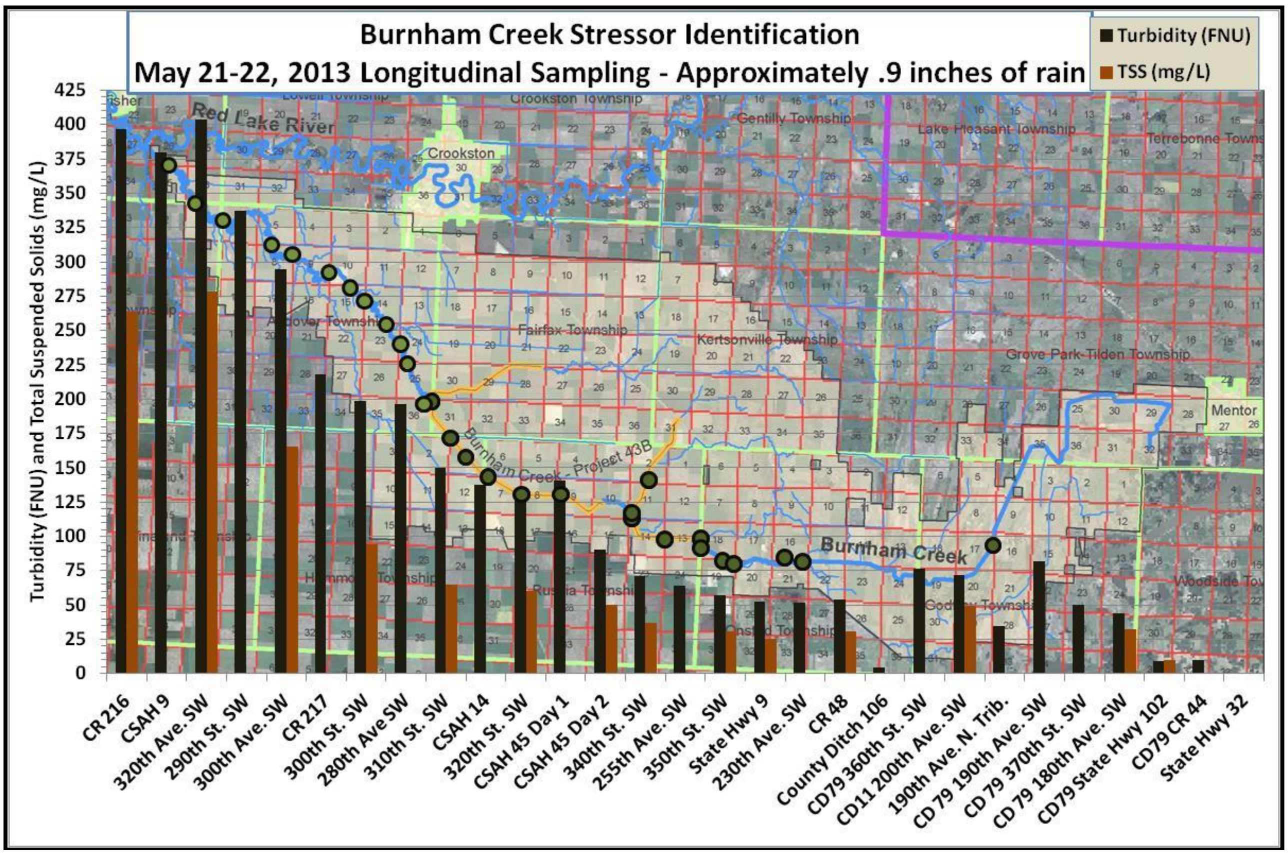


Figure 3-13. Longitudinal TSS and turbidity levels along Burnham Creek.

Kripple Creek

Longitudinal samples were collected along Kripple Creek on June 2, 2014. Kripple Creek is a tributary of the Red Lake River that begins in Glacial Ridge National Wildlife Refuge and finally joins with the Gentilly River prior to flowing into the Red Lake River north of the town of Gentilly. High turbidity and *E. coli* levels have been observed at the lower end of the watershed during routine monitoring. The sampling revealed potential sources of sediment and *E. coli.* Water flowing from Glacial Ridge NWR at the upstream end of Kripple Creek was very clear. However, TSS and turbidity levels increased greatly along the downstream portions of the stream (Figure 3-16). In particular, runoff from poorly buffered fields seemed to be the potential primary cause of the high concentrations.

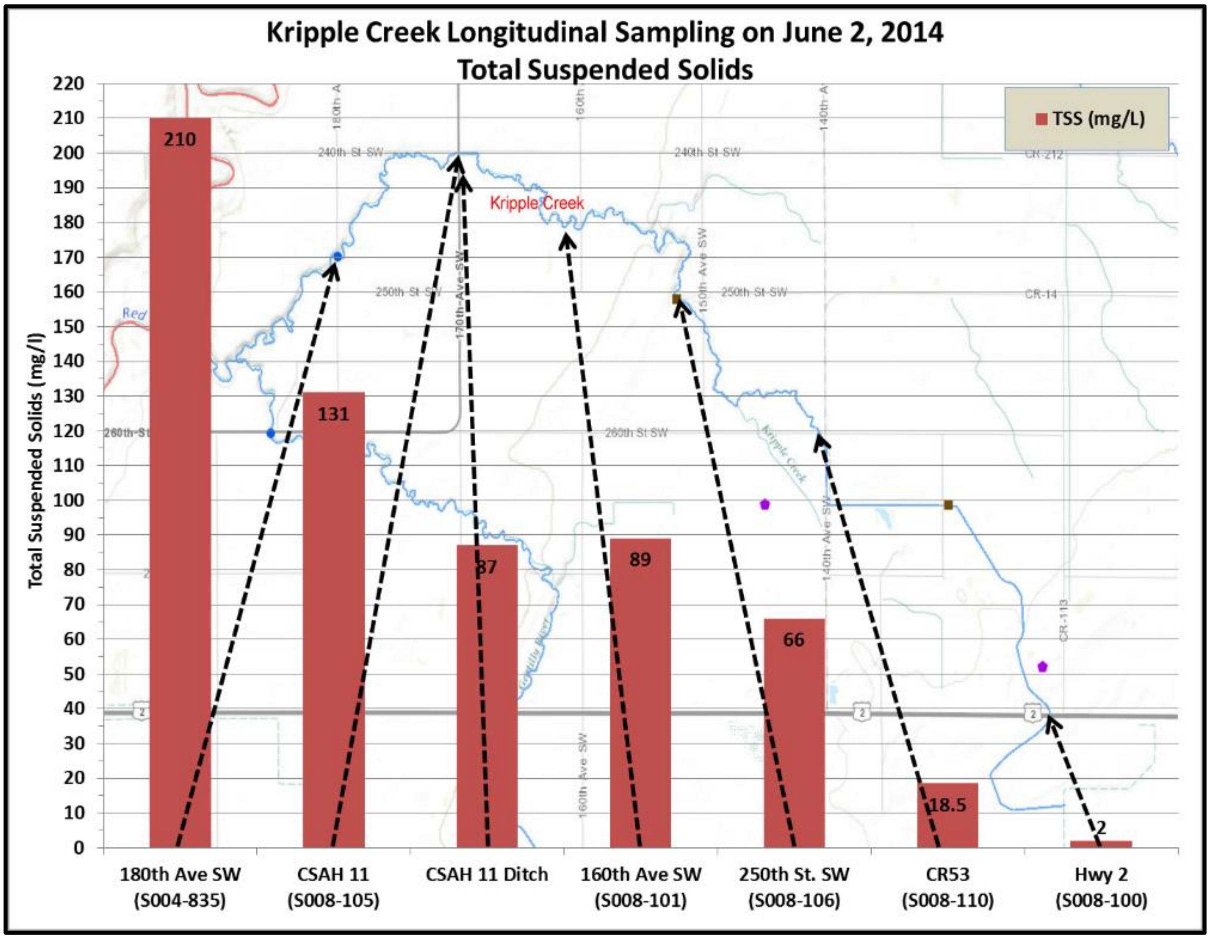


Figure 3-14. Longitudinal TSS concentrations on June 2, 2014 in Kripple Creek.

The longitudinal sampling results for *E. coli,* germane to the impairment, are shown in Figure 3-17. *E. coli* concentrations greatly increased downstream of a farm with livestock near the intersection of 260th Street Southwest and 140th Avenue South, *E. coli* concentrations decreased at each of the next three crossings that were sampled and then increased again downstream of CSAH 11.

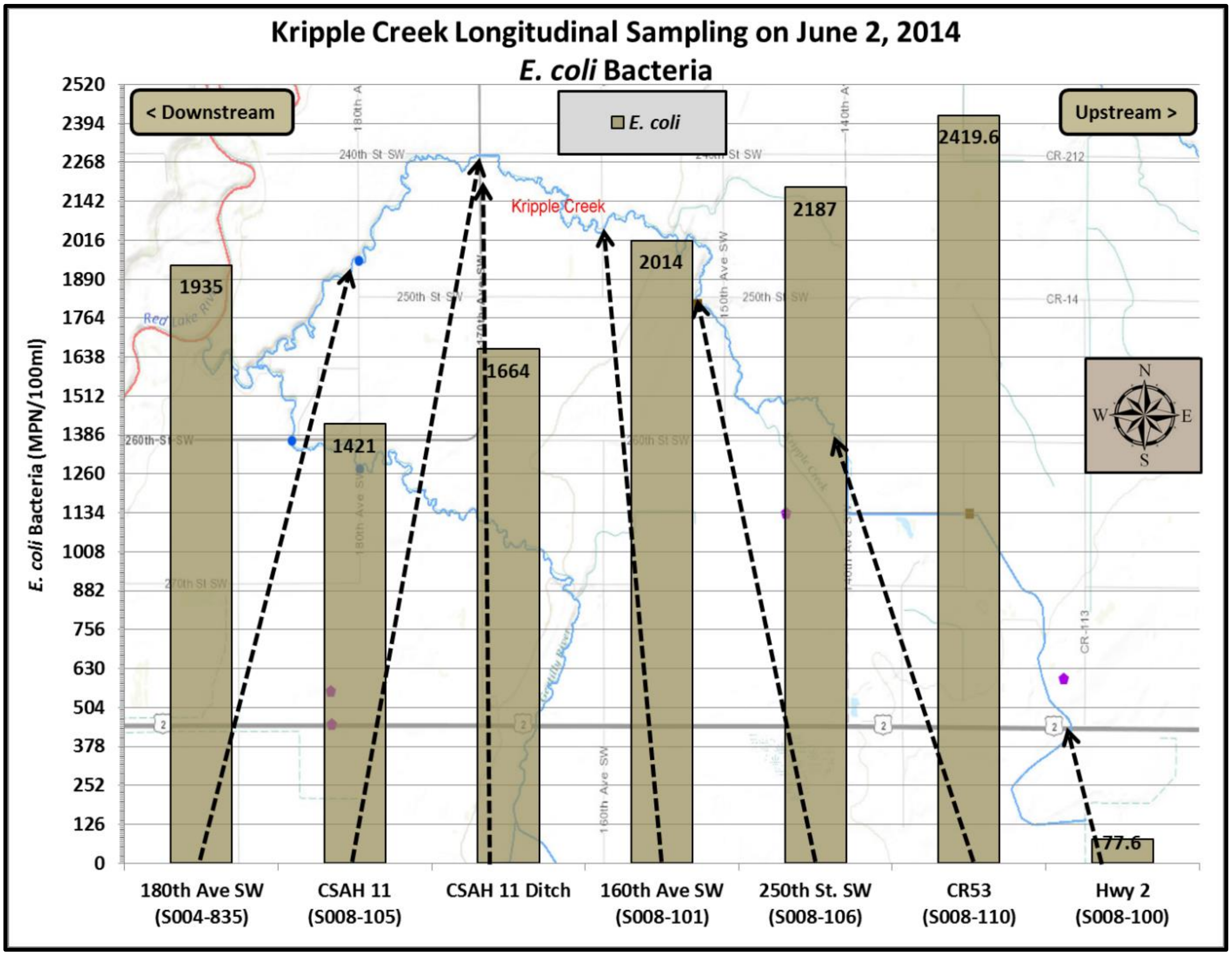


Figure 3-15. Longitudinal profile of *E. coli* concentrations in Kripple Creek during a June 2, 2014 runoff event.

Gentilly River

Longitudinal samples were collected along Gentilly River on June 5, 2014. The samples were collected after several days of rainfall in the area, including rain on the day of sample collection. *E. coli* concentrations (Figure 3-18) and turbidity levels (Figure 3-19) spike where the Polk County Ditch 140 portion of the Gentilly River crosses CR44 and 300th St. SW. A livestock operation, located east of CR44, drains to both branches of CD140 and could be contributing to high *E. coli* levels. The livestock operation is not the only source; however. There was a significant increase in *E. coli* concentrations between CR44 and 300th Street, even though there does not seem to be any obvious sources of *E. coli* (based on aerial photos) in Section 15 of Kertsonville Township. The *E. coli* concentration was high at the furthest upstream sampling site at CSAH 45. Most of the land along CD140 upstream of CSAH 45 is not farmed, so the sources of *E. coli* in this area may be “natural.” A big potential source of excessive “natural” *E. coli* bacteria could be the BR6 impoundment that would attract great numbers of waterfowl.

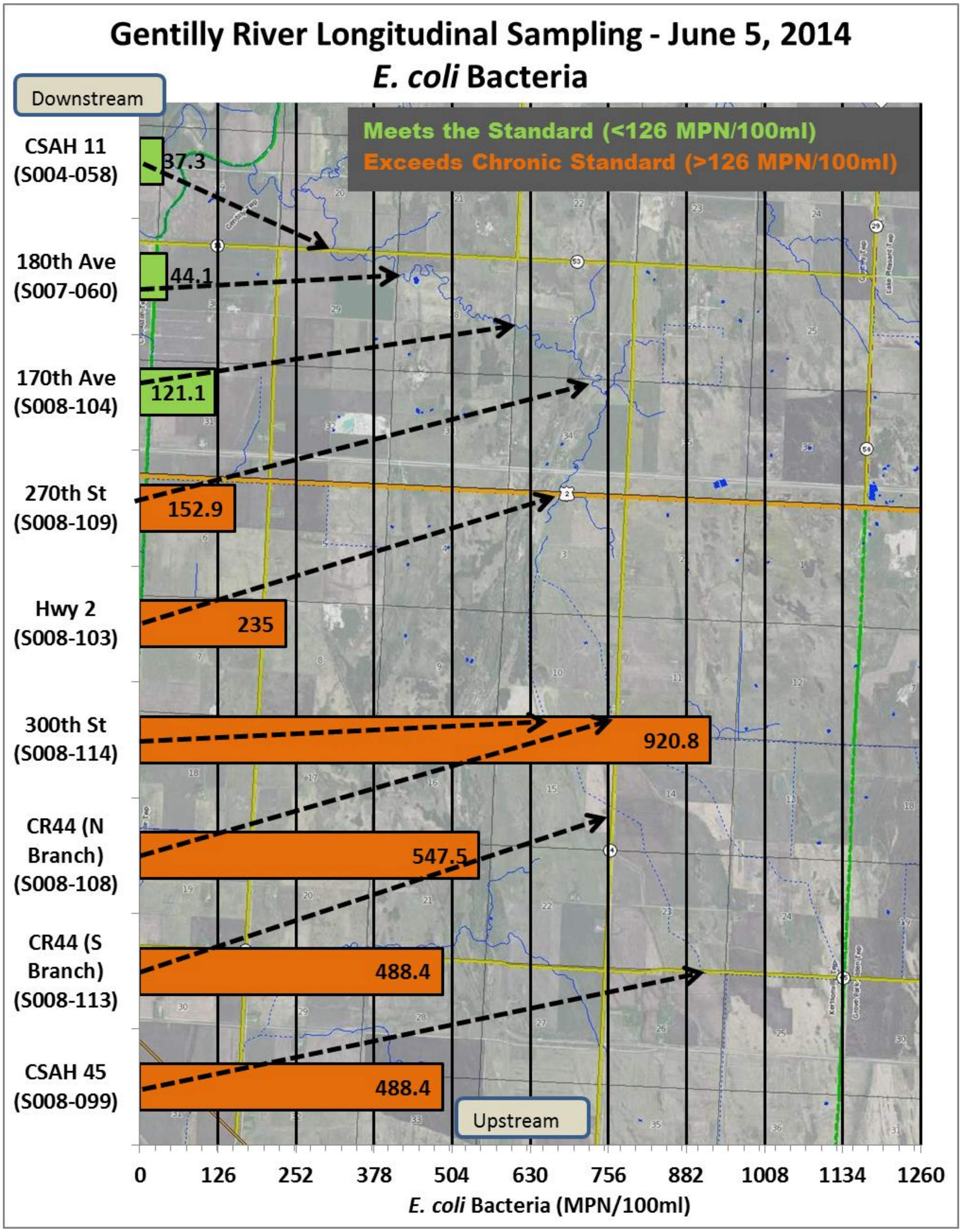


Figure 3-16. Longitudinal profile of *E. coli* concentrations along the Gentilly River on June 5, 2014.

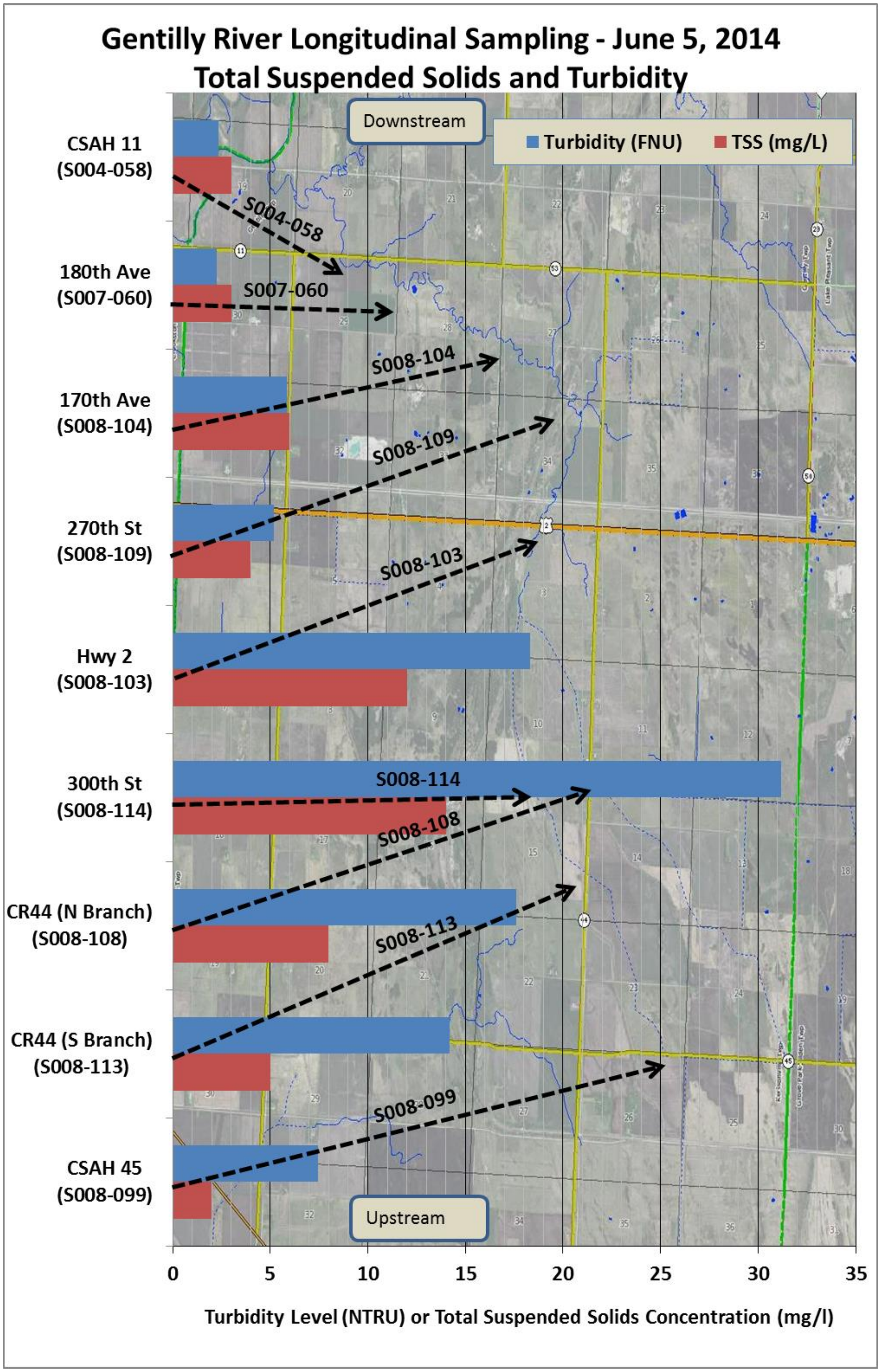


Figure 3-17. Longitudinal profile of TSS and turbidity levels along the Gentilly River on June 5, 2014.

Black River

On June 16, 2014, longitudinal samples were collected at sites along the Black River and at the pour points of two of its main tributaries (Little Black River and Browns Creek). The samples were taken after a rain event to help identify specific areas in the watershed in which runoff is significantly increasing pollutant concentrations in the river. These areas can be targeted for project implementation. Figure 3-20 shows that the most significant increase in *E. coli* concentrations was found at the CR 103 crossing.

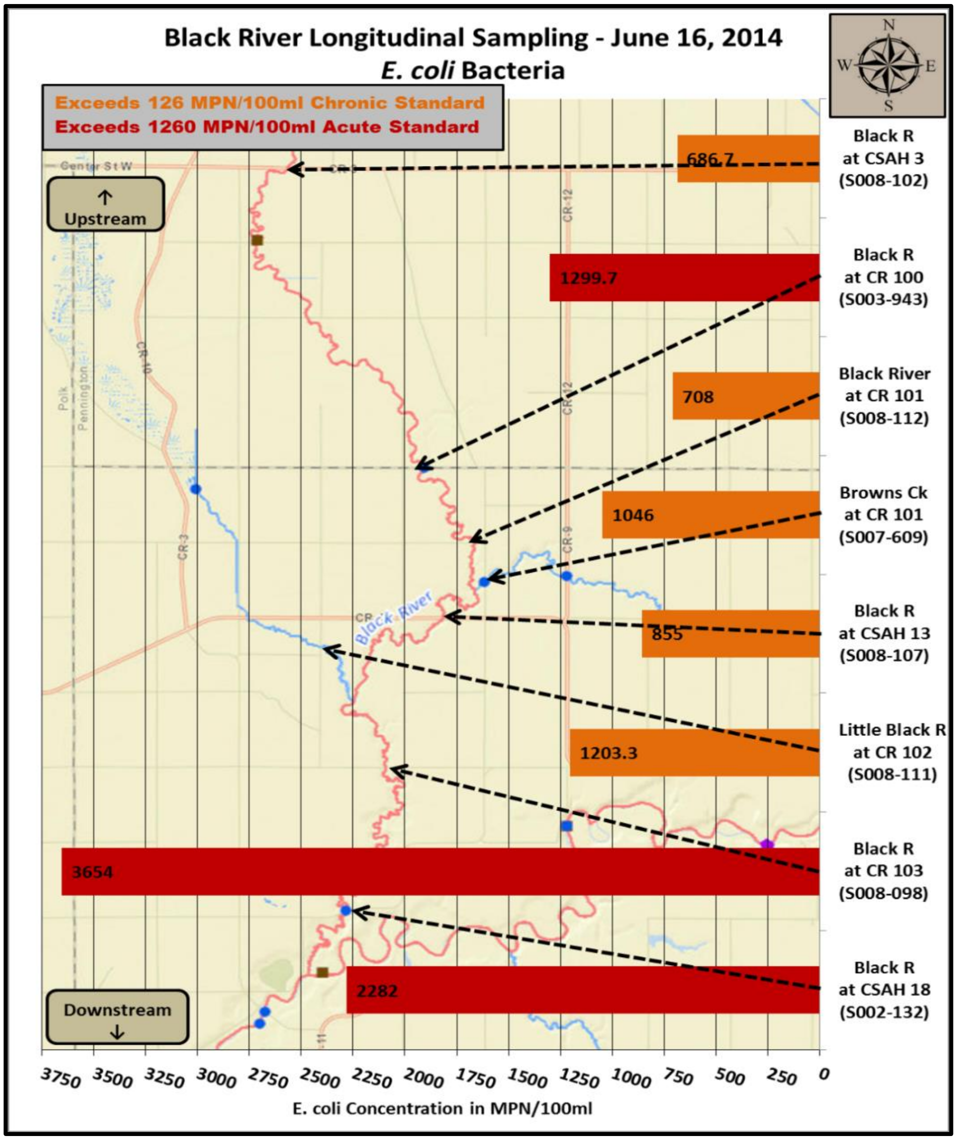


Figure 3-18. Longitudinal profile of *E. coli* concentrations along the Black River on June 16, 2014.

TSS and turbidity increase dramatically at the lower end of the Black River Watershed, as shown in Figure 3-21. Erosion control projects will be needed in the lower part of the watershed, as evidenced by high turbidity at CSAH 18 (Figure 3-22). These could include structural projects in the channel to fix eroding banks and BMPs to reduce overland erosion. Based on preliminary observations during the geomorphologic analysis of the Black River, lowering peak flow rates would reduce stress on stream banks and would be an important part of reducing erosion in the lower reach of the Black River.

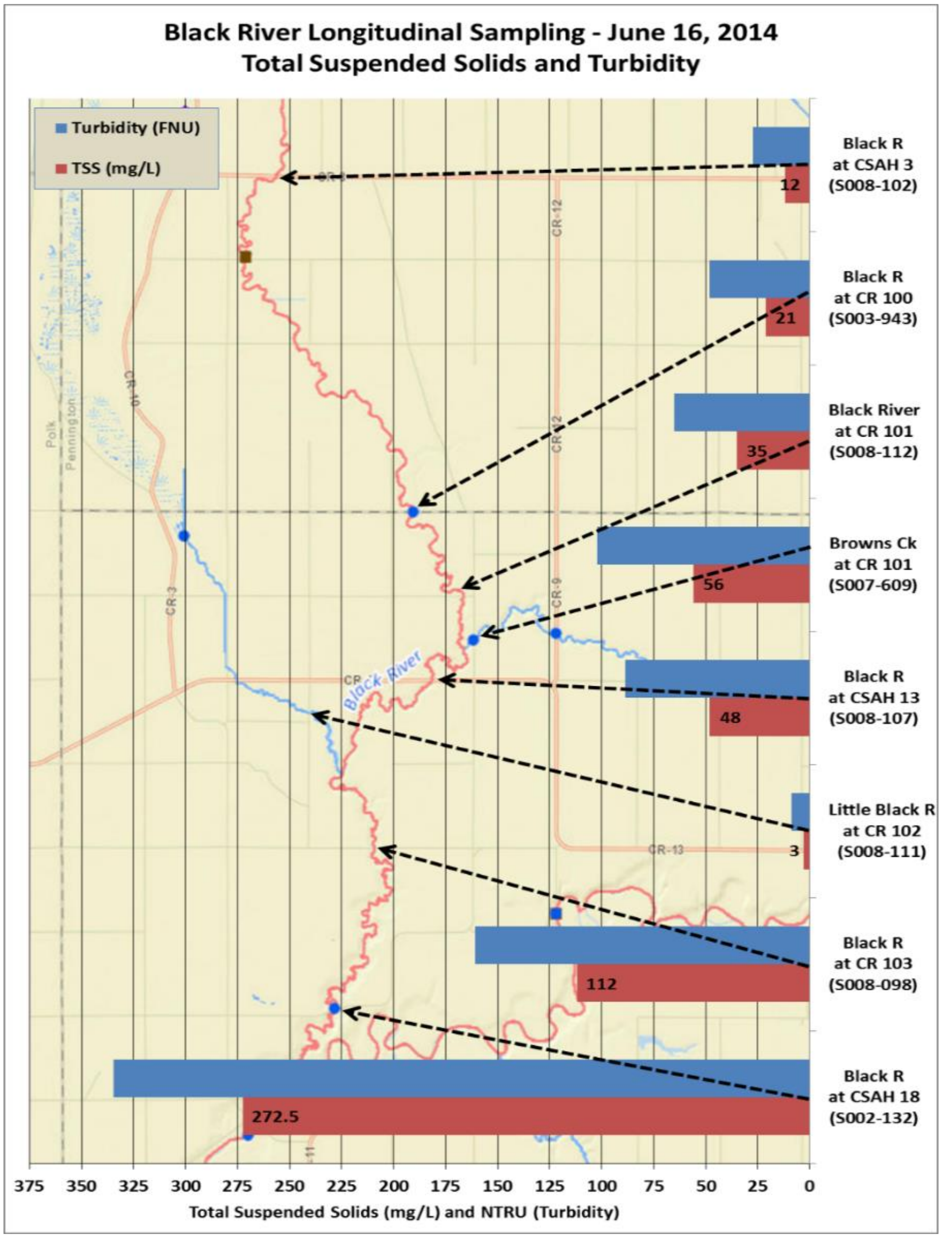


Figure 3-19. Longitudinal profile of TSS and turbidity levels along the Black River on June 16, 2014.

Figure 3-20. Muddy water in the Black River on June 16, 2014.

3.1.6 Assessment of Fluvial Geomorphology

A fluvial geomorphology study was completed for the Red Lake River watershed. Bank Erosion Hazard Index (BEHI) ratings were conducted along reaches of the Red Lake River and its tributaries in 2012. While traveling down the river in kayaks, DNR, RLWD, and MPCA staff collected notes on study bank height, root depth, root density, bankfull height, bank angle, bank material, substrate material, channel depth, and channel width. Erosion problems along those reaches were well documented with notes and georeferenced photos. Full geomorphic assessments were conducted on representative reaches along the Red Lake River and a tributary in 2012. Follow-up work was completed in 2013. The Pfankuch stability ratings were stable along the Red Lake River. Excess upland and bank erosion problems were still identified. Erosion rates were highest along TSS-impaired reaches (Table 3-2). High, steep banks are very susceptible to gully erosion. Much of the Red Lake River channel between Thief River Falls and the Clearwater River is incised. Development of the land adjacent to the Red Lake River within Thief River Falls is widespread and the buffer condition varies greatly.

Table 3-2. BANCS Model erosion estimates from the Red Lake River Fluvial Geomorphology Study.

Red Lake River Watershed Fluvial Geomorphology Study BANCS Model Erosion Estimates from 2012 Reconnaissance Reaches								
River	**Reconnaissance Reach**	**AUID(s)**	**Impaired by TSS?**	**Length (miles)**	**Erosion Volume (yds³/yr)**	**Erosion Mass (tons/yr)**	**Erosion Rate (tons/mile/yr)**	**Pfankuch Stability Rating**
Red Lake River	CSAH 3 to CSAH 219	09020303-561	No	3.4	33.3	43.3	12.7	Stable
Red Lake River	110th St. NE to 280th Ave NE	09020303-561	No	4.7	45.5	59.2	12.6	Stable
Red Lake River	East of 230th Ave NE to CSAH 7	09020303-562	No	7.6	177.3	230.6	30.3	Stable
Red Lake River	Forsberg Park to Finsbury Park	09020303-562	No	6.2	218.4	283.9	45.8	Stable
Red Lake River	Mark Blvd to Hwy 32/CR7	09020303-513	No	3.8	1545.2	2008.7	528.6	Stable
Red Lake River	Hwy 32 to Sportsman's Park near Red Lake Falls.	09020303-504	Yes	4.9	6144.3	7987.6	1630.1	Stable
Red Lake River	Sportsman's Park to 200th St. SW	09020303-510 09020303-511 09020303-502	Yes (502), 510 and 511 are unknown	6.2	6456.6	8393.6	1353.8	Stable
Red Lake River	CSAH 11 to 220th Ave SW (Otter Tail Power Dam)	09020303-512	Unknown	4.4	3038.1	3949.5	897.6	Stable
Black River	CSAH 18 to the Red Lake River	09020303-529	No	0.95	238.4	309.9	326.2	Unstable

3.2 Civic Engagement

Figure 3-21. Photos from civic engagement events.

RMB Environmental Laboratories, Inc. was hired to help with the civic engagement aspect of the Red Lake River WRAPS. At the onset of the Red Lake River WRAPS project in 2011, a list of potential stakeholders was compiled. RMB staff researched potential collaborations in order to assess the community's capacity for watershed planning and mapped social networks. RMB and RLWD staff created a tabletop display with laminated posters used during public events for the Red Lake River WRAPS.

Multiple forms of digital communication were explored as ways to expand the audience and interest in water quality issues in the Red Lake River. A blog was established for the Red Lake River watershed: https://redlakeriver.wordpress.com/. A Facebook page was created for the RLWD.

Table 3-3. Red Lake River WRAPS civic engagement activities.

Meeting	Meeting Date	Meeting Location	Number of Participants
Public "Kick-Off" (Grill Us)	September 2012	Crookston	11
Public Stakeholder Meeting	April 2013	Grand Forks	15
Public Stakeholder Meeting	April 2013	Thief River Falls	50
Thief River Falls Community Expo	April 2013	Thief River Falls	NA
Technical Advisory Committee Meeting	December 2011	Thief River Falls	NA
Technical Advisory Committee Meeting	August 2014	Thief River Falls	NA

The RLWD, with help from Emmons and Olivier Resources, Inc., has launched a new set of web pages to make it easier for anyone to learn more about a watershed. Each of the five major watersheds within the RLWD will have has its own set of pages with general information, links to reports, a photo gallery, Watershed Restoration and Protection project information, maps, and contacts. Organizing information by watershed should make it easier for people to find information that is pertinent to the area in which they live/farm/hunt/fish. The RLWD website is located at: http://www.rlwdwatersheds.org/.

RLWD staff created a Flickr account for sharing georeferenced photos of erosion problems and georeferenced scenic photos. Other local government staff can use this as a tool for finding areas where erosion control projects can be implemented. A map-based search for photos can be conducted at this site: https://www.flickr.com/map. The RLWD photos can be found at this site: https://www.flickr.com/photos/131072259@N04/.

A “Come Grill Us About Your Watershed” event was held at the Downtown Central Square in Crookston on September 24, 2012 (Figure 3-23, right photo). Flyers and postcards were created to promote the event. Fact sheets about the Red Lake River were created for display at the Crookston event and future events. Articles were written in the Crookston Times and the Grand Forks Herald about the event. The DNR and MPCA staff also helped with the event – particularly with the surveys. The DNR also brought an informational display. Staff were able to have conversations with most of the attendees.

Brochures were printed and mailed to approximately 10,000 residents of townships along the Red Lake River to provide information about the WRAPS report and promote two public stakeholders’ update meetings which were held in April 2013. A meeting was held in Grand Forks for people that live and/or work in the lower part of the Red Lake River Watershed. People who live and/or work in the upper part of the watershed were able to go to a meeting in Thief River Falls. Presentations from the meetings are available on the Red Lake River blog at http://redlakeriver.wordpress.com/.

The RLWD set up a booth at the Thief River Falls Community Expo at the Ralph Engelstad Arena on April 25, 2013, in Thief River Falls (Figure 3-23, left photo). Display boards were set up with information about the WRAPS projects and other RLWD projects. The RLWD has participated in the now-annual event in every year since 2013.

A draft Red Lake River Watershed Public Participation Strategy document was completed by RMB Environmental Laboratories for the RLWD.

Measurable goals for future civic engagement efforts in the Red Lake River Watershed include:

1. Increase volunteer participation in natural resource monitoring.
2. Increase the number of watershed residents participating in water quality discussions.
3. Find effective ways to engage citizens in a meaningful way.
4. Increase the resources utilized to communicate water quality activities within the watershed.
5. Create a document with contact information for local resources, specific to certain water quality concerns or funding sources.

RMB Environmental Laboratories, RLWD, and MPCA staff created short videos to help local citizens understand DO, turbidity, and *E. coli* bacteria. Combined, the videos have accumulated 4,505 views on YouTube as of March 4, 2019.

- Dissolved Oxygen: http://youtu.be/qUq7jFdVo3g
- Turbidity: http://youtu.be/EkH3jZvADTk
- *E. coli* bacteria: http://youtu.be/vkYUiJXyqLI

Technical advisory committee (TAC) meetings were held to seek input on the direction of the project.

- December 15, 2011
- August 27, 2014

A newsletter was composed and distributed near the end of the WRAPS project. It contained information about the locations of impairments, sources of pollution, and stressors of aquatic biology.

The RLWD and other LGUs need to continue conducting the public outreach efforts that were initiated during the WRAPS process.

Local agencies publish annual reports that provide a record of the past year's accomplishments. LGUs may continue to host open house style events that will facilitate one-on-one discussions with residents and other stakeholders. Booths at county fairs and community events (Thief River Falls Expo) are another way to connect with the public. The RLWD Water Quality Coordinator writes monthly water quality reports that originated as reports to the RLWD Board of Managers and represent a means of documenting project progress throughout the year. The reports are available on the RLWD website (www.redlakewatershed.org), shared on social media, and shared with a large list of email contacts.

The public can be kept informed of water related news, water quality problems, solutions to water issues, and opportunities for involvement in water-related programs through several different means.

- Websites of LGUs
    - RLWD
        - www.redlakewatershed.org
        - www.rlwdwatersheds.org
    - Pennington County SWCD
        - http://www.penningtonswcd.org/
    - Red Lake County SWCD
        - http://redlakecountyswcd.org/index.html
    - West Polk County SWCD
        - http://westpolkswcd.org/index.html
    - MPCA
        - http://www.pca.state.mn.us/
        - https://www.pca.state.mn.us/water/watersheds/red-lake-river
- Mailings to individual landowners
- Radio interviews
- Informational brochures and displays
- Press releases and advertisements with local media contacts

- SWCD newsletters
- Organization of events to bring attention to the resource
- Presentations for local civic groups

Local government will gain insight on water issues by consulting the public. The public can provide useful feedback on analysis, alternatives, and/or decisions. Working directly with the public throughout the process helps ensure that public concerns and aspirations are consistently understood and considered. Methods include:

- Public meetings
- Red Lake River blog: https://redlakeriver.wordpress.com/
- Social Media
    - RLWD Facebook page
    - West Polk SWCD Facebook page
- Public Comment period on final draft reports
- Open houses
- World Café discussions

Public notice for comments

An opportunity for public comment on the draft WRAPS report was provided via a public notice in the *State Register* from July 15, 2019 through August 14, 2019. There were two comment letters received and responded to as a result of the public comment period.

3.3 Restoration & Protection Strategies

To better understand what strategies are needed to accomplish water quality goals in the Red Lake River Watershed, a review of work already completed should be considered. Since 2004, 1,496 BMPs have been installed in the watershed at a cost of $21,617,000 (Figure 3-24). This number could be significantly higher as these are only the BMPs documented through governmental agencies. An unknown number of BMPs have been installed by local landowners without government assistance. Some notable BMP accomplished: 37,357 acres of cover crops; 61,822 acres of nutrient management; nearly 55 miles of shelterbelt renovation or establishment; 73,169 acres of no till and 19,140 acres of reduced tillage.

Established BMP specifics can be found at the MPCA's Healthier Watersheds website. BMP locations are tracked to the HUC – 12 level (Figure 3-25).

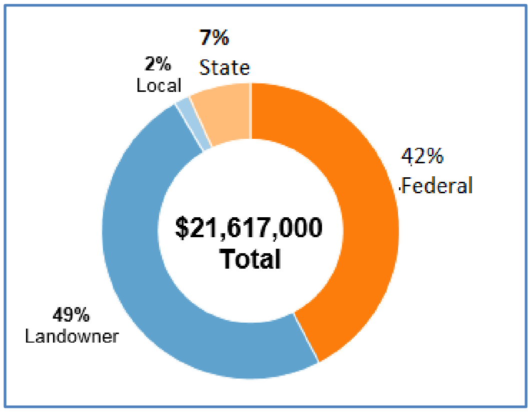


Figure 3-24. BMP spending and source of funding since 2004.

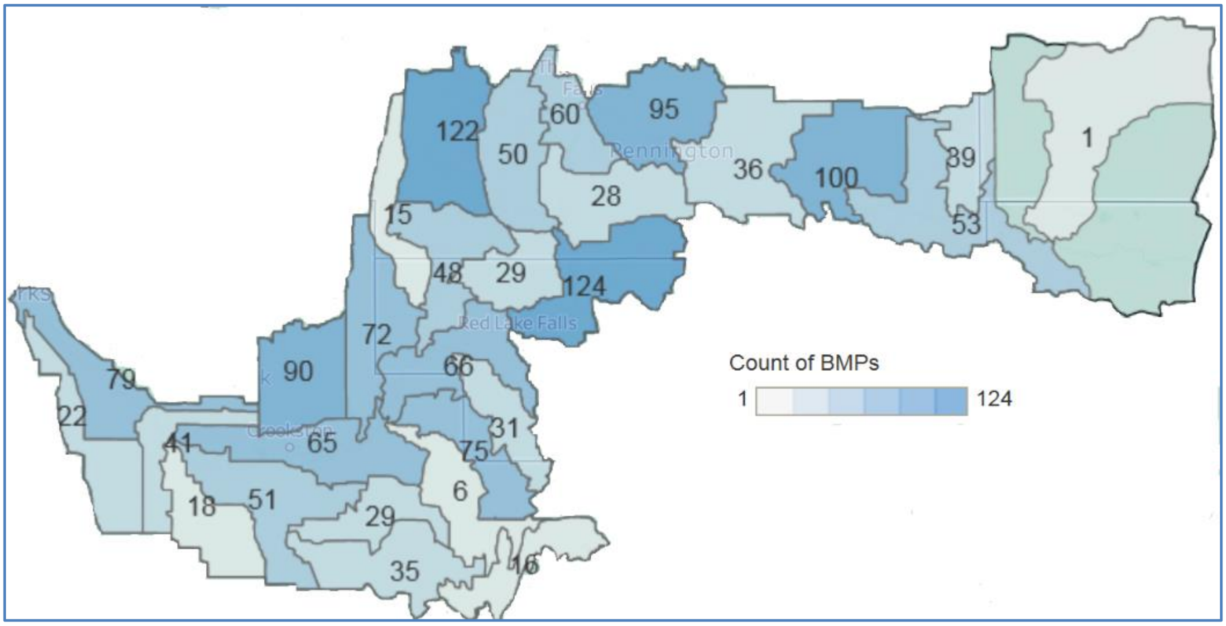


Figure 3-25. Number of BMPs by HUC – 12.

Specific projects/strategies have been identified throughout the WRAPS and other studies of the Red Lake River Watershed. Members of the Red Lake River WRAPS TAC worked together to create a list of strategies that can be used to restore impaired waters and provide protection where water quality is good. After a meeting was held to discuss the strategies, individuals from the DNR, MPCA, Pennington SWCD, Red Lake SWCD, West Polk SWCD, and the RLWD reviewed the list of strategies and suggested changes. The strategies are presented in a table for practices that can be applied to the entire watershed, and separate tables for practices that are more specifically applicable to each 10-digit HUC subwatershed. This is done in accordance with Minn. Stat. 114D.26, subd. 1, which states that WRAPS shall "contain an implementation table of strategies and actions that are capable of cumulatively achieving needed pollution load reductions for point and nonpoint sources, including:

1. Water quality parameters of concern
2. Current water quality conditions

3. Water quality goals and targets by parameter of concern
4. Strategies and actions by parameter of concern and the scale of adoptions needed for each
5. A timeline for achievement of water quality targets
6. The governmental units with primary responsibility for implementing each watershed restoration or protection strategy
7. A timeline and interim milestones for achievement of watershed restoration or protection implementation actions within 10 years of strategy adoption

Additional explanation of specific columns in table:

Water Quality – Current Conditions: "Current" condition is interpreted as the baseline condition over some evaluation period for the pollutant or non-pollutant stressor identified in the previous column. This should be a numeric descriptor and unit of measurement. This can be a current load (from TMDL or from the load monitoring program if pursuing a downstream goal and not a local goal), a pollutant concentration (e.g., *E. coli* geometric mean) or a score (e.g., IBI or Minnesota Stream Habitat Assessment (MSHA) score).

Water Quality – Goals / Targets: This should be expressed in the same terms as applied in the previous column (Current Conditions) and will generally be a load target (could be percent reduction or a load value) or a water quality concentration target. For some parameters (e.g. phosphorus reduction in a lake watershed) it may be best to use a load target. For others (e.g., *E. coli*) a concentration may be easier to both express (avoiding strings of scientific notation) and understand. For protection, specify a numeric goal/target if available.

Water Quality – Current Conditions, Goals / Targets pertaining to downstream considerations: The WRAPS (and subsequent planning work) should be developed to not only address the goal of protecting and restoring water resources within a given Minnesota major watershed, but to also contribute to pollutant load reductions needed for downstream waters (in-state and out-of-state, e.g., Mississippi River, Lake Pepin, Gulf of Mexico). To describe a "current condition" relating to a downstream goal, consider citing the load monitoring program data (e.g., "current phosphorus load is XXXX kg/year); this will in most cases be an appropriate resolution and will fit well with a load reduction goal that can be included in the goals/targets column (e.g., 45% load reduction per Nutrient Reduction Strategy).

Strategies: This column is intended to provide the high-level strategies to be used. 'High-level' generally means a category-type of action rather than a specific BMP or a specific project (e.g., 'Improve upland/field surface runoff controls' rather than 'Vegetated buffers'). The strategies should be briefly stated and then further described in

Strategy Type and Estimated Scale of Adoption Needed to Meet Final Water Quality Target: This column ties to the Strategies column and provides the basic outcome of a modeling scenario (or similar analysis) that generally describes the collective magnitude of effort (over however many years or decades) that it will take to achieve the water quality target. This estimate is meant to describe approximately "what needs to happen" but does not need to detail precisely "how" goal attainment will be achieved (the latter is left to subsequent planning steps). As such, it is acknowledged that this is an approximation only and subject to adaptive management. Detail regarding degree of implementation of various BMPs may be added per stakeholder design/support, as long as it is recognized that there are often many permutations of BMP implementation that constitute a goal attainment scenario. This column can reference example scenarios (e.g., "See BMP spreadsheet tool scenarios selected by stakeholders as viable general approaches").

Interim 10-year Milestones: This column ties to the Estimated Scale of Adoption column and should describe progress to be made toward implementing the strategy in the first 10 years. This may be provided in the form of a percentage, amount, or narrative descriptor.

Governmental Units with Primary Responsibility: Identify the governmental unit with primary responsibility at a minimum, with option to identify secondary responsibilities (using a different symbol).

Estimated Year to Achieve Water Quality Targets: This applies to the waterbody, specifically the year it is reasonably estimated that applicable water quality targets will be achieved. Explanatory information may be added either as a footnote or in the preceding narrative providing any assumptions or caveats used in the estimate.

Red Rows: Impaired waters requiring restoration

Green Rows: Unimpaired waters requiring protection

The strategies are organized by area. There are strategies that can be applied watershed-wide (Table 3-3). A separate list of strategies was assembled for each HUC10 subwatershed (Tables 3-4 through 3-9). Maps are included at the beginning of each sub-section to provide a spatial reference for the reader. These maps are particularly helpful in providing a reference for the locations of AUIDs, which can be difficult to remember (Figures 3-26 through Figure 3-33).

3.3.1 09020303 Watershed-Wide Strategies

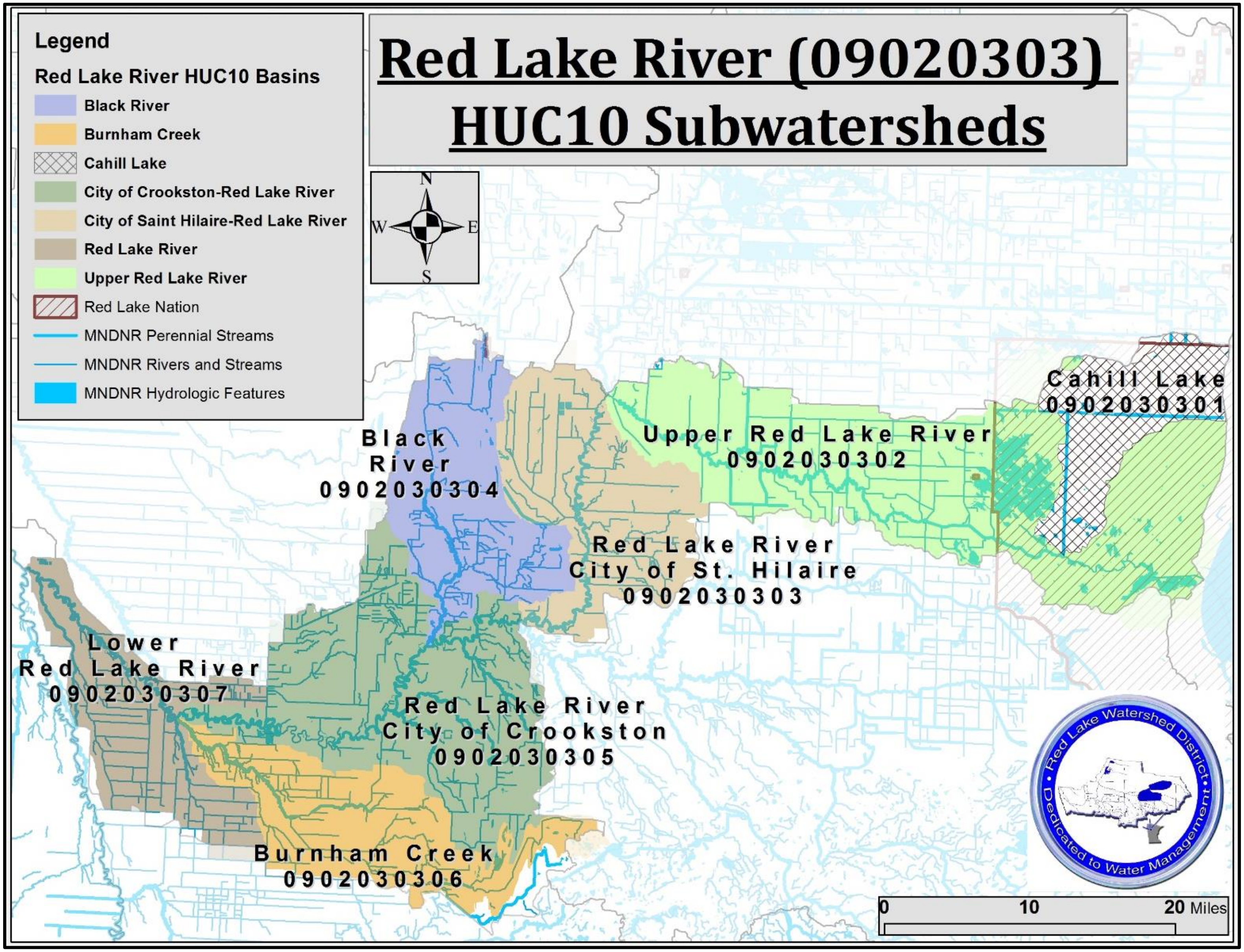


Figure 3-22. Red Lake River HUC10 Subwatersheds.

Table 3-4. 09020303 Red Lake River Watershed-Wide Restoration and Protection Strategies.

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
Watershed-Wide	All	All	Total Suspended Solids	Varies	< 15 mg/L, < 30 mg/L, or < 65 mg/L, dependent upon location and river nutrient region	Establish buffers or alternative practices along channels	This practice will now be required by law along all public waters and public drainage systems in the State.	The implementation of Minnesota's Buffer Law has resulted in an increase in the miles of streams and ditches that are protected by buffers.	●	●	●	●						●			●		2019
						Protect riparian corridors and wetlands with existing quality vegetated buffers	Watershed-wide	●Update education and outreach programs. ●Some restoration of cultivated riparian area to prairie has been completed. ● 30 miles of riparian buffers have been improved. ●Riparian zone setbacks are enforced to minimize future problems with the river encroaching upon development and to allow for easier management of the river channel and floodplain.	●	●	●	●	●			●		●					Ongoing
				Varies	< 15 mg/L, < 30 mg/L, or < 65 mg/L, dependent upon location and river nutrient region	Utilize models, tools, inventories, and site visits to implement targeted best management (side water inlets, alternative side water inlets, cover crops, and crop residue management) practices to control upland erosion.	Concentrate upon tilled lands throughout the watershed.	●Grant funds are acquired for the accelerated implementation in critical areas. ●Prioritize small watersheds for intensive sediment source inventory. ●Use GIS tools and field verification to identify sediment sources ●GIS data is used to conduct an assessment of buffer quality.	●	●	●	●				●		●				●	2027
						Compile an inventory of areas of in-channel grade and streambank instability	Red Lake River Corridor and tributaries	Assess and prioritize sub-watersheds with in-channel instability concerns.		●	●	●	●			●							2017-2025
						Stabilize the outlets of all ditches that enter the Red Lake River	Red Lake River Corridor	●Ditch outlets are prioritized by the severity of the erosion. ●300 grade stabilizations have been constructed.	●	●	●	●				●		●			●		2030
						Crop residue management & conservation tillage (e.g. no-till)	Watershed-wide	●A net increase in the percentage of tilled acres that utilize on-field BMPs to reduce soil loss. ●1,600 new acres of conservation cover.		●	●	●				●							Ongoing
						Cover Crops	Watershed-wide	●A net increase in the percentage of tilled acres that utilize on-field BMPs to reduce soil loss. ●320 new acres of cover crops.		●	●	●				●							Ongoing
						Installation and renovation of windbreaks to reduce wind erosion	Watershed-wide	There is a net gain in shelterbelts by the end of the 10-year period. The tree establishment goals of the 1W1P are achieved.		●	●	●				●							Ongoing

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
Watershed-wide	All	All	Total Suspended Solids	Varies	< 15 mg/L, < 30 mg/L, or < 65 mg/L, dependent upon location and river nutrient region	Floodplain access maintenance and improvement along ditches	Watershed-wide	● Maintenance of floodplain access is considered when ditches are cleaned or improved. ●Improved floodplain access on portions of ditches that are severely incised. ●Ditches will be reviewed to see that they are not deepened or still have access to the floodplain through as-built surveys. ●Pursue opportunities to provide/acquire funding needed to incorporate 2-stage ditch design into ditch improvement projects.	•	•	•	•							•		•		Ongoing
						Revegetation of disturbed area (e.g. ditch cleanouts)	Watershed-wide	●Revegetation of ditch cleanouts becomes a requirement during the permitting process. ●The most recently updated guidance on ditch cleanouts in utilized.	•										•		•		Ongoing
						Public Education and Outreach	Watershed-wide	●Continued distribution of annual reports and newsletters ●Monthly water quality reports. ●5 town hall or open house events are held. ●Personalized landowner contacts and information to promote BMPs in critical areas. ●SWCDs have conducted education and outreach for the MN ag Water Quality Certification Program (MAWQCP). ●A public education event aimed at reducing disposal of landscape/yard water along or within rivers and streams. ●Landowner's are encouraged to manage their riverfront property in ways that add to stability of the banks.	•	•	•	•	•	•		•		•			•	•	Ongoing
						Use conservation programs like CRP, EQIP, and RIM to encourage conservation practices in critical areas	Watershed-wide	●Outreach to landowners with expiring contracts to help prevent CRP losses. ●CRP losses are offset with perennial grasslands or alternative crops to the extent possible. ●Grant funding is acquired to provide a financial assistance to landowners that implement these projects. ●Work with landowners to implement rotational grazing systems on expiring acres.		•	•	•				•		•					Ongoing

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
Watershed-wide	All	All	Total Suspended Solids	Varies	< 15 mg/L, < 30 mg/L, or < 65 mg/L, dependent upon location and river nutrient region	Promote infiltration, retention, & extended detention practices in new & existing urban developments based on current stormwater BMPs	Cities of Thief River Falls, St. Hilaire, Red Lake Falls, Crookston, Fisher and East Grand Forks	●One stormwater retention/infiltration project has been completed within each city along the Red Lake River corridor. ●Snow storage locations are moved to avoid direct runoff from melting, sediment-laden snow piles into rivers, streams and wetlands.	•	•	•	•		•				•	•			•	Ongoing
						Educate developers, realtors, planners, & county boards on the effects development & land use can have upon water quality and the effect that flooding and erosion hazards can have upon development.	Watershed-wide	●Informational materials are distributed. ●A workshop for professionals involved with land management, regulation, and sales is held. Incentives for attendance are provided.	•	•	•	•	•	•	•	•		•	•				2030
			E. coli	Varies	< 126 MPN/100ml monthly geomean	Septic System Compliance	Watershed-wide	●Begin to conduct septic system inventories to identify non-compliant septic systems. ●Out-of-compliance systems are brought into compliance in a timely manner. ●Update county ordinances to include point of sale septic inspections. ●Help home owners get low interest loans for septic system updates.		•	•	•							•				2027
						Limit or exclude the access of livestock to waterways	Watershed-wide	●Existing *E. coli* impairments are delisted. ●Delisted *E. coli* impairments continue to meet standards. ●Livestock exclusion is implemented. ●Ensure that all feedlots and pastures are up to date and comply with regulations, ones that do not meet the regulations, work with the landowner to get compliance.		•	•	•		•		•			•				Ongoing

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
Watershed-wide	All	All	Index of Biotic Integrity	Varies	Fully support aquatic life	Improve Minnesota Stream Habitat Assessment (MSHA) scores along reaches that were given fair and poor ratings during the 2014 assessment	09020303-547 Pennington County Ditch 43	●Multiple projects have been completed. ●MSHA scores improve. ●MSHA metrics are considered during the planning of projects.	●	●			●					●				●	Ongoing
							09020303-561 Channelized reach of the Red Lake River		●	●			●					●				●	
							09020303-509 Red Lake River within the Thief River Reservoir		●	●			●					●				●	
							09020303-505 Pennington County Ditch 96		●	●			●					●				●	
							09020303-511, 502, and 503 Red Lake R. downstream Cyr Creek & downstream of Burnham Creek		●			●	●					●				●	
							09020303-554 Gentilly River		●			●	●					●				●	
							09020303-525 and 526 Kripple Creek upstream of CSAH 11		●			●	●					●				●	
							09020303-515, 09020303-551, and 09020303-552 Burnham Creek		●			●	●					●				●	
							09020303-550 Heartsville Coulee		●			●	●					●				●	
						Improve connectivity with properly sized and placed culverts on road crossings	Watershed-wide	●Complete culvert inventory that also assesses crossings for potential fish passage barriers. ●Ensure that proper culvert size and placement are being used with road work and repairs are being completed. Follow MESBOAC designs for all culvert installations (work with County. Engineers).	●	●	●	●	●						●		●		2027
						Improve connectivity by removing or retrofitting barriers to fish passage	Thief River Falls Dam, Burnham Creek Watershed, Black R. Watershed, Little Black R. Watershed, Red Lake R. dams within the Red Lake Nation, Gentilly River	The feasibility of adding fish passage or modifying structures has been explored. If changes are not feasible, evidence is provided to explain why that is the case. The history and future plans for the dams are documented.	●	□	□	□	●						●				2037
						Reduce sedimentation within channels and pools by addressing overland and stream bank erosion	Watershed-wide	●No new TSS impairments during the next assessment. ●Improve trends in total suspended solids concentrations.	●	●	●	●	●			●			□			●	2026

	Waterbody and Location			Water Quality					Governmental Units with Primary Responsibility														
HUC-10 Subwatershed	Waterbody (ID)	Location and Upstream Influence Counties	Parameter	Current Conditions	Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
Watershed-wide	All	All	Index of Biotic Integrity	Varies	Fully support aquatic life	Reduce runoff and leaching of pesticides	Watershed-wide	The MN Department of Ag doesn't find violations of pesticides during its pesticide monitoring program.		•	•	•			•	•	•						Ongoing
						Ag drainage system design training	Watershed-wide	●Multiple workshops have been organized and held. ●One managed tile system has been installed (conservation drainage) with the most current managed conservation technology.	•	•	•	•				•					•		2027
						Prevent or mitigate activities that will further alter the hydrology of the watershed. Consider opportunities to attenuate peak flows and augment base flows in streams throughout the watershed.	Watershed-wide	●Educate local landowners so there is more focus upon water storage and controlled drainage. ●Water storage projects are limited to areas (off-channel storage and wetland restorations) that will not destroy aquatic habitat and other sensitive areas. ●If ditch projects are petitioned, funding is made available for 2-stage ditch design wherever possible.	•	•	•	•	•	•				•		•	•		Ongoing

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
Watershed Wide	All, including downstream waters and Lake Winnipeg	All	Nutrients and River Eutrophication	No impairments for river eutrophication, but TP standard is exceeded in multiple reaches	<150 µg/L, <100 µg/L, or <50 µg/L, dependent upon river nutrient region assignment	Nutrient management through reduction of N losses on corn following soybeans	Watershed-Wide	●10% reduction in in TP loads from 2003 conditions ●13% reduction of N loads from 2003 conditions ●Increased education and adoption of mutually beneficial nutrient loss reduction strategies ●Increased education about water quality issues ●Increased use of demonstration projects to increase adoption of practices							●		●					●	2027
						Switch from fall to spring fertilizer applications									●		●					●	2027
						Application of P using precision fert. and manure app. techniques									●		●					●	2027
						Cover crops on fallow and short season crops				●	●	●			●	●	●					●	2027
						Perennials in riparian zones & marginal cropland									●		●		●		●	●	2027
						Research and dev. of marketable cover crops									●		●					●	2027
						Research and dev. of perennial energy crops								●	●	●	●	●		●		●	2027
						Tillage practices that leave >30% crop residue cover or alt. practice				●	●	●			●	●	●					●	2027
						Grassed waterways and structural practices for runoff control				●	●	●			●	●	●				●	●	2027
						Tile drainage water quality treatment and storage, through wetland restoration, controlled drainage, water control structures, two-stage ditches, saturated buffers, and bioreactors			●	●	●	●	●	●	●	●	●	●			●	●	2027
						Develop strong private-public partnerships to support increased implementation of voluntary BMPs			●	●	●	●	●	●	●	●	●	●	●		●	●	2027

3.3.2 0902030302 Strategies for the Upper reach of the Red Lake River

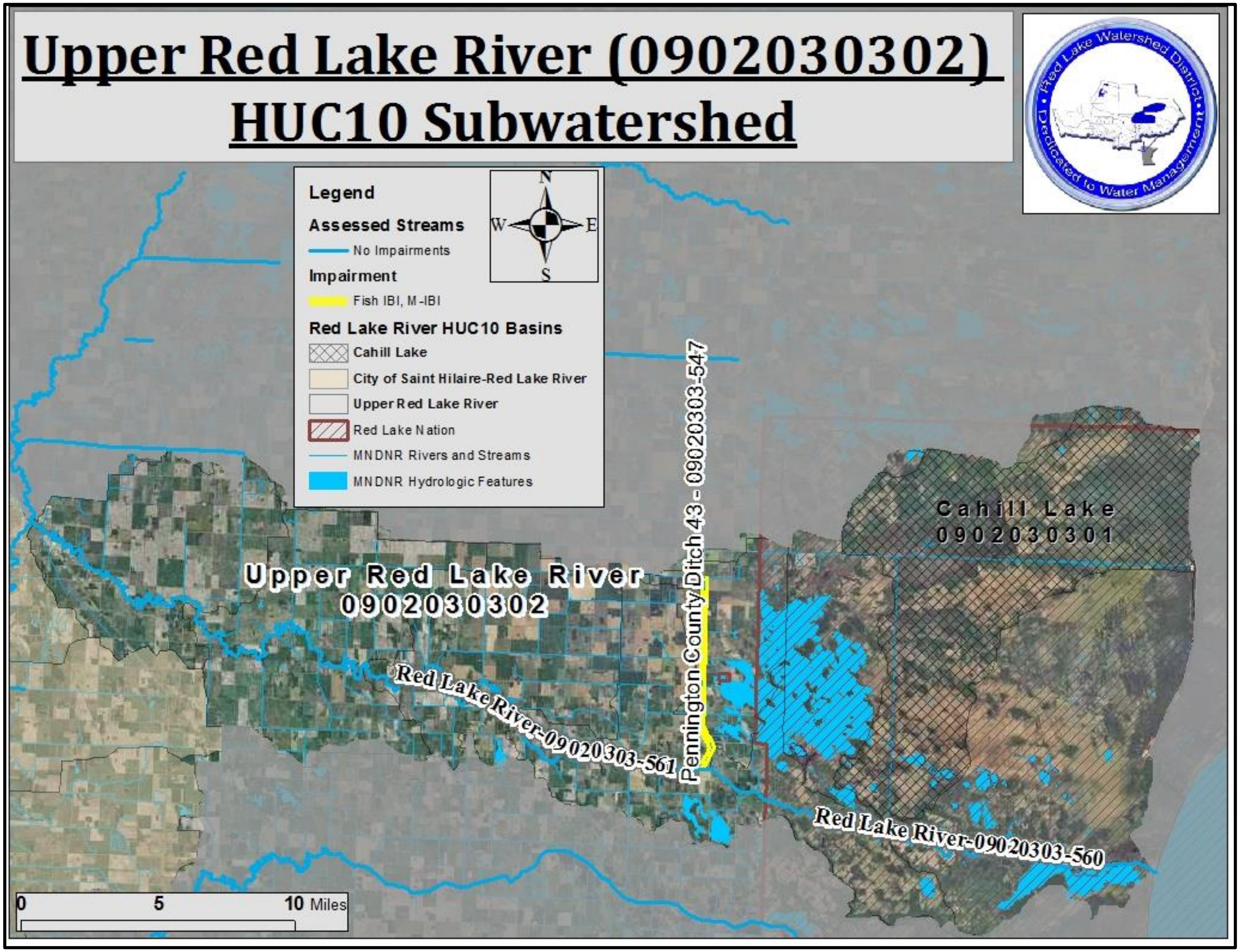


Figure 3-23. Upper Red Lake River (09020302) HUC10 subwatershed map.

Impairments:

- County Ditch 43 Unnamed ditch to Red Lake River AUID 547 – impaired for F – IBI, M – IBI

The Red Lake River, from its headwaters to its confluence with the Thief River, was formerly assessed as a single reach (AUID 09020303-508). This reach had been listed as impaired by low DO. It has now been split into three reaches so that the natural channel near Thief River Falls (09020303-562), the channelized reach (0920303-561), and the portion of the river that flows through the reservation (09020303-560) are assessed separately. Continuous monitoring data revealed that DO levels improve from upstream to downstream. Furthermore, biological sampling yielded desirable IBI scores that met water quality standards. The MPCA staff made the decision to delist the reach because the IBI scores provide proof that the reach is meeting the expectations for the support of aquatic life. Although a professional decision was made to not list any of these reaches for aquatic life impairments, it fails to meet numerical standards for water chemistry parameters. The two upstream reaches (09020303-560 and 0902033-561) fail to meet DO standards, however, there are significant wetland influences in reach 09020303-560 and not enough data yet to recategorize the reach to class 4E (natural conditions). Continuous DO monitoring proved that DO levels in the downstream portion of the Red Lake River are very good.

The Central River Nutrient Region TSS standards were applied to this reach. The reach easily meets this standard. Samples rarely exceed that level of TSS (three occurrences, total, throughout all three reaches). The new standard was applied in mid-2016 after it was approved. River Nutrient Region maps had previously indicated that the reach was assigned to the North River Nutrient Region for which a more protective 15 mg/L TSS standard was required. The upstream, 09020303-560 reach of the Red Lake River within the reservation is of exceptional quality and would have met the former 15 mg/L standard. Water quality models, windshield reconnaissance, and the 1W1P process have found that the ditch systems that transport upland runoff into the relatively stable Red Lake River channel are the most significant anthropogenic sources of sediment. Gullies in private field drainage have been documented. Those ditch systems should be targeted for BMPs that reduce sediment loss:

- Pennington County Ditches 43, 35, 44, and 55

The fish samples collected within the Thief River Falls reservoir near Nelson Drive in Thief River Falls (F-IBI at 12RD104 = 44 points) only exceeded the impairment threshold (38 points) by a relatively slim margin (6 points). That score calls attention to reach 09020303-562 as a reach that is in need of projects that will improve fish habitat to minimize the risk of future impairments.

Drinking water quality, sedimentation, and aquatic recreation are concerns within the Thief River Falls reservoir. The city of Thief River Falls draws it drinking water from the Red Lake River, downstream of the confluence with the Thief River. More detailed information regarding impacts to drinking water sources from upstream within the Thief River Watershed, can be found in the Thief River Watershed TMDL and the Thief River WRAPS, both dated March 2019.The Red Lake River is used for swimming and other forms of aquatic recreation within the Thief River Falls reservoir, which stresses the importance of minimizing *E. coli* concentrations. Sedimentation within the reservoir has been a problem. It was dredged in 1999 at a cost of $1.1 million.

Table 3-5. Restoration and Protection Strategies for the Upper Red Lake River (0902030302) HUC10.

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
Upper Red Lake River (0902030302)	Red Lake River	Beltrami and Pennington Counties	Total Suspended Solids	09020303-561 (Channelized reach of the Red Lake River downstream of the Reservation boundary) and 09020303-562 (natural reach of the Red Lake River) meet the 30 mg/l TSS standard..	> 90% of TSS samples are <30 mg/L	Identify and alleviate upland sources of sediment	Gully erosion sites that have been identified along the Red Lake R. corridor upstream of Thief River Falls	●Side water inlet prioritization and implementation plan. ●Projects has been implemented to address known erosion problems. ●Install 300 side water inlets in this watershed.	●	●								●					2027
							Pennington County Ditches 35, 44 and 55 that have been identified by models as having relatively high potential for erosion reduction through BMP implementation.		●	●								●					
						Target for project implementation, drainage areas that are shown by models to have the highest sediment yields and/or highest potential BMP effectiveness.	Pennington County Ditch 35 Pennington County Ditch 44 Sub-basins identified by PTM App	●Projects have been implemented to address all known problems.	●	●						●		●					2027
						Implement grazing management projects that eliminate intensive grazing of streambanks	Red Lake River Corridor	●480 acres of rotational and prescribed grazing.	●	●	□	□	●			●		●					2037
						Maintain the existing conditions of the channel and riparian buffers	Red Lake River Corridor	●Avoid degradation of the riparian buffer. ●Requirements of the Buffer Law are met along a high percentage of streams.	●	●			●		□	●		●					2027
			E. coli	Max Geomeans 59.8 MPN/100ml in 09020303-561, 32.9 MPN/100ml in 09020303-562	< 126 MPN/100ml monthly geomeans	Grazing management and cattle exclusion	Target operations in Section 7 of Smiley Township and Section 11 of Hickory Township in Pennington Co. where cattle have direct river access	●The Red Lake River continues to safely meet the *E. coli* water quality standard. ●*E. coli* concentrations are remaining steady or have a downward trend.	□	●					●								2020
	Red Lake River and Pennington County Ditch 43	Beltrami and Pennington Counties	Index of Biotic Integrity	F-IBI Range = 44-71, Macroinvertebrates IBI Range = 33-62	F-IBI Score > 38, Macroinvertebrates IBI score > 31	In-stream habitat improvement	Target Penn CD43 and portions of the Red Lake R that had F-IBI scores lower than 40 and/or macroinvertebrate scores lower than 50.	●One project has been implemented.	●	●			●					●			●	●	2037
	Red Lake River and Pennington County Ditch 43	Beltrami and Pennington Counties	Dissolved Oxygen	09020303-562 (downstream) meets the standard. Continuous DO data shows that 09020303-561 violates the standard. The DO impairment is still being delisted - IBI scores indicate that the needs of aquatic life are met.	> 90% of the daily minimums are > 5 mg/l	Improve the quality of riparian buffers to improve shading of the channel.	Priority should be giving to the channelized reach (09020303-561)	●57 acres of trees/shrubs are established. ●92 acres of critical area plantings are complete.	●	●													2037

3.3.3 090203030 Strategies for the "City of St. Hilaire" Red Lake River HUC10

Figure 3-24. "City of St. Hilaire" HUC10 subwatershed of the Red Lake River.

Impairments:

- Red lake River - Pennington CD96 to Clearwater AUID 504 impaired for TSS
- Pennington CD96 AUID 505 impaired for *E. coli*
- Branch 5, Pennington CD96 – Br 2 CD96 to CD96 mainstem AUID 545 impaired for F-IBI

The Red Lake River gets a "clean" start within the Thief River Falls reservoir (AUID 09020303-509) in regards to TSS within the river. Water samples from the reservoir have never exceeded the 30 mg/L TSS standard and are generally lower than 15 mg/L. This quality of water continues as the river flows south to St. Hilaire and the confluence with Pennington County Ditch 96. At this point the grade of the Red Lake River increases and so do TSS concentrations between St. Hilaire (1.8% of TSS samples exceed 30 mg/L at S003-942) and Red Lake Falls (24.5% of TSS samples exceed 30 mg/L at S003-172) resulting in the impairment of reach 09020303-504. Eroding stream banks and ditch outlets have been identified throughout this subwatershed. Erosion control projects in upstream, unimpaired reaches will benefit downstream, impaired reaches.

June *E. coli* concentrations in the 09020303-504 reach have been high enough to cause concern, particularly at the downstream end near Red Lake Falls, but managed to fall below the impairment threshold. Preliminary assessments anticipated an impairment, but subsequent samples and the submittal of data from 2011 to the EQuIS database brought the June geometric mean down to an acceptable level. Livestock have been noted along the river, but livestock access to the river is limited by the steep banks along this reach. Microbial DNA sampling identified birds as a source of fecal bacteria and ruled out other sources. Many cliff swallows live under the CSAH 13 Bridge over the Red Lake River (S003-172). Samples are collected on the downstream side of the bridge. *E. coli* concentrations have been lower during the months after the birds leave their nests. The logical conclusion is that cliff swallows are causing a localized increase in *E. coli* concentrations at the CSAH 13 Bridge.

An effort to characterize water quality within stormwater drainage systems in the city of Thief River Falls has begun in recent years. The Chief's Coulee drainage system in northern Thief River Falls was found to be conveying extreme concentrations of *E. coli* bacteria and nutrients. Samples have also returned quantifiable results for petrochemicals. The Pennington SWCD has initiated two grant-funded projects to address septic and stormwater issues along Chief's Coulee and within the city of Thief River Falls (described in more detail within Section 2.3.3).

Minimizing *E. coli* levels for safe aquatic recreation is very important along this reach. This section of the river is used for aquatic recreation, including paddling, fishing, tubing, and swimming. The tubing business of the Voyageur's View Campground is important to the city of Red Lake Falls. The bluffs along the river may represent significant erosion, but they are also quite scenic. The fishery is excellent along this reach.

Table 3-6. Restoration and Protection Strategies for the 090203030 Red Lake River HUC10.

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
City of St. Hilaire Reach of the Red Lake River and Pennington County Ditch 96 (0902030303)	Red Lake River (09020303-509) (09020303-513) (09020303-504) Penn. CD 21 (09020303-541) Penn. CD 96 (09020303-505)	Pennington and Red Lake County	Total Suspended Solids	The Red Lake River meets 30 mg/l TSS standard upstream of County Ditch 96. The Red Lake River is impaired by turbidity downstream of County Ditch 96. The Red Lake River exceeds the TSS standard but is not listed as impaired by TSS. Ditches meet the TSS standard.	> 90% of TSS samples are < 30 mg/l	Stormwater assessment	Cities of Thief River Falls and of St. Hilaire	●Areas in need of stormwater retention have been addressed with projects.	●	●								●	●				2019
						Chief's Coulee Rehabilitation	The Chief's Coulee drainage area in northern Thief River Falls. (The drainage system empties into the west side of the Red Lake River approx. 300 yards downstream of the Thief River confluence).	●Locate and eliminate sources of chemical and bacterial pollution. ●Develop a creative method for rehabilitating the stormwater channel using urban BMPs that equally address the ability of the channel to move water, ecology, aesthetics, and pollution prevention/treatment.	●	●			●	●				●					2027
						Utilize geospatial data from airborne sensors (drone technology) to identify, measure, and prioritize erosion problems	Red Lake River Corridor between Thief River Falls and Red Lake Falls	●Multiple data collection efforts are compared to measure erosion rates by measuring changes in stream bank geometry. ●Data products are utilized to target and plan erosion control projects.	●	●	●					●							2020
						Channel, bank and outlet stabilization	Red Lake River Corridor between Thief River Falls and Red Lake Falls	●Completion of 5 river bank stabilization erosion control projects. ●Completion of 3 projects that stabilize the outlets of tributaries and drainage with severe gully erosion problems. ●Complete 2 miles of channel bed and stream channel stabilization.	□	●	●		●			●							2020
						Mitigate changes in hydrology in which the increased frequency of flood events can lead to increased streambank erosion	Red Lake River Corridor	●5,000 acre feet of storage in distributed detention basins. ●1 mile of multi-stage ditch in installed. ●Restore 320 acres of wetlands.	●	●	●		●			●		●					2037
City of St. Hilaire Reach of the Red Lake River and Pennington County Ditch 96 (0902030303)	Red Lake River	Pennington and Red Lake County	*E. coli*	09020303-509 (Red Lake River between the Thief River and the Thief River Falls Dam): 83.9 MPN/100ml	< 126 MPN/100ml monthly geomeans	*Cattle Exclusion Projects *Buffer Law Compliance *Septic system inspections and updates ●City stormwater filtration	City of Thief River Falls	●Out-of-compliance septic systems and other sources of *E. coli* in the Chief's Coulee drainage area have been located and addressed ●An increased portion of the city's stormwater runoff is being filtered by stormwater BMPs	●	●								●	●				2020

Governmental Units with Primary Responsibility: RLWD through Co. Ditch Authorities/Engineers.

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
City of St. Hilaire Reach of the Red Lake River and Pennington County Ditch 96 (0902030303)	Red Lake River	Pennington and Red Lake County	*E. coli*	09020303-513 (Red Lake R. between the Thief River Falls Dam and CD 96): 49.8 MPN/100ml	< 126 MPN/100ml monthly geomeans	*Cattle Exclusion Projects *Buffer Law Compliance *Septic system inspections and updates	Livestock operations along the reach	●At a minimum, permanent vegetation is maintained in the buffer area. ●Cattle do not have access to a >50 foot buffer along the river.		●													2027
				09020303-504 (Red Lake River between Penn. CD 96 and the Clearwater River): 121.3 MPN/100ml			Red Lake River Corridor and Tributaries	The maximum monthly geomean *E. coli* concentration has dropped below 100 MPN/100ml	●	●								●					2027
				09020303-505 (Penn. CD 96): 264 MPN/100ml (Impaired)			Pennington CD96 corridor and tributaries	●At a minimum, permanent vegetation is maintained in the buffer area. ●Cattle do not have access to a >50 foot buffer along the river. ●Max monthly geomean <126 MPN/100ml	□	●						□							2020
				09020303-541 (Penn. CD 21): 993 MPN/100ml		Replacement of the Penn. CR 17 (140th Ave) bridge over CD 21 project should include eliminating pigeon roosting areas	Pennington County Ditch 21 at Penn. CD 17	●Extreme concentrations of *E. coli* are no longer recorded at this site. ●County is looking for funding to replace the aging bridge with a new structure. ●MESBOAC standards are followed so that replacement structure does not cause stream instability											●		●		2020
City of St. Hilaire Reach of the Red Lake River and Pennington County Ditch 96 (0902030303)	Red Lake River Pennington County Ditch 21 Pennington County Ditch 96	Pennington and Red Lake County	Index of Biotic Integrity	09020303-513: F-IBI=58-62 M-IBI=44-83 09020303-504: F-IBI=50-71 M-IBI=43-49 09020303-505: F-IBI=32 M-IBI=36	Fully support aquatic life Red Lake R.: F-IBI= >38, M-IBI= >31 Penn. CD 96: F-IBI= >15, M-IBI= > 22	Improve fish passage	Highway 32 crossing of Penn. CD 96	Penn. CD 96 fish passage is restored through grade stabilization downstream of Highway 32.	●	●			●								●		2020
				09020303-545: : F-IBI=0, M-IBI=36	Br 5 CD 96: F-IBI= >23, M-IBI= >22	●Assess the feasibility of stream restoration or 2-stage ditch projects ●Improve Base Flows	Pennington County Ditch 96 watershed	●Information about potential projects and the amount of landowner and stakeholder support is available by the next assessment of the watershed in 2024. ●Wetland Restorations	●	●	□		●					●			●	●	2024

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility													Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers		
City of St. Hilaire Reach of the Red Lake River and Pennington County Ditch 96 (0902030303)	Red Lake River Pennington County Ditch 21 Pennington County Ditch 96	Pennington and Red Lake Counties	Dissolved Oxygen	09020303-509: 3.7% DO5_All <5mg/l, IF DO5_9am 09020303-513: 0% DO5_All & DO5_9am <5mg/l 09020303-504 0% DO5_All <5mg/l, IF DO5_9am 09020303-505 1.8% DO5_All <5mg/l, 67.2% DO5_9am <5mg/l 09020303-541: 36% DO5_All <5mg/l, IF DO5_9am 09020303-545: No Data	>90% of daily minimums are > 5 mg/l	●2-stage ditch retrofits ●Improved Base Flow	Pennington County Ditch 96 drainage area Pennington County Ditch 21 drainage area	●One reach/branch of the ditch system has been successfully retrofitted to a 2-stage ditch design. ●Wetland restorations have been completed ●The feasibility and effectiveness of an impoundment has been examined.	•	•	□	□	•	□	□	□	□	•	□	□	•	•	2037

3.3.4 0902030304 – Strategies for the Black River HUC10 Subwatershed

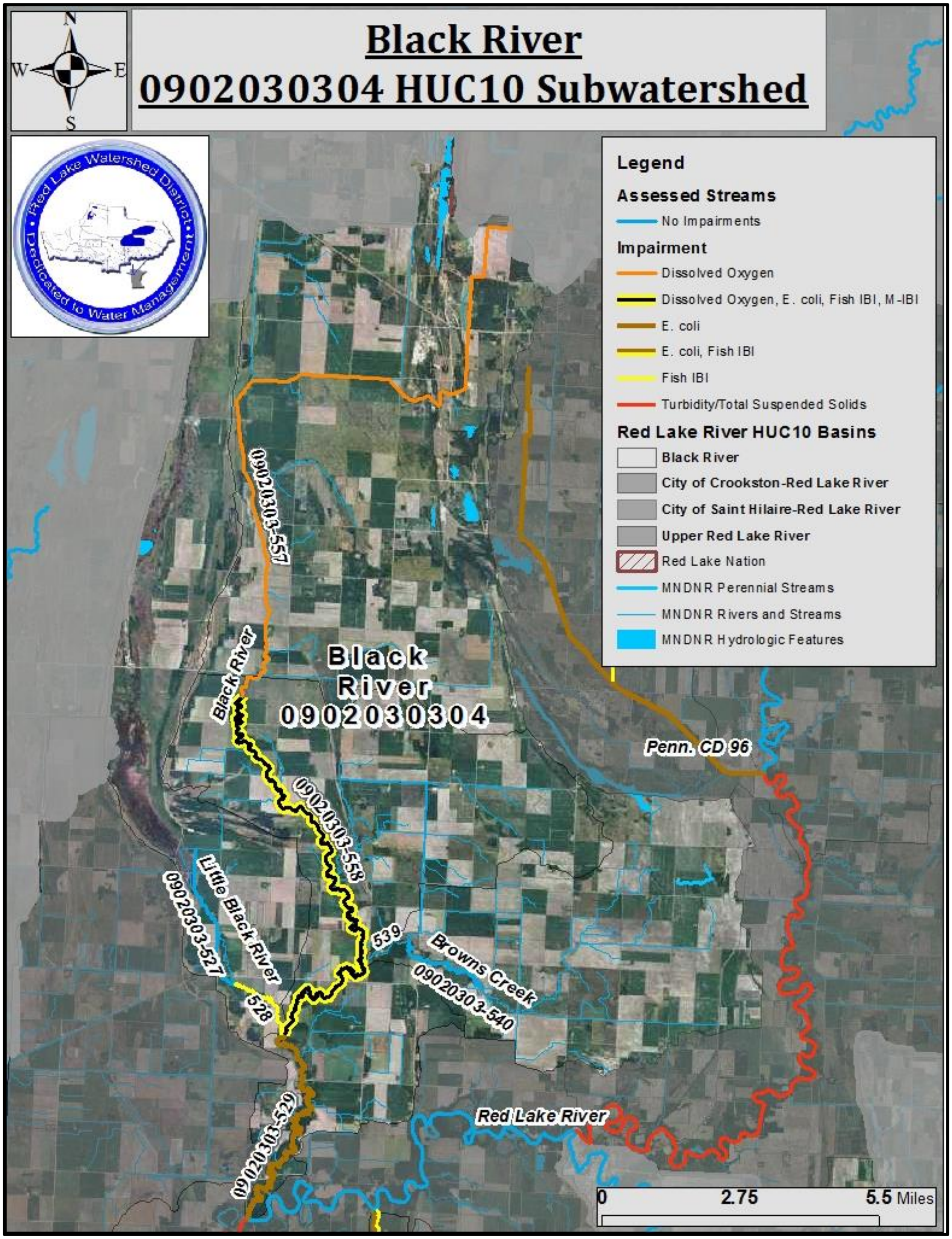


Figure 3-25. Black River HUC10 Subwatershed (0902030304).

Impairments:

- Little Black River – unnamed ditch to Black River AUID 528 impaired for F-IBI
- Black River AUID 529 impaired for *E. coli*
- Black River AUID 558 impaired for M-IBI, F-IBI, DO, *E. coli*

The 09020303-558 reach of the Black River, upstream of the Little Black River, is impaired by multiple measurements of water quality conditions: *E. coli*, DO, F-IBI, and M-IBI. The channelized reach (09020303-557) met water quality standards. However, it is dangerously close to becoming impaired by that same list of parameters. AUID 09020303-557 is considered modified or limited water resource and there has a lower F-IBI standard (23-point F-IBI) than those applied to the natural reaches of the Black River (47-point F-IBI) due to channelization. Stressors identified for 09020303-558 like low DO and a lack of base flow are also found in the upstream, channelized reach of the Black River. Sedimentation, in-stream habitat, and base flow should be addressed within the channelized, headwaters portion of the Black River to avoid future impairment. *E. coli* concentrations within the headwaters of the Black River are also relatively close to exceeding the standard. Longitudinal sampling has revealed specific information about areas that should be targeted for implementation (Section 3.1.5).

Until the 2014 assessment, the Black River was listed as impaired by turbidity (25 NTU standard) from its headwaters through to the Red Lake River. Utilizing the TSS standard, it is no longer considered impaired. However, excess sediment was identified as one of the stressors that is limiting the quality of macroinvertebrate communities.

The operation plan of the Shirrick Dam should be examined from a water quality perspective. Outside of flood conditions and emergency situations, discharge from the impoundment should be limited so that receiving waters do not exceed bankfull height. This should reduce streambank erosion of the Black River channel downstream of the dam. The channel is well buffered yet actively eroding downstream of CSAH 18. The geomorphology report recommended grade stabilization and the mitigation of flows (due to altered hydrology) from the watershed. Additional retention projects (preferably off-channel) could help provide additional moderation of flows. Reduction of peak flows should reduce the amount of erosive stress that is acting on riverbanks.

The DO impairment along the channelized (AUID 09020303-557) portion of the Black River was not carried forward to the draft 2016 List of Impaired Waters when AUID 09020303-530 was split. At the time of the 2014 assessment, insufficient violations of the DO standard had been recorded along that reach of the Black River to justify carrying the DO impairment forward. Subsequent monitoring, including the deployment of DO loggers, has identified a potential impairment along that reach. Additional monitoring and stream restoration efforts are recommended to improve conditions prior to the next assessment. Data collected through 2017 shows that AUID 09020303-557 has failed to meet the DO standard and may be listed as impaired by DO in the future.

The F-IBI and M-IBI scores of the Black River downstream of the Little Black River only met standards by relatively slim margins. Improvements are needed in order to prevent future impairments. Grade stabilization downstream of CSAH 18 could create riffle habitat and prevent further incision of the channel. The project could be designed to provide a remedy a perched culvert situation (during low flows) at the CSAH 18 crossing. Reduced erosion throughout the watershed will reduce TSS concentrations and sedimentation that seem to be negatively affecting macroinvertebrates.

A limited amount of sampling data has been collected along the Little Black River. Only two to three samples have been collected for each calendar month for the downstream portion of the stream (10 total). Still, 20% of the samples have been greater than the acute standard of 1260 MPN/ 100 mL. Every summer geometric mean, so far, is greater than the 126 MPN/100 mL standard. This reach seems destined for a future *E. coli* impairment unless actions are taken to minimize contributions from potential sources of *E. coli*. Two sources have been identified so far. One is a natural source – waterfowl within the Goose Lake swamp. Samples collected within that pool have exceeded the 126 MPN/100 mL *E. coli* standard. Obvious anthropogenic sources are limited, but one potential source is livestock operations. The number of residences along the stream is small. Targeting those residences for septic inspections and the application of grazing management BMPs should be feasible actions that can help keep this reach off the 303(d) List of Impaired Waters.

Table 3-7. Restoration and Protection Strategies for the 0902030304 Black River HUC10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility: RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
0902030304 Black River	Black River	Pennington, Polk and Red Lake Counties	Total Suspended Solids	All reaches meet the 65 mg/l standard 09020303-529: 8.9% >65mg/l 09020303-558: 0% >65mg/l 0902303-557: 7.3% >65mg/l 09020303-528: Insufficient data 09020303-527: Insufficient data	> 90% of April-Sept. samples are <65 mg/l	Moderation of discharge rates from the Shirrick Dam, when possible	Shirrick Dam and downstream waters (09020303-558 and 09020303-529)	●Flow monitoring indicates more consistent flows with lower peaks	●		●												2027
						Grade and stream bank stabilization	Black River downstream of CSAH 18	A project has been successfully planned, funded, and constructed.	●		●		●					●					2027
						Stabilize eroding outlets of private and public drainage systems	Fields along the Black River and its tributaries	●Location of all erosion problems are known. ●75% of the erosion problems have been addressed with projects. ●115 grade stabilization structures are installed. ●A grade stabilization project is implemented along the Black River between CSAH 18 and the Red Lake River.	●		●		●										2037
						Detailed assessment of geomorphology and sedimentation	Black River Corridor	●Assessment of sedimentation along the Black River upstream of the Shirrick Dam. ●Assessment of stream channel stability downstream of the Shirrick Dam. ●The root causes and solutions to active instability are identified and plans are developed alleviating the problems.	●		●		●										2037
0902030304 Black River	Black River	Pennington, Polk and Red Lake Counties	*E.coli*	3 impaired reaches: 09020303-529: Max geomean = 278 MPN/ 100ml (Impaired) 09020303-558 Max geomean = 153 MPN/ 100ml (Impaired) 09020303-557 Max geomean = 114 MPN/100ml 09020303-528 Insufficient data 09020303-527 Max geomean = 195 MPN/100ml (Impaired)	<126 MPN/100ml	Livestock exclusion and grazing management	Livestock operations along the Black River, Browns Creek and Little Black River	●The negative effects of 75% of all operations have been minimized through the implementation of BMPs. ●At least one cattle exclusion project has been implemented. ●2080 acres of rotational & prescribed grazing.		●	●												2027
						Inspect all septic systems along the Black River (human fecal DNR has been detected)	All of the Black and Little Black River watershed, particularly along the river corridors	The source of the septic effluent has been identified and eliminated.		●	●												2019

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
0902030304 Black River	Black River	Pennington, Polk and Red Lake Counties	Index of Biotic Integrity	2 impaired reaches 09020303-528 F-IBI = 24 09020303-529: F-IBI=50 M-IBI=45 09020303-558: F-IBI=25-37 M-IBI=24 (Impaired) 09020303-557: F-IBI=27-51 M-IBI=11-42	Fully Supporting aquatic life 09020303-528: F-IBI = 42 09020303-529: F-IBI > 47 M-IBI >37 09020303-557: F-IBI >23 M-IBI >22 09020303-558: F-IBI >47 M-IBI >37/41	2-Stage ditch design	09020303-557 (channelized reach)	●Project feasibility has been examined. ●1 mile of multi-stage ditch constructed.	•	•			•					•			•		2047
						Remove/retrofit private water crossings and other blockages	Section 23, Polk Centre Township, Pennington County	●Two crossings or blockages removed or retrofitted. ●Improve F-IBI scores from 2022 sampling data when compared to 2012 data.	•	•			•									•	2022
						Channel restoration for grade stabilization & connectivity	Downstream of CSAH 18, where downstream instability has created a perched culvert situation at a crossing	●F-IBI results improve in 09020303-529 (Black River-Little Black to Red Lake River). ●Improved connectivity and stream bank stability (improved stability rating during the 2023 geomorphological assessment).	•		•		•	•				•					2027
						Improve riffle habitat	09020303-558	●Complete one stream riffle project. ●IBI scores and water quality improve with stabilized stream & re-oxygenation of water.	•	•	•		•	•				•					2030
						Alter dam operation to mimic natural conditions	Shirrick Dam & Goose Lake	●Dam operation plans have been reviewed. ●Recommendations are developed and implemented for a trial period, then evaluated.	•				•										2020
						Improve base flows through retention	Black R. & Browns Creek sub-watersheds,	●One off-channel storage project has been completed. ●Base flow augmentation is included in FDR project operating plans ●180 acres of wetlands have been restored.	•														2037
0902030304 Black River	Black River	Pennington, Polk and Red Lake Counties	Dissolved Oxygen	1 Impaired Reach 09020303-527: IF DO5_All <5mg/l Insufficient DO5_9am 09020303-529: 5.4% DO5_All < 5mg/l ; 38.2% DO5_9am <5mg/l 09020303-558: 17.3% DO5_All <5mg/l IF DO5_9am (Impaired) 09020303-557: 2.6% DO5_All <5mg/l IF DO5_9am 09020303-528: 60% DO5_All <5mg/l IF DO5_9am	> 90% of daily minimums are <5 mg/l	●Wetland restorations to improve base flow ●Impoundment construction for FDR and base flow augmentation	Areas identified in restorable wetlands inventory maps and effective locations for storage and BMPs that are identified by PTMApp	●180 acres of wetlands have been restored. ●One new impoundment has been constructed	•	•	•		•										2037

3.3.5 0902030305 - Strategies for the "City of Crookston" Red Lake River HUC10

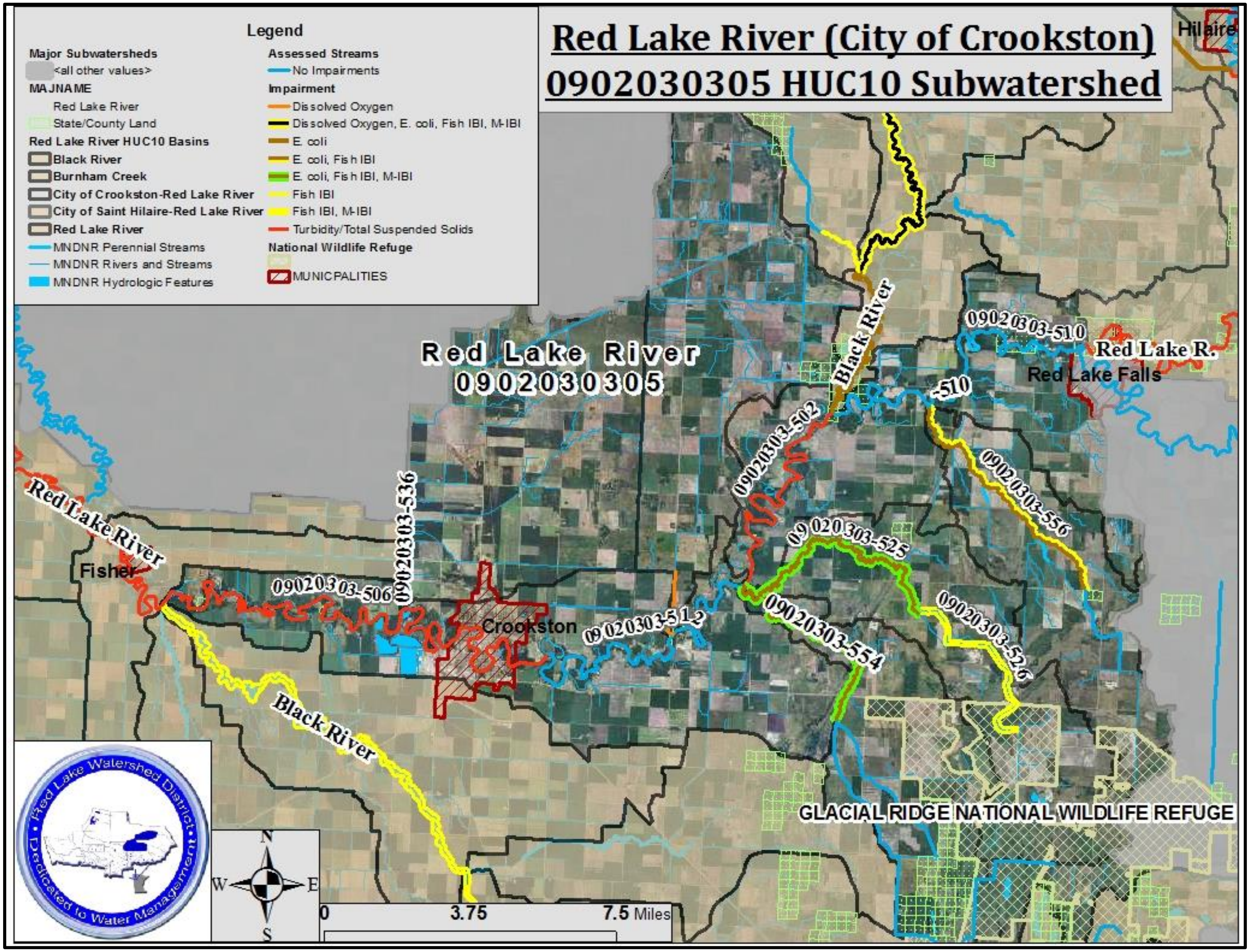


Figure 3-26. "City of Crookston" Red Lake River HUC10 Subwatershed.

Impairments:

- Red Lake River – Black River to Gentilly River AUID 502 impaired for TSS
- Red Lake River – CD99 to Burnham Creek AUID 506 impaired for TSS
- Red Lake River – Gentilly River to CD 99 AUID 512 impaired for TSS
- Kripple Creek – unnamed creek to Gentilly River AUID 525 impaired for M – IBI, F-IBI and *E. coli*
- Kripple Creek (CD66) unnamed ditch to unnamed creek AUID 526 impaired for M-IBI and F-IBI
- JD 60 – lateral ditch 4 to Red Lake River AUID 542 impaired for DO
- Gentilly River – CD140 to Red Lake River AUID 554 impaired for M-IBI, F-IBI and *E. coli*
- Cyr Creek - County Road 14 to Red Lake River AUID 556 impaired for F – IBI and *E. coli*

This subwatershed encompasses five Red Lake River AUIDs (510, 511, 502, 512, and 506). Three of those reaches are impaired by TSS. The other two have insufficient data. It is reasonable to assume, through interpolation, that reaches 510 and 511 are not meeting standards because the Red Lake River is impaired upstream (09020303-504) and downstream (09020303-502) of those reaches. Strategies for the restoration of those impaired reaches should also be applied to reaches 510 and 511 as "protection" strategies. Long-term monitoring within AUIDs 09020303-510 and 09020303-511 is not feasible due to an absence of road crossings or accesses.

There is another reach of the Red Lake River located upstream of Crookston that needs additional data collection to add confidence to water quality assessments. The AUID 09020303-512 reach of the Red Lake River was listed as impaired by turbidity and is bracketed by reaches that are impaired by TSS. Long-term monitoring within AUID 09020303-512 is recommended to collect enough TSS data for an assessment of current conditions.

Figure 3-27. Changes in the Red Lake River corridor within the city of Crookston: photos taken of the Red Lake River, facing upstream from the Sampson (Woodland Ave) Bridge in Crookston (S002-080).

The majority of 09020303-506 (CD99 to Burnham Creek) reach of the Red Lake River had excellent F-IBI scores. Fishing is popular in the Red Lake River at Crookston's Central Park, which has a boat access and streambanks that are accessible for shore fishing. A relatively recent flood protection and stream bank stabilization project (Figure 3-31) within the city of Crookston may have negatively affected fish habitat. The project replaced existing dikes (removing all trees), constructed a floodwall, and lined the channel with rock and concrete. The fish samples collected within that project area were much lower than scores recorded upstream and downstream of the city. While other sites along the 09020303-506 reach exceeded the 49-point impairment threshold by 25-41 points, the 94RD513 site actually fell short of the impairment threshold by several points. Potential impacts of stormwater, sedimentation, and unconventional pollutants (chemicals other than sediment, nutrients, and bacteria) could also be investigated within the city to identify the cause of the depressed IBI score.

M-IBI scores at some Red Lake River sampling stations near the city of Crookston (upstream at 12RD108 and downstream at 12RD112) along 09020303-506 passed the impairment threshold by relatively slim margins. For that reason, the reach has been given a high priority for protection projects by the Red Lake River 1W1P.

With a September geometric mean *E. coli* concentration of 97.4 MPN/100 mL, the Red Lake River near Huot (09020303-502) is one of the unimpaired streams that is in the most danger of becoming impaired during future assessments. The only sampling site along this reach is located a short distance downstream of the Red Lake River's confluence with the Black River, which is impaired by high *E. coli*. Restoration efforts in the Black River Watershed should benefit the Red Lake River at Huot. The Old Crossing Treaty Park in Huot is used for aquatic recreation, so maintaining safe concentrations of *E. coli* is very important.

The 0902030305 HUC10 subwatershed of the Red Lake River also encompasses the drainage areas of significant tributaries (Cyr Creek, Gentilly Creek, Kripple Creek, JD60, and CD1).

Continuous and discrete measurements of DO in Cyr Creek have revealed that the reach is not meeting the 5 mg/L standard. The stream typically goes dry in the late summer. Due to that observation and acceptable discrete readings, the reach was not listed as impaired. Removing DO data that was collected during stagnant and low flow conditions does not sufficiently reduce the rate at which the standard is exceeded. Additional monitoring is recommended for the purpose of clarifying the cause of low DO in Cyr Creek.

The wetland and prairie restorations that have been completed within the Glacial Ridge National Wildlife Refuge have been beneficial for the protection of water quality in the headwaters of Red Lake River tributaries like Kripple Creek and Burnham Creek.

The other stressors and restoration strategies for the Gentilly River, Kripple Creek, and Cyr Creek are addressed in the Red Lake River TMDL and in Section 3.3 of this report.

Significant erosion, headcutting, and bank failures are evident along the outlet of the JD60 drainage system, downstream (south) of the CSAH 11 crossing. A grade stabilization project and, most likely, a culvert replacement project would be needed in order to allow fish passage upstream into the 09020303-542 reach of JD60.

Significant water quality problems have been identified along an intermittently flowing Polk County Ditch 1. Monitoring data collection has been limited by the intermittent nature of the ditch. When the ditch is flowing, however, velocities are very high, and the steep banks are actively eroding. Bank failures were observed in recent years. A new home was constructed along the actively eroding ditch bank in 2015. This is an example that emphasizes the importance of involving and educating planning and zoning staff. There are more factors that should be considered than just the minimum requirements of shoreland rules.

Table 3-8. Restoration and protection strategies for the 0902030305 HUC10 portion of the Red Lake River watershed: Red Lake River and Gentilly River, Kripple Creek, Cyr Creek, JD60, and Polk CD1 tributaries.

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
0902030305 Red Lake River-City of Crookston	Red Lake River Gentilly Creek Kripple Creek Cyr Creek Judicial Ditch 60 Polk County Ditch 1	Red Lake and Polk Counties	Total Suspended Solids	2 reaches exceed 65 mg/l TSS standard Red Lake River 09020303-502: 29.3% >65mg/l Red Lake River 09020303-506: 13.8% >65mg/l Kripple Creek 09020303-525: 5.3% >65mg/l JD60 09020303-542: 0.0% >65mg/l Gentilly River 09020303-554: 2.2% >65mg/l Cyr Creek 09020303-556: 0.0% >65mg/l Insufficient data: 09020303-510, 511, 512, 524, 526, 536, 555	>90% of April-September samples are <65 mg/l	Stormwater assessment, retention and treatment	City of Crookston, particularly in the industrial area in the southwest part of town	●Projects have been implemented to reduce the effects of stormwater runoff in the City of Crookston. ●Stormwater sampling finds lower turbidity levels than those that were found in previous sampling efforts.	●			●						●	●				2019
						Volunteer monitoring on reaches that have no road crossings or public access	09020303-510 & 09020303-511 (Red Lake R. from the Clearwater R. to the Black River)	At least 20 transparency measurements and/or samples have been collected on inaccessible reaches.	●		●			●								●	2020
						Grade stabilization and buffer improvement along Polk County Ditch 1	09020303-536 (County Ditch 1), lower 1.25 miles	●Improve in Bank Erosion Hazard Index (BEHI) ratings along the ditch. ●Reduce erosion and bank failures. ●No damage to roads or homes due to bank failures. ●At least 4 grade stabilization structures are installed.	●			●						●			●		2019
						Grade stabilization at the Judicial Ditch 60 outlet	09020303-546 (Judicial Ditch 60), downstream of CSAH 11	●A grade stabilization project has been completed. ●At least 4 grade stabilization structures are installed.	●		●	●						●			●	●	2020
						Stream, bank and outlet stabilization.	Red Lake River corridor between the Black River and the Clearwater River and the City of Fisher	●Completed of 5 river bank stabilization erosion control projects. ●Completion of 3 projects that stabilize the outlets of tributaries and drainage with severe gully erosion problems. ●Two miles of channel bed and stream channel stabilization.	●	●	●	●	●			●							2020

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
0902030305 Red Lake River-City of Crookston	Red Lake River Gentilly Creek Kripple Creek Cyr Creek Judicial Ditch 60 Polk County Ditch 1	Red Lake and Polk Counties	*E. coli*	3 trib. of the RLR are impaired by high *E.coli:* Cyr Ck, Kripple Ck & Gentilly R. Max. Monthly Geomeans: Red Lake River 09020303-502: 97 MPN/100ml Red Lake River 09020303-506: 68 MPN/100ml Kripple Creek 09020303-525 491 MPN/100ml (impaired) Polk CD1 09020303-536: 83 MPN/100ml 090203-542 Max geomean = 68 MPN/100ml Gentilly River 09020303 -554 201 MPN/100ml (impaired) Cyr Creek 09020303-556: 278 MPN/100ml (impaired)	< 126 MPN/100ml, monthly geomeans	Targeted outreach for pasture management, livestock exclusion, and feedlot controls.	Lake Pleasant Township (Kripple Creek) Gentilly Township (Gentilly River) Kertsonville Township in Polk County	●Restoration of the Gentilly River and Kripple Creek *E. coli* Impairments. ●200 acres of rotational and prescribed grazing.	□		•	•		•		•							2020
						Inspect all septic systems along Kripple Creek (human fecal DNA has been detected)	09020303-525 and 09020303-526	●The source of the septic effluent has been identified and eliminated. ●At least 2 septic system upgrades have been completed.											•				2019

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
0902030305 Red Lake River-City of Crookston	Red Lake River Gentilly Creek Kripple Creek Cyr Creek Judicial Ditch 60 Polk County Ditch 1	Red Lake and Polk Counties	Index of Biotic Integrity	Red Lake River 09020303-510: F-IBI=65-74 M-IBI=53-57 Red Lake River 09020303-511: F-IBI=61 M-IBI=66 Red Lake River 09020303-502: F-IBI=59 M-IBI=50 Red Lake River 09020303-512: F-IBI=83 M-IBI=57 Red Lake River 09020303-506: F-IBI=46-90 M-IBI=33-59 Kripple Creek 09020303-525: F-IBI=21-41 M-IBI=34 (Impaired) Kripple Creek 09020303-526 F-IBI=33-35 M-IBI=15-37 (Impaired) Gentilly River 09020303-554 F-IBI=34-50 M-IBI=27-28 (Impaired, High Priority) Cyr Creek 09020303-556 F-IBI=7	Fully support aquatic life 09020303-510: : F-IBI >38, M-IBI >31 09020303-511 F-IBI >38, M-IBI >31 09020303-512 F-IBI >49, M-IBI >31 09020303-506 F-IBI >49, M-IBI >31 09020303-525 F-IBI >42, M-IBI >41 09020303-526 F-IBI >42, M-IBI >41 09020303-554 F-IBI >42, M-IBI >41 09020303-556 F-IBI >42	Regular inspection, beaver dam removal and nuisance beaver, particularly within ditch systems	Kripple Creek & Cyr Creek	Improved IBI scores are calculated for impaired reaches during the 2023 assessment.	•										•		•		Annual, beginning in 2017
						Improve in-stream habitat through restoration projects	Kripple Creek, especially the ditched, County Ditch 66 portion	•At least one project is completed. •At least two additional projects are being planned or assessed for feasibility.	•				•						•		•	•	2030
						Construct off-channel impoundments, restore wetlands and abandon/restore portions of unused ditches to improve infiltration, improve base flows, and reduce flashiness of flow	Kripple Creek, Gentilly River, Cyr Creek and Judicial Ditch 60 subwatersheds	•20 acres of wetlands have been restored in the Gentilly River subwatershed. •20 acres of wetlands have been restored in the Cyr Creek subwatershed. •20 acres of wetlands have been restored in the Kripple Creek subwatershed. •A stream channel restoration or 2-stage ditch conversion project has been completed.	•			•	•					•					2030
						Remove or retrofit private watercourse crossings (Texas crossings) and other anthropogenic obstructions to flow	Cyr Creek, Section 25, Louisville Township, Red Lake County Gentilly River, retrofit the old "swimming pool" dam, downstream of CSAH 11	•Remove or retrofit two watercourse crossings. •Improved F-IBI scores from 2022 sampling data when compared to 2012 data.	•		•	•	•						•			•	2022

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
0902030305 Red Lake River-City of Crookston	Red Lake River Gentilly Creek Kripple Creek Cyr Creek Judicial Ditch 60 Polk County Ditch 1	Red Lake and Polk Counties	Dissolved Oxygen	Multiple tributary reaches have failed to meet the DO standard 09020303-502 & 09020303-506 & 09020303-512: 0% of DO5_All <5mg/l 09020303-525: 0% of DO5_All <5mg/l, 3.3% of DO5_9am <5mg/l 09020303-536: 5% of DO5_All <5mg/l, 75% of DO5_9am <5mg/l 0920303-542: 11.4% of DO5_All <5mg/l, 93.3% of DO5_9am <5mg/l 09020303-554: 5.6% of DO5_All <5mg/l, 58.9% of DO5_9am <5mg/l 09020303-556: 5.6% of DO5_All <5mg/l, 43.8% of DO5_9am <5mg/l Insufficient Data: 09020303-510 09020303-511 09020303-524 09020303-526 09020303-555	> 90% of daily minimums are >5 mg/l	Improve DO, base flow, and morphology within prairie streams and ditches	09020303-536 (County Ditch 1) 09020303-542 (Jud. Ditch 60) 09020303-554 (Gentilly River) 09020303-556 (Cyr Creek)	One feasibility study has been completed or has at least been initiated.	•		•	•	•		•					•			2027
								Improve base flows through wetland restorations and FDR Projects	•		•	•	•								•	•	2037
						Improve Riparian Buffers	JD60 09020303-542	JD60 is in full compliance with the Buffer Law	•		•	•									•	•	2018

3.3.6 0902030306 – Strategies for the Burnham Creek HUC10 Subwatershed

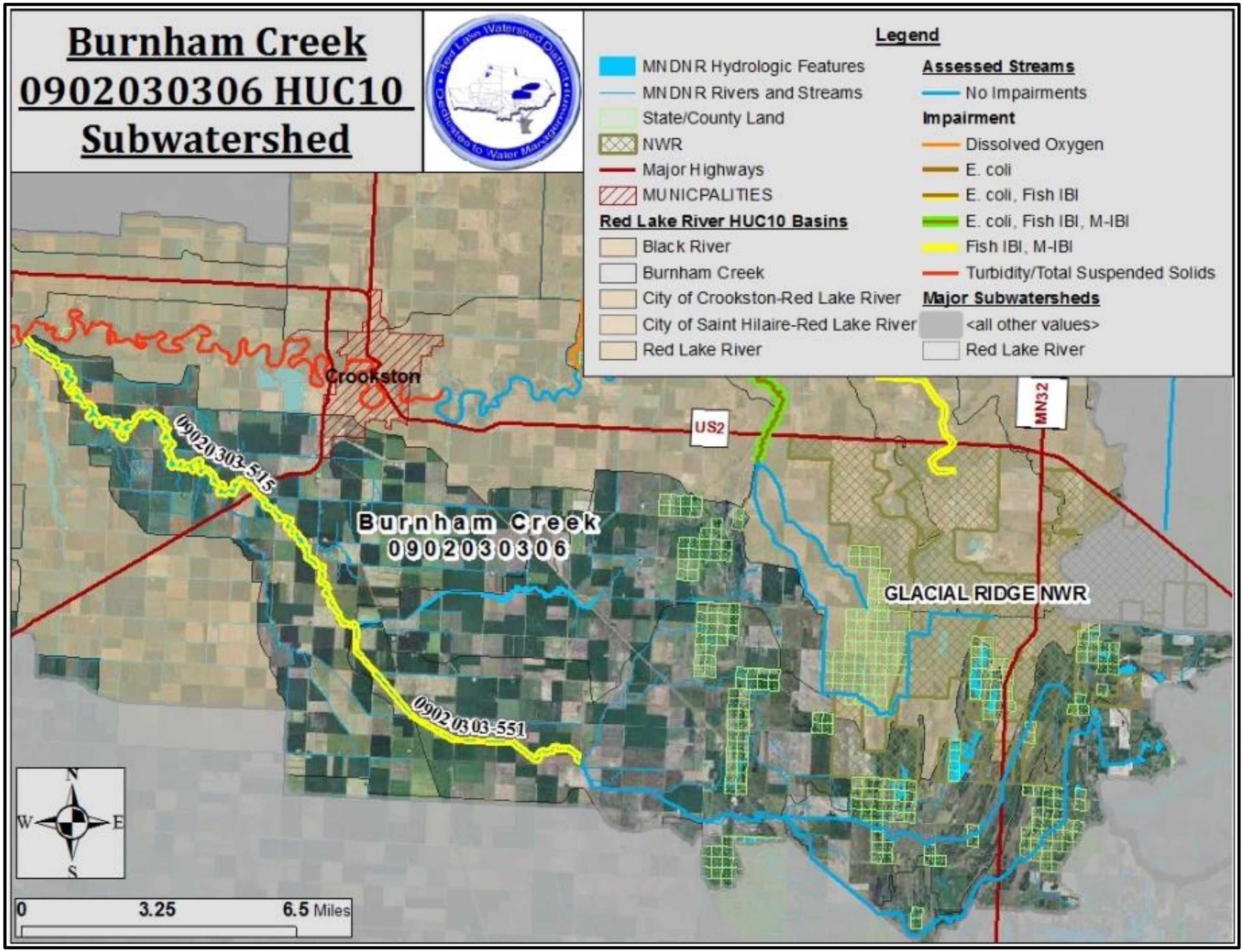


Figure 3-28. Burnham Creek HUC10 Subwatershed (0902030306).

Impairments:

- Burnham Creek – Polk CD15 to Red Lake River AUID 515 impaired for M-IBI and F-IBI
- Burnham Creek – CD106 to Polk CD15 AUID 551 impaired for M-IBI and F-IBI

Existing turbidity impairments in the Burnham Creek are no longer considered to be impaired when utilizing the TSS standard. The SID Report; however, identified excess sediment as a stressor of macroinvertebrates on both of the assessed reaches (09020303-515 and 09020303-551).

With a May geometric mean concentration of 94.4 MPN/100mL in 2004-2014 samples, the lower reach of Burnham Creek (09020303-515) is one of the unimpaired streams that are in the most danger of becoming impaired during future assessments. An assessment of 2006 through 2015 data shows that the geometric mean has decreased to 86.8 MPN/100ml.

Additional data collection is needed in upstream reaches (09020303-551, 09020303-552). Project effectiveness monitoring is being conducted at the CSAH 48 crossing to evaluate projects that were completed upstream of the CD 106 confluence. The Spring Gravel Dam stream restoration site should be monitored for project effectiveness. Additional work may be needed in the future. DO levels will be monitored at additional locations throughout the watershed. The outlets of ditch systems should be stabilized. Illicit discharges have been discovered along this reach in the past. Citizens and monitoring staff should remain alert for potential problems in the future.

Other strategies for improving water quality in Burnham Creek are included in the restoration plans of the TMDL.

Table 3-9. Restoration and protection strategies for the Burnham Creek (09020306) HUC10 Subwatershed.

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
0902030306 Burnham Creek	Burnham Creek	Polk County	Total Suspended Solids	09020303-515: 6.4% >65mg/l Insufficient data: 09020303-523, 551, 552, 559	> 90% of April-Sept. samples are <65mg/l	Grade and streambank stabilization	Burnham Creek, downstream of Hwy 75 Burnham Creek, upstream of 180th Ave. SW	•15 grade stabilization structures have been constructed. •3 miles of channel bed and stream channel stabilization.	•			•	•					•					2037
			E. coli	All reaches are meeting water quality standards 09020303-515: Max Geomean = 94.4 MPN/100ml (High Priority for Protection) Insufficient data: 09020303-523, 551, 552, 559	< 126 MPN/100 ml monthly geomeans	Increase the amount of water quality sampling in the upper reaches of the Burnham Creek watershed	09020303-523 (County Ditch 65) 09020303-551, 09020303-552 (Burnham Creek, upstream of CD 15) 09020303-559 (County Ditch 106)	•Sufficient data to assess the 09020303-551 and 09020303-552 reaches of Burnham Creek. •Sufficient periodic data from County Ditch 65 and County Ditch 106 during runoff events to indicate whether additional sampling is warranted.	•					•						•			2023
			Dissolved Oxygen	No formal impairments, but cont. DO data indicates potential impairment: 09020303-515: 4.4% of DO5_All <5mg/l, 40.8% of DO5_9am < 5mg/l 09020303-551: 30% of DO5_All <5mg/l, 31.1% of DO_9am <5mg/l Insufficient Data: 09020303-523, 552, 559	> 90% of daily minimums are >5mg/l	Improve the quality of riparian buffers by establishing woody and/or deep-rooted vegetation that will also help shade the stream channels.	Throughout the watershed, to the extent allowable by ditch law	•25 acres of tree/shrub establishment. •5 acres of critical area plantings.	•			•	□					•			•		2037

HUC-10 Subwatershed	Waterbody and Location: Waterbody (ID)	Waterbody and Location: Location and Upstream Influence Counties	Parameter	Water Quality: Current Conditions	Water Quality: Water Quality Target	Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
0902030306 Burnham Creek	Burnham Creek	Polk County	Index of Biotic Integrity	09020303-515: F-IBI= 0-58 M-IBI= 23-29 09020303-551: F-IBI= 13 M-IBI= 20	Fully support aquatic life 09020303-515: F-IBI= >50 M-IBI= >41 Burnham Creek upstream of CD15: F-IBI= >35 M-IBI= > 22	Stream restoration to improve in-stream habitat	Polk County Ditch 79 between Highway 102 ad 180th Ave. SW	●Some work has been completed, must more may be needed downstream of the Spring Gravel dam project area. ●Delisting of the biological impairment on 09020303-551.	●			●	●	●		●		●					2022
						Study the interaction between wetlands, groundwater, and stream flow in headwaters reaches	Drainage area of 09020303-551 (Burnham Creek upstream of CD 15)	Lessons learned from successful restoration strategies within Glacial Ridge National Wildlife Refuge area applied to other areas within the headwaters of Burnham Creek.	●				●	●	●	●		□					2027
						Reduce peak flows, increase infiltration, and increase base flows through storage and restorations	Drainage area of 09020303-551 (Burnham Creek upstream of CD 15)	●20 acres of wetland restorations ●5000 acre-feet of flood storage through the construction of off-channel impoundments. ●Incorporate base flow augmentation into FDR project design and operation ●Install 15 water control structures.	□				●					●					2037
						Remove or retrofit private water crossings and other obstructions	Section 9 of Russia Township Sections 14 and 15 of Andover Township	●Anthropogenic barriers to fish passage are removed. ●Improved F-IBI scores from 2022 sampling data when compared to 2012 data.	●			●	●								●	●	2022
						Ensure fish passage at public road stream crossings	Burnham Creek subwatershed	●All bridge and culvert crossing replacements are properly designed to allow fish passage. ●A workshop is held for local staff and decision makers to provide training on how to choose a culvert that is designed to allow fish passage and how to acquire funding for anything that goes beyond the replacement of crossings with identically sized structures. ●Plans and funding are established to cover any extra costs encumbered by local gov. units in order to install culverts that are properly sized and placed at proper elevations for fish passage.	●			●	●								●		2020

Governmental Units with Primary Responsibility: RLWD through Co. Ditch Authorities/Engineers.

3.3.7 0902030307 - Strategies for the Lower Red Lake River and Heartsville Coulee

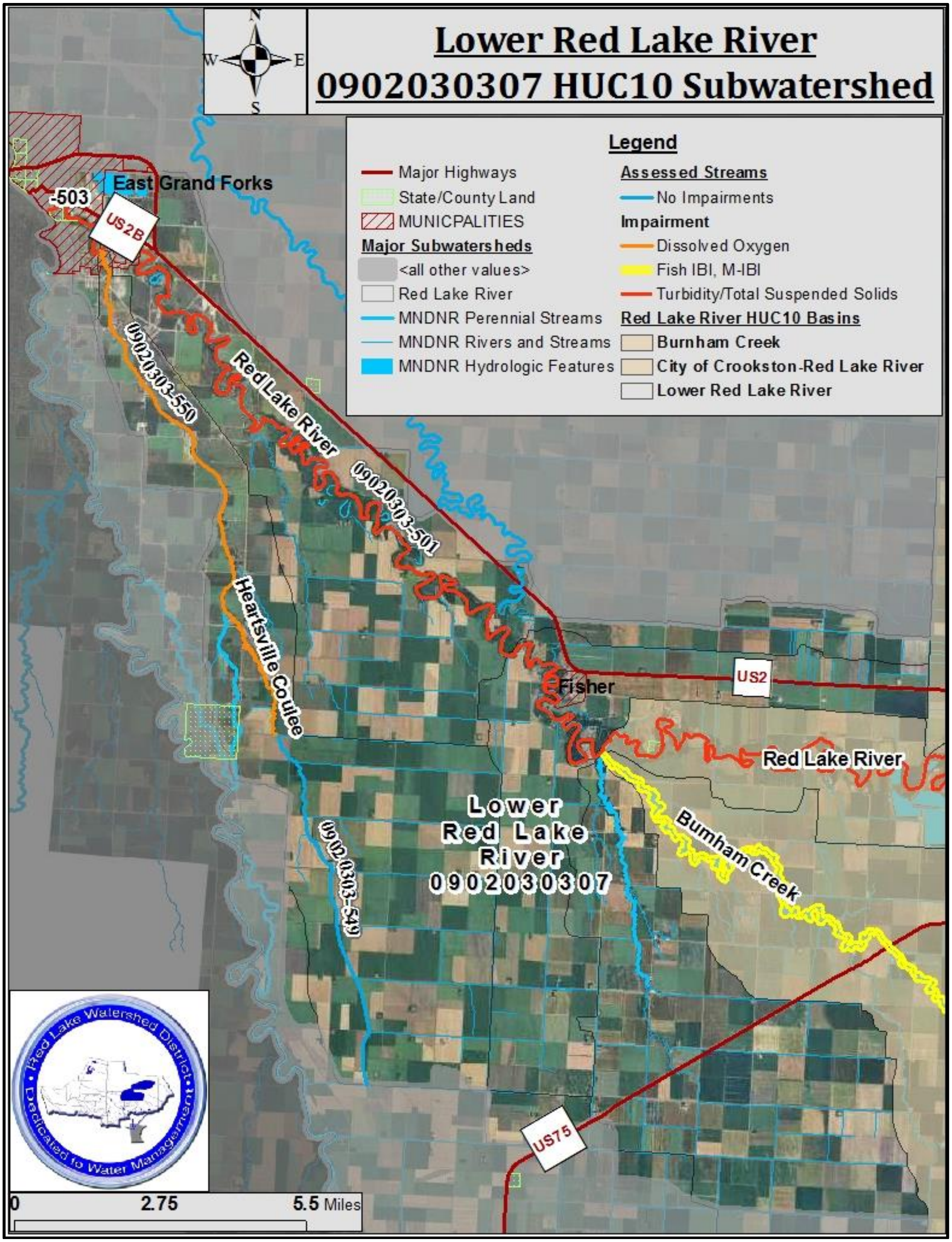


Figure 3-29. Lower Red Lake River HUC10 Subwatershed (0902030307).

Impairments:

- Red Lake River – Burnham Creek to Heartsville Coulee AUID 501 impaired for TSS
- Red Lake River – Heartsville Coulee to Red River AUID 503 impaired for TSS
- Heartsville Coulee AUID 550 impaired for DO

This subwatershed encompasses two reaches of the Red Lake River (09020303-501 and 09020303-503) and multiple reaches along the Heartsville Coulee tributary of the Red Lake River (09020303-550 and 09020303-549).

The Red Lake River downstream of Burnham Creek is one of the top five reaches in the watershed that are in the most danger of becoming impaired by low F-IBI scores. The site that barely achieved a "fair" rating was the sampling station near the Fisher Bridge (252nd Street Southwest, S000-031, 76RD023). The Red Lake River 1W1P identifies this reach as a priority waterway for the implementation of protection projects that will improve conditions in unimpaired waters and prevent future impairments.

The city of East Grand Forks draws its municipal drinking water from the Red Lake River. Treatment costs increase with greater concentrations of pollutants. TOC, in particular, is a parameter that increases treatment costs and decreases the drinkability of the water. Increased treatment of polluted surface water increases the amount of harmful disinfection byproducts, such as trihalomethane.

The RLWD Ditch 12 (09020303-549) is a recent ditch improvement project that has been completed in the headwaters of Heartsville Coulee. It failed to meet the F-IBI standard and barely met the M-IBI standard. It was not listed as impaired. At the time of sampling, the construction had been relatively recent. The channel is being managed as a drainage ditch. The channel of the ditch was constructed with meanders. The fish in this reach are ultimately limited by downstream waters, however. Heartsville Coulee is virtually impassable for fish. There is a large diversion structure near the downstream end of the drainage area. Much of Heartsville Coulee (09020303-550) resembles a wetland, has a low gradient, and experiences consistently low DO levels. The M-IBI score in RLWD Ditch 12 gives this reach a high priority for protection efforts, due to the slim margin (one point) by which the impairment threshold was surmounted.

Monitoring data is needed to understand the sediment contributions from Polk County ditch systems that flow into the Red Lake River. Water quality models (SWAT, HSPF) have identified several ditch systems as areas in which there is a relatively high potential for sediment reductions through the implementation of BMPs:

- Polk County Ditch(es) 115/123/107/163
- Polk County Ditch(es) 100/74/10/28
- Polk County Ditch(es) 69/120/96/117/116

Table 3-10. Restoration and protection strategies for the 0902030307 HUC10 subwatershed of the Red Lake River.

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility														Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers	Citizens/Landowners/Volunteers	
902030307	Red Lake River Heartsville Coulee	Polk County	Total Suspended Solids	2 impaired reaches: Red Lake River 09020303-501 (58.8% >65mg/l), Red Lake River 09020303-503 (39.5% >65mg/l), RLWD Ditch 12 09020303-549: No data Heartsville Coulee 09020303-550: 0.0% >65mg/l	>90% of April-Sept. samples are <65mg/l	Streambank Stabilization	Red Lake River Corridor	15 projects have been completed between 2016 and 2027.	•	•	•	•	•			•		•					2037
						Moderate flows through upstream flood damage reduction projects, wetland restorations, stream restorations and other projects.	Middle and Lake Runoff Timing Zones (RRB FDRWG TSAC Technical Paper 11)	●The exceedance rate of the TSS standard has decreased. ●A new impoundment has been constructed in an area that strategically benefits flood damage reduction and natural resource enhancement goals without sacrificing aquatic habitat. ●10 acres of wetland restorations have been completed.	•			•	•					•					2037
			E. coli	All reaches meet the *E. coli* standard, 09020303-501: Max geomean = 69.5 MPN/100ml. 09020303-503: Max geomean = 41.2 MPN/100ml. 09020303-549: No data. 09020303-550: Max geomean = 48.4 MPN/100ml.	< 126 MPN/100 ml monthly geomeans	Maintain current conditions and application of existing regulations	Lower Red Lake River Watershed	Monthly geometric means *E. coli* concentrations have not increased.	•			•		•					•				Ongoing
			Index of Biotic Integrity	09020303-501: F-IBI = 55-72 M-IBI = 47-59 09020303-503: F-IBI = 61 09020303-549: F-IBI = 0 M-IBI = 23	Fully Support Aquatic life, 09020303-501 & 503: F-IBI= >49 M-IBI= >31 09020303-549: F-IBI= >33 M-IBI= >22	Prevent the spread of aquatic invasive species (AIS) upstream from the Red River	Red Lake River in East Grand Forks	No AIS have been discovered in the Red Lake River Watershed.	•			•	•						•				Ongoing

HUC-10 Subwatershed	Waterbody and Location		Parameter	Water Quality		Strategies	Estimated Scale of Adoption Needed	Interim 10-yr Milestones	Governmental Units with Primary Responsibility													Citizens/Landowners/Volunteers	Timeline for Achievement of Water Quality Goals
	Waterbody (ID)	Location and Upstream Influence Counties		Current Conditions	Water Quality Target				RLWD	Pennington County SWCD	Red Lake County SWCD	West Polk County SWCD	MN DNR	MPCA	University of MN Extension	NRCS	MDA	BWSR	Counties/Townships/Cities	IWI/RRWMB	Co. Ditch Authorities/Engineers		
902030307	Red Lake River Heartsville Coulee	Polk County	Dissolved Oxygen	1 impaired reach Red Lake River 09020303-501: 0.5% of DO5_All <5mg/l Red Lake River 09020303-503: 3.8% of DO5_All <5mg/l RLWD Ditch 12 09020303-549: No data Heartsville Coulee 09020303-550: 75.7% of DO5_All <5mg/l, 100% of DO5_9am <5mg/l (Impaired)	> 90% of daily minimums are >5mg/l	Store water in impoundments and wetlands in order to augment late summer base flows	Burnham Creek headwaters	10 acres of wetlands are restored.	•			•	•										2027

4. Monitoring Plan

Local, state, and federal agencies combine efforts to collect a large amount of environmental data within the Red Lake River Watershed. Water quality in rivers and streams is monitored using specialized equipment and laboratory analysis. Stage and flow levels are monitored along the Red Lake River and its tributaries. SWCDs monitor groundwater levels. The state conducts biological (aquatic and terrestrial) monitoring. Compliance monitoring is also important for the protection of natural resources.

Water quality monitoring can be conducted for multiple purposes. Much of the data is collected for the purpose of monitoring the condition of waterways over time, assessing current water quality conditions, or calculating pollutant loads. Official water quality assessments require a minimum number of water quality measurements in order to determine whether a waterway is meeting or violating water quality standards (Figure 4-1).

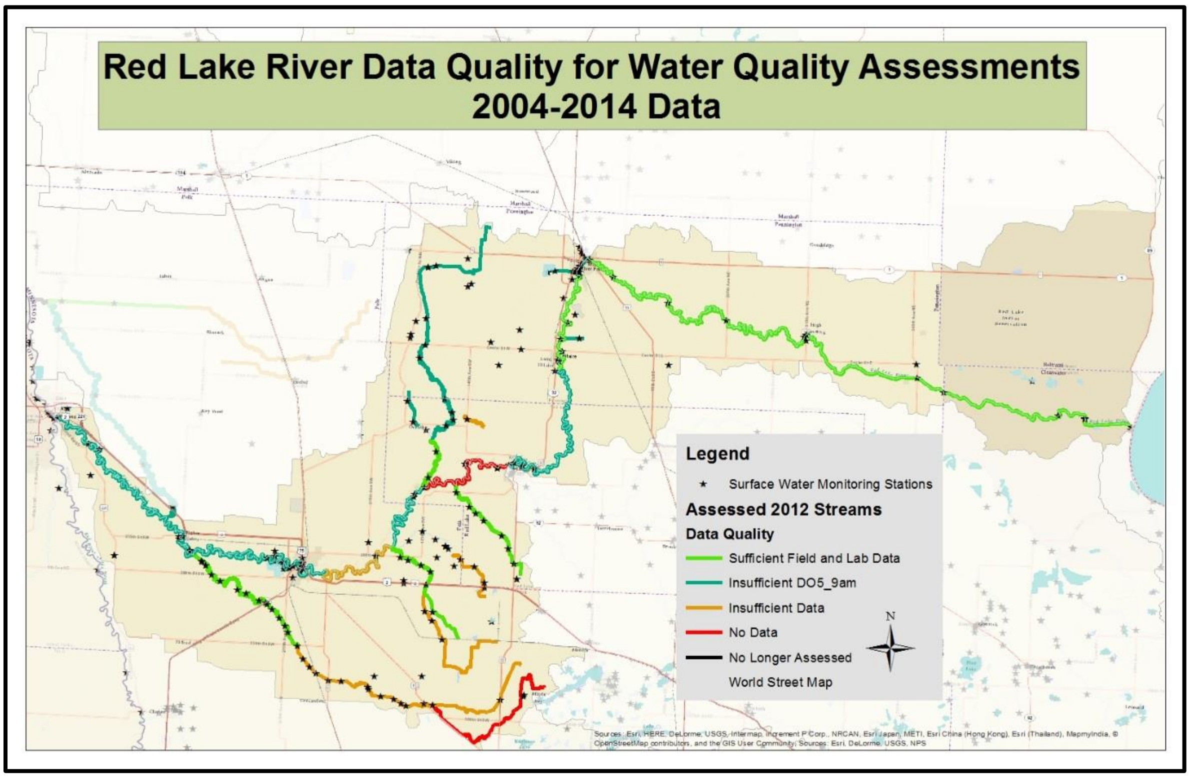


Figure 4-1. Map showing the quality of data that was available for the 2015 assessment.

The number of parameters and the frequency at which they are measured depends upon the project goals, the budget of the monitoring project, available equipment, and available staff time. Monitoring programs may be short-term or long-term. Short-term monitoring efforts may aim to achieve a minimal snapshot of water quality conditions (SWAG Grants), diagnose the source of a water quality problem, or measure the effectiveness of a project. Long-term monitoring should be sufficient to measure trends over time and to compile sufficient data for the assessment of whether or not waterways support aquatic life and recreation. All data that is collected following proper procedures needs to be submitted to the MPCA for entry and storage in the State's EQuIS water quality database. The State uses data stored in EQuIS during the official water quality assessments. Data compiled in EQuIS is also used for many other purposes, like writing TMDLs.

The parameters that are measured for long-term monitoring projects may vary slightly among organizations and monitoring sites. Basic parameters that can be measured on-site while monitoring (field parameters) include water temperature, DO, pH, specific conductivity, stage, transparency, turbidity, and observations/comments. Water samples are shipped overnight or delivered on the same day to a lab that is certified by the Minnesota Department of Health for analysis. Typically, samples are analyzed for a basic set of parameters that includes total phosphorus, orthophosphorus, TSS, ammonia N, total Kjeldahl nitrogen, nitrates and nitrites, and *E. coli*. Additional parameters like chemical oxygen demand, biochemical oxygen demand (BOD), sulfates, TOC, and/or chlorophyll-a may be collected, dependent upon project needs. TOC from the main channel of the Red Lake River and its major tributaries is useful to public water suppliers along the river in Thief River Falls and East Grand Forks. Oxygen demand data is collected at sites on reaches that are impaired by low DO levels (either officially or suspected). Chlorophyll-*a* has been collected for the MPCA from the lower end of major subwatersheds to measure eutrophication levels.

The RLWD began monitoring water quality in the Red Lake River Watershed in 1980 and now monitors 20 sites in the watershed (Figure 4-2). Newer sites that were monitored for the Red Lake River Watershed Restoration and Protection Project were added to the RLWD long-term monitoring program. The monitoring program collects data from the significant waterways within the watershed, including multiple reaches of the Red Lake River and its significant tributaries. Field measurements of DO, temperature, turbidity, specific conductivity, pH, and stage are collected during each site visit (if there is water). Four rounds of samples are also collected at and analyzed for TP, OP, TSS, total dissolved solids,

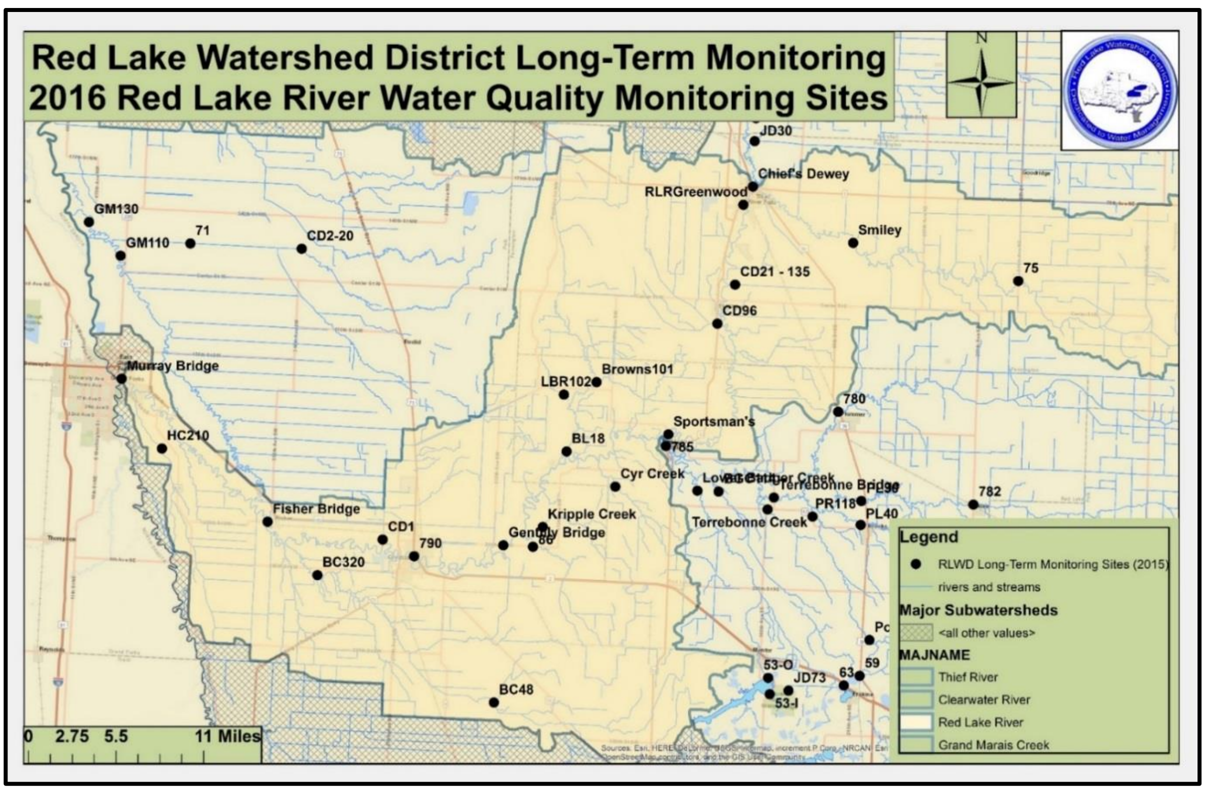


Figure 4-2. Red Lake River Long-Term Water Quality Monitoring Sites.

TKN, ammonia N, nitrates + nitrites, and *E. coli* at most of the sites. For the past few years, BOD analysis has been added for the sites that are located on reaches that have had low DO levels. BOD was replaced with chemical oxygen demand analysis in 2014 because too many BOD levels were too low to be measured. Sampling months are alternated each year with the goal of collecting at least five samples per calendar month within a 10-year period. Within the Red Lake River Watershed planning area, the RLWD monitors:

1. Red Lake River at the Louis Murray Bridge in East Grand Forks (Murray Bridge, S002-963)
2. Red Lake River at the Fisher Bridge (S000-031)
3. Red Lake River at Woodland Avenue in Crookston (790, S002-080)
4. Red Lake River at CSAH 13 near Red Lake Falls (Sportsman's Bridge, S003-172)
5. Red Lake River at Greenwood Street in Thief River Falls (RLRGreenwood, S006-225)
6. Red Lake River at the Smiley (CSAH 7) Bridge, east of Thief River Falls (Smiley, S007-063)
7. Red Lake River at Highlanding (75, S002-077)
8. Heartsville Coulee at 210th Street Southwest (HC210, S007-061). This site may be moved downstream, closer to the pour point, where there is flowing water.
9. Burnham Creek at 320th Avenue Southwest (BC320, S007-058)
10. Burnham Creek at Polk County Road 48 (BC48, S007-644)
11. Polk County Ditch 1 at County Road 61 (CD1, S007-059)
12. Gentilly River at CSAH 11 (86, S004-058)
13. Kripple Creek at 180th Avenue Southwest (S004-835)
14. Black River at CSAH 18 (BL-18, S002-132)
15. Little Black River at Red Lake County Road 102 (LBR102, S008-111)
16. Browns Creek at Red Lake County Road 101 (Browns101, S007-609)
17. Cyr Creek at Red Lake County Road 110 (S004-818)
18. Pennington County Ditch 96 at Highway 32 (CD96, S005-683)
19. Pennington County Ditch 21 at 135th Avenue Northeast (CD21-135, S008-889)
20. Chief's Coulee at Dewey Avenue within the city of Thief River Falls (S008-496)

The Red Lake County and Pennington County SWCDs have long-term monitoring programs in which monthly samples and field measurements are collected at strategic sites. The Red Lake County SWCD monitors six sites in Red Lake County, once a month, during the months of May through September. The Pennington SWCD monitors nine sites in Pennington County, May through October. The Water Quality parameters that are tested include: turbidity, ammonia, total Kjeldahl nitrogen, nitrate + nitrite, TP, OP, TSS, E.coli bacteria, specific conductivity, total dissolved solids, DO, pH, and temperature. The SWCD long-term monitoring program sites within the Red Lake River Subwatershed include:

1. Red Lake River at Red Lake County Road 3 near Huot (S002-976)
2. Red Lake River at Pennington County Road 3 near St. Hilaire (S003-942)
3. Red Lake River at 1st Street in Thief River Falls (S002-076)
4. County Ditch 70 near the Greenwood Street Bridge (S004-964)
5. Red Lake River at 250th Avenue Northeast ("Kratka Bridge," S003-947)
6. Red Lake River at 420th Avenue Southeast ("East Line," S003-944)
7. Black River at CSAH 18 (S002-132)
8. Black River at 140th Street Southwest ("Black River South," S003-943)
9. Black River at 120th Street Northwest ("Black River North," S003-948)

River Watch is a volunteer monitoring program that gives high school students the opportunity to collect water quality data. This data is collected using the same methods that are used by professionals and is stored in the EQuIS database along with all other data that is collected within the watershed. Students in East Grand Forks (Sacred Heart High School), Fisher, Crookston, Red Lake Falls, and Thief River Falls have participated in the program. The Thief River Falls River Watch program is periodically active but is currently inactive. Reviving this program and keeping it active is a recommended goal.

The Red Lake River Monitoring sites that are co-located with USGS gauging stations have been intensively monitored for other projects, including the Major WPLMN. Frequent sampling may continue for the MPCA's WPLMN. The International Water Institute has worked with the MPCA to conduct that sampling.

Robust collection of water chemistry data at long-term stream gaging sites improves the quality of water quality models (SWAT, HSPF) by providing a record of measured water quality that can be compared to the simulated conditions during the model calibration process. Key monitoring sites where more frequent data collection would aid future model calibration efforts include:

1. Red Lake River at 252nd Street Southwest in Fisher (S000-031)
2. Red Lake River at Woodland Avenue in Crookston (S002-080)
3. Red Lake River at the Smiley (CSAH 7) Bridge, east of Thief River Falls (S007-063)
4. Burnham Creek at 320th Avenue Southwest (S007-058)
5. Gentilly River at CSAH 11 (S004-058)
6. Kripple Creek at 180th Avenue Southwest (S004-835)
7. Black River at CSAH 18 (S002-132)
8. Cyr Creek at Red Lake County Road 110 (S004-818)

Additional data collection efforts and adjustments could be considered for future monitoring efforts. LGUs could stablish Regional Assessment Location monitoring sites on the Red Lake River and its most significant tributaries. Additional intensive sampling during runoff events will help shed light upon the causes of water quality problems in the watershed.

The MPCA requires a record of pre-9 a.m. DO readings to declare that the waterway contains enough DO to fully support aquatic life. The deployment of DO loggers is essential, at most sites, to obtain a record of true daily minimum DO levels and daily DO fluctuation. DO logging equipment can collect regular DO measurements (e.g. every 30 minutes) while deployed in a waterway. Equipment is deployed for a maximum of two weeks at a time before it is retrieved for data downloads, cleaning, and recalibration. Prior to the next state water quality assessment of the Red Lake River, continuous DO monitoring should be conducted to fully assess the capacity of key reaches in the watershed to support aquatic life. Data collected during the monitoring seasons of 2014 through 2023 can be used for the 2024 state water quality assessment. Priority should be given to reaches and sites that are too remotely located from LGU offices for pre-9 a.m. measurements.

Bolstered data collection efforts at key sites would aid with pre/post project evaluation:

1. RLWD Ditch 15 (Brandt Channel) at Highway 75 (S004-132) for evaluation of the effects of the Brandt Impoundment and outlet restoration project.
2. Polk County Ditch 2 at Polk County Road 62 (S004-131) to evaluate the effects of the Brandt Impoundment, Euclid Impoundment, Brandt Outlet Channel Restoration Project, and the Ditch 15 project.
3. Grand Marais Creek at Polk County Road 35 (130th Street Northwest, S008-903) to evaluate the effects of the Grand Marais Creek Outlet Restoration Project.
4. Burnham Creek at Polk County Road 48 (210th Avenue Southwest, S007-644) to evaluate the effects of erosion control and channel restoration efforts along the upper reaches of the Burnham Creek Watershed.

Long-term monitoring programs can evolve to include different or additional sites that have a strategic value that is equal to or greater than existing long-term monitoring sites.

1. The Red Lake River at 252nd Street Southwest in Fisher (S000-031) is a strategic location in the watershed because it is the furthest downstream USGS gaging stations. Samples are currently being collected frequently at the site for the WPLMN. If that program ever ends, local monitoring efforts should ensure that data collection at the site continues. If there is a need for additional parameters (like TOC) beyond those that are being collected for the WPLMN, the site could be added to a local water monitoring program immediately.
2. The Little Black River, upstream of the dam, is strategic because it is the furthest downstream monitoring site prior to the dam. High *E. coli* concentrations were found at the site during investigative sampling conducted throughout the Black River Watershed for the Red Lake River WRAPS. It would also be a good site for monitoring water quality in a reach that is disconnected

from the rest of the Black River by an impoundment. Data from the Little Black River would aid water quality model calibration.

3. The Red Lake River at CSAH 11 (S000-042) has been monitored by the Crookston River Watch program, but lab samples have only rarely been collected at the site. Because of the way that the Red Lake River is sectioned into assessment units, it is the only monitoring site on an 11.77-mile reach of the Red Lake River (09020303-506).
4. Pennington County Ditch 96 has been monitored by several short-term monitoring efforts. Being a ditch system without perennial flow, it has not been included in a long-term monitoring program. Now that water quality issues have been identified in the ditch, long-term monitoring is recommended.
5. Judicial Ditch 60 is another ditch system without perennial flow. Long-term stage/flow and water quality monitoring are recommended until the reach is removed from the 303(d) List of Impaired Waters.
6. Polk County Ditch 1 is a ditch with intermittent flow, but serious erosion problems. This channel should be a high priority for a stabilization project. Gather pre-project and post-project data from the Polk County Road 61 (S007-059).
7. Because of the erosion control, channel stabilization, and channel restoration work being conducted in the upper reaches of the Burnham Creek Watershed, additional monitoring should take place there. Historically, monitoring activity has been focused on the lower end of the watershed.

The MPCA plans to assess the Red Lake River watershed once every 10 years. The RLWD water quality staff will use the latest MPCA assessment methods to assess conditions once every two years, at a minimum. Tracking water quality conditions is important for finding reaches that can be recommended for delisting (post-restoration removal from the 303(d) List of Impaired Waters), tracking progress toward delisting, identifying new problems so they can be addressed sooner, and identifying areas that need additional data.

The RLWD shall work with city staff to collect stormwater samples in cities along the Red Lake River. City of Thief River Falls staff have expressed interest in assisting with sampling during rainfall events that occur after working hours.

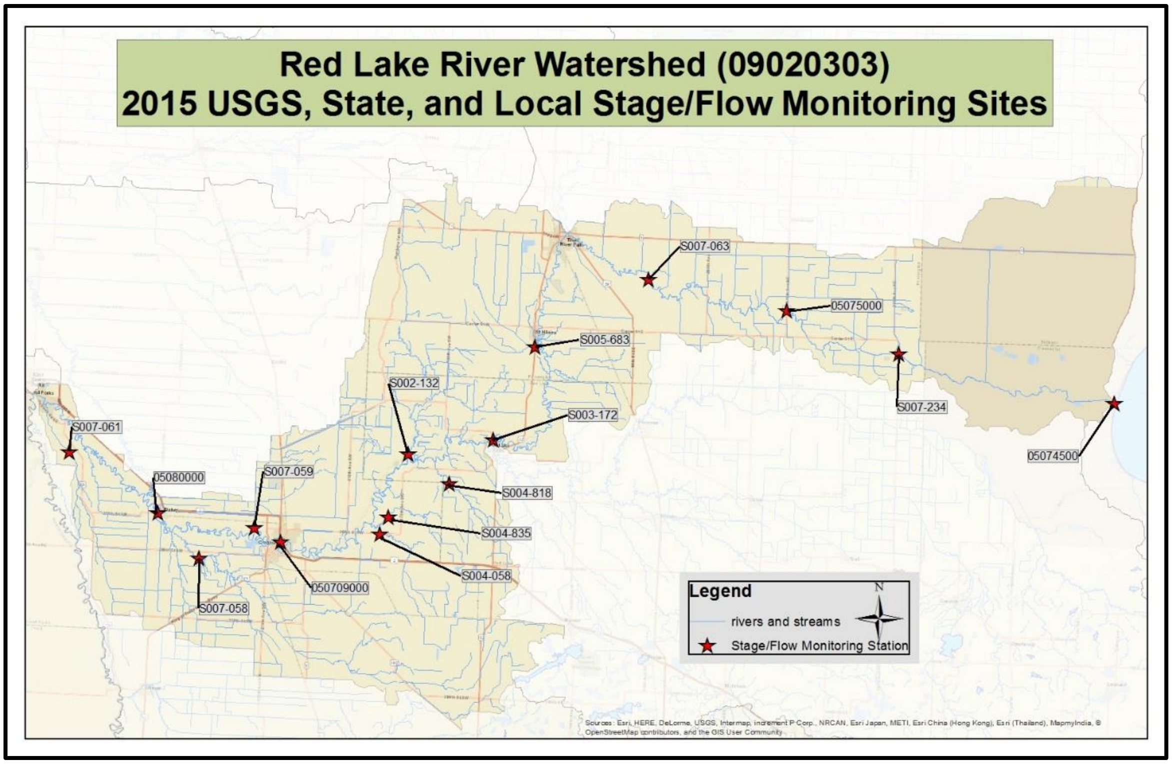


Figure 4-3. Stage and flow monitoring sites in the Red Lake River Watershed.

Figure 4-3 shows the location of stage and flow monitoring stations throughout the watershed. Real-time stage and discharge monitoring stations have been installed in several locations along the Red Lake River. The DNR/MPCA Cooperative Gauging Program also monitors several sites without the use of telemetry. These other significant reaches of the watershed are monitored with HOBO water level loggers by the RLWD.

1. USGS Gauge on the Red Lake River at Fisher
    - USGS gaging station
    - USGS# 05080000
    - EQuIS ID# S000-031
    - http://waterdata.usgs.gov/mn/nwis/uv?05080000
2. Red Lake River at Crookston
    - USGS gaging station
    - USGS# 05079000
    - EQuIS ID# S002-080
    - http://waterdata.usgs.gov/mn/nwis/uv?05079000
3. Red Lake River at CSAH 13 near Red Lake Falls
    - DNR/MPCA Cooperative Stream Gaging station

- USGS ID# 05076650
- EQuIS ID# S003-172
- http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=getsitereport&site=63025001

4. Red Lake River at the Smiley (CSAH 7) Bridge, east of Thief River Falls
    - DNR/MPCA Cooperative Stream Gaging station
    - EQuIS ID# S007-063
5. Red Lake River at Highlanding
    - USGS gaging station
    - USGS ID# 05075000
    - EQuIS ID# S002-077
    - http://waterdata.usgs.gov/mn/nwis/uv?05075000
6. Red Lake River at CSAH 27
    - RLWD HOBO Water Level Logger station
    - EQuIS ID# S007-234
7. Red Lake River at the outlet of Lower Red Lake
    - USGS gaging station operated in cooperation with the U.S. Army Corps of Engineers
    - EQuIS ID# S000-064
    - http://www.dnr.state.mn.us/waters/csg/site_report.html?mode=get_site_report&site=62021001

Stage logging stations and water level loggers are installed without telemetry or real-time data at the following locations on tributaries of the Red Lake River Watershed:

1. Heartsville Coulee at 210th Street Southwest (S007-061)
    - RLWD HOBO Water Level Logger station
2. Burnham Creek at 320th Avenue Southwest (S007-058)
    - DNR/MPCA Cooperative Stream Gaging station
3. Polk County Ditch 1 at Polk County Road 61 (S007-059)
    - RLWD HOBO Water Level Logger station
4. Gentilly River at CSAH 11 (S004-058)
    - RLWD HOBO Water Level Logger station
5. Kripple Creek at 180th Avenue Southwest (S004-835)

- RLWD HOBO Water Level Logger station

6. Black River at CSAH 18 (S002-132)
    - RLWD HOBO Water Level Logger station
7. Cyr Creek at Red Lake County Road 110 (S004-818)
    - RLWD HOBO Water Level Logger station
8. Pennington County Ditch 96 at MN Highway 32 (S005-683)
    - RLWD HOBO Water Level Logger station

The process of gathering data for water quality model calibration revealed a need for flow data from significant reaches that are separated from downstream reaches by an impoundment. The Little Black River and the Black River upstream of the Shirrick Dam are two reaches on which additional stage monitoring stations could be established.

Stage and flow near the outlets of the Thief River and Clearwater River major subwatersheds that flow into the Red Lake River are also monitored by USGS gaging stations

1. Thief River near Thief River Falls
    - USGS gaging station
    - USGS ID# 05076000
    - EQuIS ID# S002-079
    - http://waterdata.usgs.gov/mn/nwis/uv?05076000
2. Clearwater River in Red Lake Falls
    - USGS gaging station
    - USGS ID# 05078500
    - EQuIS ID# S002-118

Biological data has been treated as the ultimate measure of aquatic life support during assessments. A close examination of the data has revealed that, like any other measure of the natural world, there is a significant amount variance in the data. Evidence of extreme temporal variance was found in the Burnham Creek Watershed. Greater quantities of data (at each location), over a range of conditions, could create greater confidence in conclusions. The 2012 MPCA biological sampling effort was incomplete and not representative of typical conditions in the watershed due to exceptionally low flows and dry conditions that occurred in 2012. Reaches that are in need of follow-up sampling by the MPCA include:

- Little Black River (09020305-528) at or near site 12RD024, downstream of the County Road 102 crossing.
- Kripple Creek (09020305-525)

- Burnham Creek (09020305-515) at multiple locations. Macroinvertebrates were not sampled at sites upstream of 12RD001 (320th Avenue Southwest) along this reach in 2012.
- Burnham Creek at the Spring Gravel stream restoration site. Monitor the project's effectiveness at improving aquatic habitat.
- Branch 5 of CD 96 (09020303-545). Fish should be sampled along this reach when there is flow.
- Cyr Creek (09020303-556). Fish should be sampled while there is measurable flow. Macroinvertebrates were not sampled at all in 2012, so macroinvertebrate sampling would help improve knowledge about water quality conditions in Cyr Creek. It would allow for a comparison of F-IBI and M-IBI scores that could improve the understanding about factors limiting IBI scores in the reach.
- A quantitative longitudinal assessment of sediment deposition along the 09020303-557 and 09020303-558 reaches of the Black River is recommended as a part of future monitoring activities. This effort could be coupled with macroinvertebrate sampling to determine the effect of sediment deposition upon aquatic macroinvertebrates.
- Other forms of monitoring are also important for the protection of natural resources in the Red Lake River Watershed. An intensive geomorphological study of the watershed was completed in conjunction with the Red Lake River WRAPS. The process can be repeated at least once every 10 years to measure erosion rates and assess the accuracy of BEHI ratings.
- The findings of drainage ditch inventories can be used to identify areas that need to be addressed with BMPs to reduce erosion and sedimentation within ditches.
- Traveling along navigable streams in a kayak or canoe and documenting conditions is one of the best ways to find erosion problems, finding other sources of water quality problems, and assessing the quality of habitat along a waterway.
- The Northland Community and Technical College Aerospace Program inspecting ditch systems and identifying the sources of water quality problems. Drones are now capable of collecting high resolution three-dimensional images that can be used to find and measure erosion problems along rivers and streams.

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Red Lake River Watershed Reports

All Red Lake River Watershed reports referenced in this watershed report are available at the Red Lake River Watershed webpages:

MPCA: https://www.pca.state.mn.us/water/watersheds/red-lake-river

RLWD: http://www.rlwdwatersheds.org/rl-documents