August 2021

Watershed

Lac qui Parle River Watershed Total Maximum Daily Load

A quantification of the total maximum daily loads of bacteria and total suspended solids in the Lac qui Parle River Watershed's rivers allowed to meet and maintain their ability to support aquatic life and aquatic recreation.

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

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Acronyms

1W1P	One Watershed, One Plan
AFO	Animal feedlot operations
AU	Animal unit
BMP	Best management practice
CAFO	Concentrated animal feeding operation
cfs	Cubic foot per second
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
CWLA	Clean Water Legacy Act
EPA	U.S. Environmental Protection Agency
E. coli	*Escherichia coli*
EQuIS	Environmental quality information system
HSPF	Hydrologic Simulation Program-Fortran
HUC-08	8-digit hydrologic unit code
ITPHS	Imminent threat to public health and safety
LA	Load allocation
LC	Loading capacity
LDC	Load duration curve
LGU	Local government unit
mgd	Million gallons per day
mg/L	Milligrams per liter
mL	Milliliter
MOS	Margin of safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal separate storm sewer systems
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
NRCS	Natural Resource Conservation Service

NRS	Nutrient Reduction Strategy
NSE	Nash-Sutcliffe Efficiency
Org	Organism
Org/day	Organisms per day
PWP	Permanent Wetland Preserve
RIM	Reinvest in Minnesota
SDS	State Disposal System
sq mi	Square mile
SSTS	Subsurface sewage treatment systems
TMDL	Total maximum daily load
TSS	Total suspended solids
WID	Water identification number
WLA	Wasteload allocation
WRAPS	Watershed Restoration and Protection Strategy
WRP	Wetland Reserve Program
WWTP	Wastewater treatment plant

Executive summary

Section 303(d) of the Clean Water Act (CWA), and the state Clean Water Legacy Act (CWLA), provide authority for completing Total Maximum Daily Load (TMDL) studies to achieve state water quality standards and/or designated uses. The TMDL establishes the maximum amount of a pollutant a waterbody can receive on a daily basis and still meet water quality standards. The TMDL is divided into wasteload allocations (WLAs) for point or permitted sources, load allocations (LAs) for nonpoint sources (NPSs), and natural background levels of pollutants, plus a margin of safety (MOS).

This report addresses impaired stream reaches in the Lac qui Parle River Watershed listed on the 303(d) impaired waters list requiring a TMDL. The Lac qui Parle River Watershed, 8-digit hydrologic unit code (HUC-08) watershed number 07020003, is located in southwest Minnesota and drains portions of South Dakota; however, no allocations are assigned to areas in South Dakota. This TMDL report addresses nine impairments in eight stream reaches in Minnesota's portion of the watershed. These include eight *Escherichia coli* (*E. coli*) bacteria impairments and one total suspended solids (TSS) impairment. Addressing multiple impairments in one TMDL report is consistent with Minnesota's Water Quality Framework that seeks to develop watershed-wide protection and restoration strategies, rather than focus on individual reach impairments.

The Lac qui Parle River Watershed lies within portions of the Western Corn Belt Plains and the Northern Glaciated Plains ecoregions. The watershed covers an area of 1,100 sq mi (approximately 704,000 acres). Approximately 70% of the watershed area lies within portions of Minnesota's Lac qui Parle, Yellow Medicine, and Lincoln Counties and includes the cities of Canby, Dawson, Hendricks, and Madison. The watershed spans an area from the South Dakota border on the western end of the watershed to the confluence of the Lac qui Parle and Minnesota Rivers, just west of the city of Montevideo. Only river reaches within the boundaries of Minnesota are included in this TMDL report.

This report addresses Lac qui Parle River Watershed impairments identified as needing TMDLs in the most recent monitoring and assessment cycle (MPCA 2018b). It uses a variety of methods to evaluate current loading contributions by the various pollutant sources, as well as the pollutant loading capacity (LC) of the impaired waterbodies. The tools and methods used to develop LCs for the impaired waterbodies include the Hydrologic Simulation Program – FORTRAN (HSPF) watershed model and the load duration curve (LDC) approach.

Included in this report are a general strategy and cost estimate for implementation of management or structural practices to address the listed impairments. NPS contributions are the focus of implementation efforts. NPS contributions are not regulated and will need to be addressed on a voluntary basis. Permitted point sources will be addressed through the Minnesota Pollution Control Agency's (MPCA) National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit programs.

1. Project overview

1.1. Purpose

The CWA Section 303(d) requires that states publish a list of surface waters that do not meet water quality standards, and therefore do not support their designated use(s). These waters are then classified as impaired, which dictates that a TMDL must be completed. The TMDL calculates the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and allocates pollutant loads across the sources of pollutants.

The passage of Minnesota's CWLA in 2006 provided a policy framework and resources to state and local governments to accelerate efforts to monitor, assess, and restore impaired waters and to protect unimpaired waters. The result has been a comprehensive "watershed approach" that integrates water resource management efforts, local governments, and stakeholders to develop watershed-scale TMDLs, restoration and protection strategies, and plans for each of Minnesota's 80 major watersheds. The information gained, and strategies developed in the watershed approach are presented in major watershed-scale Watershed Restoration and Protection Strategy (WRAPS) reports, which guide restoration and protection of streams, lakes, and wetlands across the watershed, including those for which TMDL calculations are not made.

This report addresses impaired stream reaches, identified by their water identification number (WID), in the Lac qui Parle River Watershed listed on the 303(d) impaired waters list and requiring a TMDL. The Lac qui Parle River Watershed (HUC-08 07020003) is in southwestern Minnesota and drains portions of South Dakota. While the TMDLs in this report have watersheds that are partially in South Dakota, no allocations are assigned to South Dakota. This TMDL report addresses nine impairments in eight stream reaches in Minnesota's portion of the watershed. These nine impairments include eight *E. coli* bacteria impairments and one TSS impairment. Although this report addresses many impaired streams, biological impairments in this watershed are not addressed within this TMDL report. These have been deferred to allow for further investigation into the impairments. An accounting of all impairments within the Lac qui Parle River Watershed is found in **Appendix C**. The Lac qui Parle River Watershed boundaries presented in this TMDL report cover portions of three counties in Minnesota, including Lac qui Parle, Yellow Medicine, and Lincoln counties and includes the cities of Canby, Dawson, Hendricks, and Madison.

The purpose of this TMDL report is to quantify the pollutant reductions needed to meet state water quality standards for *E. coli* and TSS for stream reaches in **Table 1** and **Figure 1**. This TMDL report provides WLAs and LAs for the watershed as appropriate.

Two TMDL reports were previously completed containing parts of the Lac qui Parle River Watershed prior to this TMDL report. In 2013, the *Lac qui Parle Yellow Bank Bacteria, Turbidity, and Low Dissolved Oxygen TMDL Assessment Report* (Wenck 2013) was completed for waterbodies in the Lac qui Parle River and Yellow Bank River watersheds covering 19 impairments, which included 15 impairments in 8 stream reaches in the Lac qui Parle River Watershed. That TMDL report was approved by the U.S. Environmental Protection Agency (EPA) in May of 2013 and an implementation plan was approved by the MPCA in June of 2013. In 1999, South Dakota's Department of Environment and Natural Resources developed a TMDL for total phosphorus and accumulated sediment for Lake Hendricks (SD DENR 1999), which was approved by EPA Region 8 in April 1999; the MPCA also reviewed and accepted this TMDL.

1.2. Identification of waterbodies

The nine impairments addressed in this TMDL report are summarized in **Table 1** below. **Figure 1** shows the location of impaired waters addressed in this TMDL report for the Lac qui Parle River Watershed.

Table 1. Impaired stream reaches addressed in this TMDL report.

WID	Waterbody	Impairment/ Parameter	Designated Class	Beneficial Use	Listing Year
07020003-502	Lac qui Parle River, Tenmile Cr to Minnesota R	*Escherichia coli*	2Bg	AQR	2018
07020003-513	Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R	*Escherichia coli*	2Bg	AQR	2018
07020003-517	Lost Creek, Crow Timber Cr to W Br Lac qui Parle R	*Escherichia coli*	2Bg	AQR	2018
07020003-519	Lac qui Parle River, West Branch, MN/SD border to Lost Cr	*Escherichia coli*	2Bg	AQR	2018
07020003-523	County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R	*Escherichia coli*	7	LRV	2018
07020003-530	Unnamed creek, Unnamed cr to Lac qui Parle R	*Escherichia coli*	2Bg	AQR	2018
		Total suspended solids	2Bg	AQL	2018
07020003-580	Unnamed creek, -96.1517, 44.9533 to W Br Lac qui Parle R	*Escherichia coli*	2Bg	AQR	2018
07020003-581	Unnamed ditch (County Ditch 4), Unnamed ditch to CSAH 20	*Escherichia coli*	2Bg	AQR	2018

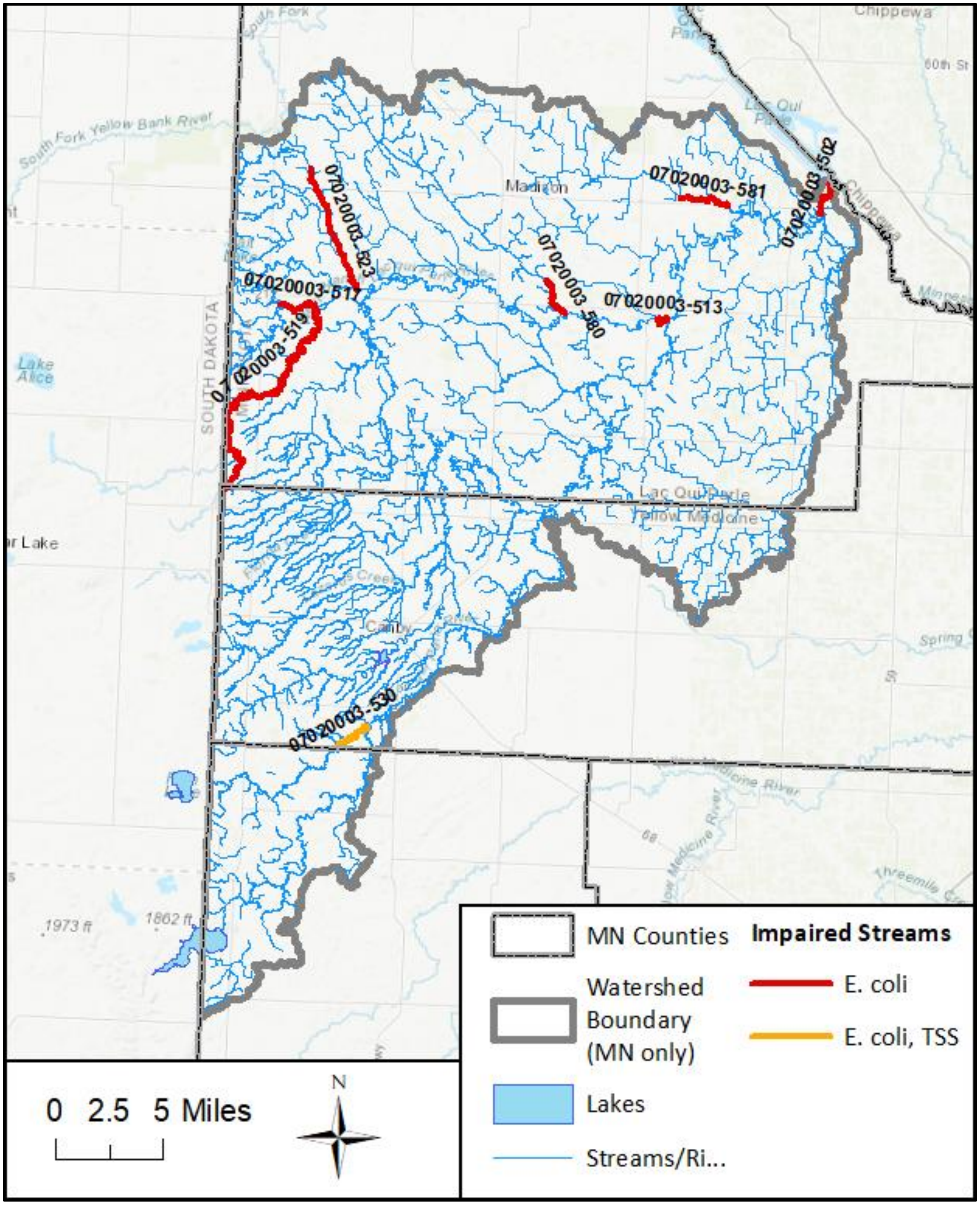

Figure 1. Impaired stream reaches covered by this TMDL report.

1.3. Priority ranking

The MPCA's schedule for TMDL completions, as indicated on Minnesota's Section 303(d) impaired waters list, reflects Minnesota's priority ranking of this TMDL report. The MPCA has aligned TMDL priorities with the watershed approach. The schedule for TMDL completion corresponds with the WRAPS report completion on the 10-year cycle. The MPCA developed a state plan, Minnesota's TMDL Priority Framework Report (MPCA 2015b), to meet the needs of EPA's national measure (WQ-27) under EPA's Long-Term Vision (EPA 2013) for Assessment, Restoration, and Protection under the CWA Section 303(d) Program. As part of these efforts, the MPCA identified water quality impaired segments that will be addressed with TMDLs by 2022. The Lac qui Parle River Watershed waters addressed by this TMDL report are part of the MPCA prioritization plan to meet EPA's national measure.

2. Applicable water quality standards and numeric water quality targets

The criteria used to determine stream and lake impairments are outlined in the MPCA's document *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment: 305(b) Report and 303(d) List* (MPCA 2019a). Minn. R. ch. 7050.0470 lists waterbody classifications and Minn. R. ch. 7050.0220 lists applicable water quality standards. The impaired waters covered in this TMDL report are classified as Class 2B and 7. Relative to aquatic life and recreation, the designated beneficial uses for the most stringent classifications, 2B and 7 waters, are:

> **Class 2B waters** – *The quality of class 2B surface waters shall be such as to permit the propagation and maintenance of a healthy community of cool or warm water aquatic biota, and their habitats according to the definitions in subpart 4c. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface water is not protected as a source of drinking water* (Minn. R. ch. 7050.0222, subp. 4).
>
> **Class 7 waters; limited resource value waters** – *The quality of class 7 waters of the state shall be such as to protect aesthetic qualities, secondary body contact use, and groundwater for use as a potable water supply.* (Minn. R. ch. 7050.0226, subp. 2)

The water quality standards shown in **Table 2** are the numeric water quality targets for each parameter shown.

2.1 Streams

Applicable water quality standards for impaired streams in this TMDL report are shown in **Table 2**, while **Table 1** shows the specific waterbodies.

Table 2. Surface water quality standards for Lac qui Parle River Watershed stream reaches addressed in this TMDL report.

Parameter	Use Class	Water Quality Standard	Units	Criteria	Period of Time Standard Applies
Escherichia coli (*E. coli*)	Class 2B	Not to exceed 126	org/100 mL	Monthly geometric mean	April 1-October 31
		Not to exceed 1,260	org/100 mL	Upper 10th percentile	
	Class 7	Not to exceed 630	org/100 mL	Monthly geometric mean	May 1- October 31
		Not to exceed 1,260	org/100 mL	Upper 10th percentile	
Total suspended solids (TSS)- Southern Nutrient Region	Class 2B	Not to exceed 65	mg/L	Upper 10th percentile	April 1 – September 30

The *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment: 305(b) Report and 303(d) List* (MPCA 2019a) provides details regarding how waters are assessed for conformance to the water quality standards.

Escherichia coli (*E. coli*)

Minnesota changed from a fecal coliform standard to an *E. coli* standard for bacteria impairments in 2008. The bacteria standard change is supported by an EPA guidance document on bacteriological criteria (EPA 1986). Minn. R. 7050.0222 Class 2B water quality standards for *E. coli* states:

> *Escherichia (E.) coli - Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.*

For Class 7 water quality standard for *E. coli*, Minn. R. 7050.0227 states:

> *Escherichia (E.) coli - Not to exceed 630 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between May 1 and October 31.*

Although surface water quality standards are based on *E. coli*, wastewater treatment plants (WWTPs) are permitted based on fecal coliform concentrations. A conversion factor of 126 *E. coli* organisms per 100 milliliters (mL) for every 200 fecal coliforms per 100 mL is assumed (MPCA 2009). The *E. coli* standard is based on the geometric mean of water quality observations. Geometric mean is used in place of arithmetic mean in order to describe the central tendency of the data, dampening the effect that very high or very low values have on arithmetic means.

Total Suspended Solids

In January of 2015, the EPA issued an approval of the adopted amendments to the State Water Quality Standards, replacing the historically-used turbidity standard with TSS standards. TSS is a measurement of the weight of suspended mineral (e.g., soil particles) or organic (e.g., algae) sediment per volume of water. The Minnesota State TSS standards are based upon river nutrient regions, which are loosely based on ecoregions (MPCA 2019b). The Lac qui Parle River Watershed is located in the Southern River Nutrient Region. Minn. R. 7050.0222 Class 2B water quality standard for TSS for this region is 65 milligrams per liter (mg/L) (MPCA 2019b).

3. Watershed and waterbody characterization

The Lac qui Parle River Watershed (**Figure 2**) drains an area of approximately 1,100 sq mis (704,000 acres) in eastern South Dakota and southwestern Minnesota. Approximately 70% of this area lies within portions of Minnesota's Lac qui Parle, Yellow Medicine, and Lincoln Counties, spanning an area from the South Dakota border on the western end of the watershed to the confluence of the Lac qui Parle and Minnesota Rivers, just west of the city of Montevideo. No part of the Lac qui Parle River Watershed in Minnesota is located within the boundary of a Native American Reservation and the TMDL does not allocate pollutant load to any federally recognized Indian tribe in this watershed.

The Lac qui Parle River flows in a predominantly southwest to northeast direction, flowing approximately 120 miles from its source, Lake Hendricks on the South Dakota border, to its confluence with the Minnesota River just west of the city of Montevideo (MPCA 2018). The watershed spans the boundary between two Minnesota ecoregions; the western edge of the watershed along the South Dakota border is in the Northern Glaciated Plains ecoregion, and the larger, eastern portion is in the Western Corn Belt Plains ecoregion. The geology is characterized by loamy, glacial till soils.

Presettlement vegetation in the watershed is shown in **Figure 3** with the primary vegetation being prairie. Lands within the Lac qui Parle River Watershed were subject to nonindigenous settlement in the mid-19th century. Over the following century and a half, the landscape underwent a near wholesale conversion from native tall grass prairie vegetation to agricultural uses. To increase arable land surface, many wetlands and free flowing streams were converted to networks of agricultural drainage ditches. Sixty-six percent of the stream miles with a definable stream channel are ditched (MPCA 2019c).

Today, the landscape in this watershed, as a whole, is dominated by agriculture, with over 65% of the land coverage dedicated to row crop farming (see **Figure 5**), and a higher percentage of 75% in the Minnesota portion of the watershed. Corn and soybeans account for nearly 80% of cropped lands. Nearly all the land (95%) in the Lac qui Parle River Watershed is privately owned, and the region is predominantly rural. The most sizable towns in this watershed are Canby (1,720), Madison (1,432), and Dawson (1,422). The remaining towns and communities throughout the watershed have less than 1,000 inhabitants.

More information on the watershed characteristics of the Lac qui Parle River Watershed can be found in the *Lac qui Parle River Watershed Characterization Report* (DNR 2019) and/or the *Lac qui Parle River Watershed Monitoring and Assessment Report* (MPCA 2018).

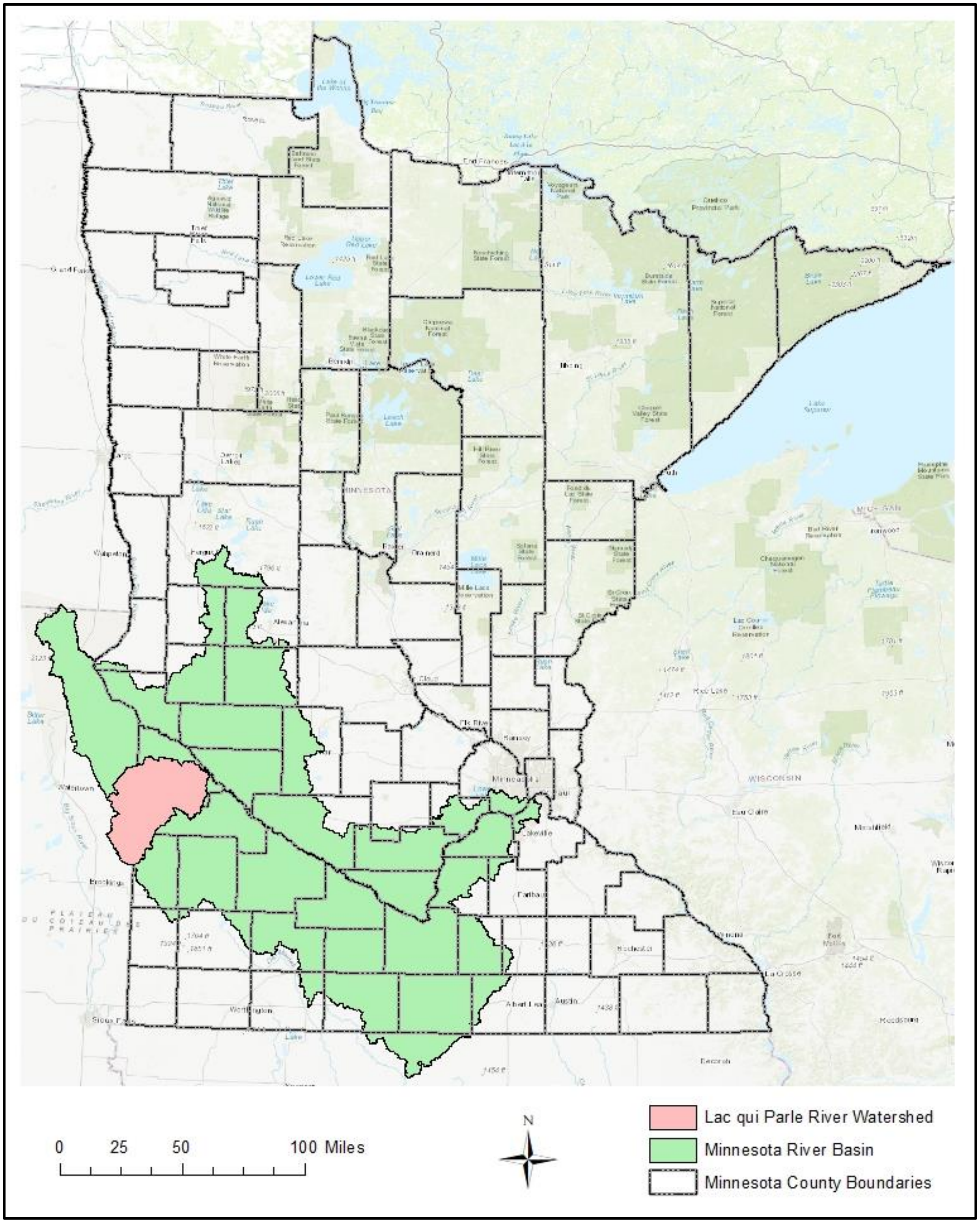

Figure 2. Location of the Lac qui Parle River Watershed.

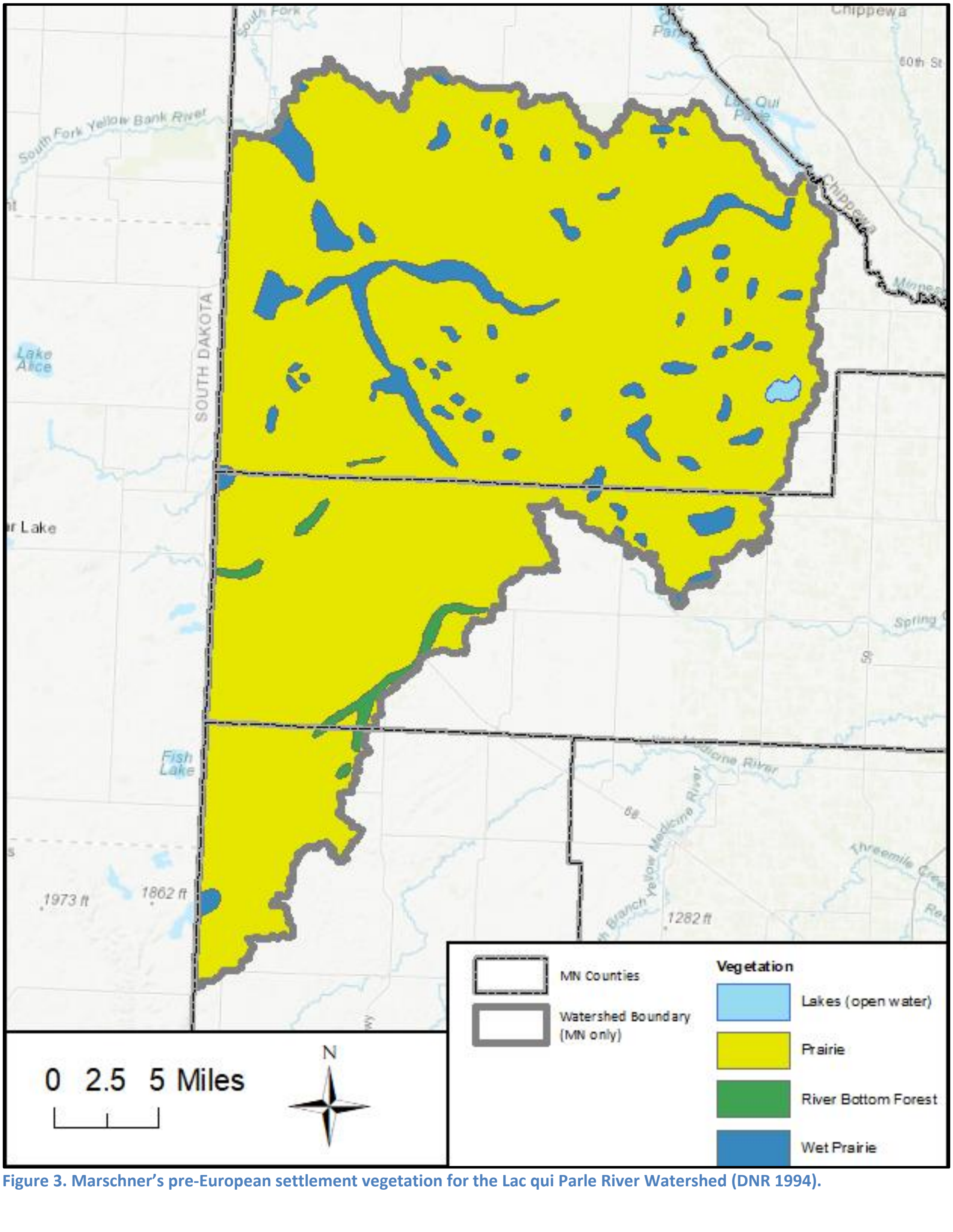

Figure 3. Marschner's pre-European settlement vegetation for the Lac qui Parle River Watershed (DNR 1994).

3.1 Streams

The eight impaired stream reaches in the Lac qui Parle River Watershed addressed in this TMDL report stretch across 45.5 river-miles and collectively drain the entire watershed area of approximately 1,100 sq mis of which, 761 sq mis are in Minnesota. Many of the impaired stream reaches drain portions of South Dakota, except for Unnamed Creek (070200023-580) and Unnamed Ditch (070200023-581), whose drainage areas lay wholly in Minnesota. This TMDL report does not address any South Dakota impaired reaches that contribute to Minnesota impaired reaches. Reach information for each impaired stream in the watershed covered by this TMDL report is presented in **Table 3.**

Table 3. Approximate drainage areas of impaired stream reaches in this TMDL report.

WID	Stream/Reach Name and Description	Reach Length [miles]	Total Drainage Area [sq mi]	Drainage Area in Minnesota [sq mi]
07020003-502	Lac qui Parle River, Tenmile Cr to Minnesota R	2.71	1,098	761
07020003-513	Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R	1.28	480	247
07020003-517	Lost Creek, Crow Timber Cr to W Br Lac qui Parle R	3.31	77.3	14.1
07020003-519	Lac qui Parle River, West Branch, MN/SD border to Lost Cr	22	75.1	11.1
07020003-523	County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R	6.87	59.2	29.1
07020003-530	Unnamed creek, Unnamed cr to Lac qui Parle R	3.05	76.3	25.2
07020003-580	Unnamed creek, -96.1517, 44.9533 to W Br Lac qui Parle R	3.2	49.9	49.9
07020003-581	Unnamed ditch (County Ditch 4), Unnamed ditch to CSAH 20	3.09	53.9	53.9

3.2 Subwatersheds

The subwatershed for each impaired stream reach is shown in **Figure 4**. Due to the Lac qui Parle River, from Tenmile Creek to the Minnesota River (07020003-502) being addressed in this report, the entire watershed is likewise covered in this TMDL report.

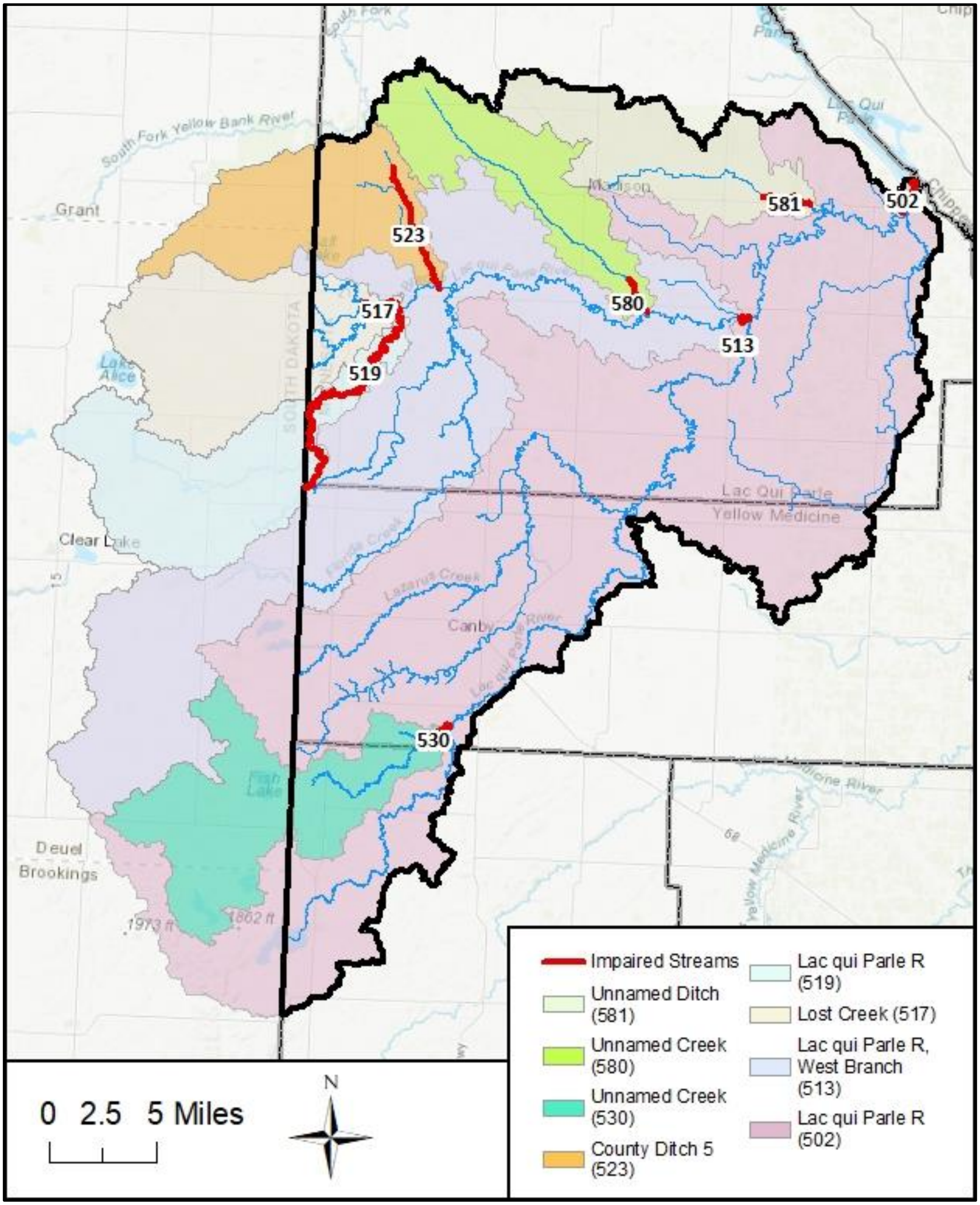

Figure 4. Drainage areas of impaired stream reaches addressed in this TMDL report.

3.3 Land use

Land cover in the Lac qui Parle River Watershed was assessed using the Multi-Resolution Land Characteristics Consortium 2016 National Land Cover Dataset (NLCD) (MRLCC 2016). This information is necessary to draw conclusions about pollutant sources that may be applicable in each impaired stream reach. The land use distribution for the watershed and the impaired stream reaches is provided in **Table 4** and shown in **Figure 5**. The percentages in **Table 4** are for total drainage area of the impaired stream reach and for Minnesota's portion of each drainage area, where applicable. The Lac qui Parle River Watershed is dominated by cropland and row crop farming, accounting for 65.7% of total watershed area. Rangeland (pasture and grasslands) makes up the second most prevalent land use type at 20.1% of the watershed area. The remaining land use types are split amongst wetlands (7.0%), developed (4.6%), open water (1.6%), forests and shrubs (0.90%), and barren (0.06%).

When comparing land use in just the Minnesota portion to the entire watershed (including South Dakota), the area in Minnesota contains a larger percentage of cropland (75.0% versus 65.7%), with a lower percentage of rangeland (10.1% versus 20.1%). The other land use types cover a similar percentage of land area.

Table 4. Land cover percentages in the Lac qui Parle River Watershed using the 2016 National Land Cover Dataset (MRLCC 2016).

WID	Drainage Area Portion	Drainage Area [sq mi]	Land Use/Land Cover Percentage of Drainage Area [%]						
			Cropland	Rangeland	Developed	Wetland	Open Water	Forest/ Shrub	Barren/ Mining
Total Watershed	Total	1,098	65.7%	20.1%	4.6%	7.0%	1.6%	0.90%	0.06%
	MN only	761	75.0%	10.1%	5.1%	7.7%	1.0%	1.0%	0.08%
07020003-502	Total	1,098	65.7%	20.1%	4.6%	7.0%	1.6%	0.90%	0.06%
	MN only	761	75.0%	10.1%	5.1%	7.7%	1.0%	1.0%	0.08%
07020003-513	Total	480	56.6%	27.5%	4.3%	9.8%	1.1%	0.66%	0.06%
	MN only	247	67.9%	11.6%	4.9%	13.6%	1.1%	0.75%	0.10%
07020003-517	Total	77.3	54.5%	33.6%	4.3%	6.0%	1.0%	0.55%	0.02%
	MN only	14.1	63.8%	14.4%	5.3%	15.6%	0.46%	0.41%	0.08%
07020003-519	Total	75.1	19.3%	66.7%	3.2%	7.7%	2.2%	0.78%	0.01%
	MN only	11.1	44.4%	33.4%	4.2%	13.6%	2.8%	1.5%	0.02%
07020003-523	Total	59.2	66.9%	10.2%	4.3%	16.9%	1.2%	0.45%	0.02%
	MN only	29.1	63.4%	6.1%	4.7%	23.5%	1.8%	0.56%	0.02%
07020003-530	Total	76.3	50.6%	33.1%	4.2%	5.3%	5.6%	1.3%	0.01%
	MN only	25.2	55.3%	30.8%	4.3%	5.1%	2.8%	1.9%	0.05%
07020003-580	Total	49.9	80.2%	2.8%	5.3%	9.8%	1.3%	0.43%	0.06%
07020003-581	Total	53.9	87.8%	1.6%	5.7%	3.5%	0.56%	0.82%	0.06%

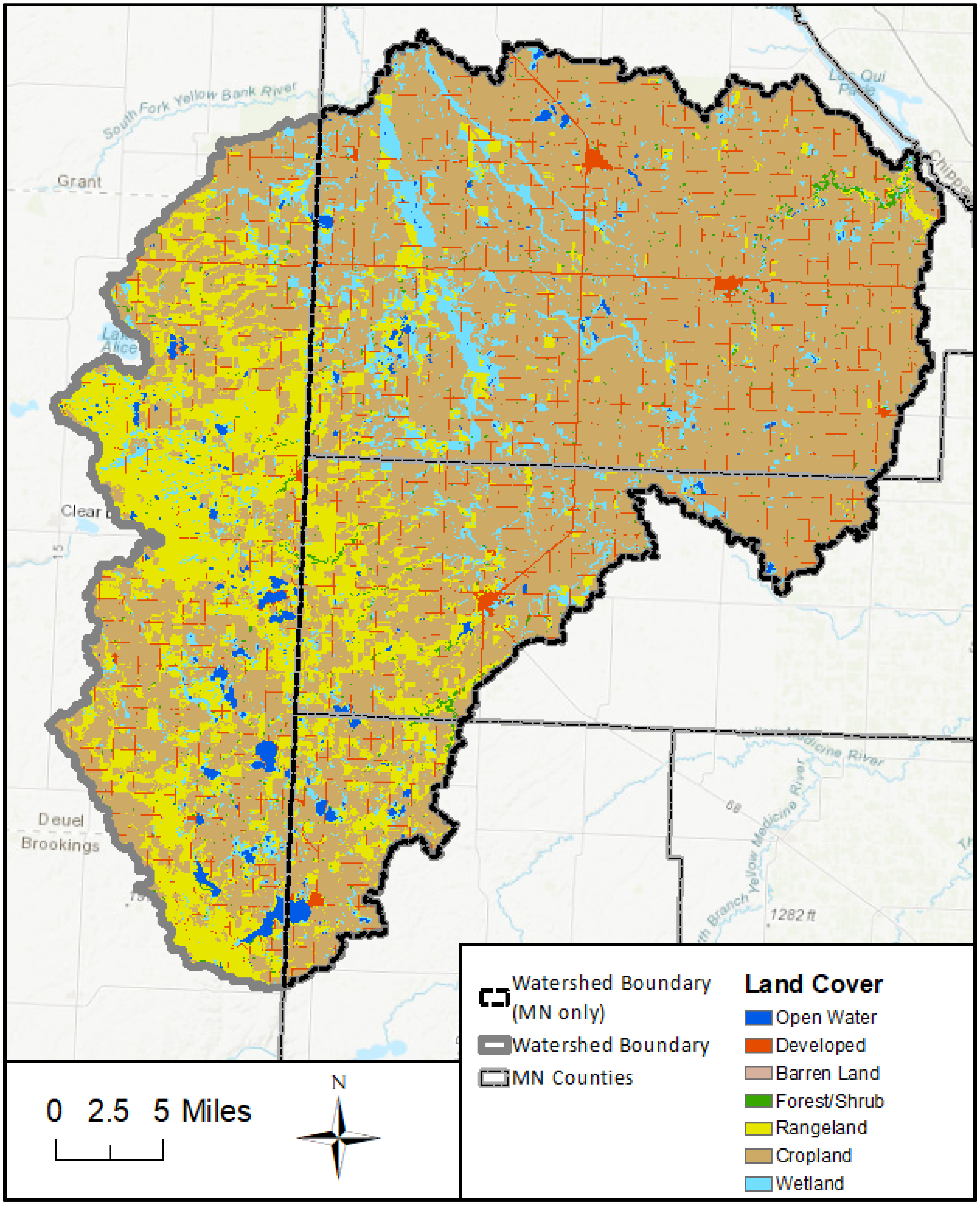

Figure 5. Land use/Land cover in the Lac qui Parle River Watershed.

3.4 Current/historical water quality

Existing water quality conditions are described using data downloaded from the MPCA's Environmental Quality Information System (EQuIS) database[1]. EQuIS stores data collected by the MPCA, partner agencies, grantees, and citizen volunteers. All water quality sampling data utilized for assessments, modeling, and data analysis, for this report and reference reports, are stored in this database and are accessible through the MPCA's Environmental Data Access website[1].

Data from the current 10-year Lac qui Parle River assessment period (2008 through 2017), consistent with the time period for the application of the water quality numeric standards, were used for development of this TMDL report. For *E. coli*, only data collected during the months of April through October for Class 2B streams and May through October for Class 7 were used. For the TSS standard, data collected from April through September were used.

Normally, the most recent 10 years of data is used to describe the current water quality conditions. Therefore, the current conditions for impaired waterbodies were derived from data collected between 2008 and 2017. Although data prior to 2008 exists, the more recent data represents the current conditions in the waterbodies addressed in this report.

Monitoring locations used for this TMDL report are shown in **Figure 6** and the data from those sites is summarized in **Table 5** and **Table 6**.

[1] https://www.pca.state.mn.us/environmental-data

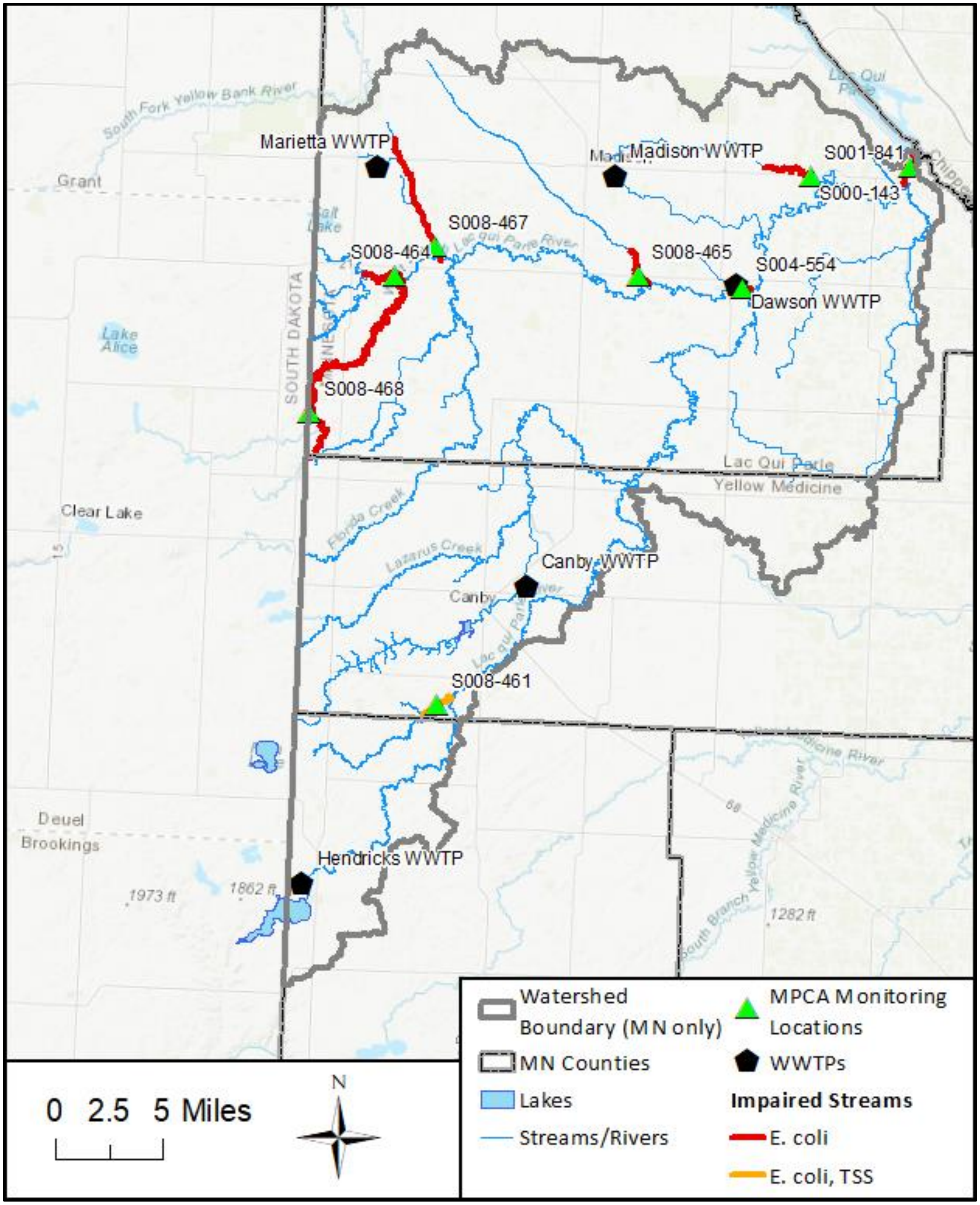

Figure 6. Monitoring locations used to develop TMDLs for impaired stream reaches addressed in this TMDL report.

3.4.1 *Escherichia coli*

E. coli is summarized using the geometric mean of all samples in a calendar month. The geometric mean normalizes data from different flow conditions and allows a percentage change to be made equally to the geometric mean across watersheds. The geometric mean can be calculated using the following function:

$$\text{Geometric mean} = \sqrt[n]{x_1 * x_2 * \ldots x_n}$$

Where $x_1, x_2, \ldots, x_n$ are *E. coli* concentrations for each sampling month.

Table 5 shows the monthly *E. coli* statistics (count, geometric mean, and number of samples above 1,260 org/100 mL) for impaired stream reaches covered in this TMDL report. It should be noted that data is only available from June through August for two years (2015-2016).

Table 5. Summary of existing *E. coli* conditions in impaired reaches requiring TMDLs in the Lac qui Parle River Watershed.

WID (last 3 digits)	Station(s)	Years	Geometric mean WQS [org/100 mL]	June			July			August		
				n	Geo[1]	%n>1260[2]	n	Geo[1]	%n>1260[2]	n	Geo[1]	%n>1260[2]
502	S000-143	2015-2016	126	5	351.2	40%	5	156.7	0%	5	100.2	20%
513	S004-554	2015-2016	126	5	310.5	0%	5	365.7	0%	5	381.4	20%
517	S008-464	2015-2016	126	5	205.3	0%	5	118.1	0%	5	139.9	0%
519	S008-468	2015-2016	126	5	902.4	40%	5	1252.3	40%	5	589.9	20%
523[3]	S008-467	2015-2016	630	5	269.2	0%	5	536.3	40%	5	100.1	0%
530	S008-461	2015-2016	126	5	1070.1	40%	5	777.8	40%	5	547.8	20%
580	S008-465	2015-2016	126	5	73.4	0%	4	373.4	25%	5	200.3	0%
581	S001-841	2015-2016	126	5	118.5	0%	5	142.4	0%	5	617.4	20%

[1]Geo = geometric mean with units of org/100 mL.

[2]%n>1260 = percentage of samples above the 1,260 org/100 mL water quality standard.

[3]Class 7 stream, impairment caused by more than 10% of samples greater than 1,260 org/100 mL.

It should be noted, County Ditch 5 (WID07020003-523) is a class 7 (limited use) stream with a geometric mean standard of 630 org/100 mL, and does not exceed the geometric mean for any month with available data. The reach does exceed the upper 10% standard of 1,260 org/100 mL for July which is the basis for the impairment.

3.4.2 Total Suspended Solids

TSS impairments are based on having more than 10% of all samples in the current assessment period exceed the current TSS standard of 65 mg/L for the Southern Rivers Nutrient Region. TSS data was summarized for the TSS impaired reach requiring a TMDL in the Lac qui Parle River Watershed in **Table 6**.

Table 6. Summary of existing TSS conditions in the impaired reach requiring a TMDL in the Lac qui Parle River Watershed.

WID	Station	Period	Number of samples	90th Percentile [mg/L]	Number of Exceedances
07020003-530	S008-461	2015-2017	12	143.1	8

3.5 Pollutant source summary

3.5.1 *Escherichia coli*

Bacteria in Minnesota streams mainly come from sources such as failing septic systems, WWTP releases, livestock, and urban stormwater. Waste from pets and wildlife is another, lesser source of bacteria. In addition to bacteria, human and animal waste may contain pathogens such as viruses and protozoa that could be harmful to humans and other animals.

The behavior of bacteria and pathogens in the environment is complex. Levels of bacteria and pathogens in a body of water depend not only on their source, but also weather, current, and water temperature. As these factors fluctuate, the level of bacteria and pathogens in the water may increase or decrease. Some bacteria can survive and grow in the environment while many pathogens tend to die off with time.

A literature review conducted by Emmons and Oliver Resources (EOR 2009) for the MPCA summarizes factors that have either a strong or a weak relationship to bacteria contamination in streams (**Table 7**). Bacteria sourcing can be very difficult due to the bacteria's ability to persist, reproduce, and migrate in unpredictable ways. Therefore, the factors associated with bacterial presence provide some confidence to bacterial source estimates.

Table 7. Summary of factor relationships associated with bacteria source estimates of streams (EOR 2009).

Strong relationship to fecal bacteria contamination in water	Weak relationship to fecal bacteria contamination in water
• High storm flow (the single most important factor in multiple studies); • % rural or agricultural areas greater than % forested areas in the landscape; • % urban areas greater than forested riparian areas in the landscape; • High water temperature; • High % impervious surfaces; • Livestock present; • Suspended solids.	• High nutrients • Loss of riparian wetlands • Shallow depth (bacteria decrease with depth) • Amount of sunlight (increased UV-A deactivates bacteria) • Sediment type (higher organic matter, clay content and moisture; finer-grained) • Soil characteristics (higher temperature, nutrients, organic matter content, humidity, moisture and biota; lower pH) • Stream ditching (present or when increased) • Epilithic periphyton present • Presence of waterfowl or other wildlife • Conductivity

Livestock and manure application, pasture area, human populations (wastewater treatment facilities and subsurface sewage treatment systems [SSTS]), pet populations, and wildlife populations were all evaluated as sources of *E. coli*. As discussed below, the relative significance of each of these sources can vary depending on manure management and storage practices, climactic conditions, and stream flow. Additional information about the methodology of bacteria source assessment in the Lac qui Parle River Watershed is found in **Appendix B**.

3.5.1.1 Permitted sources

Feedlot Facilities

In Minnesota, animal feedlot operations (AFO) are required to register with their respective county or the state if they are 1) an animal feedlot capable of holding 50 or more animal units (AUs), or a manure storage area capable of holding the manure produced by 50 or more AU outside of shoreland; or 2) an animal feedlot capable of holding 10 or more AUs, or a manure storage area capable of holding the manure produced by 10 or more AUs, that is located within shoreland. Further explanation of registration requirements can be found in Minn. R. 7020.0350. Feedlots within delegated counties are registered through a County Feedlot Officer. Feedlots in nondelegated counties, all feedlots that are at or above 1,000 AU, and all feedlots that meet the EPA definition of a Large Concentrated Animal Feeding Operation (CAFO) are registered directly with the MPCA.

CAFOs are defined by the EPA based on the number and type of animals. The MPCA currently uses the federal CWA definition of a CAFO in permit requirements of animal feedlots along with the definition of AU. In Minnesota, the following types of livestock facilities are issued, and must operate under, a NPDES Permit or a state issued SDS Permit: a) all federally defined CAFOs, which have had a discharge, some of which are under 1,000 AUs in size; and b) all CAFOs and non CAFOs that have 1,000 or more AUs.

CAFOs and AFOs with 1,000 or more AUs must be designed to contain all manure and manure contaminated runoff from precipitation events of less than a 25-year - 24-hour storm event. Having and complying with an NPDES permit allows some enforcement protection if a facility discharges due to a 25-year - 24-hour precipitation event (approximately 4.68" in 24 hours) and the discharge does not contribute to a water quality impairment. Large CAFOs permitted with an SDS permit or those not covered by a permit must contain all runoff, regardless of the precipitation event. Therefore, many Large CAFOs in Minnesota have chosen to have an NPDES permit, even if discharges have not occurred in the past at the facility. A current manure management plan, which complies with Minn. R. 7020.2225, and the respective permit is required for all CAFOs and AFOs with 1,000 or more AUs.

Permitted CAFOs are inspected by the MPCA in accordance with the MPCA NPDES Compliance Monitoring Strategy approved by the EPA. All large CAFOs (NPDES permitted, SDS permitted and not required to be permitted) are inspected by the MPCA on a routine basis with an appropriate mix of field inspections, offsite monitoring, and compliance assistance. The number of AUs by animal type registered with the MPCA feedlot database are used in this TMDL report.

The locations of registered feedlot operations and permitted CAFOs are provided in **Figure 7**, which shows the level of AUs at each location. In the watershed, there are 259 registered feedlot operations with approximately 87,286 AUs. The primary animal type in the watershed is swine (67%) and cattle (32%). A complete list of permitted CAFOs by TMDL WID is located in **Appendix D**.

Of the 259 registered feedlot operations, 23 are permitted CAFOs. One hundred-eighty facilities have open lots within the feedlot. Thirty-five facilities are located in shoreland, defined as within 1,000 feet of a lake or 300 feet of a stream or river, and 34 have an open lot in the shoreland area. Open lots, and those located near surface water bodies present a potential pollution hazard if runoff from the lot is not treated prior to reaching a surface water. All but one of the feedlots located in shoreland are open lots.

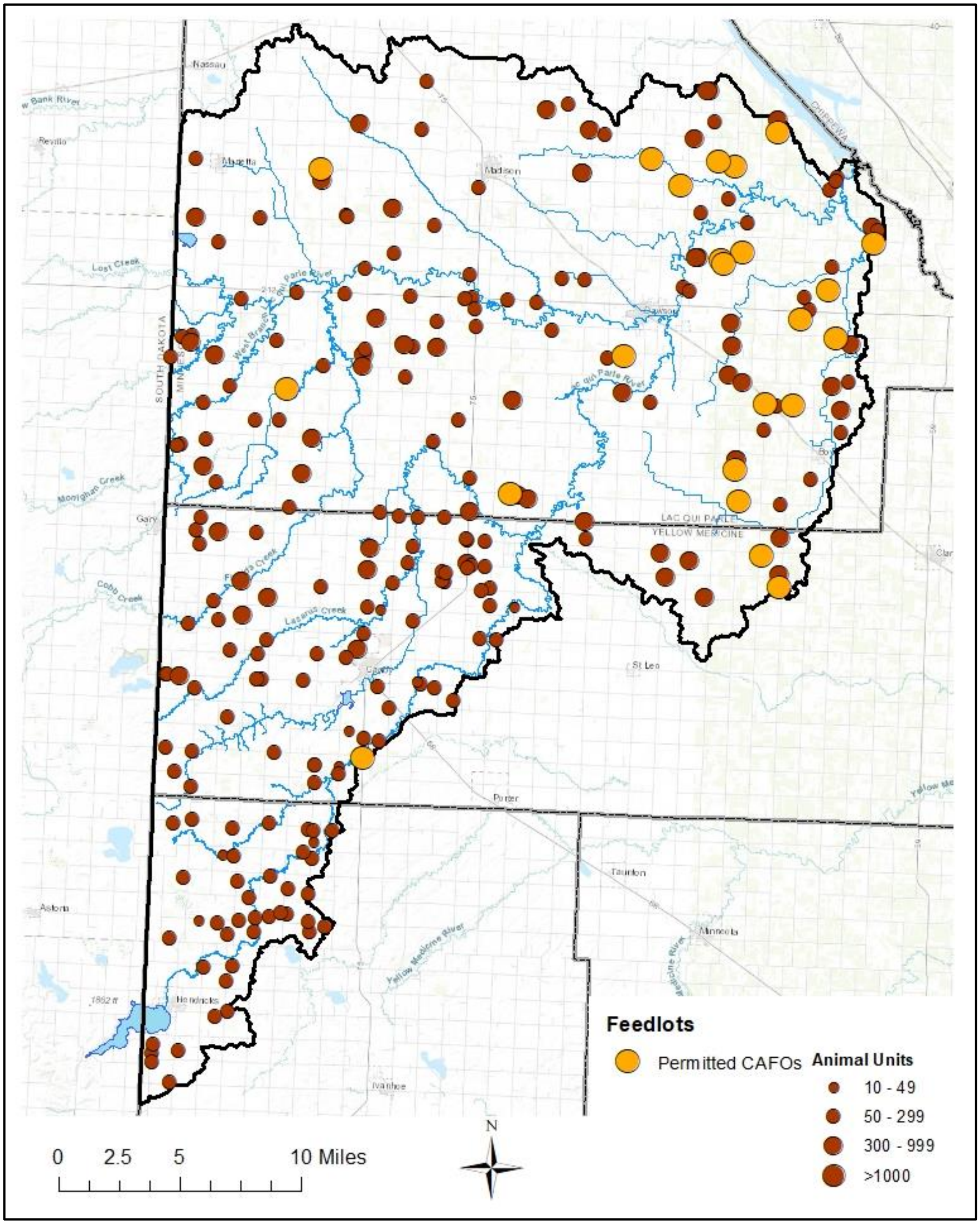

Figure 7. Feedlots and Animal Units in the Lac qui Parle River Watershed.

Wastewater Treatment Plants

Human waste can be a significant source of *E. coli* during low flow periods. There are seven active NPDES wastewater permits in the Lac qui Parle River Watershed, five with domestic wastewater permits and two with industrial wastewater permits. Of the seven permits, six WWTPs are considered sources of bacteria (see **Section 4.3.3**). Ag Processing Inc. (MN0040134) discharge consists of noncontact cooling water, boiler blowdown, water softener backwash, greensand filter backwash, and reverse osmosis reject, and is not considered a source of *E. coli*. Four of the WWTPs have controlled discharge (pond) systems with discharge windows from March 1 to June 15 and September 15 to December 15. They can be a significant source if low flow conditions occur during discharge. Two plants are continuous discharge systems, constantly releasing treated water and are unlikely to be a primary source during low flows so long as the facility meets its permit levels. Rarely, during extreme high flow conditions, WWTPs may also be a source if they become overloaded and have an emergency discharge of partially or untreated sewage, known as a release.

Municipal Stormwater Runoff

Urban areas may contribute bacteria to surface waters from pet waste and wildlife. There are no permitted Municipal Separate Storm Sewer System (MS4) areas within the Lac qui Parle River Watershed. Therefore, bacteria from permitted MS4 areas is not a source of *E. coli* in the watershed.

3.5.1.2 Nonpermitted sources

Subsurface sewage treatment systems

Failing SSTS near waterways can be a significant source of bacteria to streams and lakes, especially during low flow periods when these sources continue to discharge, and runoff driven sources are not active. The MPCA differentiates between systems that are generally failing and those that are an imminent threat to public health or safety (ITPHS). Generally, failing systems are those that do not provide adequate treatment and may contaminate groundwater. For example, a system deemed failing to protect groundwater may have a functioning, intact tank and soil absorption system, but fail to protect ground water by providing a less than sufficient amount of unsaturated soil between where the sewage is discharged and the ground water or bedrock. Systems that have been identified as an ITPHS may include systems that back up inside the house, discharge to the surface, have unsecured or damaged maintenance hole covers, and “straight pipes” which may transport raw or partially treated sewage directly to a lake, a stream, a drainage system, or ground surface (Minn. Stat. 115.55, subd. 5).

Counties are required to submit annual reports to the MPCA regarding SSTS within their respective boundaries. Data reported is aggregate information by each county so the location of SSTSs are not known to the State of Minnesota. SSTS data from 2016 in each county is shown in **Figure 8** and annual reports by counties with contributing areas in the watershed indicate that failing SSTS range from 0.95 (Lac qui Parle) to 3.07 (Lincoln) systems per 1,000 acres. These counties continue to invest in the education of landowners on the maintenance and impact failing systems can have on humans and wildlife.

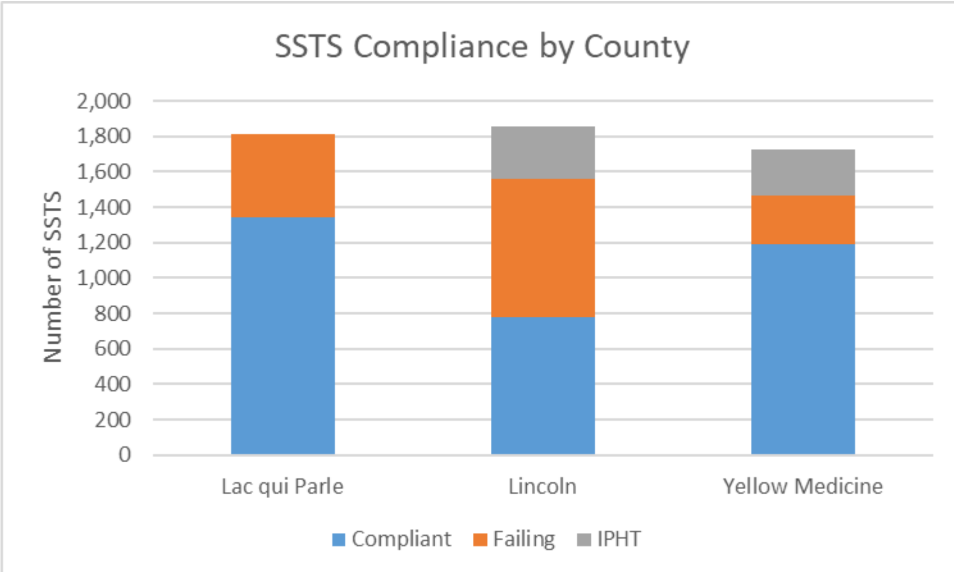

Figure 8. SSTS compliance for each county in the Lac qui Parle River Watershed as of 2016.

Non NPDES Permitted Feedlots and Manure Application

AFOs under 1,000 AUs and those that are not federally defined as CAFOS do no operate with permits. These facilities must operate their facilities in accordance with Minn. R. 7020.2000 through 7020.2150 to minimize their impact on water quality. AFOs may pose an environmental concern if the facilities are located near water and manure is inadequately managed especially in open lot feedlots. There are 180 facilities in the Lac qui Parle River Watershed that have open lots. Of those with open lots, 34 are located within 1,000 feet of a lake or 300 feet of a stream.

Approximately 66% of the AUs in the watershed are swine and the majority of the manure is held in liquid manure storage areas. Another 32% of the AUs are cattle and the manure is held in either liquid manure storage areas or in stockpiles. When stored and applied properly, manure provides a natural nutrient source for crops.

Manure can be a significant source of bacteria. AFOs create a large amount of manure that is usually stored on site until field conditions and the crop rotation allow for land application of manure as a fertilizer. The timing of manure application can decrease the likelihood of bacteria loading to nearby waterbodies. Specifically, the application of manure on frozen soil in the late-winter is likely to result in surface runoff during precipitation events and snow melt. Deferring manure application until soils have thawed decreases overland runoff associated with snow melt and precipitation events. Injected manure is a preferred best management practice (BMP) to reduce the runoff of waste and associated bacteria, as injected manure reduces the risk of surface runoff associated with large precipitation events.

Pasture

Livestock can contribute to bacteria loading to waterbodies from poorly managed pasture lands that are overgrazed, or through the direct access of livestock to surface waters. Currently, Minnesota does not have rules regulating pasture runoff. Poorly maintained pasture can have significant overland surface flow during heavy precipitation events resulting in manure transport from the pasture. Livestock with direct access to streams can defecate directly into the waterbody resulting in direct contamination.

Natural Reproduction

Evidence suggests that *E. coli* bacteria has the capability to reproduce naturally in water and sediment and therefore could be considered a self-propagating bacteria source. The relationship between bacterial sources and bacterial concentrations found in streams is complex, involving precipitation and flow, temperature, livestock management practices, wildlife activities, survival rates, land use practices, and other environmental factors. Two Minnesota studies describe the presence and growth of "naturalized" or "indigenous" strains of *E. coli* in watershed soils (Ishii et al. 2010), and ditch sediment and water (Sadowsky et al. 2015). Sadowsky et al. concluded that approximately 36.5% of *E. coli* strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. The authors suggested that 36% might be used as a rough indicator of "background" levels of bacteria at this site during the study period. While these results may not be directly transferable to other locations, they do suggest the presence of background *E. coli* and a fraction of *E. coli* may be present regardless of the control measures taken by traditional implementation strategies.

Wildlife and Pets

Wildlife and pet waste can contribute bacteria to streams and lakes, directly or through surface runoff. Like livestock and humans, *E. coli* is present in the digestive tracts of wildlife and pets and as such, some *E. coli* may be present in the water from these sources. Waterfowl contribute bacteria to the watershed by directly defecating into waterbodies and along the shorelines. They contribute bacteria by living in waterbodies, living near conveyances to waterbodies, or when their waste is delivered to water bodies in stormwater runoff. Areas such as state parks, national wildlife refuges, golf courses, and other conservation areas provide habitat for wildlife and are potential sources of bacteria due to the high density of animals.

Waterfowl populations were estimated by the U.S. Fish and Wildlife Service by utilizing pond level models that estimates breeding duck pairs. This model was developed from annual waterfowl populations surveys that have been conducted since the late 1980s (Reynolds et. al. 2006). The results of the model are used primarily for conservation planning and delivery; however, they are also utilized for estimating waterfowl densities. Waterfowl and wildlife population estimates for each *E. coli* impaired reach addressed in this TMDL report are provided in **Appendix B**.

3.5.1.3 Source Summary

Sources of fecal bacteria are typically widespread and often intermittent. In the Lac qui Parle River Watershed, the *E. coli* standard is exceeded across all flow conditions for which data were available (Figures 11 through 18), indicating a mix of source types. A qualitative approach was used to identify permitted and nonpermitted sources of *E. coli* in the watershed. *E. coli* sources evaluated in the Lac qui Parle River *E. coli* TMDLs include permitted sources such as wastewater, and permitted AFOs, and nonpermitted sources from humans, livestock, wildlife, and self-propagation. The relative significance of each source at any one time depends largely on climate, land management, and stream flow conditions.

3.5.2 Total Suspended Solids

TSS consist of soil particles, algae, and other materials that are suspended in water and cause a lack of clarity. Excessive TSS can harm aquatic life and degrade aesthetic and recreational qualities of affected waterbodies. External sources of TSS to streams and lakes include sediment loading from permitted sources outside the stream such as construction, industrial, municipal stormwater runoff, and wastewater effluent as well as nonpermitted sources such as overland erosion and atmospheric deposition. Sources of TSS that occur internally within a stream include sediment from bank erosion, scouring, and in-channel algal production. The rate of sediment loading to a stream can vary seasonally as the majority of sediment loading to waterbodies occurs during the high flows of the spring snowmelt or large precipitation events in the summer. Erosion and sediment loss are most likely during heavy precipitation events in the early spring and late fall when soil is most exposed as a result of lack of vegetation.

Figure 9 shows the major TSS source distribution at the end of Unnamed Creek (WID 07020003-530), based on the HSPF model results (Tetra Tech 2016). The largest source of TSS to the impaired reach is cropland (52%), followed by stream bed and bank erosion (37%). The remaining sources include forest and shrublands (4.3%), developed areas (3.5%), pasture and grasslands (2.5%), other land types (barren and wetlands) (0.5%), feedlots (0.04%), and point sources (0.02%).

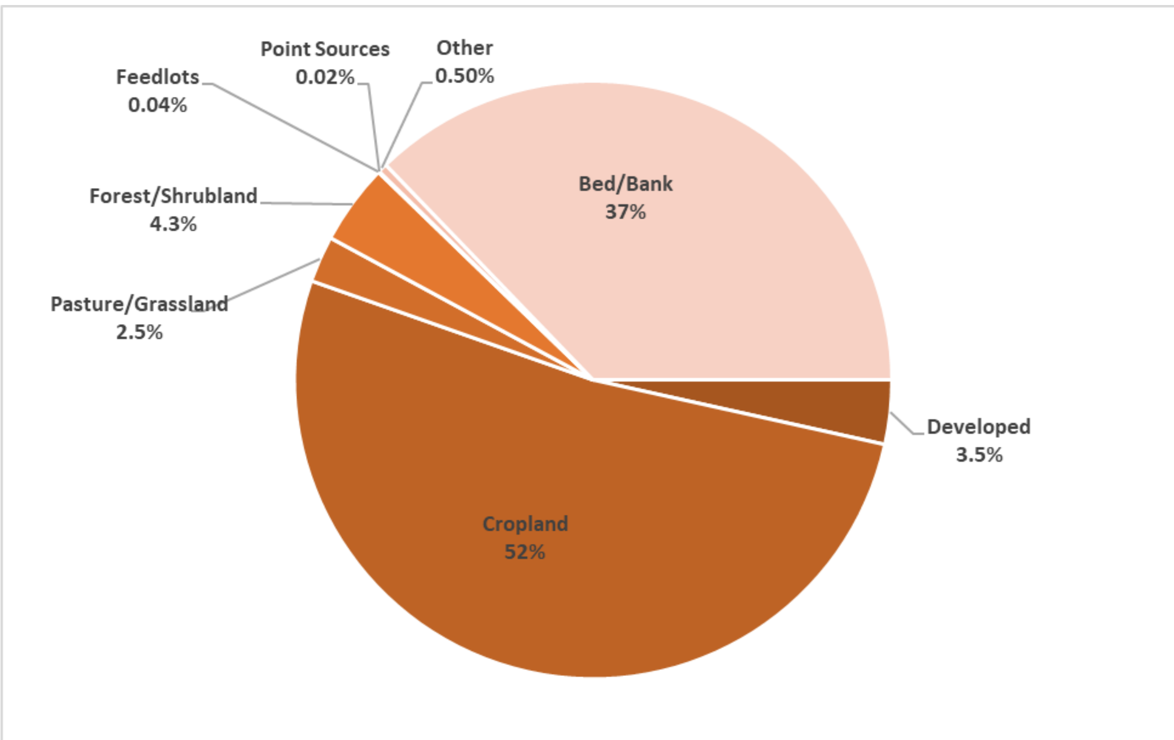

Figure 9. TSS source assessment for reach 07020003-530, based on the HSPF results, including sources in South Dakota.

The source distribution provided in **Figure 9** is based on an average annual total load of 811 tons of sediment per year (tons/yr) and is for the total drainage area, including areas in South Dakota. Of the total annual average load, 64% stems from sources within Minnesota. The distribution of sources within Minnesota roughly follows the distribution for the whole drainage area (**Figure 9**). Stream bed and bank erosion accounts for a slightly higher percentage of total sediment (45.6%), while cropland (45.2%) accounts for slightly less TSS in Minnesota's portion of the watershed. All other sources are within 1% of the distribution for the whole drainage area.

The following provides a more detailed description of the major potential sources of TSS.

3.5.2.1 Permitted sources

Wastewater Treatment Plants

Human waste and permitted NPDES sites can be a source of TSS. Permitted sites have strict TSS restrictions that commonly contribute little to the permitted daily load. Unnamed Creek (WID 07020001-530) does not contain a WWTP.

Construction Stormwater

Construction stormwater can be a source of TSS due to runoff from disturbed and easily erodible soils during construction activities. From 2008 through 2017, there were about 783 acres under a construction stormwater permit. This averages out to 78.3 acres a year, which is less than 1% of total acres a year in Minnesota's portion of the watershed. TSS from construction is not considered a significant contributor of TSS.

Industrial Stormwater

Industry can contribute to the TSS load of waterbodies, but there is little industrial activity within the watershed.

Municipal Stormwater Runoff

There are no permitted MS4 areas draining to the impaired TSS stream addressed in this TMDL report.

3.5.2.2 Nonpermitted sources

Overland Erosion

Overland runoff of sediment is the greatest contributor of TSS to the impaired reach, with approximately 63% of the TSS determined to come from overland sources. Based on the HSPF model results, the largest source of overland erosion comes from cropland (63% of total overland sediment load; 52% of total sediment load), equating to roughly 509 tons/yr. High TSS can occur when heavy rains fall onto unprotected soils, dislodging soil particles that are transported with surface runoff to adjacent waterbodies. Losses are greatest between April and June, when vegetation is not yet actively growing, and rainfall is elevated. Ephemeral streams and gullies are highly susceptible to intermittent flows and have high erosion potential in agricultural systems. Farming practices can exacerbate erosion in sensitive areas if soil is unprotected from rain and there is insufficient buffering of stream channels. Although the impaired reach's slope is relatively low (0.02%), higher slopes in the upper portions of the drainage area can impact overland erosion. Other overland erosion sources include sediment from tile drainage, sheet and rill runoff from upland fields, and livestock pastures in riparian zones.

Streambank Erosion

Streambank erosion can contribute significant amounts of sediment to streams. Stream bed and bank erosion is estimated to be responsible for 37% of the annual TSS load (equating to roughly 302 tons/yr). Streambank erosion is attributed to poor riparian vegetation management near stream channels, steep gradients in the upper portions of the watershed, and altered hydrology throughout the region. Altered hydrology has increased stream flows due to lower water storage from tiling, altered evapotranspiration cycles, an increase in precipitation, and decreased water residence time in the stream channel due to straightening. Managing water on- and below- fields in addition to deep-rooted vegetation in the riparian zone can stabilize soil and decrease sediment loading, lowering TSS in adjacent waterbodies.

Atmospheric Deposition

The atmosphere can also contribute to a stream's TSS load. Average wind speeds in the Lac qui Parle River Watershed are greater than five miles per hour and strong seasonal winds are capable of transporting sediment from fields. Dust from construction sites, bare soils, and developed areas can all contribute TSS to surface waters. Although not modeled in HSPF, windblown sediment is a likely source of TSS within the impaired reach, but is likely a small percentage.

4. TMDL development

A TMDL represents the maximum mass of a pollutant that can be assimilated by a receiving waterbody without causing an impairment in that receiving waterbody. TMDLs are developed based on the following equation:

$$\text{TMDL} = \text{LC} = \sum \text{WLA} + \sum \text{LA} + \text{MOS}$$

Where:

LC = loading capacity, the greatest amount of a pollutant a waterbody can receive and still meet water quality standards (see **Section 4.3.1**);

WLA = Wasteload allocation, the portion of the LC allocated to existing or future permitted point sources (see **Section 4.3.3**);

LA = load allocation, the portion of the LC allocated to existing or future NPS (see **Section 4.3.2**);

MOS = margin of safety, accounting for any uncertainty associated with attaining the water quality standard. The MOS may be explicitly stated as an added, separate quantity in the TMDL calculation or may be implicit, as in a conservative assumption (EPA 2007) (see **Section 4.3.4**);

Per 40 CFR 130.2(1), TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For this TMDL report, the TMDLs, allocations and margins of safety are expressed in mass/day. Each TMDL component is discussed in greater detail below.

4.1 Natural background consideration

Natural background was given consideration in the development of LA in this TMDL. Natural background is the landscape condition that occurs outside of human influence. "Natural background" is defined in both Minnesota rule and statute. Minn. R. 7050.0150, subp. 4, defines the term "Natural causes" as the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence. CWLA (Minn. Stat. § 114D.15, subd. 10) defines natural background as "characteristics of the water body resulting from the multiplicity of factors in nature, including climate and ecosystem dynamics, that affect the physical, chemical or biological conditions in a water body, but does not include measurable and distinguishable pollution that is attributable to human activity or influence." Natural background conditions refer to inputs of pollution that would be expected under natural, undisturbed conditions. Natural background sources can include inputs from natural geologic processes such as soil loss from upland erosion and stream development, atmospheric deposition, and loading from forested land, wildlife, etc. For each impairment, natural background levels are implicitly incorporated in the water quality standards used by the MPCA to determine/assess impairment, and therefore natural background is accounted for and addressed through the MPCA's waterbody assessment process. Natural background conditions were evaluated, where possible, within the modeling and source assessment. These source assessment exercises indicate natural background inputs are generally low compared to livestock, cropland, streambank, WWTPs, failing SSTSs, and other anthropogenic sources.

Based on the MPCA's waterbody assessment process and the TMDL source assessment exercises, there is no evidence at this time to suggest that natural background sources are a major driver of any of the impairments and/or affect the waterbodies' ability to meet state water quality standards. For all impairments addressed in this TMDL report, natural background sources are implicitly included in the LA portion of the TMDL allocation tables and TMDL reductions should focus on the major anthropogenic sources identified in the source assessment. Federal law instructs an agency to distinguish between natural and NPS loads "[w]herever possible." 40 CFR § 130.2(g). However, Minnesota law does not compel the MPCA to develop a separate LA for natural background sources, distinct from NPS[2].

4.2 Data Sources

4.2.1 Hydrologic Simulation Program-Fortran

The HSPF model is a comprehensive package for simulation of watershed hydrology, sediment transportation, and water quality for conventional and toxic organic pollutants. HSPF incorporates the watershed-scale Agricultural Runoff Model and NPS models into a basin-scale analysis framework that includes fate and transport in one dimensional stream channels. It is a comprehensive model of watershed hydrology and water quality that allows the integrated simulation of point sources, land and soil contaminant runoff processes, and in-stream hydraulic and sediment-chemical interactions. The result of this simulation is a time history of runoff flow rate, sediment load, and nutrient and pesticide concentrations, along with a time history of water quantity and quality at the outlet of any subwatershed.

An HSPF model was developed in 2017 for the Lac qui Parle River Watershed and updated in 2019. The HSPF model predicts the range of flows that have historically occurred in the modeled area and the load contributions from a variety of point and NPS in the watershed. The HSPF model for the Lac qui Parle River Watershed simulates hydrology and water quality for the period 1996 to 2017.

4.2.2 Environmental Quality Information System

The MPCA uses a system called EQuIS to store water quality data from more than 17,000 sampling locations across the state. All discrete water quality sampling data utilized for assessments and data analysis for this TMDL report are stored in this accessible database, described in **Section 3.4**. The EQuIS

[2] The MPCA is not required to designate a separate LA for natural background (Matter of Decision to Deny Petitions for a Contested Case Hearing, 924 N.W.2d 638 (Minn. Ct. App. 2019), review denied (Apr. 24, 2019)).

locations and water quality data used in this TMDL report are provided in **Figure 6** and summarized in **Table 5** and **Table 6**.

4.3 *Escherichia coli*

4.3.1 Loading capacity methodology

The LC is the greatest amount of a pollutant a waterbody can receive and still meet the water quality standard. The loading capacities for impaired stream reaches in the Lac qui Parle River Watershed were determined using the LDC approach. A LDC is developed by combining the (simulated or observed) river/stream flow at the downstream end of the WID with the observed/measured *E. coli* data available within the segment. Methods detailed in the EPA document *An Approach for Using Load Duration Curves in the Development of TMDLs* (EPA 2007) were used in creating the curves for the impaired streams within the Lac qui Parle River Watershed.

A system's water quality often varies based on flow regime, with elevated pollutant loadings sometimes occurring more frequently under one regime or another. Loading dynamics during certain flow conditions can be indicative of the type of pollutant source causing an exceedance (e.g., point sources may contribute more loading under low flow conditions). The LDC approach identifies these flow regimes and presents the observed and "allowable" loading within each regime, to compute necessary load reductions. To represent different types of flow events, and pollutant loading during these events, five flow regimes were identified based on percent exceedance: Very High Flow (0% to 10% of flows exceed), High Flow (10% to 40%), Mid Flow (40% to 60%), Low Flow (60% to 90%), and Very Low Flow (90% to 100%).

Benefits of LDC analysis include: (1) the loading capacities are calculated for multiple flow regimes, not just a single point; (2) use of the method helps identify specific flow regimes and hydrologic processes/patterns where loading may be a concern; and (3) ensuring that the applicable water quality standards are protective across all flow regimes. The LDC approach is limited (1) in the ability to track individual loadings or relative source contributions and (2) when a correlation between flow and water quality is lacking and flow is not the driving force behind pollutant delivery mechanics.

The LDC method is based on an analysis that encompasses the cumulative frequency of historical flow data over a specified period. Because this method uses a long-term record of daily flow volumes, virtually the full spectrum of allowable loading capacities is represented by the resulting curve (the LC curve). In the TMDL equation tables of this report (**Table 13** through **Table 25**), only five points on the entire LC curve are depicted (the midpoints of the designated flow regimes). However, it should be understood that the entire curve represents the TMDL and is what the EPA ultimately approves.

The LC for *E. coli* was calculated using both standards: the geometric mean (i.e., geomean) standard of 126 organisms/100 mL (630 organisms/100 mL for Class 7 waters) and the standard which requires fewer than 10% of samples measure above 1,260 organisms/100 mL. The TMDL allocations are calculated based on the 126 organisms/100 mL, except for the stream reaches that are class 7. Class 7 stream reaches have TMDL allocations calculated based on 630 organisms/100mL. The water quality standards for *E. coli* apply from April to October (May to October for Class 7 waters). Loads are calculated using the method in **Table 8** as organisms per day (org/day) and reported as billions of organisms/day.

Table 8. Converting flow and concentration into bacterial load.

Load (organisms/day) = *E. coli* Standard (organisms/100mL) * Flow (cfs) * Conversion factor			
Multiply **Flow** (cfs) by **28.316** to convert	ft^3 per second (cfs)	→	Liters per second
Multiply by **1000** to convert	Liters per second	→	Milliliters per second
Divide by **100** to convert	Milliliters per second	→	Organisms/second
Multiply by **86,400** to convert	Organisms per second	→	Organisms/day

Six of the eight *E. coli* impaired stream reaches drain parts of South Dakota, therefore, a percentage of the load capacity to represent Minnesota's portion was used to develop the TMDLs. To determine the percentage of load capacity for Minnesota, the HSPF model was utilized to calculate the portion of the load capacity at the end of the impaired reach that comes from Minnesota. Since HSPF does not model bacteria, flow was used as a surrogate. The percentage of flow coming from Minnesota in each impaired reach will be used to determine Minnesota's LC. A table is presented for each reach with the total load capacity along with Minnesota's portion. The TMDL tables represent the Minnesota portion of the load capacity only.

4.3.2 Load allocation methodology

LA represents the portion of the LC designated for NPS of *E. coli*. The LA is the remaining load once the WLA and MOS are determined and subtracted from the LC. The LA includes all sources of *E. coli* that do not require NPDES permit coverage, including unregulated watershed runoff, wildlife sources , and a consideration for "natural background" conditions. NPS of *E. coli* were previously discussed in **Section 3.5.1**.

4.3.3 Wasteload allocation methodology

WLAs are developed for any permitted discharge in the drainage area of an impaired reach. These are discharges requiring an NPDES permit, and typically include water treatment plants, permitted MS4s, industrial discharges, construction stormwater, and permitted CAFOs.

Wastewater Treatment Plants

WWTPs are based on the reported maximum allowable discharge and the permitted concentration limits. For controlled systems, maximum daily flow is based on six inch per day discharge from the facility's secondary pond. The conversion for WWTPs from concentrations to loads is shown in **Table 9**. The estimated maximum flow rate for controlled systems in shown in **Table 10.** The WWTPs, permit numbers, permitted flows, and WLAs are provided in **Table 11.** WWTPs discharging into impaired reaches did not require any changes to their discharge permit limits due to the WLAs calculated in this TMDL report.

Table 9. Converting flow and concentrations into bacterial loads for wasteload allocations.

Wasteload (organisms/day) = *E. coli* Limit (126 organisms/100mL) * Flow (mgd) * Conversion factor			
Multiply organisms/100mL by **10** to convert	organisms per 100 mL	→	organisms per Liter
Multiply by **3.785** to convert	organisms per Liter	→	organisms per gallon
Multiply by **1,000,000** to convert	organisms per gallon	→	organisms per million gallons

Table 10. Secondary pond size and maximum daily discharge for controlled WWTP systems.

Name	Secondary Pond Acreage (ac)	Gallons per acre-inch	Volume of 6" discharge (mgd)
Canby WWTP	16	27,154	2.607
Hendricks WWTP	15	27,154	2.449
Marietta WWTP	2	27,154	0.334
PURIS Proteins LLC	15	27,154	2.444

Table 11. Bacteria WLAs for NPDES permits in impaired reaches of the Lac qui Parle River Watershed.

Name	Permit No.	Station	Permit Limit (as *E. coli)*		Max Daily Flow (mgd)	*E. coli* WLAs (billion org/day)	Flow Type
			org/100 mL	org/L			
Canby WWTP	MNG580154	SD 001	126	1260	2.607[1]	12.432	Controlled
Dawson WWTP	MN0021881	SD 002	126	1260	0.471	2.246	Continuous
Hendricks WWTP	MN0021121	SD 002	126	1260	2.449[1]	11.678	Controlled
Madison WWTP	MN0051764	SD 002	126	1260	0.48	2.289	Continuous
Marietta WWTP	MNG580160	SD 001	126	1260	0.334[1]	1.593	Controlled
PURIS Proteins LLC	MN0048968	SD 001	126	1260	2.444[1]	11.655	Controlled

[1]Based on 6" daily discharge of secondary pond (see Table 10).

Straight Pipe Septic Systems

Straight pipe septic systems are illegal and unpermitted, and as such, receive a WLA of zero.

Industrial and Construction Permits

WLAs for permitted construction stormwater (permit# MNR100001) were not developed for *E. coli*, since *E. coli* is not a typical pollutant associated with construction sites. Industrial stormwater receives a WLA only if bacteria or *E. coli* is part of benchmark monitoring for an industrial site in the drainage area of an impaired water body. There are no bacteria or *E. coli* benchmarks associated with any Industrial Stormwater Permits (Permit# MNR050000) in the impaired watersheds. Therefore, no industrial stormwater *E. coli* WLAs were assigned.

Municipal Separate Storm Sewer System

There are no MS4 NPDES stormwater permits in the watershed, therefore, no MS4 area is assigned a WLA.

Livestock Facilities

NPDES permitted feedlot facilities are assigned a zero WLA. This is consistent with the conditions of the permits, which allow no pollutant discharge from the livestock housing facilities and associated sites.

Discharge of bacteria (*E. coli*) from fields where manure has been land-applied may occur during runoff events, but those discharges are covered under the LA portion of the TMDL and do not require an additional WLA. A list of CAFOs and the WIDs they contribute to is included in **Appendix D**.

WLA during low flows

The total daily LC of some stream reaches during low and very low flow regimes are very small due to the occurrence of very low flows in the stream/river. Consequently, for some of the impaired reaches the permitted wastewater design discharge is close to, or higher than the streamflow during these flow regimes. This translates to these point sources appearing to use all of, or exceeding, the LC during these flow periods. In reality, this will never occur as the discharge is a part of the streamflow and can never exceed total streamflow. To account for these unique situations, the WLA (and LA) are expressed as an equation rather than an absolute number. The equation is:

Allocation = Point Source Discharge X Water Quality Standard Concentration

The units in the equation are converted so that they are consistent to the allocation and a proper load can be calculated. This assigns a concentration-based limit to the WLA for these lower flow rates.

4.3.4 Margin of safety

The purpose of the MOS is to account for uncertainty with the allocations. Uncertainty can be associated with data collection, lab analysis, data analysis, modeling error, and implementation activities. An explicit 10% of the LC was established as the MOS and was applied to each flow regime for all LDCs developed for this TMDL. The LDC approach minimizes a great deal of uncertainty by using the full flow spectrum, represented by five flow regime values. The explicit 10% MOS accounts for:

- Uncertainty in the simulated flow data from the HSPF model;
- Uncertainty in the observed water quality data;
- Uncertainty with regrowth, die-off, and natural background levels of *E. coli*; and
- Uncertainty that the water quality data adequately represents conditions in the reach.

The majority of the MOS is apportioned to uncertainty related to the HSPF model. The hydrologic calibration statistics for the HSPF model at the Lac qui Parle River near Lac qui Parle, Minnesota (USGS station ID 05300000) were:

- 7.5% Error in total flow volume;
- 13.7% Error in bottom 50% low flows;
- -1.2% Error in the top 10% high flows;
- A Nash-Sutcliffe coefficient of model fit efficiency (NSE) of 0.514 for daily flows;
- And, an NSE of 0.749 for monthly flows.

Overall, the HSPF model accuracy was determined to be “Fair” to “Good”. More information on the calibration of the HSPF model can be found in Tetra Tech (2016).

4.3.5 Seasonal variation

Geometric means for *E. coli* within the impaired reaches are often above the state chronic standard from April through October. Exceedances of the acute standard are also common in these reaches during this time period. Fecal bacteria are most productive at temperatures similar to their origination environment in animal digestive tracts. Thus, these organisms are expected to be at their highest concentrations during warmer summer months when streamflow is low and water temperatures are high. High *E. coli* concentrations in many of the reaches continue into the fall, which may be attributed to constant sources of *E. coli* (such as failing SSTS and animal access to the stream) and less flow for dilution. However, some of the data may be skewed as more samples were collected in the summer months than in October. Seasonal and annual variations are accounted for by setting the TMDL across the entire flow record using the load duration method.

4.3.6 TMDL summary

The LDCs in **Figure 10** through **Figure 17** shows the percent likelihood of flow exceedance on the x-axis, while the computed *E. coli* loading is shown on the y-axis. “Allowable” loadings under each flow condition, based on the water quality standards (both the geometric mean and instantaneous standards), is shown with a red and green line. Observed loads are also shown, indicated by points on the plot. The median loads for each flow regime are shown as a solid blue line for median existing loads (labeled as “Existing”) and a dashed red line for median “allowable” load (labeled as “Target”) for the geometric mean standard under each flow condition. Observed loads are broken out by station, allowing for a detailed examination of when and where loading exceedances have occurred. The “allowable” loads are the LC of the stream reach.

The following rounding conventions were used in the *E. coli* TMDL tables:

- Values ≥10 reported in mass/day have been rounded to the nearest whole value.
- Values <10 and ≥1 reported in mass/day have been rounded to the nearest tenth.
- Values <1 and ≥0.01 reported in mass/day have been rounded to the nearest hundredth.
- Values <0.01 reported in mass/day have been rounded to enough significant digits so that the value is greater than zero and a number is displayed in the table.
- While some of the numbers in the tables show multiple digits, they are not intended to imply great precision.
- Some small arithmetic errors may exist; this is due to rounding errors.
- Mass refers to billions of organisms for *E. coli*.

Each table offers a representative load reduction to provide watershed planners a single target reduction to aid in planning that is not dependent on flow conditions. A single, representative load reduction is easier for watershed planners to translate into annual load reductions when developing restoration and protection plans to improve water quality in the watershed. Since *E. coli* is assessed by month, a flow weighted average of the monthly geometric means was used to determine the representative existing condition. The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard with the exception of County Ditch 5 which based its reduction on achieving the acute standard of 1,260 org/100 ml. Load reductions for each flow regime can be found in **Appendix A**.

The baseline year for the *E. coli* TMDLs is 2016. The available *E. coli* data is from 2015 - 2016 and 2016 was closer to the average flow condition of the LDC period (2008 through 2017) than 2015.

Lac qui Parle River, Tenmile Cr to Minnesota R (07020003-502)

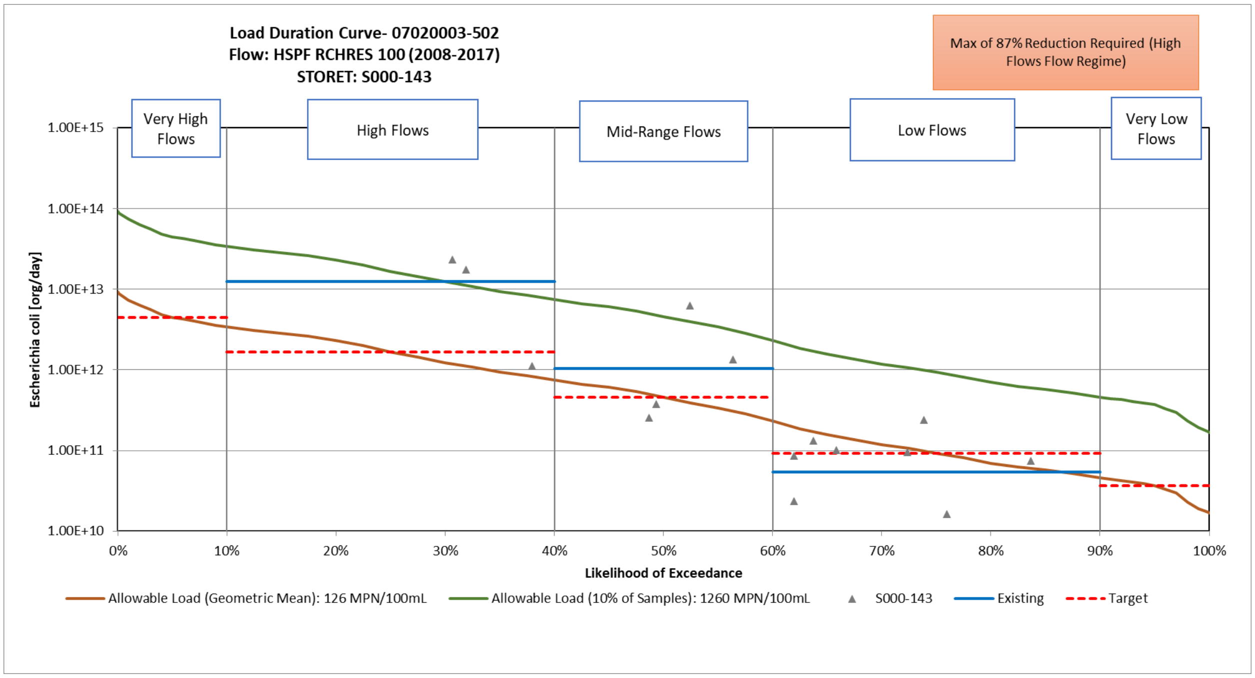

Figure 10. Lac qui Parle River, Tenmile Cr to Minnesota R (07020003-502).

Table 12. Minnesota's *E. coli* load capacity for Lac qui Parle River, Tenmile Cr to Minnesota R (07020003-502), based on the 126 organisms/100mL standard.

MN's % of Load Capacity: 72.2%	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Total Load Capacity	4440	1660	454	93	37
MN Load Capacity	3205	1199	328	67	27

Table 13. *E. coli* allocations for Lac qui Parle River, Tenmile Cr to Minnesota R (07020003-502).

Escherichia coli		Flow Condition				
		Very High	High	Mid-Range	Low	Very Low
		[Billions organisms/day]				
Loading Capacity		**3,205**	**1,199**	**328**	**67**	**27**
Wasteload Allocation	*Canby WWTP*	12	12	12	12	###[1]
	Dawson WWTP	2.2	2.2	2.2	2.2	###[1]
	Hendricks WWTP	12	12	12	12	###[1]
	Madison WWTP	2.3	2.3	2.3	2.3	###[1]
	Marietta WWTP	1.6	1.6	1.6	1.6	###[1]
	PURIS Proteins LLC	12	12	12	12	###[1]
	Total WLA	**42**	**42**	**42**	**42**	**###[1]**
Load Allocation	**Total LA**	**2,842**	**1,037**	**253**	**18**	**###[2]**
Margin of Safety (MOS)		**321**	**120**	**33**	**6.7**	**2.7**
Average existing monthly geometric mean		**202.7 org/100 mL**				
Overall estimated percent reduction[3]		**39%**				

###[1] = The permitted wastewater design flows exceed the streamflow in the indicated flow zone. The allocations are expressed as an equation rather than an absolute number: (flow contribution from source) X (126 org/100 mg/L) X conversion factors. See Section 4.3.3 for details.

###[2] = WLA exceeded load capacity for this zone, therefore LA is determined by the formula: Allocation = (flow from a given source) X (*E. coli* concentration standard).

[3]The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard.

Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R (07020003-513)

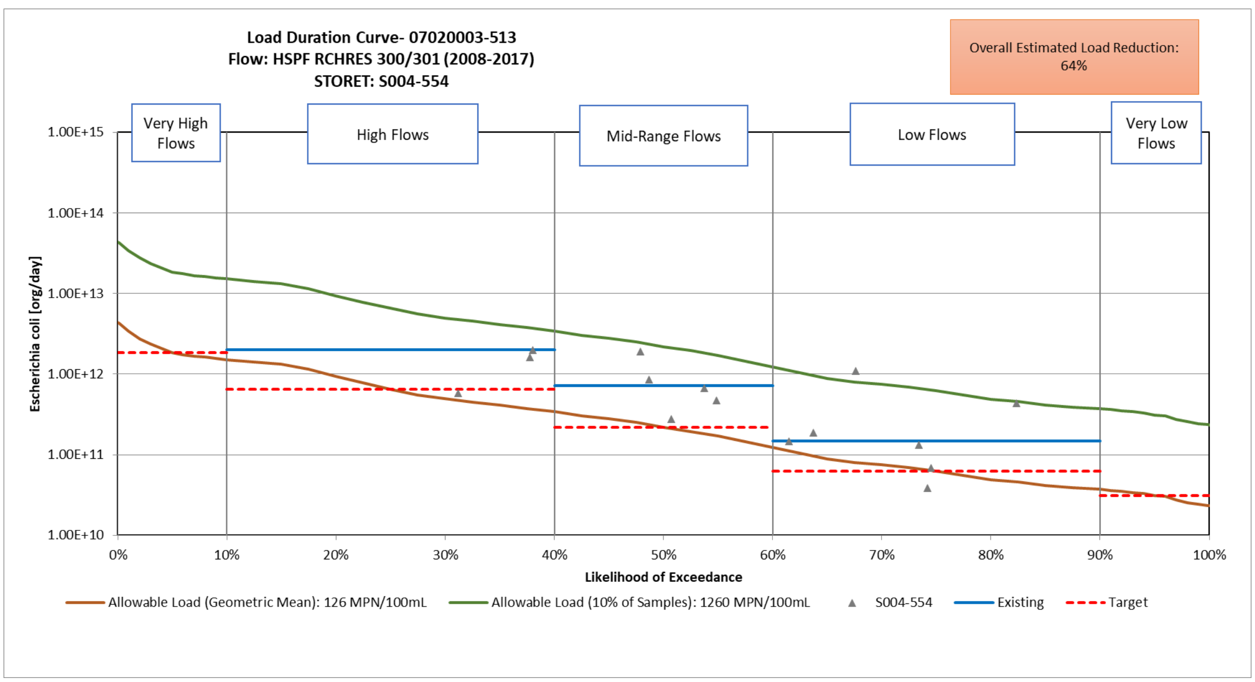

Figure 11. Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R (07020003-513) *E. coli* LDC.

Table 14. Minnesota's *E. coli* load capacity for Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R (07020003-513), based on the 126 organisms/100mL standard.

MN's % of Load Capacity: 53.3%	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Total Load Capacity	1,834	653	220	62	31
MN Load Capacity	978	348	117	33	17

Table 15. *E. coli* allocations for Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R (07020003-513).

Escherichia coli		Flow Condition				
		Very High	**High**	**Mid-Range**	**Low**	**Very Low**
		[Billions organisms/day]				
Loading Capacity		**978**	**348**	**117**	**33**	**17**
Wasteload Allocation	*Dawson WWTP*	2.2	2.2	2.2	2.2	2.2
	Marietta WWTP	1.6	1.6	1.6	1.6	1.6
	Total WLA	**3.8**	**3.8**	**3.8**	**3.8**	**3.8**
Load Allocation	**Total LA**	**876**	**309**	**101**	**26**	**11**
Margin of Safety (MOS)		**98**	**35**	**12**	**3.3**	**1.7**
Average existing monthly geometric mean		**352.5 org/100 mL**				
Overall estimated percent reduction[1]		**64%**				

[1]The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard.

Lost Creek, Crow Timber Cr to W Br Lac qui Parle R (07020003-517)

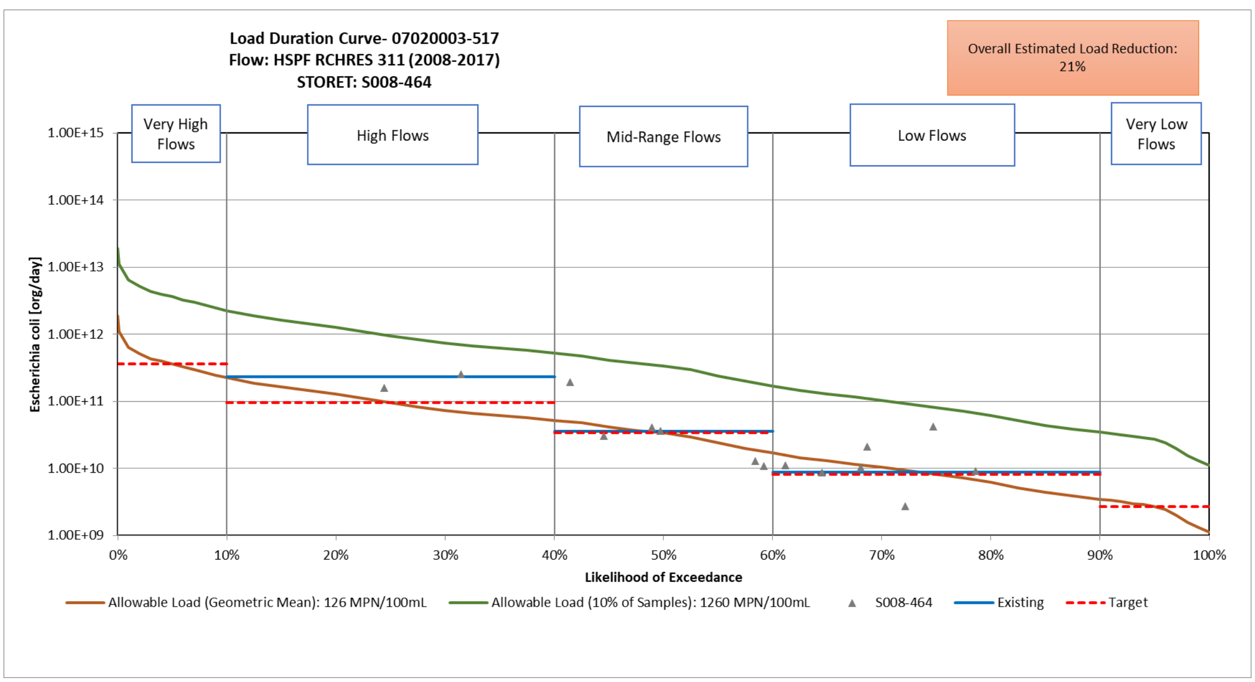

Figure 12. Lost Creek, Crow Timber Cr to W Br Lac qui Parle R (07020003-517) *E. coli* LDC.

Table 16. Minnesota's *E. coli* load capacity for Lost Creek, Crow Timber Cr to W Br Lac qui Parle R (07020003-517), based on the 126 organisms/100mL standard.

MN's % of Load Capacity: 18.2%	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Total Load Capacity	363	95	34	8.2	2.7
MN Load Capacity	66	17	6.2	1.5	0.49

Table 17. *E. coli* allocations for Lost Creek, Crow Timber Cr to W Br Lac qui Parle R (07020003-517).

Escherichia coli	**Flow Condition**				
	Very High	**High**	**Mid-Range**	**Low**	**Very Low**
	[Billions organisms/day]				
Loading Capacity	**66**	**17**	**6.2**	**1.5**	**0.49**
Wasteload Allocation	**0**	**0**	**0**	**0**	**0**
Load Allocation	**59**	**15**	**5.6**	**1.3**	**0.44**
Margin of Safety (MOS)	**6.6**	**1.7**	**0.62**	**0.15**	**0.049**
Average existing monthly geometric mean	**154.4 org/100 mL**				
Overall estimated percent reduction[1]	**21%**				

[1] The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard.

Lac qui Parle River, West Branch, MN/SD border to Lost Cr (07020003-519)

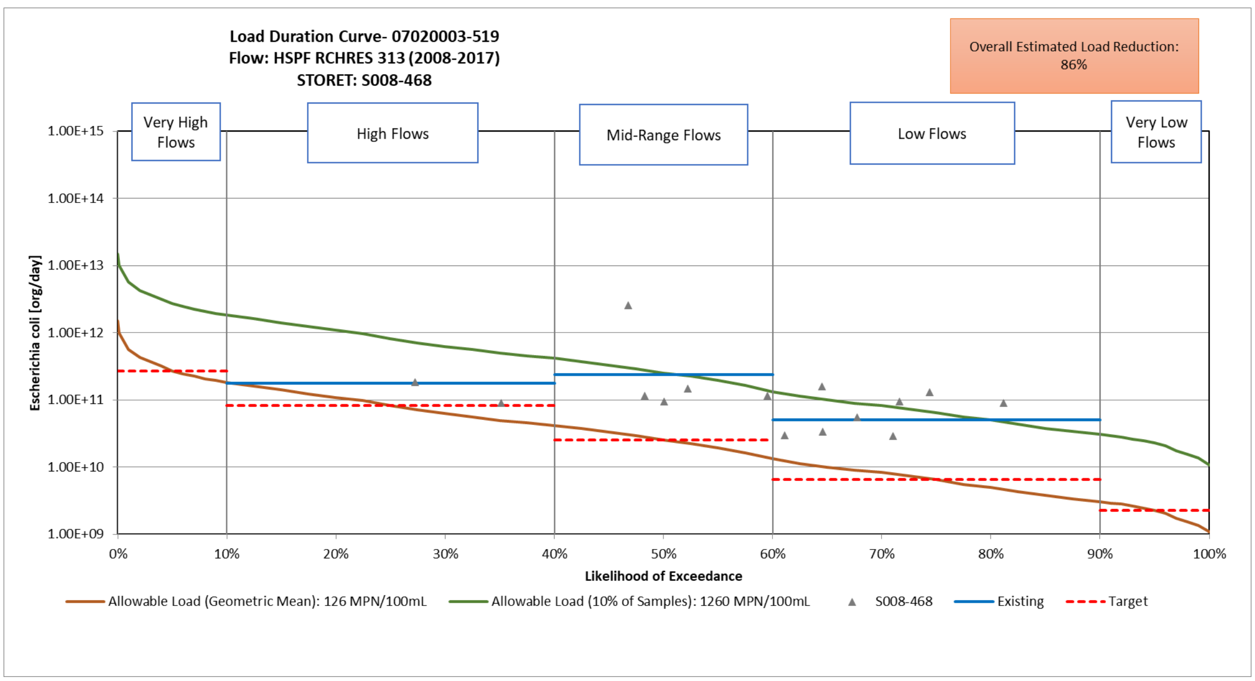

Figure 13. Lac qui Parle River, West Branch, MN/SD border to Lost Cr (07020003-519) *E. coli* LDC.

Table 18. Minnesota's *E. coli* load capacity for Lac qui Parle River, West Branch, MN/SD border to Lost Cr (07020003-519), based on the 126 organisms/100mL standard.

MN's % of Load Capacity: 15.9%	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Total Load Capacity	273	82	25	6.5	2.3
MN Load Capacity	43	13	4	1	0.36

Table 19. *E. coli* allocations for Lac qui Parle River, West Branch, MN/SD border to Lost Cr (07020003-519).

Escherichia coli	**Flow Condition**				
	Very High	**High**	**Mid-Range**	**Low**	**Very Low**
	[Billions organisms/day]				
Loading Capacity	**43**	**13**	**4.0**	**1.0**	**0.36**
Wasteload Allocation	**0**	**0**	**0**	**0**	**0**
Load Allocation	**39**	**12**	**3.6**	**0.9**	**0.32**
Margin of Safety (MOS)	**4.3**	**1.3**	**0.40**	**0.10**	**0.036**
Average existing monthly geometric mean	**914.9 org/100 mL**				
Overall estimated percent reduction[1]	**86%**				

[1] The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard.

County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R (07020003-523)

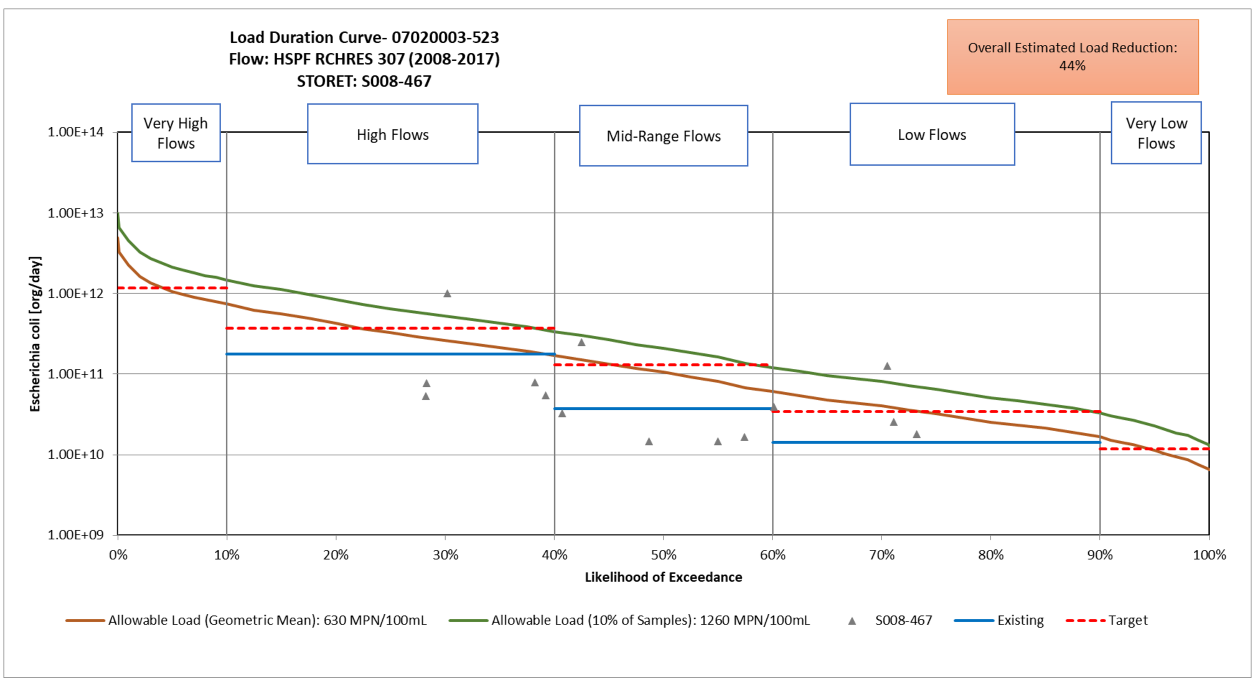

Figure 14. County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R (07020003-523) *E. coli* LDC.

Table 20. Minnesota's *E. coli* load capacity for County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R (07020003-523), based on the 630 organisms/100mL standard.

MN's % of Load Capacity: 47.1%	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Total Load Capacity	1,177	368	130	34	12
MN Load Capacity	554	173	61	16	5.6

Table 21. *E. coli* allocations for County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R (07020003-523).

Escherichia coli		**Flow Condition**				
		Very High	**High**	**Mid-Range**	**Low**	**Very Low**
		[Billions organisms/day]				
Loading Capacity		**554**	**173**	**61**	**16**	**5.6**
Wasteload Allocation	*Marietta WWTP*	1.6	1.6	1.6	1.6	1.6
	Total WLA	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**
Load Allocation	**Total LA**	**497**	**154**	**53**	**13**	**3.4**
Margin of Safety (MOS)		**55**	**17**	**6.1**	**1.6**	**0.56**
Average existing monthly geometric mean		**301.9 org/100 mL**				
Maximum monthly 90th percentile		**2,246 org/100 mL**				
Overall estimated percent reduction[1]		**44%**				

[1]The overall estimated percent reduction is the reduction in the maximum monthly 90th percentile to meet the 1,260 org/100 mL standard.

Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530)

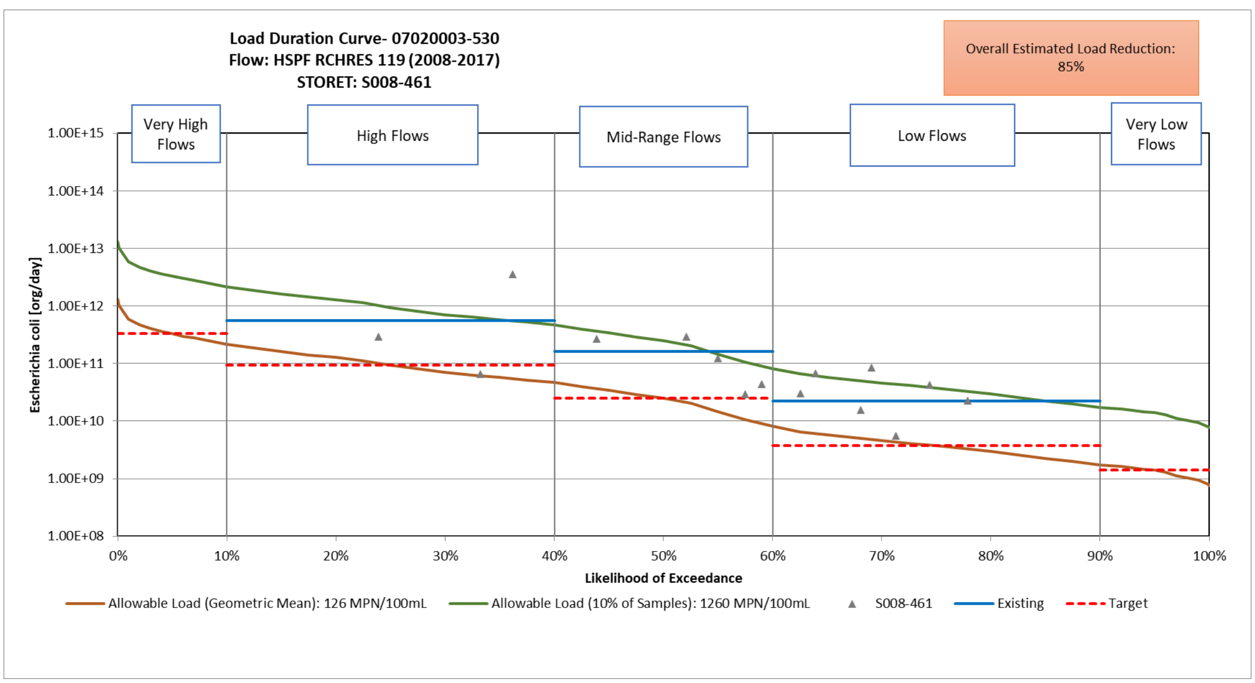

Figure 15. Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530) *E. coli* LDC.

Table 22. Minnesota's *E. coli* load capacity for Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530), based on the 126 organisms/100mL standard.

MN's % of Load Capacity: 39.7%	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Total Load Capacity	328	94	25	3.7	1.4
MN Load Capacity	130	37	9.9	1.5	0.56

Table 23. *E. coli* allocations for Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530).

Escherichia coli	**Flow Condition**				
	Very High	**High**	**Mid-Range**	**Low**	**Very Low**
	[Billions organisms/day]				
Loading Capacity	**130**	**37**	**9.9**	**1.5**	**0.56**
Wasteload Allocation	**0**	**0**	**0**	**0**	**0**
Load Allocation	**117**	**33**	**8.9**	**1.3**	**0.50**
Margin of Safety (MOS)	**13**	**3.7**	**0.99**	**0.15**	**0.056**
Average existing monthly geometric mean	**798.6 org/100 mL**				
Overall estimated percent reduction[1]	**85%**				

[1] The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard.

Unnamed creek, -96.1517, 44.9533 to W Br Lac qui Parle R (07020003-580)

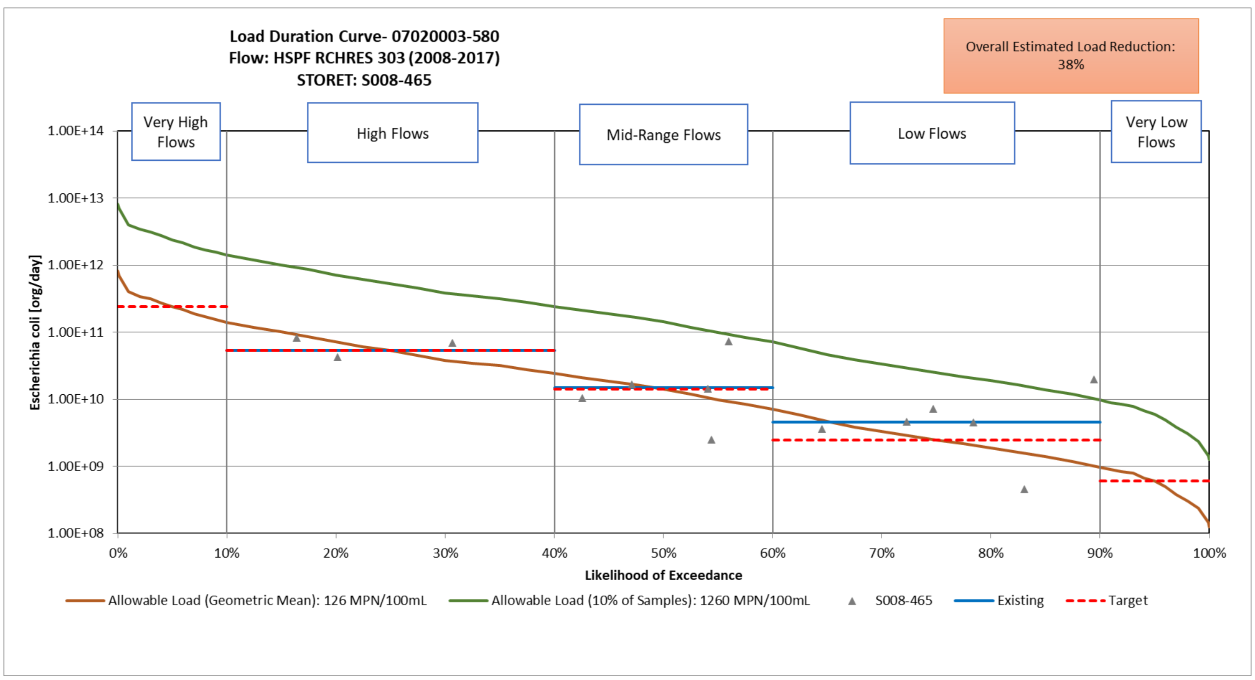

Figure 16. Unnamed creek, -96.1517, 44.9533 to W Br Lac qui Parle R (07020003-580) *E. coli* LDC.

Table 24. *E. coli* allocations for Unnamed creek, -96.1517, 44.9533 to W Br Lac qui Parle R (07020003-580), based on the 126 organisms/100mL standard.

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	239	53	14	2.5	1.4
Wasteload Allocation	0	0	0	0	0
Load Allocation	215	48	13	2.3	1.3
Margin of Safety (MOS)	24	5.3	1.4	0.2	0.1
Average existing monthly geometric mean	215.7 org/100 mL				
Overall estimated percent reduction[1]	38%				

[1] The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard.

Unnamed ditch (County Ditch 4), Unnamed ditch to CSAH 20 (07020003-581)

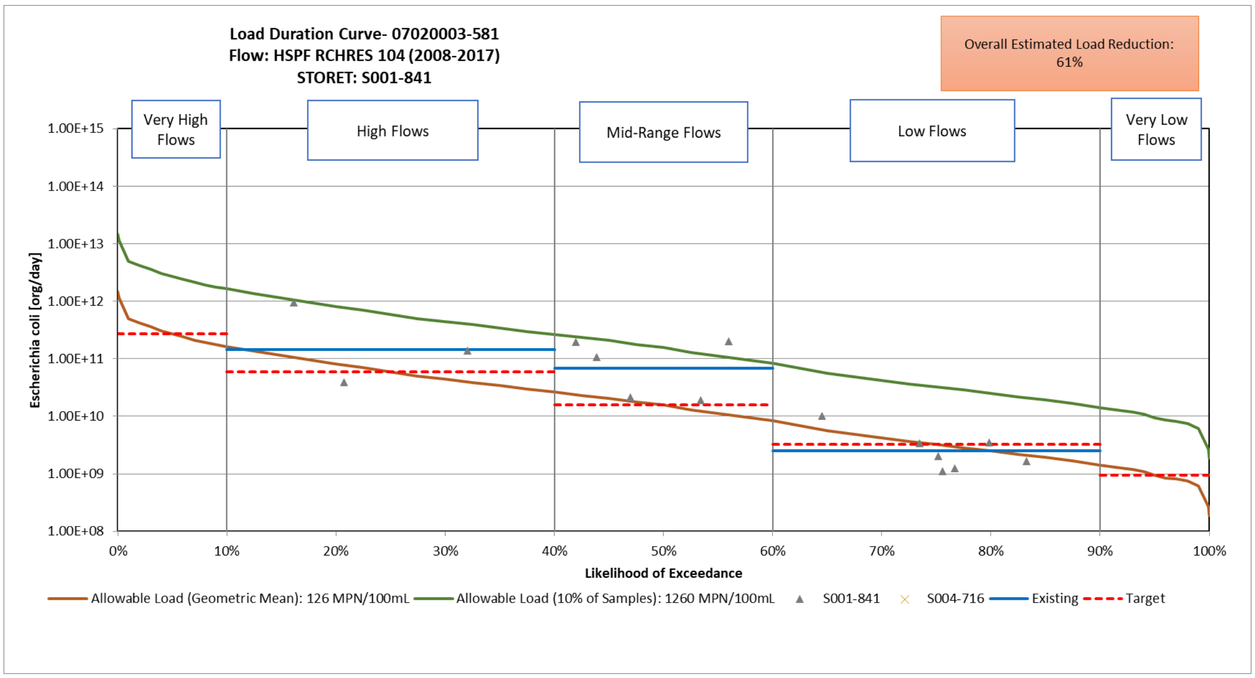

Figure 17. Unnamed ditch (County Ditch 4), Unnamed ditch to CSAH 20 (07020003-581) *E. coli* LDC.

Table 25. *E. coli* allocations for Unnamed ditch (County Ditch 4), Unnamed ditch to CSAH 20 (07020003-581), based on the 126 organisms/100mL standard.

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**274**	**59**	**16**	**3.2**	**0.94**
Wasteload Allocation	**0**	**0**	**0**	**0**	**0**
Load Allocation	**247**	**53**	**14**	**2.9**	**0.85**
Margin of Safety (MOS)	**27**	**5.9**	**1.6**	**0.32**	**0.09**
Average existing monthly geometric mean	**292.8 org/100 mL**				
Overall estimated percent reduction[1]	**61%**				

[1] The overall estimated percent reduction is the reduction in the flow weighted geometric mean to meet the 126 org/100 mL standard.

4.4 Total Suspended Solids

4.4.1 Loading capacity methodology

Like *E. coli*, LDCs were used to represent the LC for the TSS impaired reach. Description of the LDC methodology can be found in **Section 4.3.1**. The flow component of the LC curve is based on the HSPF simulated daily average flows (2008 through 2017), and the concentration component comes from the TSS concentration criteria of 65 mg/L for the Southern River Nutrient Region. The TSS LDC for the impaired reach is shown in **Section 4.4.6**. The orange curve in the LDC (**Figure 18**) represents the allowable TSS LC of the reach for each daily flow. The median (or midpoint) load of each flow regime is used to represent the total load capacity in the TMDL tables.

Table 26 provides the methodology and conversion factors to transform flows and concentrations to loads. The TSS standard-based LDC was created using the Southern River Nutrient Region TSS standard of 65 mg/L. The TSS standard only applies during the months of April through September. Loads for TSS are calculated as tons/day.

Table 26. Converting flow and concentration to sediment load.

Load (tons/day) = TSS standard (mg/L) * Flow (cfs) * Conversion Factor			
For each flow regime			
Multiply **flow** (cfs) by **28.31** (L/ft^3) and **86,400** (sec/day) to convert	cfs	→	L/day
Multiply **TSS Standard** (65 mg/L) by **L/day** to convert	L/day	→	mg/day
Divide **mg/day** by **907,184,740** (mg/ton) to convert	mg/day	→	tons/day

Unnamed Creek (07020003-530) drains parts of South Dakota, therefore, a percentage of the load capacity to represent Minnesota's portion was used to develop the TMDL. To determine the percentage of load capacity for Minnesota in Unnamed's drainage area, the HSPF model was utilized to calculate the portion of the existing load at the end of the reach that comes from Minnesota. It was determined that 64.4% of the existing load of sediment comes from Minnesota in Unnamed Creek; therefore, 64.4% of the LC was used to develop the TMDL. **Table 27** displays the total load capacity along with Minnesota's portion. The TMDL table (**Table 28**) represents the Minnesota portion of the load capacity.

4.3.2 Load allocation methodology

LAs represent the portion of the LC designated for NPS of TSS. The LA is the remaining load once the WLAs and MOS are determined and subtracted from the LC. The LA includes all sources of TSS that do not require NPDES permit coverage, including unregulated watershed runoff, atmospheric deposition, and a consideration for "natural background" conditions. NPS of TSS were previously discussed in **Section 3.5.2**.

4.4.3 Wasteload allocation methodology

WLAs are developed for any point source/permitted discharge in the drainage area of an impaired reach. These are discharges requiring an NPDES permit, and typically include water treatment facilities, permitted MS4s, industrial discharges, construction stormwater, and permitted feedlots. WLA for the impaired reach is provided in the TMDL table in **Section 4.4.6**.

Wastewater Treatment Plants

There are no WWTPs in the TSS impaired reach. Therefore, no TSS WLA for WWTPs were assigned.

Straight Pipe Septic Systems

Straight pipe septic systems are illegal and unpermitted and receive a WLA of zero.

Industrial and Construction Permits

WLAs for construction and industrial stormwater discharges that are covered by the State's general permits (permit # MNR100001 and MNR050000, respectively) were combined and addressed through a categorical allocation.

Stormwater runoff from construction sites that disturb: (a) one acre of soil or more, (b) less than one acre of soil and are part of a "larger common plan of development or sale" that is greater than one acre, or (c) less than one acre, but determined to pose a risk to water quality are regulated under the state's NPDES/SDS General Stormwater Permits for Construction Activity (MNR1000001). This permit identifies and requires BMPs to be implemented to protect water resources from mobilized sediment and other pollutants of concern. If the owner/operators of impacted construction sites obtain and abide by the NPDES/SDS General Construction Stormwater Permit, the stormwater discharges associated with those sites are expected to meet the WLAs set in this TMDL report.

Similar to construction activities, industrial sites are regulated under general permits, in this case either the NPDES/SDS Industrial Stormwater Multi-Sector General Permit (MNR050000) or the NPDES/SDS General Permit for Construction Sand & Gravel, Rock Quarrying, and Hot Mix Asphalt Production facilities (MNG490000). Like the NPDES/SDS General Construction Stormwater Permit, these permits identify BMPs to be implemented to protect water resources from pollutant discharges at the site. If the owner/operators of industrial sites abide by the necessary NPDES/SDS General Stormwater Permits, the discharges associated with those sites are expected to meet the WLAs set in this TMDL report.

Due to the transient nature of construction activities and the minimal amount of industrial activity, it is assumed that 0.1% of the drainage area is under construction and industrial activities at any given time.

Therefore, to calculate the WLA for construction and industrial stormwater, this TMDL report assumes that 0.1% of the load capacity for the stream reach is assigned to construction/industrial stormwater WLA.

Municipal Separate Storm Sewer System

There are no permitted MS4s in the TSS impaired reach, therefore, no TSS WLA for MS4s were assigned.

Livestock Facilities

NPDEs permitted feedlot facilities are assigned a WLA of zero. This is consistent with the conditions of the permits, which allow no pollutant discharge from the livestock housing facilities and associated sites. A list of CAFOs in this watershed is in **Appendix D**.

4.4.4 Margin of safety

The purpose of the MOS is to account for uncertainty with the TMDL allocations. Uncertainty can be associated with data collection, lab analysis, data analysis, modeling error, and implementation activities. An explicit 10% of the LC was established as the MOS and was applied to each flow regime for all LDCs developed for this TMDL. The LDC approach minimizes a great deal of uncertainty by using the full flow spectrum, represented by five flow regime values. The explicit 10% MOS accounts for:

- Uncertainty in the simulated flow data from the HSPF model;
- Uncertainty in the observed water quality data; and
- Extreme variability in streamflow. Allocations and loading capacities are based on flow, which often varies by several orders of magnitude. This variability is accounted for by using the five flow regimes and the LDCs.

The majority of the MOS is apportioned to uncertainty related to the HSPF model. The hydrologic calibration statistics for the HSPF model at the Lac qui Parle River near Lac qui Parle, Minnesota (USGS station ID 05300000) were:

- 7.5% Error in total flow volume;
- 13.7% Error in bottom 50% low flows;
- -1.2% Error in the top 10% high flows;
- An NSE of 0.514 for daily flows;
- And, an NSE of 0.749 for monthly flows.

Overall, the HSPF model accuracy was determined to be “Fair” to “Good”. More information on the calibration of the HSPF model can be found in Tetra Tech (2016). There is no reason to believe a 10% MOS is inappropriate as it is consistent with HSPF modeling errors.

4.4.5 Seasonal variation

Both seasonal variation and critical conditions are accounted for in this TMDL report through the application of LDCs. LDCs evaluate water quality conditions across all flow regimes including high flow, which are the runoff conditions where sediment transport tends to be greatest. Seasonality is accounted for by addressing all flow conditions in a given reach. The maximum load reduction for the TSS TMDL occurs during high flow conditions.

4.4.6 TMDL summary

The LDC in **Figure 18** shows the percent likelihood of flow exceedance on the x-axis, while the computed TSS loading is shown on the y-axis. “Allowable” loadings under each flow condition, based on the water quality standard is shown with a red line. Observed loads are also shown, indicated by points on the plot. The median loads for each flow regime are shown as a solid blue line for median existing loads (labeled as “Existing”) and a dashed red line for median “allowable” load (labeled as “Target”) for the standard under each flow condition. Observed loads are broken out by station, allowing for a detailed examination of when and where loading exceedances have occurred. The “allowable” loads are the LC of the stream reach.

The following rounding conventions were used in the TMDL table:

- Values ≥10 reported in mass/day have been rounded to the nearest whole value.
- Values <10 and ≥1 reported in mass/day have been rounded to the nearest tenth.
- Values <1 and ≥0.01 reported in mass/day have been rounded to the nearest hundredth.
- Values <0.01 reported in mass/day have been rounded to enough significant digits so that the value is greater than zero and a number is displayed in the table.
- While some of the numbers in the table show multiple digits, they are not intended to imply great precision.
- Some small arithmetic errors may exist; this is due to rounding errors.
- Mass refers to tons of TSS.

The TMDL table provides a representative load reduction to provide watershed planners a single target reduction to aid in planning that is not dependent on flow conditions. A single, representative load reduction is easier for watershed planners to translate into annual load reductions when developing restoration and protection plans to improve water quality in the watershed. For TSS, the representative existing condition is taken as the 90th percentile of the observed TSS concentrations. The overall estimated percent reduction is the reduction of the existing condition to meet the 65 mg/L standard. Load reductions for each flow regime can be found in **Appendix A**.

Most of the data used to develop the LDC in the impaired reach is from 2015. Therefore, 2015 is the baseline year for the TSS TMDL.

Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530)

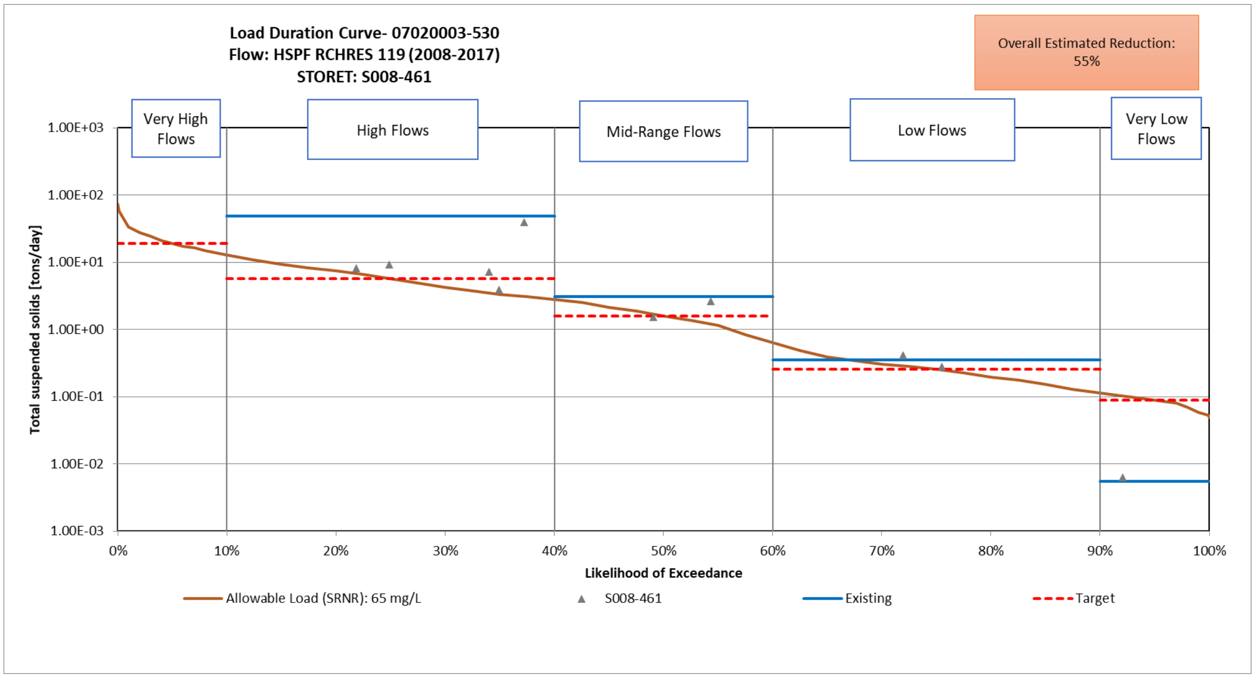

Figure 18. Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530) TSS LDC.

Table 27. Minnesota's TSS load capacity for Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530).

MN's % of Load Capacity: 64.4%	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[tons/day]				
Total Load Capacity	19	5.7	1.6	0.26	0.09
MN Load Capacity	12	3.7	1	0.17	0.058

Table 28. TSS allocations for Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530).

Total Suspended Solids		**Flow Condition**				
		Very High	**High**	**Mid-Range**	**Low**	**Very Low**
		[tons/day]				
Loading Capacity		**12**	**3.7**	**1.0**	**0.17**	**0.058**
Wasteload Allocation	*Construction/Industrial Stormwater*	**0.012**	**0.004**	**0.001**	**0.0002**	**0.0001**
	Total WLA	**0.01**	**0.004**	**0.001**	**0.0002**	**0.0001**
Load Allocation	**Total LA**	**11**	**3.3**	**0.90**	**0.15**	**0.052**
Margin of Safety (MOS)		**1.2**	**0.37**	**0.10**	**0.017**	**0.006**
90th Percentile Concentration		**143.1 mg/L**				
Overall estimated percent reduction		**55%**				

5. Future growth considerations

Potential changes in population and land use/land cover over time in the Lac qui Parle River Watershed could result in changing sources of pollutants. According to the Minnesota State Demographic Center

(MDA 2015), over the next 20 years (2015 to 2035), the populations in the Lac qui Parle River Watershed are projected to decrease in all counties (Lac qui Parle -22.9%, Lincoln -2.7%; Yellow Medicine -6.9%). As with the majority of Minnesota, this loss of population will likely occur in the rural areas and small towns and will result in a negligible amount of change in land use. Overall, there is likely very little to no anticipated future growth in the watershed. Possible changes and how they may or may not impact TMDL allocations are discussed below.

5.1 New or expanding permitted MS4 WLA transfer process

Future transfer of watershed runoff loads in this TMDL report may be necessary if any of the following scenarios occur within the project watershed boundaries.

1. New development occurs within a regulated MS4. Newly developed areas that are not already included in the WLA must be transferred from the LA to the WLA to account for the growth.
2. One regulated MS4 acquires land from another regulated MS4. Examples include annexation or highway expansions. In these cases, the transfer is WLA to WLA.
3. One or more nonregulated MS4 becomes regulated. If this has not been accounted for in the WLA, then a transfer must occur from the LA.
4. Expansion of a U.S. Census Bureau Urban Area encompasses new regulated areas for existing permittees. An example would be existing state highways that were outside of an urban area at the time the TMDL report was completed but are now inside a newly expanded urban area. This will require either a WLA to WLA transfer or a LA to WLA transfer.
5. A new MS4 or other stormwater-related point source is identified and is covered under an NPDES Permit. In this situation, a transfer must occur from the LA.

Load transfers will be based on methods consistent with those used in setting the allocations in this TMDL report. In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

5.2 New or expanding wastewater

The MPCA, in coordination with EPA Region 5, has developed a streamlined process for setting or revising WLAs for new or expanding wastewater discharges to waterbodies with an EPA approved TMDL. This procedure will be used to update WLAs in approved TMDLs for new or expanding wastewater dischargers whose permitted effluent limits are at or below the instream target and will ensure that the effluent concentrations will not exceed applicable water quality standards or surrogate measures. The process for modifying any and all WLAs will be handled by the MPCA, with input and involvement by the EPA, once a permit request or reissuance is submitted. The overall process will use the permitting public notice process to allow for the public and EPA to comment on the permit changes based on the proposed WLA modification(s). Once any comments or concerns are addressed, and the MPCA determines that the new or expanded wastewater discharge is consistent with the applicable water quality standards, the permit will be issued and any updates to the TMDL WLA(s) will be made.

For more information on the overall process, visit the MPCA's TMDL Policy and Guidance webpage.

6. Reasonable assurance

A TMDL report needs to provide reasonable assurance that water quality targets will be achieved through the specified combination of point and NPS reductions reflected in the LAs and WLAs. According to EPA guidance (EPA 2002), "When a TMDL is developed for waters impaired by both point and NPS, and the WLA is based on an assumption that nonpoint-source load reductions will occur... the TMDL should provide reasonable assurances that nonpoint-source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for the EPA to determine that the TMDL, including the LA and WLAs, has been established at a level necessary to achieve water quality standards". In the Lac qui Parle River Watershed, considerable reductions in NPS are required.

The MPCA, other state agencies, and local government partners will:

- Evaluate existing programmatic, funding, and technical capacity to implement basin and watershed strategies.
- Identify gaps in current programs, funding, and local capacity to achieve the needed controls.
- Build program capacity for short-term and long-term goals. Demonstrate increased implementation and/or pollutant reductions.
- Commit to track/monitor/assess and report progress at set regular times.

6.1 Regulatory

6.1.1 Construction Stormwater

Regulated construction stormwater was given a categorical WLA is this study. Construction activities disturbing one acre or more are required to obtain NPDES permit coverage through the MPCA. Compliance with TMDL requirements are assumed when a construction site owner/operator meets the conditions of the Construction General Permit and properly selects, installs, and maintains all BMPs required under the permit, including any applicable additional BMPs required in Section 23 of the Construction General Permit for discharges to impaired waters, or compliance with local construction stormwater requirements if they are more restrictive than those in the State General Permit.

6.1.2 Industrial Stormwater

Industrial stormwater was given a categorical WLA in this study. Industrial activities require permit coverage under the state's NPDES/SDS Industrial Stormwater Multi-Sector General Permit (MNR050000) or NPDES/SDS Nonmetallic Mining/Associated Activities General Permit (MNG490000). If a facility owner/operator obtains stormwater coverage under the appropriate NPDES/SDS permit and properly selects, installs, and maintains BMPs sufficient to meet the benchmark values in the permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL report.

6.1.3 Wastewater NPDES & SDS Permits

The MPCA issues permits for WWTPs and industrial facilities that discharge into waters of the state. The permits have site specific effluent limits (if necessary) for TSS and bacteria that are protective of applicable water quality standards. WWTPs discharging into impaired reaches did not require any changes to their discharge permit limits due to the WLAs calculated in this TMDL report. Permits regulate discharges with the goals of 1) protecting public health and aquatic life, and 2) assuring that every facility treats wastewater. In addition, NPDES and SDS permits set limits and establish controls for land application of waste and byproducts. Since 1996, the MPCA southwest wastewater staff have helped four small communities upgrade their sewer systems throughout the region that includes the Lac qui Parle River Watershed.

NPDES/SDS permits for discharges that may cause or have reasonable potential to cause or contribute to an exceedance of a water quality standard are required to contain water quality-based effluent limits (WQBELs) consistent with the assumptions and requirements of the WLAs in this TMDL report. Attaining the WLAs, as developed and presented in this TMDL report, is assumed to ensure meeting the water quality standards for the relevant impaired waters listings. During the permit issuance or reissuance process, wastewater discharges will be evaluated for the potential to cause or contribute to violations of water quality standards. WQBELs will be developed for facilities whose discharges are found to have a reasonable potential to cause or contribute to pollutants above the water quality standards. The WQBELs will be calculated based on low flow conditions, may vary slightly from the TMDL WLAs, and will include concentration based effluent limitations.

6.1.4 Subsurface Sewage Treatment Systems Program

SSTS, commonly known as septic systems, are regulated by Minn. Stat. §§ 115.55 and 115.56. Counties and other local government units (LGUs) that regulate SSTS must meet the requirements for local SSTS programs in Minn. R. ch. 7082. Counties and other LGUs must adopt and implement SSTS ordinances in compliance with Minn. R. chs. 7080 - 7083.

These regulations detail:

- Minimum technical standards for individual and mid-size SSTS.
- A framework for LGUs to administer SSTS programs.
- Statewide licensing and certification of SSTS professionals, SSTS product review and registration, and establishment of the SSTS Advisory Committee.
- Various ordinances for SSTS installation, maintenance, and inspection.

Each county maintains an SSTS ordinance, in accordance with Minnesota statutes and rules establishing minimum requirements for regulation of SSTS, for the treatment and dispersal of sewage within the applicable jurisdiction of the county, to protect public health and safety, to protect groundwater quality, and to prevent or eliminate the development of public nuisances. Ordinances serve the best interests of the county's citizens by protecting health, safety, general welfare, and natural resources. In addition, each county zoning ordinance prescribes the technical standards that on-site septic systems are required to meet for compliance and outlines the requirements for the upgrade of systems found not to be in compliance. This includes systems subject to inspection at transfer of property, upon the addition of living space that includes a bedroom and/or a bathroom, and at discovery of the failure of an existing system. In order to increase the number of compliance inspections, the MPCA has developed and administers several grants to LGUs for various ordinances. Additional grant dollars are awarded to counties that have additional provisions in their ordinance above the minimum program requirements.

The MPCA has worked with counties through the SSTS Implementation and Enforcement Task Force to identify the most beneficial way to use these funds to accelerate SSTS compliance statewide. **Figure 19** shows the number of SSTS replaced in the counties that are included in the Lac qui Parle River Watershed between 2002 and 2016.

The MPCA staff keeps a statewide database of potentially unsewered or undersewered areas that could include ITPHS systems. Some of those systems potentially could be straight pipe systems. The counties and LGUs are working on assessing these areas and determining if any individual straight pipes exist.

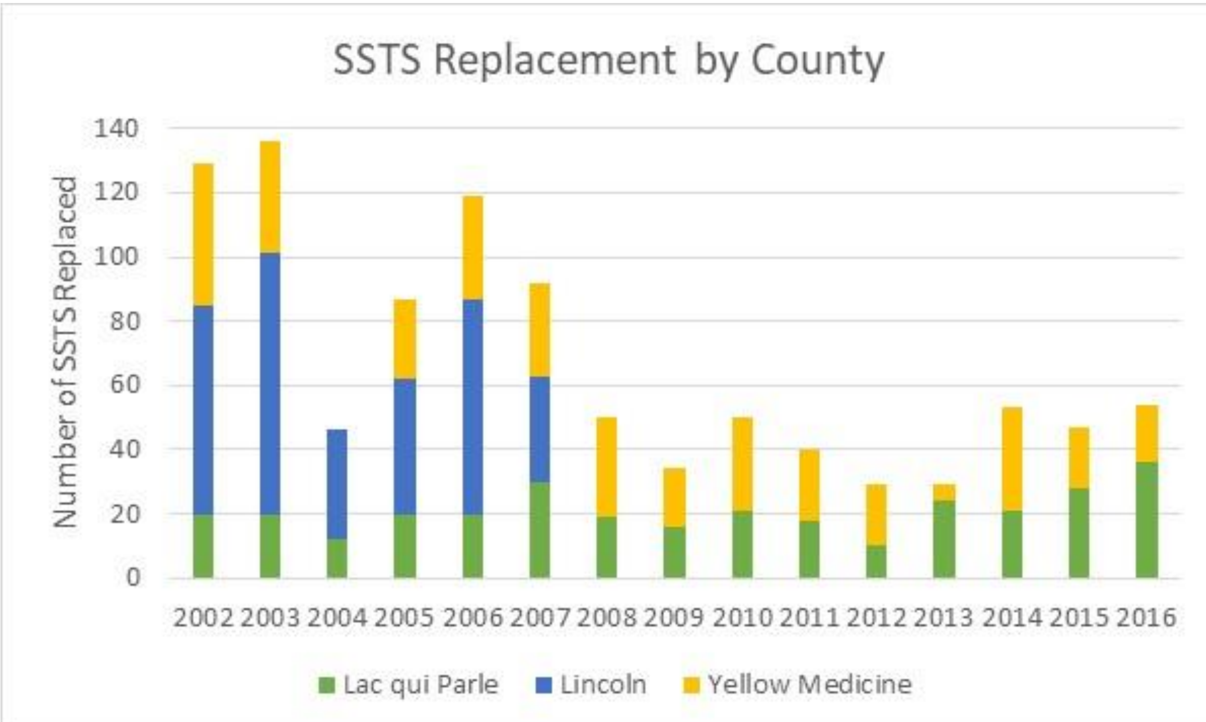

Figure 19: The number of SSTS replacements by County and year in the Lac qui Parle River Watershed.

Upon confirmation of a straight pipe system, the county sends out a notice of noncompliance, which starts a 10-month deadline to bring the system into compliance.

6.1.5 Feedlots

All feedlots in Minnesota are regulated by Minn. R. ch. 7020. The MPCA has regulatory authority of feedlots, but counties may choose to participate in a delegation of the feedlot regulatory authority to the local unit of government. Delegated counties are then able to enforce Minn. R. ch. 7020 (along with any other local rules and regulations) within their respective counties for facilities that are under the Large CAFO threshold. In the Lac qui Parle River Watershed, the counties of Lac qui Parle, Lincoln, and Yellow Medicine are delegated the feedlot regulatory authority. The counties will continue to implement the feedlot program and work with producers on manure management plans.

The MPCA regulates the collection, transportation, storage, processing and disposal of animal manure and other livestock operation waste. The MPCA Feedlot Program implements rules governing these activities and provides assistance to counties and the livestock industry. The feedlot rules apply to most aspects of livestock waste management including the location, design, construction, operation and management of feedlots and manure handling facilities.

There are two primary concerns about feedlots in protecting water:

- Ensuring that manure on a feedlot or manure storage area does not run into water.
- Ensuring that manure is applied to cropland at a rate, time and method that prevents bacteria and other possible contaminants from entering streams, lakes and ground water.

6.1.7 Nonpoint Sources

Existing regulations on NPS of pollution are limited. The following are the current, existing NPS statutes/rules in Minnesota:

- 50-foot buffer required for the shore impact zone of streams classified as protected waters (Minn. Stat. § 103F.201) for agricultural land uses and 16.5-foot minimum width buffer required on public drainage ditches (Minn. Stat. § 103E.021). As of February 2021, all the counties in the Lac qui Parle River Watershed are 99.34% to 99.62% in compliance (J. Beckler, personal communication, February 23, 2021).
- Protecting highly erodible land within the 300-foot shoreland district (Minn. Stat. § 103F.201).
- Excessive soil loss statute (Minn. Stat. § 103F.415).
- Nuisance NPS pollution (Minn. R. 7050.0210, subp. 2).

6.2 Nonregulatory

6.2.1 Pollutant Load Reduction

Reliable means of reducing NPS pollutant loads are fully addressed in the Lac qui Parle River Watershed WRAPS Report (MPCA 2020d), a document that is written to be a companion to this TMDL report. In order for the impaired waters to meet water quality standards, the majority of pollutant reductions in the Lac qui Parle River Watershed will need to come from NPS. Agricultural drainage and surface runoff are major contributors of bacteria, sediment, and increased flows throughout the watershed. The BMPs selected in the WRAPS report strategy tables have demonstrated effectiveness in reducing contributions of pollutants to surface water. The combinations of BMPs discussed throughout the WRAPS process were derived from Minnesota's Nutrient Reduction Strategy (NRS; MPCA 2015a) and related tools. As such, they were vetted by a statewide engagement process prior to being applied in the Lac qui Parle River Watershed.

Selection of sites for BMPs will be led by LGUs, county SWCDs, watershed districts, and counties, with support from state and federal agencies. These BMPs are supported by programs administered by the SWCDs and the Natural Resource Conservation Service (NRCS). Local resource managers are well-trained in promoting, placing, and installing these BMPs. Some counties within the watershed have shown significant levels of adoption of these practices. State and local agencies will need to work with landowners to identify priority areas for BMPs and practices that will help reduce bacteria runoff, as well as streambank and overland erosion. Agencies, organizations, LGUs, and citizens alike need to recognize that resigning waters to an impaired condition is not acceptable. Throughout the course of the WRAPS and TMDL meetings, local stakeholders endorsed the BMPs selected in the WRAPS report. These BMPs reduce pollutant loads from runoff (i.e. sediment and pathogens) and loads delivered through drainage tiles or groundwater flow.

Several nonpermitted reduction programs exist to support implementation of NPS reduction BMPs in the Lac qui Parle River Watershed. These programs identify BMPs, provide means of focusing BMPs, and support their implementation via state initiatives, ordinances, and/or dedicated funding.

From 2004 to 2019, over 2,300 BMPs were installed in the Lac qui Parle River Watershed by local partners (MPCA 2020a). **Figure 20** depicts the number of BMPs per subwatershed in the Lac qui Parle River Watershed. Additional information about the BMPs may be found on the MPCA's Healthier Watershed website.

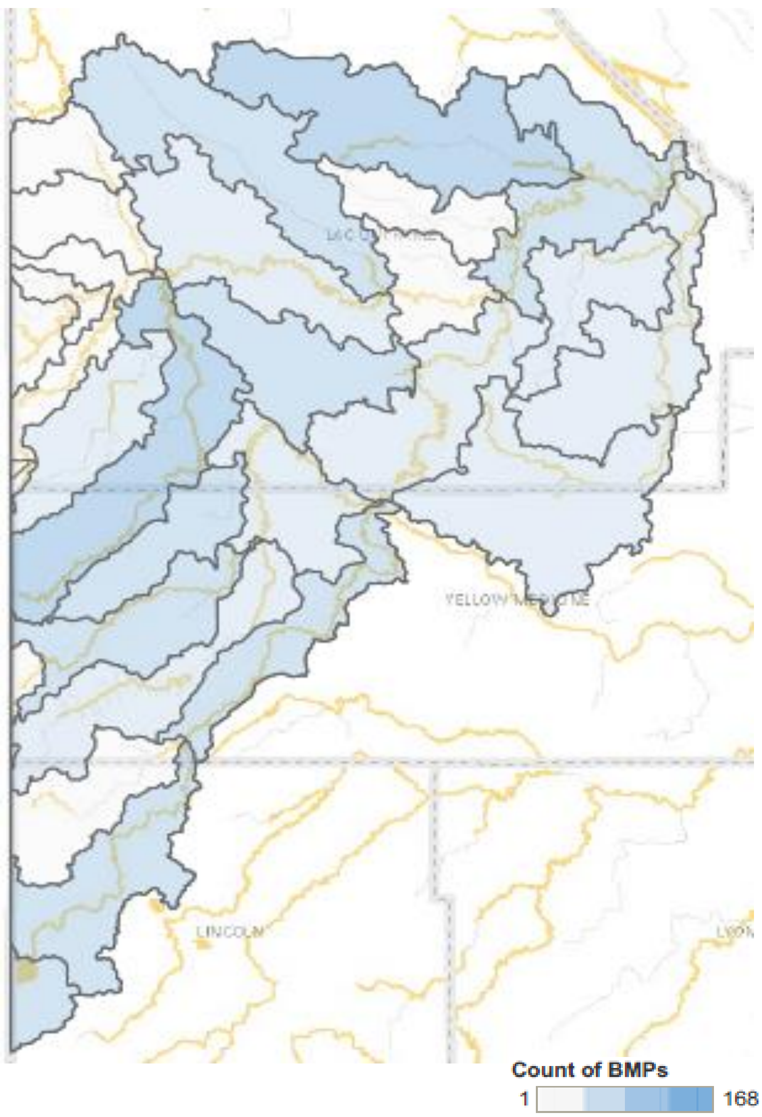

Figure 20. Number of BMPS per subwatershed in the Lac qui Parle River Watershed (MPCA 2020a).

To help achieve NPS reductions, a large emphasis has been placed on public participation, where the citizens and communities that hold the power to improve water quality conditions are involved in discussions and decision-making. The watershed's citizens and communities will need to voluntarily adopt the practices at the necessary scale and rates to achieve the 10-year targets presented in the Lac qui Parle River Watershed WRAPS Report. The WRAPS report also presents the pollutant goals and targets to the primary sources and the estimated years to meet the goals. The strategies identified were used to calculate the adoption rates needed to meet the goals. In addition to public participation, several government programs are in place to support a political and social infrastructure that aims to increase the adoption of strategies that will improve watershed conditions and reduce loading from NPS. **Section 6.2.3** provides information on funding spent in the watershed through these government programs as well as local and landowner contributions.

Minnesota Nutrient Reduction Strategy

The Minnesota Nutrient Reduction Strategy (MPCA 2014) guides activities that support nitrogen and phosphorus reductions in Minnesota waterbodies and those downstream of the state (e.g., Lake Winnipeg, Lake Superior, and the Gulf of Mexico). The NRS was developed by an interagency coordination team with help from public input. Fundamental elements of the NRS include:

- Defining progress with clear goals
- Building on current strategies and success
- Prioritizing problems and solutions
- Supporting local planning and implementation

Included within the strategy discussion are alternatives and tools for consideration by drainage authorities, information on available tools and approaches for identifying areas of phosphorus and nitrogen loading and tracking efforts within a watershed, and additional research priorities. The NRS is focused on incremental progress and provides meaningful and achievable nutrient load reduction milestones that allow for better understanding of incremental and adaptive progress toward final goals. It has set a reduction of 45% for both phosphorus and nitrogen in the Mississippi River, downstream of the Lac qui Parle.

Successful implementation of the NRS will require broad support, coordination, and collaboration among agencies, academia, local government, and private industry. The MPCA is implementing a framework to integrate its water quality management programs on a major watershed scale, a process that includes:

- Intensive watershed monitoring
- Assessment of watershed health
- Development of WRAPS reports
- Management of NPDES and other regulatory and assistance programs

This framework will result in nutrient reduction for the basin as a whole and the major watersheds within the basin.

Minnesota Agricultural Water Quality Certification Program

The Minnesota Agricultural Water Quality Certification Program (MAWQCP) is a voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect waters. Those who implement and maintain approved farm management practices are certified and in turn obtain regulatory certainty for a period of 10 years.

Through this program, certified producers receive:

- **Regulatory certainty**: Certified producers are deemed to be in compliance with any new water quality rules or laws during the period of certification
- **Recognition**: Certified producers may use their status to promote their business as protective of water quality
- **Priority for assistance**: Producers seeking certification can obtain specially designated technical and financial assistance to implement practices that promote water quality

Through this program, the public receives assurance that certified producers are using conservation practices to protect Minnesota's lakes, rivers, and streams. Since the start of the program in 2014, through 2020, the Ag Water Quality Certification Program has:

- Enrolled over 692,000 acres;
- Included 984 producers;
- Added more than 2,000 new conservation practices;
- Kept over 38,000 tons of sediment out of Minnesota rivers;
- Saved over 108,000 tons of soil and 47,000 pounds of phosphorus on farms; and
- As of June 2020, there are 825 acres certified under the MAWQCP in the Lac qui Parle River Watershed.

Other NPS Implementation Programs

Water Quality Trends for Minnesota Rivers and Streams at Milestone Sites (MPCA 2014b) notes that sites across Minnesota show reductions over the period of record for TSS, phosphorus, ammonia, and biochemical oxygen demand. The Minnesota NRS documented a 33% reduction of the phosphorus load leaving the state via the Mississippi River from the pre-2000 baseline to current (MPCA 2015a). These reports generally agree that while further reductions are needed, municipal and industrial phosphorus loads, as well as loads of runoff-driven pollutants (i.e. TSS) are decreasing; a conclusion that lends assurance that the Lac qui Parle River Watershed WRAPS and TMDL phosphorus goals and strategies are reasonable and that long-term, enduring efforts to decrease erosion and nutrient loading to surface waters have the potential to reduce pollutant loads.

Federal CWA Section 319 grants and state Clean Water Partnership grants and loans have been utilized within the Lac qui Parle River Watershed. Section 319 grants are utilized by local units of government to work with citizens and landowners to implement NPS conservation practices. These funds also help with education and public participation to promote voluntary practices and educate on water quality. Clean Water Partnership grants were awarded to local units of government to implement conservation practices and fund education and public participation activities. Clean Water Partnership loans are loaned out to local units of governments and have primarily been utilized to upgrade septic systems within the basin.

Conservation easements are a critical component of the state's efforts to improve water quality by reducing soil erosion, phosphorus, and nitrogen loading, and improving wildlife habitat and flood attenuation on private lands. Easements protect the state's water and soil resources by permanently restoring wetlands, adjacent native grassland wildlife habitat complexes and permanent riparian buffers. In cooperation with counties and SWCDs, USDA NRCS and Board of Water and Soil Resources (BWSR) programs compensate landowners for granting conservation easements and establishing native vegetation habitat on economically marginal, flood-prone, environmentally sensitive or highly erodible lands. These easements vary in length of time from 10 years to permanent/perpetual easements. Types of conservation easements in Minnesota include: Conservation Reserve Program (CRP); Conservation Reserve Enhancement Program (CREP); Reinvest in Minnesota (RIM); and the Wetland Reserve Program (WRP) or Permanent Wetland Preserve (PWP) and are implemented throughout Minnesota (**Figure 21)**. As of October 2019, in the counties of Lac qui Parle, Lincoln, and Yellow Medicine, there were 71,744 acres of short-term conservation easements such as CRP and 23,097 acres of long term or permanent easements (CREP, RIM, WRP; BWSR 2019).

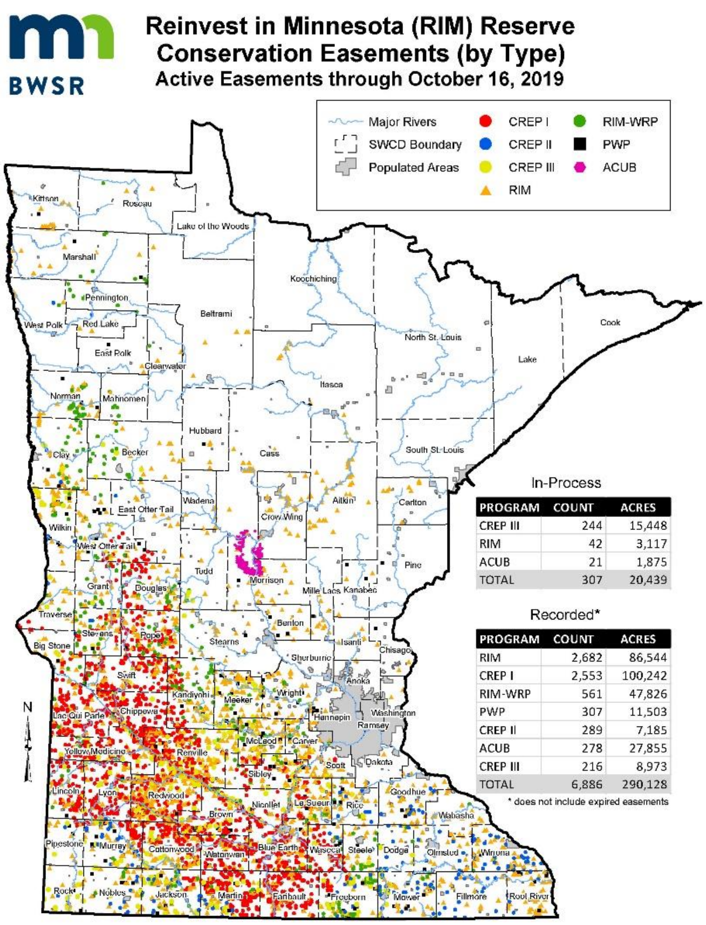

Figure 21. Reinvestment in Minnesota Reserve Conservation Easements in Minnesota (BSWR 2019)

6.2.2 Prioritization

The Lac qui Parle River Watershed WRAPS details a number of tools that provide means for identifying priority pollutant sources and implementation work in the watershed. Further, LGUs in the Lac qui Parle River Watershed often employ their own local analysis for determining priorities for work.

Light Detection and Ranging (LiDAR) data is available for all of the Lac qui Parle River Watershed within Minnesota. It is being increasingly used by LGUs to examine landscapes, understand watershed hydrology, and prioritize BMP targeting.

6.2.3 Funding

On November 4, 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment to the state's constitution to:

- protect drinking water sources;
- protect, enhance, and restore wetlands, prairies, forests, and fish, game, and wildlife habitat;
- preserve arts and cultural heritage;
- support parks and trails; and
- protect, enhance, and restore lakes, rivers, streams, and groundwater

This is a secure funding mechanism with the explicit purpose of supporting water quality improvement projects.

Additionally, there are many other funding sources for nonpoint pollutant reduction work; they include but are not limited to CWA Section 319 grant programs, the state Clean Water Partnership zero-interest loan program, the Agricultural BMP Loan Program, and NRCS incentive programs. Programs and activities are also occurring at the local government level, where county staff, commissioners, and residents work together to address water quality issues.

Since 2004, over $65 million dollars have been spent addressing water quality issues in the Lac qui Parle River Watershed (MPCA 2020c; **Figure 22**). Additional information about funding may be found on the MPCA's Healthier Watersheds website.

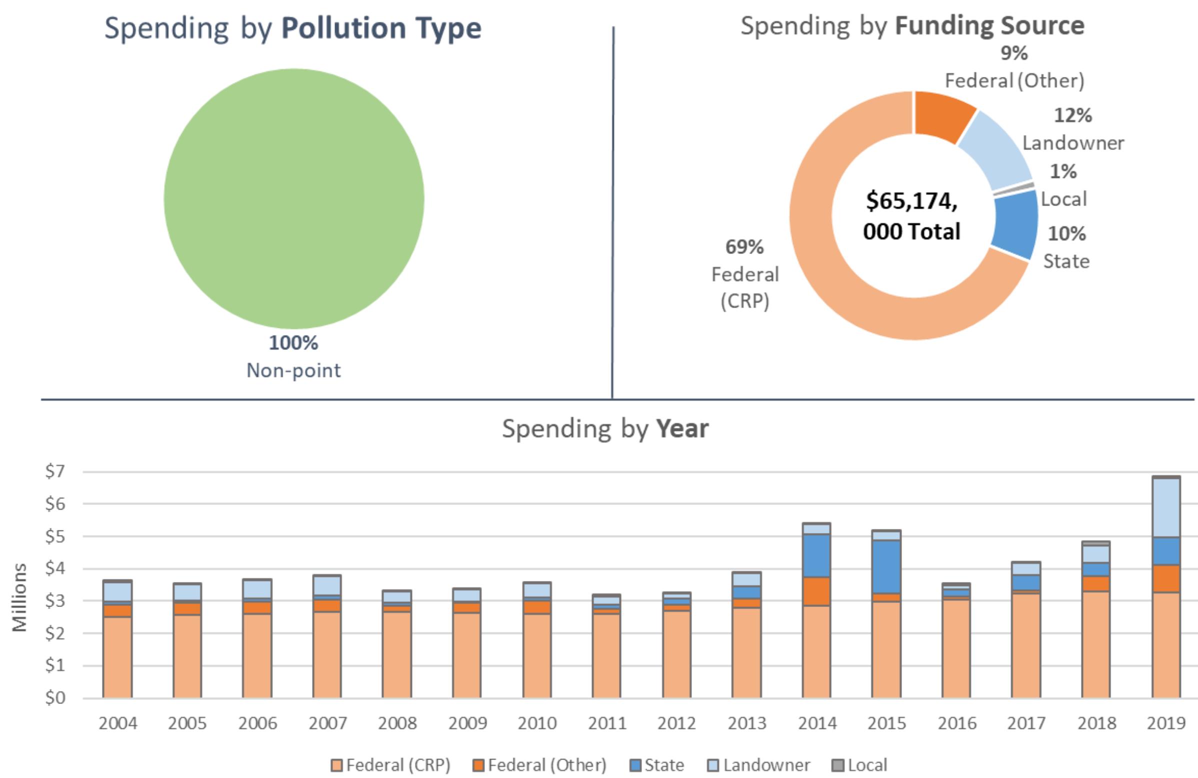

Figure 22. Spending (2004 – 2019) addressing water quality issues in the Lac qui Parle River Watershed (MPCA 2020c).

6.2.4 Planning and Implementation

The WRAPS, TMDLs, and all the supporting documents provide a foundation for planning and implementation. Subsequent planning, including development of a "One Watershed, One Plan" (1W1P) for the Lac qui Parle River Watershed, will draw on the goals, technical information, and tools to choose actions for implementation. For the purposes of reasonable assurance, the WRAPS report is sufficient in that it provides strategies for achieving pollutant reduction goals. However, many of the goals outlined in this TMDL report are very similar to objectives outlined in County Water Plans. County plans have the same goal of removing streams from the 303(d) impaired waters list. These plans provide watershed-specific strategies for addressing water quality issues. In addition, the commitment and support from the local governmental units will ensure that this TMDL project is carried successfully through implementation.

LGUs, including counties, SWCDs and the Lac qui Parle – Yellow Bank Watershed District, are currently developing a 1W1P for the Lac qui Parle River Watershed. The watershed was selected for planning funding in 2020. A 1W1P is a comprehensive watershed management plan that utilizes a scientific-based approach to watershed management for planning purposes within the watershed boundary. According to Minnesota Statute 103B.801, these plans must address surface water restoration. The data included in this TMDL will be drawn on in the plan development process.

Local partners have already been implementing BMPs to address bacteria and sediment in the Lac qui Parle River Watershed. A project is underway to protect Del Clark Lake and to restore Canby Creek. The lake is the only confirmed recreational waterbody in the watershed with water quality in full support of aquatic recreation. Due to the lake's location as a flood prevention measure for the town of Canby, a large amount of topographic relief is found in the tributaries prior to outletting into the lake. As a result, large amounts of sediment and nutrient loading is observed in the lake following snowmelt and large precipitation events. A current Minnesota Clean Water Fund grant is underway to develop control basins in three small tributaries immediately upstream to protect Del Clark Lake. Additional upstream BMPs in the Canby Creek watershed will be installed to restore a recent impairment listing in Canby Creek.

Since 2005, multiple low interest loans provided by the Clean Water Partnership loan program were implemented in the Lac qui Parle River Watershed to upgrade septic systems. The loans were offered to watershed citizens to assist with the costs of replacing failing septic systems. The loan program has historically assisted in replacing approximately 12 systems per year, with the number rising closer to 20 systems in recent years.

6.3 Reasonable Assurance Summary

In summary, significant time and resources have been devoted to identifying the best BMPs in the Lac qui Parle River Watershed, providing means of focusing them, and supporting their implementation via state initiatives and dedicated funding. The Lac qui Parle River Watershed WRAPS and TMDLs process engaged partners to arrive at reasonable examples of BMP combinations that attain pollutant reduction goals. Minnesota is a leader in watershed planning as well as monitoring and tracking progress toward water quality goals and pollutant load reductions. Finally, examples cited herein confirm that BMPs and restoration projects have proven to be effective over time and, as stated by the State of Minnesota Court of Appeals in A15-1622 MCEA vs MPCA and MCES.

Substantial evidence exists to conclude that voluntary reductions from NPS have occurred in the past and can be reasonably expected to occur in the future. The NRS (MPCA 2015, and 2020 progress report) provides substantial information on existing state programs designed to achieve reductions in NPS pollution, as evidence that reductions in nonpoint pollution have been achieved and can reasonably be expected to continue to occur.

7. Monitoring plan

Data from three water quality monitoring programs enables water quality condition assessment and creates a long-term data set to track progress towards water quality goals. BMPs implemented by LGUs will continue to be tracked through BWSR's e-Link system. These programs will continue to collect and analyze data in the Lac qui Parle River Watershed as part of Minnesota's Water Quality Monitoring Strategy (MPCA 2011). Data needs are considered by each program and additional monitoring is implemented when deemed necessary and feasible. These monitoring programs are summarized below:

Intensive Watershed Monitoring (MPCA 2012) data provides a periodic but intensive "snapshot" of water quality throughout the watershed. This program collects water quality and biological data at roughly 100 stream and 50 lake monitoring stations across the watershed for 1 to 2 years, every 10 years. To measure pollutants across the watershed the MPCA will revisit and reassess the watershed, as well as have capacity to visit new sites in areas with BMP implementation activity.

Watershed Pollutant Load Monitoring Network (MPCA 2016b) data provide a continuous and long-term record of water quality conditions at the major watershed and subwatershed scale. This program collects pollutant samples and flow data to calculate continuous daily flow, sediment, and nutrient loads. In the Lac qui Parle River Watershed, there is year-round site near the outlet of the Lac qui Parle River and two seasonal (spring through fall) subwatershed sites.

Citizen Stream and Lake Monitoring Program (MPCA 2020b) data provide a continuous record of waterbody transparency throughout much of the watershed. This program relies on a network of private citizen volunteers who make monthly lake and river measurements throughout the year. Approximately six citizen monitoring locations exist in the Lac qui Parle River Watershed.

8. Implementation strategy summary

The strategies described in this section are potential actions to reduce bacteria (*E. coli*) and TSS in the Lac qui Parle River Watershed in Minnesota. A more detailed discussion on implementation strategies can be found in the Lac qui Parle River Watershed WRAPS Report (MPCA 2020d).

8.1 Permitted sources

8.1.1 Construction stormwater

The WLA for stormwater discharges from sites where there is construction activity reflects the number of construction sites greater than one acre expected to be active in the watershed at any one time, and the BMPs and other stormwater control measures that should be implemented at the sites to limit the discharge of pollutants of concern. The BMPs and other stormwater control measures that should be implemented at construction sites are defined in Minnesota’s NPDES/SDS General Stormwater Permit for Construction Activity (MNR100001). If a construction site owner/operator obtains coverage under the NPDES/SDS General Stormwater Permit and properly selects, installs, and maintains all BMPs required under the permit, including those related to impaired waters discharges and any applicable additional requirements found in Appendix A of the Construction General Permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL. Construction activity must also meet all local government construction stormwater requirements.

8.1.2 Industrial stormwater

The WLA for stormwater discharges from sites where there is industrial activity reflects the number of sites in the watershed for which NPDES Industrial Stormwater Permit coverage is required, and the BMPs and other stormwater control measures that should be implemented at the sites to limit the discharge of pollutants of concern. The BMPs and other stormwater control measures that should be implemented at the industrial sites are defined in the State’s NPDES/SDS Industrial Stormwater Multi-Sector General Permit (MNR050000), or NPDES/SDS General Permit for Construction Sand and Gravel, Rock Quarrying and Hot Mix Asphalt Production facilities (MNG490000). If a facility owner/operator obtains stormwater coverage under the appropriate NPDES/SDS Permit and properly selects, installs, and maintains all BMPs required under the permit, the stormwater discharges would be expected to be consistent with the WLA in this TMDL report. It should be noted that all local stormwater management requirements must also be met.

8.1.3 Wastewater

The MPCA issues permits for WWTPs that discharge into waters of the state. The permits have site-specific limits that are based on water quality standards. WWTPs discharging into impaired watersheds did not require any changes to their discharge permit limits due to the WLAs calculated in this TMDL report. Permits regulate discharges with the goals of protecting public health and aquatic life and assuring that every facility treats wastewater. In addition, SDS Permits set limits and establish controls for land application of sewage.

8.2 Nonpermitted sources

A summary of potential BMPs to reduce NPS is provided in **Table 29**. Potential BMPs and implementation strategies are explored more thoroughly in the Lac qui Parle River Watershed WRAPS Report (MPCA 2020d).

Table 29. Summary of agricultural BMPs for agricultural sources and their primary targeted pollutants.

Land use	Lac qui Parle River Watershed BMPs	Targeted Pollutant	
		Bacteria	Sediment
Cultivated Crops	Grassed waterway	x	x
	Conservation tillage		x
	Critical area planting		x
	Improved manure field application	x	
	Cover crops		x
	WASCOBS, terraces, flow-through basins		x
	Buffers, border filter strips	x	x
	Contour strip cropping (50% crop in grass)	x	x
	Wind Breaks		x
	Conservation cover (replacing marginal farmed areas)	x	x
	In/near ditch retention/treatment	x	x
	Alternative tile intakes	x	x
	Wetland Restoration	x	x
	Retention Ponds	x	x
	Mitigate agricultural drainage projects	x	x
	Maintenance and new enrollment of BMPs, CRP, RIM, etc.	x	x
Pastures	Rotational grazing/improved pasture vegetation management	x	x
	Livestock stream exclusion and watering facilities	x	x
Cities & yards	Infiltration/retention ponds, wetlands		x
	Street sweeping & storm sewer mgt.	x	x

Land use	Lac qui Parle River Watershed BMPs	Targeted Pollutant	
		Bacteria	Sediment
	Trees/native plants		x
	Permeable pavement for new construction		x
SSTS	Maintenance and replacement/upgrades	x	
Feedlots	Feedlot runoff controls including buffer strips, clean water diversions, etc.	x	
Streams, ditches, & ravines	Protect and restore buffers, natural features	x	x
	Reduce or eliminate ditch clean-outs		x
	Bridge/culvert design		x
	Streambank stabilization		x
	Ravine/stream (grade) stabilization		x
	Stream channel restoration and floodplain reconnection		x
Lakes & Wetlands	Near-water vegetation protection and restoration		x
Grassland & Forest	Protect and restore areas in these land uses, increase native species populations		x

8.3 Cost

The CWLA requires that a TMDL report include an overall approximation of the cost to implement a TMDL [Minn. Stat. 2007 § 114D.25]. The costs to implement the activities outlined in the Lac qui Parle WRAPS Report (MPCA 2020d) are approximately $20 to $40 million over the next 20 years. This range reflects the level of uncertainty in the source assessment and addresses the high priority sources identified in **Section 3.5**. The cost includes increasing local capacity to oversee implementation in the watershed and the voluntary actions needed to achieve reductions. Required buffer installation and replacement of ITPHS systems are not included.

8.4 Adaptive management

Adaptive management is an iterative implementation process that makes progress toward achieving water quality goals while using new data and information to reduce uncertainty and adjust implementation activities, as shown in **Figure 23**. The State of Minnesota has a unique opportunity to adaptively manage water resource plans and implementation activities every 10 years. This opportunity resulted from a voter-approved tax increase to improve state waters. The resulting interagency coordination effort is referred to as the Minnesota Water Quality Framework, which works to monitor and assess Minnesota's major watersheds every 10 years. This framework supports ongoing implementation and adaptive management of conservation activities and watershed-based local planning efforts utilizing regulatory and nonregulatory means to achieve water quality standards.

Implementation of TMDL related activities can take many years, and water quality benefits associated with these activities can also take many years. As the pollutant source dynamics within the watershed are better understood, implementation strategies and activities will be adjusted and refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired reaches and lakes. The follow-up water monitoring program outlined in **Section 7** will be integral to the adaptive management approach, providing assurance that implementation measures are succeeding in achieving water quality standards. Adaptive management does not include changes to water quality standards or LC. Any changes to water quality standards or LC must be preceded by appropriate administrative processes, including public notice and an opportunity for public review and comment.

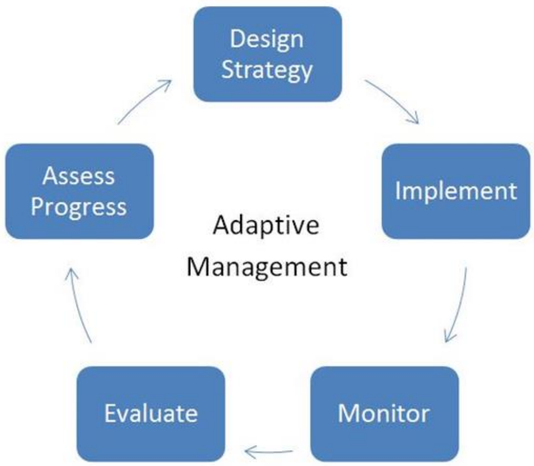

Figure 23. The cycle of adaptive management.

A list of implementation strategies in the WRAPS report prepared in conjunction with this TMDL report will focus on adaptive management (Figure 23). Continued monitoring and "course corrections" responding to monitoring results are the most appropriate strategy for achieving the water quality goals established in this TMDL report. Management activities will be changed or refined to efficiently meet the TMDLs and lay the groundwork for de-listing the impaired waterbodies.

9. Public participation

Public participation was a major focus during the Lac qui Parle River Watershed project related to WRAPS and the TMDL report. The MPCA worked with county and SWCD staff, the Lac qui Parle Yellow Bank Watershed District, and other state agency staff in the three counties to help with education on water quality and impaired reaches. Local partner involvement related to the TMDL report included report development and editing and setting pollution reduction goals.

A local engagement workshop was held to obtain farmer, landowner, and local government partner input on preferred BMPs. This information was obtained through a survey containing the full suite of possible practices. Workshop attendees were requested to rank each parameter as well as the practices within each parameter in order of importance

Public notice

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from June 7, 2021 to July 7, 2021. No comment letters were received as a result of the public comment period.

10. Literature cited

Board of Water and Soil Resources (BWSR). 2019. Conservation Lands Summary – Statewide. https://bwsr.state.mn.us/sites/default/files/2019-08/CLS_Statewide_Summary.pdf

Emmons & Oliver Resources, Inc. (EOR). 2009. Literature Summary of Bacteria-Environmental Associations. https://www.pca.state.mn.us/sites/default/files/wq-iw8-08l.pdf

Environmental Protection Agency, United States (EPA). 1986. Bacteriological Ambient Water Quality Criteria for Marine and Fresh Recreational Waters. Office of Research and Development- Microbiology and Toxicology Division. Cincinnati, OH and Office of Water Regulations and Standards Division. Washington D.C.

Environmental Protection Agency, United States (EPA). 2002. Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992. https://www.epa.gov/sites/production/files/2015-10/documents/2002_06_04_tmdl_guidance_final52002.pdf

Environmental Protection Agency (EPA). 2007. An Approach for Using Load Duration Curves in the Development of TMDLs. U.S. Environmental Protection Agency Office of Water, Washington, DC https://www.epa.gov/sites/production/files/2015-07/documents/2007_08_23_tmdl_duration_curve_guide_aug2007.pdf

Environmental Protection Agency (EPA). 2013. A Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program. https://www.epa.gov/sites/production/files/2015-07/documents/vision_303d_program_dec_2013.pdf

Ishii, Satoshi, Tao Yan, Hung Vu, Dennis L. Hansen, Randall E. Hicks, and Michael J. Sadowsky. 2010. Factors Controlling Long-Term Survival and Growth of Naturalized *Escherichia coli* Populations in Temperate Field Soils. Microbes and Environments, Vol. 25, No. 1, pp. 8–14, 2010.

Minnesota Department of Administration (MDA). State Demographic Center. 2015. 2015-2035 County Population Projections, totals only. https://mn.gov/admin/demography/data-by-topic/population-data/

Minnesota Department of Natural Resources (DNR). 1994. Presettlement Vegetation. https://gisdata.mn.gov/dataset/biota-marschner-presettle-veg

Minnesota Department of Natural Resources (DNR). 2019. Lac qui Parle River Watershed Characterization Report. https://wrl.mnpals.net/islandora/object/WRLrepository%3A3341

Minnesota Pollution Control Agency (MPCA). 2009. Bacteria TMDL Protocols and Submittal Requirements. https://www.pca.state.mn.us/sites/default/files/wq-iw1-08.pdf

Minnesota Pollution Control Agency (MPCA). 2011. Minnesota's water quality Monitoring Strategy 2011 to 2021. https://www.pca.state.mn.us/sites/default/files/p-gen1-10.pdf

Minnesota Pollution Control Agency (MPCA). 2012. Intensive Watershed Monitoring. https://www.pca.state.mn.us/water/watershed-sampling-design-intensive-watershed-monitoring

Minnesota Pollution Control Agency (MPCA). 2014a. The Minnesota Nutrient Reduction Strategy. https://www.pca.state.mn.us/sites/default/files/wq-s1-80.pdf

Minnesota Pollution Control Agency (MPCA). 2014b. Water Quality Trends for Minnesota Rivers and Streams at Milestone Sites. https://www.pca.state.mn.us/sites/default/files/wq-s1-71.pdf

Minnesota Pollution Control Agency (MPCA). 2015a. Nutrient Reduction Strategy. http://www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/nutrient-reduction/nutrient-reduction-strategy.html

Minnesota Pollution Control Agency (MPCA). 2015b. Prioritization Plan for Minnesota 303(d) Listings to Total Maximum Daily Loads. https://www.pca.state.mn.us/sites/default/files/wq-iw1-54.pdf

Minnesota Pollution Control Agency (MPCA). 2016b. Watershed Pollutant Load Monitoring Network. https://www.pca.state.mn.us/sites/default/files/wq-cm1-03.pdf

Minnesota Pollution Control Agency (MPCA). 2018. Lac qui Parle River Watershed Monitoring and Assessment Report. https://www.pca.state.mn.us/sites/default/files/wq-ws3-07020003b.pdf

Minnesota Pollution Control Agency (MPCA). 2019a. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List. https://www.pca.state.mn.us/sites/default/files/wq-iw1-04k.pdf

Minnesota Pollution Control Agency (MPCA). 2019b. Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria. https://www.pca.state.mn.us/sites/default/files/wq-s6-18.pdf

Minnesota Pollution Control Agency (MPCA). 2019c. Statewide Altered Watercourse Project. https://gisdata.mn.gov/dataset/water-altered-watercourse

Minnesota Pollution Control Agency (MPCA). 2020a. Best management practices implemented by watershed. https://www.pca.state.mn.us/water/best-management-practices-implemented-watershed

Minnesota Pollution Control Agency (MPCA). 2020b. Citizen water monitoring. https://www.pca.state.mn.us/water/citizen-water-monitoring

Minnesota Pollution Control Agency (MPCA). 2020c. Spending for watershed implementation projects. https://www.pca.state.mn.us/water/spending-watershed-implementation-projects

Minnesota Pollution Control Agency (MPCA). 2020d. The Lac qui Parle River Watershed WRAPS Report. https://www.pca.state.mn.us/water/watersheds/lac-qui-parle-river

Multi-Resolution Land Characteristics Consortium (MRLCC). 2016. NLCD 2015 Land Cover (CONUS). https://www.mrlc.gov/data/nlcd-2016-land-cover-conus

Reynolds, Ronald, Terry Shaffer, Charlies Loesch, Robert Cox Jr. 2006. The Farm Bill and Duck Production in the Prairie Pothole Region: Increasing the Benefits. Wildlife Society Bulletin 34(4); 963-974.

Sadowsky M. J., R. Chandrasekaran, M. Hamilton, P. Wang, C. Staley, S. Matteson, A. Birr. 2015. Geographic isolation of *Escherichia coli* genotypes in sediments and water of the Seven Mile Creek — A constructed riverine watershed. Science of the Total Environment 538 (2015) 78–85, https://www.sciencedirect.com/science/article/pii/S0048969715305179

South Dakota Department of Environment and Natural Resources (SD DENR). 1999. SD Department of Environment & Natural Resources Watershed Protection Program Total Maximum Daily Load:

Lake Hendricks Watershed, Brookings County South Dakota. https://denr.sd.gov/dfta/wp/tmdl/tmdl_hendricks.pdf

Tetra Tech. 2016. Minnesota River Headwaters and Lac qui Parle River Basins Watershed Model Development Final Report. Prepared for Minnesota Pollution Control Agency. 116pp.

Wenck Associates, Inc. 2013. Lac qui Parle Yellow Bank Bacteria, Turbidity, and Low Dissolved Oxygen TMDL Assessment Report. Prepared for Lac qui Parle Yellow Bank Watershed District. https://www.pca.state.mn.us/water/tmdl/lac-qui-parle-yellow-bank-bacteria-turbidity-and-low-dissolved-oxygen-tmdl-project

Appendices

Appendix A. Stream Load Calculations

Loading Capacity Methodology

Data

The water quality data used to develop the LDCs were obtained from the MPCA through their EQuIS database and Environmental Data Application (EDA) data portal (https://www.pca.state.mn.us/quick-links/eda-surface-water-data). Flow data was extracted from the Minnesota River-Headwaters and Lac qui Parle HSPF watershed model (Tetra Tech 2016). For the purposes of creating the LDCs, water quality data and flow for 2008 through 2017 were used to correspond with the most current assessment period and conditions.

Table 1A provides a list of available water quality stations and HSPF model reaches used to develop the LDCs. It should be noted that not all water quality stations located in LDC reaches are listed in **Table 1A,** only those with data that was included in the LDCs.

Table 1A. WIDs with developed LDCs, stressors, flow data sources, and water quality stations used.

WID	Pollutant/Stressor	Flow Station USGS or HSPF ID	Available Water Quality Stations
07020003-502	*Escherichia coli*	HSPF RCHRES 100	S000-143
07020003-513	*Escherichia coli*	HSPF RCHRES 300+301	S004-554
07020003-517	*Escherichia coli*	HSPF RCHRES 311	S008-464
07020003-519	*Escherichia coli*	HSPF RCHRES 313	S008-468
07020003-523	*Escherichia coli/*	HSPF RCHRES 307	S008-467
07020003-530	*Escherichia coli/* Total Suspended Solids	HSPF RCHRES 119	S008-461
07020003-580	*Escherichia coli*	HSPF RCHRES 303	S008-465
07020003-581	*Escherichia coli*	HSPF RCHRES 140	S001-841

Flow Regimes and Reductions

The tables below (**Table 2A** through **Table 10A**) for each impaired reach include the existing load, load reduction, and percentage of load reduction needed to meet the water quality standard for each flow regime and the average existing monthly geometric mean and the overall load reduction percentage in provided for each impaired reach.

Escherichia coli

Table 2A. *E. coli* loading capacity for Lac qui Parle River, Tenmile Cr to Minnesota R (07020003-502).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**4,440**	**1,660**	**454**	**93**	**37**
Existing Load	NA[1]	12,379	1,043	54	NA[1]
Load Reduction	NA[1]	10,718	588	-38	NA[1]
Percent Load Reduction	NA[1]	87%	56%	-71%	NA[1]
Average existing monthly geometric mean	**202.7 org/100 mL**				
Overall estimated percent reduction	**39%**				

[1]No observed water quality data available for this flow regime.

Table 3A. *E. coli* loading capacity for Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R (07020003-513).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**1,834**	**653**	**220**	**62**	**31**
Existing Load	NA[1]	2,006	716	148	NA[1]
Load Reduction	NA[1]	1,353	496	86	NA[1]
Percent Load Reduction	NA[1]	67%	69%	58%	NA[1]
Average existing monthly geometric mean	**352.5 org/100 mL**				
Overall estimated percent reduction	**64%**				

[1]No observed water quality data available for this flow regime.

Table 4A. *E. coli* loading capacity for Lost Creek, Crow Timber Cr to W Br Lac qui Parle R (07020003-517).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**363**	**95**	**34**	**8.2**	**2.7**
Existing Load	NA[1]	230	36	8.8	NA[1]
Load Reduction	NA[1]	135	2.0	0.6	NA[1]
Percent Load Reduction	NA[1]	59%	6%	7%	NA[1]
Average existing monthly geometric mean	**154.4 org/100 mL**				
Overall estimated percent reduction	**21%**				

[1]No observed water quality data available for this flow regime.

Table 5A. *E. coli* loading capacity for Lac qui Parle River, West Branch, MN/SD border to Lost Cr (07020003-519).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**273**	**82**	**25**	**6.5**	**2.3**
Existing Load	NA[1]	178	236	50	NA[1]
Load Reduction	NA[1]	96	210	44	NA[1]
Percent Load Reduction	NA[1]	54%	89%	87%	NA[1]
Average existing monthly geometric mean	**914.9 org/100 mL**				
Overall estimated percent reduction	**86%**				

[1]No observed water quality data available for this flow regime.

Table 6A. *E. coli* loading capacity for County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R (07020003-523).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**1,177**	**368**	**130**	**34**	**12**
Existing Load	NA[1]	179	37	14	NA[1]
Load Reduction	NA[1]	-189	-93	-20	NA[1]
Percent Load Reduction	NA[1]	-106%	-251%	-140%	NA[1]
Average existing monthly geometric mean	**301.9 org/100 mL**				
Overall estimated percent reduction	**-107%**				

[1]No observed water quality data available for this flow regime.

Table 7A. *E. coli* loading capacity for Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**328**	**94**	**25**	**3.7**	**1.4**
Existing Load	NA[1]	554	161	22	NA[1]
Load Reduction	NA[1]	459	136	19	NA[1]
Percent Load Reduction	NA[1]	83%	84%	83%	NA[1]
Average existing monthly geometric mean	**798.6 org/100 mL**				
Overall estimated percent reduction	**85%**				

[1]No observed water quality data available for this flow regime.

Table 8A. *E. coli* loading capacity for Unnamed creek, -96.1517, 44.9533 to W Br Lac qui Parle R (07020003-580).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**239**	**53**	**14**	**2.5**	**1.4**
Existing Load	NA[1]	53	15	4.6	NA[1]
Load Reduction	NA[1]	-0.2	0.7	2.1	NA[1]
Percent Load Reduction	NA[1]	0%	5%	46%	NA[1]
Average existing monthly geometric mean	**215.7 org/100 mL**				
Overall estimated percent reduction	**38%**				

[1]No observed water quality data available for this flow regime.

Table 9A. *E. coli* loading capacity for Unnamed ditch (County Ditch 4), Unnamed ditch to CSAH 20 (07020003-581).

Escherichia coli	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[Billions organisms/day]				
Loading Capacity	**274**	**59**	**16**	**3.2**	**0.9**
Existing Load	NA[1]	145	68	2.5	NA[1]
Load Reduction	NA[1]	87	52	-0.7	NA[1]
Percent Load Reduction	NA[1]	60%	77%	-28%	NA[1]
Average existing monthly geometric mean	**292.8 org/100 mL**				
Overall estimated percent reduction	**61%**				

[1]No observed water quality data available for this flow regime.

Total Suspended Solids

Table 10A. TSS loading capacity for Unnamed creek, Unnamed cr to Lac qui Parle R (07020003-530).

Total Suspended Solids	Flow Condition				
	Very High	High	Mid-Range	Low	Very Low
	[tons/day]				
Loading Capacity	**19**	**5.7**	**1.6**	**0.3**	**0.1**
Existing Load	NA[1]	48	3.1	0.4	0.01
Load Reduction	NA[1]	42.7	1.5	0.1	-0.1
Percent Load Reduction	NA[1]	88%	49%	27%	-1525%
90th Percentile Concentration	**143.1 mg/L**				
Overall estimated percent reduction	**55%**				

[1]No observed water quality data available for this flow regime.

References

Tetra Tech, 2016. "*Minnesota River Headwaters and Lac qui Parle River Basins Watershed Model Development-Final Report*." Prepared for the Minnesota Pollution Control Agency. Research Triangle Park, NC. 116 pp.

Appendix B. Source Summary

Introduction

Using results from the Minnesota River-Headwaters and Lac qui Parle Rivers' HSPF model, areas within the Lac qui Parle Watershed were prioritized based upon the magnitude of NPSs, to identify sources of pollutants and identify subwatersheds where restoration and protection strategies would be most beneficial. Sources of pollutants where identified and mapped by using yields leaving the landscape and within the channel for land use/land cover types and at the subwatershed scale. The HSPF model was utilized to estimate total sediment (TS) leaving the landscape and within the channel. The mapping of pollutants includes the annual average yields at the hydrologic response unit (HRU) scale, the average annual yield at the subwatershed scale, prioritization maps developed for several stressors including altered hydrology (expressed as RO) and turbidity and habitat alteration/geomorphology (TS), and a field stream index (FSI) map, which compares the water quality load delivered to the stream to the flux in the channel segment and highlights sources and sinks in the watershed. Subwatersheds were prioritized by ranking the area-averaged yields (pounds/acre/year) from the HSPF model for TS. Prioritization is based solely on the estimated mass leaving the landscape. The consideration of other factors could change the prioritization outcome.

In addition, a bacteria source assessment was conducted to rank contributing sources and identify the potential sources within the watershed and within the drainage areas of impaired stream reaches. This covers the source assessment and prioritization of subwatershed within the LQPRW (HUC-08 07200003) to inform the TMDL study.

Land Use/Land Cover

Historically, land cover in the watershed during European settlement times (mid-late 1800s) consisted almost entirely of prairies in the western half of the watershed and a mix of mainly prairies and aspen-oak land in the eastern half (Marschner 1930). More current land use within the watershed can be described using the Multi-Resolution Land Characteristic Consortium Dataset[3] (NLCD 2006). **Table 1B** contains a summary of land uses/land cover in the watershed, as well as the percentage of total area and areas in located in Minnesota. Agriculture is the primary land use in the watershed, followed by pasture and grasslands. **Figure 1B** maps the 2006 NLCD land use/land cover dataset for the watershed. It should be noted that **Table 1B** and **Figure 1B** provide the NLCD 2006 distribution instead of newer versions of the data (at this date of publication) since it is the bases for the development of the HSPF model and the HRUs used in the HSPF model. Much like most of rural Minnesota, land use/land has not seen significant changes in the last few generations of NLCDs (2001, 2006, and 2011), so it was determined for this source assessment, showing the 2006 NLCD data was appropriate to be consistent with the model results used to summaries the source assessment.

[3] http://www.mrlc.gov/

Table 1B. NLCD Land Use/Land Cover (2006) for the LQPRW.

NLCD ID	Description	Total Acres	% of Watershed	MN Acres	% MN Watershed
11	Open Water	11,142	1.59%	4,959	1.02%
21	Developed, Open Space	30,405	4.33%	22,656	4.65%
22	Developed, Low Intensity	1,596	0.23%	1,480	0.30%
23	Developed, Medium Intensity	490	0.07%	450	0.09%
24	Developed, High Intensity	153	0.02%	148	0.03%
31	Barren Land	409	0.06%	386	0.08%
41	Deciduous Forest	6,267	0.89%	4,846	0.99%
42	Evergreen Forest	6.2	0.001%	3.3	0.001%
52	Shrub/Scrub	72	0.01%	15	0.003%
71	Grassland	75,962	10.81%	15,146	3.11%
81	Pasture/Hay	65,070	9.26%	33,868	6.95%
82	Cultivated Crops	461,718	65.71%	365,747	75.04%
90	Woody Wetlands	2,217	0.32%	2,038	0.42%
95	Emergent Herbaceous Wetlands	47,124	6.71%	35,682	7.32%

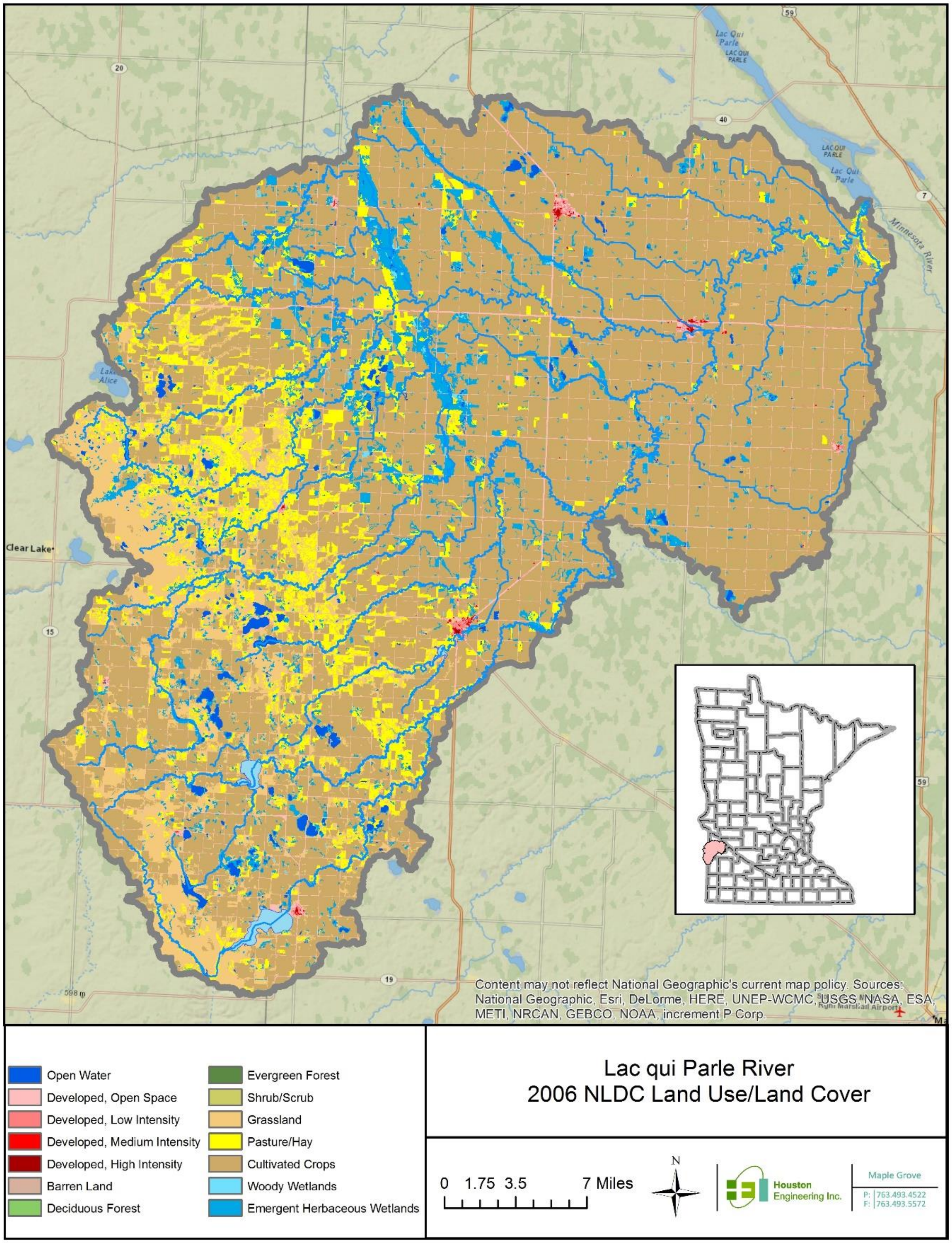

Figure 1B. Land Use/Land Cover in the LQPRW (NLCD 2006).

The Lac qui Parle River and Minnesota River-Headwaters HSPF Model

Hydrology and water quality were simulated using the HSPF watershed model. The LQPRW was modeled as part of the Minnesota River-Headwaters and Lac qui Parle River HSPF model (referred to as the LqP/MRH HSPF model for the remainder of the memorandum. The LqP/MRH HSPF model was developed as part of the State's effort to support TMDLs, WRAPS, and comprehensive watershed planning under Minnesota's Watershed Approach. The HSPF model was developed to simulate hydrology, sediment transport, and water quality, including simulation of dissolved oxygen, temperature, nitrogen and phosphorus at a 12-digit HUC scale.

The model set-up of the LqP/MRH HSPF is shown in **Figure 2B**. In HSPF, a watershed is divided into "model segments", called weather zone, based on the locations of the climate stations. Each model segment uses a unique set of climate data. Each model segment is further divided into subwatersheds with each subwatershed containing one hydrologic reach (lake, reservoir, or river) and roughly the size of a 12-digit HUC. Each modeling segment is composed of multiple HRUs called PERLNDs (pervious areas) and IMPLNDs (impervious areas). These PERLNDs and IMPLNDs are typically based on land uses and soil types and a subwatershed can be composed of multiple PERLND/IMPLND types. Runoff and water quality loadings are simulated for each PERLND/IMPLND in a modeling segment, i.e. the same flows and loadings are used across all subwatersheds in a modeling segment for each individual PERLND/IMPLND type. The amount of runoff and loading differ between subwatersheds based on differing acreage of each PERLND/IMPLND type.

Figure 2B shows the set-up of the LqP/MRH HSPF model, including both the Minnesota River-headwaters and Lac qui Parle watersheds since the model was developed with both watersheds. The LqP/MRH HSPF model is composed of six modeling segments, or weather zones (**Figure 2B**), and further divided into 145 subwatersheds, 90 in the Minnesota River-headwaters watershed and 55 in the LQPRW. Each modeling segment, is divided by up to 23 pervious HRUs (PERLNDs) and three impervious HRUs (IMPLND; **Table 2B**), for a total of 138 possible PERLNDs and 18 IMPLNDs in the HSPF model (**Figure 3B**). It should be noted, impervious areas (IMPLND) and tillage and drainage practices in croplands are taken as a percentage of area and not represented as separate HRUs in **Figure 3B.**

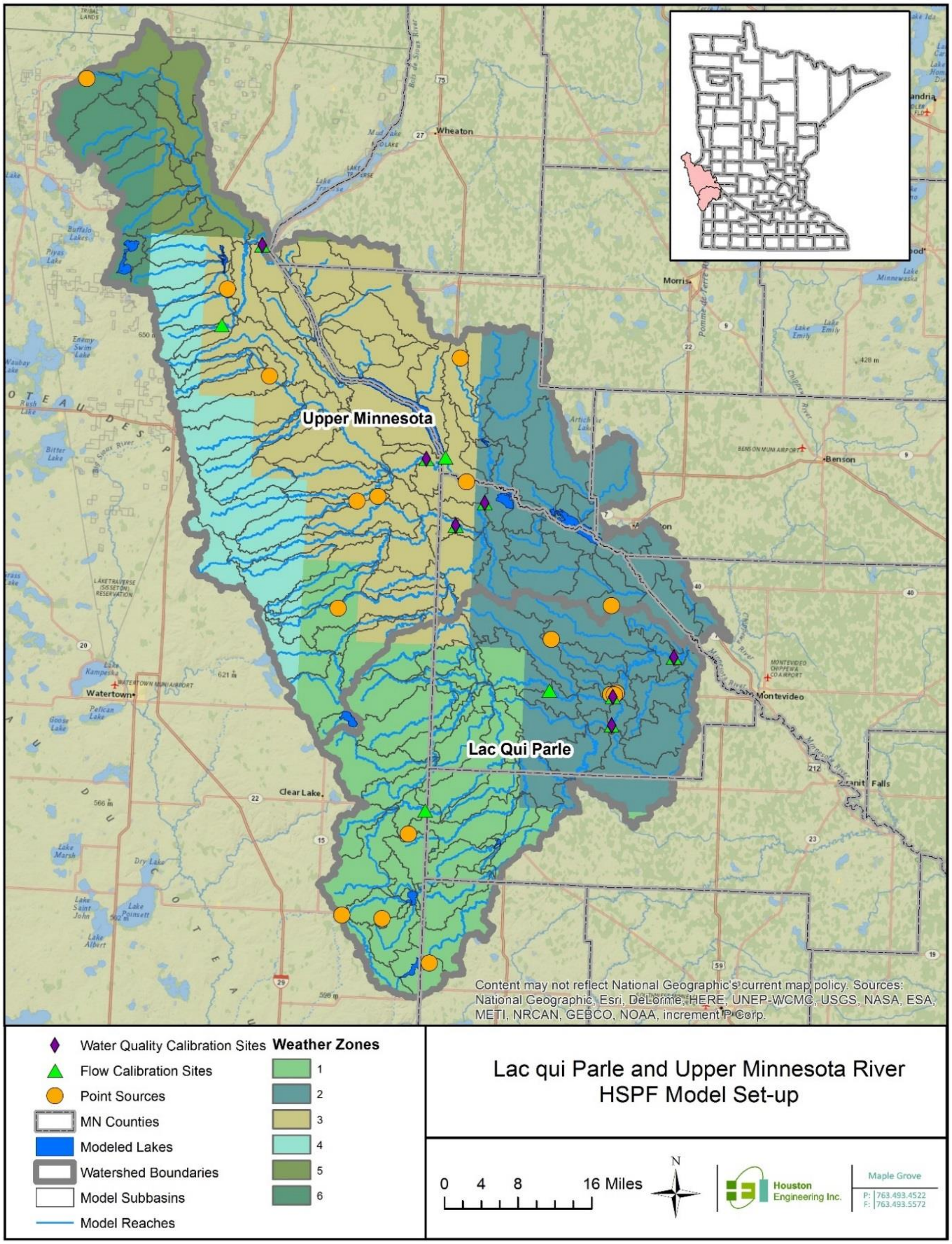

Figure 2B. Model set-up for the LqPR/UMR HSPF model.

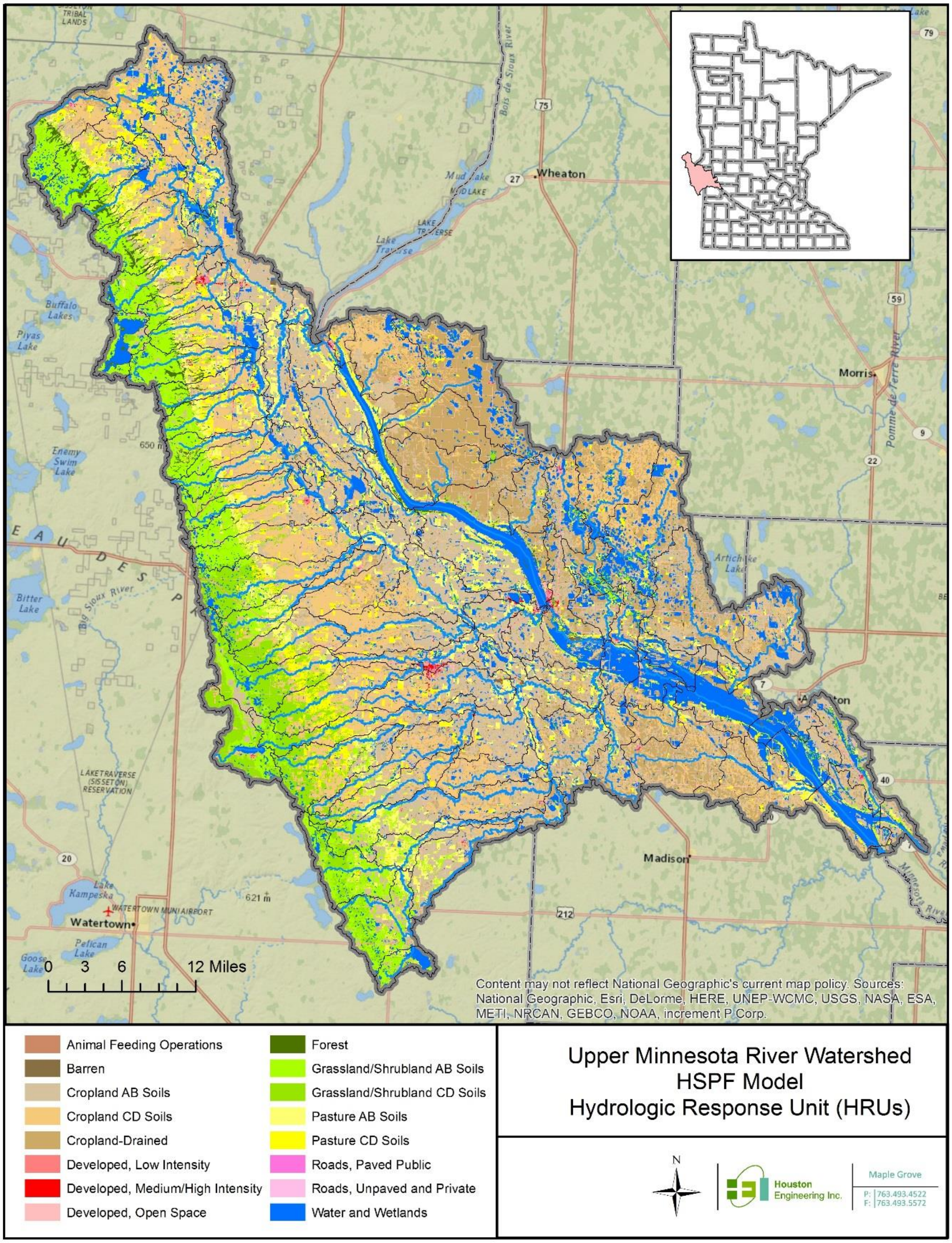

Figure 3B. Hydrologic Response Units (HRUs) for the LqPR/UMR HSPF model.

Table 2B. Description of the base HRUs in the MRH/LqP HSPF model (TetraTech 2016).

HRU Description	HSG	Base Number	Acres	Data Source(s)
Water and Wetlands	CD	101	236,910	Directly from NLCD (Merge Open Water & Wetlands)
Developed, Open Space	-	102	74,864	Directly from NLCD
Developed, Low Intensity	-	103	6,320	Directly from NLCD
Developed, Medium/High Intensity	-	104	2,505	Directly from NLCD (Merge Medium and High Density)
Barren	CD	105	2,090	Directly from NLCD
Forest	-	106	29,268	NLCD Forest Codes (Deciduous, evergreen, mixed)
Grassland/Shrubland AB Soils	AB	107	171,464	NLCD Herbaceous/Shrub + SSURGO HSG Overlay
Grassland/Shrubland CD Soils	CD	108	99,649	NLCD Herbaceous /Shrub + SSURGO HSG Overlay
Pasture AB Soils	AB	109	136,413	NLCD Pasture + SSURGO HSG Overlay
Pasture CD Soils	CD	110	96,471	NLCD Pasture + SSURGO HSG Overlay
Cropland AB Soils, Conventional Tillage, Nonmanured	AB	111	346,868	NLCD Cultivated Crops + HSG Overlay, TTS, USDA
Cropland CD Soils, Conventional Tillage, Nonmanured	CD	112	275,350	NLCD Cultivated Crops + HSG Overlay, TTS, USDA
Cropland-Drained, Conventional Tillage	-	113	182,202	NLCD Cultivated Crops + HSG Overlay, TTS, USDA
Roads, Paved Public	-	116	3,171	TIGER Primary, Secondary, and Local Streets (9m)
Roads, Unpaved and Private	-	117	20,273	TIGER Private Road and Vehicular Trail (9m)
Animal Feeding Operations	-	118	619	MPCA Feedlot layer, CAFO = No
Cropland AB Soils, Conservation Tillage, Nonmanured	AB	119	104,173	NLCD Cultivated Crops + HSG Overlay, TTS, USDA
Cropland CD Soils, Conservation Tillage, Nonmanured	CD	120	71,738	NLCD Cultivated Crops + HSG Overlay, TTS, USDA
Cropland-Drained, Conservation Tillage	-	121	149,905	NLCD Cultivated Crops + HSG Overlay, TTS, USDA
Cropland AB Soils, Conventional Tillage, Manured	AB	122	37,230	NLCD Cultivated Crops + HSG Overlay, TTS, USDA
Cropland-Drained, Conventional Tillage, Manured	-	123	18,587	NLCD Cultivated Crops + HSG Overlay, TTS, USDA

The LqP/MRH HSPF was developed to simulate hydrology, sediment transport, and water quality for the period 1993 through 2012. TS were extracted at the HRU scale and the subwatershed (reach) scale and used to develop this source assessment and priority rankings. For each water quality parameter, four maps were created to show the sources of each parameter. They include an annual average yield map at the HRU scale, an average annual yield at the subwatershed scale, a prioritization map, and a FSI map, which compares the water quality load delivered to the stream to the flux in the channel segment and highlights sources and sinks in the watershed.

The HRU and subwatershed yield map can be used to complete pollutant sources assessments. It shows which land segments and subwatersheds are the largest sources of sediment per area and time (annual average) delivered to the channel (edge of field) and maps the different stressors which can lead to impairment. The map was generated by extracting the flow and loadings from each PERLND and IMPLND, averaging the annual total flows and loads over the modeling period (1995 through 2012) for each PERLND/IMPLND, and using the areas of each PERLND/IMPLND in each subwatershed to get a subwatershed unit area, annual average yield.

The priority rankings map uses the information in the yield map to identify specific priority subwatersheds, which should be preferentially considered for targeting fields for practice implementation based solely on water quality. This map was developed by taking the yields at the watershed and major tributary scales and ranking them smallest to largest and calculating their percentile rank. The ranks are summarized as the lowest implementation priority (lowest 10%), low priority (10% through 25%), moderate priority (25% through 75%), high priority (75% through 90%), and highest priority (highest 10%). The highest priority subwatersheds with the highest yields and most likely would benefit the most from implementation and protective strategy management.

The FSI map highlights stream reaches that are sinks or sources of a pollutant combined with a ratio between in-channel sources to overland sources. The FSI also provides guidance, subject to field verification, about where field practices rather than in-stream implementation activities, provide the largest potential water quality benefit. The map shows the magnitude of field source loads relative to in-stream sources and are taken as the overland field load divided by the in-channel flux. Positive numbers represent a source of in-stream materials and a negative number represents a sink for in-stream materials. If the FSI is between -1 and 1, the dominate processes in the subwatershed are in-channel, meaning the in-channel flux is larger than the overland sources. If the FSI is less than -1 or greater than 1, field sources are larger than the in-stream sources.

Total Sediment

TS contributes total suspended sediment impairments. The HSPF parameters used to estimate TS are provided in **Table 3B**. Overland sediment can be extracted directly from the HSPF model as TS from overland sources using the SEDMNT group for PERLNDs and SOLIDS group for IMPLNDs. In channel sediment loading and sediment flux can be extracted directly using the SEDTRN group. In channel sediment flux can be taken as the change in bed storage.

Table 3B. HSPF parameters used to describe total sediment.

WQ Parameter	Description	Volume	Group	Variable	x1	x2	Factor
Total Sediment	Total Sediment	PERLND	SEDMNT	SOSED	1	1	
	Total Solids	IMPLND	SOLIDS	SOSLD	1	1	
	Inflow of Sediment	RCHRES	SEDTRN	ISED	4	1	
	Outflow Sediment	RCHRES	SEDTRN	ROSED	4	1	
	Sediment Flux/Change in Storage	RCHRES	SEDTRN	DEPSCR	4	1	

Figure 4B shows the annual average (1995 through 2012) TS yields delivered to the channel by HRU. **Figure 5B** shows the annual average (1995 through 2012) TS yields delivered to the channel by subwatershed. **Figure 6B** shows the subwatershed prioritization for the stressor “elevated turbidity” and “loss of habitat” based on annual average (1995 through 2012) TSS yields by subwatershed. **Figure 6B** shows the subwatersheds with the highest average TS yields. **Figure 7B** shows the FSI for TS and indicates the stream reaches that are sources and sinks for TS and the subwatersheds where overland sources of TS are dominate and where in-channel processes are dominate. Overall, the stream reaches in the Lac qui Parle River are TS sinks.

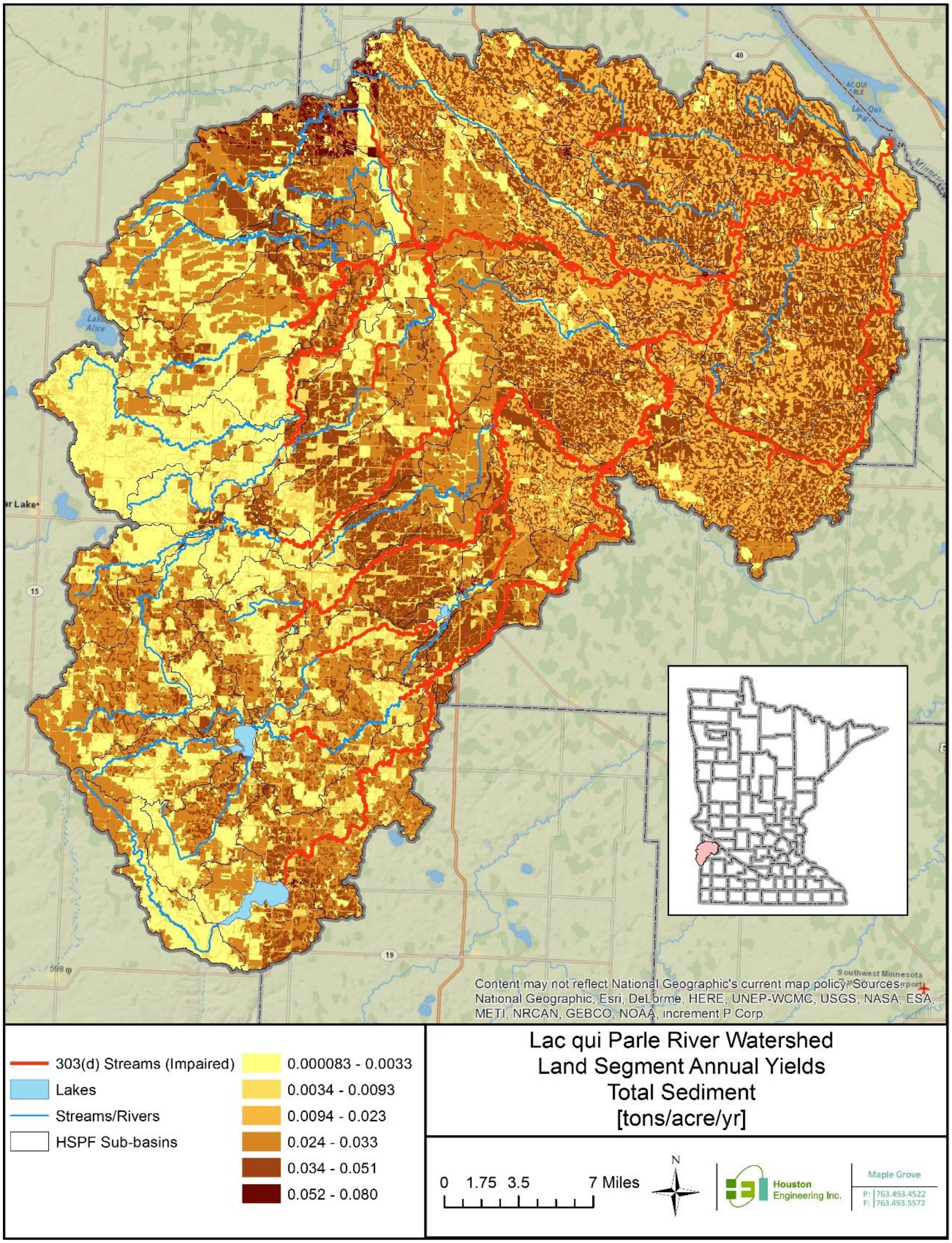

Figure 4B: Average (1995-2012) Total Sediment Yield delivered to the channel from the HSPF model by land segment.

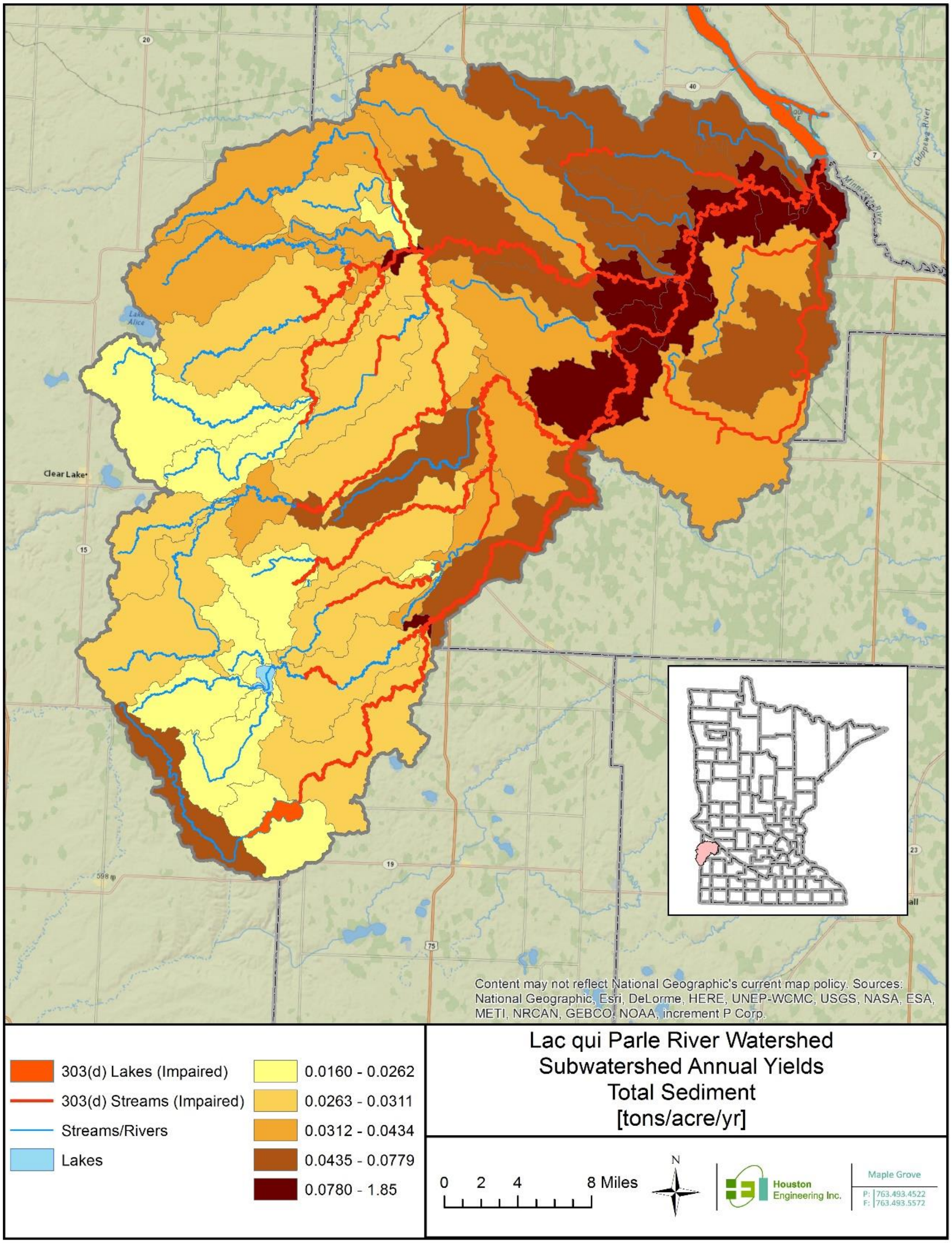

Figure 5B: Average (1995-2012) Total Sediment Yield delivered to the channel from the HSPF model by subwatershed.

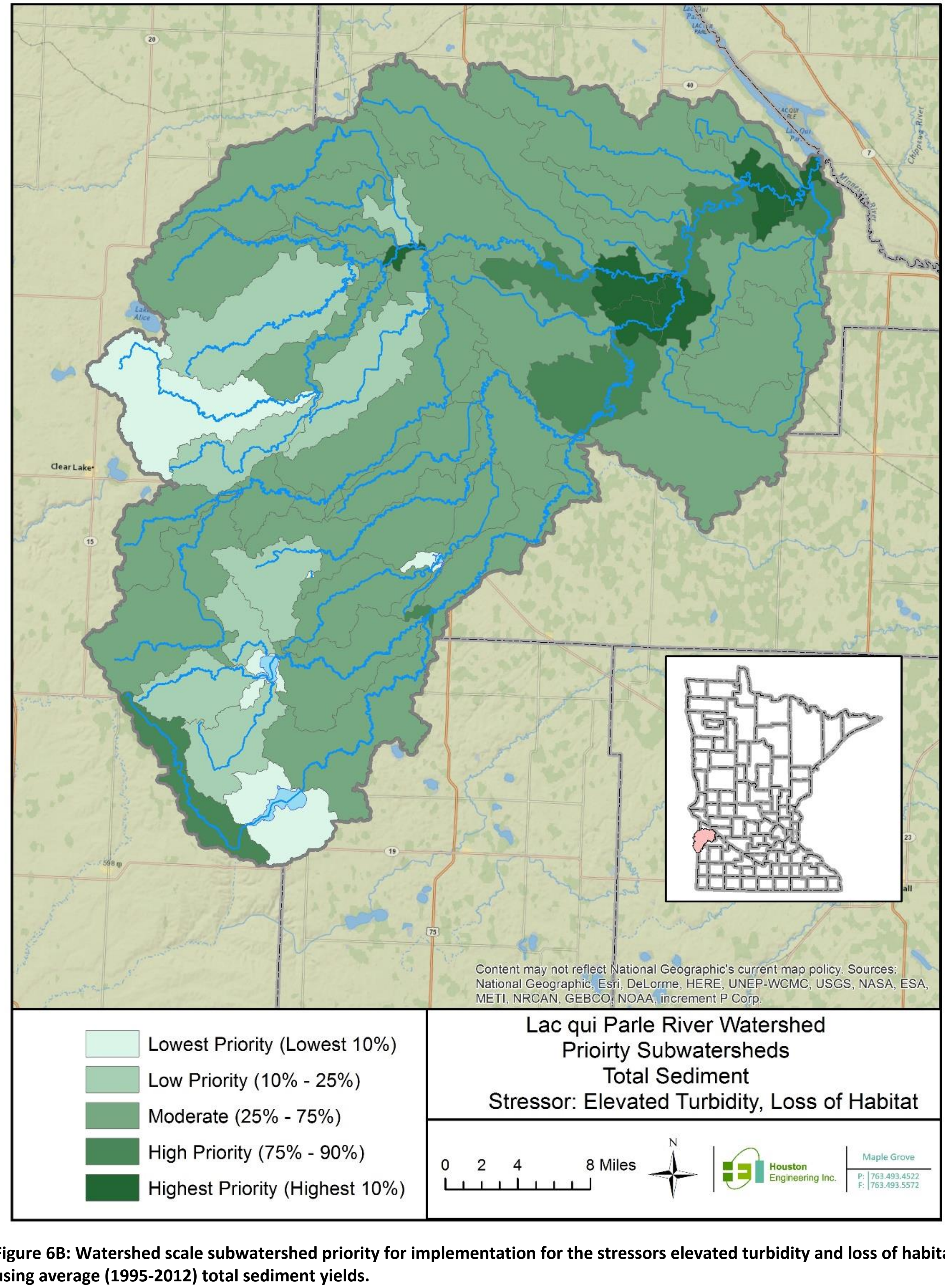

Figure 6B: Watershed scale subwatershed priority for implementation for the stressors elevated turbidity and loss of habitat, using average (1995-2012) total sediment yields.

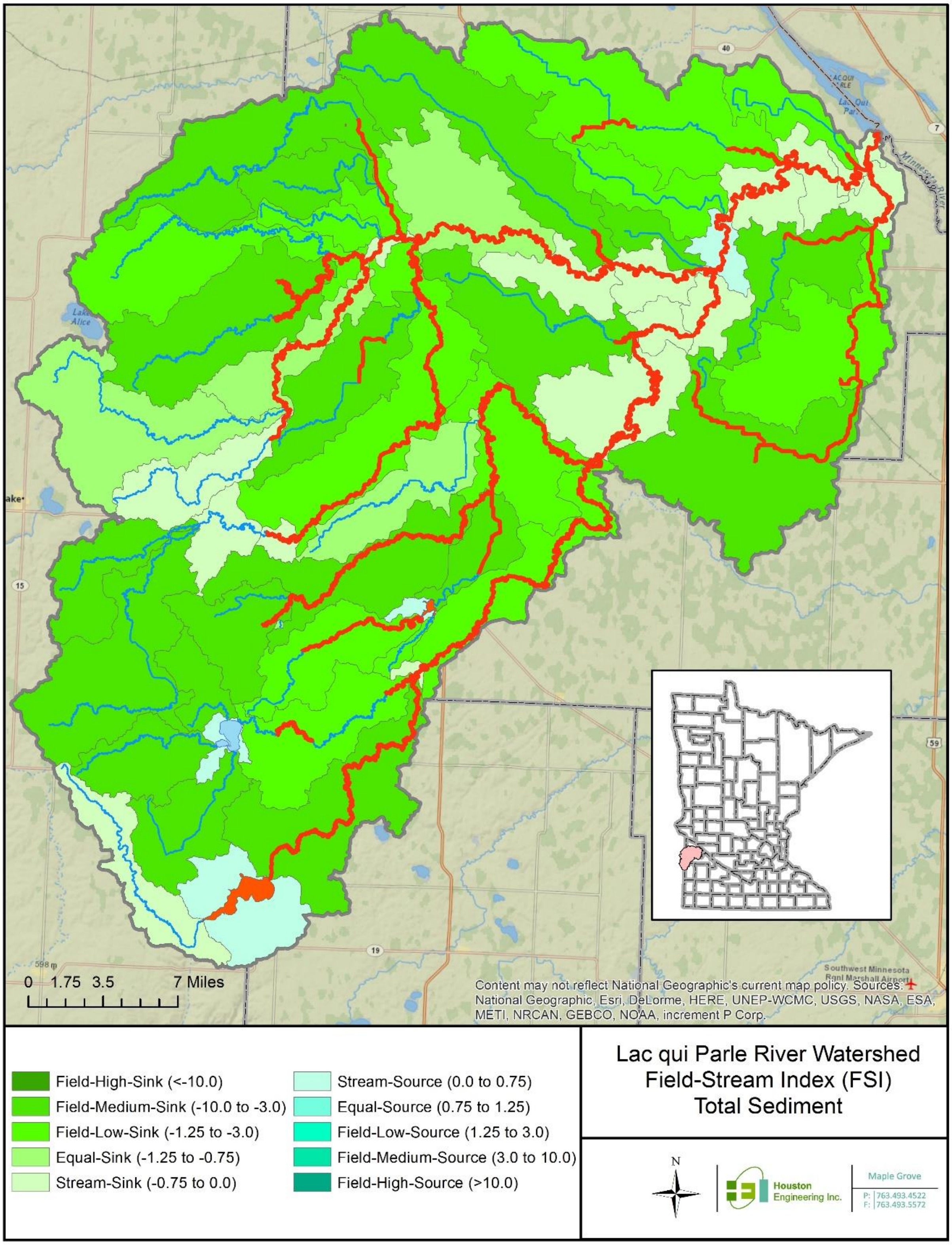

Figure 7B: Watershed scale subwatershed priority for implementation of field and stream practices (Field Stream Index) for the stressor elevated turbidity using total sediment (1995-2012) annual average load.

Escherichia coli

The relationship between bacterial sources and bacterial concentrations found in streams is complex, driven in part by the amount of precipitation and runoff, surface water temperature, the type of livestock management practices, wildlife population abundance and spatial distribution, bacterial survival rates, land use practices, and other environmental factors. These relationships were evaluated to determine the sources of bacteria. To evaluate the potential sources of bacteria delivered to waterbodies, a qualitative bacteria source investigation was conducted based on source population estimates and delivery mechanics.

Sources of Bacteria

Permitted Sources

Wastewater Treatment Facilities

Permitted WWTFs in the State of Minnesota are required to monitor their effluent to ensure that concentrations of specific pollutants remain within levels specified in their NPDES discharge permit. In Minnesota, WWTFs are permitted based on fecal coliform, not *E. coli*. Effluent limits require that fecal coliform concentrations remain below 200 organisms/100 mL (MPCA 2002). Based on the previous fecal standard and the current *E. coli* standard, a ratio of 200:126 (0.63) is used to convert fecal coliform to *E. coli*. Therefore, the effluent limit for *E. coli* concentrations remains below 126 organisms/100 mL.

The LQPRW contains nine "minor" (as defined by the MPCA) WWTPs and three industrial dischargers. Six of the WWTPs are located in Minnesota and three in South Dakota. **Table 4B** identifies the NPDES permit dischargers in the LQPRW, and their permitted daily discharge flow and permitted daily bacteria load.

Table 4B. NPDES permit facilities, permitted flows, and bacteria loads for minor facilities in the LQPRW.

NPDES Permit Number	Location Name	State	Permit Type	Avg. Flow (mgd)	Equivalent Bacteria Load as *E. coli*: 126 org/100mL [billion org/day]
SD0025194	Astoria	SD	WWTP	0.29	1.383
SD0026514	Cochrane	SD	WWTP	10.81	51.554
SD0021571	Toronto	SD	WWTP	0.16	0.763
MN0040134	Ag_Process	MN	Noncontact cooling	1.38	NA
MN0048968	AMPI_SD001	MN	Industrial	2.02	NA
MN0048968	AMPI_SD002	MN	Noncontact cooling	0.07	NA
MNG580154	Canby	MN	WWTP	2.36	11.255
MN0021881	Dawson	MN	WWTP	0.21	1.002
MN0021121	Hendricks	MN	WWTP	1.09	5.198
MN0061077	MadisonWTP	MN	WTP	0.08	0.382
MN0051764	MadisonWWTP	MN	WWTP	0.27	1.288
MNG580160	Marietta	MN	WWTP	1.79	8.537

NPDES Permitted Concentrated Animal Feeding Operation

The MPCA regulates the collection, transportation, storage, processing, and disposal of animal manure and other livestock operation wastes (MPCA 2011). The MPCA currently uses the federal definition of a CAFO in its regulation of animal facilities. In Minnesota, the following types of livestock facilities are issued, and must operate under, a NPDES Permit: (a) all federally defined (CAFOs); and (b) all CAFOs and non-CAFOs, which have 1,000 or more AUs (MPCA 2010). As required by the permit, NPDES permitted feedlots are required to have no direct discharge to surface waterbodies. Bacteria for manure from any NPDES permitted feedlot is accounted for in the field application of manure.

Nonpermitted

Humans

Subsurface Sewage Treatment Systems

Malfunctioning SSTSs can be an important source of fecal contamination to surface waters, especially during dry periods when these sources continue to discharge and surface water runoff is minimal. Malfunctioning SSTSs are commonly placed in two categories: IPHTs or failing to protect groundwater (i.e., failing). IPHT indicates the system has a sewage discharge to surface water; sewage discharge to ground surface; sewage backup; or any other situation with the potential to immediately and adversely affect or threaten public health or safety. Failing to protect groundwater indicates the bottom of the system does not have the required separation to groundwater or bedrock.

Based on an area-weighted average, the rural population in the LQPRW has an estimated 758 systems with inadequate treatment of household wastewater. This includes individual residences and any un-sewered communities. An MPCA document (MPCA 2011) reports numbers from 2000 through 2009 on the total number of SSTSs by county, along with the average estimated percent of SSTSs that are failing versus the percent that are considered IPHTs. The total numbers of SSTSs per county were multiplied by the estimated percent IPHT and percent failing within each area (MPCA 2011) to compute the number of potential IPHTs and potentially failing SSTSs per county. **Table 5B** provides the county totals for failing SSTSs and IPHT systems for counties in the LQPRW.

Table 5B. 2009 SSTS compliance status in the watershed (MPCA 2011).

County	%Area with the watershed	Identified # of SSTSs	2009 Average Estimate of %Failing	# of potentially failing SSTSs	2009 Average Estimate of %IPHT	# of potential IPHTs
Lac qui Parle	65.2%	1792	35%	627	0%	0
Lincoln	4.4%	1791	48%	860	20%	358
Yellow Medicine	34.0%	1737	25%	434	25%	434

Companion Animals

Companion animals, such as dogs and cats, can contribute bacteria to a watershed when their waste is not disposed of properly. Dog waste can be a significant source of bacteria to water resources (Geldreich 1996) at a local level when in the immediate vicinity of a waterbody. It was estimated that 34.3% of households own dogs and each dog owning households has 1.4 dogs (AVMA 2007). Waste from domestic cats is usually collected by owners in the form of litter boxes. Therefore, it is assumed that domestic cats do not supply significant amounts of bacteria on the watershed scale. Feral cats may supply a significant source of bacteria and are accounted for under wildlife. Population estimates of domestic dogs were taken from the 2010 Census as a function of number of households per census block. Distribution of bacteria from companion animals is applied to the developed categories in the NLCD land cover layer (**Figure 1B**). The bacteria sources, assumptions, and distribution used to estimate the potential source of bacteria related to humans are listed in **Table 6B**.

Table 6B: Data sources, assumptions, and distribution of bacteria attributed to humans.

Bacteria Source	Distribution
Un-sewered Communities-Failing and IPHT SSTS Population in un-sewered communities based on 2010 Census Block information. Number of failing and IPHT SSTS from County estimates (MPCA 2011).	The population of un-sewered communities were estimated, based on 2010 Census Block data. Production rates of 1.3 x 10^9 cfu/day/person was used. Total bacteria were applied to Developed land use classes in the NLCD 2006 dataset.
Companion Animals (Dogs only) 34.3% of households own dogs, 1.4 dogs in households with dogs. Populations of dogs was based on the 2010 Census Block data.	An estimated 38% of dog owners do not dispose of waste properly (TBEP 2011). Population distributions are based on 2010 Census Blocks. Production rates of 3.2 x 10^9 cfu/day/dog was used. Total bacteria were distributed among Developed land use classes in the NLCD 2006 dataset.

Livestock

Populations

The USDA National Agricultural Statistics Service (NASS) provides livestock numbers, by county. Estimated numbers are available for cattle, hogs, horses, sheep, goats, and poultry (chicken and turkey) through the U.S. Census of Agriculture. The NASS statistics where compared to the animal counts in the MPCA's feedlot dataset and were found to be comparable. County livestock populations were distributed across the watershed in an area-weighted basis. Livestock waste is distributed throughout the LQPRW in four main categories: grazing animals, AFOs, land application of manure, and small operations. Discussion of each of these categories follows.

Livestock - Grazing

Grazing occurs on pastured areas where concentrations of animals allow grasses or other vegetative cover to be maintained during the growing season. The state of Minnesota does not require permitting or registration of grazing pastures. Grazing cattle were assumed to be the total cattle population from the Census of Agriculture (see *Livestock Populations*) minus the cattle of feed.

Livestock - Animal Feedlot Operations

AFOs with less than 1,000, but more than 50, AUs (and are outside of shoreland areas) are regulated by the MPCA under a registration program. AFOs with more than 10 AUs and inside shoreland areas are also regulated under this program. Shoreland is defined in Minn. Stat. § 103F.205 to include: land within 1,000 feet of the normal high-watermark of lakes, ponds, or flowages; land within 300 feet of a river or stream; and designated floodplains (MPCA 2010). These smaller facilities are subject to state feedlot rules, which include provisions for registration, inspection, permitting, and upgrading.

Livestock - Land Application of Manure

Manure is often surface applied or incorporated into fields as a fertilizer and soil amendment. The land application of manure has the potential to be a substantial source of fecal bacteria, transported to waterbodies from surface runoff and drain tile intakes. Minn. R. ch. 7020 contains manure application setbacks based on research related to nutrient transport, but the effectiveness of these setbacks on bacteria transport to surface waters is unknown. A portion of the livestock population was assumed to supply manure for land application (see **Table 7B**).

Livestock – Small Operations

Small-scale animal operations do not require registration and are not included in the MPCA's geographic feedlots (AFOs) database, but should be included in the Census of Agriculture (see *Livestock Populations*). All cattle, goats, horses, sheep, and poultry were treated as partially housed or open lot operations, and literature estimates were used to identify the number of AFOs without runoff controls (see **Table 7B**). The geographic areas for stockpiling or spreading of manure from these small, partially housed or open lot operations is based on NLCD 2006 *Pasture/Hay* land cover.

Table 7B: Data sources, assumptions, and watershed distribution of bacteria from livestock.

<table>
<tr><th colspan="2">Bacteria Sources</th><th>Distribution</th></tr>
<tr><td colspan="2">Grazing
Grazing populations estimates for cattle, horses, goats, and sheep were based on NASS Quick Stats (http://www.nass.usda.gov/Quick_Stats/).</td><td>Bacteria from grazing animals was applied to pasture classes in the NLCD 2006 dataset.</td></tr>
<tr><td rowspan="2">Animal Feeding Operation (AFO)
AFO populations for cattle, goats, hogs, horses, poultry, and sheep are based on NASS Quick Stats (http://www.nass.usda.gov/Quick_Stats/)</td><td>Partially Housed or Open Lot without Runoff Controls[4]
The proportion of AFO animals that are partially housed or in open lots without runoff controls:
- Cattle 50%
- Poultry 8%
- Goats 42%
- Sheep 42%
- Hogs 15%</td><td>Bacteria from Open Lot AFOs was applied to barren, scrub/shrub, grassland, and pasture classes of the NLCD 2011 dataset.</td></tr>
<tr><td>Land Application of Manure1
- Cattle 50%
- Poultry 92%
- Goats 58%
- Sheep 58%
- Hogs 85%</td><td>Land application of manure was distributed across the cropland class of the NLCD 2011 dataset.</td></tr>
</table>

[4] Estimates based on Mulla et al. 2001.

Livestock populations were estimated for cattle, chickens, goats, horses, sheep, and turkeys for each county and are provided in **Table 8B**. **Figure 8B** shows the distribution of AUs (livestock) in the Minnesota portion of the watershed based the MPCA's feedlot dataset.

Table 8B. Livestock Population Estimates (numbers) in the watershed.

Animal	Type	Lac qui Parle	Lincoln	Yellow Medicine
Cattle	Beef	14,478	21,741	27,376
	Cattle on Feed	4,507	7,171	10,879
Other	Pigs	97,508	93,371	120,257
	Sheep and Goats	2,061	4,528	6,072
	Horses	435	280	272
Poultry	Layers	251	694	584
	Boilers	1,674	(D)[1]	237
	Turkey	(D)[1]	(D)[1]	203,028
	Ducks and other	155	42	119

[1]Population from single farm, not reported.

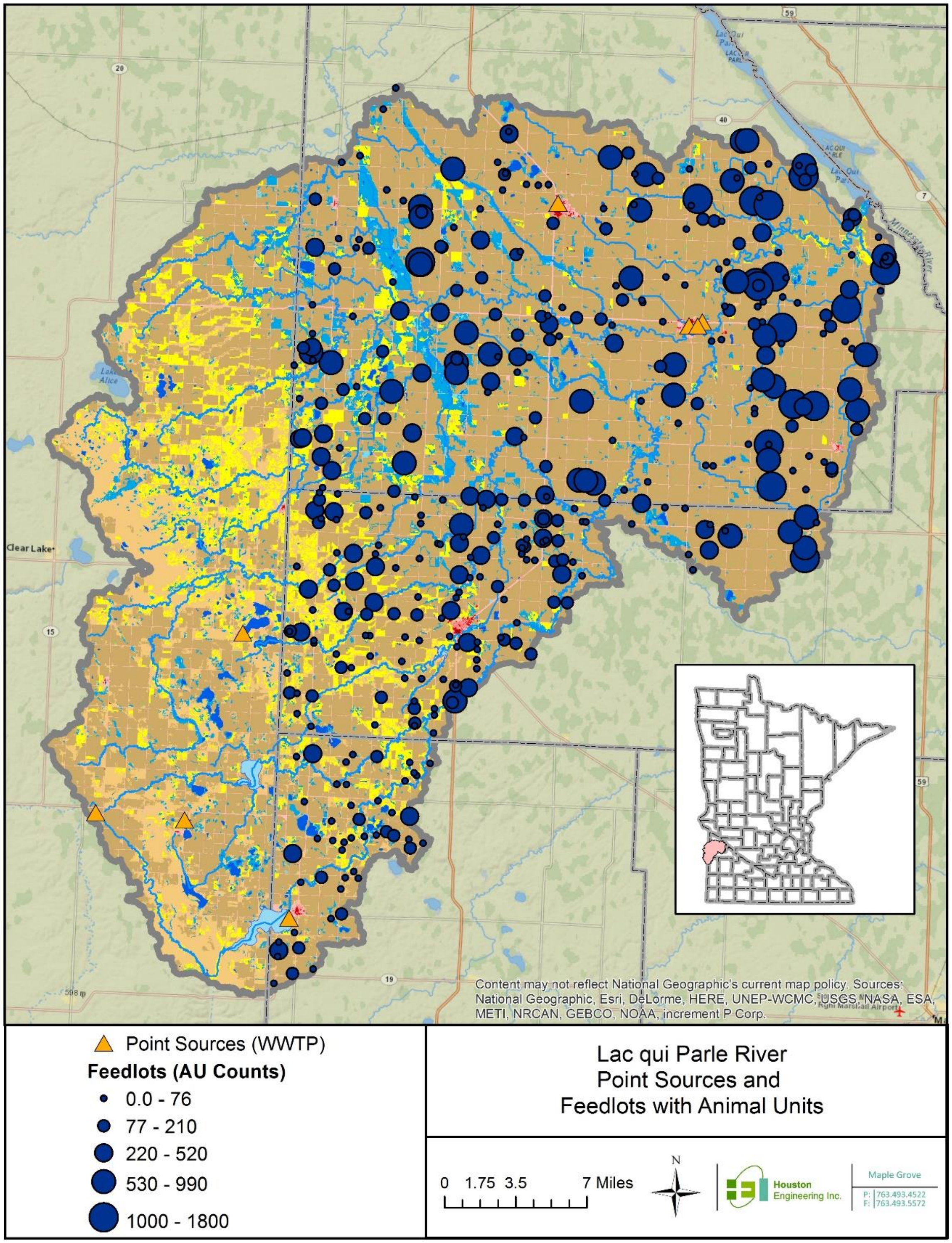

Figure 8B. Animal unit counts by feedlot in the LQPRW.

Wildlife

Wildlife, especially waterfowl, contribute bacteria to the watershed by directly defecating into waterbodies and through runoff from wetlands and fields adjacent to waterbodies, which are used as feeding grounds. In the LqP River watershed, land cover which could potentially attract wildlife includes: herbaceous wetlands and row crops adjacent to streams and lakes, wildlife management areas (WMA), and open water. Wildlife contribute bacteria to surface waters by living in waterbodies, living near conveyances to waterbodies, or when their waste is delivered to waterbodies during storm runoff events. Areas such as WMAs, state parks, national parks, national wildlife refuges, golf courses, state forest, and other conservation areas provide habitat for wildlife and are potential sources of bacteria due to high densities of animals. Additionally, private land managed for wildlife with practices such as food-plotting or supplemental feeding can concentrate wildlife and have the potential to be a source of bacteria from wildlife sources.

Fate and transport mechanisms differ between wildlife that live in surface waters (e.g., ducks, geese, cliff swallows, shorebirds, and beavers) where bacteria are directly delivered to waters and wildlife that live in upland areas (e.g., deer) where bacteria delivery is primarily driven by washoff and surface runoff. The wildlife considered as potential sources of bacteria include deer, ducks, geese, and others. Data sources and assumptions for wildlife populations are shown in **Table 9B**. In addition, a category called "other wildlife" was added to the source summary. These other animals include all other wildlife that may dwell in the watershed, such as beaver, raccoons, coyote, foxes, squirrels, etc. It is possible that the "other wildlife" category may at times be a significant source of bacteria, which lacks the data needed to account for it in this assessment. An example might be cliff swallows nesting under bridges, which may be in close proximity to sampling sites. The lack of data needed for this source assessment is a limitation of this technique.

Table 9B. Data Sources and Assumption for Wildlife Population and Bacteria Delivery.

Bacteria Source	Delivery
Deer The DNR report "Status of Wildlife populations, Fall 2009" includes a collection of studies that estimate wildlife populations of various species (Dexter, 2009). Pre-fawn deer densities (in deer per sq mi) were reported by DNR deer permit area.	Bacteria from deer were applied to all land use classes in the NLCD 2006 dataset except for open water and developed land use classes.
Ducks Populations of breeding ducks was taken from the U.S. Fish and Wildlife "Thunderstorm" Maps for the Prairie Pothole Region of Minnesota and Iowa	The USFW "Thunder Maps" are spatially distributed and were used once a bacteria production rate was applied.
Geese Population estimates were taken from the state-wide DNR's Minnesota Spring Canada Goose Survey, 2009 (Rave, 2009). Counts were reported by Level I Ecoregion. An area-weighted estimate was taken from the state-wide data, resulting in an estimate of 9,145 geese in the LQPRW.	Bacteria from geese were distributed to areas within a 100 ft buffer of and including wetlands and open water classes in the NLCD 2006 dataset.
Other Wildlife Other wildlife in the LqP River watershed includes such animals as swallows, beaver, raccoons, coyote, foxes, and squirrels. Instead of estimating individual populations of each type of wildlife within the watershed. The bacteria production was assumed to be the same as the bacteria production from deer. Therefore, the bacteria production from deer was doubled to account for all other wildlife in the watershed that are not accounted for explicitly.	Same as deer.

Natural/Background Sources

Two Minnesota studies described the potential for the presence of "naturalized" or "indigenous" *E. coli* in watershed soils (Ishii et al. 2006) and ditch sediment and water (Sadowsky et al. 2010; Chandrasekaran et al., 2015). Sadowsky et al. (2010) conducted DNA fingerprinting of *E. coli* in sediment and water samples from Seven Mile Creek, located in south-central Minnesota. They concluded that roughly 63.5% of the bacteria were represented by a single isolate, suggesting new or transient sources of *E. coli*. The remaining 36.5% of strains were represented by multiple isolates, suggesting persistence of specific *E. coli*. The authors suggested that 36% might be used as a rough indicator of "background" levels of bacteria at this site during the study period but results might not be transferable to other locations without further study. Although the result may not be transferable to other locations, they do suggest the presence of natural background *E. coli* and a fraction of *E. coli* may be present regardless of the control measures taken by traditional implementation strategies.

Table 10B provides a summary of *E. coli* sources for impaired reaches in the Minnesota portion of the Lac qui Parle River Watershed.

Table 10B. Bacteria sources by animal units or individuals for each impaired reach for the Minnesota portion of their respective watersheds.

Category	Source	Animal units or individuals	Category	Source	Animal units or individuals
Lac qui Parle River (07020003-502)			County Ditch 5 (07020003-523)		
Livestock[1]	Horse	93	Livestock[1]	Horse	0
	Pig	58,273		Pig	770
	Cattle	27,793		Cattle	215
	Chicken/Turkey	958		Chicken/Turkey	0
	Other Livestock	169		Other Livestock	0
Wildlife[2]	Deer[3]	5,479	Wildlife[2]	Deer[3]	295
	Waterfowl[4]	5,838		Waterfowl[4]	288
	Geese[5]	3,265		Geese[5]	125
	Other[6]	5,479		Other[6]	295
Human (population #)	Failing Septic Systems[7]	1,710	Human (population #)	Failing Septic Systems[7]	53
	WWTP Effluent[8]	6		WWTP Effluent[8]	1
Domestic Animals	Improperly Managed Pet Waste[9]	2,266	Domestic Animals	Improperly Managed Pet Waste[9]	83
West Branch Lac qui Parle River (07020003-513)			Unnamed creek (07020003-530)		
Livestock[1]	Horse	66	Livestock[1]	Horse	1
	Pig	8,635		Pig	150
	Cattle	8,237		Cattle	656
	Chicken/Turkey	953		Chicken/Turkey	2
	Other Livestock	136		Other Livestock	10
Wildlife[2]	Deer[3]	2,394	Wildlife[2]	Deer[3]	381
	Waterfowl[4]	2,487		Waterfowl[4]	253

Category	Source	Animal units or individuals	Category	Source	Animal units or individuals
	Geese[5]	1,060		Geese[5]	108
	Other[6]	2,394		Other[6]	381
Human (population #)	Failing Septic Systems[7]	457	Human (population #)	Failing Septic Systems[7]	131
	WWTP Effluent[8]	2		WWTP Effluent[8]	0
Domestic Animals	Improperly Managed Pet Waste[9]	731	Domestic Animals	Improperly Managed Pet Waste[9]	32
Lost Creek (07020003-517)			Unnamed creek (07020003-580)		
Livestock[1]	Horse	0	Livestock[1]	Horse	0
	Pig	1,320		Pig	1,784
	Cattle	511		Cattle	310
	Chicken/Turkey	0		Chicken/Turkey	0
	Other Livestock	0		Other Livestock	30
Wildlife[2]	Deer[3]	386	Wildlife[2]	Deer[3]	249
	Waterfowl[4]	183		Waterfowl[4]	426
	Geese[5]	60		Geese[5]	214
	Other[6]	386		Other[6]	249
Human (population #)	Failing Septic Systems[7]	26	Human (population #)	Failing Septic Systems[7]	91
	WWTP Effluent[8]	0		WWTP Effluent[8]	0
Domestic Animals	Improperly Managed Pet Waste[9]	18	Domestic Animals	Improperly Managed Pet Waste[9]	150
West Branch Lac qui Parle River (07020003-519)			Unnamed ditch (County Ditch 4) (07020003-581)		
Livestock[1]	Horse	12	Livestock[1]	Horse	0
	Pig	0		Pig	8,586
	Cattle	623		Cattle	468
	Chicken/Turkey	1		Chicken/Turkey	0
	Other Livestock	3		Other Livestock	0
Wildlife[2]	Deer[3]	375	Wildlife[2]	Deer[3]	269
	Waterfowl[4]	161		Waterfowl[4]	262
	Geese[5]	48		Geese[5]	231
	Other[6]	375		Other[6]	269
Human (population #)	Failing Septic Systems[7]	20	Human (population #)	Failing Septic Systems[7]	98
	WWTP Effluent[8]	0		WWTP Effluent[8]	0
Domestic Animals	Improperly Managed Pet Waste[9]	12	Domestic Animals	Improperly Managed Pet Waste[9]	260

[1]Animal units based on registered feedlots (https://gisdata.mn.gov/dataset/env-feedlots).

[2] Wildlife numbers represent total number of individual animals.

[3]Deer populations based on MNDNR "Status of Wildlife populations, Fall 2009" (https://www.dnr.state.mn.us/publications/wildlife/populationstatus2009.html).
[4]Duck population calculated by U.S. Fish and Wildlife Service utilizing "Thunderstorm" Maps for the Prairie Pothole Region.
[5] Geese population estimates were taken from the state-wide DNR's Minnesota Spring Canada Goose Survey, 2009 (Rave 2009).
[6]Other wildlife includes such animals as swallows, beaver, raccoons, coyote, foxes, and squirrels and taken as the same population as deer.
[7]Reported as population size in watershed based on county SSTS inventory (MPCA 2016) and drainage area size. Assumes 3 persons per failing system.
[8]Reported as number of WWTPs.
[9] Number of households in watershed multiplied by 0.58 dogs/ household.

Appendix C. TMDL Accounting

Water body name	AUID	Use Class	Year Listed	Proposed Category	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
Lac qui Parle River, W Br Lac qui Parle R to Tenmile Cr	07020003-501	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	5	Chlorpyrifos		No
			1994	4A	Dissolved oxygen	CBOD, NBOD, SOD	No - TMDL completed in 2013 (PRJ06876-001)
			2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2006	4A	Turbidity	TSS	No - TMDL completed in 2013 (PRJ06876-001)
Lac qui Parle River, Tenmile Cr to Minnesota R	07020003-502	2Bg, 3C	2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
Lac qui Parle River, Headwaters (Lk Hendricks 41-0110-00) to Lazarus Cr (Canby Cr)	07020003-505	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2006	5	Fish bioassessments		No - deferred to collect additional data
			2006	4A	Turbidity	TSS	No - TMDL completed in 2013 (PRJ06876-001)
Lac qui Parle River, Lazarus Cr (Canby Cr) to W Br Lac qui Parle R	07020003-506	2Bg, 3C	2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2006	4A	Turbidity	TSS	No - TMDL completed in 2013 (PRJ06876-001)
Lazarus Creek (Canby Creek), Canby Cr to Lac qui Parle R	07020003-508	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2018	5	Fish bioassessments		No - deferred to collect additional data
			2006	4A	Turbidity	TSS	No - TMDL completed in 2013 (PRJ06876-001)
Lazarus Creek, MN/SD border to Canby Cr	07020003-509	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2006	5	Fish bioassessments		No - deferred to collect additional data
Lac qui Parle River, West Branch, Unnamed cr to Unnamed ditch	07020003-512	2Bg, 3C	2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
Lac qui Parle River, West Branch, Unnamed ditch to Lac qui Parle R	07020003-513	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
Lac qui Parle River, West Branch, Florida Cr to Unnamed cr	07020003-515	2Bg, 3C	2018	5	Fish bioassessments		No - deferred to collect additional data
Lac qui Parle River, West Branch, Lost Cr to Florida Cr	07020003-516	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data

Water body name	AUID	Use Class	Year Listed	Proposed Category	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
			2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2018	5	Fish bioassessments		No - deferred to collect additional data
			2010	4A	Turbidity	TSS	No - TMDL completed in 2013 (PRJ06876-001)
Lost Creek, Crow Timber Cr to W Br Lac qui Parle R	07020003-517	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	5	Dissolved oxygen		No - deferred to collect additional phosphorus data to confirm source of impairment
			2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
			2018	5	Fish bioassessments		No - deferred to collect additional data
Lac qui Parle River, West Branch, MN/SD border to Lost Cr	07020003-519	2Bg, 3C	2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
			2018	5	Fish bioassessments		No - deferred to collect additional data
Crow Timber Creek, MN/SD border to Lost Cr	07020003-520	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
Florida Creek, MN/SD border to W Br Lac qui Parle R	07020003-521	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2006	5	Fish bioassessments		No - deferred to collect additional data
			2006	4A	Turbidity	TSS	No - TMDL completed in 2013 (PRJ06876-001)
County Ditch 5, T118 R46W S23, north line to W Br Lac qui Parle R	07020003-523	7	2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
County Ditch 34, Unnamed ditch to Tenmile Cr	07020003-526	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
Unnamed creek, Unnamed cr to Lac qui Parle R	07020003-530	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
			2018	5	Fish bioassessments		No - deferred to collect additional data
			2018	4A	Total suspended solids (TSS)	TSS	**Yes**
Unnamed creek, CD 29A to Lac qui Parle R	07020003-534	2Bg, 3C	2018	5	Fish bioassessments		No - deferred to collect additional data
Canby Creek, T114 R46W S21, south line to Del Clark Lk	07020003-557	1B, 2Ag, 3B	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	5	Fish bioassessments		No - deferred to collect additional data
Unnamed creek, Unnamed cr to Unnamed cr	07020003-567	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
Unnamed creek, Unnamed cr to Unnamed cr	07020003-569	2Bg, 3C	2018	5	Fish bioassessments		No - deferred to collect additional data

Water body name	AUID	Use Class	Year Listed	Proposed Category	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
Unnamed ditch, Unnamed ditch to Tenmile Cr	07020003-570	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
Unnamed ditch, Unnamed ditch to Tenmeil Cr	07020003-571	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
Unnamed ditch, Headwaters to Unnamed ditch	07020003-575	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	5	Fish bioassessments		No - deferred to collect additional data
Tenmile Creek, Headwaters to CSAH 18	07020003-577	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2004	5	Fish bioassessments		No - deferred to collect additional data
Tenmile Creek, CSAH 18 to Lac qui Parle R	07020003-578	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2006	4A	Fecal coliform	Fecal coliform	No - TMDL completed in 2013 (PRJ06876-001)
			2018	5	Fish bioassessments		No - deferred to collect additional data
Unnamed creek, -96.1517, 44.9533 to W Br Lac qui Parle R	07020003-580	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
			2018	5	Fish bioassessments		No - deferred to collect additional data
Unnamed ditch (County Ditch 4), Unnamed ditch to CSAH 20	07020003-581	2Bg, 3C	2018	4A	*Escherichia coli (E. coli)*	*E. coli*	**Yes**
Unnamed ditch (County Ditch 4), CSAH 20 to Lac qui Parle R	07020003-582	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	5	Fish bioassessments		No - deferred to collect additional data
Cobb Creek, Unnamed cr to -96.3457, 44.8724	07020003-583	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
Canby Creek, CSAH 3 to Lazarus Cr	07020003-586	2Bg, 3C	2018	5	Fish bioassessments		No - deferred to collect additional data
Unnamed creek, -95.9114, 45.012 to Lac qui Parle R	07020003-588	2Bg, 3C	2018	5	Benthic macroinvertebrates bioassessments		No - deferred to collect additional data
			2018	5	Fish bioassessments		No - deferred to collect additional data
Hendricks	41-0110-00	2B, 3C	2018	5	Fish bioassessments		No - deferred to collect additional data
			2010	4A	Nutrients	Phosphorus	No - TMDL completed in 1999 by SD DENR (631)
Unnamed Wetland	87-0121-00	2D, 3D, 4C	2010	5	Aquatic plant bioassessments		No
			2010	5	Benthic macroinvertebrates bioassessments		No

Appendix D. Feedlots

Permitted CAFOs

Name	Reg Num	County	WID
Christensen Farms Site F146	073-50001	Lac qui Parle	502
Kuhlmann Farms Inc	073-50003	Lac qui Parle	502
Stratmoen Hog Finishing Inc	073-50004	Lac qui Parle	502
Mortenson Hog Farms	073-50005	Lac qui Parle	502, 513, 580
Lee Johnson Farm	073-62843	Lac qui Parle	502
David Dahl Farm	073-80100	Lac qui Parle	502
Wayne Dahl Hog Farm	073-80101	Lac qui Parle	502, 581
Greg Bothun Farm Baxter Section 6	073-83860	Lac qui Parle	502
Mike & Jared Anhalt Turkey Farm	073-96591	Lac qui Parle	502
Jeffrey Abraham Farm - Sec 21	073-96784	Lac qui Parle	502
Jason and Andrea Hastad	073-96789	Lac qui Parle	502
Joe Bothun	073-100040	Lac qui Parle	502
Greg Bothun Section 12	073-100041	Lac qui Parle	502
Cori Bothun Farm - Sec 28	073-100829	Lac qui Parle	502
Dave DeJong Farm - Sec 1	073-102740	Lac qui Parle	502
SFLLC-Dawson Prairie Pork Site	073-105620	Lac qui Parle	502
Dane Prestholdt Farm	073-107300	Lac qui Parle	502, 581
Brent Dahl Farm	073-110480	Lac qui Parle	502, 581
Bothun Hog Site LLC	073-125560	Lac qui Parle	502
Todd Bach Farm - Maxwell 24	073-125734	Lac qui Parle	502
Robertson Finisher	073-127134	Lac qui Parle	502
B-C-H Enterprises LLP - Site I	173-50372	Yellow Medicine	502
Alfred Jessen Farm	173-100141	Yellow Medicine	502

Feedlot Summary by Impaired Reach

	Description	Watershed	Impaired Reaches (last 3 digits of WID)							
			502	513	517	519	523	530	580	581
General	Total Feedlots	259	259	63	6	4	4	9	6	11
	Total Permitted CAFOs	23	23	2	0	0	0	0	1	3
	Total AUs	87,286	87,286	18,027	1,831	639	985	819	2,124	9,055
	Primary Animal Type[1]	Swine 67%	Swine 67%	Swine 48%	Swine 72%	Cattle 98%	Swine 78%	Cattle 80%	Swine 84%	Swine 95%
		Cattle 32%	Cattle 32%	Cattle 46%	Cattle 28%	Horses 2%	Cattle 22%	Swine 18%	Cattle 15%	Cattle 5%
Sensitive Areas	Open Lot Feedlots	180	180	47	3	3	4	8	4	5
	Feedlots in Shoreland	35	35	11	1	2	0	3	0	0
	Open Lot Feedlots in Shoreland	34	34	10	1	2	0	3	0	0

[1]Percentages based on AUs. top 2 provided as primary animal type.