Minnesota River *E. coli* Total Maximum Daily Load and Implementation Strategies

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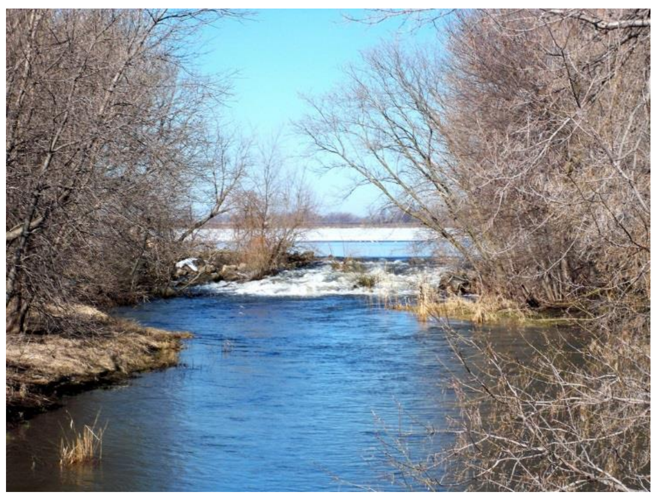

MINNESOTA POLLUTION CONTROL AGENCY

CLEAN WATER LAND & LEGACY AMENDMENT

May 2019

wq-iw7-48e

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Abbreviations

AFO	animal feeding operation
AUID	assessment unit identification
billion org/day	billions of organisms per day
BMP	best management practice
BWSR	Board of Water and Soil Resources
CAFO	concentrated animal feeding operation
CFR	Code of Federal Regulations
DMR	discharge monitoring report
E. coli	*Escherichia coli*
EIMS	Environmental Information Management Systems
EPA	United States Environmental Protection Agency
EQuIS	Environmental Quality Information System
HUC	hydrologic unit code
HSPF	Hydrologic Simulation Program–FORTRAN
IPHT	imminent public health threat
LA	load allocation
MCES	Metropolitan Council Environmental Services
MnDOT	Minnesota Department of Transportation
mi^2	square mile
MOS	margin of safety
MPCA	Minnesota Pollution Control Agency
MS4	municipal separate storm sewer system
NASS	National Agricultural Statistics Service
NPDES	National Pollutant Discharge Elimination System
NWIS	National Water Information System
org/100 mL	organisms per 100 milliliters
SDS	state disposal system
SSTS	subsurface sewage treatment system
SWPPP	stormwater pollution prevention plan
TMDL	total maximum daily load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WLA	wasteload allocation
WPLMN	Watershed Pollutant Load Monitoring Network
WRAPS	watershed restoration and protection strategies
WWTP	wastewater treatment plant
1W1P	One Watershed, One Plan

Executive Summary

The Clean Water Act, Section 303(d) requires that total maximum daily loads (TMDLs) be established for surface waters that do not meet applicable water quality standards necessary to support their designated uses. A TMDL determines the maximum amount of a pollutant a receiving waterbody can assimilate while still achieving water quality standards, and allocates pollutant load reductions to pollution sources. This TMDL study covers five *Escherichia coli* (*E. coli*) bacteria impairments along the Minnesota River main stem. The project area is the Minnesota River Basin, excluding the local drainage area to the river reaches downstream of the city of Carver (Figure 1). The Minnesota River Basin covers 12 eight-digit hydrologic unit code (HUC8) watersheds from the headwaters to the mouth of the Minnesota River.

Many fecal coliform and *E. coli* TMDLs have been previously completed on impaired reaches located within the watersheds of the impairments addressed in this report. Because loading capacities and allocations have already been developed for the reaches with approved TMDLs, this report focuses on the watershed areas of the five Minnesota River impairments that are not already covered by an approved TMDL. This area is referred to as the "TMDL project focus area" in this report.

Land use in the Minnesota River Basin is dominated by agriculture consisting of primarily corn and soybean rotations. There are also small sections of developed area, wetland, and forest. The monitoring data and source assessment suggest that the bacteria impairments are due to a mix of sources and pathways. Livestock from unpermitted animal feeding operations (AFO) and imminent public health threat (IPHT) septic systems are the primary sources of concern in the TMDL project focus area. The impairments are of a low to moderate magnitude compared to the degree of impairment of the tributaries.

A load duration curve approach was used to determine the TMDL, or allowable pollutant load, for each impaired stream. The load duration curves represent the allowable *E. coli* load at any given flow condition. Allocations for load, wasteload, and margin of safety (MOS) are provided. The load allocation (LA) for each TMDL represents the allowable amount of loading from non-permitted sources, including unregulated watershed runoff and IPHT septic systems. Wasteload allocations (WLAs) for permitted sources are provided for wastewater, regulated stormwater, and permitted AFO. Water quality data were compared with the water quality standard to estimate reduction needs. Reductions needed to meet the TMDLs range from 19% to 60%, with the highest reductions needed in the watershed of the most downstream reach (i.e., Minnesota River from Cherry Creek to High Island Creek).

This report includes an implementation strategies section to substitute for a separate strategies report. The Minnesota Pollution Control Agency (MPCA) believes this is an appropriate approach given that the main stem river impairments addressed in this report may in large part be due to the tributary impairments already addressed (or will be later addressed) in separate TMDLs. The implementation strategy prioritizes geographic areas for implementation and provides a description of management activities to reduce *E. coli* loading from permitted sources and the non-permitted sources identified as high priority sources—livestock and IPHT septic systems. The goal of the strategies is to restore impaired streams and protect unimpaired streams from impairment.

1. Project Overview

1.1 Purpose

The Clean Water Act and U.S. Environmental Protection Agency (EPA) regulations require that TMDLs be developed for waters that do not support their designated uses. In simple terms, a TMDL is a “pollution diet” to attain and maintain water quality standards in waters that are not currently meeting them. This TMDL study covers *E. coli* and fecal coliform bacteria impairments along the Minnesota River main stem. *E.coli* replaced fecal coliform as Minnesota’s water quality standard in 2008. Bacteria listings prior to then remain as “fecal coliform.” However, all impairment listings and TMDLs completed subsequent to that year, including in this report, are based on *E. coli*. The project area is the Minnesota River Basin, excluding the local drainage area to the river reaches downstream of the city of Carver (Figure 1). The Minnesota River Basin covers 12 eight-digit HUC8 watersheds from the headwaters to the mouth of the Minnesota River.

This report is a combined TMDL and strategies report. The strategies portion provides high-level recommended actions, which is appropriate for bacteria impairments given the difficulty in quantifying the efficacy of practices. Furthermore, the main stem river impairments addressed in this report may in large part be due to the tributary impairments already addressed (or will be later addressed) in separate TMDLs. (The completed TMDLs are cited in Section 1.2.)

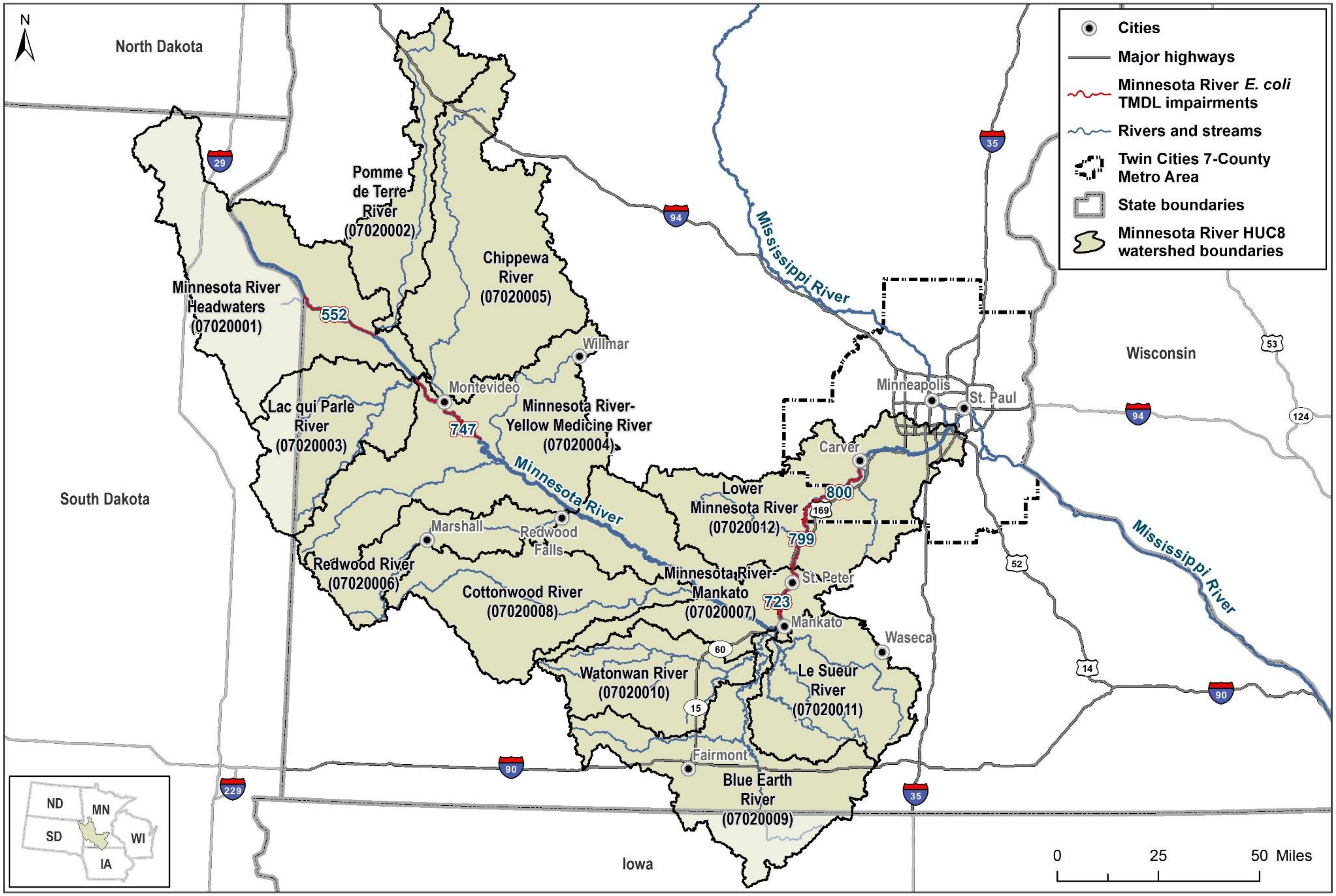

Figure 1. Minnesota River *E. coli* and fecal coliform impairments.

1.2 Identification of Waterbodies

Of the 14 assessment units (referred to by assessment unit identification, or AUID) that constitute the Minnesota River from its headwaters to mouth, six reaches fully support aquatic recreation as measured by *E. coli* or fecal coliform concentrations, two reaches have insufficient information, one reach has not been assessed, and five reaches are impaired (Table 1). This TMDL report addresses the five aquatic recreation impairment listings for the Minnesota River (Figure 1, Table 1). Some of the impaired reaches listed in Table 1 are consolidated reaches of older, shorter assessment units with fecal coliform impairments:

- 07020004-747: This AUID is a consolidation of 07020004-668, 501, 519, 583, and 575. The 1994 fecal coliform listing on reach 501 was carried forward to the new, consolidated AUID.
- 07020007-723: This AUID is a consolidation of 07020007-502, 501, and 599. The 1994 fecal coliform listing on reach 501 was carried forward to the new, consolidated AUID.
- 07020012-799: This AUID is a consolidation of 07020012-507, 504, and 503. The 2002 fecal coliform listings on reaches 507 and 503 were carried forward to the new, consolidated AUID.
- 07020012-800: This AUID is a consolidation of 07020012-502, 501, and 532. The 2002 fecal coliform listings on reaches 502 and 501 were carried forward to the new, consolidated AUID.

Table 1. Minnesota River main stem *E. coli*/fecal coliform assessment status

Based on the draft 2018 impaired waters list. Impaired reaches are shaded for emphasis. Reaches are listed in order from upstream to downstream.

HUC8 Watershed	AUID	Reach Name and Description	Use Class	Aquatic Recreation Assessment Status (Year Listed)	Pollutant or Stressor
Minnesota River Headwaters	07020001-552	Minnesota River, Big Stone Lake to Marsh Lake Dam	1C, 2Bd, 3C	Impaired (2018)	*Escherichia coli*
	07020001-554	Minnesota River, Marsh Lake Dam to Lac qui Parle Dam	2B, 3C	Not assessed	NA
Minnesota River–Yellow Medicine River	07020004-747	Minnesota River, Lac qui Parle Dam to Granite Falls Dam	1C, 2Bd, 3C	Impaired (1994)	Fecal coliform
	07020004-748	Minnesota River, Granite Falls Dam to Yellow Medicine River	2B, 3C	Fully supporting	NA
	07020004-749	Minnesota River, Yellow Medicine River to Echo Creek	2B, 3C	Fully supporting	NA
	07020004-750	Minnesota River, Echo Creek to Beaver Creek	2B, 3C	Fully supporting	NA
Minnesota River–Mankato	07020007-720	Minnesota River, Beaver Creek to Little Rock Creek	2B, 3C	Fully supporting	NA
	07020007-721	Minnesota River, Little Rock Creek to Cottonwood River	2B, 3C	Insufficient data	NA
	07020007-722	Minnesota River, Cottonwood River to Blue Earth River	2B, 3C	Insufficient data	NA
	07020007-723	Minnesota River, Blue Earth River to Cherry Creek	2B, 3C	Impaired (1994)	Fecal coliform
	07020012-799	Minnesota River, Cherry Creek to High Island Creek	2B, 3C	Impaired (1994)	Fecal coliform

HUC8 Watershed	AUID	Reach Name and Description	Use Class	Aquatic Recreation Assessment Status (Year Listed)	Pollutant or Stressor
Lower Minnesota River	07020012-800	Minnesota River, High Island Creek to Carver Creek	2B, 3C	Impaired (2002)	Fecal coliform
	07020012-506	Minnesota River, Carver Creek to RM 22	2B, 3C	Fully supporting	NA
	07020012-505	Minnesota River, RM 22 to Mississippi River	2C, 3C	Fully supporting	NA

NA: not applicable

Many fecal coliform and *E. coli* TMDLs have been completed on impaired reaches located within the watersheds of the impairments addressed in this report (Figure 2). Appendix A lists all reaches with approved *E. coli* or fecal coliform TMDLs in the Minnesota River Basin; these approved TMDLs are included in the following reports:

- *Carver County Bacterial TMDL Report* (Wenck Associates 2007)
- *Chippewa River Fecal Coliform Total Maximum Daily Load Report* (MPCA 2006)
- *Chippewa River Watershed Total Maximum Daily Load* (MPCA 2017a)
- *Cottonwood River Fecal Coliform TMDL Report* (Redwood–Cottonwood Rivers Control Area 2013a)
- *Fecal Coliform TMDL Assessment for 21 Impaired Streams in the Blue Earth River Basin* (Water Resources Center and Blue Earth River Basin Alliance 2007)
- *Fecal Coliform TMDL Assessment for High Island Creek and Rush River* (Water Resources Center and Sibley County 2008)
- *Hawk Creek Watershed TMDL* (MPCA 2017b)
- *Lac qui Parle Yellow Bank Bacteria, Turbidity, and Low Dissolved Oxygen TMDL Assessment Report* (Wenck Associates 2013)
- *Le Sueur River Watershed TMDL* (MPCA 2015a)
- *Pomme de Terre River, Muddy Creek to Marsh Lake, Fecal Coliform TMDL* (MPCA 2007a)
- *Pomme de Terre River Watershed TMDL Report* (MPCA 2015b)
- *Redwood River Fecal Coliform TMDL Report* (Redwood–Cottonwood Rivers Control Area 2013b)
- *South Branch Yellow Medicine River Fecal Coliform TMDL Report* (Yellow Medicine River Watershed District 2004)
- *Yellow Medicine River Watershed TMDL* (MPCA 2016a)

There are no approved *E. coli* or fecal coliform bacteria TMDLs for impaired reaches in the South Dakota portion of the watershed. However, the *Lac qui Parle Yellow Bank Bacteria, Turbidity, and Low Dissolved Oxygen TMDL Assessment Report* (Wenck Associates 2013), which addresses impairments in Minnesota, also includes watershed area in South Dakota.

Because loading capacities and allocations have already been developed for the reaches with approved TMDLs, this report focuses on the watershed areas of the five Minnesota River impairments that are not already covered by an approved TMDL (Figure 2). This area is referred to as the "TMDL project focus area" in this report. Impaired reaches in the Lower Minnesota River Watershed are expected to have approved TMDLs within the approximate time frame of this project; therefore, the watersheds of these reaches are *not* included in the TMDL project focus area. Other *E. coli* TMDLs are also in progress but on a longer timeline; watersheds of these impairments *are* included in the TMDL project focus area. In some instances, there are incomplete TMDLs within the watersheds of approved TMDLs; because the watershed areas of the incomplete TMDLs are already addressed in an approved TMDL, they are not included in the TMDL project focus area.

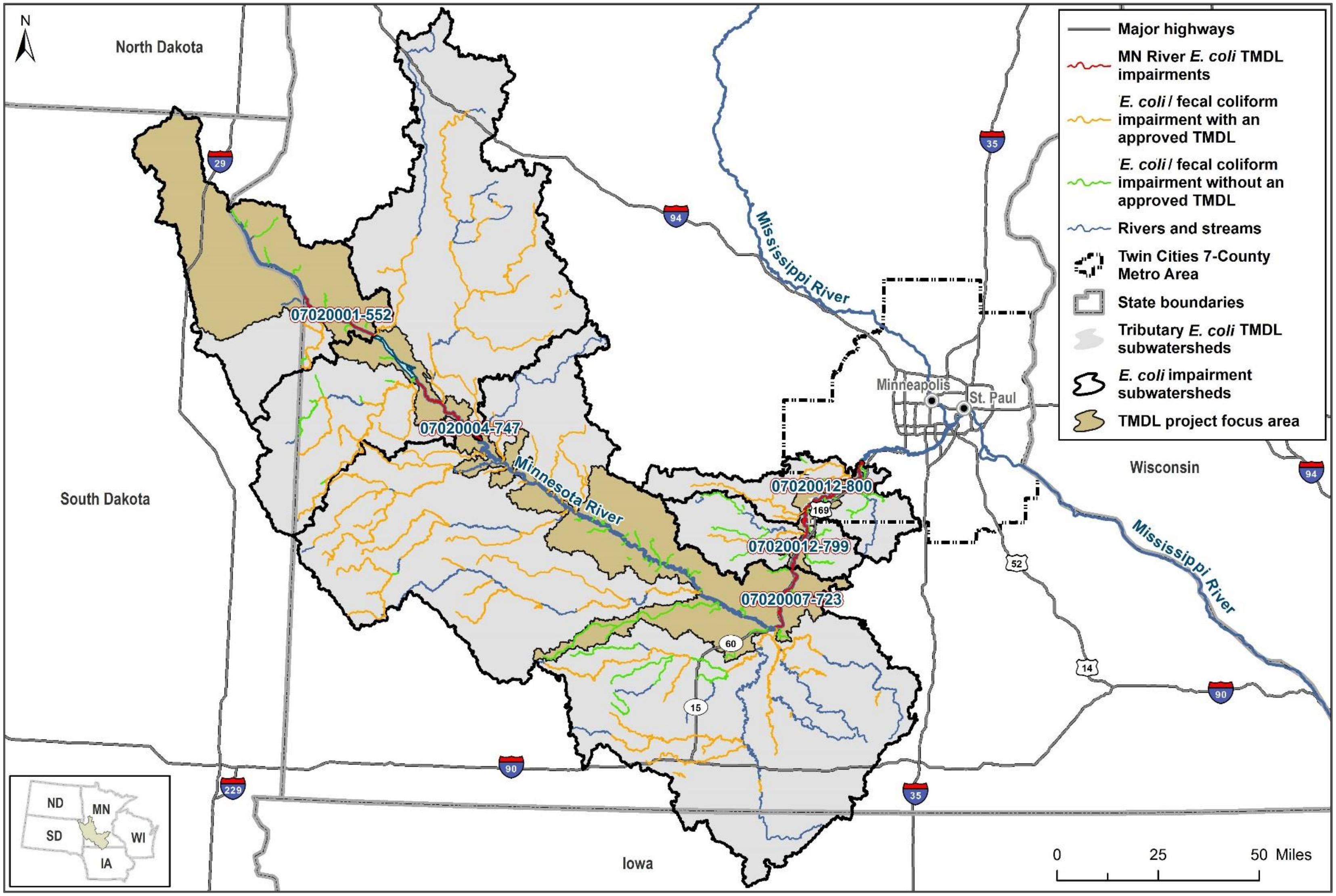

Figure 2. *E. coli* impairment subwatersheds and *E. coli* / fecal coliform impairments in the Minnesota River Basin project area.

Impaired reaches in the Lower Minnesota River Watershed (AUIDs 07020012-799 and -800) that do not have approved TMDLs are expected to have approved TMDLs within the approximate time frame of this project; the watersheds of these reaches are *not* included in the TMDL project focus area.

1.3 Priority Ranking

The MPCA's schedule for TMDL completions, as indicated on the 303(d) impaired waters list, reflects Minnesota's priority ranking of this TMDL. The MPCA developed a state plan, Minnesota's TMDL Priority Framework Report, to meet the needs of the EPA's national measure (WQ-27) under EPA's Long-Term Vision for Assessment, Restoration and Protection under the Clean Water Act Section 303(d) Program. As part of these efforts, the MPCA identified water quality impaired segments that will be addressed by TMDLs by 2022. The Minnesota River Basin waters addressed by this TMDL are part of the MPCA's prioritization plan to meet EPA's national measure.

2. Applicable Water Quality Standards and Numeric Water Quality Targets

Minnesota water quality standards protect waterbodies throughout the state. The standards consist of the designated uses, criteria to protect the uses, and other provisions such as antidegradation policies that protect the waterbody.

2.1 Designated Uses

Use classifications are defined in Minn. R. 7050.0140, and water use classifications for individual waterbodies are provided in Minn. R. 7050.0470, 7050.0425, and 7050.0430. This project addresses aquatic recreation impairments on class 2 waters. The impaired reaches of the Minnesota River in this report are either classified as class 2B or 2Bd waters (refer back to Table 1 for the aquatic recreation uses along the Minnesota River). Both class 2B and 2Bd waters are protected for aquatic recreation activities including bathing. Class 2Bd waters are additionally protected as a drinking water source.

2.2 Numeric Water Quality Standards

The numeric water quality standards for class 2B and 2Bd waters are defined in Minn. R. 7050.0222. In Minnesota, *E. coli* is used as an indicator species of potential waterborne pathogens. There are two numeric *E. coli* standards—one is applied to monthly *E. coli* geometric mean concentrations, and the other is applied to individual samples (Table 2). Exceedances of either *E. coli* standard indicate that a waterbody does not meet the designated use.

Some of the impaired reaches in this project were listed based on exceedance of fecal coliform, which was the bacterial water quality standard indicator organism in Minn. R. ch. 7050, prior to 2008. The Statement of Need and Reasonableness for the rulemaking that changed this standard to *E. coli* indicated that the *E. coli* concentration standard of 126 organisms per 100 mL was considered reasonably equivalent to the previous fecal coliform standard of 200 organisms per 100 milliliters from a public health protection standpoint. Furthermore, in monitoring datasets containing these two parameters a good relationship via a regression equation was established. Thus, it has been the MPCA's policy since that rule change to complete TMDLs for fecal coliform listings and to do so using the *E. coli* standard. All of the TMDLs completed in this report are *E. coli* TMDLs, and the data presented in *Current/Historic Water Quality* (Section 3.3) and *TMDL Development* (Section 4) are *E. coli* data.

Table 2. Minnesota water quality standards for stream *E. coli* impairments

Waterbody Type and Class	Parameter	Numeric Water Quality Standard
Class 2B and 2Bd streams	*E. coli*	Not to exceed 126 organisms per 100 milliliters (org/100 mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% 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.

3. Watershed and Waterbody Characterization

The Minnesota River begins near the Minnesota–South Dakota border, flows for 335 miles through some of the richest agricultural land in Minnesota, and joins the Mississippi River at Pike Island in Ft. Snelling State Park, near the city of St. Paul. The river drains a 17,003-square mile (mi^2) basin, including all or parts of 37 counties. Its 13 major watersheds range in size from 699 mi^2 (the Redwood River Watershed) to 2,078 mi^2 (the Chippewa River Watershed). MPCA (2015c, p. 30–31) previously described the Minnesota River Basin as follows.

> The Minnesota River flows southeast from its source at Big Stone Lake on the South Dakota border to Mankato, then northeast to join the Mississippi River at Fort Snelling, traversing a total of 335 miles. Its drainage basin (excluding its Metroshed portion) covers about 10.3 million acres...
>
> Land use, runoff and water quality change together as the river flows from west to east... Throughout all but the easternmost part of the basin, cultivated cropland dominates the landscape, accounting for an average of 80% of land use basin-wide.
>
> In the lower precipitation area of the western basin, land use includes corn production, soybean production, wheat production and grazing of beef cattle. Runoff rates are relatively low... Tributaries such as the Pomme de Terre and Lac qui Parle continue to support fairly healthy beds of mussels, a sign of relatively good water quality.
>
> As the river enters south-central Minnesota, higher average precipitation and rich, fine-textured soils favor the corn-soybean rotation, with an area of sugar beet production in the Hawk Creek Watershed. Land drainage through surface ditches and pattern tiling is more intense here...

Additional watershed characterization and water quality information has been summarized in multiple reports and research papers, including TMDL and watershed restoration and protection strategies (WRAPS) reports and references cited within. Approved TMDL reports are listed in Section 1.2, and the following are completed WRAPS reports in the Minnesota River Basin:

- *Chippewa River WRAPS Report* (Chippewa River Watershed Project and MPCA 2017)
- *Hawk Creek Watershed and Surrounding Direct Minnesota River Tributaries Restoration and Protection Strategies* (MPCA 2017c)
- *Pomme de Terre River Watershed Report* (MPCA 2013)
- *Yellow Medicine River and Surrounding Direct Minnesota River Tributaries Restoration and Protection Strategies* (MPCA 2016b)
- *Le Sueur River WRAPS Report* (MPCA 2015c)

Regarding tribal lands, the Upper Sioux Community and the Lower Sioux Community are located in the TMDL project focus area of impaired reach 07020007-723. The impaired reach does not flow through nor is it adjacent to the tribal lands. Potential *E. coli* load from the tribal lands is low relative to the total load to the impaired reach, and is accounted for in the LAs. The TMDL for reach 07020007-723 does not specify a reduction needed from tribal lands.

The following sections provide summaries of the impaired subwatersheds, land cover, water quality, and sources of fecal contamination.

3.1 Watersheds

Watersheds that drain to impaired waters range from 1,976 mi^2 to 16,559 mi^2 (Table 3). The watershed area includes all drainage area to the impairment, including from all upstream assessment units. Twenty-three percent to seventy-nine percent of each impairment's watershed area is addressed in already approved *E. coli* or fecal coliform TMDLs. The impairments and watershed boundaries are shown in Figure 1.

Table 3. Watershed areas

Reach Name (AUID)	Watershed Area (mi^2)	Area of Watersheds with Approved *E. coli* / Fecal Coliform TMDLs (mi^2)	Percent of Watershed Area with Approved *E. coli* / Fecal Coliform TMDLs
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	1,976	461	23%
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	6,375	4,600	72%
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	15,174	11,814	78%
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	15,823	12,403	78%
Minnesota River, High Island Creek to Carver Creek (07020012-800)	16,559	13,072	79%

3.2 Land Use

Land use in the 17,003-mi^2 Minnesota River Basin is dominated by agriculture, consisting of primarily corn and soybean rotations (Table 4 and Figure 3). There are also small sections of developed area, wetland, and forest. The watersheds of the impaired reaches range from approximately 50% to over 70% cropland.

Table 4. Land use by impaired reach

Data from USDA National Agricultural Statistics Service's Cropland Data Layer, 2015. Data are presented for the entire watersheds, as opposed to just the TMDL project focus area.

Reach Name (AUID)	Percent of Watershed								Subwatershed Area (mi^2)
	Developed	Corn	Soy	Other Crops	Grassland/ Pasture	Forest	Wetlands	Open Water	
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	5	22	26	5	25	2	10	5	1,976
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	5	28	27	5	16	4	10	5	6,375
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	6	36	31	3	10	3	8	3	15,174
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	6	37	31	3	9	3	8	3	15,823
Minnesota River, High Island Creek to Carver Creek (07020012-800)	6	37	31	3	9	3	8	3	16,559

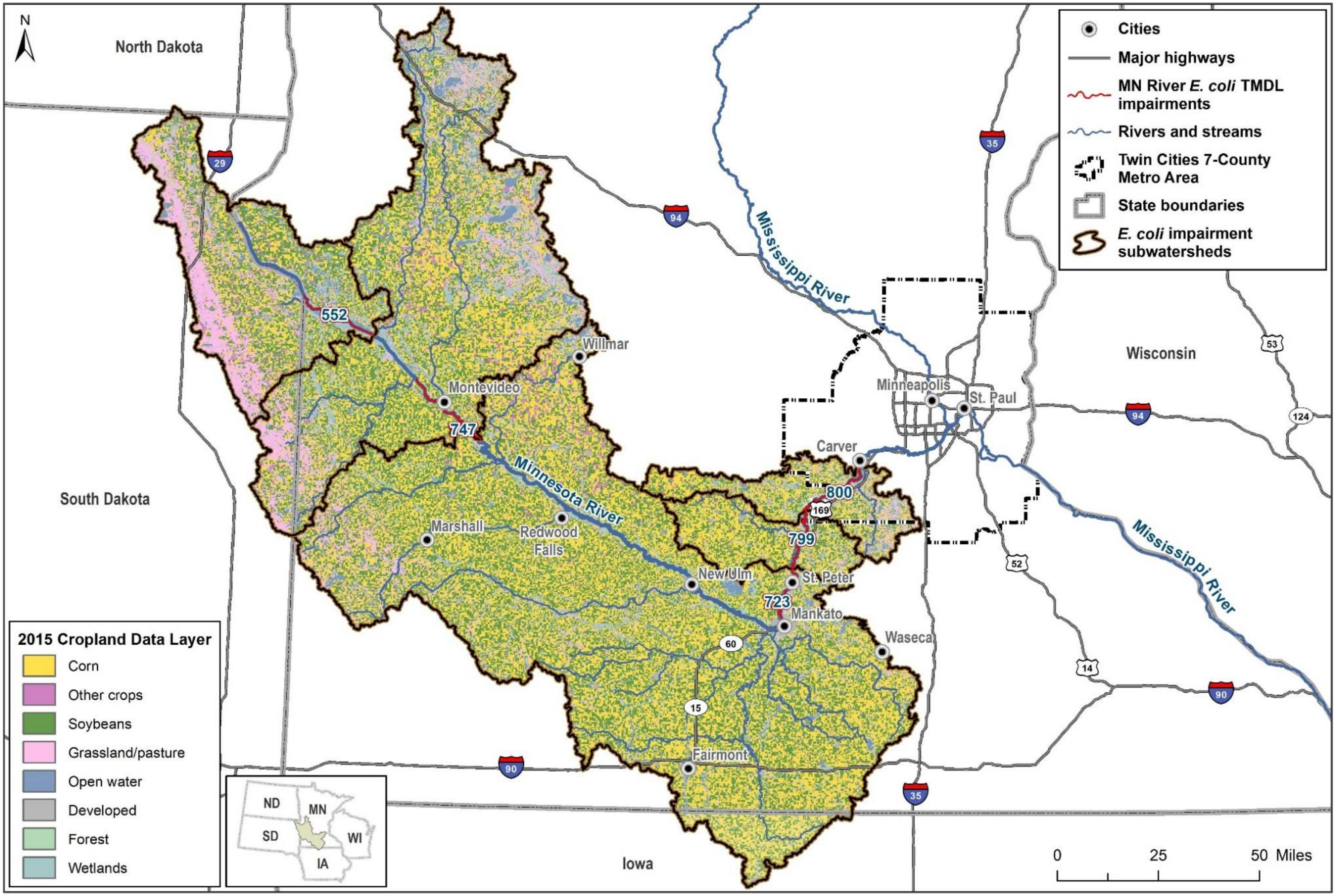

Figure 3. Land cover in the impairment watersheds.

3.3 Current/Historic Water Quality

Flow and water quality data are presented to evaluate the impairments and trends in water quality. Data from the 10-year period 2006 through 2015 were used in the water quality summary tables and figures.

Flow records with year-round data were prioritized over seasonal and shorter flow records. The analyses used the following sources of flow data (Table 5):

- Flow data from the United States Geological Survey's (USGS) National Water Information System (NWIS) were downloaded for the Minnesota River long-term continuous flow gauges. Flows were drainage area-weighted when the data did not explicitly represent the impaired watershed.
- Daily average flows were simulated with the MPCA's Hydrologic Simulation Program–FORTRAN (HSPF) model application (2016-02-18 version) for the most upstream reach—Minnesota River, Big Stone Lake to Marsh Lake Dam. The model reports (Tetra Tech 2015, RESPEC 2014) describe the framework and the data that were used to develop the model and include information on the calibration.

Table 5. Flow data sources

Reach Name (AUID)	Flow Source	Period of Record
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	HSPF model subwatershed #451	01/01/1993–12/31/2012
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	USGS 05311000 (area-weighted)	01/01/1986–12/31/2015
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	USGS 05325000 (area-weighted)	01/01/1986–12/31/2015
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	USGS 05330000 (area-weighted)	01/01/1986–12/31/2015
Minnesota River, High Island Creek to Carver Creek (07020012-800)	USGS 05330000 (area-weighted)	01/01/1986–12/31/2015

The analyses used the following sources of water quality data:

- The MPCA provided water quality data from the Environmental Quality Information System (EQuIS) database (2006 through 2015).
- Data were downloaded from the Metropolitan Council Environmental Services' (MCES) Environmental Information Management Systems (EIMS) for the Minnesota River at Jordan (site MI 39.4; 2006–2015).

E. coli data from 2006 to 2015 were summarized by year to evaluate potential trends in long-term water quality and by month to evaluate seasonal variation. The summaries of data by year only consider data from samples collected during the time period that the standard is in effect (April through October). The summaries of data by month aggregate data across years; for example, all June data from the 10-year period of record were aggregated. Where there are multiple sites along one assessment unit, data from the sites were combined and summarized together. The frequency of exceedances represents the percentage of samples that exceed the water quality standard.

Two summary tables are provided for each impairment (Table 6 through Table 15). The first table presented for each impairment includes the percent of samples in each *year* that exceed the individual sample standard. The second table includes the percent of samples in each *month* (across multiple years) that exceed the individual sample standard. Because the *E. coli* standard states that “nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters,” the months in which greater than 10% of samples exceed the standard are highlighted. Values in the first summary table (by year) are not highlighted, even if more than 10% of the samples exceed the standard.

Water quality duration curves are provided for each impairment (Figure 6 through Figure 10). Concentration duration curves are a form of water quality duration curves and are used to evaluate the relationships between hydrology and water quality, because water quality is often a function of stream flow. Either monitored or simulated daily average stream flow is depicted in these figures, and only the single sample standard reference line is shown.

The resulting concentration duration curve can provide insight into pollutant sources. The exceedances at the right side of the graph occur during low flow conditions, and may be derived from sources such as IPHT septic systems. Exceedances on the left side of the graph occur during higher flow conditions, and may be derived from sources such as runoff. Concentration duration curves can be used to support selection of implementation practices that are most effective for reducing loads on the basis of flow regime. If loads are considerable during wet-weather events, implementation efforts can target best management practices (BMPs) that will most effectively reduce watershed runoff.

Patterns in water quality are observed among the impaired streams:

- Three of the impaired reaches (Big Stone Lake to Marsh Lake Dam, Lac qui Parle Dam to Granite Falls Dam, and Cherry Creek to High Island Creek) have relatively low levels of impairment, with few months violating either the monthly geometric mean standard or the individual sample standard. The violations of the monthly geometric mean standard in these reaches range from 156 to 231 org/100 mL.
- The other two reaches (Blue Earth River to Cherry Creek and High Island Creek to Carver Creek) show moderate impairment. The monthly geometric mean standard was violated for two out of seven months in the Blue Earth River to Cherry Creek reach and for three out of seven months in the High Island Creek to Carver Creek reach. The violations of the monthly geometric mean standard range from 159 to 314 org/100 mL.
- On average, concentrations increase as flows increase (Figure 4). The few exceedances of the individual sample standard occur across a range of flow conditions (Figure 6 through Figure 10), indicating a mix of sources or pathways.
- Concentrations vary seasonally, with concentrations highest on average in June, and with the majority of exceedances of the monthly geometric mean standard in June (Figure 5).
- Only four monthly geometric means out of the 25 monthly geometric means (16%) across all five reaches violate the standard for this main stem TMDL project (Figure 5). In comparison, 22 out of 42 months (52%) in the Chippewa River Watershed TMDL (MPCA 2017a), 29 out of 55 months (53%) in the Lac qui Parle River Watershed TMDL (Wenck Associates 2013), and 49 out

of 74 months (66%) in the Hawk Creek Watershed TMDL (MPCA 2017b) violated the monthly geometric mean standard.

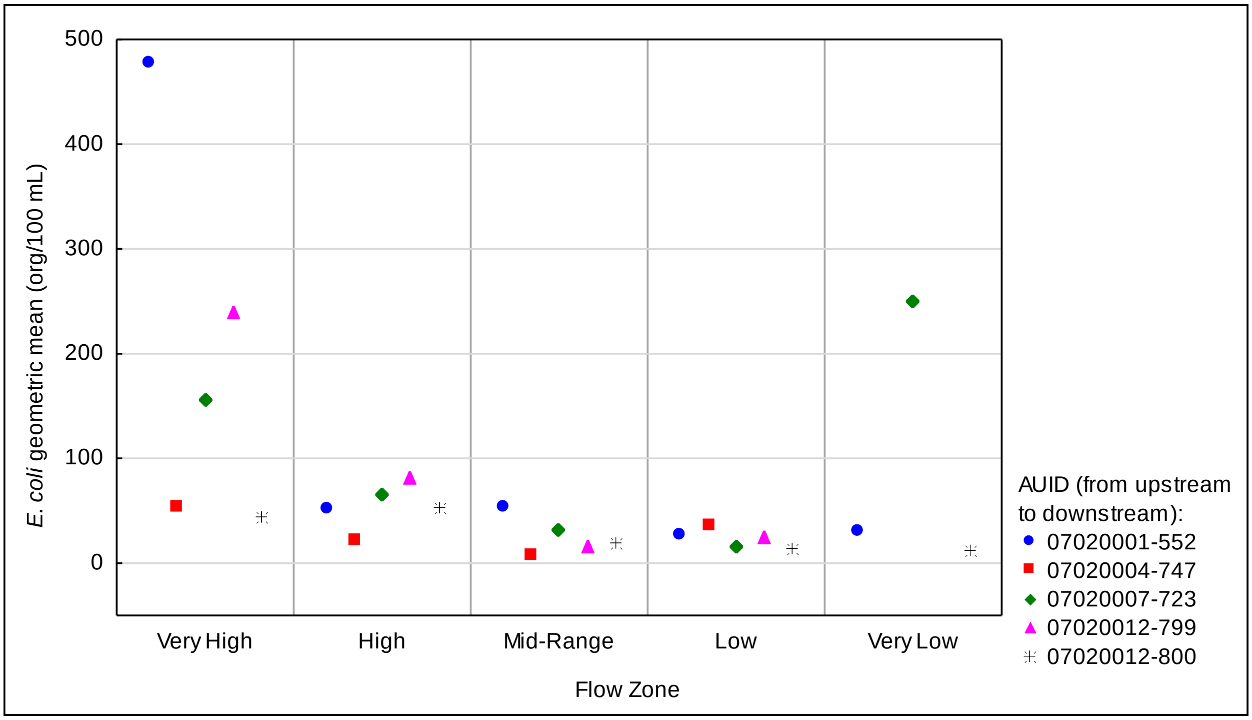

Figure 4. *E. coli* concentrations by flow zone and by impaired reach.
The high geometric mean for AUID 07020007-723 under very low flows is due to one high sample (4,332 org/100 mL).

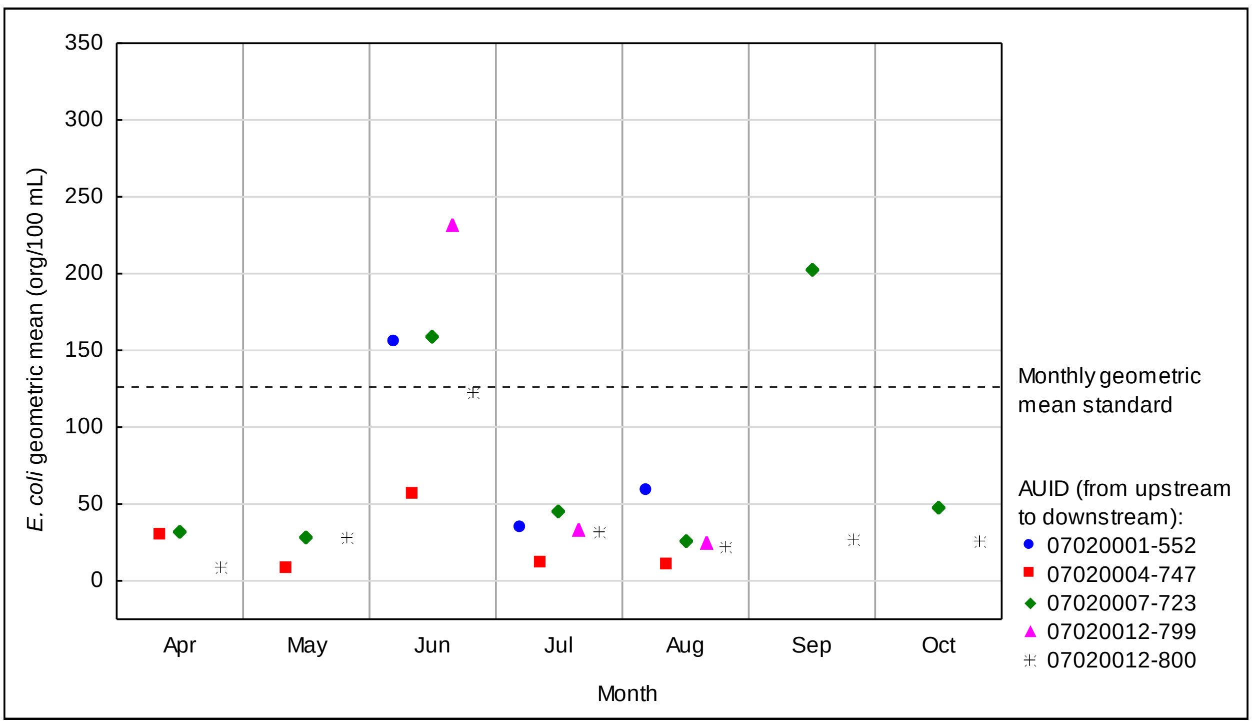

Figure 5. *E. coli* concentrations by month and by impaired reach.
Geometric means are not displayed if the sample size is less than or equal to two.

The following sections present the water quality summary tables and concentration duration curves for the five impairments. Some of the annual or monthly maximum concentrations are recorded as ≥ 2,420 org/100 mL. The maximum recordable value for *E. coli* concentration depends on the extent of sample dilution and is often 2,420 org/100 mL. Concentrations that are noted as ≥ 2,420 org/100 mL are likely higher, and the magnitude of the exceedances is not known.

Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)

Table 6. Annual summary of *E. coli* data at Minnesota River, Big Stone Lake to Marsh Lake Dam (AUID 07020001-552)

MPCA Sites S000-234 and S002-241; Apr–Oct.

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
2011	9	126	20	960	0	0
2012	7	63	10	≥ 2,420	1	14
2014	8	58	6	≥ 2,420	1	13
2015	7	42	8	276	0	0
Total	*31*	*69*	*6*	*≥ 2,420*	*2*	*6*

Table 7. Monthly summary of *E. coli* data at Minnesota River, Big Stone Lake to Marsh Lake Dam (AUID 07020001-552)

MPCA Sites S000-234 and S002-241; 2006–2015. Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual sample standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
June	10	156	22	≥ 2,420	1	10
July	10	36	6	148	0	0
August	11	60	10	≥ 2,420	1	9

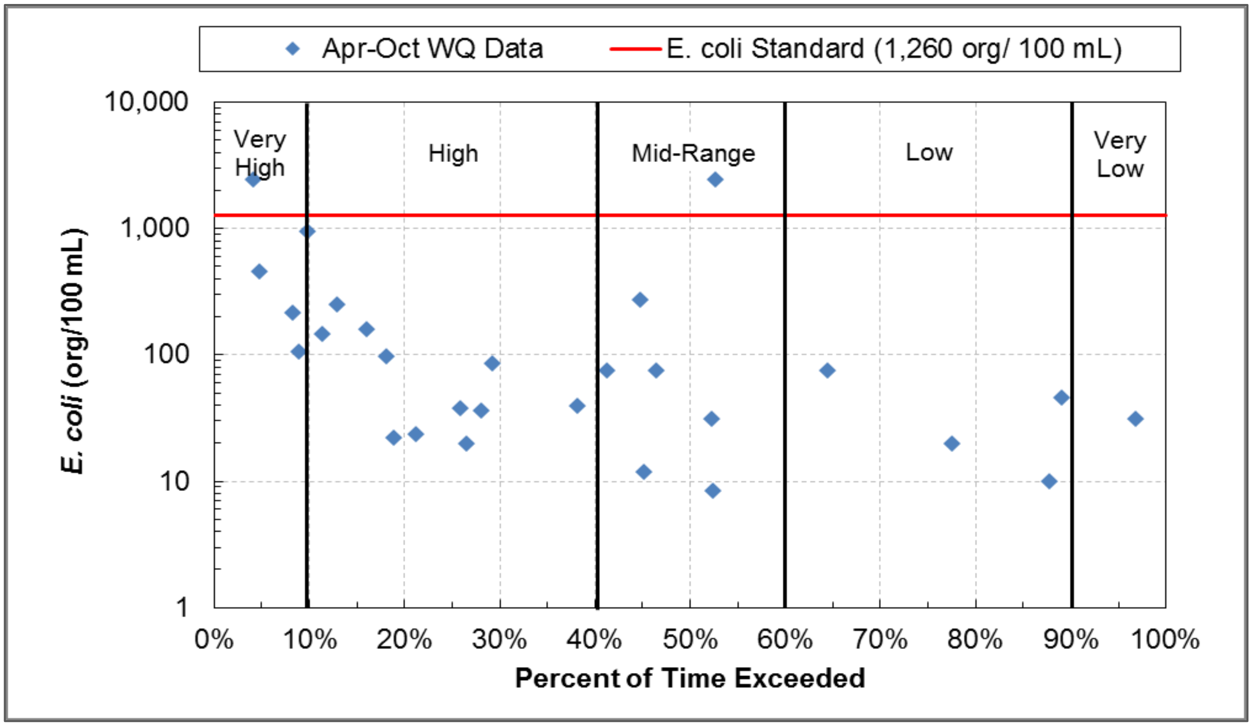

Figure 6. *E. coli* concentration duration plot of Minnesota River, Big Stone Lake to Marsh Lake Dam (AUID 07020001-552). MPCA Sites S000-234 and S002-241; 2006–2015.

Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)

Table 8. Annual summary of *E. coli* data at Minnesota River, Lac qui Parle Dam to Granite Falls Dam (AUID 07020004-747)
MPCA Sites S004-649 and S007-851; Apr–Oct.

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
2008	16	22	1	1,700	2	13
2014	8	22	1	430	0	0
2015	7	30	9	167	0	0
Total	*31*	*23*	*1*	*1,700*	*2*	*6*

Table 9. Monthly summary of *E. coli* data at Minnesota River, Lac qui Parle Dam to Granite Falls Dam (AUID 07020004-747)

MPCA Sites S004-649 and S007-851; 2006–2015. Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual sample standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
April	4 [a]	30	1	1,700	1	25
May	4 [a]	9	1	1,414	1	25
June	9	58	5	430	0	0
July	5	12	5	30	0	0
August	7	11	1	313	0	0
September	1 [a]	46	46	46	0	0
October	1 [a]	290	290	290	0	0

[a] Not enough samples to assess compliance with the monthly geometric mean standard.

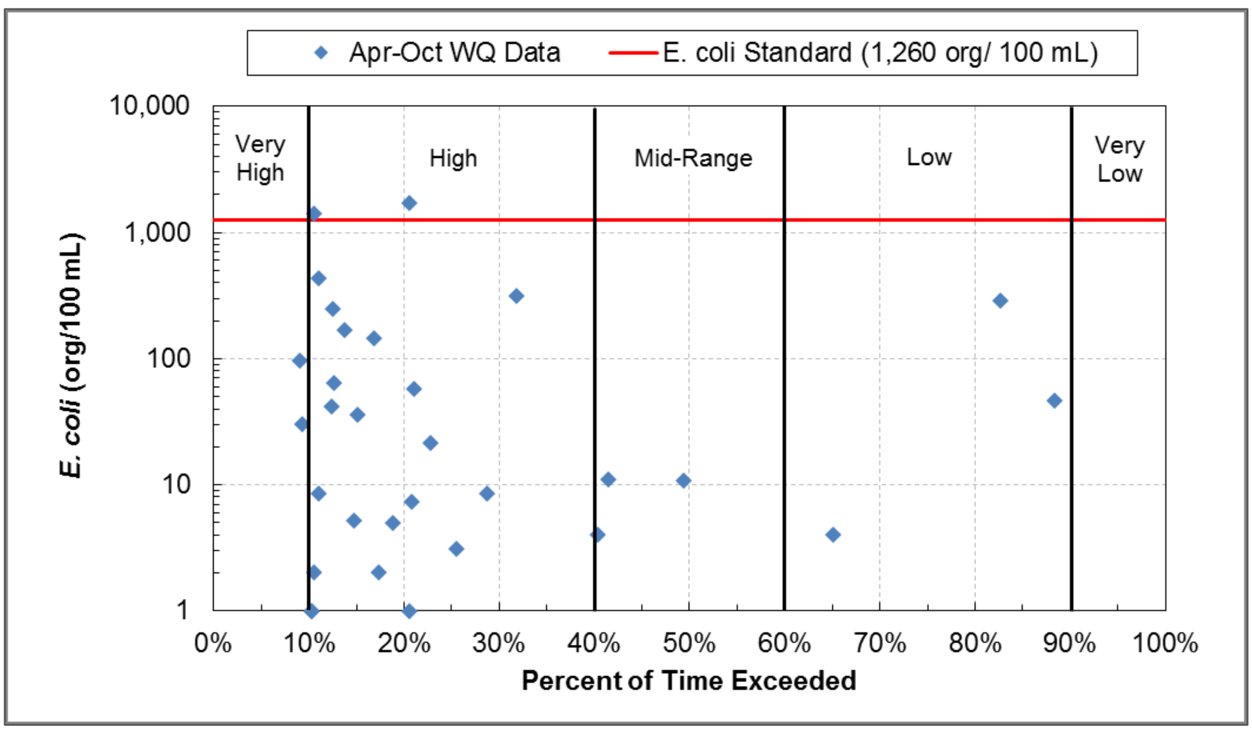

Figure 7. *E. coli* concentration duration plot, Minnesota River, Lac qui Parle Dam to Granite Falls Dam (AUID 07020004-747). MPCA Sites S004-649 and S007-851, 2006–2015.

Minnesota River, Blue Earth River to Cherry Creek (07020007-723)

Table 10. Annual summary of *E. coli* data at Minnesota River, Blue Earth River to Cherry Creek (AUID 07020007-723)

MPCA Sites S000-041, S004-130, and S007-861; Apr–Oct.

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
2006	14	48	4	770	0	0
2008	25	88	2	≥ 2,420	1	4
2009	19	27	4	488	0	0
2010	20	90	5	4,332	2	10
2014	8	45	9	980	0	0
2015	7	139	21	830	0	0
Total	*93*	*62*	*2*	*≥ 2,420*	*3*	*3*

Table 11. Monthly summary of *E. coli* data at Minnesota River, Blue Earth River to Cherry Creek (AUID 07020007-723)

MPCA Sites S000-041, S004-130, and S007-861; 2006–2015. Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual sample standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
February	1	125	125	125	NA	NA
April	13	32	2	488	0	0
May	15	28	5	770	0	0
June	22	159	15	980	0	0
July	12	45	4	548	0	0
August	11	25	4	365	0	0
September	13	202	26	4,332	3	23
October	7	48	19	488	0	0

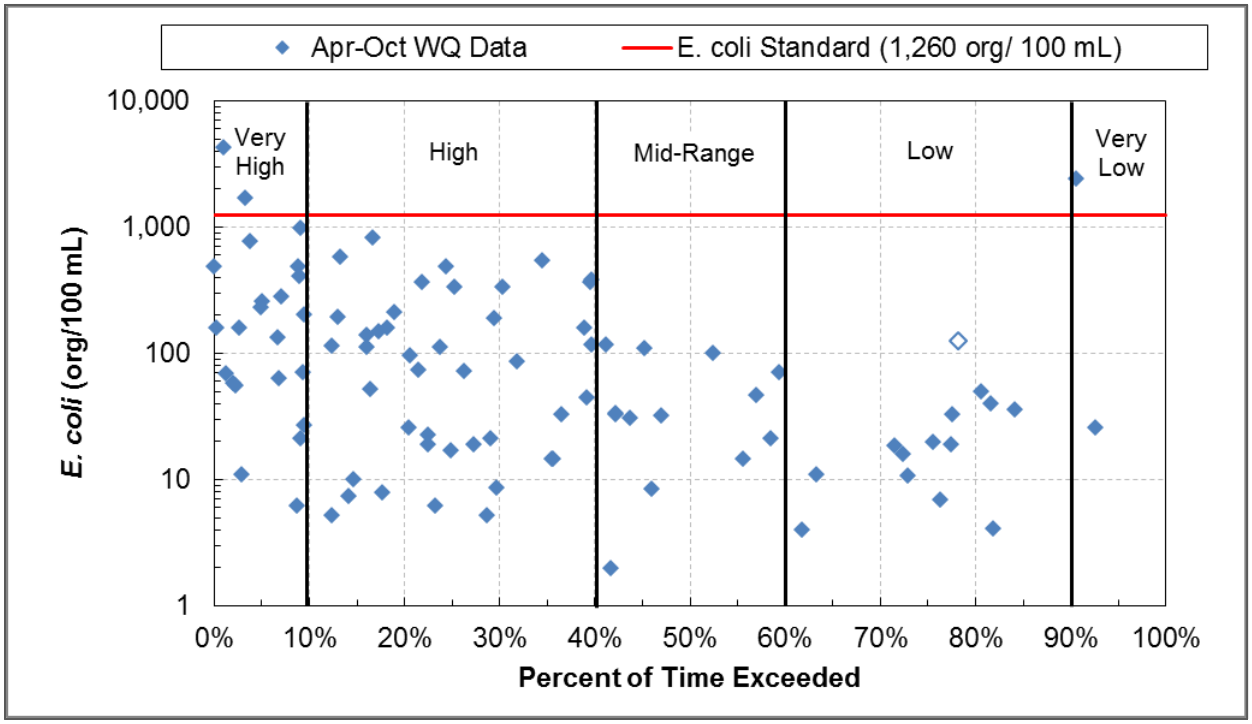

Figure 8. *E. coli* concentration duration plot, Minnesota River, Blue Earth River to Cherry Creek (AUID 07020007-723). MPCA Sites S000-041, S004-130, and S007-861; 2006–2015.

Minnesota River, Cherry Creek to High Island Creek (07020012-799)

Table 12. Annual summary of *E. coli* data at Minnesota River, Cherry Creek to High Island Creek (AUID 07020012-799)
MPCA Sites S000-040 and S007-855; Apr–Oct.

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
2006	13	46	5	820	0	0
2008	1	12	12	12	0	0
2014	8	34	3	1,120	0	0
2015	7	135	17	617	0	0
Total	*29*	*52*	*3*	*1,120*	*0*	*0*

Table 13. Monthly summary of *E. coli* data at Minnesota River, Cherry Creek to High Island Creek (AUID 07020012-799)

MPCA Sites S000-040 and S007-855; 2006–2015. Values in red indicate months in which the monthly geometric mean standard of 126 org/100 mL was exceeded or the individual sample standard of 1,260 org/100 mL was exceeded in greater than 10% of the samples.

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
April	2 [a]	84	39	180	0	0
May	2 [a]	95	11	820	0	0
June	7	231	91	1,120	0	0
July	7	33	7	291	0	0
August	7	25	3	460	0	0
September	2 [a]	18	17	20	0	0
October	2 [a]	18	12	26	0	0

[a] Not enough samples to assess compliance with the monthly geometric mean standard.

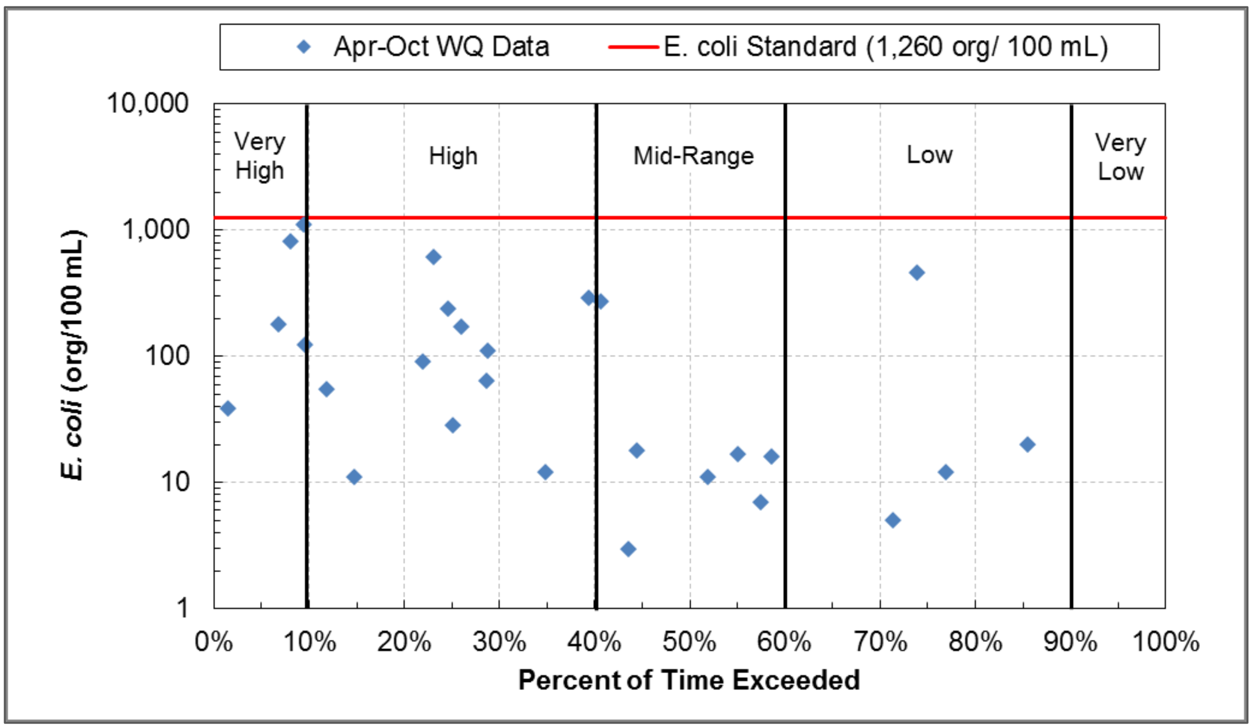

Figure 9. *E. coli* concentration duration plot, Minnesota River, Cherry Creek to High Island Creek (AUID 07020012-799). MPCA Sites S000-040 and S007-855; 2006–2015.

Minnesota River, High Island Creek to Carver Creek (07020012-800)

Table 14. Annual summary of *E. coli* data at Minnesota River, High Island Creek to Carver Creek (AUID 07020012-800)

MPCA Site S007-856 and MCES Site MI 39.4; Apr–Oct.

Year	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
2006	29	16	1	866	0	0
2007	28	43	2	1,414	1	4
2008	28	18	1	870	0	0
2009	29	20	1	1,300	1	3
2010	29	45	4	≥ 2,420	1	3
2011	31	24	3	452	0	0
2012	30	27	2	≥ 2,420	2	7
2013	30	34	5	1,483	1	3
2014	38	37	1	≥ 2,420	2	5
2015	37	44	2	1,120	0	0
Total	*309*	*29*	*1*	*≥ 2,420*	*8*	*3*

Table 15. Monthly summary of *E. coli* data at Minnesota River, High Island Creek to Carver Creek (AUID 07020012-800)

MPCA Site S007-856 and MCES Site MI 39.4; 2006–2015. When the data are aggregated by month across years, none of the monthly geometric means exceed the monthly geometric mean standard. However, when data are summarized by month and year, there are three exceedances of the monthly geometric mean standard—198 org/100 mL (June 2012), 314 org/100 mL (June 2014), and 137 org/100 mL (June 2015).

Month	Sample Count	Geometric Mean (org/100 mL)	Minimum (org/100mL)	Maximum (org/100mL)	Number of Individual Sample Standard Exceedances (> 1,260 org/100 mL)	Percent of Individual Sample Standard Exceedances
January	19	36	2	192	NA	NA
February	19	39	10	260	NA	NA
March	38	32	1	≥ 2,420	NA	NA
April	42	9	1	133	0	0
May	43	29	2	≥ 2,420	1	2
June	47	123	2	≥ 2,420	4	9
July	50	32	1	285	0	0
August	46	22	1	1,300	1	2
September	41	28	2	≥ 2,420	1	2
October	40	25	1	1,414	1	3
November	21	16	2	548	NA	NA
December	20	19	3	719	NA	NA

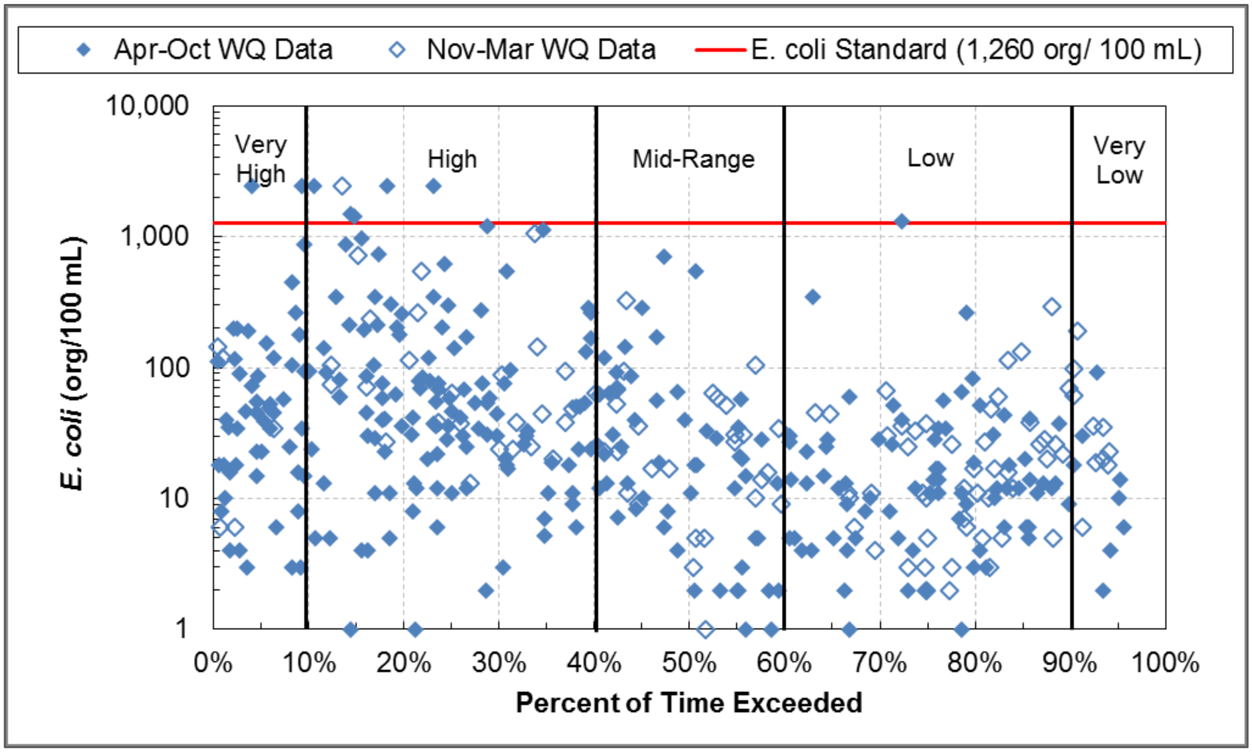

Figure 10. *E. coli* concentration duration plot, Minnesota River, High Island Creek to Carver Creek (AUID 07020012-800). MPCA Site S007-856 and MCES Site MI 39.4; 2006–2015.

3.4 *E. coli* Source Summary

E. coli sources evaluated in the Minnesota River *E. coli* TMDLs are permitted sources such as wastewater, stormwater, and permitted AFOs, and non-permitted sources from humans, livestock, and wildlife. This source assessment addresses the sources in the TMDL project focus area identified in Figure 2. The *E. coli* sources to the upstream impairments with approved TMDLs ("tributary *E. coli* TMDL subwatersheds" in Figure 2) are identified in the approved *E. coli* and fecal coliform TMDL reports for those watersheds. Additional information on potential *E. coli* sources to Minnesota waters, including source types and delivery mechanisms, can be found in the *Upper Mississippi River Bacteria TMDL Study & Protection Plan* (EOR 2014).

E. coli is unlike other pollutants in that it is a living organism, and so can multiply and persist in soil and water environments (Ishii et al. 2006; Chandrasekaran et al. 2015; Sadowsky et al. n.d.). Additionally, the use of watershed models for estimating relative contributions of *E. coli* sources delivered to streams is difficult and generally has high uncertainty. Thus, a simpler weight of evidence approach was used to determine the likely primary sources of *E. coli*, with a focus on the sources that can be effectively reduced with management practices.

Permitted

Pollutant sources regulated through National Pollutant Discharge Elimination System (NPDES) permits that were evaluated as potential sources of *E. coli* in the impaired watersheds include wastewater effluent, stormwater runoff from permitted municipal separate storm sewer systems (MS4s), and permitted AFOs.

Wastewater

There are 29 permitted wastewater dischargers with fecal coliform limits in the TMDL project focus area (Figure 11 and Figure 12). Wastewater dischargers that operate under NPDES permits are required to disinfect wastewater to reduce fecal coliform concentrations to 200 organisms/100 mL or less as a monthly geometric mean. Like *E. coli*, fecal coliform bacteria are an indicator of fecal contamination. The primary function of a bacterial effluent limit is to assure that the effluent is being adequately treated with a disinfectant to assure a complete or near complete kill of fecal bacteria prior to discharge (MPCA 2007b). Dischargers to class 2 waters are required to disinfect from April 1 through October 31, and dischargers to class 7 waters are required to disinfect from May 1 through October 31, which is one month shorter than the time frame of the *E. coli* standard of the downstream impaired reaches. There are six dischargers to class 7 waters (Figure 11 and Figure 12); these dischargers are a potential source of *E. coli* to surface waters in April when disinfection is not required.

To determine the likelihood that dischargers to class 7 waters contribute to *E. coli* impairments in April, discharge volumes, surface water monitoring data, and the locations of the effluent discharge points were evaluated. All but one of the facilities is located over 10 miles upstream of the relevant impaired river reach; due to bacteria die-off and the relatively small volumes of the discharges (Table 16), these facilities are unlikely to contribute significantly to the impairments. The Cleveland Wastewater Treatment Plant (WWTP) discharge is located approximately seven miles upstream of the impaired Minnesota River Reach from Blue Earth River to Cherry Creek. Cleveland WWTP's maximum daily pond flow represents less than 1% of the flow in the *very low* flow zone of the impaired reach, suggesting that the impact of loading from Cleveland WWTP effluent on the Minnesota River is insignificant. The Cleveland WWTP discharges into Cherry Creek, which has two *E. coli* monitoring samples from April of 2009, both of which are from very high flow zones and neither of which exceeded the instream standard. April *E. coli* data on the Minnesota River are also limited and are from sites located over 10 miles downstream. Based on the distance of the facility from the impaired reach and the small discharge volumes relative to river volumes, April loading from the WWTPs that are not required to disinfect in April is not considered a significant source.

Table 16. Design flows of WWTPs that are not required to disinfect in April as a percent of river flows

Wastewater Facility (NPDES Permit #)	Flow (cfs) [a]	Impaired Reach Very Low Flow (cfs) [b]	Facility Design Flow as a Percent of Very Low Flows in Impaired Reach
Belview WWTP (MNG580003)	1.3	272	0.5%
Cleveland WWTP (MNG580009)	1.7	272	0.6%
Comfrey WWTP (MN0021687)	0.12	272	< 0.1%
Evan WWTP (MNG580202)	0.22	272	< 0.1%
Hanska WWTP	1.2	272	0.4%
Morgan WWTP	3.6	272	1.3%

[a] Flow is either the average wet weather design flow (for continuously discharging facilities) or the maximum daily pond flow (for controlled discharges).

[b] 95th percentile flow.

Monthly geometric means of effluent monitoring data are used to determine compliance with permits. Of the 29 WWTPs in the TMDL project focus area, 10 facilities have documented fecal coliform permit exceedances as provided in discharge monitoring reports (DMRs) for the time period between 2006 and

2015 (Table 17). Exceedances of wastewater fecal coliform permit limits could lead to exceedances of the instream *E. coli* standard at times. For the majority of the exceedances listed in Table 17, there are no surface water *E. coli* samples from the Minnesota River during the same month; therefore it is difficult to determine if the permit exceedances led to exceedances of the surface water *E. coli* standard. Minnesota River samples are available from April of 2006, which is when the Hanley Falls WWTP recorded a permit exceedance. The river flows were in the *very high* flow zone when the samples were taken, and the *E. coli* concentrations in the river ranged from 56 to 160 org/100 mL during that month; these concentrations all meet the surface water numeric standard.

There are no permitted combined sewer overflows in the TMDL project focus area, and there are no recorded untreated wastewater releases (2006 through August 2017) during the months that the *E. coli* standard applies.

Because the wastewater effluent limit exceedances are infrequent and because the volumes of the discharges relative to the volume of water in the river are small, wastewater discharges are not considered a significant source. See Table 25 in Section 4.1 for a complete list of the permitted wastewater dischargers.

Table 17. Wastewater treatment facilities with documented fecal coliform permit exceedances (2006–2015)

<table>
<tr><th>Wastewater Facility (NPDES Permit #)</th><th>E. coli Impairment AUID</th><th>Number of Permit Exceedances (2006–2015)</th><th>Reported Fecal Coliform Calendar Monthly Geometric Means that Exceed Permit Limit (org/100 mL)</th></tr>
<tr><td>Odessa WWTP (MNG580099)</td><td rowspan="3">07020001-552, 07020004-747, 07020007-723</td><td>2</td><td>875
1,000</td></tr>
<tr><td>Ortonville WWTP (MNG580151)</td><td>1</td><td>210</td></tr>
<tr><td>Clinton WWTP (MNG580193)</td><td>1</td><td>469</td></tr>
<tr><td>Bellingham WWTP (MNG580152)</td><td>07020004-747, 07020007-723</td><td>1</td><td>18,767</td></tr>
<tr><td>Morgan WWTP (MN0020443)</td><td rowspan="6">07020007-723</td><td>2</td><td>523
643</td></tr>
<tr><td>Morton WWTP (MN0051292)</td><td>2</td><td>247
350</td></tr>
<tr><td>Saint George District Sewer System (MN0064785)</td><td>1</td><td>253</td></tr>
<tr><td>Fairfax WWTP (MNG580080)</td><td>1</td><td>580</td></tr>
<tr><td>Searles WWTP (MNG580060)</td><td>2</td><td>493
312</td></tr>
<tr><td>Hanley Falls WWTP (MNG580122)</td><td>1</td><td>350</td></tr>
</table>

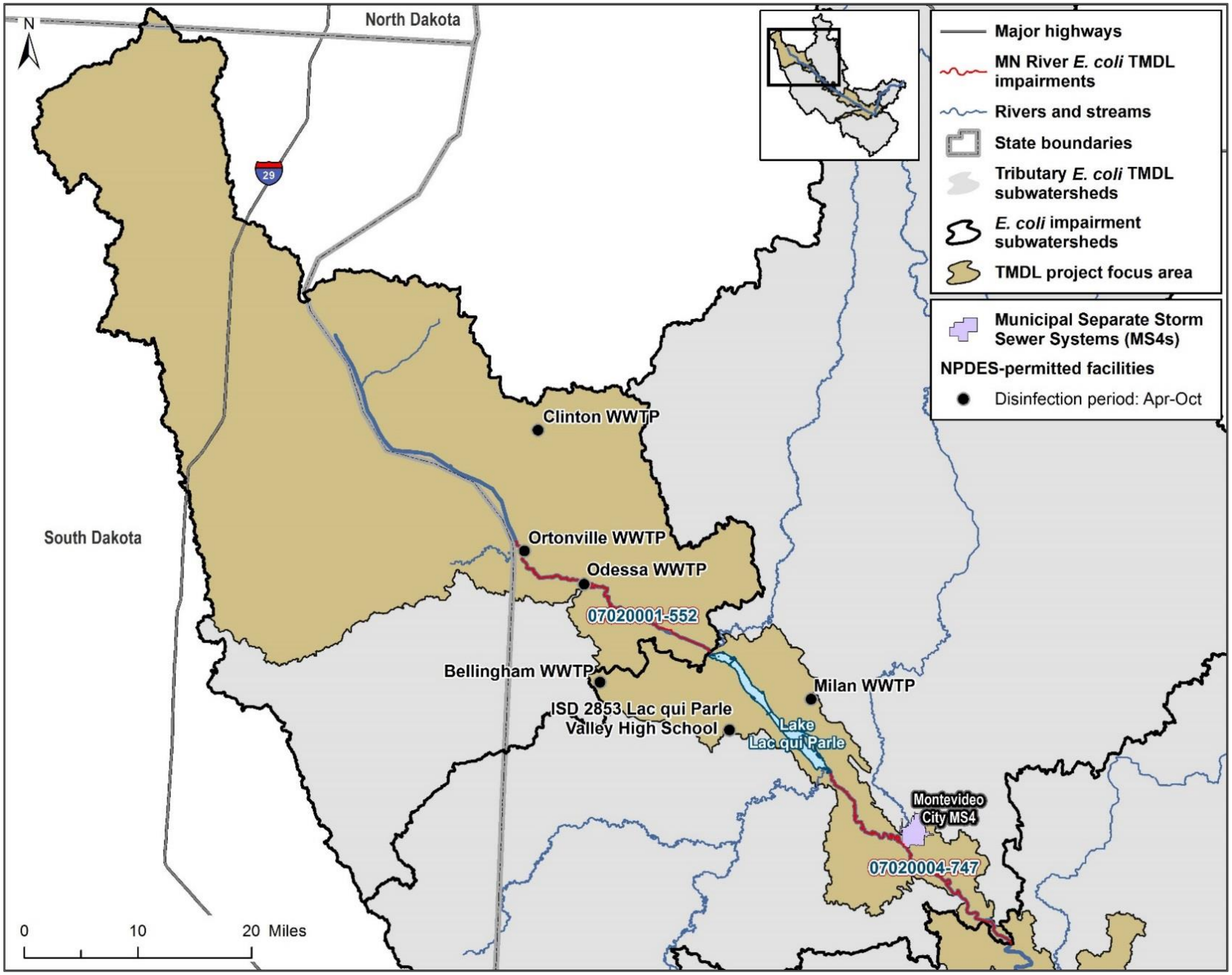

Figure 11. Permitted wastewater treatments facilities and MS4s in upper TMDL project focus area (07020001-552 and 07020004-747).

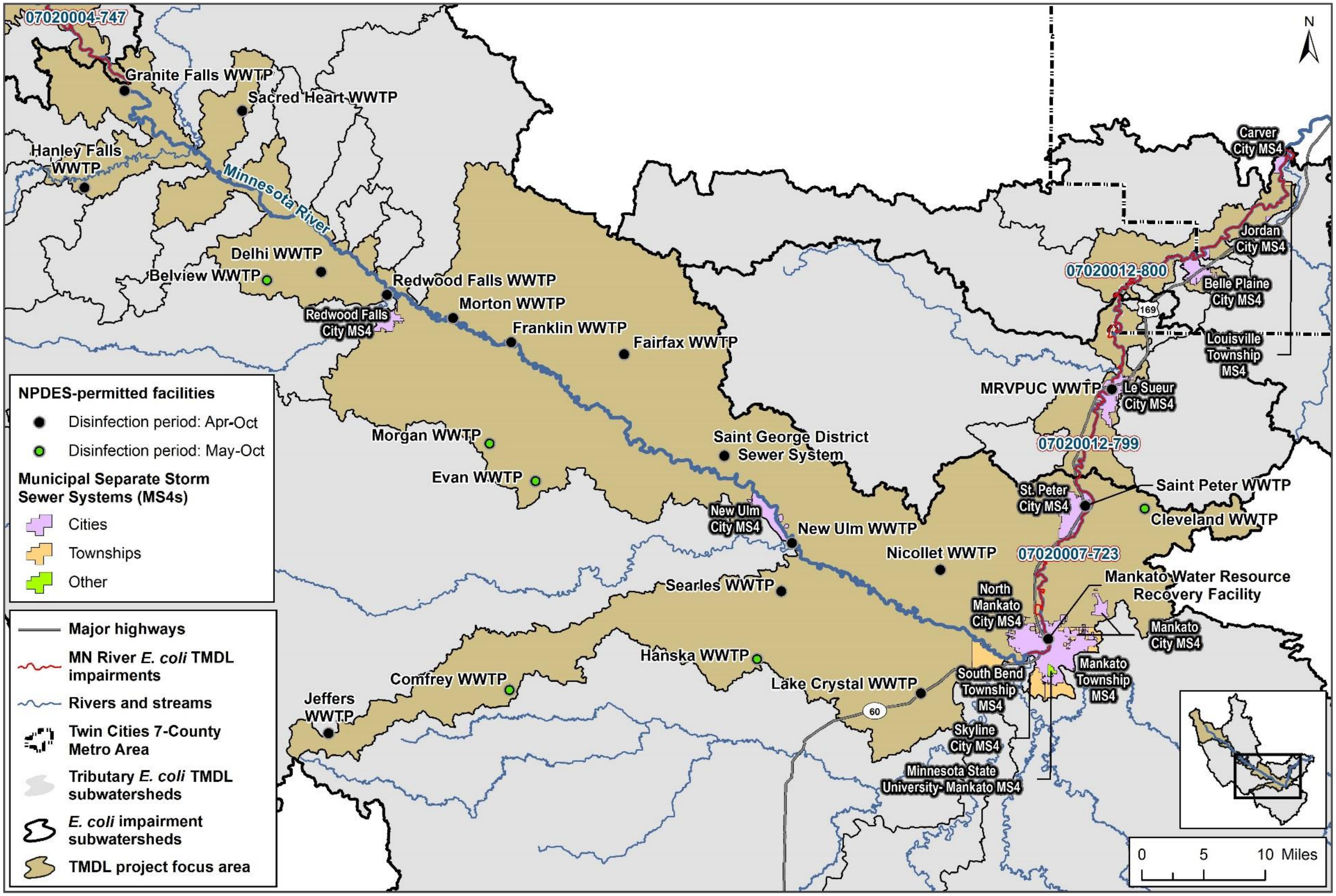

Figure 12. Permitted wastewater treatments facilities and MS4s in lower TMDL project focus area (07020007-723, 07020012-799, and 07020012-800).

Belle Plaine, Jordan, and Le Sueur City MS4s are not currently regulated but are expected to come under permit coverage in the next permit cycle. In addition to the permitted MS4s depicted in the map, MnDOT Outstate District and Blue Earth County are also permitted MS4s in the TMDL project focus area.

Municipal Separate Storm Sewer Systems

Permitted MS4s can be a source of *E. coli* to surface waters through the impact of urban systems on delivery of *E. coli* from humans, pets, and wildlife to surface waters. Impervious areas (such as roads, driveways, and rooftops) can directly connect the location where *E. coli* is deposited on the landscape to points where stormwater runoff carries *E. coli* into surface waters. For example, there is a greater likelihood that uncollected pet waste in an urban area will reach surface waters through stormwater runoff than it would in a rural area with less impervious surface. Wildlife, such as birds and raccoons, can be another source of *E. coli* in urban stormwater runoff (Wu et al. 2011, Jiang et al. 2007). Recent studies in Minneapolis using microbial markers show that birds are a primary source of the *E. coli* entering stormwater conveyances (Sadowsky et al. 2017). Growth and persistence of *E. coli* in soil and organic debris were also noted in the Minneapolis study.

While the project focus area is mostly rural, small portions contain permitted MS4 area and may be a possible source of *E. coli* (Table 18). City and township boundaries of permitted MS4s are displayed in Figure 11 and Figure 12.

Table 18. Area of permitted MS4s within TMDL project focus area by impaired segment

Reach Name (AUID)	Regulated MS4 Area (mi^2)	Percent of Project Focus Area (%)
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	0	0
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	1.5	0.6
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	27	1.7
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	1.9	3.1
Minnesota River, High Island Creek to Carver Creek (07020012-800)	2.4	3.7

Permitted Animal Feeding Operations

There are 128 NPDES permitted AFOs and/or federally defined concentrated animal feeding operations (CAFOs) in the project focus area (Appendix B, Table 38). Except for basin overflows that are caused by extreme climatic events, permitted AFOs and CAFOs are required to contain runoff (40 CFR 412.31). Facilities that are permit compliant are not considered to be a substantial source of *E. coli* to surface waters on an average annual basis. It should be noted that manure that is transported off site (for spreading on cropland) is not covered by the permit. That manure is a potential nonpoint source of pollution.

A watershed with a high percentage of the *E. coli* production generated in CAFOs and NPDES permitted feedlots would be expected to have less *E. coli* loading from feedlots to surface waters than if the feedlots were not permitted. Table 19 summarizes the proportion of the livestock throughout the TMDL project focus area contained within CAFOs and/or NPDES permitted feedlots.

Table 19. Percent of animal units in CAFOs and NPDES permitted feedlots in the Minnesota portion of TMDL focus area

Data provided by MPCA 2017.

Reach Name (AUID)	Percent Animal Units in CAFOs and/or NPDES permitted feedlots (%)
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	52
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	30
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	52
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	67
Minnesota River, High Island Creek to Carver Creek (07020012-800)	0

Non-Permitted

Non-permitted pollutant sources evaluated as potential sources of *E.coli* in the impaired watersheds include non-permitted livestock, human sources of waste such as faulty septic systems and application of biosolids, wildlife populations, and non-permitted urban stormwater runoff.

Livestock

Animal waste from AFOs can be delivered to surface waters from failure of manure containment, runoff from the AFO itself, runoff from pastures or direct deposit into streams by grazing animals, or runoff from nearby fields and tile lines where the manure is applied. In Minnesota, feedlots with greater than 50 animal units (AUs), or greater than 10 AUs in shoreland areas, are required to register with the state.

The animals raised in AFOs produce manure that is stored in pits, lagoons, tanks, and other storage devices. The manure is then applied or injected to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. Recent increases in the cost of commercial fertilizer has led to improved dispersal and application practices for manure utilization. AFOs, however, can be a source of *E. coli* to surface waters—inadequately treated manure runoff from open lot feedlot facilities and improper application of manure can contaminate surface or groundwater.

Confined swine operations typically use liquid manure storage areas that are located under the confinement barn. Wash water used to clean the floors and remove manure buildup combines with the solid manure to form a liquid or slurry in the pit. The mixture is usually land applied in the spring and fall by injection/incorporation into the soil or transported offsite. Some facilities may have “open-air” liquid manure storage areas, which can be a source of *E. coli* to surface waters if improperly managed.

Dairies handle manure in a variety of ways: all liquid form, all solid form or a combination with a portion as liquid and a portion as solid. Other potential sources of wastewater include process wastewater such as parlor wash down water, milk-house wastewater, silage leachate, and runoff from outdoor silage feed storage areas. These wastewater sources can be a source of *E. coli* to surface waters if not properly managed. In addition, many small dairy operations have limited to no manure storage.

Most poultry manure is handled as a dry solid; liquid poultry manure handling and storage is rare. Improperly stockpiled poultry manure or improper land application can be a source of *E. coli* to surface waters.

While a full accounting of the fate and transport of manure was not conducted for this project, a large portion of it is ultimately applied to the land surface and, therefore, this source is of concern. Minn. R. 7020.2225 contains several requirements for land application of manure; however, there are no explicit requirements for *E. coli* or bacteria treatment prior to land application. Manure practices that inject or incorporate manure pose lower risk to surface waters than surface application with little or no incorporation. In addition, manure application on frozen/snow covered ground in late winter months presents a high risk for runoff (Frame et al. 2012).

Animal counts by county were obtained from 2012 agricultural census data from the United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) for Minnesota and South Dakota. The county-based animal counts were area weighted based on the area of each county in each TMDL project focus area and used to estimate *E. coli* production by animal type for each impairment (Table 20). The majority of the *E. coli* produced from livestock is from cattle and pigs, with the greatest *E. coli* production in the Minnesota River, Blue Earth River to Cherry Creek TMDL focus area.

Some feedlot owners have signed open lot agreements with the MPCA. In an open lot agreement, a feedlot owner commits to correcting open lot runoff problems. In exchange for this commitment, the open lot agreement provides a flexible time schedule to feedlot owners to correct open lot runoff problems and a conditional waiver from retroactive enforcement penalties. A watershed with a higher percentage of the *E. coli* production generated in feedlots that are part of open lot agreements might have less *E. coli* loading from feedlots to surface waters. The percentage of livestock that are contained on feedlots with open lot agreements is generally low, ranging from none in the Minnesota River, Big Stone Lake to Marsh Lake Dam focus area to 6.6% in the Minnesota River, High Island Creek to Carver Creek focus area.

Table 20. *E. coli* production by livestock animal type in TMDL focus area (Minnesota and South Dakota)

Reach Name (AUID)	Animal Units	Percent of *E. coli* Production (%)					*E. coli* Production (billion cfu/day) [a]
		Cattle	Pigs	Goats/Sheep	Horses	Poultry	
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	101,211	40	51	7	< 1	2	510,016
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	20,208	13	77	5	< 1	5	163,079
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	329,095	6	90	2	< 1	2	3,065,200
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	12,814	8	82	2	< 1	8	103,041
Minnesota River, High Island Creek to Carver Creek (07020012-800)	10,533	18	54	3	< 1	25	58,355

[a] Production rates for cattle (2.7×10^9), poultry (1.3×10^8), goats and sheep (9.0×10^9), and pigs (4.5×10^9) are from Metcalf and Eddy (1991). The production rate for horses (2.1×10^8) is from American Society of Agricultural Engineers (1998). The production rates are provided in the literature as fecal coliform organisms produced per animal per day; these rates were converted to *E. coli* production rates by multiplying by 0.5 (Doyle and Erickson 2006). Production rates units are organisms per day per head.

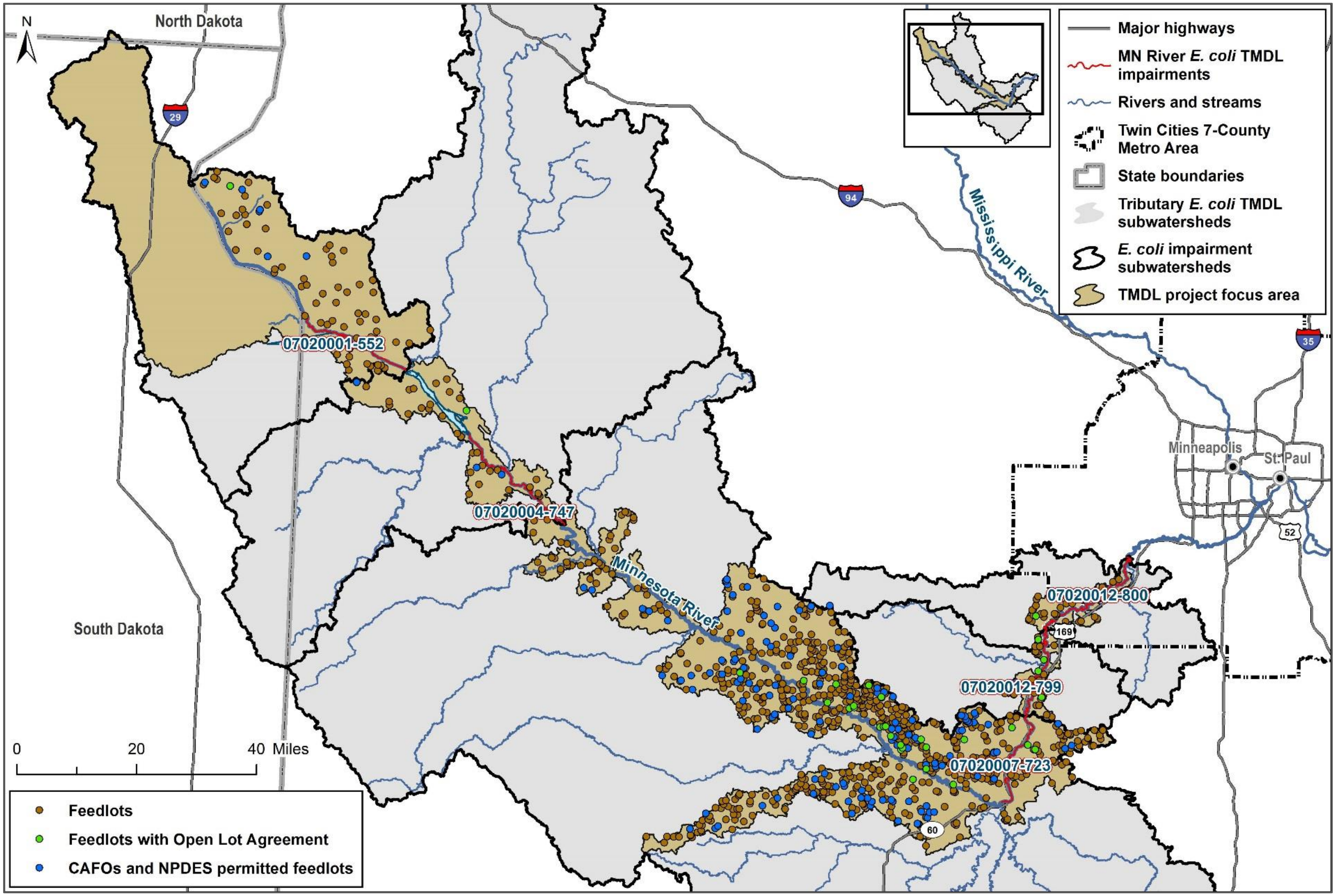

Figure 13. Feedlots, CAFOs, and feedlots with open lot agreements in TMDL project focus area.

Human

Septic systems that function properly are typically not considered sources of *E. coli* to surface waters. Septic systems that discharge untreated sewage to the land surface are considered an IPHT and can contribute *E. coli* to surface waters. (IPHTs are officially referred to as "imminent threat to public health or safety" in Minn. R. ch. 7080.) Average percent IPHT data by county were area-weighted to the project focus areas. The estimated percent of septic systems that are IPHTs ranges from 10% in the area draining to the Big Stone Lake to Marsh Lake Dam reach to 18% in the area draining to the Lac qui Parle Dam to Granite Falls Dam reach (Table 21).

Table 21. Average percent imminent public health threats in the TMDL project focus areas

2017 data from MPCA. These percentages are reported as estimates by local units of government for planning purposes and general trend analysis. These values may be inflated due to relatively low total septic systems estimated per jurisdiction. Additionally, estimation methods for these figures can vary depending on local unit of government resources available.

Reach Name (AUID)	Average Percent IPHT in TMDL Project Focus Area [a]
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	10
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	18
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	16
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	14
Minnesota River, High Island Creek to Carver Creek (07020012-800)	12

[a] Based on 2017 county average percent IPHT from MPCA, area-weighted to TMDL project focus areas.

Carver County evaluated sources of fecal contamination in the Carver Creek and Bevens Creek Watersheds using microbial source tracking techniques. Microbial markers were used to determine the presence or absence of human and cattle fecal contamination in water samples from 15 sites. The study was conducted after a targeted effort to replace direct discharges (i.e., straight pipes) with septic systems was undertaken. The marker for human sources of fecal contamination was present at a higher frequency than the marker for cattle sources, suggesting that failing septic systems represent a substantial source of pathogens to Carver Creek and Bevens Creek (personal communication, Charlie Sawdey 2017). Whereas the area studied is not in the TMDL project focus area, the results are relevant to other rural areas in the Minnesota River Basin.

Other human sources of *E. coli* in the watershed include straight pipe discharges, earthen pit outhouses, and land application of septage. Straight pipe systems are unpermitted sewage disposal systems that transport raw or partially settled sewage directly to a lake, stream, drainage system, or the ground surface. Straight pipe systems and earthen pit outhouses likely exist in the Lower Minnesota Watershed, but their numbers and locations are unknown and were not quantified.

Application of biosolids from wastewater treatment facilities could also be a potential source of *E. coli*. Application is regulated under Minn. R. ch. 7401, and includes pathogen reduction in biosolids prior to spreading on agricultural fields or other areas. Application should not result in violations of the *E. coli* water quality standard.

Wildlife

In the rural portions of the project area, deer, waterfowl, and other animals can be *E. coli* sources, with greater numbers in conservation and remnant natural areas, wetlands and lakes, and river and stream corridors.

Pre-fawn deer densities in the Minnesota River deer permit areas range from 2 to 16 deer per square mile from the years 2010 through 2016 (DNR 2017), while livestock AU densities range between 60 and 150 AUs per square mile (NASS 2012). Additionally, the per animal *E. coli* production rates of deer and waterfowl are substantially less than the production rates of cattle and pigs, the most common livestock types in the TMDL project focus area (Table 22). It is unlikely that the production of *E. coli* from wildlife substantially contributes to the three most downstream impairments (Blue Earth to Cherry Creek, Cherry Creek to High Island Creek, and High Island Creek to Carver Creek). There may, however, be some instances of large geese or other waterfowl populations for some contributing areas.

Table 22. *E. coli* production rates of wildlife relative to livestock

Animal Type	Production Rate (org/day per head)	Reference
Deer	1.8×10^8	Zeckoski et al. 2005
Waterfowl	1.0×10^7	Alderisio and DeLuca 1999 and City of Eden Prairie 2008
Cattle	2.7×10^9	Metcalf and Eddy 1991
Pigs	4.5×10^9	Metcalf and Eddy 1991

For the two upstream impairments, Big Stone Lake to Marsh Lake Dam (AUID 07020001-552) and Lac qui Parle Dam to Granite Falls Dam (07020004-747), waterfowl may contribute to the impairments due to their potentially high densities and direct access to surface waters. The downstream half of the impaired reach that stretches from Big Stone Lake to Marsh Lake Dam is located in the Lac qui Parle State Wildlife Management Area, which is a 24,311-acre wildlife area that contains Lac qui Parle Lake and Marsh Lake (Figure 14). Native plants located throughout the area provide food for resident and migratory birds, making the area a popular location for several species of waterfowl. The area is also home to pheasant, deer, and small game, all of which may contribute *E. coli* to the Minnesota River. The impaired reach that stretches from the Lac qui Parle Dam to the Granite Falls Dam is located immediately downstream of the wildlife management area (Figure 14) and likely is also affected by *E. coli* loading from wildlife.

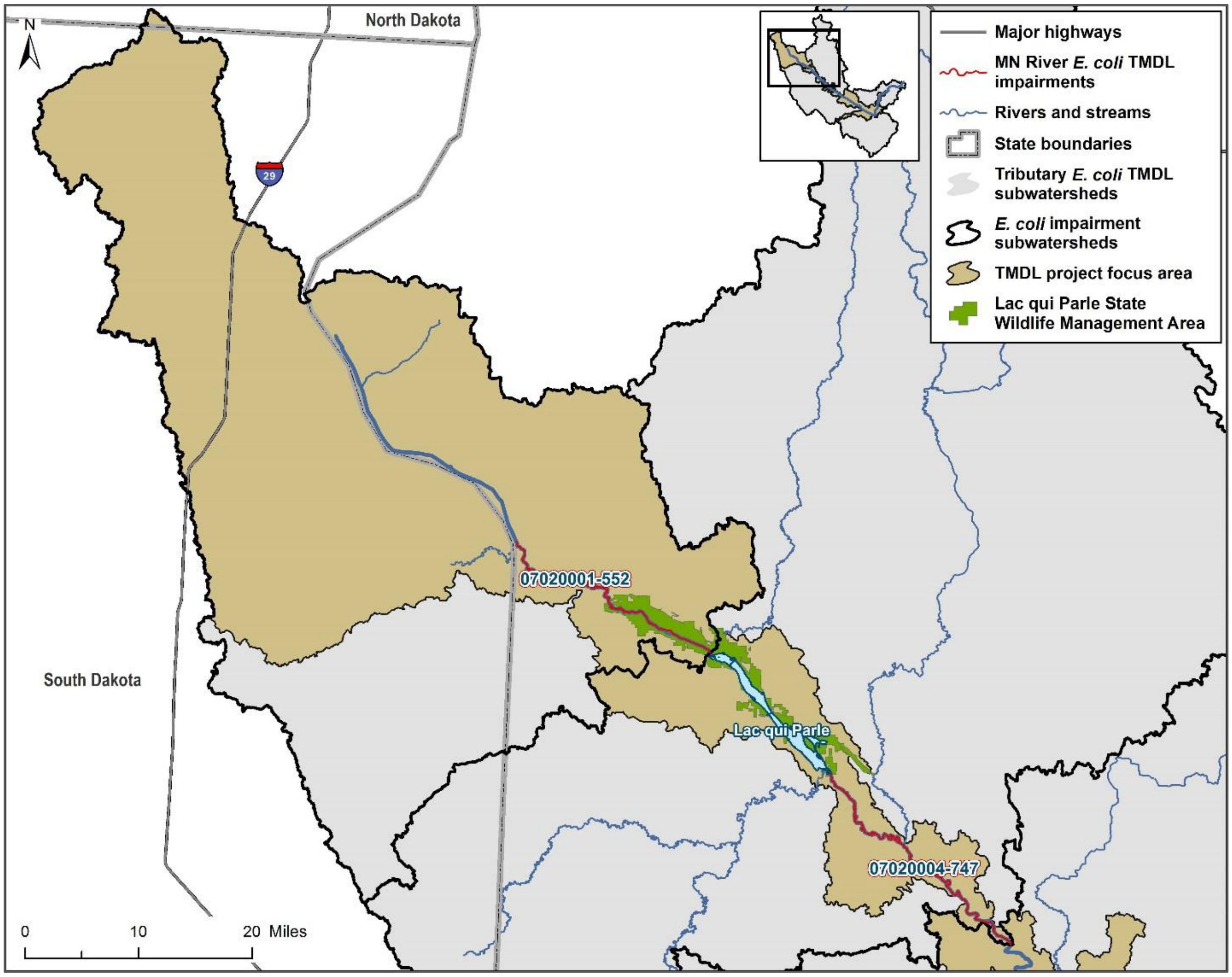

Figure 14. Lac qui Parle State Wildlife Management Area near Big Stone Lake to Marsh Lake Dam (07020001-552) and Lac qui Parle Dam to Granite Falls Dam (07020004-747).

Non-Permitted Urban Stormwater Runoff

Stormwater runoff from non-permitted developed areas has the same source types and mechanisms of delivery as stormwater runoff from permitted MS4 communities, discussed under permitted sources. The developed areas in the impairment watersheds that are not regulated through an MS4 permit can be a source of *E. coli* loads to surface waters.

Summary of Results

E. coli sources in the TMDL project focus area were considered for the source assessment. Using a qualitative, weight of evidence approach, the summary of *E. coli* sources identifies which source types exist in each impaired watershed and which of the source types should be a source of concern, based on the following:

- Waste from livestock is a source of concern when non-permitted feedlots are numerous and/or are located close to surface waterbodies. Because of the high density of feedlots throughout the TMDL project focus area, waste from livestock is considered a high priority for all of the impairments.
- Waste from wildlife may be a significant source in the Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552) and the Minnesota River, Lac qui Parle Dam to Granite Falls Dam

(07020004-747) due to the presence of the Lac qui Parle State Wildlife Management Area. Any potential contributions from the area are considered natural and therefore not a priority source for management.

- Due to the high percent of septic systems that are estimated to be IPHTs (Table 21), IPHTs are a high priority for all impaired watersheds.
- Effluent from WWTPs is typically below the *E. coli* standard and is not considered a source of concern. The WWTPs that do not disinfect their effluent in April are not considered a source of concern because of their distance upstream of the impaired reaches and because of their low discharge volumes relative to the river flow.
- Stormwater runoff is considered a lower priority source of *E. coli* loading in the project focus area due to the small extent of developed area relative to other land covers and source types.

The monitoring data and source assessment suggest that the impairments are due to a mix of sources and pathways (Table 23). Livestock from unpermitted AFOs and IPHTs are the primary sources of concern in the TMDL project focus area. Because the extent of monitoring data are limited and the source assessment is qualitative, this source summary should be considered approximate.

Table 23. Summary of *E. coli* sources in TMDL project focus area

Reach Name (AUID)	Livestock [a]	Wildlife	Humans		Stormwater Runoff [b]
			IPHT	WWTP	
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	●	○ [c]	●	○	○
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	●	○ [c]	●	○	○
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	●	○	●	○	○
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	●	○	●	○	○
Minnesota River, High Island Creek to Carver Creek (07020012-800)	●	○	●	–	○

[a] Livestock that are a priority for targeting include non-permitted AFOs and permitted facilities and/or CAFOs that are not permit compliant.

[b] Stormwater runoff includes *E. coli* from wildlife and pets in developed areas.

[c] Wildlife is likely a substantial source of *E. coli;* however, it is not targeted for implementation.

● *E. coli* source that is a higher priority for targeting

○ *E. coli* source that is a lower priority for targeting

– Not an *E. coli* source

4. TMDL Development

A TMDL is the total amount of a pollutant that a receiving waterbody can assimilate while still achieving water quality standards. TMDLs can be expressed in terms of mass per time or by other appropriate measures. TMDLs are composed of the sum of WLAs for point sources and LAs for nonpoint sources and natural background levels. In addition, the TMDL includes a MOS, either implicit or explicit, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

TMDL = WLA + LA + MOS

A summary of the allowable *E. coli* loads and allocations is presented in this section.

Allowable *E. coli* loads in streams were determined through the use of load duration curves. A load duration curve is similar to a concentration duration curve (Section 3.3) except that loads rather than concentrations are plotted on the vertical axis. Discussions of load duration curves are presented in *An Approach for Using Load Duration Curves in the Development of TMDLs* (EPA 2007). The approach involves calculating the allowable loadings over the range of flow conditions expected to occur in the impaired stream by taking the following steps:

1. A flow duration curve for the stream was developed by generating a flow frequency table and plotting the data points to form a curve. The data reflect a range of natural occurrences from extremely high flows to extremely low flows. The flow data are either monitored or simulated daily average flows (see Section 3.3 and Table 5 for a description of the flow data used). The drainage area-ratio method was used to extrapolate monitored or simulated flows to the locations of the impaired segment outlets.
2. The flow duration curve was translated into a load duration curve by multiplying each flow value by the *E. coli* water quality standard (as a concentration), then multiplying by conversion factors to yield results in the proper unit. The resulting points were plotted to create a load duration curve.
3. Each water quality sample was converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected. Then, the individual loads were plotted as points on the load duration curve graph and can be compared to the water quality standard, or load duration curve.
4. Points plotting above the curve represent deviations from the water quality standard/target and the daily allowable load. Those plotting below the curve represent compliance with standards and the daily allowable load.

The stream flows displayed on load duration curves may be grouped into various flow regimes to aid with interpretation of the load duration curves (EPA 2007):

- Very high flow zone: stream flows that plot in the 0 to 10 percentile range, related to flood flows
- High zone: flows in the 10 to 40 percentile range, related to wet weather conditions
- Middle (“Mid”) zone: flows in the 40 to 60 percentile range, median stream flow conditions
- Low zone: flows in the 60 to 90 percentile range, related to dry weather flows

- Very low flow zone: flows in the 90 to 100 percentile range, related to drought conditions

The load duration curve method is based on an analysis that encompasses the cumulative frequency of historic 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. In the TMDL equation tables, only five points on the entire loading capacity curve are depicted—the midpoints of the designated flow zones (e.g., for the high flow zone [10th to 40th percentile], the TMDL was calculated at the 25th percentile). However, the entire curve represents the TMDL and is what is ultimately approved by the EPA.

The range of years of monitoring data used to calculate the loading capacity and the percent reductions needed to meet the TMDL vary by waterbody. The baseline year for crediting load reductions for a given waterbody (Table 24) is the mid-point year of the time period used to estimate existing concentrations presented in the TMDL tables. See Section 4.1 for a discussion of the approaches and Section 3.3 for the range of data years associated with each waterbody. As such, any activities implemented during or after the baseline year that led to a reduction in pollutant loads to the waterbodies may be considered as progress towards meeting a WLA or LA. The rationale for this is that projects undertaken recently may take a few years to influence water quality.

Table 24. Baseline year for crediting load reductions to impaired waterbodies

Reach Name (AUID)	Baseline Year
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	2013
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	2011
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	2010
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	2010
Minnesota River, High Island Creek to Carver Creek (07020012-800)	2010

4.1 TMDL Approach

Loading Capacity and Load Reduction

The loading capacity was calculated as flow multiplied by the *E. coli* geometric mean standard, 126 org/100 mL. It is assumed that practices that are implemented to meet the geometric mean standard will also address the individual sample standard (1,260 org/100 mL) and that the individual sample standard will also be met. The overall estimated percent reduction needed to meet each TMDL was calculated by comparing the highest observed (monitored) monthly geometric mean from the months that the standard applies to the geometric mean standard (monitored – standard / monitored). As the term implies, these *overall estimated percent reductions* provide a rough approximation of the overall reduction needed for the waterbody to meet the TMDL. They should not be construed to mean that each of the separate sources listed within the TMDL table needs to be reduced by that amount.

"Unallocated loads" are provided for flow zones in which the geometric mean of the monitored concentrations in that flow zone, based on five or more samples, is less than the standard. The unallocated load represents the difference between the load at the water quality standard and the existing load calculated from the monitored geometric mean in a flow zone; the unallocated load was calculated as loading capacity minus MOS minus the existing load. Unallocated loads are provided to ensure that *E. coli* loading does not increase in the flow zones where the standard is currently met.

Boundary Conditions

Allocations for two types of boundary conditions were calculated—upstream approved TMDLs and area within South Dakota. The boundary condition allocations were estimated on an area basis as the percent of the watershed area that the boundary condition represents multiplied by the loading capacity minus the MOS minus the unallocated load (where applicable) minus wastewater WLAs.

Wasteload Allocation

Wastewater

The *E. coli* WLAs for wastewater are based on the *E. coli* geometric mean standard of 126 organisms per 100 mL and either the facility's average wet weather design flow (for continuous dischargers) or the maximum daily discharge volume (for WWTPs with controlled discharge, Table 25). Permitted WWTPs in the TMDL project focus area are mapped in Figure 11 and Figure 12.

The facilities that discharge to class 2 waters are required to disinfect from April 1 through October 31, which is the same time period that the class 2 stream *E. coli* standard applies. For these facilities, it is assumed that if a facility meets the fecal coliform limit of 200 organisms per 100 mL it is also meeting the *E. coli* WLA. On March 17, 2008, Minn. R. ch. 7050 water quality standards for bacteria were changed from fecal coliform concentration to *E. coli* concentration, supported by an EPA guidance document on bacteriological criteria (EPA 1986). In conjunction with the change of indicator organisms for bacterial water quality, a decision was made to retain existing fecal coliform effluent limits for wastewater treatment facilities. This decision is extensively documented in the regulation's Statement of Need and Reasonableness, Book III, Section VII.G.

Facilities that discharge to class 7 waters are required to disinfect from May 1 through October 31; however, the *E. coli* standard of the impaired reaches applies from April through October. The weight of evidence in the source assessment (Section 3.4) suggests that these facilities do not lead to exceedances of the stream *E. coli* standard and are not considered to be significant contributors to Minnesota River *E. coli* impairments in April. The existing permit limits are sufficiently protective and consistent with the assumptions and requirements of the TMDL.

Straight pipes are illegal conveyances of raw sewage from homes and businesses directly to surface water. Straight pipes receive a WLA of zero for all impaired waterbodies because discharges from straight pipes are not authorized under any NPDES/State Disposal System (SDS) permits.

Table 25. WLAs for permitted wastewater dischargers

Discharge used for WLA calculation is either the average wet weather design flow (for continuously discharging facilities) or the maximum daily pond flow (for controlled discharges).

Reach Name (AUID)	Wastewater Facility (NPDES Permit #)	Discharge (million gallons per day)	*E. Coli* Wasteload Allocation (billion organisms per day) [a]
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	Clinton WWTP (MNG580193)	0.749	3.574
	Odessa WWTP (MNG580099)	0.196	0.932
	Ortonville WWTP (MNG580151)	3.584	17.094
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	Bellingham WWTP (MNG580152)	0.344	1.639
	ISD 2853 Lac qui Parle Valley High School (MNG580091)	0.293	1.399
	Milan WWTP (MNG580141)	0.538	2.564
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	Belview WWTP (MNG580003)	0.868	4.141 [a]
	Cleveland WWTP (MNG580009)	1.075	5.128 [a]
	Comfrey WWTP (MN0021687)	0.075	0.358 [a]
	Delhi WWTP (MN0067008)	0.014	0.067
Minnesota River, Blue Earth River to Cherry Creek (07020007-723), continued	Evan WWTP (MNG580202)	0.145	0.692 [a]
	Fairfax WWTP (MNG580060)	4.220	20.125
	Franklin WWTP (MN0021083)	0.115	0.548
	Granite Falls WWTP (MN0021211)	0.800	3.815
	Hanley Falls WWTP (MNG580122)	0.244	1.166
	Hanska WWTP (MN0052663)	0.749	3.574 [a]
	Jeffers WWTP (MNG580111)	0.342	1.632
	Lake Crystal WWTP (MN0055981)	0.590	2.814
	Mankato Water Resource Recovery Facility (MN0030171)	11.250	53.652
	Morgan WWTP (MN0020443)	2.314	11.034 [a]
	Morton WWTP (MN0051292)	0.133	0.634
	New Ulm WWTP (MN0030066)	6.770	32.287
	Nicollet WWTP (MNG580037)	2.558	12.199
	Redwood Falls WWTP (MN0020401)	1.321	6.300
	Sacred Heart WWTP (MN0024708)	0.237	1.130
	Saint George District Sewer System (MN0064785)	0.007	0.033
	Saint Peter WWTP (MN0022535)	4.000	19.076
	Searles WWTP (MNG580080)	0.385	1.834
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	MRVPUC WWTP (MN0068195)	1.842	8.785

[a] WLAs noted with footnote apply May–Oct; all others apply Apr–Oct.

Municipal Separate Storm Sewer Systems

MS4s are defined by the EPA as conveyance systems owned or operated by an entity such as a state, city, township, county, district, or other public body having jurisdiction over disposal of stormwater or other wastes. Stormwater runoff that falls under the MS4 general permit is regulated as a point source and, therefore, must be included in the WLA portion of a TMDL. The EPA recommends that WLAs be broken down as much as possible in the TMDL, as information allows. This facilitates implementation planning and load reduction goals for the MS4 entities.

Under phase II of the NPDES stormwater program, MS4 communities outside of urbanized areas with populations greater than 10,000 (or greater than 5,000 if they discharge to or have the potential to discharge to an outstanding value resource, trout lake, trout stream, or impaired water) and MS4 communities within urbanized areas are regulated MS4s.

Under the NPDES stormwater program, MS4 entities are required to obtain a permit, then develop and implement an MS4 stormwater pollution prevention program (SWPPP), which outlines a plan to reduce pollutant discharges, protect water quality, and satisfy water quality requirements in the Clean Water Act. An annual report is submitted to the MPCA each year by the permittee documenting progress on implementation of the SWPPP. The municipal stormwater permit holds permittees responsible for stormwater discharging from the conveyance system they own and/or operate. The conveyance system includes ditches, roads, storm sewers, and stormwater ponds.

The phase II general NPDES/SDS municipal stormwater permit for MS4 communities has been issued to cities, townships, and counties in the TMDL project focus area. The regulated MS4 areas were determined using the following approaches:

- **City, Township, and Nontraditional MS4s:** Approximated using developed land within their jurisdictional boundaries. Developed land is any of the four developed land cover classes in the 2011 National Land Cover Database: open space, low intensity, medium intensity, and high intensity.
- **County MS4s:** The MS4 permits for the regulated road authorities apply to roads within the U.S. Census Bureau 2010 urban area. The regulated roads and rights-of-way were approximated by the county road lengths (county and county state aid highways in MnDOT's STREETS_LOAD shapefile[1]) in the 2010 urban area multiplied by an average right-of-way width of 90 feet on either side of the centerline.
- **MnDOT Outstate District MS4:** The Minnesota Department of Transportation (MnDOT) Outstate District provided a list of regulated roads and rights-of-way in the Minnesota River Basin. Buffers set to the rights-of-way on the regulated roads (MnDOT's STREETS_LOAD shapefile[1]) were delineated within the Mankato 2010 urban area.

The estimated regulated area of permitted MS4s within each TMDL project focus area was divided by the total focus area for that impairment to represent the percent coverage of permitted MS4s within each TMDL project focus area. WLAs for permitted MS4s were calculated for each TMDL project focus area as the percent coverage of the permitted MS4s multiplied by the loading capacity minus the MOS minus the unallocated load (where applicable) minus the wastewater WLAs. There are 14 permitted MS4s in the TMDL project focus area (Table 26). The MnDOT MS4 WLA was calculated as an individual WLA, and the remaining permitted MS4s were combined into one categorical WLA for each applicable impairment.

[1] "Roads, Minnesota, 2012" downloaded from https://gisdata.mn.gov/dataset/trans-roads-mndot-tis,

Table 26. Permitted MS4s in TMDL project focus area

Reach Name (AUID)	Permitted MS4s
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	None
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	Montevideo City MS4 (MS400261)
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	Blue Earth County MS4 (MS400276) Mankato City MS4 (MS400226) Mankato Township MS4 (MS400297) Minnesota State University – Mankato MS4 (MS400279) MnDOT Outstate District MS4 (MS400180) New Ulm City MS4 (MS400228) North Mankato City MS4 (MS400229) Redwood Falls City MS4 (MS400236) Skyline City MS4 (MS400292) South Bend Township MS4 (MS400299) St. Peter City MS4 (MS400245)
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	Le Sueur City MS4 [a]
Minnesota River, High Island Creek to Carver Creek (07020012-800)	Belle Plaine City MS4 [a] Carver City MS4 (MS400077) Jordan City MS4 [a] Louisville Township MS4 (MS400144)

[a] Not currently regulated but expected to come under permit coverage in the next permit cycle.

Permitted Animal Feeding Operations

NPDES permitted AFOs and federally defined CAFOs are required to completely contain runoff and therefore receive a WLA of zero for all impaired waterbodies.

Load Allocation

The LA represents the portion of the loading capacity that is allocated to pollutant loads that are not regulated through an NPDES permit (e.g., unregulated watershed runoff and IPHT septic systems). The LA for each *E. coli* TMDL was calculated as the loading capacity minus the MOS minus the unallocated load (where applicable) minus the WLAs (for wastewater and permitted MS4s).

Natural background sources of *E. coli* are primarily wildlife. Because of the challenges in quantifying these sources of *E. coli*, natural background sources are not separated out and are implicitly included in the LA portion of the TMDL allocation tables. (It should also be noted that 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.)

Margin of Safety

The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. Section 303(d) of the Clean Water Act and EPA's regulations in 40 CFR 130.7 require that:

> TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a MOS which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

The MOS can either be implicitly incorporated into conservative assumptions used to develop the TMDL or be added as a separate explicit component of the TMDL. An explicit MOS of 5% was included in the TMDLs to account for uncertainty that the pollutant allocations would attain the water quality targets. This MOS is considered to be sufficient given the datasets used and high quality of modeling. Flow data used to develop the TMDLs are derived from either long-term monitoring data or HSPF-simulated daily flow data. Where monitoring data were used, the flow data consist of over 16 years of daily flow records. The Minnesota River HSPF model was calibrated and validated using 57 stream flow gaging stations, with at least three gaging stations for each HUC8 watershed (Tetra Tech 2015; RESPEC 2014). Calibration results indicate that the HSPF model is a valid representation of hydrologic conditions in the watershed. The MOS accounts for the uncertainty in flow that results from area-weighting flows from a nearby flow gauge or model reach.

Seasonal Variation and Critical Conditions

Both seasonal variation and critical conditions are accounted for in the *E. coli* TMDLs through the application of load duration curves. Concentration and load duration curves evaluate water quality conditions across all flow regimes (Figure 4) including high flow, which is the runoff condition where *E. coli* loading from upland sources tends to be greatest, and low flow, when loading from wastewater and other direct sources to the waterbodies has the greatest impact. Seasonality was evaluated in the water quality assessment (Figure 5) and is accounted for by addressing all flow conditions in a given reach. Seasonal variation is also addressed by the water quality standards' application during the period when the highest pollutant concentrations are expected via snowmelt and/or storm event runoff.

TMDL Summaries

Figure 15 through Figure 19 present the load duration curves for each impaired reach, and Table 27 through Table 31 present the TMDLs, allocations, and percent reductions. TMDLs and allocations are presented in billions of organisms per day (billion org/day). Allocations are rounded to two significant digits, except in the case of values greater than 100, which are rounded to the nearest whole number.

Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)

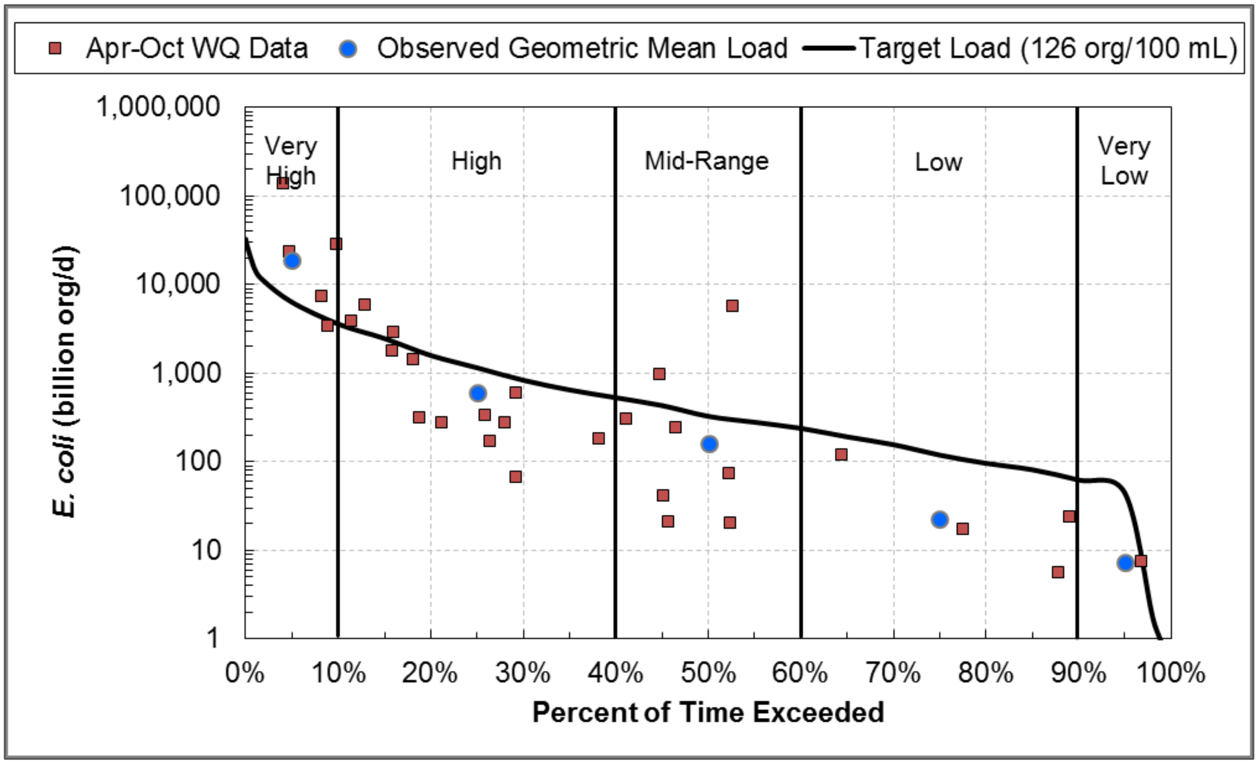

Figure 15. *E. coli* load duration curve, Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552). MPCA Sites S000-234 and S002-241; 2006–2015.

Table 27. *E. coli* TMDL summary, Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)

TMDL Parameter	Flow Zones				
	Very High	High	Mid	Low	Very Low
Allocations	***E. coli* Load, Apr–Oct (billion org/day)**				
Boundary Condition: Upstream Approved TMDL Area in MN and SD	1,392	135	33	21	4.7
Boundary Condition: South Dakota [a]	2,921	284	69	45	10
WLA: Clinton WWTP (MNG580193) [b]	3.6	3.6	3.6	3.6	3.6
WLA: Odessa WWTP (MNG580099) [b]	0.93	0.93	0.93	0.93	0.93
WLA: Ortonville WWTP (MNG580151) [b]	17	17	17	17	17
Load Allocation	1,667	162	39	26	5.6
Unallocated Load	0	489	146	0 [c]	0 [c]
Margin of Safety	316	58	16	5.9	2.2
Loading Capacity	6,318	1,150	325	119	44
Other Calculations					
Maximum Monthly Geometric Mean Concentration (org/100 mL)	156				
Overall Estimated Percent Reduction	19%				

[a] Does not include the portion of the upstream approved TMDL that is in South Dakota.

[b] More detailed wastewater WLAs (i.e., with more significant digits) are provided in Table 25.

[c] Fewer than 5 samples in flow zone; unallocated load not estimated.

Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)

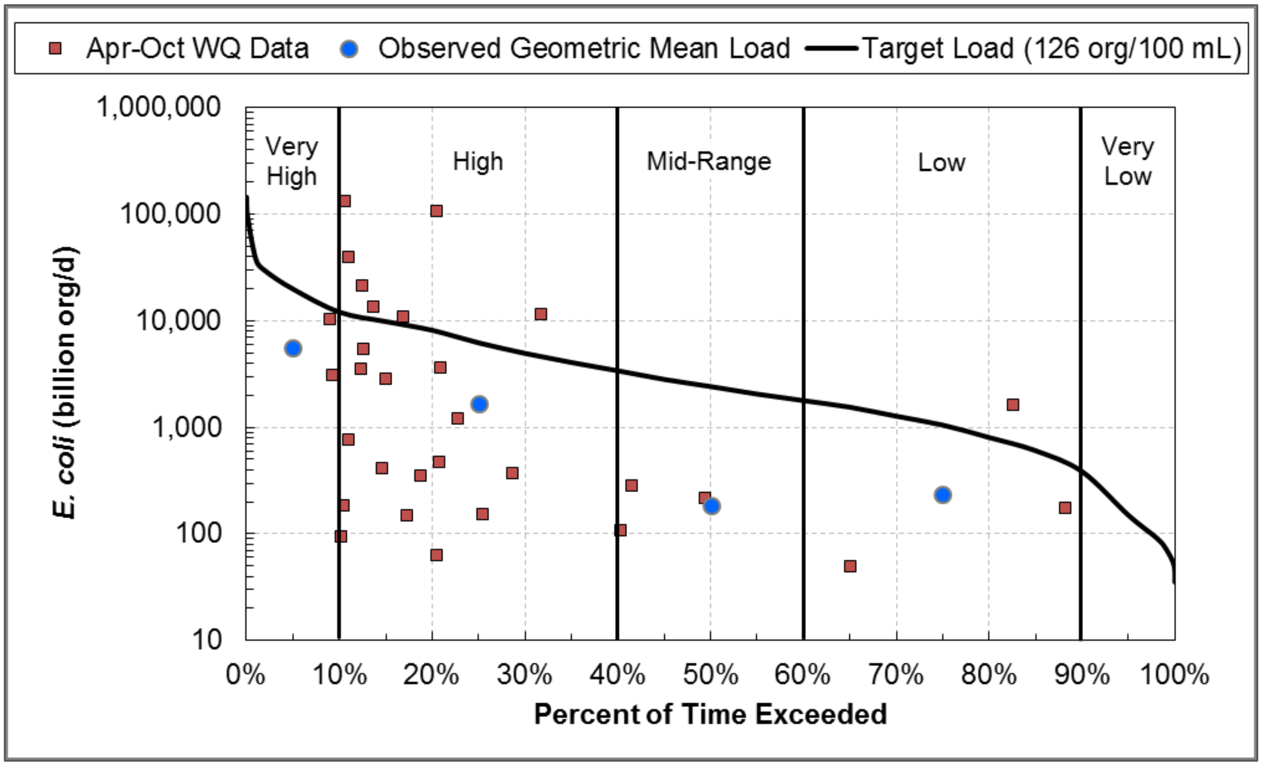

Figure 16. *E. coli* load duration curve, Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747). MPCA Sites S004-649 and S007-851, 2006–2015.

Table 28. *E. coli* TMDL summary, Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)

TMDL Parameter	Flow Zones				
	Very High	High	Mid	Low	Very Low
Allocations	***E. coli* Load, Apr–Oct (billion org/day)**				
Boundary Condition: Upstream Approved TMDL Area	18,132	1,616	2,199	953	131
WLA: City, County, and/or Township MS4	4.4	0.39	0.54	0.23	0.032
WLA: Bellingham WWTP (MNG580152) [a]	1.6	1.6	1.6	1.6	1.6
WLA: ISD 2853 Lac qui Parle Valley High School (MNG580091) [a]	1.4	1.4	1.4	1.4	1.4
WLA: Milan WWTP (MNG580141) [a]	2.6	2.6	2.6	2.6	2.6
Load Allocation	775	69	94	41	4.9
Unallocated Load	0 [b]	4,230	0 [b]	0 [b]	0 [b]
Margin of Safety	996	312	121	53	7.5
Loading Capacity	19,913	6,233	2,420	1,053	149
Other Calculations					
Maximum Concentration (org/100 mL) [c]	1,700				
Overall Estimated Percent Reduction	26%				

[a] More detailed wastewater WLAs (i.e., with more significant digits) are provided in Table 25.

[b] Fewer than 5 samples in flow zone; unallocated load not estimated.

[c] The geometric mean standard (measured as maximum monthly geometric mean of months with at least 5 samples) was not exceeded (Table 9). The individual sample standard was exceeded once in April (1,700 org/100 mL) and once in May (1,414 org/100 mL). The individual sample standard allows for 10% of the observations to exceed the standard. Because of the small sample sizes, the single exceedances during April and June result in 25% individual sample standard exceedances (Table 9). The overall estimated percent reduction is based on the maximum observed concentration relative to the individual sample standard, or 1,260 org/100 mL. The impairment assessment for this reach was based on carrying forward a fecal coliform impairment from former AUID 07020004-501, which is a subsegment of this new, consolidated reach.

Minnesota River, Blue Earth River to Cherry Creek (07020007-723)

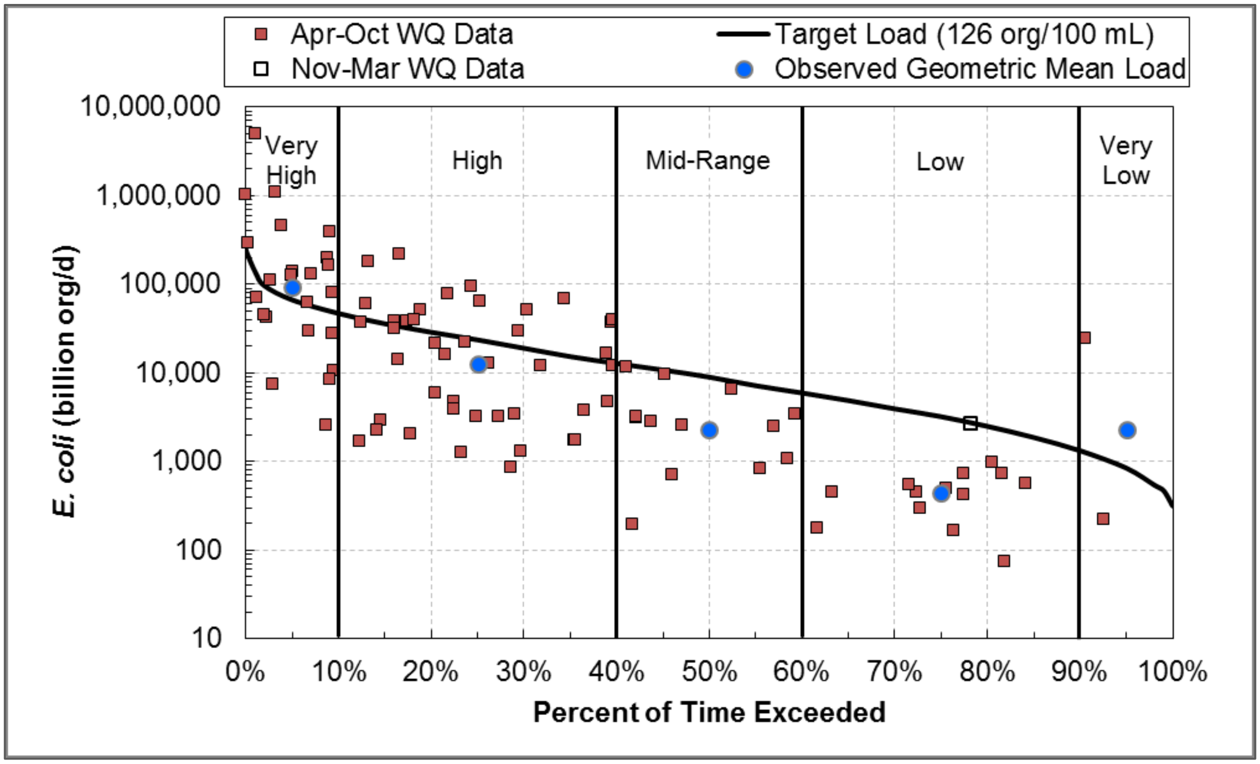

Figure 17. *E. coli* load duration curve, Minnesota River, Blue Earth River to Cherry Creek (07020007-723).
MPCA Sites S000-041, S004-130, and S007-861; 2006–2015.

Table 29. *E. coli* TMDL summary, Minnesota River, Blue Earth River to Cherry Creek (07020007-723)

TMDL Parameter	Flow Zones				
	Very High	High	Mid	Low	Very Low
Allocations	***E. coli* Load, Apr–Oct (billion org/day)**				
Boundary Condition: Upstream Approved TMDL Area	56,473	11,074	1,903	234	550
WLA: MnDOT Outstate MS4	3.0	0.58	0.10	0.012	0.029
WLA: City, County, and/or Township MS4	108	21	3.6	0.45	1.0
WLA: Belview WWTP (MNG580003) [a]	4.1	4.1	4.1	4.1	4.1
WLA: Cleveland WWTP (MNG580009) [a]	5.1	5.1	5.1	5.1	5.1
WLA: Comfrey WWTP (MN0021687) [a]	0.36	0.36	0.36	0.36	0.36
WLA: Delhi WWTP (MN0067008) [a]	0.067	0.067	0.067	0.067	0.067
WLA: Evan WWTP (MNG580202) [a]	0.69	0.69	0.69	0.69	0.69
WLA: Fairfax WWTP (MNG580060) [a]	20	20	20	20	20
WLA: Franklin WWTP (MN0021083) [a]	0.55	0.55	0.55	0.55	0.55
WLA: Granite Falls WWTP (MN0021211) [a]	3.8	3.8	3.8	3.8	3.8
WLA: Hanley Falls WWTP (MNG580122) [a]	1.2	1.2	1.2	1.2	1.2
WLA: Hanska WWTP (MN0052663) [a]	3.6	3.6	3.6	3.6	3.6
WLA: Jeffers WWTP (MNG580111) [a]	1.6	1.6	1.6	1.6	1.6
WLA: Lake Crystal WWTP (MN0055981) [a]	2.8	2.8	2.8	2.8	2.8
WLA: Mankato Water Resource Recovery Facility (MN0030171) [a]	54	54	54	54	54
WLA: Morgan WWTP (MN0020443) [a]	11	11	11	11	11
WLA: Morton WWTP (MN0051292) [a]	0.63	0.63	0.63	0.63	0.63
WLA: New Ulm WWTP (MN0030066) [a]	32	32	32	32	32
WLA: Nicollet WWTP (MNG580037) [a]	12	12	12	12	12
WLA: Redwood Falls WWTP (MN0020401) [a]	6.3	6.3	6.3	6.3	6.3
WLA: Sacred Heart WWTP (MN0024708) [a]	1.1	1.1	1.1	1.1	1.1
WLA: Saint George District Sewer System (MN0064785) [a]	0.033	0.033	0.033	0.033	0.033
WLA: Saint Peter WWTP (MN0022535) [a]	19	19	19	19	19
WLA: Searles WWTP (MNG580080) [a]	1.8	1.8	1.8	1.8	1.8
Load Allocation	6,461	1,267	218	27	63
Unallocated Load	0	9,854	6,194	2,600	0
Margin of Safety	3,328	1,179	447	160	42
Loading Capacity	66,555	23,577	8,947	3,203	838
Other Calculations					
Maximum Monthly Geometric Mean Concentration (org/100 mL)	202				
Overall Estimated Percent Reduction	38%				

[a] More detailed wastewater WLAs (i.e., with more significant digits) are provided in Table 25.

Minnesota River, Cherry Creek to High Island Creek (07020012-799)

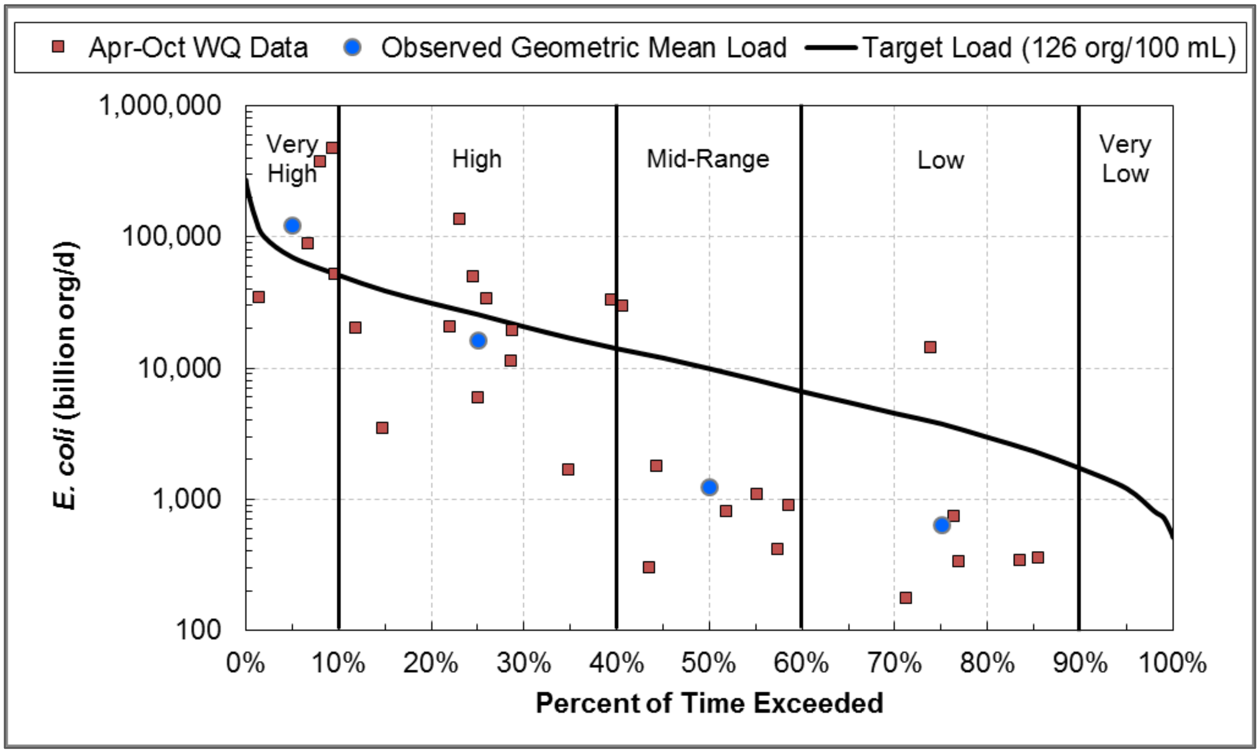

Figure 18. *E. coli* load duration curve, Minnesota River, Cherry Creek to High Island Creek (07020012-799).
MPCA Sites S000-040 and S007-855; 2006–2015.

Table 30. *E. coli* TMDL summary, Minnesota River, Cherry Creek to High Island Creek (07020012-799)

TMDL Parameter	Flow Zones				
	Very High	High	Mid	Low	Very Low
Allocations	***E. coli* Load, Apr–Oct (billion org/day)**				
Boundary Condition: Upstream Approved TMDL Area	66,387	16,287	1,243	636	1,133
WLA: MRVPUC WWTP (MN0068195) [a]	8.8	8.8	8.8	8.8	8.8
WLA: City, County, and/or Township MS4	7.9	1.9	0.15	0.075	0.13
Load Allocation	243	59	5.1	2.1	5.1
Unallocated Load	0	8,042	8,154	2,929	0 [b]
Margin of Safety	3,508	1,284	495	188	60
Loading Capacity	70,155	25,683	9,906	3,764	1,207
Other Calculations					
Maximum Monthly Geometric Mean Concentration (org/100 mL)	231				
Overall Estimated Percent Reduction	45%				

[a] More detailed wastewater WLAs (i.e., with more significant digits) are provided in Table 25.

[b] Fewer than 5 samples in flow zone; unallocated load not estimated.

Minnesota River, High Island Creek to Carver Creek (07020012-800)

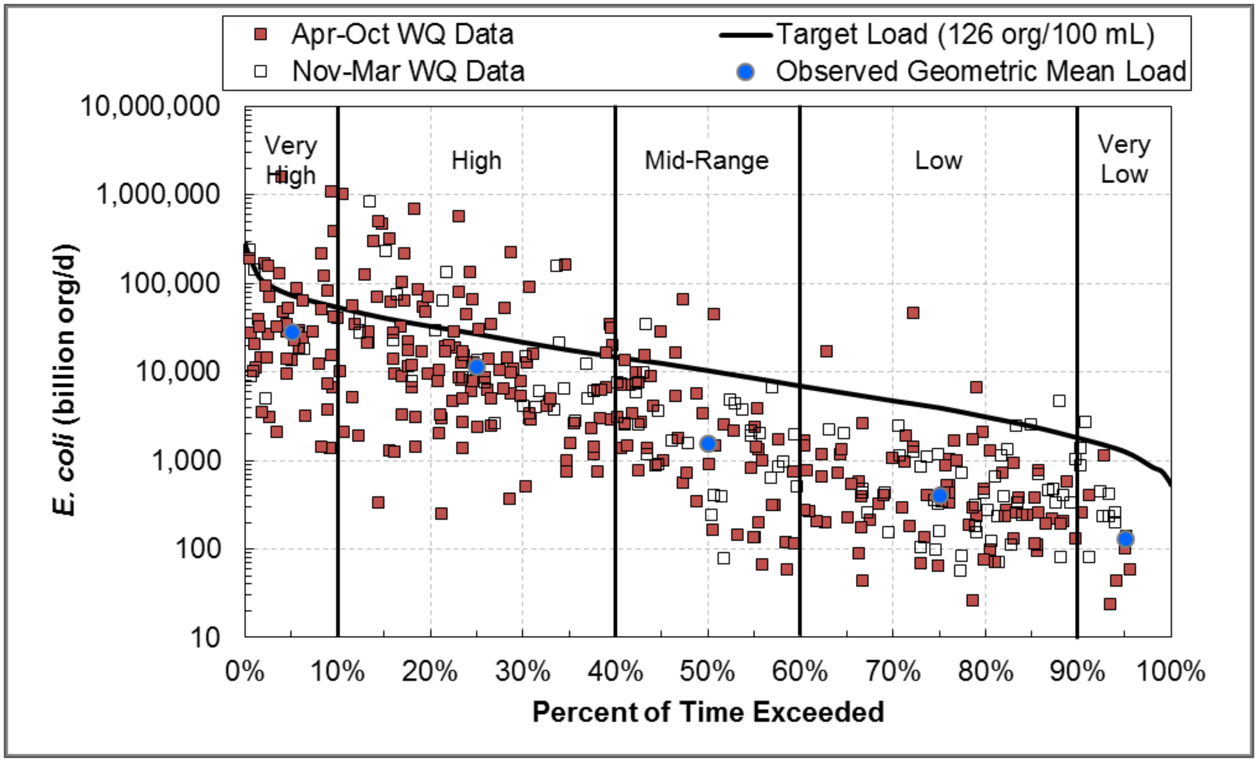

Figure 19. *E. coli* load duration curve, Minnesota River, High Island Creek to Carver Creek (07020012-800). MPCA Site S007-856 and MCES Site MI 39.4; 2006–2015.

Table 31. *E. coli* TMDL summary, Minnesota River, High Island Creek to Carver Creek (07020012-800)

TMDL Parameter	Flow Zones				
	Very High	High	Mid	Low	Very Low
Allocations	***E. coli* Load, Apr–Oct (billion org/day)**				
Boundary Condition: Upstream Approved TMDL Area	28,269	11,745	1,574	411	131
WLA: City, County, and/or Township MS4	4.1	1.7	0.23	0.060	0.019
Load Allocation	108	45	5.8	1.9	1.0
Unallocated Load	41,366	13,742	8,269	3,329	1,068
Margin of Safety	3,671	1,344	518	197	63
Loading Capacity	73,418	26,878	10,367	3,939	1,263
Other Calculations					
Maximum Monthly Geometric Mean Concentration (org/100 mL)	314				
Overall Estimated Percent Reduction	60%				

5. Future Growth Considerations

5.1 New or Expanding Permitted MS4 WLA Transfer Process

Future transfer of watershed runoff loads in this TMDL 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 non-regulated MS4s become 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 is existing state highways that were outside an Urban Area at the time the TMDL 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 a 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. In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and will have an opportunity to comment.

5.2 New or Expanding Wastewater

The MPCA, in coordination with the 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 (MPCA 2012). 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 needs to provide reasonable assurance that water quality targets will be achieved through the specified combination of point and nonpoint source reductions reflected in the LAs and WLAs. According to EPA guidance (EPA 2002a):

> When a TMDL is developed for waters impaired by both point and nonpoint sources, 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 implement water quality standards.

In order to address *E. coli* loads in the Minnesota River, already-required point source controls will be effective in improving water quality if accompanied by considerable reductions in nonpoint source loading. Reasonable assurance for permitted sources such as stormwater, CAFOs, and wastewater is provided via compliance with their respective NPDES permit programs.

Reasonable assurance for non-permitted sources such as livestock and human sources (e.g., septic and straight pipe systems) is provided by the numerous existing plans, nonpoint source reduction programs, and partner organizations that continue to work towards improving water quality in the Minnesota River Basin.

6.1 NPDES Permit Programs

MS4 Program

The MPCA is responsible for applying federal and state regulations to protect and enhance water quality in the State of Minnesota. The MPCA oversees stormwater management accounting activities for all MS4 entities previously listed in this TMDL study. The Small MS4 General Permit requires regulated municipalities to implement BMPs that reduce pollutants in stormwater to the maximum extent practicable. A critical component of permit compliance is the requirement for the owners or operators of a regulated MS4 conveyance to develop a Stormwater Pollution Prevention Program (SWPPP). The SWPPP program addresses all permit requirements, including the following six measures:

- Public education and outreach
- Public participation
- Illicit Discharge Detection and Elimination Program
- Construction site runoff controls
- Post-construction runoff controls
- Pollution prevention and municipal good housekeeping measures

A SWPPP is a management plan that describes the MS4 permittees' activities for managing stormwater within their regulated area. In the event of a completed TMDL study, MS4 permittees must document the WLA in their future NPDES/SDS Permit application and provide an outline of the BMPs to be implemented that address any needed reductions. The MPCA requires MS4 owners or operators to submit their application and corresponding SWPPP document to the MPCA for review. Once the application and SWPPP are deemed adequate by the MPCA, all application materials are placed on 30-day public notice, allowing the public an opportunity to review and comment on the prospective program. Once NPDES/SDS Permit coverage is granted, permittees must implement the activities described within their SWPPP and submit an annual report to the MPCA documenting the implementation activities completed within the previous year, along with an estimate of the cumulative pollutant reduction achieved by those activities. For information on all requirements for SWPPPs and annual reporting, please see the Minnesota Stormwater Manual.

This TMDL assigns *E. coli* WLAs to all regulated MS4s in the study area. The Small MS4 General Permit requires permittees to develop compliance schedules for EPA approved TMDL WLAs not already being met at the time of permit application. A compliance schedule includes BMPs that will be implemented over the permit term, a timeline for their implementation, and a long term strategy for continuing progress towards assigned WLAs. For WLAs being met at the time of permit application, the same level of treatment must be maintained in the future. Regardless of WLA attainment, all permitted MS4s are still required to reduce pollutant loadings to the maximum extent practicable.

Permitted Wastewater NPDES Program

Wastewater dischargers that operate under NPDES permits are required to disinfect wastewater to reduce fecal coliform concentrations to 200 organisms/100 mL or less as a monthly geometric mean. Like *E. coli*, fecal coliform bacteria are an indicator of fecal contamination. The primary function of a bacterial effluent limit is to assure that the effluent is being adequately treated with a disinfectant to assure a complete or near complete kill of fecal bacteria prior to discharge (MPCA 2007b).

MPCA Feedlot Program

The MPCA Feedlot Program implements rules governing the collection, transportation, storage, processing, and disposal of animal manure and other livestock operation wastes. Minn. R. ch. 7020 regulates feedlots in the state of Minnesota. All feedlots capable of holding 50 or more AUs, or 10 in shoreland areas, are subject to this rule. A feedlot holding 1,000 or more AUs is permitted in the state of Minnesota. The focus of the rule is on those animal feedlots and manure storage areas that have the greatest potential for environmental impact.

The Feedlot Program is implemented through cooperation between the MPCA and county governments in 50 counties in the state. The MPCA works with county representatives to provide training, program oversight, policy and technical support, and formal enforcement support when needed. A county participating in the program, or a delegated county, has been given authority by the MPCA to delegate administration of the feedlot program. These delegated counties receive state grants to help fund their feedlot programs based on the number of feedlots in the county and the level of inspections they complete. In recent years, annual grants given to these counties totaled about two million dollars (MPCA 2017d). All of the major counties within the TMDL project focus area for the Minnesota River *E. coli* TMDL are delegated counties with the exception of Chippewa, Redwood, Sibley, and Scott. In these counties, the MPCA is tasked with running the Feedlot Program.

The MPCA's stormwater program, NPDES permit program for wastewater, and feedlot program are regulatory activities providing reasonable assurance that implementation activities are initiated, maintained, and consistent with WLAs assigned in this study.

6.2 Examples of Non-Permitted Source Reduction Programs

Several non-permitted reduction programs exist to support implementation of nonpoint *E. coli* reduction BMPs in the Minnesota River Basin. These programs identify BMPs, provide means of focusing BMPs, and support their implementation via state initiatives, ordinances, and/or provide dedicated funding. The following examples describe large-scale programs that have proven to be effective and/or will reduce *E. coli* loads going forward.

MPCA Feedlot Program

All feedlots capable of holding 50 or more AUs, or 10 in shoreland areas, are subject to Minn. R. ch. 7020 and included in the MPCA Feedlot Program, including non-permitted feedlots. Information on the MPCA Feedlot Program is provided above in Section 0 and 6.1.

SSTS Implementation and Enforcement Taskforce

Subsurface sewage treatment systems (SSTS) are regulated through Minn. Stat. §§ 115.55 and 115.56. Regulations include:

- Minimum technical standards for individual and mid-size SSTS
- A framework for local units of government 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 septic installation, maintenance, and inspection

In 2008, the MPCA amended and adopted rules concerning the governing of SSTS. In 2010, the MPCA was mandated to appoint a Subsurface Sewage Treatment Systems Implementation and Enforcement Task Force (SIETF). Members of the SIETF include representatives from the Association of Minnesota Counties, Minnesota Association of Realtors, Minnesota Association of County Planning and Zoning Administrators, and the Minnesota Onsite Wastewater Association. The group was tasked with:

- Developing effective and timely implementation and enforcement methods to reduce the number of SSTS that are an IPHT and enforce all violation of the SSTS rules (See report to the legislature; MPCA 2011)
- Assisting MPCA in providing counties with enforcement protocols and inspection checklists

Currently, a system is in place in the state that when a straight pipe system or other IPHT location is confirmed, county health departments send notices of non-compliance. Upon doing so, a 10-month deadline is set for the system to be brought into compliance (Minn. Stat. § 115.55). All known IPHTs are recorded in a statewide database by the MPCA. From 2006 to 2017, 742 straight pipes were tracked by the MPCA statewide. Seven hundred-one of those were abandoned, fixed, or were found not to be a straight pipe system. There have been 17 Administrative Penalty Orders issued and docketed in court.

The remaining straight pipe systems received a notification of non-compliance which triggers a 10-month deadline.

Buffer Program

The Buffer Law signed by Governor Dayton in June 2015 was amended on April 25, 2016 and further amended by legislation signed by Governor Dayton on May 30, 2017. The Buffer Law requires the following:

- For all public waters, the more restrictive of:
    - a 50-foot average width, 30-foot minimum width, continuous buffer of perennially rooted vegetation, or
    - the state shoreland standards and criteria.
- For public drainage systems established under Minn. Stat. ch. 103E, a 16.5-foot minimum width continuous buffer.

Alternative practices are allowed in place of a perennial buffer in some cases. The amendments enacted in 2017 clarify the application of the buffer requirement to public waters, provide additional statutory authority for alternative practices, address concerns over the potential spread of invasive species through buffer establishment, establish a riparian protection aid program to fund local government buffer law enforcement and implementation, and allow landowners to be granted a compliance waiver until July 1, 2018, when they have filed a compliance plan with the soil and water conservation district.

The Board of Water and Soil Resources (BWSR) provides oversight of the buffer program, which is primarily administered at the local level.

Agricultural Water Quality Certification Program

The Minnesota Agricultural Water Quality Certification Program 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. As of January 2019, about 450,000 acres have been certified, with many additional acres under review.

6.3 Summary of Existing Plans and Organizations

Minnesota has a long history of water management by local governments, made apparent by the number of local water plans in the Minnesota River Basin. The One Watershed, One Plan (1W1P) legislation allows comprehensive plans, local water management plans, or watershed management plans to serve as substitutes for one another or to be replaced with one comprehensive watershed management plan (Minn. Stat. §103B.101, subd. 14). Further legislation defining purposes and outlining additional structure for 1W1P is found in Minn. Stat. §103B.801.

1W1Ps are expected to have positive impacts on water quality in the TMDL project focus area, as they provide the opportunity to align local water planning on major watershed boundaries with state and local strategies developed through WRAPS and TMDL projects towards prioritized, targeted, and measurable implementation plans. Within the Minnesota River Basin, one 1W1P has been completed (Yellow Medicine River) and three others have received funding for plan development (Pomme de Terre, Watonwan and Hawk Creek) as of August 2018. Current 1W1P watershed status can be found at: http://www.bwsr.state.mn.us/planning/1W1P/index.html).

The transition to 1W1Ps will take time. Prior to full adoption, water planning continues to be done outside of the Twin Cities Metropolitan Area on a county basis, per the Comprehensive Local Water Management Act (Minn. Stat. §103B.301) (see the local water plan map for status of local water management plans and the list below for current plans). Within the metropolitan area, water planning is subject to Minn. R. ch. 8410, and is done on a watershed district or watershed management organization basis. Local water plans incorporate implementation strategies aligned with or called for in TMDLs and WRAPS and are implemented by county Soil and Water Conservation Districts (SWCDs).

The following is a list of available watershed district, watershed management organization, and county water plans for major counties in the TMDL project focus area; URL links are provided as well:

- Big Stone County Water Plan (2014–2023)
- Blue Earth County Water Management Plan (2017–2026)
- Brown County Comprehensive Local Water Management Plan (2008-–2018), Amended 2013
- Carver County Watershed Management Organization Comprehensive Water Resources Management Plan (2010–2020)
- The 2013–2023 Chippewa County Water Plan (2013–2023)
- Cottonwood County Comprehensive Local Water Management Plan (2017–2027)
- Lac qui Parle County Local Water Management Plan (2003–2012)
- Lac qui Parle – Yellow Bank Watershed District Watershed Management Plan (2009-2019)
- Le Sueur County Local Comprehensive County Water Management Plan (2016–2021)
- Nicollet County Local Water Management Plan (2008–2018, 2013 amendment)
- Redwood County Comprehensive Local Water Management Plan (2006–2016, 2016 Amendment 2016–2020)

- Renville County Comprehensive Water Management Plan (2013–2023)
- Scott County Comprehensive Water Resources Management Plan (2019–2026)
- Sibley County Comprehensive Local Water Plan (2013–2023)
- Stevens County Local Water Management Plan Amendment (2010–2015)
- Swift County 2014–2023 Local Water Plan (2014–2023)
- Upper MN River Watershed District Plan Update (September 2013)
- Watonwan County Local Water Management Plan (2008–2018)
- Yellow Medicine County Comprehensive Local Water Plan (2017–2021)
- Yellow Medicine River Watershed District (2017–2026)

Local SWCDs are active in the project area and impaired watersheds. The SWCDs provide technical and financial assistance on topics such as conservation farming, nutrient management, streambank stabilization, and many others. SWCD involvement through the TMDL project area includes conservation farming tours, workshops, educational activities, agricultural BMP installation and cost share, and tree and rain barrel sales for county residents to help improve water quality. There are 35 SWCDs in the TMDL project area, all of which are working to improve water quality.

Big Stone Soil SWCD, for one example, set the following goals in their 2014 comprehensive water plan:

- Identifying and cost-sharing sites where cattle exclusions are needed
- Upgrading five feedlots with BMPs to eliminate runoff to nearby waters
- Promoting 500 acres of pasture management
- Upgrading 10 noncompliant SSTS systems annually

In 2016, Big Stone SWCD provided funding for four agricultural BMPs, had over 20,000 acres of land enrolled in their Conservation Stewardship Program, funded 34 Environmental Quality Incentive Program contracts, hired a new Farm Bill Technician to carry out various Farm Bill programs, and held several conservation workshops. In addition, Big Stone SWCD developed a Marsh Lake Restoration Plan within the Lac qui Parle Wildlife Management Area to restore river habitat, control carp populations by removing their winter refuge, provide ecosystem connectivity, and restore the natural flooding and drying cycles in the area. Lastly, there is an on-going effort on Big Stone Lake to reduce erosion. The project began in 2015 and helps riparian landowners to improve eroding shorelines on Big Stone Lake just upstream of the impaired segment from Big Stone Lake to Marsh Lake Dam (0702001-522).

Several other TMDLs for *E. coli* and/or fecal coliform exist in the Minnesota River Basin outside of the project focus area for this report, as summarized in Section 1.2. Each of these TMDL projects includes implementation activities and reasonable assurance. It is expected that the programs and policies put in place to implement these TMDLs will be applicable to the Minnesota River *E. coli* TMDL focus area as well.

In addition to local governments, counties, watershed districts, watershed management organizations, soil and water conservation districts, state and federal agencies, and volunteer/nongovernmental organizations, there are numerous watershed groups in the Minnesota River Basin (Table 32). These watershed groups have different types of organization and structure, but share a common goal to protect and improve water quality. They typically conduct watershed outreach and education activities, monitoring, research, and project planning and implementation. They are often the link between landowners and planning initiatives set on a watershed, region, or basin-wide scale. The level of activity being conducted by these organizations and available funding mechanisms, such as the Clean Water Fund and Clean Water Act Section 319 grant programs, Farm Bill cost-share programs, and Clean Water Partnership and Agricultural BMP loan programs, to continue funding their work provide additional reasonable assurance that implementation will continue to occur to address nonpoint sources of sediment. For example, the Greater Blue Earth River Alliance has secured over $6 million in grant funds over the past 11 years to conduct research and implementation activities focused on water quality.

Table 32. Watershed groups in project area

Watershed Group	Website
Chippewa River Watershed Project	http://www.chippewariver.org/
Hawk Creek Watershed Project	https://www.hawkcreekwatershed.org/
Redwood–Cottonwood Rivers Control Area	http://www.rcrca.com/
Greater Blue Earth River Alliance	http://www.gberba.org/
Le Sueur River Watershed Network	http://lesueurriver.org
High Island Creek Watershed Project	https://www.sibleyswcd.org/watersheds-program

Other organizations in the Minnesota River Basin that are supporting implementation include:

- Minnesota River Basin Data Center, Minnesota State University Mankato Water Resource Center (http://mrbdc.mnsu.edu/)—Providing basin-wide data management and coordination.
- Minnesota River Watershed Alliance and Minnesota River Congress (http://watershedalliance.blogspot.com/)—Coordinating basin-wide governance and opportunities for stakeholders.
- Coalition for a Clean Minnesota River (http://www.ccmnriver.org/)—A grass-roots organization coordinating citizen and business interests in basin-wide efforts.

The Minnesota River Basin Data Center includes a list of other organizations that are active in the Minnesota River Basin. (Note, however, that the center's list of organizations is not up to date as of the writing of this report.)

Participation of farmers and landowners is essential to implementing nonpoint source BMPs and improving water quality in the TMDL project focus area. Educational efforts and cost-share programs will likely increase participation to levels needed to protect water quality. Additional assurance can be achieved during implementation of the TMDLs through contracts, memorandums of understanding, and other similar agreements, especially for BMPs that receive outside funds and cost share.

7. Monitoring Overview

This section provides an overview of the major monitoring approaches currently operating at many scales in multiple watersheds within the Minnesota River Basin. Some LGUs conduct additional monitoring. Improving water quality depends on many factors, and improvements might take several years to show a decreasing trend in pollution levels.

Monitoring is important for several reasons, including:

- Evaluating waterbodies to determine if they are meeting water quality standards and tracking trends
- Determining impact of potential *E. coli* loading from upstream lakes (Big Stone Lake upstream of reach 07020001-552 and Lac qui Parle Lake upstream of reach 07020004-747)
- Determining potential impact of tributaries with existing *E. coli*/fecal coliform TMDLs on the Minnesota River
- Assessing potential sources of *E. coli*
- Determining the effectiveness of implementation activities in the watershed
- Delisting of waters that are no longer impaired

Monitoring is also a critical component of an adaptive management approach and can be used to help determine when a change in management is needed. Several types of monitoring will be important to measuring success. The six basic types of monitoring listed below are based on the EPA's *Protocol for Developing Pathogen TMDLs* (EPA 2000).

- **Baseline monitoring—**characterizes existing conditions and provides a basis for future comparisons.
- **Implementation monitoring—**tracks implementation of *E. coli* reduction practices using BWSR's eLink or other tracking mechanisms.
- **Flow monitoring—**is combined with water quality monitoring at the site to allow for the calculation of pollutant loads.
- **Effectiveness monitoring—**determines whether a practice or combination of practices are effective in improving water quality.
- **Trend monitoring—**allows the statistical determination of whether water quality conditions are improving.
- **Validation monitoring—**validates the source analysis and linkage methods in *E. coli* source tracking to provide additional certainty regarding study findings.

There are many monitoring efforts in place to address each of the six basic types of monitoring. Key monitoring programs that will provide the information to track trends in water quality and evaluate compliance with TMDLs include the following:

- Intensive watershed monitoring and assessment at the HUC8 scale associated with Minnesota's watershed approach, led by the MPCA in collaboration with LGUs. This monitoring effort is conducted every 10 years for each HUC8. An outcome of this monitoring effort is the identification of waters that are impaired (i.e., do not meet standards and need restoration) and waters in need of protection to prevent impairment. Over time condition monitoring can also identify trends in water quality. This helps determine whether water quality conditions are improving or declining, and it identifies how management actions are improving the state's waters overall.
- The MPCA began monitoring and assessing its large rivers in 2013, beginning with the Mississippi River from its headwaters to St. Anthony Falls. The Minnesota River was monitored in 2014 and was evaluated as a whole for levels of nutrients, sediment, indicator bacteria, toxics, dissolved oxygen, chloride, pH, ammonia, communities of fish and macroinvertebrates such as aquatic insects, flow of rivers and streams, and contaminants in fish. The MPCA is working with bordering states to develop a uniform monitoring and assessment process.
- The MPCA's Watershed Pollutant Load Monitoring Network (WPLMN) measures and compares data on pollutant loads from Minnesota's rivers and streams and tracks water quality trends. The WPLMN does not monitor fecal bacteria, but does monitor pollutants associated with fecal bacteria such as nitrogen and phosphorus. Trends in nutrient loads are often associated with trends in fecal bacteria and can therefore inform overall water quality condition. WPLMN data is used to assist with assessing impaired waters, watershed modeling, determining pollutant source contributions, developing watershed and water quality reports, and measuring the effectiveness of water quality restoration efforts. Data are collected along major rivers, at major watershed (i.e., HUC8) outlets to major rivers, and in several subwatersheds. This long-term monitoring program began in 2007, including some sites that pre-existed the network for years or even decades.
- BMP implementation monitoring is conducted by both BWSR (i.e., eLink) and USDA. Both agencies track the locations of BMP installations. Tillage transects and crop residue data are collected periodically and reported through the Tillage Transect Survey Data Center.
- Discharges from permitted municipal and industrial wastewater sources are reported through discharge monitoring records; these records are used to evaluate compliance with NPDES permits. Summaries of discharge monitoring records are available through the MPCA's Wastewater Data Browser.

8. Prioritizing and Implementing Restoration and Protection Strategies

This implementation strategy provides a framework that watershed stakeholders may use to guide implementation in the Minnesota River Watershed. It identifies key geographic areas for implementation, and provides a description of management activities to reduce *E. coli* loading from permitted sources and the non-permitted sources identified as high priority—livestock and human sources—to restore impaired streams and protect unimpaired streams from impairment. The implementation strategies, including estimated scales of adoption and timelines, provided in this section are the result of watershed and pollutant source assessment conducted as part of the TMDL development and professional judgment based on what is known at this time, and thus should be considered approximate. Furthermore, many strategies are predicated on funding being secured. As such, the proposed actions outlined are subject to adaptive management—an iterative approach of implementation, evaluation, and course correction.

Following the description of management activities is an expanded strategies table that contains strategies, goals, estimated scale of adoption, lead responsibilities, and time frames for each management activity. This table contains both restoration and protection strategies to address *E. coli* loading in the TMDL project focus area. In doing so, this implementation strategy section provides a substitute to a separate strategies report. The MPCA believes this is an appropriate approach, given that the main stem river impairments addressed in this report may, in large part, be due to the tributary impairments already addressed (or will be later addressed) in separate TMDLs, WRAPS, and 1W1Ps.

The overall TMDL project focus area is made up of restoration and protection areas. While allocations for the Minnesota River *E. coli* TMDLs include all upstream waterbodies not already encompassed in an *E. coli* or fecal coliform TMDL, the Minnesota River from Beaver Creek to Little Rock Creek (AUID 07020007-720) and the three reaches upstream of it were found to meet aquatic recreation standards in a recent MPCA assessment (MPCA 2017e; see Table 1). Therefore, the subwatersheds of these unimpaired reaches are the protection area, and will be evaluated separately as the focus of protection efforts. The remaining subwatersheds of impaired or unassessed reaches are the restoration areas, and are the focus of restoration efforts (Figure 20).

Implementation of restoration and protection strategies will be conducted by numerous entities in the Minnesota River Basin as indicated in Section 6.

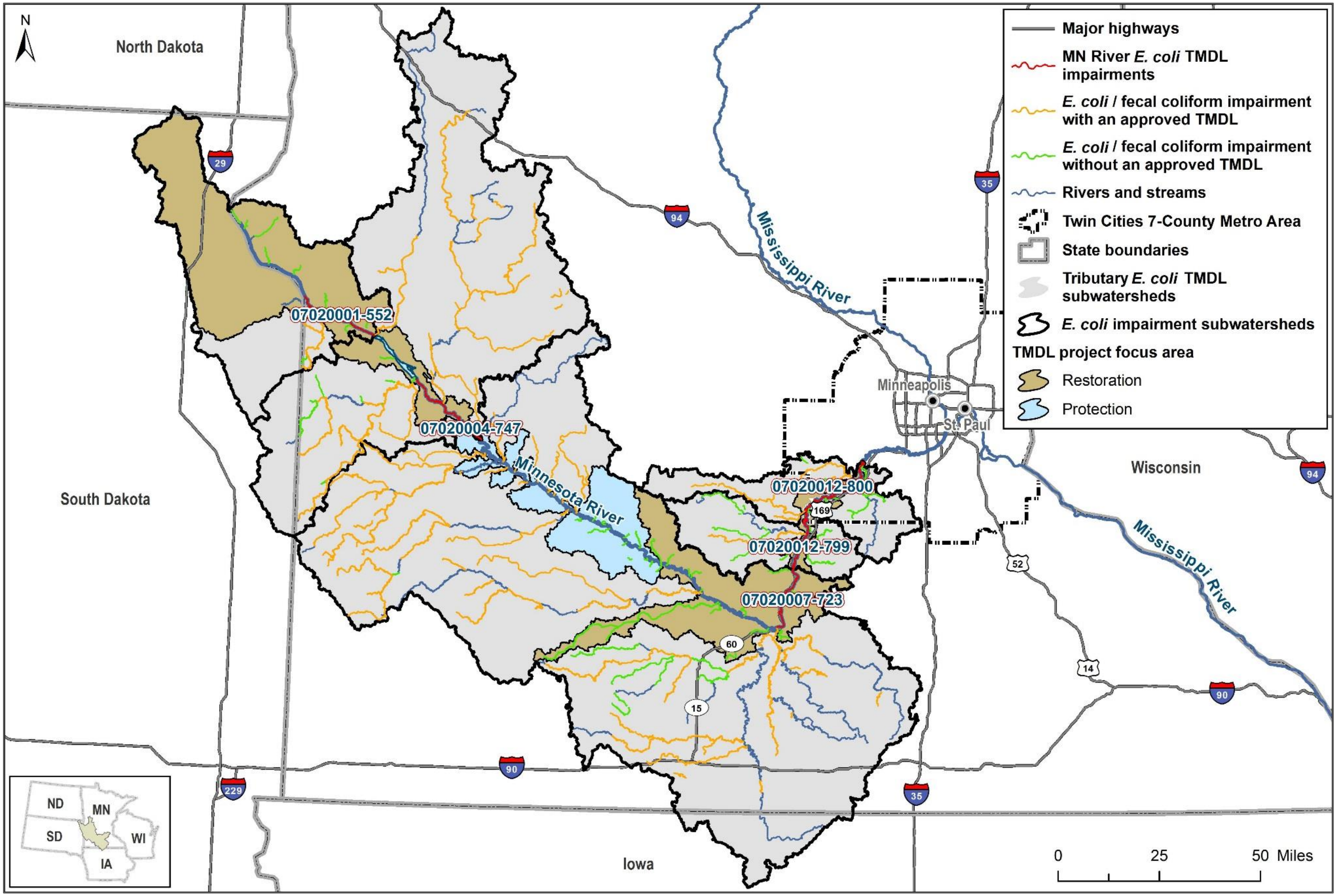

Figure 20. Restoration and protection areas in the TMDL project focus area.

8.1 Implementation Strategies for Permitted Sources

Permitted sources that are in compliance with their permits are not considered a significant source of *E. coli* loading to the project focus area.

Wastewater

Effluent from WWTPs is typically below the *E. coli* standard and is not considered a significant source of *E. coli* for the Minnesota River impairments. Municipal wastewater treatment facilities are regulated through NPDES permits. These permits include *E. coli* effluent limits designed to meet water quality standards, along with monitoring and reporting requirements to ensure effluent limits are met.

Regulated MS4

There is currently little land use in the TMDL project focus area of the Minnesota River *E. coli* TMDLs that is classified as developed (Table 4) and only 33 square miles of regulated MS4 area (Table 18), which is less than 0.3% of the project focus area. Because of the small extent of developed area relative to other land covers and source types, permitted stormwater runoff is not considered a priority source of *E. coli* for the Minnesota River impairments.

For new development projects, MPCA's current phase II MS4 general permit requires no net increase from pre-project conditions (on an annual average basis) of stormwater discharge volume. For redevelopment projects, MPCA's current phase II MS4 general permit requires a net reduction from pre-project conditions (on an annual average basis) of stormwater discharge volume. While stormwater is not a source of *E. coli* itself, it serves as a conveyance system for *E. coli* in the landscape to enter waterbodies. These stormwater volume provisions likely will reduce or prevent increases in annual *E. coli* loading—stormwater treatment practices such as bioretention, stormwater ponds, and infiltration remove from 35 to 100% of bacteria loads in stormwater (Minnesota Stormwater Manual contributors 2019). More information on *E. coli* in stormwater can be found in the Minnesota Stormwater Manual.

Permitted Animal Feeding Operations

Relatively high percentages of AUs in the TMDL project area are in CAFOs and/or NPDES permitted feedlots, with the exception of the Minnesota River from High Island Creek to Carver Creek (Table 19). Due to the requirement of permitted AFOs and CAFOs to contain runoff, facilities that are permit compliant are not expected to be a significant source of *E. coli* to surface waters. Permitted AFOs and CAFOs that are not in compliance with their permits, however, would be a source. Regular compliance inspections and permitted AFO owner education programs can help to ensure that all permitted AFOs meet permit requirements.

8.2 Implementation Strategies for Livestock Sources

Non-permitted facilities' livestock were identified as a priority source of *E. coli* in the TMDL project focus area (Table 23). Table 33 summarizes AUs by type for the restoration areas. Livestock in the protection area and in the South Dakota portion of the project area were not included in the analysis. Managers should continue to implement livestock management strategies in the protection area.

Table 33. Animal units by animal type for watersheds identified for restoration efforts
See Figure 13 for a map of feedlot locations and Table 3 for watershed areas.

Reach Name (AUID)	Number of Non-Permitted Feedlots	Number of Animal Units in Non-Permitted Feedlots [a]					
		Cattle	Pigs	Goats/Sheep	Horses	Poultry	Other
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	62	6,691	1,867	684	39	<1	0
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	37	3,893	2,115	18	67	2	5
Minnesota River, Blue Earth River to Cherry Creek (07020007-723) [b]	463	30,827	60,333	231	819	565	37
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	22	1,464	1,289	10	22	<1	8
Minnesota River, High Island Creek to Carver Creek (07020012-800)	30	1,609	905	3	327	<1	0
Total	**614**	**44,484**	**66,509**	**946**	**1,274**	**567**	**50**

a. Data from MPCA's feedlot database (feedlots in South Dakota are not included); NPDES permitted feedlots and CAFOs are excluded.
b. Animals units limited to portion of the subwatershed that is identified for restoration.

Several BMPs exist to limit fecal bacteria loading from livestock operations. The Agricultural BMP Handbook for Minnesota includes BMP effectiveness estimates based on existing scientific literature, costs and other economic considerations for each agricultural BMP (Lenhart et al. 2017). Animal operations in the watershed are typically either pasture-based or confined, or sometimes a combination of the two. The operation type, operation management, and animal type dictate the potential impact on water quality and also which practices are needed to manage manure from the facility. Potential BMPs to limit fecal bacteria loading and their NRCS practice standard codes are provided below.

Waste storage facilities (313) and nutrient management (590)

Manure management strategies depend on a variety of factors. A pasture or open lot system with a relatively low density of animals (one to two head of cattle per acre [EPA 2003]) may not produce manure in quantities that require management for the protection of water quality. For mid-size and large facilities, additional waste storage is needed. A waste storage facility is "an impoundment created by excavating earth or a structure constructed to hold and provide treatment to agricultural waste" (Lenhart et al. 2017). Waste storage facilities hold and treat waste directly from animal operations, process wastewater, or contaminated runoff.

Utilization of waste usually involves land application on the farm or transportation to another site. Utilization of waste usually involves land application on the farm or transportation to another site. Minn. R. 7020.2225 contains several requirements for land application of manure. These requirements vary depending on feedlot size and include provisions on manure nutrient testing, nutrient application rates (based on determination of crop needs and phosphorus soil testing), manure management plans, recordkeeping, and various limitations in certain areas or near environmentally-sensitive areas. Manure is typically applied to the land once or twice per year. To maximize the amount of nutrients and organic material retained in the soil, application should not occur on frozen ground or when precipitation is forecast during the next several days. A study conducted by researchers with the University of Wisconsin Extension and Discovery Farms found that manure applied on top of a few inches of snow (less than 6 to 12 inches), especially in early winter months (late November to January), does not typically increase the risk of runoff as compared to late winter months. During this time, manure tends to have better contact with the soil thus increasing its ability to adhere to soil (Frame et al. 2012).

Filter strips (636), riparian buffers (390) and clean water diversions (362)

Filter strips, riparian buffers, and clean water diversions may be used to collect, direct, and contain manure laden runoff from agricultural fields. Feedlot/wastewater filter strips are defined as "a strip or area of vegetation that receive and reduce sediment, nutrients, and pathogens in discharge from a setting basin or the feedlot itself. In Minnesota, there are five levels of runoff control, with Level 1 being the strictest and for the largest operations" (Lenhart et al. 2017). Riparian buffers are composed of a mix of grasses, forbs, sedges, and other vegetation that serves as an intermediate zone between upland and aquatic environments (Lenhart et al. 2017). The vegetation is tolerant of intermittent flooding and/or saturated soils that are prone to occur in intermediate zones.

Riparian buffers and filter strips provide many of the same benefits and can effectively address water quality degradation from fecal bacteria while enhancing habitat. Riparian buffers and filter strips that include perennial vegetation and trees can filter runoff from adjacent cropland, provide shade and habitat for wildlife, and reinforce streambanks to minimize erosion. The root structure of the vegetation uses enhanced infiltration of runoff and subsequent trapping of pollutants. Both, however, are only effective in this manner when the runoff enters the BMP as a slow moving, shallow "sheet"; concentrated flow in a ditch or gully will quickly pass through the vegetation offering minimal opportunity for retention and uptake of pollutants. Similarly, tile lines can often allow water to bypass a buffer or filter strip, thus reducing its effectiveness. Mowing filter strips and riparian buffers encourages sunlight and air movement that are needed to desiccate the entrapped pathogen. Use of multiple filter strips limits the possibility of overloading them and allows for harvesting, maintenance, and resting.

Clean runoff water diversion involves a channel constructed across the slope to prevent rainwater from entering the feedlot area or the farmstead to reduce water pollution. Clean water diversions can take many forms including roof runoff management, grading, earthen berms, and other barriers that direct uncontaminated runoff from areas that may contain high levels of *E. coli* (Lenhart et al. 2017).

Access control/fencing (472 and 382), and alternative water supply

Reducing animal access to streams, permanently fencing, and providing alternate water systems may be used to reduce fecal bacteria loading from livestock with access to streams. Access control and fencing practices generally refer to permanently excluding animals from coming into contact with water resources. They can also refer to the spatial or temporal limiting of livestock access as a management tool (Lenhart et al. 2017). These BMPs limit or eliminate livestock access to a stream or waterbody, thus removing the potential for livestock waste to enter a waterbody directly. Fencing can be used with controlled stream crossings to allow livestock to cross a stream while minimizing disturbance to the stream channel and streambanks. Providing alternative water supplies for livestock allows animals to access drinking water away from the stream, thereby minimizing the impacts to the stream and riparian corridor. Some researchers have studied the impacts of providing alternative watering sites without structural exclusions and found that cattle spend 90% less time in the stream when alternative drinking water is furnished (EPA 2003). EPA (2003) estimates that fecal coliform reductions from 29% to 46% can be expected.

8.3 Implementation Strategies for Human Sources

IPHTs including faulty septic systems and straight pipes were identified as a priority source of human *E. coli* loading in the TMDL project focus area (Table 23). BMPs to reduce *E. coli* loads include system upgrades and replacement, maintenance, compliance with state and county codes, and public education.

System upgrades/replacement

In Minnesota, all known IPHTs must be brought into compliance within a 10-month period (see Section 6.2). The reductions in *E. coli* loading resulting from upgrading or replacing failing systems in the watershed depends on the level of failure present in the watershed. Upgrading or replacing IPHT systems will result in 100% reduction in fecal bacteria loading from that system and should be a priority.

System maintenance

The most cost-effective BMP for managing loads from septic systems is regular maintenance. EPA recommends that septic tanks be pumped every three to five years depending on the tank size and number of residents in the household (EPA 2002b). When not maintained properly, septic systems can cause the release of pathogens, as well as excess nutrients, into surface water. Annual inspections, in addition to regular maintenance, ensure that systems function properly. Compliance with state and county code is essential to reducing *E. coli* loading from septic systems. Septic systems are regulated under Minn. Stat. §§ 115.55 and 115.56. Counties must enforce ordinances in Minn. R. ch. 7080 to 7083.

Public Education

Education is another crucial component of reducing *E. coli* loading from septic systems. Education can occur through mass mailings and radio and television advertisements. An inspection program can also help with public education because inspectors can educate owners about proper operation and maintenance during inspections.

8.4 Estimated Scale of Adoption

The reductions needed in the TMDL project focus area are relatively low compared to upstream *E. coli* and fecal coliform TMDLs—over 75% reduction in *E. coli* loading is needed for many of the upstream impaired reaches. In addition, because a large part of the subwatersheds of the impaired reaches are covered by completed *E. coli* or fecal coliform TMDLs (Figure 2), it is expected that the implementation of tributary TMDLs will result in load reductions to the five main stem impaired river reaches addressed in this report.

The load reductions expected if the upstream TMDLs are met were compared to the overall load reductions needed to meet the TMDLs identified in this report. Additionally, the percent load reductions required in upstream TMDLs were compiled (Figure 21). For each of the impaired Minnesota River reaches, this information was then used to rank the level of effort needed to reduce *E. coli* loads within the TMDL project focus area relative to the level of effort needed to reduce *E. coli* loads in the subwatersheds of the upstream impairments. These “estimated scale of adoption” rankings in Table 34 (low or moderate) compare each TMDL project focus area to the relevant upstream impairments; the rankings do not represent a comparison of the levels of effort needed for implementation among the five main stem impairments.

For example, the estimated scale of adoption for the TMDL project focus area of the most downstream reach (AUID 07020012-800) is estimated to be low relative to the upstream impaired watersheds that drain to that reach (Table 34). The scale of adoption is estimated to be low because, while the overall percent reduction needed in the reach is 60%, the *E. coli* load reductions needed from upstream impairments range from 40% to over 70% (Figure 21). Additionally, the TMDL project focus area of the impairment is small relative to the watershed area of the upstream impairments. Therefore, while implementation activities will still likely be needed to achieve the needed reductions, much of the reduction may be achieved upstream.

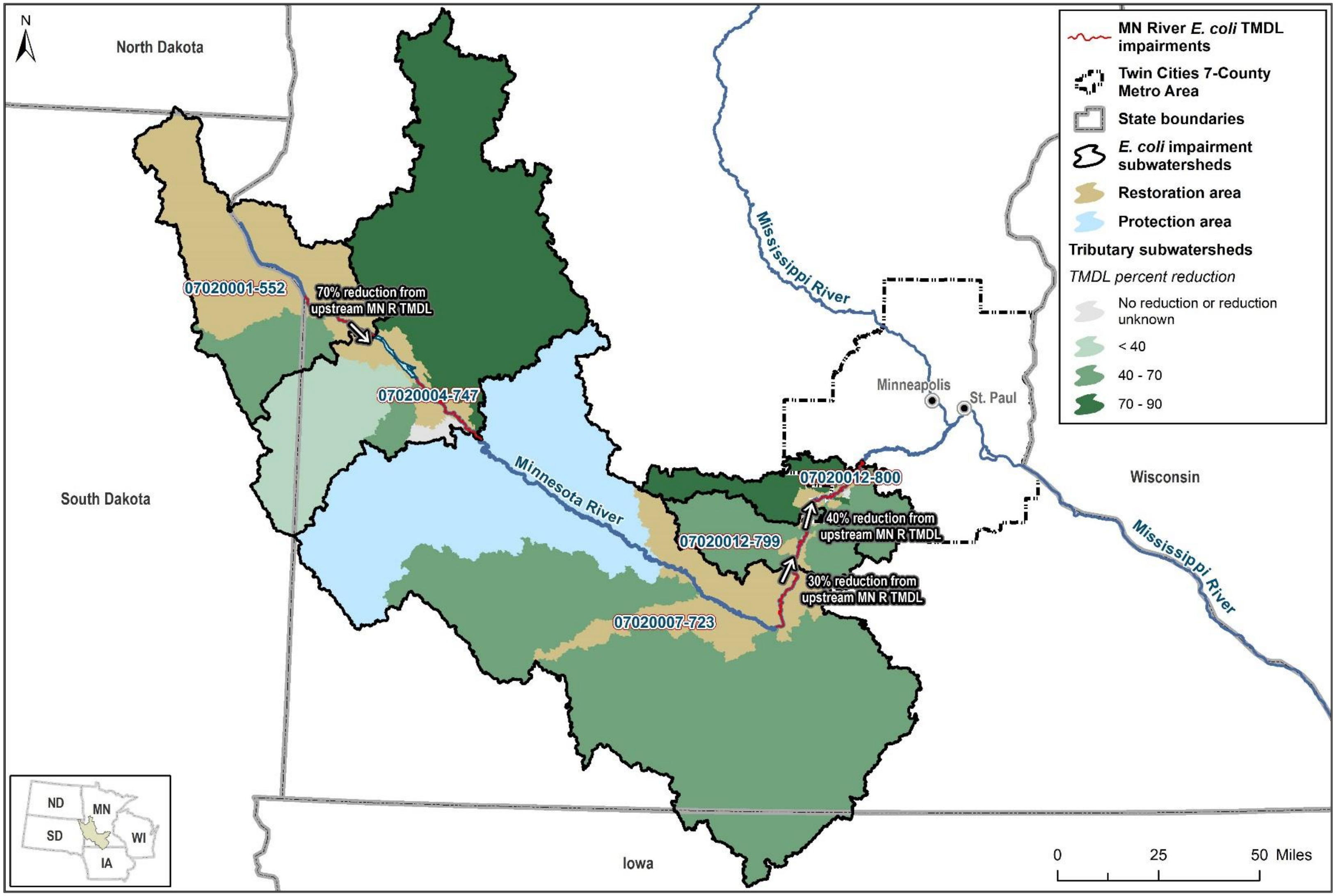

Figure 21. Percent reductions required from upstream TMDLs.

The arrows and associated percent reductions from upstream Minnesota River TMDLs represent the percent reductions needed to achieve the TMDLs in this report and their relationship to a downstream TMDL restoration area.

8.5 Restoration and Protection Strategies

The following section summarizes the applicable implementation strategies and estimated scale of adoption for restoration and protection in the Minnesota River *E. coli* TMDL project focus area. Table 34 provides an overview of the areas identified for restoration, and Table 35 provides an overview of the area identified for protection. A full suite of proposed implementation strategies and goals for the entire TMDL project focus area is provided in Table 36.

Achieving the water quality goals for the Minnesota River *E. coli* TMDLs will rely heavily on the success of the upstream TMDLs (Figure 21). Because the upstream TMDL reports do not identify implementation timelines, it is difficult to accurately estimate the timeline to achieve the water quality target in the Minnesota River impairments. However, priority *E. coli* sources in the TMDL project area are well understood, very few exceedances were observed in some of the impaired reaches, and implementation largely requires enforcement of existing rules (see Section 0). Full implementation in the TMDL restoration area is estimated to occur in the next 20 years.

Table 34. Current conditions, goals, and estimated scale of adoption for restoration areas

HUC 8	Waterbody (-AUID)	Location and Upstream Influence Counties	Current Conditions	Goals / Targets	Estimated Scale of Adoption [a]
Minnesota River Headwaters (07020001)	Minnesota River, Big Stone Lake to Marsh Lake Dam (-552)	Big Stone, Lac qui Parle, Swift and Chippewa counties	See Table 6 and Table 7	19% reduction in *E. coli* per TMDL	Moderate
Hawk–Yellow Medicine River (07020004)	Minnesota River, Lac qui Parle Dam to Granite Falls Dam (-747)	Chippewa, Lac qui Parle, Yellow Medicine, Renville and Redwood counties	See Table 8 and Table 9	26% reduction in *E. coli* per TMDL	Low
Minnesota River–Mankato (07020007)	Minnesota River, Blue Earth River to Cherry Creek (-723)	Nicollet, Le Sueur, Brown, Sibley, Renville and Blue Earth counties	See Table 10 and Table 11	38% reduction in *E. coli* per TMDL	Moderate
Lower Minnesota River (07020012)	Minnesota River, Cherry Creek to High Island Creek (-799)	Scott, Carver, and Sibley counties	See Table 12 and Table 13	45% reduction in *E. coli* per TMDL	Moderate
	Minnesota River, High Island Creek to Carver Creek (-800)	Hennepin, Dakota, Scott and Carver counties	See Table 14 and Table 15	60% reduction in *E. coli* per TMDL	Low

a. Estimated scales of adoption are based on semi-quantitative analysis of reductions expected from existing TMDLs of contributing tributaries and reductions required for Minnesota River impaired reaches (Table 27 through Table 31); see Section 8.4.The rankings compare each TMDL project focus area to the relevant upstream impairments; the rankings do not represent a comparison of the levels of effort needed for implementation among the five main stem impairments.

Table 35. Current conditions and goals for protection areas

HUC 8	Waterbody (AUID)	Location and Upstream Influence Counties	Current Conditions	Goals / Targets
Minnesota River–Mankato (07020007); Hawk–Yellow Medicine (07020004)	Beaver Creek to Little Rock Creek (07020007-720)	Renville, Brown, Redwood, Yellow Medicine and Chippewa counties	Fully supporting aquatic recreation	*E. coli* standard

Table 36. Proposed restoration and protection strategies for the Minnesota River *E. coli* TMDL

Waterbody (AUID)	Strategy Type	Strategy	Current Adoption Level (if known)	Suggested Goal	Units
All	Compliance with all NPDES permits (wastewater, MS4, and feedlots)				
	Address non-permitted human sources of fecal bacteria (i.e., septic systems and IPHTs)	Inventory and assess the potential for septic systems/private wastewater systems to be sources of *E. coli* Replace all systems deemed IPHTs (e.g., straight pipes, surface seepage) Identify opportunities for cluster systems and work with landowners to implement Landowner focused education and outreach on septic system maintenance and compliance Support increased compliance inspections (in addition to current point of sale inspections); also required to get a building permit Additional setbacks in sensitive areas	Current point of sale inspections	Complete inventory and inspection of SSTS every 10 years 100% of SSTS in compliance with Minn. Stat. §§ 115.55	% of septic systems
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552) Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747) Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	Address livestock sources of fecal bacteria (see Table 33)	Maintain current feedlot and livestock inventory Open lot runoff management to meet 7020 rules Manure and other wastewater storage in ways that prevent runoff Proper management of open-air liquid swine manure storage areas Proper management of process wastewater from dairy operations, such as parlor wash down water, milk-house wastewater, and silage leachate and runoff from outdoor silage feed storage areas Proper stockpiling of poultry manure Provide outreach and education to animal agriculture producers and animal hobby farm owners	Current feedlot database	100% of feedlots in compliance with Minn. R. 7020	% feedlots

Waterbody (AUID)	Strategy Type	Strategy	Current Adoption Level (if known)	Suggested Goal	Units
Minnesota River, Cherry Creek to High Island Creek (07020012-799) Minnesota River, High Island Creek to Carver Creek (07020012-800)	Address livestock sources of fecal bacteria (see Table 33), continued	Increase livestock exclusion on tributaries to Minnesota River Limit winter land application of manure, especially late winter during periods of snow melt (Feb–March) Improve and expand riparian buffers adjacent to pasture and hay lands Encourage rotational grazing			
All	Education and outreach	Continued implementation of a watershed and water quality education and outreach program focused on: Agricultural producers Septic system maintenance and compliance Riparian users/owners Municipal operations Stakeholders and residents	–	Ongoing	# of outreach efforts

8.6 Adaptive Management

The implementation strategy focuses on adaptive management (Figure 22) to ensure management decisions are based on the most recent knowledge. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the strategy is inadequate or ineffective. Continued monitoring and course corrections responding to monitoring results are the most appropriate strategy for attaining the water quality goals established in this TMDL.

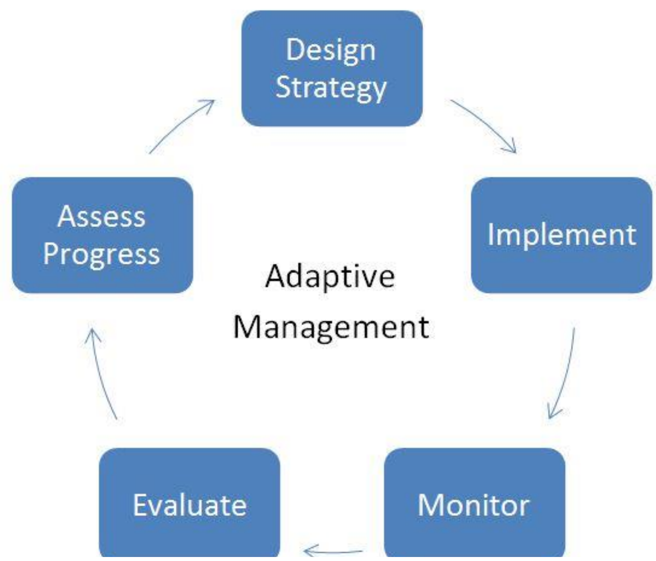

Figure 22. Adaptive management process.

Natural resource management involves a temporal sequence of decisions (or implementation actions), in which the best action at each decision point depends on the state of the managed system (Williams et al. 2009). As a structured iterative implementation process, adaptive management offers the flexibility for responsible parties to monitor implementation actions, determine the success of such actions, and ultimately, base management decisions upon the measured results of completed implementation actions and the current state of the system. This process enhances the understanding and estimation of predicted outcomes and ensures refinement of necessary activities to better guarantee desirable results. In this way, understanding of the resource can be enhanced over time and management can be improved (Williams et al. 2009).

Implementation will be conducted using an adaptive management approach. Changes in technology, research, weather, and other variables may alter the course of action. Continued monitoring and adjustments responding to monitoring results are the most appropriate strategy for attaining the water quality targets established in this TMDL.

8.7 Cost

TMDLs are required to include an overall approximation of implementation costs (Minn. Stat. 2007, § 114D.25). The costs to implement the activities outlined in the strategy are approximately $4 million to $10 million dollars over the next 20 years. This range reflects the level of uncertainty inherent in any fecal bacteria source assessment, and addresses the high priority sources identified in Section 3.4. The cost includes increasing local capacity to oversee implementation in the watershed and the voluntary actions needed to achieve reductions. Compliance costs for feedlots, septics, and buffer installation are an additional $15 to $30 million.

9. Public Participation

The TMDL project focus area is a relatively small portion of the entire watershed area of the impairments addressed in this report (Figure 2). Individual public participation efforts were previously conducted for the reaches in the watersheds with approved *E. coli*/fecal coliform TMDLs. To provide an opportunity for public participation that addresses the TMDL project focus area of this project, a draft of this TMDL report was made available for an informal comment period and communicated via three MPCA e-newsletters in July and August of 2018: Watershed Connections, Waterfront Bulletin and Agricultural Stewardship: Land Water, Livestock. Collectively, these newsletters reach over 5000 people.

An opportunity for public comment on this draft TMDL report was provided via a public notice in the *State Register* from February 4, 2019, through March 6, 2019. The MPCA received three comment letters during the public notice period. The MPCA revised the TMDL report based on some of the comments received and mailed responses to the commenters on May 3, 2019.

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Appendix A. Minnesota River Basin tributaries with *E. coli*/fecal coliform impairments

Table 37. Minnesota River Basin tributaries with *E. coli*/fecal coliform impairments

Reaches are listed in order from upstream to downstream.

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Minnesota River Headwaters	07020001-508	Little Minnesota River	MN/SD border to Big Stone Lake	Not completed
	07020001-541	Unnamed creek	Unnamed creek to Big Stone Lake	Not completed
	07020001-571	Fish Creek	Headwaters to CSAH 33	Not completed
	07020001-504	Unnamed creek (West Salmonsen Creek)	Unnamed creek to Big Stone Lake	Not completed
	07020001-568	Unnamed creek (Meadowbrook Creek)	340th St to Big Stone Lake	Not completed
	07020001-536	Stony Run Creek	Long Tom Lake to Unnamed creek	Not completed
	07020001-531	Stony Run Creek	Unnamed creek to Minnesota River	Not completed
	07020001-551	Unnamed creek	Headwaters to S Fork Yellow River	Not completed
	07020001-526	Yellow Bank River, South Fork	MN/SD border to N Fork Yellow Bank River	Approved TMDL
	07020001-510	Yellow Bank River, North Fork	MN/SD border to Yellow Bank River	Approved TMDL
	07020001-525	Yellow Bank River	N Fork Yellow Bank River to Minnesota River	Approved TMDL
	07020001-570	Unnamed creek	CSAH 38 to Marsh Lake	Not completed
	07020001-521	Unnamed creek (Five Mile Creek)	Unnamed creek to Marsh Lake	Not completed
	07020001-547	Emily Creek	Unnamed creek to Lac Qui Parle Lake	Not completed
Pomme de Terre River	07020002-556	Dry Wood Creek	Dry Wood Lake to Pomme de Terre River	Approved TMDL
	07020002-501	Pomme de Terre River	Muddy (Mud) Creek to Minnesota River (Marsh Lake)	Approved TMDL
Lac qui Parle River	07020003-530	Unnamed creek	Unnamed creek to Lac Qui Parle River	Not completed
	07020003-505	Lac qui Parle River	Headwaters (Lake Hendricks 41-0110-00) to Lazarus Creek (Canby Creek)	Approved TMDL
	07020003-508	Lazarus Creek (Canby Creek)	Canby Creek to Lac Qui Parle River	Approved TMDL
	07020003-506	Lac qui Parle River	Lazarus Creek (Canby Creek) to W Br Lac Qui Parle River	Approved TMDL
	07020003-519	Lac qui Parle River, West Branch	MN/SD border to Lost Creek	Not completed
	07020003-517	Lost Creek	Crow Timber Creek to W Br Lac Qui Parle River	Not completed
	07020003-523	County Ditch 5	T118 R46W S23, north line to W Br Lac Qui Parle River	Not completed
	07020003-516	Lac qui Parle River, West Branch	Lost Creek to Florida Creek	Approved TMDL

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Lac qui Parle River, continued	07020003-521	Florida Creek	MN/SD border to W Br Lac Qui Parle River	Approved TMDL
	07020003-580	Unnamed creek	-96.1517, 44.9533 to W Br Lac Qui Parle River	Not completed
	07020003-512	Lac qui Parle River, West Branch	Unnamed creek to Unnamed ditch	Approved TMDL
	07020003-513	Lac qui Parle River, West Branch	Unnamed ditch to Lac Qui Parle River	Not completed
	07020003-581	Unnamed ditch (County Ditch 4)	Unnamed ditch to CSAH 20	Not completed
	07020003-501	Lac qui Parle River	W Br Lac Qui Parle River to Tenmile Creek	Approved TMDL
	07020003-577	Tenmile Creek	Headwaters to CSAH 18	Approved TMDL
	07020003-578	Tenmile Creek	CSAH 18 to Lac Qui Parle River	Approved TMDL
	07020003-502	Lac qui Parle River	Tenmile Creek to Minnesota River	Not completed
Minnesota River–Yellow Medicine River	07020004-535	Stony Run Creek	T116 R40W S30, west line to Minnesota River	Approved TMDL
	07020004-534	Palmer Creek (County Ditch 68)	Headwaters to Minnesota River	Approved TMDL
	07020004-536	Hazel Creek	Unnamed creek to Minnesota River	Approved TMDL
	07020004-545	Unnamed creek	Headwaters to Yellow Medicine River	Approved TMDL
	07020004-584	Yellow Medicine River	Headwaters to Mud Creek	Approved TMDL
	07020004-543	Mud Creek	Headwaters to T114 R43W S35, south line	Approved TMDL
	07020004-600	Unnamed creek	CD 34 to CD 35	Approved TMDL
	07020004-550	Judicial Ditch 29	T111 R44W S16, south line to S Br Yellow Medicine River	Approved TMDL
	07020004-595	Unnamed creek	Headwaters to Unnamed creek	Approved TMDL
	07020004-597	Unnamed creek	Unnamed creek to Unnamed creek	Approved TMDL
	07020004-599	Unnamed creek	Unnamed creek to S Br Yellow Medicine River	Approved TMDL
	07020004-503	Yellow Medicine River, South Branch (County Ditch 35)	Headwaters to Yellow Medicine River	Approved TMDL
	07020004-513	Yellow Medicine River	S Br Yellow Medicine River to Spring Creek	Approved TMDL
	07020004-538	Spring Creek	Headwaters to Yellow Medicine River	Approved TMDL
	07020004-622	Judicial Ditch 17	CD 3 to Yellow Medicine River	Approved TMDL
	07020004-568	Hawk Creek	Unnamed creek to Unnamed creek	Approved TMDL
	07020004-689	County Ditch 11	Unnamed ditch to Hawk Creek	Approved TMDL
	07020004-589	Unnamed ditch	Chetomba Creek to Spring Creek	Approved TMDL

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Minnesota River–Yellow Medicine River, continued	07020004-587	Hawk Creek	Spring Creek to Minnesota River	Approved TMDL
	07020004-547	Judicial Ditch 10 (Wood Lake Creek)	Wood Lake outlet to Minnesota River	Approved TMDL
	07020004-648	Unnamed creek (County Ditch 119)	Unnamed creek to Minnesota River	Approved TMDL
	07020004-555	Boiling Spring Creek	T114 R37W S20, west line to Minnesota River	Approved TMDL
	07020004-526	Sacred Heart Creek	Headwaters to Minnesota River	Approved TMDL
	07020004-525	Timms Creek	Headwaters to Minnesota River	Approved TMDL
	07020004-615	Middle Creek	CD 120 to Minnesota River	Approved TMDL
	07020004-617	Smith Creek (County Ditch 125A)	T113 R35W S4, north line to Minnesota River	Approved TMDL
	07020004-530	Beaver Creek, West Fork	Headwaters to E Fork Beaver Creek	Approved TMDL
	07020004-586	Beaver Creek, East Fork	T115 R35W S35, north line to W Fork Beaver Creek	Approved TMDL
	07020004-528	Beaver Creek	E Fork Beaver Creek to Minnesota River	Approved TMDL
Chippewa River	07020005-503	Chippewa River	Stowe Lake to Little Chippewa River	Approved TMDL
	07020005-628	Trapper Run Creek	Strandness Lake to Pelican Lake	Approved TMDL
	07020005-713	Little Chippewa River	Unnamed creek to CD 2	Approved TMDL
	07020005-523	Outlet Creek	Lake Minnewaska to Lake Emily	Approved TMDL
	07020005-505	Chippewa River	Unnamed creek to E Br Chippewa River	Approved TMDL
	07020005-515	Chippewa River, East Branch	Headwaters (Amelia Lake 61-0064-00) to Mud Creek	Approved TMDL
	07020005-554	Mud Creek	CD 15 to E Br Chippewa River	Approved TMDL
	07020005-518	Mud Creek	T121 R39W S2, south line to E Br Chippewa River	Approved TMDL
	07020005-514	Chippewa River, East Branch	Mud Creek to Chippewa River	Approved TMDL
	07020005-579	County Ditch 3	CD 7 to Chippewa River	Approved TMDL
	07020005-506	Chippewa River	E Br Chippewa River to Shakopee Creek	Approved TMDL
	07020005-570	County Ditch 27	Unnamed ditch to Unnamed ditch	Approved TMDL
	07020005-567	County Ditch 29	Headwaters to Unnamed ditch	Approved TMDL
	07020005-566	Unnamed ditch (Judicial Ditch 29)	Headwaters to CD 29	Approved TMDL
	07020005-917	Unnamed creek (Huse Creek)	Headwaters to Norway Lake	Approved TMDL
	07020005-557	Shakopee Creek	Swan Lake to Shakopee Lake	Approved TMDL
	07020005-559	Shakopee Creek	Shakopee Lake to Chippewa River	Approved TMDL

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Chippewa River, continued	07020005-511	Cottonwood Creek	T120 R41W S21, west line to Chippewa River	Approved TMDL
	07020005-508	Chippewa River	Cottonwood Creek to Dry Weather Creek	Approved TMDL
	07020005-509	Dry Weather Creek	Headwaters to Chippewa River	Approved TMDL
	07020005-584	Unnamed creek	Unnamed creek to Chippewa River	Approved TMDL
	07020005-501	Chippewa River	Watson Sag to Minnesota River	Approved TMDL
Redwood River	07020006-512	Judicial Ditch 12 (Tyler Creek)	CD 14 to Redwood River	Approved TMDL
	07020006-505	Redwood River	Headwaters to Coon Creek	Approved TMDL
	07020006-511	Coon Creek	Lake Benton to Redwood River	Approved TMDL
	07020006-510	Redwood River	Coon Creek to T110 R42W S20, north line	Not completed
	07020006-502	Redwood River	T111 R42W S33, west line to Threemile Creek	Approved TMDL
	07020006-504	Threemile Creek	Headwaters to Redwood River	Approved TMDL
	07020006-506	Clear Creek	Headwaters to Redwood River	Approved TMDL
	07020006-509	Redwood River	Clear Creek to Redwood Lake	Approved TMDL
	07020006-501	Redwood River	Ramsey Creek to Minnesota River	Approved TMDL
Minnesota River–Mankato	07020007-569	Crow Creek	CD 52 to T112 R35W S2, north line	Not completed
	07020007-587	Birch Coulee Creek	JD 12 to Minnesota River	Not completed
	07020007-645	Purgatory Creek	Unnamed creek to Minnesota River	Not completed
	07020007-527	Wabasha Creek	T112 R34W S19, west line to Minnesota River	Not completed
	07020007-704	Threemile Creek	CD 140 to Minnesota River	Not completed
	07020007-644	Unnamed creek	Unnamed creek to Minnesota River	Not completed
	07020007-689	Fort Ridgley Creek	T112 R33W S24, north line to Minnesota River	Not completed
	07020007-622	Spring Creek (Judicial Ditch 29)	T111 R33W S23, west line to T111 R33W S23, east line	Not completed
	07020007-573	Spring Creek	T111 R32W S21, west line to Minnesota River	Not completed
	07020007-712	County Ditch 13	245th Ave to Minnesota River	Not completed
	07020007-571	County Ditch 10 (John's Creek)	T110 R32W S1, west line to Minnesota River	Not completed
	07020007-687	Little Rock Creek (Judicial Ditch 31)	Mud Lake to Minnesota River	Not completed
	07020007-684	Eightmile Creek	366th St/T-39 to Minnesota River	Not completed
	07020007-641	Huelskamp Creek	Unnamed creek to Minnesota River	Not completed

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Minnesota River–Mankato, continued	07020007-709	Fritsche Creek (County Ditch 77)	-94.4172 44.3557 to Minnesota River	Not completed
	07020007-640	Heyman's Creek	Unnamed creek to Minnesota River	Not completed
	07020007-518	Altermatts Creek	T108 R34W S35, south line to Little Cottonwood River	Not completed
	07020007-676	Little Cottonwood River	Headwaters to T109 R31W S22, north line	Not completed
	07020007-677	Little Cottonwood River	T109 R31W S15, south line to Minnesota River	Not completed
	07020007-691	Morgan Creek	T109 R29W S30, south line to Minnesota River	Not completed
	07020007-683	Swan Lake Outlet (Nicollet Creek)	CD 39 to Minnesota River	Not completed
	07020007-557	County Ditch 56 (Lake Crystal Inlet)	Headwaters to Lake Crystal	Not completed
	07020007-534	Minneopa Creek	T108 R28W S23, south line to Minnesota River	Not completed
	07020007-604	Unnamed creek	Headwaters to Unnamed creek	Not completed
	07020007-603	Unnamed creek	Unnamed creek to Unnamed creek	Not completed
	07020007-602	Unnamed creek	Headwaters to Unnamed creek	Not completed
	07020007-600	Unnamed creek	Unnamed creek to Unnamed creek	Not completed
	07020007-598	Unnamed ditch	Unnamed creek to underground pipe	Not completed
	07020007-679	County Ditch 46A	-94.0803 44.2762 to Sevenmile Creek	Not completed
	07020007-703	Sevenmile Creek	MN Hwy 99 to CD 46A	Not completed
	07020007-637	Unnamed creek (Sevenmile Creek Tributary)	Headwaters to T109 R27W S15, north line	Not completed
	07020007-562	Sevenmile Creek	T109 R27W S4, north line to Minnesota River	Not completed
	07020007-693	Shanaska Creek	Shanaska Creek Rd to Minnesota River	Not completed
	07020007-613	Rogers Creek (County Ditch 78)	CD 21 to Unnamed creek	Not completed
Cottonwood River	07020008-515	Meadow Creek	Headwaters to Cottonwood River	Approved TMDL
	07020008-524	Lone Tree Creek	T109 R39W S7, west line to Cottonwood River	Approved TMDL
	07020008-516	Plum Creek (Judicial Ditch 20A)	Headwaters to Cottonwood River	Approved TMDL
	07020008-504	Cottonwood River	Plum Creek to Dutch Charley Creek	Approved TMDL
	07020008-517	Dutch Charley Creek	Highwater Creek to Cottonwood River	Approved TMDL
	07020008-508	Cottonwood River	Coal Mine Creek to Sleepy Eye Creek	Approved TMDL
	07020008-512	Sleepy Eye Creek	Headwaters to Cottonwood River	Approved TMDL

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Cottonwood River, continued	07020008-501	Cottonwood River	JD 30 to Minnesota River	Approved TMDL
Blue Earth River	07020009-504	Blue Earth River	W Br Blue Earth River to Coon Creek	Approved TMDL
	07020009-527	Dutch Creek	Headwaters to Hall Lake	Approved TMDL
	07020009-526	Center Creek	George Lake to Lily Creek	Approved TMDL
	07020009-525	Lily Creek	Headwaters (Fox Lake 46-0109-00) to Center Creek	Approved TMDL
	07020009-503	Center Creek	Lily Creek to Blue Earth River	Approved TMDL
	07020009-522	Elm Creek	S Fork Elm Creek to Cedar Creek	Approved TMDL
	07020009-560	Cedar Creek (Cedar Run Creek)	T104 R33W S6, west line to Cedar Lake	Approved TMDL
	07020009-521	Cedar Creek (Cedar Run Creek)	Cedar Lake to Elm Creek	Approved TMDL
	07020009-505	Judicial Ditch 3	Headwaters to Elm Creek	Approved TMDL
	07020009-502	Elm Creek	Cedar Creek to Blue Earth River	Approved TMDL
	07020009-509	Blue Earth River	Rapidan Dam to Le Sueur River	Approved TMDL
	07020009-501	Blue Earth River	Le Sueur River to Minnesota River	Approved TMDL
Watonwan River	07020010-566	Watonwan River	Headwaters to T107 R33W S33, east line	Approved TMDL
	07020010-567	Watonwan River	T107 R33W S34, west line to N Fork Watonwan River	Approved TMDL
	07020010-564	Watonwan River, North Fork	Headwaters to T107 R32W S6, east line	Not completed
	07020010-562	Watonwan River	N Fork Watonwan River to T107 R32W S13, east line	Approved TMDL
	07020010-563	Watonwan River	T107 R31W S18, west line to Butterfield Creek	Approved TMDL
	07020010-576	St James Creek	T106 R32W S25, west line to T106 R31W S19, north line	Not completed
	07020010-502	St James Creek	T106 R31W S18, south line to Butterfield Creek	Not completed
	07020010-516	Butterfield Creek	Headwaters to St James Creek	Not completed
	07020010-515	St James Creek	Butterfield Creek to Watonwan River	Not completed
	07020010-511	Watonwan River	Butterfield Creek to S Fork Watonwan River	Approved TMDL
	07020010-568	Watonwan River, South Fork	-94.8475 43.8813 to Irish Lake	Not completed
	07020010-581	Judicial Ditch 1	T105 R33W S8, west line to Irish Lake	Not completed
	07020010-517	Watonwan River, South Fork	Willow Creek to Watonwan River	Approved TMDL
	07020010-510	Watonwan River	S Fork Watonwan River to Perch Creek	Not completed

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Watonwan River, continued	07020010-574	Spring Branch Creek	T106 R30W S22, west line to Perch Creek	Not completed
	07020010-523	Perch Creek	Spring Creek to Watonwan River	Not completed
	07020010-501	Watonwan River	Perch Creek to Blue Earth River	Approved TMDL
Le Sueur River	07020011-516	Boot Creek	Unnamed creek to T105 R22W S6, north line	Approved TMDL
	07020011-507	Le Sueur River	CD 6 to Cobb River	Approved TMDL
	07020011-504	Little Cobb River	Bull Run Creek to Cobb River	Approved TMDL
	07020011-503	Unnamed creek (Little Beauford Ditch)	Headwaters to Cobb River	Approved TMDL
	07020011-556	Cobb River	T107 R26W S30, west line to Le Sueur River	Approved TMDL
	07020011-531	Rice Creek	Headwaters to Maple River	Approved TMDL
	07020011-552	County Ditch 3 (Judicial Ditch 9)	JD 9 to Maple River	Approved TMDL
	07020011-534	Maple River	Rice Creek to Le Sueur River	Approved TMDL
	07020011-501	Le Sueur River	Maple River to Blue Earth River	Approved TMDL
Lower Minnesota River	07020012-602	Barney Fry Creek	CD 47A to CD 35	Not completed [a]
	07020012-824	Le Sueur Creek	W Prairie St to Forest Prairie Creek	Not completed [a]
	07020012-725	Forest Prairie Creek	CD 29 to Le Sueur Creek	Not completed [a]
	07020012-555	Rush River, North Branch (Judicial Ditch 18)	Headwaters to Titlow Lake	Not completed [a]
	07020012-714	County Ditch 18	CD 40 to Titlow Lake	Not completed [a]
	07020012-713	Unnamed ditch	Headwaters to Titlow Lake	Not completed [a]
	07020012-558	Rush River, North Branch (County Ditch 55)	Unnamed ditch to T112 R27W S17, east line	Not completed [a]
	07020012-550	Rush River, Middle Branch (County Ditch 23 and 24)	CD 42 to Rush River	Not completed [a]
	07020012-509	Judicial Ditch 1A	CD 40A to S Br Rush River	Not completed [a]
	07020012-825	Rush River, South Branch	Unnamed ditch to -94.0478 44.4761	Approved TMDL
	07020012-826	Rush River, South Branch	-94.0478 44.4761 to Rush River	Approved TMDL
	07020012-521	Rush River	S Br Rush River to Minnesota River	Approved TMDL
	07020012-761	Unnamed creek	Unnamed creek to JD 2	Not completed [a]
	07020012-756	Unnamed creek	Headwaters to Minnesota River	Not completed [a]

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Lower Minnesota River, continued	07020012-653	High Island Creek	JD 15 to Bakers Lake	Approved TMDL
	07020012-837	High Island Creek	Bakers Lake to -94.2538 44.6574	Approved TMDL
	07020012-838	High Island Creek	-94.2538 44.6574 to Unnamed creek	Approved TMDL
	07020012-833	High Island Creek	Unnamed creek to -94.0936 44.6181	Approved TMDL
	07020012-588	High Island Ditch 2	Unnamed creek to High Island Creek	Approved TMDL
	07020012-831	Buffalo Creek (County Ditch 59)	High Island Ditch 5 to 276th St /Co Rd 65	Approved TMDL
	07020012-832	Buffalo Creek	276th St /Co Rd 65 to High Island Creek	Approved TMDL
	07020012-834	High Island Creek	-94.0936 44.6181 to Minnesota River	Approved TMDL
	07020012-753	Unnamed creek	Headwaters to Unnamed creek	Not completed [a]
	07020012-749	Big Possum Creek	Unnamed creek to Minnesota River	Not completed [a]
	07020012-575	Robert Creek	Unnamed creek to Unnamed creek (at Belle Plaine Sewage Ponds)	Not completed [a]
	07020012-830	Unnamed creek (Brewery Creek)	US Hwy 169 to Minnesota River	Not completed [a]
	07020012-746	Unnamed creek	Headwaters to Unnamed creek	Not completed [a]
	07020012-843	Bevens Creek	Headwaters (Washington Lake 72-0017-00) to 154th St	Approved TMDL
	07020012-533	Unnamed ditch	T115 R26W S14, north line to CD 4A	Not completed [a]
	07020012-844	Bevens Creek	154th St to -93.8615 44.7265	Approved TMDL
	07020012-845	Bevens Creek	-93.8615 44.7265 to -93.8455 44.7327	Approved TMDL
	07020012-846	Bevens Creek	-93.8455 44.7327 to Unnamed creek	Approved TMDL
	07020012-847	Bevens Creek	Unnamed creek to -93.7156 44.7438	Approved TMDL
	07020012-848	Bevens Creek	-93.7156 44.7438 to Silver Creek	Approved TMDL
	07020012-812	Silver Creek	CD 32 to -93.769 44.687	Approved TMDL
	07020012-629	Judicial Ditch 22	Unnamed creek to Silver Creek	Not completed [a]
	07020012-813	Silver Creek	-93.769 44.687 to Bevens Creek	Approved TMDL
	07020012-514	Bevens Creek	Silver Creek to Minnesota River	Approved TMDL
	07020012-628	County Ditch 10	CD 3 to Raven Str	Not completed [a]
	07020012-842	Raven Stream, West Branch	270th St to E Br Raven Str	Not completed [a]
	07020012-716	Raven Stream	E Br Raven Str to Sand Creek	Not completed [a]
	07020012-817	Porter Creek	Langford Rd/MN Hwy 13 to Sand Creek	Not completed [a]

HUC8 Watershed	AUID	Reach Name	Reach Description	TMDL Status
Lower Minnesota River, continued	07020012-513	Sand Creek	Porter Creek to Minnesota River	Not completed [a]

[a] Impaired reaches in the Lower Minnesota River Watershed noted as "Not completed" are expected to have approved TMDLs within the time frame of this project; the watersheds of these reaches are *not* included in the TMDL focus area for this project. Other *E. coli* TMDLs throughout the Minnesota River Basin are also in progress but on a longer time line.

Appendix B. Minnesota River E. coli TMDL project focus area feedlots

Table 38. Feedlots located in the project focus area

County	Feedlot Name	Permit	Permit type	Primary animal type	AU	Subwatershed
Big Stone	Diekmann Farms Inc - Site 1	MNG440380	NPDES	Swine 55-300 lbs	1125	Barry Lake
	Diekmann Farms Inc - Site 3	MNG440371	NPDES	Swine 55-300 lbs	1350	Fish Creek
	Prairie Pride of Big Stone	MNG441299	NPDES	Swine >300 lbs	1687.5	Thielke Lake
	Prairie Pride of Big Stone	MNG441299	NPDES	Swine >300 lbs	1737.5	Thielke Lake
Blue Earth	Hoppe Finisher	MNG441766	NPDES	Swine 55-300 lbs	990	City of Mankato-Minnesota R
	Jones Farms Facility #1	MNG441942	NPDES	Swine 55-300 lbs	1440	Judicial Ditch No 48
	Lantz Enterprise Inc - Site 2	MNG441142	NPDES	Swine >300 lbs	1300	Judicial Ditch No 48
	Lantz Enterprise Inc – Site 3	NA	NA	Swine 55-300 lbs	750	Judicial Ditch No 48
	Multi-Site - TLP North & South	MNG441169	NPDES	Swine 55-300 lbs	720	Judicial Ditch No 48
	Multi-Site - TLP North & South	MNG441169	NPDES	Swine 55-300 lbs	720	Judicial Ditch No 48
Brown	BayCon Society Inc	MNG450031	SDS	Swine 55-300 lbs	1200	Morgan Creek
	Christensen Farms Sites C002	MNG440150	NPDES	Swine >300 lbs	1028	Spring Creek
	Christensen Farms Sites C006	MNG440150	NPDES	Swine >300 lbs	456	Spring Creek
	Christensen Farms Site C010	MNG440151	NPDES	Swine >300 lbs	1108	Morgan Creek
	Christensen Farms Site R002	NA	NA	Swine 55-300 lbs	840	County Ditch No 28-1
	Clyde Larson Farm - Sec 19	NA	NA	Swine 55-300 lbs	900	Morgan Creek
	Dean Schneider Farm	MNG450030	SDS	Swine 55-300 lbs	1582.8	Little Cottonwood R
	Eischen and Sons Farm	MNG441314	NPDES	Swine 55-300 lbs	990	County Ditch No 28-1
	Eric Helget Farm	NA	NA	Swine 55-300 lbs	936	Little Cottonwood River
	Helget Finisher	MNG440640	NPDES	Swine 55-300 lbs	900	Gilman Lake-Little Cottonwood R
	John Hillesheim Site F024	NA	NA	Swine 55-300 lbs	936	County Ditch No 10-MN R
	Krzmarzick Site 2	NA	NA	Swine 55-300 lbs	990	County Ditch No 10-MN R

County	Feedlot Name	Permit	Permit type	Primary animal type	AU	Subwatershed
Brown	Larson Turkeys	NA	NA	Turkeys >5 lbs	830	Morgan Creek
	Mark O Sletta Farm	MNG440360	NPDES	Swine 55-300 lbs	1248	Morgan Creek
	MT - Finishers	MNG450040	SDS	Swine 55-300 lbs	1800	Little Cottonwood R
	Nelson Finisher	MNG441322	NPDES	Swine 55-300 lbs	990	Morgan Creek
	Patrick Krzmarzick Farm 1	MNG440158	NPDES	Swine 55-300 lbs	1560	Co Ditch No 10-Minnesota R
	Patrick Mohr Farm - Sec 27	MNG440079	NPDES	Swine 55-300 lbs	1200	Morgan Creek
	Rathman's Inc	MNG440357	NPDES	Swine 55-300 lbs	1152	Gilman Lake-Little Cottonwood R
	Richard Maurer Farm	MNG441227	NPDES	Swine 55-300 lbs	1440	Spring Creek
	Robert Goblirsch Farm 2	MNG440641	NPDES	Swine 55-300 lbs	936	Little Cottonwood River
	Schieffert Finishing Old Site	MNG441348	NPDES	Swine 55-300 lbs	1575	Spring Creek
	Schneider Farm 2	MNG450178	SDS	Swine 55-300 lbs	1560	Little Cottonwood R
	Schwartz Farms Inc - Prairieville Site	MNG441244	NPDES	Swine 55-300 lbs	990	Spring Creek
	Schwartz Farms Inc - Stately 27	MNG440938	NPDES	Swine 55-300 lbs	900	Headwaters Little Cottonwood R
	Tews Farms	NA	NA	Beef Cattle	772	Headwaters Little Cottonwood Rr
	TJ Turkeys LLP	MNG440683	NPDES	Turkeys >5 lbs	1022	Morgan Creek
	Tom Byro Farm	NA	NA	Swine 55-300 lbs	900	Morgan Creek
Chippewa	Erick Meyer Farm	NA	NA	Swine 55-300 lbs	990	Judicial Ditch No 8
	STAK'D Pork LLC	MNG440127	NPDES	Swine 55-300 lbs	1080	Spring Creek
Cottonwood	Christensen Farms Site C011	MNG440062	NPDES	Swine >300 lbs	1200	County Ditch No 28-1
	Christensen Farms Site F137	NA	NA	Swine 55-300 lbs	936	County Ditch No 28-1
	Schwartz Farms Inc - Wolf	MNG440854	NPDES	Swine 55-300 lbs	900	Headwaters Little Cottonwood R
Lac qui Parle	Bellingham Farm	NA	NA	Swine 55-300 lbs	825	County Ditch No 3A
	Christensen Farms Site F146	MNG450054	SDS	Swine 55-300 lbs	1152	County Ditch No 34
	Lee Johnson Farm	MNG440431	NPDES	Swine 55-300 lbs	1248	Co Ditch No 34
	Wayne Dahl Hog Farm	MNG440446	NPDES	Swine 55-300 lbs	1715	Co Ditch No 34
	David Dahl Farm	MNG440868	NPDES	Swine 55-300 lbs	1430	Co Ditch No 34

County	Feedlot Name	Permit	Permit type	Primary animal type	AU	Subwatershed
Lac qui Parle	Jeffrey Abraham Farm - Sec 21	MNG440738	NPDES	Swine 55-300 lbs	1250	Co Ditch No 34
	Sundlee Pork Inc	MNG440970	NPDES	Swine >300 lbs	1778.4	Co Ditch No 90-Minnesota R
	Dane Prestholdt Farm	MNG440807	NPDES	Swine 55-300 lbs	1200	Co Ditch No 34
Le Sueur	Blue Sky Dairy LLC	MN0071145	NPDES	Dairy Cattle >1000 lbs	1505.8	Shanaska Creek
	Borgmeier Finisher Site	MNG441916	NPDES	Swine 55-300 lbs	1062	Shanaska Creek
	Pheasant Run Great Plains Family Farms Inc	MNG440163	NPDES	Swine >300 lbs	1384.6	Cherry Creek
Nicollet	Altmann Family Pork	MNG440034	NPDES	Swine 55-300 lbs	2112	City of New Ulm-Minnesota R
	Courtland Dairy LLC	MNG441235	NPDES	Dairy Cattle >1000 lb	1680	City of Courtland-Minnesota R
	Daniel Mages Farm - Sec 17	MNG440944	NPDES	Swine 55-300 lbs	900	Fritsche Creek
	Duane Hacker Farm - Sec 16	MNG450019	SDS	Swine 55-300 lbs	900	Fritsche Creek
	Granby Calf Ranch LLC	MNG441167	NPDES	Dairy Cattle - Calf	950.4	Middle Lake
	Jason Enter - Site 1	NA	NA	Swine 55-300 lbs	900	City of New Ulm-MN R
	Jason Enter - Site 2	NA	NA	Swine 55-300 lbs	900	City of New Ulm-MN R
	Jason Enter Site #3	NA	NA	Swine 55-300 lbs	900	City of New Ulm-MN R
	Jason and Michele Schroeder	NA	NA	Swine 55-300 lbs	900	City of Courtland-MN R
	Jonathan R Rewitzer Farm	MNG440774	NPDES	Swine 55-300 lbs	923.1	City of New Ulm-Minnesota R
	Josie's Pork Farm - Site 1	MNG450060	SDS	Swine 55-300 lbs	1792.5	Rogers Creek
	K & K Wenner Farms	MNG440772	NPDES	Swine 55-300 lbs	1200	Rogers Creek
	Lakeview Pork LLC	NA	NA	Swine 55-300 lbs	900	Swan Lake
	Martens Family Farm	MNG441251	NPDES	Swine 55-300 lbs	1191.6	City of New Ulm-Minnesota R
	MG Waldbaum/Michael Foods - Lake Prairie	MNG441044	NPDES	Chickens, Layers, <5 lbs	5760	City of Le Sueur-Minnesota R
	Michels Farms Inc - Sec 21	NA	NA	Swine 55-300 lbs	870	Sevenmile Creek
	Mike Vogel Farm - Sec 34	MNG450018	SDS	Swine 55-300 lbs	1125	Sevenmile Creek
	New Sweden Dairy	MNG441333	NPDES	Dairy Cattle <1000 lb	4943.7	Rogers Creek
	Northern Plains Dairy	MNG440992	NPDES	Dairy Cattle <1000 lb	3300	Sevenmile Creek
	Peichel 2 - Nicollet	MNG440194	NPDES	Swine 55-300 lbs	1560	Little Rock Creek

County	Feedlot Name	Permit	Permit type	Primary animal type	AU	Subwatershed
Nicollet	PJM Pork	MNG440546	NPDES	Swine 55-300 lbs	1500	City of New Ulm-Minnesota R
	Randy Reinhart Farm - Sec 21	MNG441890	NPDES	Swine 55-300 lbs	1923	City of New Ulm-Minnesota R
	Randy Reinhart Farm - Sec 26	MNG440193	NPDES	Swine 55-300 lbs	1900.8	City of New Ulm-Minnesota R
	Rebco Pork II	MNG441328	NPDES	Swine 55-300 lbs	1440	City of Courtland-Minnesota R
	Rebco Pork Inc	MNG450059	SDS	Swine >300 lbs	1130	City of Courtland-MN R
	Rebco Run LLC	NA	NA	Swine 55-300 lbs	990	Swan Lake Outlet
	Ryan Bode Farm	MNG450020	SDS	Swine 55-300 lbs	1200	Fritsche Creek
	Ryan Franta Farm	MNG441139	NPDES	Swine 55-300 lbs	1800	Fritsche Creek
	Svin Hus Inc	MNG440908	NPDES	Swine 55-300 lbs	1080	City of Mankato-Minnesota R
	Tim Harmening Farm	MNG440518	NPDES	Swine 55-300 lbs	1314	City of New Ulm-Minnesota R
	Timothy A. Waibel Farm	MNG440327	NPDES	Swine 55-300 lbs	1650	City of Courtland-Minnesota R
	Waibel Pork Inc	MNG440169	NPDES	Swine 55-300 lbs	1232.4	Swan Lake
	Wakefield Pork Inc - Prairieland Pork	MNG441168	NPDES	Swine >300 lbs	1112.5	Middle Lake
	Wayne Havemeier Farm - Sec 2	MNG441261	NPDES	Swine 55-300 lbs	900	Rogers Creek
	Wendinger Bryan 2	MNG440227	NPDES	Swine 55-300 lbs	1248	Fritsche Creek
	Wykson Growers LLC	MNG450017	SDS	Chickens, Layers, <5 lbs	975	Rogers Creek
Redwood	Christensen Farms Site F148	MNG450065	SDS	Swine 55-300 lbs	1200	Rice Creek
	Hacker Farms Inc	MNG440282	NPDES	Swine 55-300 lbs	1560	Judicial Ditch No 17
	Hentges Family Farm - Site 2	MNG441285	NPDES	Swine 55-300 lbs	990	Middle Creek-Minnesota R
	Jared Schiller Farm	MNG450001	SDS	Swine 55-300 lbs	1500	County Ditch No 64
	Jordan Hog Finishing Site	MNG440316	NPDES	Swine 55-300 lbs	1200	Rice Creek
	Kerkhoff Cattle Co Inc	MNG440763	NPDES	Beef Cattle	3740	Wabasha Creek
	Neitzel Pork Project	MNG440280	NPDES	Swine 55-300 lbs	1200	Wabasha Creek
	Neitzel Pork Project - Site 2	NA	NA	Swine 55-300 lbs	990	County Ditch No 109
	Polesky Site 2	MNG440395	NPDES	Swine 55-300 lbs	1440	Co Ditch No 109
	Polesky Site 3	MNG440394	NPDES	Swine 55-300 lbs	1140	Judicial Ditch No 17

County	Feedlot Name	Permit	Permit type	Primary animal type	AU	Subwatershed
Redwood	R & J Feedlot	NA	NA	Swine 55-300 lbs	900	Crow Creek
Renville	Christensen Farms Site C042	MNG441070	NPDES	Swine >300 lbs	1458	Co Ditch No 124
	Christensen Farms Site NF002 Finisher	MNG441071	NPDES	Swine 55-300 lbs	2688	County Ditch No 124
	Erickson Brothers	MNG440393	NPDES	Swine 55-300 lbs	1152	County Ditch No 124
	F155 Greenslit	NA	NA	Swine 55-300 lbs	990	Purgatory Creek
	Jerry R Weldy Farm	MNG440844	NPDES	Swine 55-300 lbs	768	Purgatory Creek
	JR Pork	MNG441781	NPDES	Swine 55-300 lbs	900	Fort Ridgely Creek
	KNK Farms - Site 1	NA	NA	Swine 55-300 lbs	936	County Ditch No 106A
	KNK Farms - Site 2 - N	MNG440243	NPDES	Swine 55-300 lbs	1200	County Ditch No 106A
	KNK Farms - Site 3	NA	NA	Swine 55-300 lbs	936	Co Ditch 106A
	Lee Farms Inc	MNG440503	NPDES	Swine 55-300 lbs	1300	Threemile Creek-Minnesota R
	Nosbush Dairy LLP	MNG441342	NPDES	Dairy Cattle >1000 lb	1631.6	Fort Ridgely Creek
	RBS LLP Site F128	NA	NA	Swine 55-300 lbs	990	Purgatory Creek
	Revier Cattle Co Inc	MNG440929	NPDES	Beef Cattle	10500	County Ditch No 124
	Revier Feedlot Inc	MN0066311	NPDES	Beef Cattle	4270	County Ditch No 124
	Rieke Farms Inc	MNG440429	NPDES	Swine 55-300 lbs	1200	Little Rock Creek
	Tim Schweiss Farm	MNG440770	NPDES	Swine 55-300 lbs	900	Co Ditch No 34
	Willmar Poultry Farms Inc - Green	MNG440457	NPDES	Turkeys >5 lbs	1150	Birch Coulee Creek
	Willmar Poultry Farms - Wilson	MNG441118	NPDES	Turkeys >5 lbs	1190	City of Morton-Minnesota R
Sibley	Bode Dairy and Feedlots Co - Sec 7	MNG441269	NPDES	Dairy Cattle >1000 lb	1611.4	Judicial Ditch No 8
	Larry Baumgardt Farm - Sibley Site	MNG450160	SDS	Swine 55-300 lbs	1200	Judicial Ditch No 8
	Peichel 1 - Sibley	MNG440130	NPDES	Swine 55-300 lbs	1298	Eightmile Creek
	Twin Pine Farms LLP	MNG442009	NPDES	Swine >300 lbs	1162	Judicial Ditch No 8
Swift	Jennie-O Turkey Store - Commerford Brood	MNG440107	NPDES	Turkeys >5 lbs	2937.78	Judicial Ditch No 8

County	Feedlot Name	Permit	Permit type	Primary animal type	AU	Subwatershed
Swift	Jennie-O Turkey Store - Swenson	MNG440107	NPDES	Turkeys >5 lbs	2937.78	Judicial Ditch No 8
Traverse	Zych Feedlot Inc	MNG441954	NPDES	Beef Cattle	1427	City of Beardsley
Yellow Medicine	Paul Kvistad Poultry	MNG441052	NPDES	Turkeys >5 lbs	920	Co Ditch No 104-Minnesota R
	Pederson Pork Farm	MNG441085	NPDES	Swine 55-300 lbs	1350	Co Ditch No 2-Minnesota R