Escherichia coli BACTERIA TOTAL MAXIMUM DAILY LOAD EVALUATION FOR PLATTE CREEK CHARLES MIX COUNTY, SOUTH DAKOTA

South Dakota Department of Agriculture and Natural Resources

Division of Resource Conservation and Forestry

Watershed Protection Program

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Acronym List

Acronym	Definition
ARSD	Administrative Rules of South Dakota
AFO	Animal Feeding Operation
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
cfs	Cubic Feet Per Second
CFU	Colony Forming Unit
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DANR	Department of Agriculture & Natural Resources (South Dakota)
DMR	Discharge Monitoring Reports
EPA	Environmental Protection Agency (U.S.)
GM	Geometric Mean
HUC	Hydrologic Unit Code
IR	Integrated Report (South Dakota's Water Quality Integrated Report)
LA	Load Allocation
LDC	Load Duration Curve
mL	Milliliter
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
NASS	National Agricultural Statistic Survey
NPDES	National Pollutant Discharge Elimination System
SDSWQS	South Dakota Surface Water Quality Standards
SSM	Single Sample Maximum
SWPPP	Stormwater Pollution Protection Plan
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WLA	Wasteload Allocation
WPP	Watershed Protection Program (South Dakota)
WQM	Water Quality Monitoring

Platte Creek Total Maximum Daily Load Summary

Waterbody Type:	River/Stream
Reach Number:	SD-MI-R-PLATTE_01_USGS
303(d) Listing Parameter:	Pathogens (*Escherichia coli*)
Designated Uses of Concern:	Immersion Recreation
Location:	Platte Lake to Missouri River
Size of Impaired Waterbody:	SD-MI-R-PLATTE_01_USGS – Approx.16.1 miles

Size of Watershed:

HUC 12	Acres
101401011306	18,348
101401011307	21,357
101401011308	22,268
Total	~ 61,975

Indicator(s):	Concentration of *Escherichia coli* (colony forming units per 100 milliliters [mL])
Analytical Approach:	Load Duration Curve Framework
TMDL Priority Ranking:	Priority 1 (2026 Integrated Report [IR])
Target (Water Quality Standards):	*Escherichia coli* (*E. coli*) - single sample maximum concentration of ≤ 235 CFU/100mL and a geometric mean of ≤ 126 CFU/100mL based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period.

Total Maximum Daily Load Summary

Immersion Recreation *E. coli* TMDL	SD-MI-R-PLATTE_01_USGS TMDL Table				
	High Flows	Moist Conditions	Mid-Range Conditions	Dry Conditions	Low Flows
Flow Rate	≤ 10.0%	10 - 40.0%	40 - 60%	60 - 90%	≥ 90.0%
WLA - City of Platte	1.17E+10	1.17E+10	1.17E+10	9.90E+09	1.13E+09
10% Margin of Safety	1.22E+12	1.45E+11	6.03E+09	1.50E+09	1.71E+08
LA	1.09E+13	1.30E+12	4.26E+10	6.00E+09	6.85E+08
TMDL @ 235 cfu/day	1.22E+13	1.45E+12	6.03E+10	1.50E+10	1.71E+09
Current Load	9.73E+14	2.62E+13	2.16E+12	9.23E+10	3.41E+10
Load Reduction	99%	94%	97%	84%	95%

1.0 Document Summary

The Environmental Protection Agency (EPA) delegates authority to the South Dakota Department of Agriculture and Natural Resources (SD DANR) in accordance with Section 303(d) of the federal Clean Water Act (CWA), to develop impaired waters lists and Total Maximum Daily Load (TMDL) reports for waters that do not meet water quality standards. The intent of this document is to clearly identify the components of the TMDL process and facilitate EPA review and approval. This TMDL addresses the *Escherichia coli (E. coli)* bacteria impairment in Platte Creek identified as SD-MI-R-PLATTE_01_USGS.

SD-MI-R-PLATTE_01_USGS was considered high priority for TMDL development in the 2026 Integrated Report for Surface Water Quality Assessment (IR). SD-MI-R-PLATTE_01_USGS was first listed in the 2020 IR. The impaired waterbody begins at Platte Lake located in Charles Mix County, South Dakota extending until its confluence with the Missouri River at Lake Francis Case (SD-MI-R-FRANCIS_CASE_01).

The SD-MI-R-PLATTE_01_USGS *E. coli* TMDL report will include general information on the pollutant of concern, watershed characteristics, applicable South Dakota water quality standards, source assessment of possible pollutant sources in the watershed, and implementation guidance for water quality improvement projects.

1.1 *E. coli* Summary

Escherichia coli (E. coli) bacteria are the most abundant coliform bacteria present in human and animal intestines. Their presence can be attributed primarily to fecal origin, and their presence in water can be an indication of recent contamination. The presence of *E. coli* pathogens in a waterway can impair the waterbody's recreation beneficial uses and put humans at risk for contracting water-borne illnesses. Common sources of pathogens include sources from agricultural practices, failing or malfunctioning septic systems, confined feedlots, and wildlife. Pathogenic bacteria (*E. coli*) enter surface waters through runoff events, snowmelt, or are deposited directly into the waterway. *E. coli* production in SD-MI-R-PLATTE_01_USGS is attributable to both naturally occurring and human-caused sources.

In this TMDL, immersion recreation is the most stringent *E. coli* standard for the SD-MI-R-PLATTE_01_USGS beneficial uses. An *E. coli* reduction is needed in all flow zones to meet the TMDL. To comply with the *E. coli* water quality standards, agricultural implementation projects need to be introduced to mitigate and control *E. coli* concentrations within the SD-MI-R-PLATTE_01_USGS watershed.

2.0 Watershed Characteristics

In this section of the TMDL, watershed characteristics including drainage area, geology and soil, demographics, and land cover for segment SD-MI-R-PLATTE_01_USGS will be referenced. The drainage area determines water volume and distribution, while geology and soil type influence runoff patterns and infiltration. Demographics highlight human activities impacting land use and water quality, and land cover affects water retention, erosion, and biodiversity.

2.1 Drainage Area

SD-MI-R-PLATTE_01_USGS is a 16.1-mile stream segment that begins near Platte, SD in the southcentral region of South Dakota, where it flows to Highway 1804 and meets its confluence with the Missouri River at Lake Francis Case (SD-MI-R-FRANCIS_CASE_01). The total drainage area of SD-MI-R-PLATTE_01_USGS and its tributaries include three Hydrologic Unit Codes (HUCs): HUC 12 – 101401011308, HUC 12 – 101401011306, and HUC – 101401011307 and is approximately 61,975 acres (***Figure 1***). The total drainage area that contributes flow to United States Geological Survey (USGS) gage 06452320, encompasses approximately 747.38 square miles (478,323 acres) and was delineated using the USGS StreamStats tool.[1]

Several tributaries of the SD-MI-R-PLATTE_01_USGS watershed including Edgerton and Castalia are not sampled. Insufficient data from both creeks result in the unknown status of *E. coli* impairment. SD-MI-R-PLATTE_01_USGS meets the main river channel of the Missouri River at SD-MI-R-FRANCIS_CASE_01 which is not considered impaired for *E. coli* as reported in the 2026 IR.

[1] https://streamstats.usgs.gov/ss/

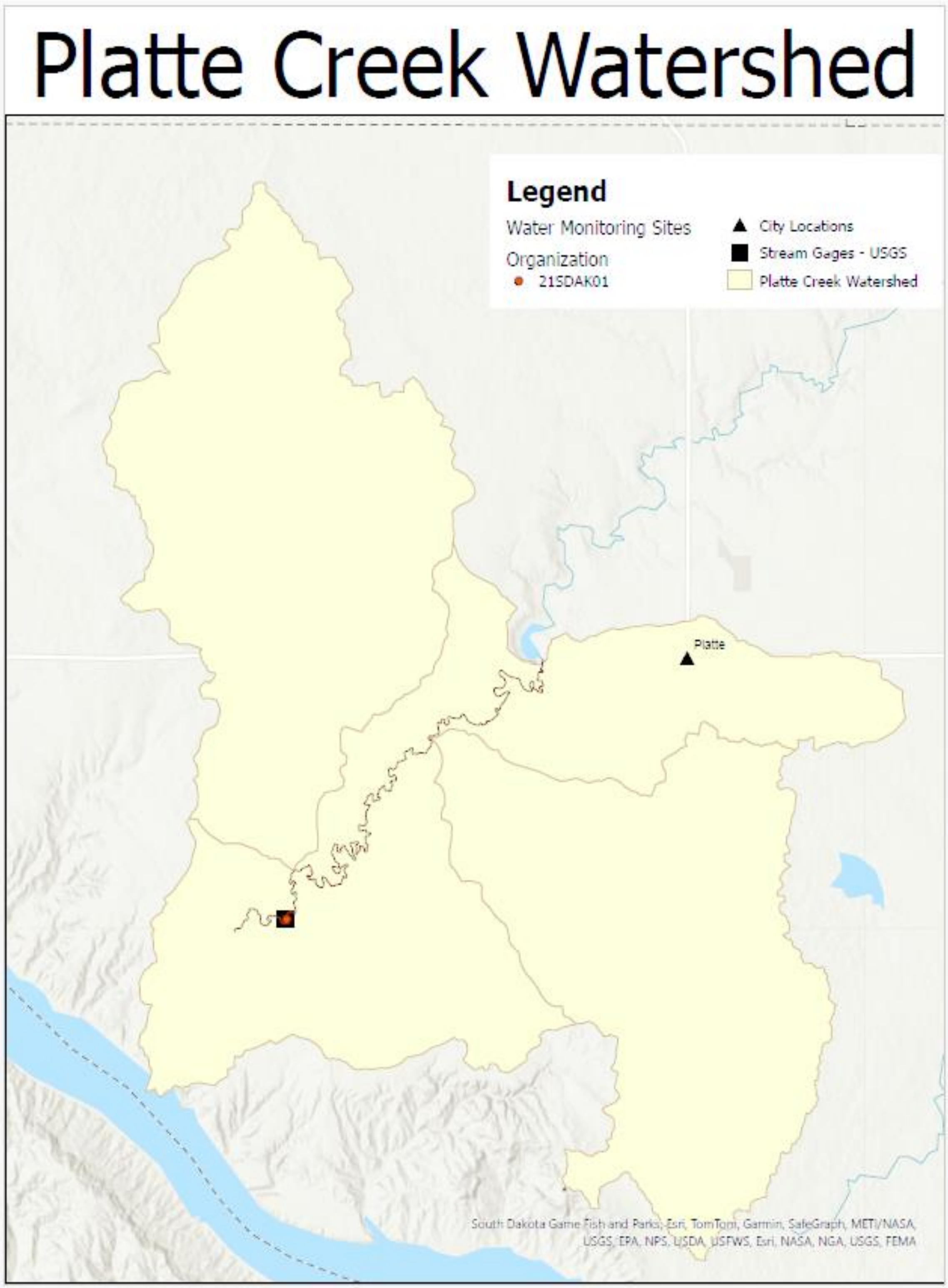

Figure 1 *- Platte Creek Watershed.*

2.2 Ecoregion

The SD-MI-R-PLATTE_01_USGS watershed is part of the Level I Great Plains Ecoregion, more specifically the [Level III Northwestern Glaciated Plains Ecoregion](). This region lies between the Northern Glaciated Plains, which are typically flatter, wetter, and more conducive to agriculture, and the Northwestern Great Plains, which are more rugged and drier. The landscape features rolling hills and gentle plains, predominantly covered by moraine, outwash, and glaciolacustrine sediments (Wiken et. al, 2011). The watershed predominantly contains fertile mollisol soils, but there are traces of entisols and inceptisols near the confluence with the Missouri River (***Figure 2***).

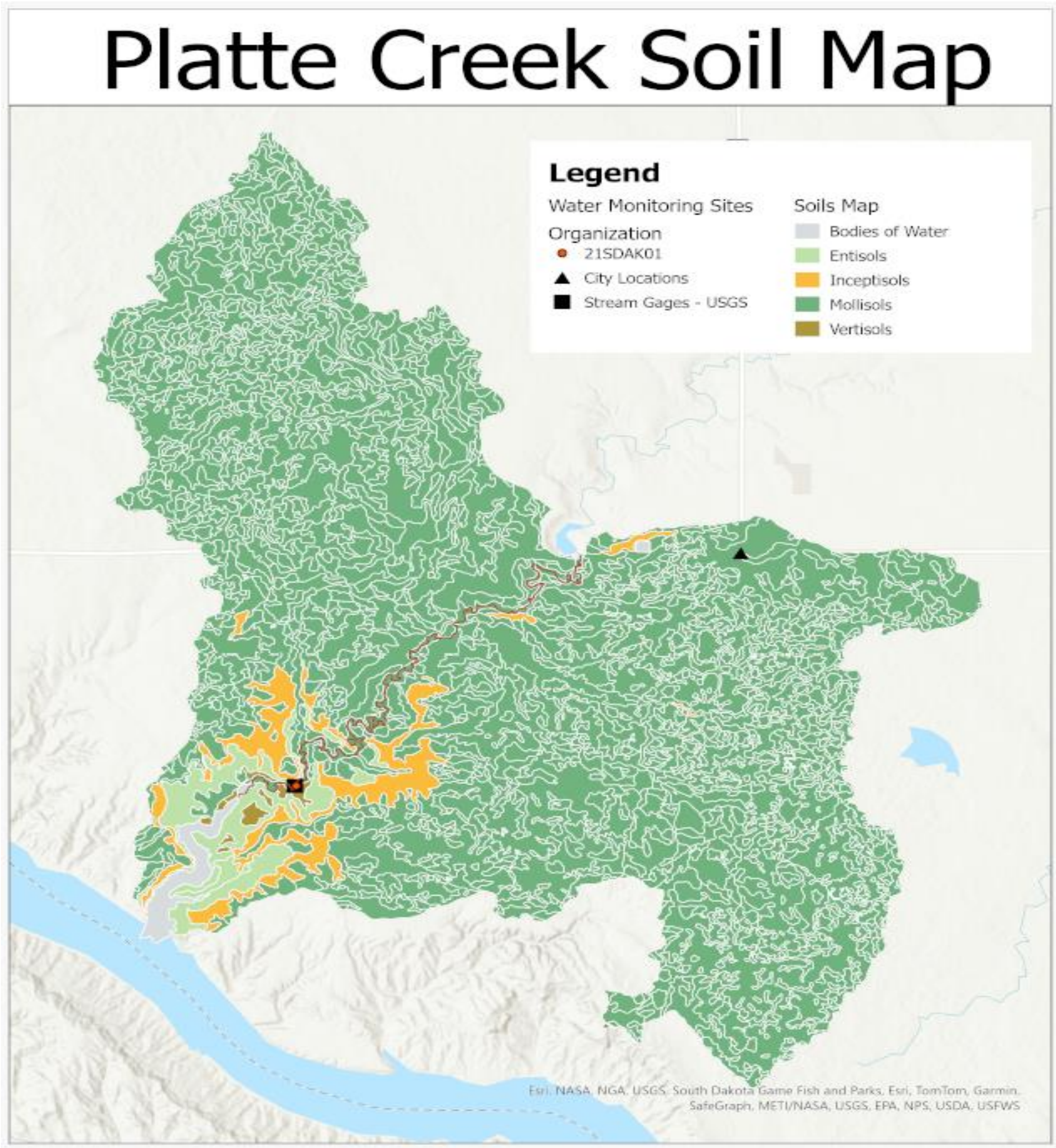

***Figure 2** - Platte Creek Watershed Soil Map.*

2.3 Demographics

The SD-MI-R-PLATTE_01_USGS watershed is in Charles Mix County. The associated town and populations within the watershed were gathered from the 2020 U.S Census Bureau data. Charles Mix County has an estimated population of 9,382 individuals, with 1,296 of those individuals residing in Platte, South Dakota. Charles Mix County covers 1,097 square miles and has a population density of approximately nine individuals per square mile (U.S Census Bureau, 2020). The SD-MI-R-PLATTE_01_USGS watershed spans approximately 97 square miles within the county, so it is estimated that 873 individuals reside in the watershed area (97 square miles of watershed × nine individuals per square mile). However, because Platte, SD is located within the SD-MI-R-PLATTE_01_USGS watershed boundaries and has a population of 1,296 individuals, this population estimate will be used to more accurately describe human *E. coli* contribution within the watershed.

2.4 Land Cover

The surrounding land in the SD-MI-R-PLATTE_01_USGS watershed consists of highly fertile soil, which is predominately utilized for agriculture and rangeland for cattle grazing. Cropland is scattered throughout the northern and eastern portions of the watershed, where land is primarily dedicated to the cultivation of soybeans, corn, and alfalfa. The rolling hills, which are part of the floodplain adjacent to the stream segment, are predominantly covered with herbaceous vegetation, which may be utilized for grazing and provide cover for local wildlife. In addition to agricultural uses, there are several animal feeding operations (AFOs) within the watershed, with beef and swine being the primary livestock products. These operations have the potential to contribute nutrients, such as nitrogen and phosphorus, and contaminants such as *E. coli* to surface waters if runoff or unauthorized discharges occur. The developed area in the watershed is primarily represented by the City of Platte, which serves as the largest urban center within the watershed boundaries. The extent of the developed land in this area is shown in ***Figure 3***.

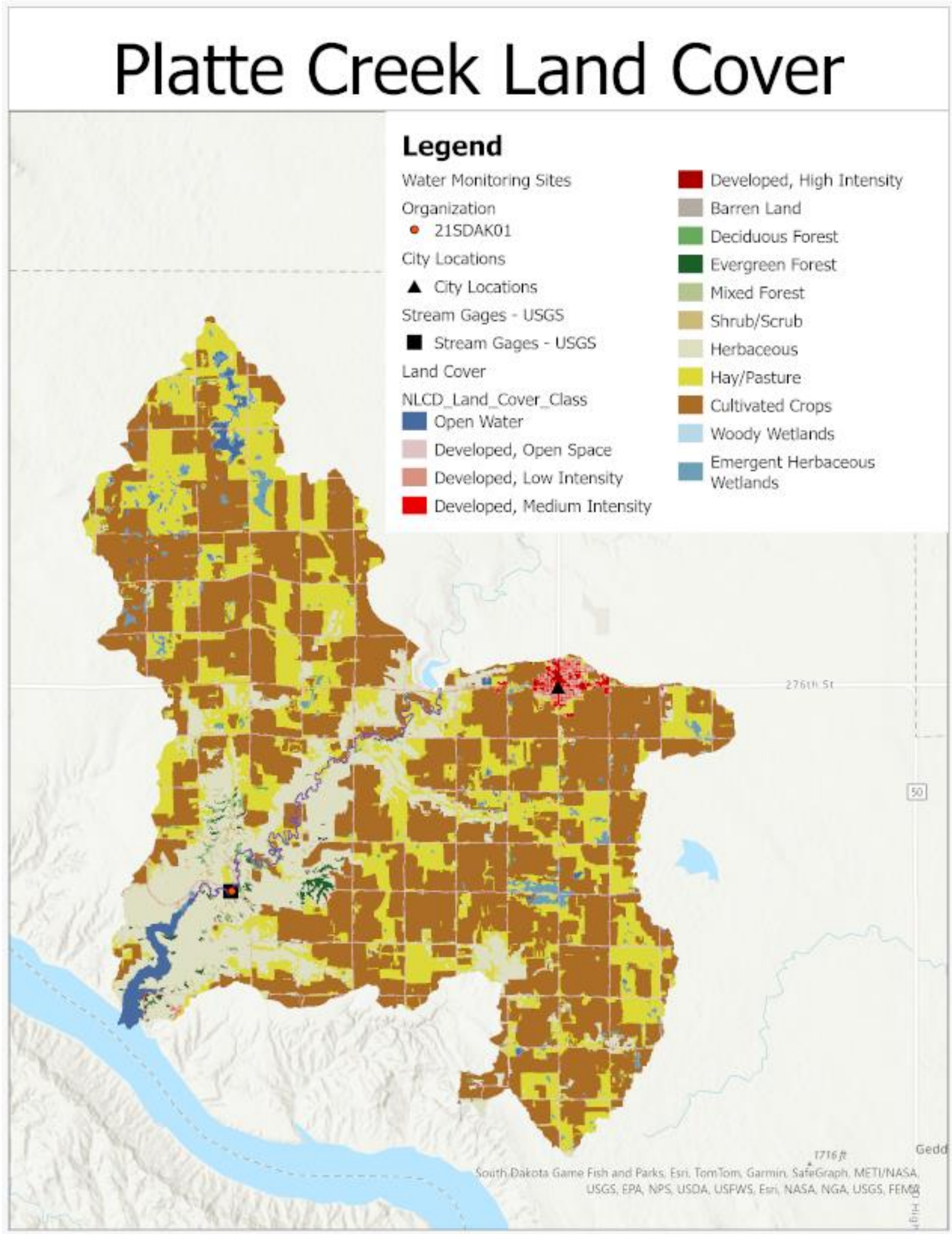

Figure 3 *- Platte Creek Land Cover.*

3.0 South Dakota Water Quality Standards

Water quality standards are comprised of three main parts as defined in the Federal Clean Water Act (33 U.S.C. §1251 et seq.) and Administrative Rules of South Dakota (ARSD) Chapter 74:51:01:

- Beneficial Uses: Functions or activities that reflect waterbody management goals
- Criteria: Numeric concentrations or narrative statements that represent the level of water quality required to support beneficial uses
- Antidegradation: Additional policies that protect high quality waters

3.1 Beneficial Uses

Each individual waterbody within South Dakota is designated one or more beneficial uses. A list of beneficial uses for South Dakota waters can be found here: Administrative Rule 74:51 South Dakota Legislature

1) Domestic water supply
2) Coldwater permanent fish life propagation
3) Coldwater marginal fish life propagation
4) Warmwater permanent fish propagation
5) Warmwater semipermanent fish life propagation
6) Warmwater marginal fish life propagation
7) Immersion recreation
8) Limited contact recreation
9) Fish and wildlife propagation, recreation, and stock watering
10) Irrigation waters
11) Commerce and industry

All waters (both lakes and streams) within South Dakota are designated the beneficial use of (9) fish and wildlife propagation, recreation, and stock watering. All streams are designated the beneficial uses of (9) fish and wildlife propagation, recreation, and stock watering and (10) irrigation, unless stated otherwise in the ARSD. Additional uses are designated by the state based on a beneficial use analysis of each waterbody.

SD-MI-R-PLATTE_01_USGS has been assigned the following beneficial use designations: (6) warmwater marginal fish life propagation, (8) limited contact recreation, (9) fish and wildlife propagation, recreation, and stock watering, and (10) irrigation waters.

SD-MI-R-FRANCIS_CASE_01 is the downstream water that receives flow from SD-MI-R-PLATTE_01_USGS and has been assigned the beneficial uses of (1) domestic water supply, (4) warmwater permanent fish life propagation, (7) immersion recreation, (8) limited contact recreation, (9) fish and wildlife propagation, recreation, and stock watering, (10) irrigation, and (11) commerce and industry. In the 2026 IR, SD-MI-R-FRANCIS_CASE_01 is meeting all of the beneficial uses assigned to it.

3.2 Water Quality Criteria

The water quality standard criteria for SD-MI-R-PLATTE_01_USGS must be met to protect the beneficial uses of the reach. When multiple criteria exist for a particular parameter, the most stringent criteria are used. (***Table 1***).

Table 1 *- South Dakota Surface Water Quality Criteria for Platte Creek*

Parameter	Criteria	Beneficial Use
Alkalinity ($CaCO_3$)	≤ 750 mg/L[1]	Fish and wildlife propagation, recreation, and stock watering
	≤ 1313 mg/L[2]	
Total dissolved solids	≤ 2,500 mg/L[1]	
	≤ 4,375 mg/L[2]	
Conductivity at 25°C	≤ 4,000 micromhos/cm[1]	
	≤ 7,000 micromhos/cm[2]	
Nitrates as N	≤ 50 mg/L	
	≤ 88 mg/L	
pH	≥ 6.0 - ≤ 9.5 units	
Total petroleum hydrocarbon	≤ 10 mg/L	
Oil and grease	≤ 10 mg/L	
Conductivity at 25°C	≤ 2,500 micromhos/cm[1]	Irrigation
	≤ 4,375 micromhos/cm[2]	
Sodium adsorption ratio	≤ 10 ratio	
Total ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A[1]	Warmwater marginal fish life propagation waters
	Equal to or less than the result from Equation 2 in Appendix A[2]	
Dissolved Oxygen[3] (October 1 – April 30)	≥ 4.0 mg/L	
Dissolved Oxygen[3] (May 1 – September 30)	≥ 5.0 mg/L	
Undissociated hydrogen sulfide[2]	≤ 0.002 mg/L	
pH (standard units)	≥ 6.0 - ≤ 9.0 units	
Total Suspended Solids	≤ 150 mg/L[1]	
	≤ 263 mg/L[2]	
Temperature	≤ 90 °F	
Dissolved Oxygen[3] (limited contact recreation)	≥ 5.0	Limited Contact Recreation
Escherichia coli (May 1 – September 30)	≤ 630 cfu/100 mL[4]	
	≤ 1178 cfu/100 mL[2]	
Microcystin	8 µg/L[5]	
Cylindrospermopsin	15 µg/L[5]	

1) 30-day average as defined in ARSD 74:51:01:01(60); (2) daily maximum; (3) DO as measured anywhere in the water column of a non-stratified waterbody, or in the epilimnion of a stratified waterbody; (4) Geometric mean as defined in ARSD 74:51:01:01(24) and 74:51:01:50-51; (5) Not to be exceeded in more than three 10 day assessment periods over the course of the recreation season.

3.2.1 *E. coli* Water Quality Criteria

South Dakota adopted numeric *E. coli* criteria for the protection of the immersion (7) and limited contact recreation uses (8). Immersion recreation waters are to be maintained suitable for activities such as swimming, bathing, water skiing and other similar activities with a high degree of water contact that make bodily exposure and ingestion more likely. Limited contact recreation waters are to be maintained suitable for boating, fishing, and other water-related recreation other than immersion recreation.

Through the 1970's and 1980's EPA epidemiological studies identified *E. coli* as a good predictor of gastrointestinal illnesses in fresh waters (US EPA, 1986). *E. coli* is a class of bacteria naturally found in the intestinal tract of humans and warm-blooded animals. The presence and concentration of *E. coli* in surface waters, typically measured in colony forming units (cfu) or counts (#) per 100 mL, is used to identify fecal contamination and as an indicator for the likely presence of other pathogenic microorganisms. *E. coli* bacteria standards in South Dakota are expressed as a count/100 mL. Laboratory results for *E. coli* were expressed as Most Probable Number (MPN) and Colony Forming Units (cfu), respectively. Both units are considered equivalent and representative of the number or count of bacteria/100 mL. In 1986 EPA recommended states adopt *E. coli* criteria for immersion recreation based on a rate of 8 illnesses per 1,000 swimmers (US EPA, 1986). While it is generally understood that limited contact recreation is associated with a reduced illnesses risk and different routes of exposure, it is difficult to directly relate an illness rate to these activities from epidemiological studies based on immersion recreation. Therefore, to protect downstream uses and establish effluent limitations for limited contact recreation waters, EPA has suggested numeric criteria five times the immersion recreation values (US EPA, 2002). Because of the reduced risk, the multiplier was considered protective of the limited contact recreation use through the EPA and SD DANR water quality standards review and approval process.

The South Dakota *E. coli* criteria for the limited contact recreation beneficial use requires that 1) no single sample exceed 1,178 cfu/100 mL and 2) during a 30-day period, the geometric mean (GM) of a minimum of five samples collected during separate 24-hour periods must not exceed 630 cfu/100 mL (Administrative Rule 74:51:01:51) The South Dakota *E. coli* criteria for the immersion recreation beneficial use requires that 1) no single sample maximum (SSM) exceed 235 cfu/100 ml and 2) during a 30-day period, the geometric mean of a minimum of five samples collected during separate 24-hr periods must not exceed 126 cfu/100 mL (Administrative Rule 74:51:01:50). As noted, these limited contact criteria are five times the corresponding immersion recreation criteria. *E. coli* criteria apply from May 1st through September 30th, which is considered the recreation season in South Dakota (*Table 2*).

TMDLs must be protective of downstream uses and associated water quality criteria. SD-MI-R-PLATTE_01_USGS flows into the Missouri River, Lake Francis Case (SD-MI-R-FRANCIS_CASE_01) and is designated the beneficial use (7) immersion recreation which has stricter criteria. SD-MI-R-FRANCIS_CASE_01 is currently meeting *E. coli* water quality criteria and is in full support of its designated immersion recreation use. Because of this agreement, the

Platte Creek TMDL will be written to the downstream *E. coli* criterion for immersion recreation to be protective of the downstream recreation use. (SD DANR, 2026).

***Table 2** - Immersion Recreation Water Quality Criteria for Platte Creek.*

Parameter	Criteria	Beneficial Use
Escherichia coli (May 1st – September 30th)	$\leq$ 235 CFU/100 mL$^{(2)}$	Immersion Recreation
	$\leq$ 126 CFU/100 mL$^{(4)}$	

(2) daily maximum; (4) Geometric mean as defined in ARSD 74:51:01:01(24) and 74:51:01:50-51;

3.3 Antidegradation

This TMDL document is consistent with South Dakota antidegradation policies (ARSD 74:51:01:34) because it provides recommendations and establishes pollutant limits at water quality levels necessary to meet criteria and fully support existing beneficial uses.

4.0 Numeric TMDL Targets

TMDLs are required to identify a numeric target to measure whether the applicable water quality standard is attained. A maximum allowable load, or TMDL, is ultimately calculated by multiplying this target with a flow value and a unit conversion factor. Generally, the pollutant causing the impairment and the parameter expressed as a numeric water quality criterion are the same. In these cases, selecting a TMDL target is as simple as applying the numeric criteria. Occasionally, an impairment is caused by narrative water quality criteria violations or by parameters that cannot be easily expressed as a load. When this occurs, the narrative criteria must be translated into a numeric TMDL target (e.g., nuisance aquatic life translated into a total phosphorus target) or a surrogate target established (e.g., a pH cause addressed through a total nitrogen target) and a demonstration should show how the chosen target is protective of water quality standards.

There are two numeric *E. coli* criteria for TMDL target consideration (***Table 1 and Table 2***). When multiple numeric criteria exist for a single parameter, the most stringent criterion is selected as the TMDL target. To judge whether one is more protective of the beneficial use, it is necessary to further evaluate how the criteria were derived (***Appendix C***). Criteria development revealed that the GM and SSM criterion are equally protective of the beneficial use because they are based on the same illness rate and only differ simply from different statistical values and sampling timeframes (USEPA, 2012). Because assessment data was insufficient to calculate a monthly GM, the SSM *E. coli* criterion of 235 CFU/100 mL was selected as the numeric TMDL target for SD-MI-R-PLATTE_01_USGS. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

5.0 Impairment Assessment Methods

Assessment methods document the decision-making process used to define whether water quality standards are met. SD DANR evaluates monitoring data following these established procedures to determine if: 1) one or more beneficial use is not supported, 2) the waterbody is impaired, and 3) it should be placed on the next 303(d) list. Waterbodies impaired by pollutants require TMDLs and these assessment methods are commonly used again in the process sometime after TMDLs have been established and restoration efforts have been implemented. In select cases, attainment is judged instead by comparing current conditions to TMDL loading limits. For example, when certain characteristics of the pollutant (e.g., bioaccumulative) or waterbody (e.g., a reservoir filling with sediment) prioritize loading concerns. South Dakota's assessment method for *E. coli* bacteria describes what constitutes a minimum sample size and how an impairment decision is made is presented in ***Table 3***.

Table 3 *- Assessment Methods for Determining Support Status for Section 303(d) (SDDANR 2026).*

Integrated Report Assessment Methods		
Description	**Minimum Sample Size**	**Impairment Determination Approach**
FOR CONVENTIONAL PARAMETERS: • TSS • *E. coli* • pH • Temperature • Dissolved Oxygen	STREAMS: Minimum of 20 samples (collected on separate days) for any one parameter are required within a waterbody reach. Minimum of 10 chronic (calculated) results are required for chronic criteria (30-day averages and geomeans). LAKES: Reference the lake listing methodology starting on page 31 of the 2022 IR.	STREAMS: >10% exceedance for daily maximum criteria (acute or >10% exceedance for 30-day average criteria OR when overwhelming evidence suggests nonsupport/support LAKES: Reference the lake listing methodology starting on page 31 of the 2022 IR.

The assessment method mentions chronic and acute criteria. Although these terms do not directly relate to *E. coli* bacteria criteria as discussed in ***Appendix C***, the assessment method is organized together with other conventional parameters in the IR to show that a consistent approach is applied to many pollutants. In this limited definition, chronic refers to the GM and acute refers to the SSM *E. coli* bacteria criteria. Different assessment methods have been established for toxic parameters and mercury in fish tissue.

6.0 Source Assessment and Allocations

In **Section 6.1** and **6.2**, point sources and nonpoint sources of *E. coli* in the SD-MI-R-PLATTE_01_USGS watershed are presented. Point sources are regulated and permitted under the National Pollutant Discharge Elimination System (NPDES). Nonpoint sources were identified by estimating population densities within the watershed area.

6.1 Point Sources

The EPA defines point source pollution as "any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel, conduit, discrete fissure, or container. It also includes vessels or other floating watercraft from which pollutants are or may be discharged. By law, the term 'point source' also includes concentrated animal feeding operations, which are places where animals are confined and fed. By law, agricultural stormwater discharges and return flows from irrigated agriculture are not 'point sources'" (US EPA).[2] Potential point sources of *E. coli* bacteria in the SD-MI-R-PLATTE_01_USGS watershed are documented below to consider Waste Load Allocations (WLA) for TMDL development.

City of Platte (NPDES Permit #SD0020354)

The City of Platte operates a wastewater treatment facility located approximately 1.5 miles west of Platte, SD in the South ½ of Section 15, Township 99 North, Range 68 West, in Charles Mix County, South Dakota (Latitude 43.385582°, Longitude -98.872068°, Navigational Quality GPS). The facility consists of a three-cell stabilization pond system designed for intermittent discharges when storage capacity requires release.[3]

Effluent from Outfall 001 is discharged to an unnamed tributary of Platte Creek. From the outfall, the discharge travels approximately 0.7 miles to the confluence with SD-MI-R-PLATTE_01_USGS, which then flows an additional 16.1 miles before entering Lake Francis Case. The system is regulated under an NPDES permit that requires monthly Discharge Monitoring Reports (DMRs) to ensure compliance with all effluent limits.

The current permit includes *E. coli* limits of 630 cfu/100 mL (30-day geometric mean) and 1,178 cfu/100 mL (daily maximum). *E. coli* must be monitored three times per week during the discharge period. According to the facility's Statement of Basis, the discharge is not expected to cause or contribute to exceedance of the South Dakota Surface Water Quality Standards (SDSWQS) in Lake Francis Case because of the long travel distance, significant dilution, and attenuation occurring with Platte Creek (*Appendix D*).

For purposes of this TMDL, the facility is assigned a WLA. The applicable WLAs vary by flow zone and are presented in **Section 8.2**.

[2] US EPA (U.S. Environmental Protection Agency). National Pollution Elimination System Permit Basics. https://www.epa.gov/npdes/npdes-permit-basics

[3] City of Platte Discharge Permit

6.1.1 Construction Stormwater Permits

Construction activities have the potential to produce pollutants that may contaminate stormwater runoff. Currently there is one non-major construction permit that is ongoing in the watershed. The permit authorizes discharge of stormwater but does not authorize discharge if the discharge will cause or have the reasonable potential to cause or contribute to violations of surface water quality. Stormwater construction activities must have coverage and comply with South Dakota's *General Permit Authorizing Stormwater Discharges Associated with Construction Activities*[4] ensuring that discharges are minimal.

A Stormwater Pollution Protection Plan (SWPPP) is required for all permitted construction and industrial stormwater sites. The SWPPP is a written document that outlines how contractors will ensure stormwater runoff leaving the site will not become contaminated with pollutants. Construction stormwater permittees can be found in ***Appendix B***. A WLA of zero was assigned to each construction stormwater permittee in the SD-MI-R-PLATTE_01_USGS TMDL since these permits are not expected to be a source of bacteria pollution.

6.1.2 CAFOS in the Platte Creek Watershed

There are three permitted Concentrated Animal Feeding Operations (CAFOs) within the SD-MI-R-PLATTE_01_USGS watershed (***Table 4***). Two of the operations have permit coverage under the 2003 General Water Pollution Control Permit for CAFOs and are denoted by an SDG-01* permit number. One permit coverage falls under the 2017 General Water Pollution Control Permit for CAFOs and is denoted by an SDG-1* permit number. All CAFO's are required to maintain compliance with provisions of the SD Water Pollution Control Act (SDCL 34A-2). SDCL 34A-2-36.2 requires each concentrated animal feeding operation, as defined by Title 40 Codified Federal Regulations Part 122.23 dated January 1, 2007, to operate under a general or individual water pollution control permit issued pursuant to 34A-2-36. The general permit ensures that all CAFO's in SD have permit coverage regardless of if they meet conditions for coverage under an NPDES permit.

All facilities with a general permit number that starts with SDG-01* are covered under the 2003 General Water Pollution Control Permit for Concentrated Animal Feeding Operations. These permits require housed lots to have no discharge of solid or liquid manure to waters of the state. They also allow open lots to have a discharge of manure or process wastewater from properly designed, constructed, operated and maintained manure management systems in the event of a 25-year, 24-hour or 100-year, 24-hour storm event if all permit conditions are met. The general permit was reissued and became effective on April 15, 2017. All CAFO's covered under the 2003 general permit have a deadline to apply for coverage under the 2017 general permit.

All facilities with a general permit number starting with SDG-1* are covered under the 2017 General Water Pollution Control Permit for Concentrated Animal Feeding Operations. The 2017 general permit allows no discharge of manure or process wastewater from operations with state permit coverage or NPDES permit coverage for new source swine, poultry, and veal operations,

[4] https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/docs/DANR_ConstructionGeneralPermit2023.pdf

as well as other housed lots with covered manure containment systems. Operations also have the option to apply for a state issued NPDES permit. Operations covered by the 2017 general permit or NPDES permit for open or housed lots with uncovered manure containment systems can only discharge manure or process wastewater from properly designed, constructed, operated and maintained manure management systems in the event of 25-year, 24-hour storm event if they meet the permit conditions.

Table 4 *- Concentrated Animal Feeding Lots in the Platte Creek Watershed.*

Name of Facility	Type of Operation	SD General Permit #
Academy Pork, LLP	Production swine (housed lot)	SDG-100116
Hoeksema Feedlot	Beef cattle (open lot)	SDG-0100455
DeHaan Livestock & Grain Farms, Inc.	Beef cattle (open lot)	SDG-0100455

Both the 2003 and 2017 general permits have nutrient management planning requirements based on EPA's regulations and the South Dakota Natural Resources Conservation Services 590 Nutrient Management Technical Standard to ensure the nutrients are applied at agronomic rates with management practices to minimize the runoff potential. Additionally, the general permits include design standards, operation and maintenance record keeping, inspections, and other reporting requirements.

For more information about South Dakota's CAFO requirements and general permits visit: South Dakota Feedlot Permit Program (sd.gov). Because CAFOs operating in compliance with their general permit are not expected to discharge, this TMDL does not assign WLAs to CAFOs in the watershed. The TMDL assumes their contribution of *E. coli* is negligible under permit conditions; therefore, no additional permit requirements are established by this TMDL. Complying with the facility's general CAFO permit requirements ensures discharges to be unlikely and the TMDL assumes their *E. coli* contribution is minimal, and unless found otherwise, no additional permit conditions are required by this TMDL.

6.2 Nonpoint Sources

To help identify sources of bacterial contamination and support development of TMDLs, an estimate of nonpoint source contributions of *E. coli* was conducted for the SD-MI-R-PLATTE_01_USGS watershed. Nonpoint source pollution arises from diffuse sources within the watershed area that enter waterbodies via surface runoff during precipitation events or through direct deposition into streams. Potential contributors of nonpoint source *E. coli* pollution primarily include wildlife (i.e., natural background), agriculture activities, and human sources. *E. coli* is commonly used as an indicator organism for fecal contamination in waterbodies, as its presence suggests the potential for other harmful pathogens originating from fecal waste. As such, understanding the sources and magnitude of *E. coli* loading is essential for assessing water quality and guiding mitigation strategies.

A comprehensive assessment of total *E. coli* production from nonpoint sources was conducted for the SD-MI-R-PLATTE_01_USGS watershed. Due to limited literature values for *E. coli* production from various livestock, human and wildlife species, fecal coliform data were used as a surrogate (***Table 5***). Since *E. coli* is a subset of fecal coliform bacteria and often behaves similarly in aquatic environments, fecal coliform loading is a reliable indicator for estimating *E. coli* presence when direct data are limited. Furthermore, fecal coliform contributions are treated as synonymous with *E. coli* based on the strong correlation documented in statewide paired bacteria data as referenced in the Bacteria Translation TMDL: [DANR.sd.gov Translation.]()

Data from the National Agricultural Statistic Survey (NASS) and the most recent South Dakota Game Fish and Parks County wildlife survey were used to estimate livestock and wildlife densities, respectively (USDA, 2022; Huxoll, 2002). These animal density estimates informed the relative contributions of bacterial loading within the SD-MI-R-PLATTE_01_USGS watershed (***Table 5***). The watershed area of the impaired segment represents approximately 8% of the total acreage area in Charles Mix County.

E. coli production estimates for humans, livestock, and most wildlife species were obtained from EPA's Bacteria Indicator Tool and are represented by *Bacteria/Animal/Day* (USEPA, 2000). Total estimated bacteria production per species, represented as *Bacteria/Acre/Day*, was calculated by multiplying the number of individuals per acre (*#/Acre Watershed)* by the *Bacteria/Animal/Day* (bacteria production from an individual species). This yielded the per-acre, per-day bacteria load from each species (*Bacteria/Acre/Day)*. Each species' contribution was then divided by the total *Bacteria/Acre/Day* to estimate the percent contribution attributed to livestock, humans and wildlife. This method allowed for a standardized comparison of bacterial contributions across various species within the watershed.

Estimated *E. coli* production from nonpoint sources in the SD-MI-R-PLATTE_01_USGS watershed was approximately 1.79E+11 cfu/acre day. This bacterial load emphasizes the potential for nonpoint sources to impair water quality, particularly in areas with concentrated animal activity. These findings provide a foundation for prioritizing management efforts and reducing bacterial pollution through targeted best management practices (**Section 13.0**).

Table 5 - Platte Creek E. coli Nonpoint Source Bacteria Production.

Species	#/Acre Watershed	Bacteria/Animal/Day	Bacteria/Acre/Day	Percent
Beef Cow[2]	1.77E+00	1.00E+11	1.77E+11	98.91%
Dairy Cow[2]	1.45E-02	1.00E+11	1.45E+09	0.81%
Hogs[2]	4.03E-02	1.10E+10	4.44E+08	0.25%
Human[2]	2.06E-02	2.00E+09	4.13E+07	0.02%
All Wildlife	Sum of all Wildlife		2.34E+07	0.01%
Whitetail Deer[2]	4.76E-03	5.00E+08	2.38E+06	
Mule Deer[2]	2.45E-03	5.00E+08	1.23E+06	
Turkey (Wild)[1]	1.63E-03	9.30E+07	1.52E+05	
Oppossum[4]	4.08E-03	1.30E+08	5.31E+05	
Mink[4]	3.39E-04	1.30E+08	4.41E+04	
Beaver[2]	8.23E-04	2.50E+08	2.06E+05	
Muskrat[2]	4.08E-03	1.30E+08	5.31E+05	
Skunk[4]	4.76E-03	1.30E+08	6.19E+05	
Badger[4]	1.50E-03	1.30E+08	1.95E+05	
Coyote[3]	6.78E-04	4.10E+09	2.78E+06	
Fox[3]	3.39E-04	4.10E+09	1.39E+06	
Raccoon[2]	5.44E-03	1.30E+08	7.07E+05	
Jackrabbit[4]	4.21E-03	1.30E+08	5.47E+05	
Cottontail Rabbit[4]	1.49E-02	1.30E+08	1.94E+06	
Squirrel[4]	7.47E-03	1.30E+08	9.71E+05	
Partridge[2]	5.49E-04	1.36E+08	7.46E+04	
Prairie Chicken[2]	1.63E-03	1.36E+08	2.22E+05	
Sharptail Grouse[2]	1.23E-03	1.36E+08	1.67E+05	
Nest Canada Geese[2]	1.61E-04	4.90E+10	7.91E+06	
Tundra Swan Peak	1.61E-05	4.90E+10	7.91E+05	
Bobwhite Quail	1.29E-04	1.36E+08	1.76E+04	
Total	4.84066E-05		1.79E+11	100.00%

(1) USEPA 2001

(2) Bacteria Indicator Tool

(3) Best Professional Judgement based off of Dogs

(4) FC/Animal/Day copied from Racoon to provide a more conservative estimate of background effects of wildlife

6.2.1 Agricultural Sources

To better understand the sources of nonpoint *E. coli* pollution, livestock density data was used to estimate bacterial contributions from agricultural activities in the SD-MI-R-PLATTE_01_USGS watershed.

Data from the 2022 NASS was used to estimate livestock densities within the watershed. Agricultural activities such as dairy farming, raising poultry and livestock, can contribute to *E. coli* loading in waterways through fecal deposition. This contamination may occur directly into surface waters or indirectly via watershed-scale runoff during precipitation events. Agricultural land use is distributed throughout the watershed, with stream-adjacent areas primarily consisting of grassland and pasture.

Although swine were absent in the 2022 NASS data for Charles Mix County, South Dakota, the presence of one CAFO warranted a site-specific estimate (***Table 4***). Bacterial production from swine was estimated to use the minimum population threshold for a swine CAFO (2,500 head), multiplied by the number of known facilities (one), to approximate the swine density in the SD-MI-R-PLATTE_01_USGS watershed. CAFOs are regulated through a permitting process to ensure pollutants are not discharged directly from the facilities.

The largest contributor of *E. coli* in the SD-MI-R-PLATTE_01_USGS watershed was attributed to beef cattle (***Table 5***). Estimated bacteria production from beef cattle alone accounted for 98.91% of the total livestock-related contributions. Altogether, livestock were responsible for approximately 99.97% of total estimated *E. coli* production within the watershed. This indicates that nearly all the livestock-related bacterial loading originates from beef cattle, with minimal contributions from other species.

These results highlight the disproportionate impact of beef cattle operations on bacterial loading and underscore the importance of targeting pastureland management practices, particularly in areas adjacent to streams, to reduce nonpoint source pollution.

6.2.2 Human Sources

Human sources of bacterial production are most commonly associated with failing, improperly designed, or poorly maintained septic systems, which can introduce contaminants into nearby waterways. Within the SD-MI-R-PLATTE_01_USGS watershed, however, the majority of the residential population is located within the City of Platte and is served by the municipal wastewater collection and treatment system. As a result, only a relatively small number of residences rely on individual septic systems. Properly functioning septic systems are assumed to have negligible effect on surface water quality and therefore, do not contribute a measurable bacteria load.

To provide context and support comparison across potential source categories, an estimated bacteria production value for humans was calculated based on the residential population (***Table 5***). Population data provided by the U.S Census Bureau estimated 1,279 individuals within the watershed. Using an average daily bacterial production rate of 1.95×10^9 cfu per person (Yagow et al. 2001), the total estimated human contribution accounts for less than 1% of overall bacterial loading. While this value does not reflect actual loading under current assumptions, it serves to highlight the dominant influence of agricultural sources in the watershed.

6.2.3 Natural Background Sources

Naturally occurring sources of *E. coli* within the SD-MI-R-PLATTE_01_USGS watershed are represented through wildlife population estimates. Data utilized to support these estimates were obtained from the South Dakota Department of Game, Fish, and Parks County Wildlife Surveys (Huxoll, 2002).

The contribution of animal waste to surface water contamination is influenced by both species-specific habitat preferences and the proximity of those habitats to waterbodies. Waterfowl, for example, frequently deposit fecal matter directly into streams or within adjacent floodplains, where it may be transported to surface waters during precipitation or runoff events. Wildlife-associated *E. coli* inputs within the SD-MI-R-PLATTE_01_USGS watershed are considered minimal, with estimates indicating they comprise less than 1% of the total *E. coli* load.

7.0 Water Quality Data and Discharge Information

This section summarizes the water quality and discharge data used in the development of the SD-MI-R-PLATTE_01_USGS TMDL. All measured flow and water quality data used in the development of this TMDL are provided in ***Appendix A***.

Water quality data was collected to assess *E. coli* concentrations during the recreational season. Data was obtained through internal monitoring conducted by the South Dakota and Department of Agriculture and Natural Resources (SD DANR) at Ambient Water Quality Station WQM 460194. Sampling procedures followed the *South Dakota Standard Operating Procedures for Field Samplers,*[5] and all water samples were analyzed by the State Health Laboratory in Pierre, SD.

Hydrologic data was obtained from the U.S. Geological Survey (USGS) gaging station 06452320, located near the confluence with stream segment SD-MI-R-FRANCIS_CASE_01. Streamflow information from this site was used to characterize the watershed's hydrologic conditions and support flow-based analyses. Detailed descriptions of the *E. coli* data and flow data are provided in **Sections 7.1** and **7.2**, respectively.

7.1 *E. coli* Water Quality Data

E. coli water quality data was obtained from station WQM 460194 during the recreation season (May 1st - September 30th), beginning in 2016. This monitoring station is located on the overpass along SD Highway 1804 at coordinates Latitude 43.327170°, Longitude -98.970499° (***Figure 1***). Each *E. coli* sample was paired with corresponding flow data to enable its use in the Load Duration Curve (LDC) analysis. Samples were collected at least once per month; however, the

[5] Standard Operating Procedures for Field Samplers

sampling frequency did not meet the minimum requirement to calculate a geometric mean (GM), as defined in the South Dakota Administrative Rules of South Dakota (ARSD).

A total of 38 *E. coli* samples were collected and used for TMDL development. The minimum recorded concentration was 1.0 cfu/100 mL, and the maximum exceeded the laboratory analysis threshold of 24,200 cfu/100 mL. The maximum *E. coli* concentration (24,200 cfu/100 mL) was collected in 2020 but was not included in the graph due to scale ***Figure 4***. Of the 38 samples, 16 exceeded the SSM criterion of 235 cfu/100 mL, which applies to the immersion recreation beneficial use designated for SD-MI-R-PLATTE_01_USGS. This represents approximately 42% of samples collected at WQM 460194 from 2016 to 2024.

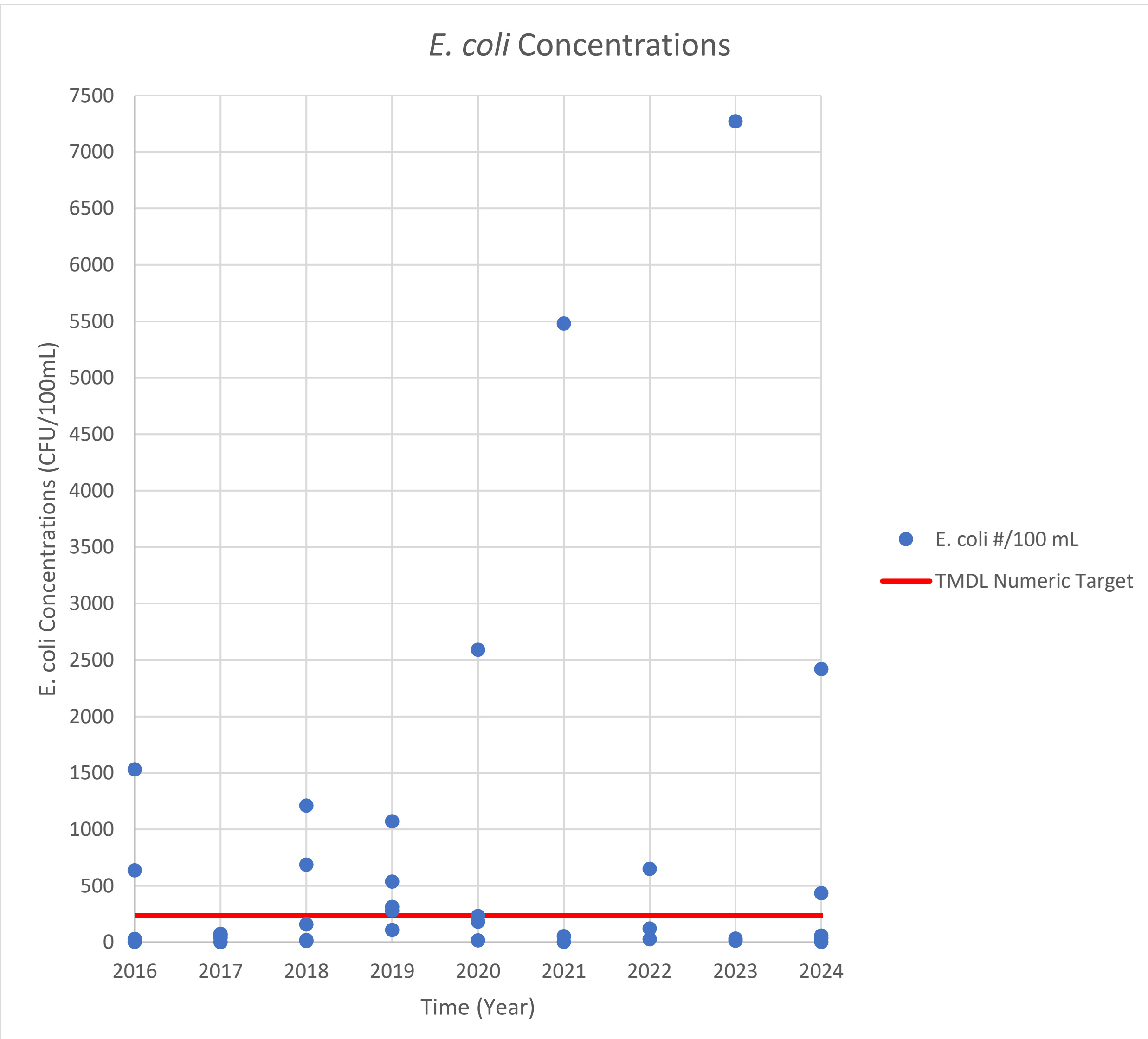

***Figure 4** – Observed E. coli Concentrations*

7.2 Discharge Data

Long-term hydrologic data for the SD-MI-R-PLATTE_01_USGS watershed was obtained from the U.S. Geological Survey (USGS) gaging station 06452320, located on Highway 1804 near the confluence with stream segment SD-MI-R-FRANCIS_CASE_01. This station captures discharge conditions at the downstream end of the assessment unit. Flow monitoring began in 1990 and remains active as of 2026.

Mean daily discharge data were extracted from this station during the period between 2016-2024, representing a comprehensive record of streamflow variability across seasonal and annual conditions. These flows were used to develop a flow frequency curve, which allowed for the classification of flow conditions into distinct hydrologic zones (e.g., high flow, moist conditions, mid-range, dry, and low flow). These zones are essential for interpreting pollutant transport dynamics under varying runoff scenarios.

The flow frequency data served as the basis for constructing the LDC. The LDC plots pollutant concentration or load against the percentage of time a give flow is exceeded, enabling the identification of critical flow conditions when exceedances occur. By linking flow to *E. coli* concentrations, this analysis supports the allocation of allowable pollutant loads and identification of likely source categories under different flow regimes.

Where applicable, flow data was aligned with corresponding *E. coli* samples collected at WQM 460194 to ensure accurate loading assessments.

8.0 TMDL Allocations

Contributing factors of pollution are split between point and nonpoint sources. Wasteload allocations (WLAs) are the allocated loads for point sources including all sources subject to regulation under the NPDES program. Therefore, load allocations (LAs) are the allocated loads of nonpoint sources as well as natural background sources. TMDL (or loading capacity) is the sum of waste load allocations, load allocations, and a margin of safety (MOS).

A TMDL is expressed by the equation: $TMDL = \Sigma WLA + \Sigma LA + MOS$, where:

ΣWLA is the sum of the wasteload allocation(s) (point sources)
ΣLA is the sum of the load allocation(s) (nonpoint sources)
MOS = margin of safety

8.1 Margin of Safety (MOS)

In accordance with regulations, a margin of safety was established to account for uncertainty in the data analysis. A margin of safety may be provided (1) by using conservative assumptions in the calculation of the loading capacity of the waterbody and (2) by establishing allocations that in total are lower than the defined loading capacity. In the case of SD-MI-R-PLATTE_01_USGS, the latter approach was used to establish a safety margin on the *E. coli* TMDL.

A 10% explicit MOS was calculated within the duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). This 10% explicit MOS was calculated from the TMDL within each flow zone. The remaining assimilative capacity was attributed to nonpoint sources (LA) or point sources (WLA).

8.2 Waste Load Allocation (WLA)

All NPDES permitted facilities within the SD-MI-R-PLATTE_01_USGS watershed were identified and reviewed for WLA consideration in **Section 6.1.** The City of Platte wastewater treatment facility is the only permitted point source with the potential to contribute *E. coli* to Platte Creek.

The facility operates a three-cell stabilization pond system that discharges intermittently when storage levels require release. Discharges are infrequent, short in duration, and enter Platte Creek through an unnamed tributary approximately 0.7 miles upstream of the confluence. The facility has discharged a total of three times during the current permit cycle, all of which occurred outside the recreational season (October 1 – April 30).

8.2.1 Unadjusted WLA

The unadjusted WLA for this TMDL was calculated using the 80th percentile flow rate (0.262 MGD) reported in the City of Platte wastewater treatment facility's discharge monitoring reports (DMR) for the current permit cycle. This flow rate was multiplied by the facility's single-sample maximum *E. coli* permit limit of 1,178 cfu/100 mL, resulting in an unadjusted daily maximum WLA of 1.17E +10^{10} (cfu/day). This unadjusted WLA represents the maximum allowable point-source load based on facility discharge characteristics and serves as a baseline for evaluating point-source contributions across the flow duration curve.

8.2.2 Adjusted WLA

Comparison of the unadjusted WLA to the loading capacity in **Section 10.0**demonstrated that the facility's allowable, unadjusted WLA is fully assimilated in the higher-flow zones of the flow duration curve. However, in the dry-condition and low-flow zones, the unadjusted WLA exceeds the available loading capacity.

To address this exceedance and to incorporate the WLA into the LDC framework in a manner consistent with approved South Dakota TMDLs, the WLA was adjusted within the lower two flow zones using a proportional allocation of available loading capacity. This adjustment is based on observed flow and water quality conditions and is intended to better reflect actual stream conditions during dry and low-flow periods while ensuring that the WLA remains consistent with the loading capacity available under those conditions.

To support this allocation, representative hydrologic conditions during the recreational season were evaluated using monthly average streamflow data. Results indicate that late summer and early fall represent the period of lowest streamflow within the watershed, with September identified as the minimum flow month. However, review of DMR records from 2016-2024 indicated that the City of Platte WWTF did not discharge during September within the available period of record. Therefore, July conditions were selected to represent critical low-flow discharge conditions because they reflect both low seasonal streamflow and documented WWTF discharge activity.

Average July streamflow in Platte Creek was determined to be 0.78 cfs. Review of DMR records identified July discharge events in 2019 and 2020 with corresponding average discharge rates of 0.38 MGD and 0.288 MGD, respectively. The average July discharge rate for these events was calculated to be approximately 0.334 MGD, equivalent to 0.517 cfs. Comparison of the representative July WWTF discharge rate to average July streamflow in Platte Creek indicates that the facility could contribute approximately 66% of total streamflow under representative low-flow discharge conditions. Representative WWTF discharge flow was calculated as:

$$\frac{0.517\ cfs\ (July\ Discharge\ from\ WWTF)}{0.78\ cfs\ (July\ Average\ Streamflow)} \times 100 = 66.3\%$$

Based on this analysis, 10% of the loading capacity within the dry-condition and low-flow zones was reserved as an explicit MOS. The remaining loading capacity was proportionally distributed between point and nonpoint sources based on estimated hydrologic contribution during representative low-flow conditions, with approximately 66% assigned to the WLA. This allocation approach reflects the proportional contribution of the WWTF during periods of greatest water quality sensitivity while maintaining consistency with observed hydrologic conditions, documented facility discharge behavior, and established TMDL allocation methodologies used within South Dakota. This results in an adjusted WLA of 9.90E+09 cfu/day for the dry-condition zone and 1.13+09 cfu/day for the low-flow zone. These adjusted WLAs represent allowable mass-based point source contributions that do not exceed the assimilative capacity of Platte Creek under critical low-flow conditions while maintaining consistency with observed hydrologic conditions and established TMDL allocation approaches.

8.2.3 Regulatory Implementation

The City of Platte WWTF is the only permitted point-source discharger in the watershed, and the full WLA is assigned to this facility. Under current operating conditions, the assigned WLA does not limit attainment of the TMDL. The facility remains subject to its existing NPDES permit requirements, including the single-sample maximum *E. coli* effluent limit of 1,178 cfu/100mL. Any future expansion of the facility’s discharge capacity or the addition of new point sources within the watershed would require reevaluation of the WLA to ensure that sufficient loading capacity remains within the TMDL framework.

8.2.4 In-Stream Attenuation

Following discharge, *E. coli* concentrations are further reduced through natural die-off processes during transport within the unnamed tributary and the main stem of Platte Creek, providing additional reductions prior to reaching downstream waters, including Lake Francis Case. For more information regarding *E. coli* decay rates see ***Appendix D***.

8.2.5 CAFOs

There are three permitted CAFOs in the SD-MI-R-PLATTE_01_USGS watershed. CAFOs were not assigned a WLA in the TMDL as they are not allowed to discharge their waste in accordance with provisions of their NPDES permits.

8.3 Load Allocations (LA)

EPA regulations require that a TMDL include load allocations (LAs) that represent the portion of the loading capacity attributable to nonpoint sources and sources of natural background. Within the SD-MI-R-PLATTE_01_USGS watershed, the predominant sources of *E. coli* loading is dominated by diffuse, land-based sources including activities such as livestock grazing, manure deposition on pasture and rangeland, runoff from feeding areas, and wildlife contributions. These sources occur across the full range of flow conditions and are the primary drivers of exceedance observed in the load duration curve framework.

The loading capacity for each flow-duration zone was calculated by multiplying the applicable downstream water-quality criterion of 235 cfu/100 mL by the 95th percentile representative streamflow for each flow zone, based on data from USGS gage 06452320. Portions of the loading capacity were allocated to point sources as a WLA, to nonpoint sources as a LA, and to the MOS to account for uncertainty, as described in **Section 8.2**.

For each flow zone, the LA was calculated as the remaining portion of the loading capacity after accounting for the WLA and MOS, such that:

LA = LC (-) WLA (-) MOS

Consistent with EPA guidance, the sum of the WLA, LA, and MOS equals the loading capacity for each flow zone. The resulting LAs represent the allowable *E. coli* loads from nonpoint and background sources that are consistent with attainment of water-quality standards under all flow conditions. Because nonpoint sources dominate *E. coli* loading in the watershed, achievement of the TMDL will depend primarily on implementation of appropriate best management practices (BMPs) to reduce bacteria contributions from agricultural lands and wildlife sources.

9.0 *Escherichia coli* (*E. coli*) TMDL Loading Analysis

The TMDL for SD-MI-R-PLATTE_01_USGS was developed using a Load Duration Curve (LDC) analytical approach. The LDC considers the entire flow regime and presents an accurate representation of the allowable loading capacity of a pollutant based on the relevant water quality criterion. The LDC approach is an appropriate method for determining flow-variable *E. coli* loading for SD-MI-R-PLATTE_01_USGS and is helpful when discerning patterns of impairment and possible sources across different hydrologic flow conditions. Typically, the LDC is separated into five flow zones (***Figure 5***) high flows (0-10 percent), moist conditions (10-40 percent), mid-range conditions (40-70 percent), dry conditions (70-90 percent) and low flows (90-100 percent) in accordance with EPA guidance (USEPA, 2007). Mid-range conditions and dry conditions were adjusted slightly to 40-60% and 60-90% to accommodate the WLA adjustment.

In **Section 3.2**, it was discussed why the immersion recreation SSM of 235 cfu/100 mL for *E. coli* was selected as the numeric TMDL target for SD-MI-R-PLATTE_01_USGS. The LDC was calculated by multiplying the SSM criterion (235 cfu/100 mL) by the average daily flows and then multiplying that by a unit conversion factor (24,465,525 mL*s / ft^3*day). The LDC is then a representation of the TMDL across the entire flow regime.

$$235\ \frac{mg}{L} \times Average\ daily\ flow \times Conversion\ factor = TMDL$$

In a LDC, flow duration intervals are expressed as a percentage. The highest stream flow in the record corresponds with 0% and the lowest period being 100%. This illustrates the percentage of time specified flows are equal or exceed a specific streamflow value over a given historical period. The numeric water quality target (235 cfu/100 mL) for *E. coli* immersion recreation is used to determine the loading capacity. Once loading capacity is calculated and plotted with the load capacity curve, load reductions can be visualized across a full range of flow conditions. Loads that are plotted above the load duration curve in any flow zone represent exceedances of the loading capacity. Loads below the curve represent allowable daily loads within the flow zone and are in attainment of water quality standards. *E. coli* samples collected from SD-MI-R-PLATTE_01_USGS at WQM 460194 exceed the TMDL in all the flow zones (***Figure 7***)

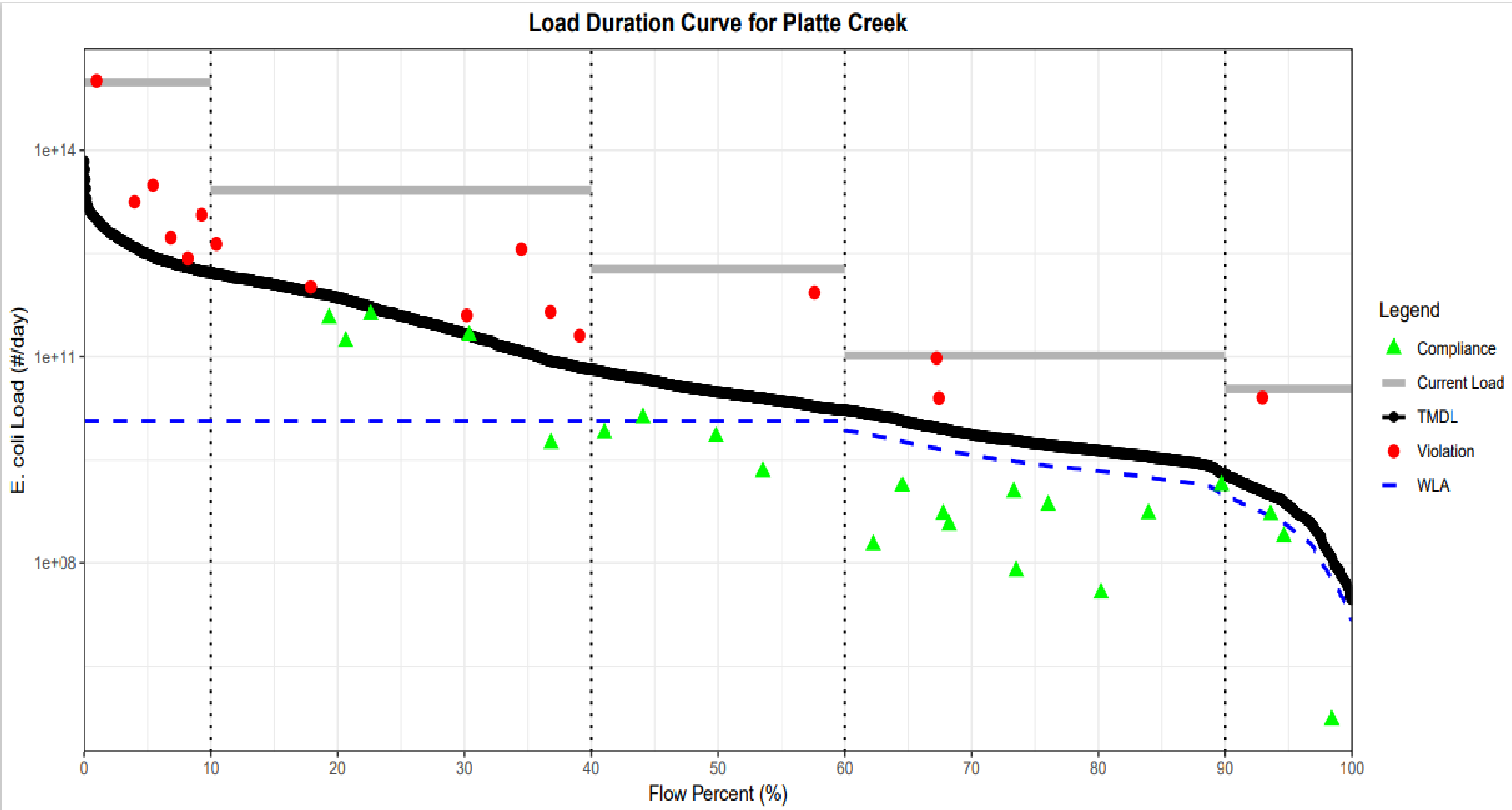

Figure 5 *- Load Duration Curve for Platte Creek.*

10.0 Numeric TMDL and Flow Zones

The TMDL for SD-MI-R-PLATTE_01_USGS and allocations for each flow zone are presented in ***Table 6***. A maximum allowable load, or TMDL, is calculated by multiplying the numeric target (235 cfu/100 mL) with discharge measurements and a unit conversion factor. The entire TMDL is allocated to LA or nonpoint sources of pollution, requiring reductions to come from this section.

***Table 6** - E. coli TMDL and Flow Allocations.*

Immersion Recreation *E. coli* TMDL	SD-MI-R-PLATTE_01_USGS TMDL Table				
	High Flows	Moist Conditions	Mid-Range Conditions	Dry Conditions	Low Flows
Flow Rate	≤ 10.0%	10 - 40.0%	40 - 60%	60 - 90%	≥ 90.0%
WLA - City of Platte	1.17E+10	1.17E+10	1.17E+10	9.90E+09	1.13E+09
10% Margin of Safety	1.22E+12	1.45E+11	6.03E+09	1.50E+09	1.71E+08
LA	1.09E+13	1.30E+12	4.26E+10	6.00E+09	6.85E+08
TMDL @ 235 cfu/day	1.22E+13	1.45E+12	6.03E+10	1.50E+10	1.71E+09
Current Load	9.73E+14	2.62E+13	2.16E+12	9.23E+10	3.41E+10
Load Reduction	99%	94%	97%	84%	95%

10.1 High Flows

The high flow zone for SD-MI-R-PLATTE_01_USGS represents flows that were greater than or equal to 292.08 cfs (highest 10% of flows). The flows represented in this zone occur on an infrequent basis and are typically the result of significant run-off events such as spring snowmelt, or intense rain events. *E. coli* sources across the watershed have the potential to be conveyed to the stream channel during high flow conditions.

Of the six samples that were taken at SD-MI-R-PLATTE_01_USGS within this flow zone, a total of six samples exceeded the numeric target of 235 cfu/100 mL. All six samples were used to calculate the current load of the zone and estimate reductions. The 95th percentile *E. coli* concentration and flow was calculated at 18797.5 cfu/100mL and 2114.88 cfs, respectively. A reduction of 99% is needed in order to comply with the TMDL.

$$235\,\frac{cfu}{100mL}\,(TMDL\ Target) * 2114.88\ cfs\ (95th\ percentile\ flow) * conversion\ factor$$
$$= 1.22E + 13\ (\frac{cfu}{day})$$

10.2 Moist Conditions

The moist condition flows for SD-MI-R-PLATTE_01_USGS extends from approximately 292.07 cfs – 11.38 cfs. Moist conditions flows represent moderate storm events following snow melt, and moderate rainfall events.

Of the 11 samples that were taken at SD-MI-R-PLATTE_01_USGS within this flow zone, a total of six samples exceeded the numeric target of 235 cfu/100 mL. All 11 samples were used to calculate the current load of the zone and estimate reductions. The 95th percentile *E. coli* concentration and flow was calculated at 4240 cfu/100 mL and 253.00 cfs, respectively. A reduction of 94% is needed in order to comply with the TMDL.

$$235\,\frac{cfu}{100mL}\,(TMDL\ Target) * 253\ cfs\ (95th\ percentile\ flow) * conversion\ factor$$
$$= 1.45E + 12\ (\frac{cfu}{day})$$

10.3 Mid-Range Conditions

The mid-range flows for SD-MI-R-PLATTE_01_USGS extends from approximately 11.37 cfs – 2.93 cfs. The flows represented in this zone occur mid to late summer where vegetation is mature, and streamflow is sustained between precipitation events. As a result, bacteria source from this zone are likely from direct contamination in the stream or near the stream channel.

Of the five samples that were taken at SD-MI-R-PLATTE_01_USGS within this flow zone, a total of one samples exceeded the numeric target of 235 cfu/100 mL. All five samples were used to calculate the current load of the zone and estimate reductions. The 95^{th} percentile *E. coli* concentration and flow was calculated at 8412.6 cfu/100 mL and 10.5 cfs, respectively. A reduction of 97% is needed in order to comply with the TMDL.

$$235\,\frac{cfu}{100mL}\,(TMDL\ Target) * 10.5\ cfs\ (95th\ percentile\ flow) * conversion\ factor$$
$$= 6.03E + 10\ (\frac{cfu}{day})$$

10.4 Dry Conditions

The dry condition flows for SD-MI-R-PLATTE_01_USGS extends from approximately 2.92 cfs – 0.34 cfs. Dry condition flows are best characterized as below average base flow conditions influenced by periods of dryness or groundwater sources. Bacteria sources during dry conditions are likely to originate in the stream channel.

Of the 12 samples that were taken at SD-MI-R-PLATTE_01_USGS within this flow zone, a total of two samples exceeded the numeric target of 235 cfu/100 mL. All 12 samples were used to calculate the current load of the zone and estimate reductions. The 95^{th} percentile *E. coli* concentration and flow was calculated at 1445.95 cfu/100mL and 2.6 cfs, respectively. A reduction of 84% is needed in order to comply with the TMDL.

$$235\,\frac{cfu}{100mL}\,(TMDL\ Target) * 2.6\ cfs\ (95th\ percentile\ flow) * conversion\ factor$$
$$= 1.50E + 10\ (\frac{cfu}{day})$$

10.5 Low Flows

The low flow zone for SD-MI-R-PLATTE_01_USGS represents flows that were less than or equal to 0.33 cfs. Low flow is characterized as the flow of water in a stream during prolonged dry weather.

Of the four samples that were taken at SD-MI-R-PLATTE_01_USGS within this flow zone, one sample exceeded the numeric target of 235 cfu/100 mL. All four samples were used to calculate the current load of the zone and estimate reductions. The 95th percentile *E. coli* concentration and flow was calculated at 4676.3100mL and 0.30 cfs, respectively. A reduction of 95% is needed in order to comply with the TMDL.

$$235\frac{cfu}{100mL}(TMDL\ Target) * 0.30\ cfs\ (95th\ percentile\ flow) * conversion\ factor = 1.71E + 09\ (\frac{cfu}{day})$$

11.0 Seasonality

Seasonality is an important consideration for *E. coli* impairments in SD-MI-R-PLATTE_01_USGS because water quality standards for the TMDL criteria apply only during the recreation season from May 1st – September 30th. Observed *E. coli* sample data used to develop this TMDL was collected during this period to ensure consistency with applicable standards.

Seasonal variation is also incorporated through the load duration curve framework, which evaluates *E. coli* loading across a range of hydrologic conditions. Observed *E. coli* violations occur across multiple flow regimes during the recreation season, with the greatest loads associated with high and moist flow conditions, indicating that watershed-scale runoff during spring and early summer precipitation events is a significant contributor. Exceedances are also observed in low-flow conditions, suggesting in-stream livestock contributions.

12.0 Critical Conditions

Critical conditions represent the combination of environmental factors (e.g., flow, precipitation, and pollutant loading) under which *E. coli* concentrations are most likely to exceed water quality standards. For Platte Creek, critical conditions occur during high to moderate flow events when *E. coli* loading is greatest and exceedances of the 235 cfu/100 mL criterion are most frequent. These conditions are typically associated with snowmelt and precipitation-driven runoff during the spring and early summer months, when bacteria are transported from the watershed into the stream.

E. coli exceedances are also observed during dry and low-flow conditions, indicating that localized sources such as direct livestock access to the stream may contribute to elevated concentrations when dilution is limited. To meet TMDL reduction goals under critical conditions, implementation of best management practices should focus on reducing bacteria transport during runoff events and limiting direct *E. coli* inputs during low-flow periods. Addressing these critical conditions will ensure that water quality standards are met under the most challenging scenarios and maintained throughout the recreation season.

13.0 Water Quality Improvement and Monitoring Strategy

This section describes the overall strategy designed to ensure attainment of the beneficial use support and *E. coli* standards for this TMDL.

13.1 Monitoring Strategy

Monitoring is necessary component for assuring attainment of the *E. coli* TMDL. The focus of monitoring is to evaluate methods for reducing *E. coli* loads from identified nonpoint and point sources, as well as the continued evaluation of in-stream *E. coli* conditions within the watershed.

Long-term monitoring will continue for segment SD-MI-R-PLATTE_01_USGS as part of SD DANR's ambient water quality monitoring program at established water quality monitoring (WQM) station 460194. In addition, partnering organizations will continue monitoring efforts through internal project activities and future Rotating Basin Project Partnerships, as available. Sampling is expected to continue indefinitely, dependent on resource availability and funding. Where applicable, supporting streamflow data will continue to be collected through existing stream gage networks to aid in interpretation of *E. coli* data. Additional targeted monitoring will focus on evaluating the effectiveness of implemented best management practices (BMPs) and documenting progress toward attainment of the *E. coli* water quality standard.

13.2 Implementation

Watershed-scale implementation projects may be accomplished through financial and technical assistance provided by SD DANR. Financial support is administered for implementation projects that protect and improve water quality in South Dakota. Available funding programs include the Consolidated Water Facilities Construction program, the Clean Water State Revolving Fund (CWSRF) program, the Riparian Buffer Initiative (RBI) program, and the Section 319 Nonpoint Sources Management Program.

Coordination with ongoing Section 319 implementation efforts, including the Soil Health Improvement and Planning Project and the South Central Watershed Implementation Project provides opportunities for collaborative solutions to reduce *E. coli* in SD-MI-R-PLATTE_01_USGS. In addition, the South Dakota Nonpoint Source Information & Education Project offers educational resources focused on nonpoint source pollution prevention and reduction practices. Continued collaboration with existing and future Section 319 projects is recommended to support bacteria reduction efforts within the watershed.

SD DANR recommends implementation of BMPs to address bacteria sources and reduce runoff to surface waters in the SD-MI-R-PLATTE_01_USGS watershed. The Riparian Buffer Initiative (RBI) provides an eligible framework through which multiple BMPs may be implemented by qualifying landowners within the focus area. BMPs applicable to reduce *E. coli* loading from a variety of sources include:

- Relocating livestock feeding areas, water sources, and grazing activities away from streams
- Protecting and restoring riparian corridors to establish permanent vegetation for streambank stabilization and erosion control
- Managing and containing manure from animal feeding operations to prevent runoff to surface waters

13.3 Adaptive Management

Adaptive management is a systematic approach to improving water quality management by evaluating outcomes and incorporating new information over time. There is inherent uncertainty in the TMDL process, including quantification of pollutant source contributions, characterization of spatial and seasonal loading conditions, and evaluation of BMP effectiveness. Continued monitoring of water quality conditions and implementation activities allows SD DANR to assess progress toward meeting applicable water quality standards and supporting designated beneficial uses.

SD DANR and/or EPA may adjust the LAs and/or WLAs established in this TMDL to account for new information or circumstances identified during TMDL implementation. New information may include, but is not limited to, water quality monitoring data, BMP effectiveness information, land use changes, or improved understanding of pollutant sources. Any proposed adjustment to the LAs or WLAs will be subject to SD DANR review, including an opportunity for public participation.

Adjustments to LAs or WLAs will only be proposed if the revised allocations do not result in a change to the established loading capacity. The adjusted TMDL, including its WLAs and LAs, will remain set at a level necessary to implement applicable water quality standards, and any adjustment WLA will be supported by a demonstration that the corresponding load allocations are practicable. SD DANR will follow EPA guidance for revising or withdrawing TMDLs, consistent with considerations documented in EPA's 2012 draft memorandum, prior to taking action.

13.4 Reasonable Assurance

Reasonable assurance demonstrates that the load and wasteload allocations established in this TMDL are both achievable and sufficient to meet applicable *E. coli* water quality standards. This assurance is provided through a combination of existing regulatory controls for point sources, ongoing voluntary implementation efforts addressing nonpoint sources, and a flow-based TMDL framework that accounts for hydrologic variability and critical conditions within the watershed.

Implementation of the wasteload allocation for point sources will occur through the NPDES permitting process, as described in **Section 6.1**. Enforceable permit limits, monitoring requirements, and regulatory oversight provide reasonable assurance that point source discharges will be consistent with the WLA.

Load allocations for nonpoint sources will be addressed through voluntary implementation of best management practices supported by existing state and federal conservation programs, technical assistance, and incentive-based funding. These programs have been successfully implemented in similar watershed and provide reasonable assurance that nonpoint source load reductions can be achieved over time.

Progress toward achieving the *E. coli* water quality standard will be evaluated through continued monitoring and adaptive management, as described under **Section 13.0**. Collectively, enforceable point source controls, established nonpoint source implementation programs and adaptive management provide reasonable assurance that the allocations established in this TMDL are achievable and protective of designated uses.

13.5 Public Participation

STATE AGENCIES

South Dakota Department of Agriculture and Natural Resources (SD DANR) was the primary state agency involved in the completion of this TMDL assessment. SD DANR's water quality monitoring (WQM) network provided much of the data used in this TMDL. SD DANR provides technical and financial support, and other resources to projects.

FEDERAL AGENCIES

Environmental Protection Agency (EPA) provided most of the funding through the 319(d), 106, and 604(b) sections of the Clean Water Act for approved nonpoint source management projects.

LOCAL GOVERNMENT, INDUSTRY, ENVIRONMENTAL, AND OTHER GROUPS, AND PUBLIC AT LARGE

The Soil Health Improvement Planning Project and the South Central Watershed Implementation Project have provided watershed planning, stakeholder engagement, outreach and education efforts within the watershed. These projects have been done with landowners and local partners to promote conservation planning and implementation of BMPs aims at improving water quality. Activities associated with these projects include outreach and education, technical assistance, and coordination of implementation efforts to address nonpoint source pollution, including *E. coli*.

The South Central Water Development District has jurisdiction with the watershed and may provide additional support as needed. The district has the authority to assist with project coordination, stakeholder engagement, and implementation activities, and may offer technical and administrative support to facilitate watershed-scale water quality improvement efforts.

A 30-day public comment period was issued for the original draft TMDL. A public notice letter was published in the following local newspapers: BLANK, BLANK, Blank. The draft TMDL document and ability to comment was made available on DANRs One-Stop Public Notice Page at: DANR Public Notices (sd.gov). The public comment period began BLANK and ended BLANK. No public comments were received during the 30-day comment period.

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Appendix A: Measured Discharge and E. coli Data at WQM 460194

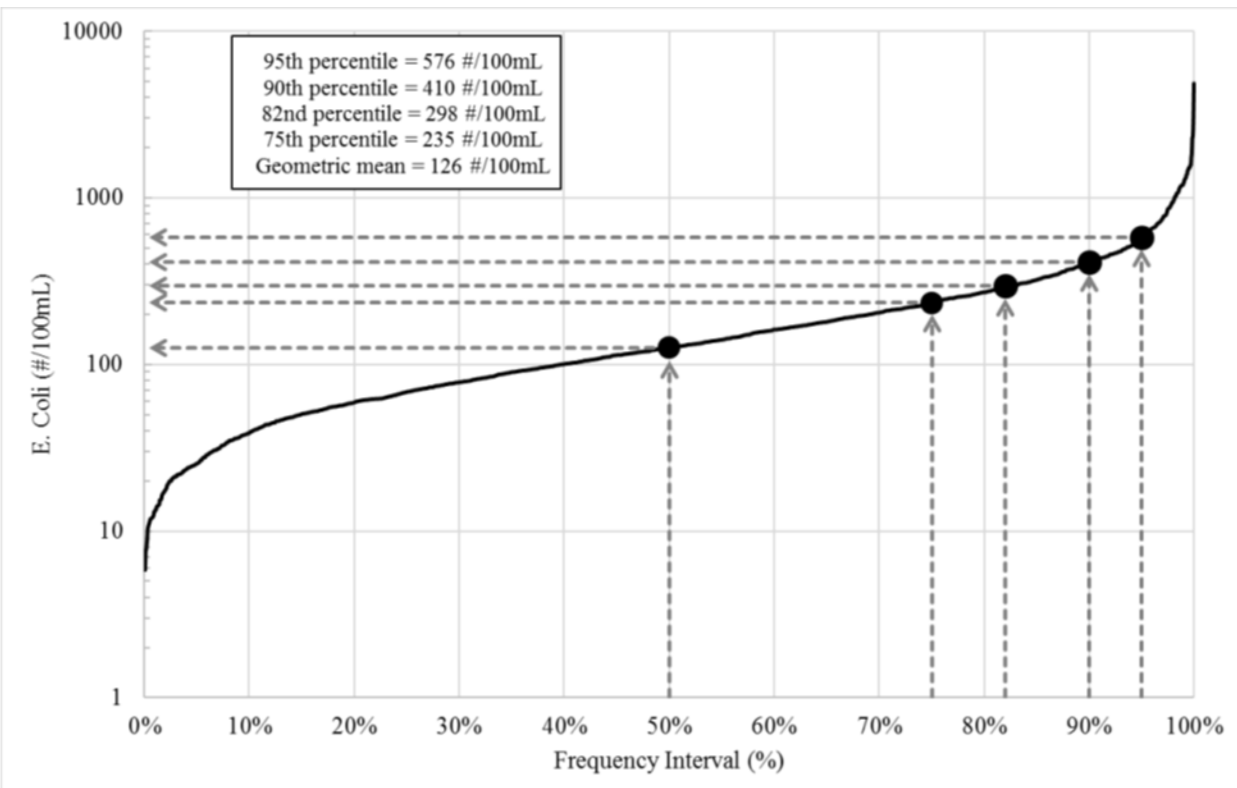
Observed E. coli Loading					
Sample Date	**Station ID**	***E. coli* (#/100 mL)**	**Discharge (cfs)**	**Observed *E. coli* Loading (#/day)**	**Flow Frequency Percentage**
06/10/2020	460194	24200	1718.229	1.02E+15	0.98
08/19/2019	460194	1070	677.219	1.77E+13	3.98
07/07/2020	460194	2590	487.844	3.09E+13	5.43
07/24/2019	460194	537	407.115	5.35E+12	6.83
09/10/2019	460194	314	348.188	2.67E+12	8.19
05/04/2016	460194	1530	305.156	1.14E+13	9.27
06/02/2016	460194	637	278.479	4.34E+12	10.44
06/11/2019	460194	278	151.500	1.03E+12	17.88
05/15/2019	460194	109	135.302	3.61E+11	19.33
07/15/2024	460194	57.1	117.563	1.64E+11	20.64
08/17/2020	460194	181	92.027	4.08E+11	22.60
05/08/2024	460194	435	37.266	3.97E+11	30.18
05/12/2020	460194	231	35.811	2.02E+11	30.37
08/08/2023	460194	7270	20.397	3.63E+12	34.49
06/12/2018	460194	1210	15.059	4.46E+11	36.78
09/10/2020	460194	15	14.955	5.49E+09	36.83
05/21/2018	460194	687	12.033	2.02E+11	39.07
07/06/2016	460194	30	10.485	7.70E+09	41.04
05/08/2017	460194	63	8.249	1.27E+10	44.08
05/10/2021	460194	52.8	5.296	6.84E+09	49.84
07/23/2018	460194	20	4.359	2.13E+09	53.53
09/08/2016	460194	10500	3.307	8.49E+11	57.60
08/19/2024	460194	3	2.489	1.83E+08	62.24
05/17/2022	460194	26.3	2.059	1.32E+09	64.53
06/04/2024	460194	2420	1.609	9.53E+10	67.24
06/07/2022	460194	649	1.574	2.50E+10	67.43
05/04/2023	460194	13.4	1.555	5.10E+08	67.76
08/01/2018	460194	10	1.462	3.58E+08	68.23
06/07/2017	460194	41	1.063	1.07E+09	73.33
06/07/2021	460194	3	1.039	7.63E+07	73.51
06/06/2023	460194	31.2	0.903	6.89E+08	76.04
08/03/2016	460194	2	0.745	3.65E+07	80.21
09/23/2024	460194	34.5	0.616	5.20E+08	83.95
09/11/2018	460194	158	0.351	1.35E+09	89.71
07/06/2021	460194	5480	0.190	2.55E+10	92.93
07/11/2022	460194	122	0.168	5.02E+08	93.59
09/12/2017	460194	74	0.134	2.43E+08	94.62
08/09/2017	460194	1	0.022	5.28E+05	98.41

Appendix B: Construction Stormwater Permits

NPDES ID	Coverage Status	Owner Name	Project City	Project County	Latitude	Longitude	Acres Disturbed
SDR10P5H7	Active	South Dakota Game Fish and Parks	Platte	Charles Mix	43.297059	-98.998787	1.8

Appendix C: TMDL Numeric Target Selection Rationale

South Dakota's *E. coli* criteria are based on EPA recommendations originally published in 1986 (US EPA, 1986). EPA issued slightly modified recommendations in 2012 that did not substantially change the underlying analysis or criteria values in South Dakota (US EPA, 2012). As recommended, SD DANR adopted *E. coli* criteria that contain two components: a geometric mean (GM) and a single sample maximum (SSM). The GM was established from epidemiological studies by comparing average summer exposure to an illness rate of 8:1,000. The SSM component was computed using the GM value and the corresponding variance observed in the epidemiological study dataset (i.e., log-standard deviation of 0.4). EPA provided four different SSM values corresponding to the 75th, 82nd, 90th, and 95th percentiles of the expected water quality sampling distribution around the GM to account for different recreational use intensities (**Figure below**). South Dakota adopted the most stringent recommendation, the 75th percentile, into state water quality standard regulations as the SSM protective of designated beaches.



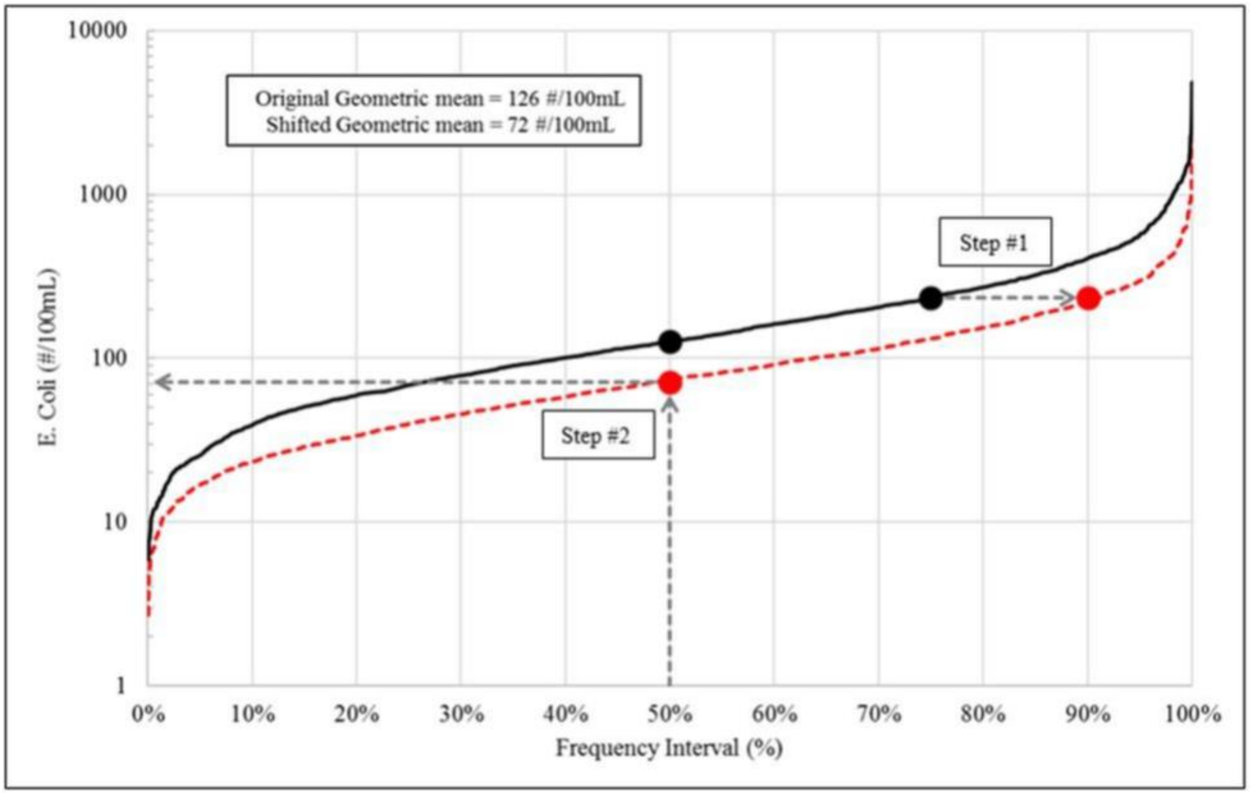
Log-Normal Frequency Distribution Used to Establish South Dakota's Immersion Recreation *E. coli* Criteria of 126 (GM) and 235 (SSM) #/100mL (EPA, 1986).

Dual criteria were established to balance the inherent variability of bacteria data and provide flexibility for handling different sampling routines. Together, the GM and SSM describe a water quality distribution expected to be protective of immersion contact recreation. The GM and SSM are equally protective of the beneficial use because they are based on the same illness rate and differ simply representing different statistical values and sampling timeframes. While this investigation has revealed the GM and SSM *E. coli* criteria to be equally protective of the immersion recreation use, a likewise conclusion can be made for the GM and SSM criteria associated with the limited contact recreation use since those values were simply derived as five times the immersion values.

As described in EPA's *Protocol for Developing Pathogen TMDLs*, the availability of data may dictate which criterion should be used as the TMDL target (EPA, 2001). When a geometric mean of the sampling dataset can be calculated as defined by South Dakota Administrative Rules (i.e., at least five samples separated by a minimum of 24-hours over a 30-day period) and compared to the GM criterion, SD DANR uses the GM criterion as the TMDL target. This establishes a smaller overall loading capacity and is considered a conservative approach to setting the TMDL.

When a proper GM cannot be calculated, as in this case for Medary Creek (SD-BS-R-MEDARY_01), SD DANR uses the SSM as the TMDL target. This is permissible because the SSM is equally protective of the beneficial use as discussed above. Although this target selection leads to the establishment of a larger allowable load, in some respects it is more appropriate because timeframes align better (i.e., the SSM is associated with a single day and TMDLs establish daily loads, versus the 30-day GM). Additionally, certain aspects of SD DANR's *E. coli* assessment method, when combined with a SSM TMDL target, result in an expected dataset GM more protective than the GM criterion. SD DANR uses assessment methods to define how to interpret and apply water quality standards to 303(d) impairment decisions.

Returning to the original distribution used to establish South Dakota's Immersion Recreation *E. coli* criteria in the **Figure above**, remember that SD DANR chose to adopt a SSM concentration based on the most stringent recommendation (75th percentile). According to assessment methods in South Dakota, however, the SSM concentration is treated as a 90th percentile (i.e., 10% exceedance frequency). Step #1 in the **Figure below** shows how doing so effectively moves the SSM point to the right. If the original log-normal frequency distribution with a log-standard deviation of 0.4 is subsequently re-fitted to this new 90th percentile point at 235 #/100mL (red dotted line), the corresponding 50th percentile (GM) is 72 #/100mL as shown in Step #2 of the **Figure below**.



The Effective Impact of South Dakota's *E. coli* Assessment Method on the Criteria's Original LogNormal Frequency Distribution (Black line = original; red dotted line = shifted)

The GM associated with this shifted distribution is more stringent than the GM of the original distribution (#/100mL), thus this demonstrates that attaining a maximum daily SSM target in a TMDL will also achieve the 30-day GM criterion when following South Dakota's assessment method. A similar conclusion was determined by EPA in *An Approach for Using Load Duration Curves in the Development of TMDLs* (US EPA, 2007) using Michigan criteria as an example.

Finally, while the SSM is associated with a single day of sampling and the GM is associated with 30 days of sampling, it is not technically appropriate to refer to them as "acute" and "chronic" criteria. Those terms distinguish timeframes over which harm-to-use impacts develop, not the sampling or averaging timeframe as with the SSM and GM. Acute refers to an effect that comes about rapidly over short periods of time. Chronic refers to an effect that can build up over longer periods, sometimes as long as the lifetime of a subject. In the case of *E. coli*, gastrointestinal illness develops within a matter of hours to days. Both the SSM and GM are derived from this same timeframe and based on the same underlying illness rate, thus treating the SSM as an acute criterion and assuming it to be less stringent is incorrect. EPA recommends states use the GM and SSM together, rather than just the GM or just the SSM, to judge whether water quality is protective of recreational uses. SD DANR follows these guidelines and only relies on one criterion when forced by data availability.

Appendix D: *E. coli* Die-off Considerations

Natural die-off of bacteria during transport can substantially reduce delivered loads between a source and a downstream receiving water. For sources located a considerable distance upstream of an impaired waterbody, particularly under dry and low-flow conditions when velocities are reduced and travel times increase, bacterial die-off is an important factor in evaluating downstream water quality protection.

The City of Platte wastewater treatment facility (WWTF) is the only permitted point source within the SD-MI-R-PLATTE_01_USGS watershed with the potential to contribute *E. coli* to Platte Creek. Discharges from the WWTF are intermittent and enter Platte Creek through an unnamed tributary approximately 0.7 miles upstream of the mainstem. From this location, flow travels approximately 16.1 miles downstream to its confluence with Lake Francis Case.

WLAs were initially calculated based on permitted discharge flows and the facility's SSM *E. coli* permit limit. To support evaluation of downstream water quality protection, natural bacterial die-off during downstream transport was evaluated using estimated travel time and first-order decay.

Travel Time Estimation

Travel time for *E. coli* transport from the City of Platte WWTF to Lake Francis Case was estimated using reach length and flow-regime-specific channel velocity data derived from USGS channel-measurement records collected between 1988 and 2026.[6] Velocity data were stratified using load duration curve (LDC) percentiles to distinguish between dry-flow and low-flow hydrologic conditions.

The LDC framework was used to partition hydrologic conditions into two representative regimes: a dry-flow regime, and a low-flow regime. Channel velocity measurements associated with each regime were extracted from USGS channel measurements for Station 06452320.

Within each flow regime, channel velocity exhibited skewed distributions due to hydraulic variability and measurement conditions. Therefore, the median channel velocity was selected as the representative statistic for each regime to reduce sensitivity to outliers and better represent typical hydraulic conditions. The resulting median channel velocities were 0.45 ft/s for the dry condition flow regime, and 0.165 ft/s for the low flow regime.

Travel time for the dry-flow regime was calculated as:

$$t = \frac{L}{v} = \frac{88{,}704\ ft}{0.45(\frac{ft}{s})} = 197{,}120\ s \approx 2.28\ days$$

[6] https://api.waterdata.usgs.gov/ogcapi/v0/openapi?f=html#/channel-measurements/getChannel-measurementsFeatures

Travel time for the low-flow regime was calculated as:

$$t = \frac{L}{v} = \frac{88{,}704\ ft}{0.165(\frac{ft}{s})} = 537{,}600\ s \approx 6.22\ days$$

Where:

- L = reach length (16.8 miles)
- v = representative median velocity (0.45 ft/s) and (0.165 ft/s)

E. coli Decay Analysis

Natural bacterial die-off of *E. coli* during downstream transport was evaluated to estimate the concentration delivered to Lake Francis Case from the City of Platte WWTF. Bacterial decay was calculated using first-order exponential decay equation:

$$C_x = C_0 e^{-kt}$$

Where:

- C_0 = *E. coli* concentration at the discharge location (1,178 cfu/100 mL)
- C_x = *E. coli* concentration delivered to the downstream receiving water
- k = decay coefficient (day^{-1})
- t = travel time (days)

A decay coefficient of 0.96 day^{-1} was applied based on EPA guidance, representing the median fecal coliform disappearance rate derived from 30 in-suit field studies (EPA, 1985)[7]. Although derived from fecal coliform data, this coefficient is commonly applied to *E. coli* in TMDL analyses because *E. coli* is a subset of fecal coliform bacteria and exhibits similar in-stream persistence and die-off behavior. This value is consistent with decay rates used in previously approved bacteria TMDLs and is appropriate for modeling natural bacterial die-off in surface waters where site-specific data are unavailable.

Substituting the WWTF permit limit concentration of 1,178 cfu/100 mL, the decay coefficient, and the estimated travel time into the decay equation for the dry and low flow regime yields:

$$C_x = 1{,}178 \times e^{-(0.96)(2.28)} = 131 \frac{cfu}{100\ mL}$$

$$C_x = 1{,}178 \times e^{-(0.96)(6.22)} = 3.0 \frac{cfu}{100\ mL}$$

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[7] US EPA (U.S. Environmental Protection Agency). 1985. Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling. Second Edition. EPA/600/3-85/040. Environmental Research Laboratory, Athens, GA.

This calculation indicates that *E. coli* concentrations are substantially reduced during transport through the unnamed tributary and Platte Creek prior to reaching Lake Francis Case. Application of the first-order decay equation indicates that an *E. coli* concentration of 1,178 cfu/100 mL at the WWTF discharge would be reduced to approximately 131 cfu/100 mL and 3.0 cfu/100mL at Lake Francis Case under dry and low-flow conditions. This estimate is based on a conservative travel time derived using a representative median channel velocity measured during dry conditions.

These results demonstrate that substantial natural attenuation of E. coli occurs during downstream transport from the City of Platte WWTF to Lake Francis Case. Under the evaluated dry-flow condition, the permitted discharge concentration of 1,178 cfu/100 mL is estimated to decrease to approximately 132 cfu/100 mL prior to reaching the receiving water, while concentrations under low-flow conditions are estimated to decrease to approximately 3.0 cfu/100 mL due to increased travel time and associated bacterial die-off. These estimated downstream concentrations are below the applicable E. coli water quality criteria for recreation waters, indicating that the permitted discharge from the WWTF is not expected to cause or contribute to exceedances in Lake Francis Case under the evaluated conditions. The analysis therefore supports the conclusion that the existing permit limit is protective of downstream water quality when natural in-stream bacterial decay is considered.

Appendix E – EPA Approval Letter and Decision Document