Escherichia coli (*E. coli*) BACTERIA TOTAL MAXIMUM DAILY LOAD EVALUATION FOR MEDARY CREEK BROOKINGS COUNTY, SOUTH DAKOTA

South Dakota Department of Agriculture and Natural Resources

Division of Resource Conservation and Forestry

Watershed Protection Program

2023

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Acronym List

Acronym	Definition
ARSD	Administrative Rules of South Dakota
BMP	Best Management Practice
BSRP	Big Sioux River Implementation Project
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)
EDWDD	East Dakota Water Development District
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
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
NASS	National Agricultural Statistic Survey
NPDES	National Pollutant Discharge Elimination System
SSM	Single Sample Maximum
SRAM	Seasonal Riparian Area Management
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WISKI	Water Information Systems by KISTERS
WLA	Wasteload Allocation
WPP	Watershed Protection Program (South Dakota)
WQM	Water Quality Monitoring

Total Maximum Daily Load Summary

Waterbody Type:	River/Stream
Assessment Unit Identification (AUID):	SD-BS-R-MEDARY_01
303(d) Listing Parameter:	Pathogens (*Escherichia coli*)
Designated Uses of Concern:	Limited Contact Recreation
Location:	Minnesota Border to the confluence with the Big Sioux River
Size of Impaired Waterbody:	Approximately 38.2 miles

Size of Watershed:

Name	HUC12	Acres
Upper Deer Creek (SD/MN)	101702020901	29,510.54
Lower Deer Creek	101702020902	13,238.51
Lower Medary Creek	101702021003	26,129.84
Middle Medary Creek	101702021002	31,226.16
Upper Medary Creek (SD/MN)	101702021001	28,395.90
		128,500.95

Indicator(s):	Concentration of *Escherichia coli* (colony forming units per 100 milliliter [mL])
Analytical Approach:	Load Duration Curve Framework
TMDL Priority Ranking:	High Priority (2022 Integrated Report [IR])
Target (Water Quality Criteria):	*Escherichia coli* (*E. coli*) - Maximum daily concentration of ≤ 1178 CFUs/100mL and a geometric mean of ≤ 630 CFUs/100mL based on a minimum of five (5) samples obtained during separate 24-hour periods for any 30-day period.

Limited Contact Recreation *E. Coli* TMDL	Medary Creek Flow Zones Expressed as (CFU/day)				
	High Flows	Moist Conditions	Mid-Range Conditions	Dry Conditions	Low Flows
Flow Rate	≥ 306.76	306.75 -112.94	112.93 - 38.26	38.25- 4.37	≤ 4.36
WLA	0	0	0	0	0
LA	5.06E+13	7.09E+12	2.82E+12	8.74E+11	1.02E+11
10% Explicit MOS	5.62E+12	7.88E+11	3.13E+11	9.71E+10	1.13E+10
TMDL @ 1178 CFU/100mL	5.62E+13	7.88E+12	3.13E+12	9.71E+11	1.13E+11
Current Load	4.36E+13	6.17E+12	4.74E+12	1.12E+12	1.30E+11
Load Reduction	0%	0%	33.82%	13.64%	13.22%

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. The intent of this document is to clearly identify the components of the TMDL process and facilitate EPA review and approval. Medary Creek segment 1 was considered high priority for TMDL development in the 2022 Integrated Report for Surface Water Quality Assessment. The impaired waterbody begins at the Minnesota border in Brookings County, South Dakota extending to its confluence with the Big Sioux River and is identified as SD-BS-R-MEDARY_01 (SD DANR, 2022). This TMDL document addresses the *Escherichia coli (E. coli)* bacteria impairment for Medary Creek segment 1.

1.1 *E. coli* Summary

Elevated concentrations of *E. coli* can put humans at risk for contracting water-borne illnesses. The presence of *E. coli* pathogens in a waterway can also impair the waterbody's recreation beneficial uses. Water quality assessment methods are designed to evaluate the most sensitive use to ensure protection of all the beneficial uses. In this TMDL, limited contact recreation has the most stringent *E. coli* standard for Medary Creek's beneficial uses. *E. coli* production in Medary Creek segment 1 is attributable to both naturally occurring and human-caused sources. Human-caused sources include agricultural practices and failing or malfunctioning septic systems. Naturally occurring sources of *E. coli* is primarily from wildlife excrement. An *E. coli* reduction is needed in several flow zones in order 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 Medary Creek segment 1 watershed.

2.0 Watershed Characteristics

The following sections provide a general description of the physical and human geography of the watershed area. This includes location, climate, hydrology, topography, and land use.

2.1 Location

The general location of Medary Creek segment 1 is presented in ***Figure 1***. Medary Creek segment 1 is a tributary of the Big Sioux River in eastern South Dakota. The stream measures approximately 38.2 miles (61.48 km) from the Minnesota border, running west until its confluence with the Big Sioux River. U.S Highway 14 is north of the stream and U.S. State Highway 324 & 13 are located south of the stream. The total drainage area by Medary Creek and its tributaries, including Deer Creek, encompasses 128,500.95 acres (200.78 square miles). Approximately 102,084 acres (159.506 square miles) reside in South Dakota. Medary Creek's headwaters are concentrated in the northeast portion of Brookings County near the South Dakota/Minnesota border. ARCMap geoprocessing tools were used to calculate the length and size of the Medary Creek segment 1 watershed.

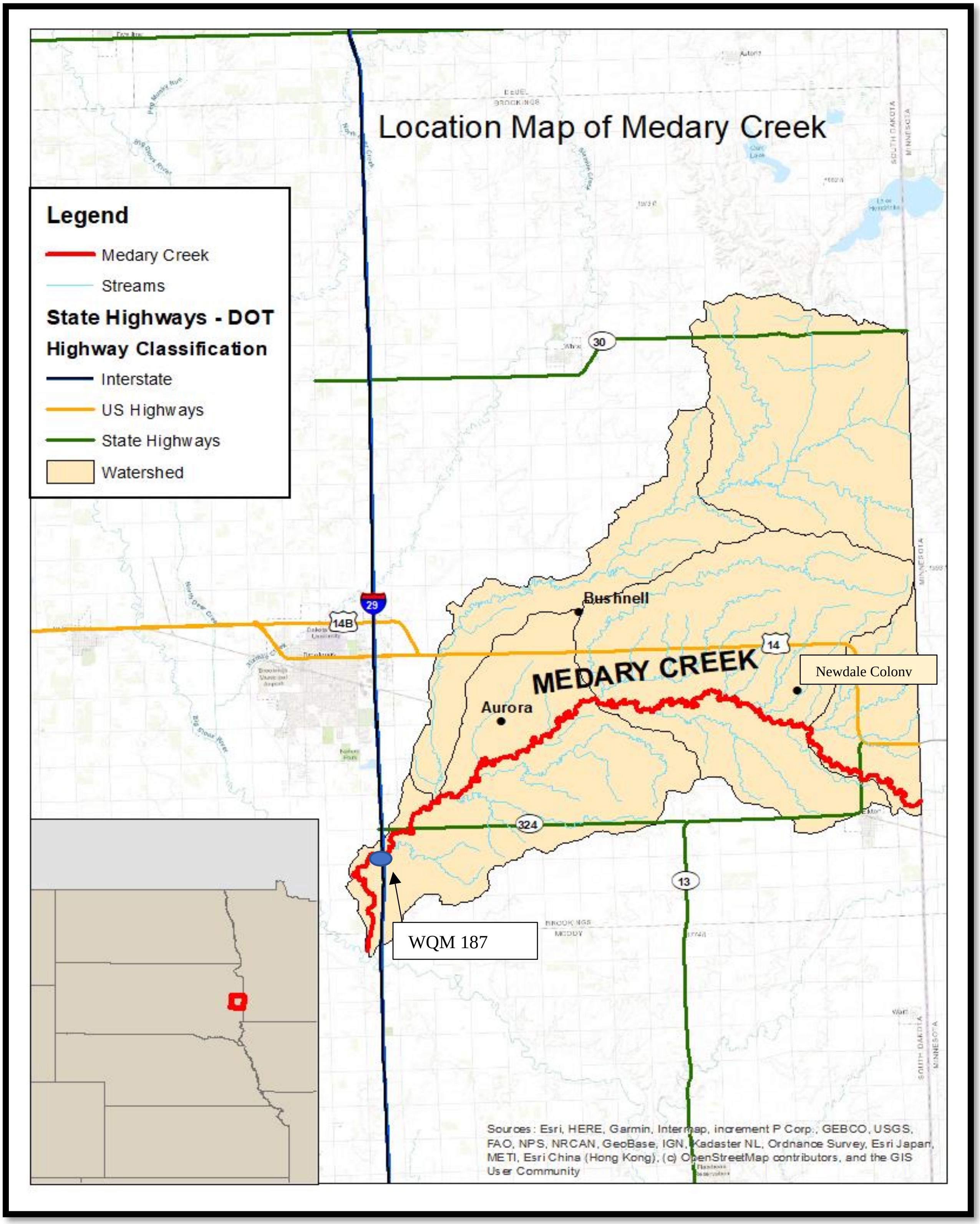

Figure 1- Medary Creek Watershed Location Map

2.2 Climate

Medary Creek's climate is considered humid continental with humid summers and cold, dry winters, and is in USDA Hardiness Zone 4. Climate data from January 2010 through December 2021 was retrieved from the National Centers for Environmental Information (NOAA, 2022) and presented in ***Table 1***. The lowest average temperature was recorded at 4.6°F in February 2019. The highest average temperature was recorded at 77.4°F in July 2012. Averages were calculated monthly by adding daily temperatures together and dividing by the number of days within that month. As for daily temperatures, a maximum temperature of 89.2°F was recorded in July 2012 while a minimum temperature of -3.5°F was recorded in February 2019. Most of the precipitation falls during the warming period, and rainfall is usually heaviest late spring and in the summer months. Average period temperature was estimated at 44.02°F and the average annual period precipitation for Brookings County was 2.36 inches. These were calculated by finding the monthly averages and dividing by the twelve months of the year.

Table 1- Average Temperature and Precipitation in Brookings County, South Dakota

Year	Average Yearly Tempeature (°F)	Annual Maximum Temperature (°F)	Annual Minimum Temperature (°F)	Average Annual Precipitation (inches)
2010	43.76	53.7	33.8	3.12
2011	43.13	53.5	32.8	2.05
2012	47.38	59.1	35.6	1.95
2013	41.32	51.4	31.2	2.16
2014	41.09	51.3	30.9	2.04
2015	45.64	56.1	35.2	2.33
2016	46.42	56.5	36.4	2.55
2017	45.04	55.3	34.8	2.28
2018	42.5	52.1	32.9	2.72
2019	40.93	50	31.8	3.39
2020	44.69	55.3	34.1	1.69
2021	46.3	56.9	35.7	2.02
Period Average	44.02	54.27	33.77	2.36

2.3 Hydrology

The Medary Creek segment 1 watershed is comprised of five United States Geological Survey (USGS) Hydrologic Unit Code (HUC) boundaries. Its reach is concentrated in the eastern portion of Brookings County. The five HUC 12 subwatersheds can be found in ***Figure 2***. Medary Creek's major tributary, Deer Creek, is not considered impaired for *E. coli*.

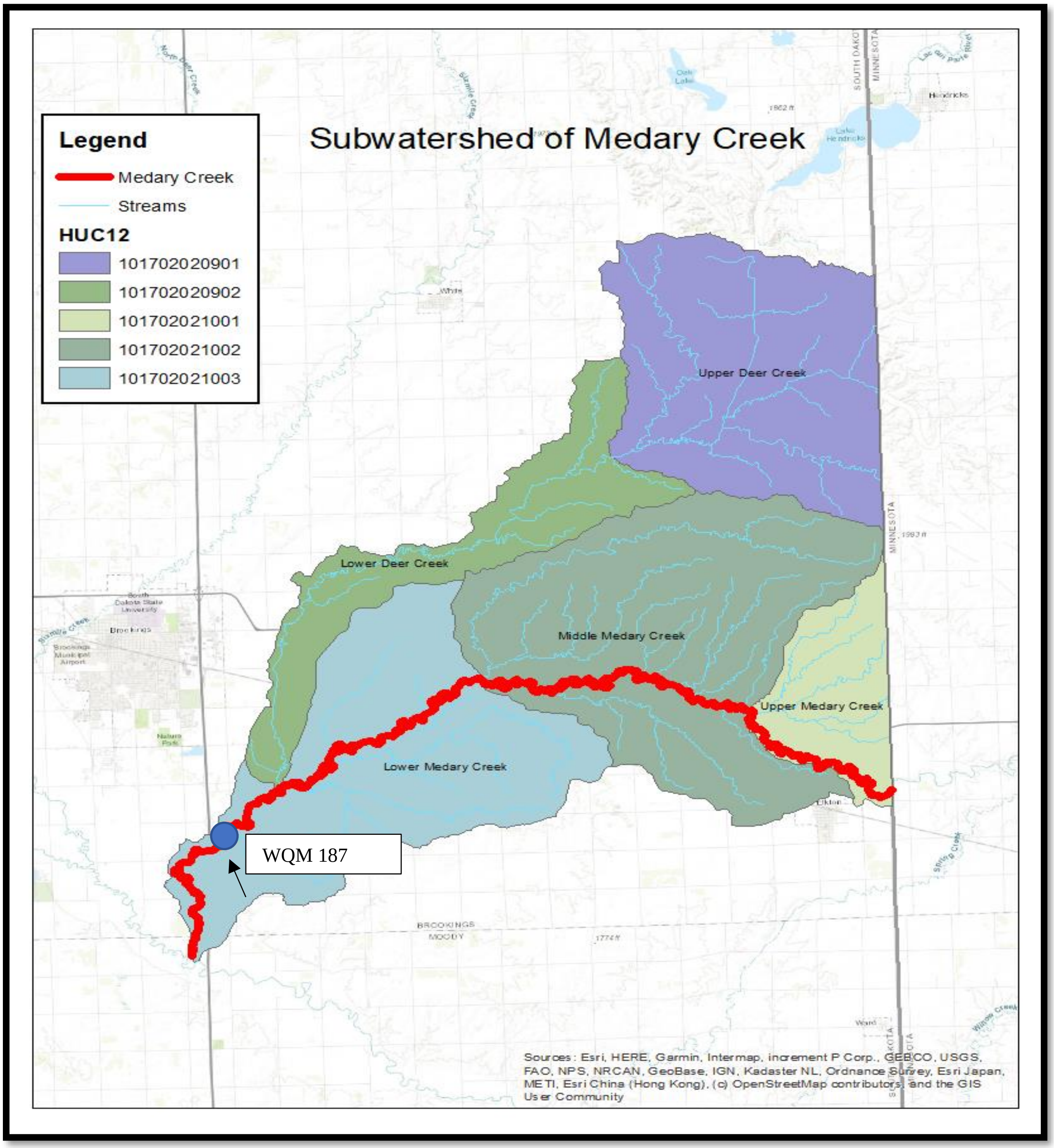

Figure 2 - Subwatershed Map of Medary Creek

2.4 Topography

Elevational change is minimal within the watershed, with the Upper Deer Creek subwatershed possessing the highest elevation. The Medary Creek watershed has a maximum elevation of 610 meters (2001 feet) and a minimum elevation of 475 meters (1558 feet) near the confluence with the Big Sioux River. The topographical map represents the elevational changes in the South Dakota portion of the Medary Creek watershed (***Figure 3)***.

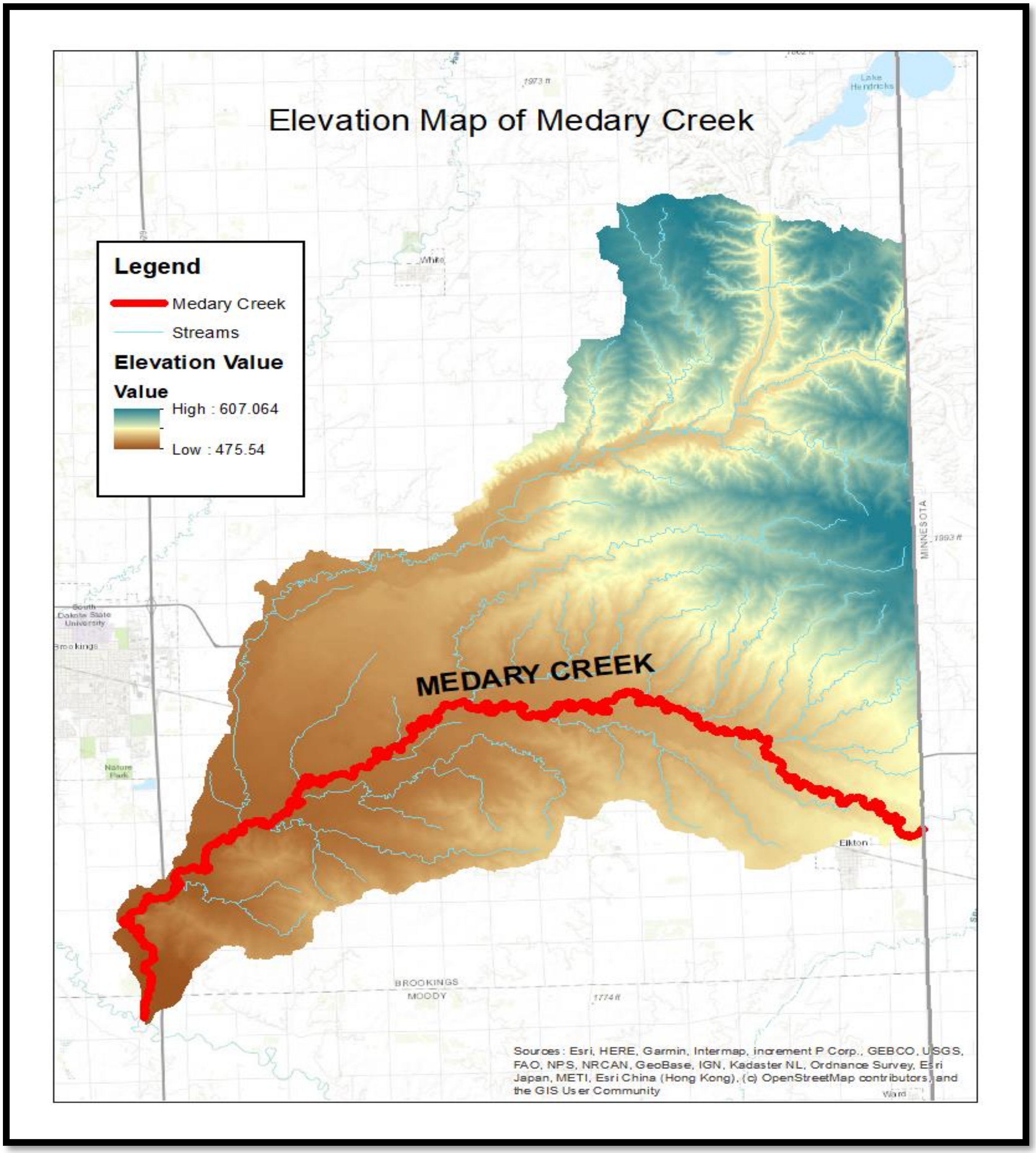

Figure 3- Topographic Map of Medary Watershed

2.5 Demographics

The Medary Creek segment 1 watershed encompasses three municipalities: Aurora, Bushnell, and Newdale Colony. According to the 2020 U.S. Census Bureau, Bushnell and Newdale Colony have populations less than 100, with Aurora nearing three thousand. Approximately 2,043 individuals account for the rural population within the watershed. The total estimated population residing in the Medary Creek segment 1 watershed is around 4,985 individuals. A list of municipalities and their population can be found in ***Table 2***.

Table 2- Population of Municipalities in the Medary Creek Watershed

Town	Population (2020)
Aurora	2,747
Bushnell	71
Newdale Colony	6

2.6 Land Use

The two dominate land types in the Medary Creek segment 1 watershed consist of grassland and cropland. The cropland is used for growing corn, soybeans, and alfalfa, with corn covering 32% of land in the watershed. The additional agricultural land is predominately small grains consisting of oats, barley, and rye.

Grassland and pastures are predominately found in and around waterways and are concentrated in the Upper Deer Creek subwatershed. Grasslands represent a valuable resource and have many environmental benefits including wildlife habitat production, provision of biodiversity, and influential controls on hydrologic processes (Kibria et al. 2016). Grasslands also prevent flooding by reducing surface runoff which alleviates erosion control and water quality deterioration. Agricultural land used for livestock grazing can result in the degradation of riparian zones and have impacts on water quality by increasing water temperatures, sedimentation, and nutrient levels. The land use of the Medary Creek segment 1 watershed is displayed in ***Figure 4***.

Around 4% of the land use consists of developed areas which surround municipalities located in the watershed. Other low intensity developments are sporadic within the watershed. Land use change can contribute to alteration of surface runoff, flood frequency, baseflow, and annual mean discharge.

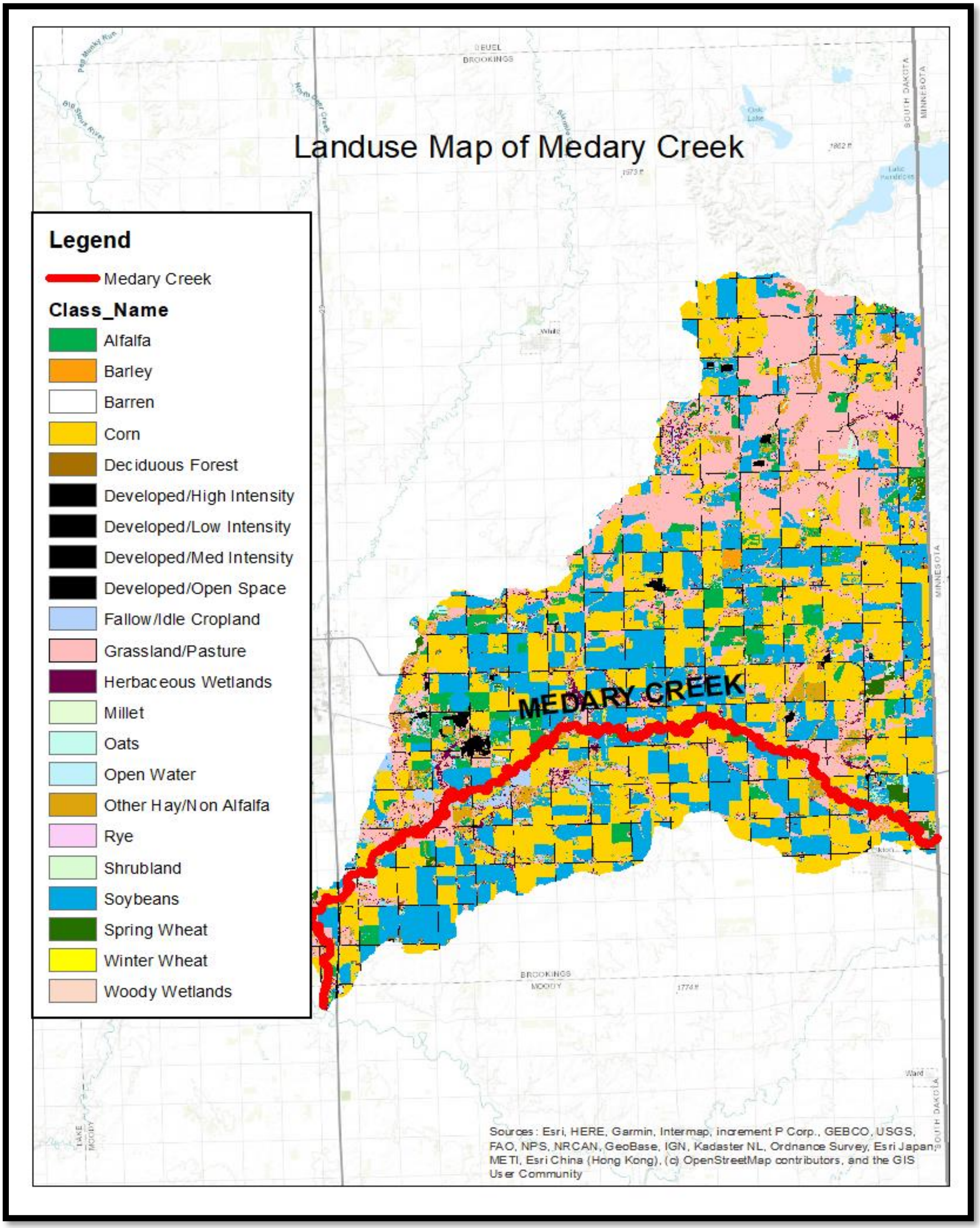

Figure 4- Land Use Map of Medary Creek Watershed

3.0 South Dakota Water Quality Standards

Water quality standards are comprised of three main components 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

The waterbodies in South Dakota are assigned 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 streams in South Dakota are assigned the beneficial uses (9) fish and wildlife propagation, recreation, and stock watering and (10) irrigation, unless stated otherwise in the Administration Rules of South Dakota (ARSD). Additional uses are designated by the state based on a waterbody specific use attainability assessment.

Medary Creek segment 1 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.

3.2 Water Quality Criteria

The water quality standard criteria that must be met to protect the beneficial uses of Medary Creek segment 1 can be found in ***Table 3***. When multiple criteria exist for a particular parameter, the most stringent criterion is used.

Table 3- South Dakota Surface Water Quality Criteria for Medary Creek

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

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 100ml, 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/100mL. 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/100mL. 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 5 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 5 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 1 through September 30, which is considered the recreation season.

TMDLs must be protective of downstream uses and associated water quality criteria. Medary Creek segment 1 flows into Big Sioux River segment 7 (SD-BS-R_BIG_SIOUX_07) which is also designated the limited contact recreation beneficial use. Because of this agreement, the Medary Creek segment 1 *E. coli* TMDL will be protective of the downstream recreation use. Big Sioux River segment 7 is currently meeting *E. coli* water quality criteria and is supporting the designated limited contact recreation use (SD DANR, 2022).

Medary Creek upstream of the South Dakota border (MN10170202-501) has been designated by Minnesota as a Class 2b Aquatic Recreation water. The daily SSM and monthly GM *E. coli* criteria for Class 2b Aquatic Recreation waters is 1,260 MPN/100mL and 126 MPN/100mL, respectively. Both criterion are applicable from April 1 to October 31. An assessment of the aquatic recreation use has not been conducted by the Minnesota Pollution Control Agency due to insufficient data (i.e., EPA category 3) according to Minnesota's 2022 305(b) assessment results available in How's My Waterway. South Dakota's daily SSM criterion (1,178 CFU/100mL) is more stringent than Minnesota's daily criterion (1,260 MPN/100mL), which should be considered in future TMDL development for Medary Creek in Minnesota to ensure protection of the downstream use in South Dakota.

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 3***). 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 B***). 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 1,178 cfu/100mL was selected as the numeric TMDL target for Medary Creek segment 1. 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 4***.

Table 4- Assessment Methods for Determining Support Status for Section 303(d) (SD DANR 2022)

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 B***, the assessment method is organized together with other conventional parameters in the Integrated Report 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 6.0**, nonpoint sources, and point sources of *E. coli* in the Medary Creek segment 1 watershed are presented. All point sources are identified with a permit through the National Pollutant Discharge Elimination System (NPDES). Nonpoint sources were identified by estimating population densities within the watershed area.

6.1 Point Sources

The U.S. Environmental Protection Agency (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 craft 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)[1]. Point sources are often wastewater treatment plants or industrial facilities that discharge effluent directly into waterbodies. Point sources of *E. coli* and potential impact are documented in this section to consider Waste Load Allocation (WLA) for TMDL development.

City of Aurora (NPDES Permit # SDG821661)

The city of Aurora is not permitted to discharge wastewater from its wastewater treatment facility. As a result, this facility is not expected to contribute *E. coli* bacteria to Medary Creek segment 1 and was not assigned a WLA in the TMDL.

Valero Renewable Fuels Company (NPDES Permit # SD0027898)

Valero is an ethanol processing plant and is not designed to discharge domestic wastewater (no *E. coli* effluent limits). As a result, discharge from this facility is not expected to contribute *E. coli* to Medary Creek segment 1 and was not assigned a WLA in the TMDL.

Newdale Colony (NPDES Permit # SDG829001)

Newdale Colony is not permitted to discharge wastewater from its wastewater treatment facility. As a result, this facility is not expected to contribute *E. coli* bacteria to Medary Creek segment 1 and was not assigned a WLA in the TMDL.

6.1.1 CAFOs in the Medary Creek Watershed

There are eleven permitted Concentrated Animal Feeding Operations (CAFOs) within the Medary Creek segment 1 watershed (***Table 5***). Seven 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. Bobcat Farms RE, LLC, Christensen Farms & Feedlots, Inc. F165, KC Dairies, LLP, and Norfeld Hutterian Brethren, Inc. (North Site) have state permit coverage under

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

the 2017 General Water Pollution Control Permit for CAFOs and are 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 a 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, and allows open lots to only have a discharge of manure or process wastewaters from properly designed, constructed, operated and maintained manure management systems in the event of 25-years, 24-hour or 100-year, 24-hour storm event if they meet the permit conditions. The general permit was reissued and became effective on April 15, 2017. All CAFO's with coverage under the 2003 general permit have a deadline to apply for coverage under the 2017 general permit.

All facilities with a general permit number that starts 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, and 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 5- Concentrated Animal Feeding Lots in Medary Creek Watershed

Name of Facility	Type of Operation	SD General Permit #
Bobcat Farms RE, LLC	production swine (housed lot)	SDG-100557
Buffalo Ridge Ranch	production swine (housed lot)	SDG-0100159
Christensen Farms & Feedlots, Inc. F165	finisher swine (housed lot)	SDG-100134
Crosswind Heifer Facility	dairy cattle (housed lot)	SDG-0100009
Hilltop Farms, LLC	dairy (housed lot)	SDG-0100007
KC Dairies, LLP	dairy (housed lot)	SDG-100031
Kodiak Pork RE, LLC	production swine (housed lot)	SDG-0100522
Luze & Sons Feedlot	beef cattle (housed and open lots)	SDG-0100467
Norfeld Hutterian Brethren, Inc. (North Site)	multiple animals (housed lots)	SDG-100456

Norfeld Hutterian Brethren, Inc. (Swine Operation)	finisher swine (housed lot)	SDG-0100098
Rolland Hutterian Brethren, Inc.	multiple animals (housed lots)	SDG-0109191

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, maintenance, inspections, record keeping, and reporting requirements.

For more information about South Dakota's CAFO requirements and general permits visit: South Dakota Feedlot Permit Program (sd.gov). As long as these facilities comply with the general CAFO permit requirements ensuring their discharges are unlikely and indirect loading events, the TMDL assumes their *E. coli* contribution is minimal, and unless found otherwise, no additional permit conditions are required by this TMDL.

Potential *E. coli* sources from Minnesota include several CAFO's, Supreme Pork Inc. and Ash Grove Dairy. Under their NPDES permits, both facilities are not permitted to discharge into waters of the state. As a result, both facilities are not expected to contribute *E. coli* bacteria to Medary Creek segment 1.

6.2 Nonpoint Sources

A comprehensive assessment of the total *E. coli* production from nonpoint sources was estimated for the Medary Creek segment 1 watershed. Nonpoint sources of *E. coli* originate primarily from wildlife (i.e., natural background), agriculture and humans. Due to a lack of literature values for *E. coli* for many livestock, human and wildlife species, source calculations were based on fecal coliform (***Table 6***). This is an acceptable surrogate to source characterization because *E. coli* is a bacterium within the fecal coliform group. Further, fecal coliform source contributions are considered synonymous with *E. coli* based on the close statewide paired bacteria data relationship documented 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, 2019; Huxoll, 2002). Animal density information was used to estimate relative source contributions of bacteria for the Medary Creek segment 1 watershed (***Table 6***). The watershed encompasses approximately 19.8% of Brookings County. The total number of livestock in Brookings County were divided proportional to the number of acres in the watershed. The same procedure was also used for humans and wildlife. *E. coli* estimates for livestock and most wildlife species were obtained from EPA's Bacteria Indicator Tool (USEPA, 2000). Bacteria production in the Medary Creek segment 1 watershed was estimated at 2.10E+10 colony forming units/acre/day (***Table 6***).

Table 6- Medary Creek E. coli Nonpoint Source Bacteria Production

Species	#/acre watershed	Bacteria/Animal/Day	Bacteria/Acre/Day	Percent
Beef Cow[2]	1.61E-01	1.00E+11	1.61E+10	76.84%
Dairy Cow[2]	3.55E-02	1.00E+11	3.55E+09	16.94%
Hogs[2]	9.80E-02	1.10E+10	1.08E+09	5.14%
Human[2]	4.88E-02	2.00E+09	9.77E+07	0.47%
All Wildlife	Sum of all Wildlife		1.28E+08	0.61%
Whitetail Deer[2]	5.24E-03	5.00E+08	2.62E+06	
Mule Deer[2]	4.90E-05	5.00E+08	2.45E+04	
Turkey (Wild)[1]	9.80E-05	9.30E+07	9.11E+03	
Oppossum[4]	6.76E-03	1.30E+08	8.79E+05	
Mink[4]	4.51E-03	1.30E+08	5.86E+05	
Beaver[2]	3.38E-03	2.50E+08	8.45E+05	
Muskrat[2]	1.46E-02	1.30E+08	1.90E+06	
Skunk[4]	1.24E-02	1.30E+08	1.61E+06	
Badger[4]	9.01E-04	1.30E+08	1.17E+05	
Coyote[3]	7.89E-04	4.10E+09	3.23E+06	
Fox[3]	1.58E-03	4.10E+09	6.47E+06	
Raccoon[2]	2.25E-02	1.30E+08	2.93E+06	
Jackrabbit[4]	5.63E-03	1.30E+08	7.32E+05	
Cottontail Rabbit[4]	2.25E-02	1.30E+08	2.93E+06	
Squirrel[4]	2.25E-02	1.30E+08	2.93E+06	
Partridge[2]	4.51E-03	1.36E+08	6.13E+05	
Prairie Chicken[2]	2.25E-05	1.36E+08	3.06E+03	
Sharptail Grouse[2]	1.13E-04	1.36E+08	1.53E+04	
Nest Canada Geese[2]	2.03E-03	4.90E+10	9.94E+07	
Total			2.10E+10	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 Agriculture Sources

Agricultural sources of *E. coli* can be present in the fecal deposits livestock produce which can enter waterways through direct deposition or indirectly from watershed-scale run-off during precipitation events. Most of the rangeland and pasture is in the northern portion of the watershed (***Figure 4***).

Swine were absent in the 2022 NASS estimates for Brookings County. A decision was made to estimate bacteria production from swine based on the five swine CAFOs that exist in the watershed (***Table 5***). The minimum number of swine in a CAFO (2,500 head) was multiplied by the five swine facilities to estimate population density of swine in the Medary Creek watershed. CAFOs are regulated as part of the permitting process to ensure pollutants are not discharged directly from the facilities. Other species' bacteria contribution estimates were calculated by multiplying the population density by the bacteria produced from each species per day.

Beef cattle were determined as the largest source of *E. coli* in the Medary Creek segment 1 watershed accounting for 76.84% of the total bacteria production. Total bacteria production from livestock was estimated at 98.92% (***Table 6).*** Implementing best management practices (BMPs) focused on reducing bacteria inputs from livestock sources is warranted to achieve TMDL goals.

6.2.2 Human Sources

Data provided by the U.S Census Bureau and ArcMap program was used to calculate the watershed area so human sources of bacteria production could be estimated. The total population of the three municipalities include 2,824 individuals. The estimated rural population living in the watershed is approximately 2,043. It is then assumed that the rural population is equipped with properly functioning septic systems that contribute no load production. The bacteria production of a single human per day is estimated at 1.95E+09 (Yagow et al. 2001). The total production from humans in the watershed is less than 1%.

6.2.3 Natural Background Sources

Naturally occurring *E. coli* sources are represented through wildlife estimates in the Medary Creek segment 1 watershed. Wildlife population density estimates were obtained from the South Dakota Department of Game, Fish, and Parks. It was estimated that wildlife contributed less than 1% of the total *E. coli* produced in the watershed. From the assessment, the main wildlife producer of bacteria was Canada Geese (*Branta Canadensis*) which produced 9.94E+07 cfu per acre per day.

7.0 Data Collection

7.1 Water Quality Data and Discharge Information

All measured flow and water quality data acquired for the development of this TMDL can be found in ***Appendix A***. *E. coli* data was obtained from one monitoring station by two sources: DANR – Ambient Water Quality Monitoring and East Dakota Water Development District (EDWDD) internal monitoring and Rotating Basins Project monitoring. Sampling methods were conducted in accordance with the South Dakota Standard Operating Procedures for Field Samplers (sd.gov). The samples were then sent to the State Health Laboratory in Pierre, SD for analysis.

The Medary Creek Water Quality Monitoring (WQM) site was established in 2016. The assigned WQM Station ID for Medary Creek segment 1 is WQM 187 and is located at 473rd Avenue off the Elkton exit (44.237144, -96.747038) (***Figure 1)***. *E. coli* data was obtained from this monitoring station between the years 2016 and 2022 during the recreational season (May 1st through September 30th).

7.1.1 Flow Information and Data

In 2018, a long-term continuous stream stage recorder was installed at WQM 187 as part of the Watershed Protection Programs (WPP) Statewide Streamflow Monitoring Network: SD DANR Streamflow Monitoring Network. This electronic stage recorder measures stream height from a fixed position on the bridge deck to the water surface. The stage recorder was calibrated with a fixed wire weight gage tied to bridge deck elevation at mean sea level. The recorder is programmed to log stream stage at 15-minute intervals. Field staff from WPP and EDWDD measured stream discharge periodically at varying stages of the hydrograph during the period of record (5/22/18 to 9/20/22).

The hydrologic modeling program Water Information Systems (WISKI) (version 7.4.13 SR7) developed by Kister's Inc., (https://www.kisters.net/NA/) was used to generate a stage-discharge rating curve (relationship) for the period of record. Rating curve development involved functions available in WISKI to create the best fit line between paired stage and periodic discharge measurements (***Figure 5***). Three equations were generated to best estimate flow for a given stage at different height intervals:

81.5 - 86: (Discharge Corrected [ft^3/s]) = 74599.72382 - 1888.783185 * (Stage corrected [ft])^1 + 11.94213435 * (Stage corrected [ft])^2

86 - 87.25: (Discharge Corrected [ft^3/s]) = 4.37661e-78 * (Stage corrected [ft])^ 41.3869

87.25 - 92: (Discharge Corrected [ft^3/s]) = 356917.2534 - 8751.912387 * (Stage corrected [ft])^1 + 53.5421742 * (Stage corrected [ft])^2

Equation based flows generated from the continuous stage data were used to develop a mean daily flow record (in cubic feet per second [cfs or ft^3/s]). The mean daily flows were used to develop a flow frequency curve for the aforementioned period of record. The flow frequency curve was used to develop the Load Duration Curve (LDC) based TMDL.

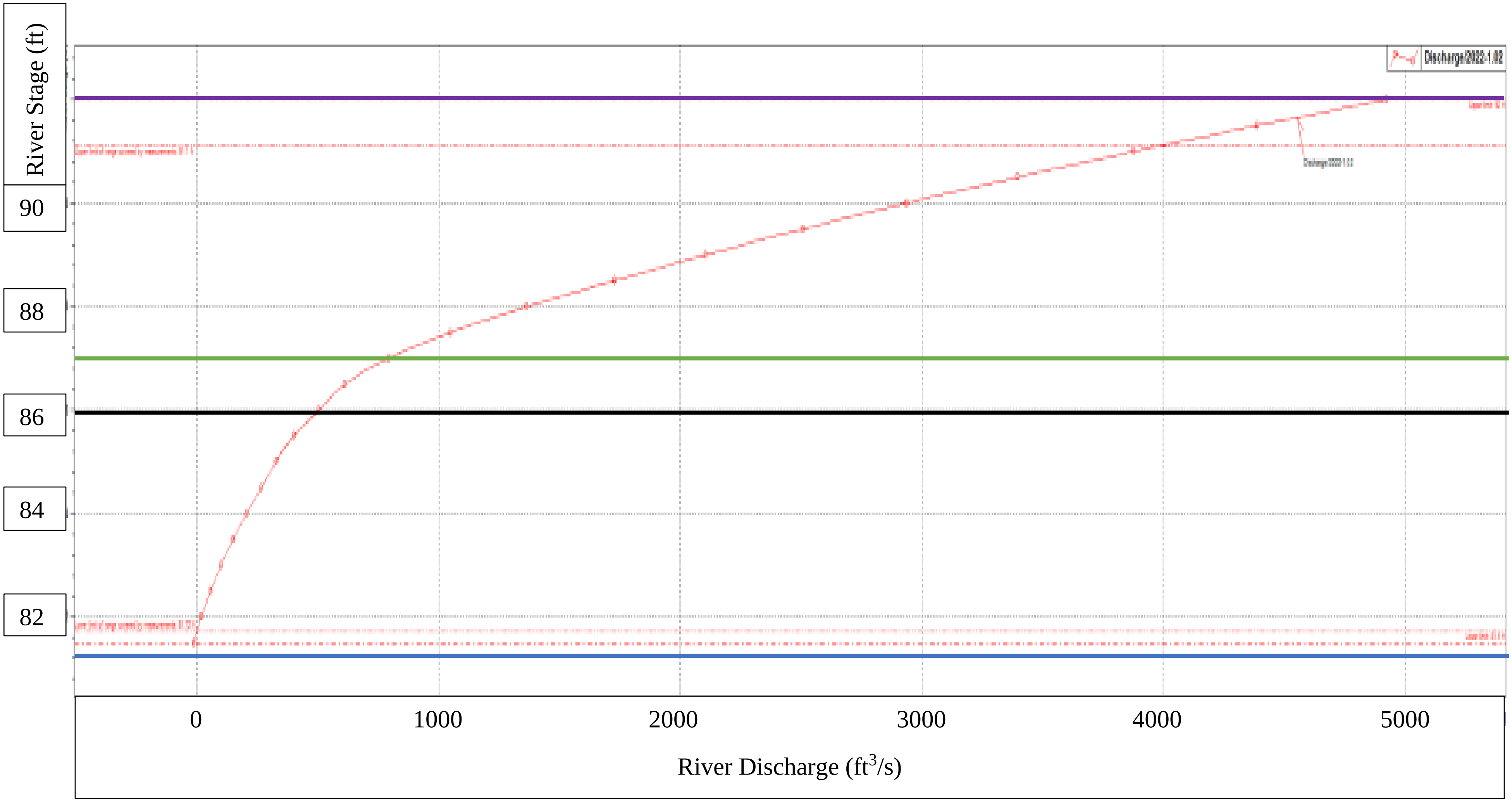

Figure 5- WQM 187 Rating Curve

7.1.2 *E. Coli* Water Quality Data

E. coli sample data was obtained from station WQM 187 during the recreation season (May 1st through September 30th) starting in 2016. Since flow data started in 2018, only *E. coli* samples from 2018 - 2022 were used for TMDL development (***Appendix A***), although the 2016-2017 sample years were included in ***Figure 6***.

In total, 63 *E. coli* samples were collected and used for TMDL development. *E. coli* concentrations range from a minimum of 8.5 cfu/100mL to a maximum of 3,460 cfu/100mL. Eight of the 63 samples exceeded the SSM criterion (1178 cfu/100 mL) for waters designated to the limited contact recreation use. Two samples collected in 2021 had an *E. coli* concentration of 1,200 cfu/100mL ***Figure 6***. The maximum *E. coli* concentration (3,460 cfu/100mL) was collected in 2018 but was not included in the graph to due to scale.

Approximately 12.7% of *E. coli* samples collected at WQM 187 from 2018-2022 exceeded the 1,178 cfu/mL SSM for limited contact recreation. *E. coli* data from WQM 187 was collected at a minimum once per month to a maximum of four times within a month. *E. coli* samples were not collected at a frequency required to calculate a GM.

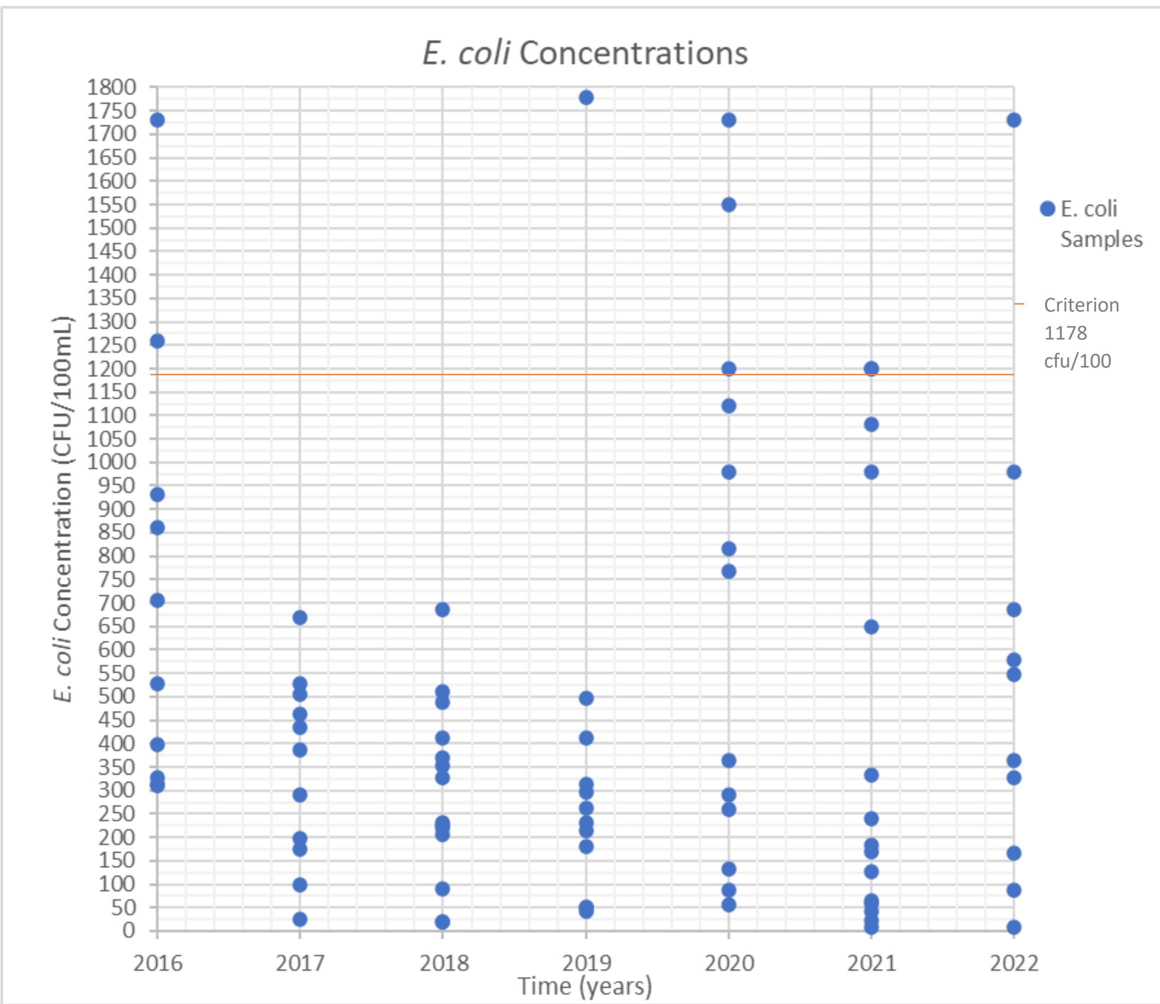

Figure 6 - E. coli Concentrations

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

The TMDL for Medary Creek segment 1 was developed using a Load Duration Curve (LDC) approach. A LDC model is a representation of the allowable loading capacity of a pollutant based on the relevant water quality criterion. The LDC considers the entire flow regime, thus, making it an appropriate method for determining flow-variable *E. coli* loading for Medary Creek. The LDC is separated into five flow zones (***Figure 7***); 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).

In **Section 4.0**, it was discussed why the limited contact recreation SSM of 1178 cfu/100mL for *E. coli* was selected as the numeric TMDL target for Medary Creek segment 1. The LDC was calculated by multiplying the SSM criterion by the average daily flow and then multiplying that by a unit conversion factor (24,465,525 mL*s / ft^3*day). The LDC represents the TMDL across the entire flow regime.

When the individual sample observations are plotted on the LDC, characteristics of the water quality impairment are shown. Observations that are plotted above the curve are exceeding the TMDL, while those below the curve are in compliance. *E. coli* samples collected from Medary Creek segment 1 exceed the TMDL in three flow zones (***Figure 7***). There are no exceedances in the high flow zone, but an exceedance in this zone can typically indicate nonpoint source contributions from storm-runoff. Exceedances in low flow zones typically indicate point sources or in-stream load contributions.

9.0 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 are the allocated loads of nonpoint sources as well as natural background sources. The 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 = ΣWLA + ΣLA + 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

9.1 Margin of Safety (MOS)

TMDLs are required to include a MOS to for uncertainty in data analyses. A margin of safety is established (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 Medary Creek segment 1, the latter approach was used to establish a safety margin for this TMDL.

An explicit MOS of 10% was calculated within the duration curve framework because the allocations are a direct function of flow, accounting for potential flow variability. Once the MOS was calculated for each flow zone, the remaining assimilative capacity was allocated to nonpoint sources (LA).

9.2 Waste Load Allocations (WLA)

There are two permitted wastewater treatment facilities in the watershed and in accordance with their NPDES permits, they are not allowed to discharge. Valero is the third permitted wastewater treatment facility and, in accordance with their NPDES permit, can discharge. However, Valero is an ethanol plant with no domestic waste discharged and is not expected to contain any amounts of *E. coli*. Valero was not given a wasteload allocation in the TMDL.

There are eleven permitted CAFOs in the Medary Creek segment 1 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. The WLA was set at zero (0) in all five flow zones.

9.3 Load Allocations (LA)

EPA regulations require that a TMDL include LAs, which identify the loading capacity from nonpoint sources and sources of natural background. Most of the bacteria production was associated with agricultural sources. A list of bacteria producers and their daily bacteria production per acre can be found in ***Table 6***. The LA was calculated by subtracting the 10 percent explicit MOS from the TMDL load at the standard for each flow zone (seen in the equation below).

LA = TMDL (-) MOS

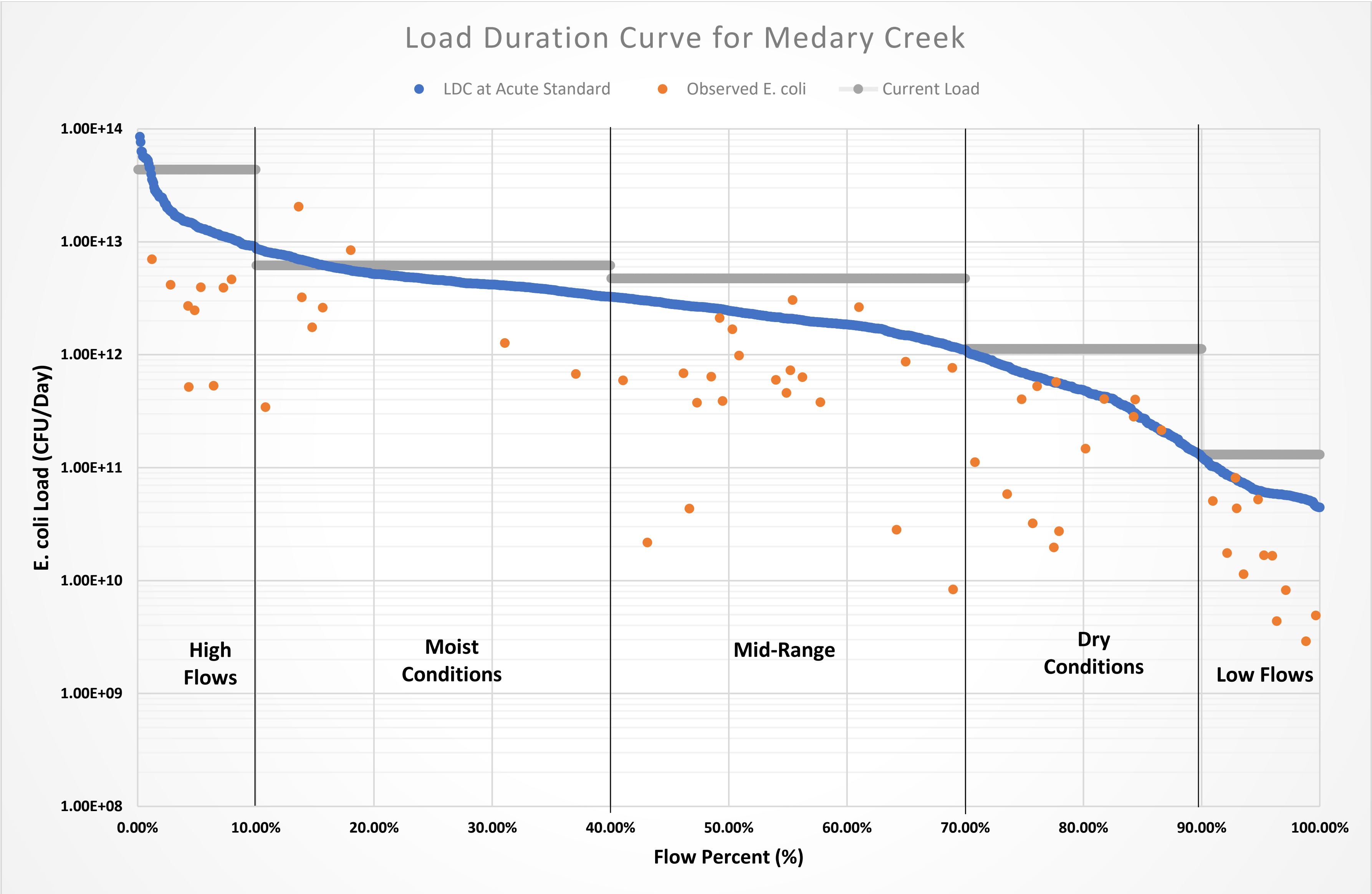

Figure 7 - Load Duration Curve for Medary Creek

Current load was calculated based off the 95th percentile flow and *E. coli* concentrations for all flow zones. Current loads above the LDC require a load reduction to reach TMDL attainment. There are three flow zones that require reductions (***Figure 7)***. Current loads below the LDC implies they are within TMDL attainment. Load reduction percentages for each flow zone were calculated using the following equation:

Percent reduction = [(existing load) – (allowable load)]/(existing load)*100

10.0 Numeric TMDL and Flow Zones

TMDL and allocations for each flow zone are presented in ***Table 7***. A maximum allowable load, or TMDL, is ultimately calculated by multiplying the numeric target (1178 CFU/100mL) with a flow value and a unit conversion factor. The entire TMDL is allocated to LA or nonpoint sources of pollution, requiring reductions to come from this section. There are no direct sources of *E. coli* from point sources.

Table 7- E. coli TMDL and Flow Allocations

Limited Contact Recreation *E. Coli* TMDL	Medary Creek Flow Zones Expressed as (CFU/day)				
	High Flows	Moist Conditions	Mid-Range Conditions	Dry Conditions	Low Flows
Flow Rate	≥ 306.76	306.75 -112.94	112.93 - 38.26	38.25- 4.37	≤ 4.36
WLA	0	0	0	0	0
LA	5.06E+13	7.09E+12	2.82E+12	8.74E+11	1.02E+11
10% Explicit MOS	5.62E+12	7.88E+11	3.13E+11	9.71E+10	1.13E+10
TMDL @ 1178 CFU/100mL	5.62E+13	7.88E+12	3.13E+12	9.71E+11	1.13E+11
Current Load	4.36E+13	6.17E+12	4.74E+12	1.12E+12	1.30E+11
Load Reduction	0%	0%	33.82%	13.64%	13.22%

10.1 High Flows

The high flow zone represents flows that were greater than or equal to 306.76 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. Most of the flows greater than 306.76 cfs were the result of the flood year in 2019. This in part was caused by significant snowmelt after a bomb cyclone hit the plains in March 2019. There were nine samples within this flow zone that were used to calculate the current load from which reductions were calculated. The 95th percentile bacteria concentration and flow was calculated at 915.20 cfu/100 mL, and 1949.30 cfs, respectively. A reduction is not needed in the high flow zone.

TMDL

1,178 CFU/100mL (TMDL target) * 1,949.30 cfs (95th percentile flow) * 24,465,525 (conversion factor) = 5.62E+13

10.2 Moist Conditions

The moist condition flows extend from approximately 306.75 cfs to 112.94 cfs. Moist condition flows represent moderate storm events following snow melt, and moderate rainfall events. This flow zone had the least number of samples, with eight samples being collected, with two of the observed concentrations exceeding the SSM. The 95th percentile bacteria concentration and flow was calculated at 922.6 cfu/100 mL, and 273.29 cfs, respectively. A reduction in loading is not needed in the moist conditions flow zone; however, individual samples did exceed the SSM.

TMDL

1,178 CFU/100mL (TMDL target) * 273.29 (95th percentile flow) * 24,465,525 (conversion factor) = 7.88E+12

10.3 Mid-range Conditions

Mid-range flow conditions represent flow rates between 112.93 cfs and 38.26 cfs. Mid-range flows are likely to occur mid to late summer where vegetation is mature, and streamflow is sustained between precipitation events. As a result, bacteria sources from this zone are likely from direct contamination in the stream or near the stream channel. This flow zone is represented by twenty-one samples, with two samples exceeding the SSM for limited contact recreation. The 95th percentile bacteria concentration and flow was calculated at 1,780 cfu/100 mL, and 108.74 cfs, respectively. A 33.82% reduction is needed to achieve compliance with the TMDL target. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

TMDL

1,178 CFU/100mL (TMDL target) * 108.74 cfs (95th percentile flow) * 24,465,525 (conversion factor) = 3.13E+12

10.4 Dry Conditions

Dry condition flows extend from 38.25 cfs and 4.37 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. Thirteen samples were collected within this flow zone, three of which exceeded the SSM. The 95th percentile bacteria concentration and flow was calculated at 1364 cfu/100 mL, and 33.71 cfs, respectively. A required *E. coli* reduction of 13.64% is needed to achieve compliance with the TMDL target. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

TMDL

1,178 CFU/100mL (TMDL target) * 33.71 cfs (95th percentile flow) * 24,465,525 (conversion factor) = 9.71E+11

10.5 Low Flows

The low flow zone represents flows at or below 4.36 cfs. Low flow is characterized as the flow of water in a stream during prolonged dry weather (EPA, 1986). Twelve samples were collected within this flow zone, one of which exceeded the SSM. The 95th percentile bacteria concentration and flow was calculated at 1357.5 cfu/100 mL, and 3.91 cfs, respectively. A reduction of 13.22% is needed to achieve compliance with the TMDL target. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

TMDL

1,178 CFU/100mL (TMDL target) * 3.91 cfs (95th percentile flow) * 24,465,525 (conversion factor) = 1.13E+11

11.0 Seasonality

Seasonality is important when considering bacteria contamination as pathogen transmission may be greatly influenced by fluctuating environmental factors. For example, it has been reported that the growth and survival of *E. coli* in water and cattle manure depends on temperature while the effects of climate on hydrology may include earlier snowmelt, change in streamflow timing, altered spring maximum flows, and intensified summer droughts (Kibria et al. 2016).

Seasonal variation is a component of the load duration curve framework that examines the seasonal exceedance pattern of individual *E. coli* bacteria loads. Sample data was collected May through September when the recreational standards apply for the limited contact beneficial use, this TMDL can only be applicable during this time.

Stream flows ranged considerably, with the highest average being in September (294 cfs) and the lowest monthly average occurring in August (96 cfs). Monthly average *E. coli* concentrations were also calculated, with the lowest monthly average occurring in May (11.5 cfu/100 mL) and the highest being in June (659.5 cfu/100 mL). Daily bacteria concentrations exceed the single sample maximum threshold in four flow regimes: moist conditions, mid-range conditions, dry conditions and low flows. This data suggests bacteria contamination happens more readily during summer when flows are typically lower due to warmer temperatures and depletion of snow-melt.

12.0 Critical Conditions

Critical conditions can be described as the "worst case" scenario of environmental factors (e.g., stream flow, air temperature, loads, etc.). During critical condition periods, if water quality standards were met under those conditions, it would be likely that the water quality standards would be met overall (U.S. EPA, 2007). *E. coli* bacteria concentrations and loading in Medary Creek segment 1 are greatest during moderate flows, and low flow zones. As a result, remediation efforts should focus on reducing *E. coli* in Medary Creek segment 1 by implementing best management practices that focus on limiting watershed-scale runoff from moderate flows, and by limiting the instream *E. coli* contribution from livestock sources. Implementing these practices will mitigate this critical condition in order to meet reduction goals and maintain the water quality criteria set forth in this TMDL.

13.0 Water Quality Improvement Plan and Monitoring Strategy

To ensure attainment of the TMDL, best management practices will need to be implemented. Additional monitoring and evaluation efforts will be targeted toward the effectiveness of implemented BMPs.

13.1 Monitoring Strategy

To assure the attainment of the TMDL, monitoring will be a necessary component during and after implementation practices. The focus of monitoring is to evaluate methods for reducing loads from identified nonpoint sources of *E. coli* as well as the continued evaluation of *E. coli* conditions in the Medary Creek watershed.

Stream water quality monitoring will continue at SD DANR's ambient water quality monitoring station WQM 187. In addition, EDWDD will continue monitoring at site WQM 187 through internal projects and Rotating Basin Project Partnership. Sampling is expected to continue indefinitely depending on resource availability and funding. As part of the Streamflow Monitoring Network, Watershed Protection Program staff will continue to maintain the continuous stream gage at WQM site 187. Additional monitoring will be focused on the effectiveness of implemented BMPs.

13.2 Implementation

Watershed-scale implementation projects can be accomplished by using financial and technical assistance through SD DANR. Financial support is administered to implementation projects aiming to protect and improve the water quality in South Dakota. Funding provided by DANR include the Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (CWSRF) program, and the Section 319 Nonpoint Sources Management Program. Working with ongoing 319 implementation projects such as the Big Sioux River Implementation Project is recommended to find solutions for reducing bacteria in Medary Creek.

SD DANR recommends several Best Management Practices (BMPs) to manage bacteria sources and reduce runoff in Medary Creek. Seasonal Riparian Area Management (SRAM) is a BMP that is now eligible in the focus area to landowners who meet the requirements for approval. The following additional practices are recommended to reduce the bacteria runoff from livestock contributors:

- Relocate livestock feeding, water sources, and grazing areas away from streams
- Protect riparian corridors to establish permanent vegetation for streambank stabilization and erosion control
- Control and contain manure from animal feeding areas

13.3 Adaptive management

The Department (or EPA) may adjust the load and/or waste load allocations in this TMDL to account for new information or circumstances that are developed or come to light during the implementation of the TMDL and a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment of the load and waste load allocation will only be made following an opportunity for public participation. New information generated during TMDL implementation may include, among other things, monitoring data, BMP effectiveness information and land use information. The Department will propose adjustments only in the event that any adjusted LA or WLA will not result in a change to the loading capacity; the adjusted TMDL, including its WLAs and LAs, will be set at a level necessary to implement the applicable water quality standards and any adjusted WLA will be supported by a demonstration that load allocations are practicable. The Department will follow EPA guidance for revising or withdrawing TMDLs in accordance with considerations documented in EPA's 2012 draft memo before taking action: https://www.epa.gov/sites/default/files/2015-10/documents/draft-tmdl_32212.pdf.

13.4 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 also provided technical support and other resources throughout the course of the Rotating Basins Project.

Coordination with the Minnesota Pollution Control Agency (MPCA) is important to ensure future TMDL development is conducted to protect the downstream beneficial uses of Medary Creek.

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

East Dakota Water Development District (EDWDD) was the lead project sponsor of the Rotating Basins- Big Sioux River Assessment Project (2020-2021). The district held monthly informational meetings for the general public and governmental entities. Meetings discussed information on the progress and effectiveness of implementation projects. EDWDD provided staff, financial, and technical assistance, and is the project sponsor and coordinator of the Big Sioux River Implementation Project (BSRP). BSRP is a 319-funded project that is implementing BMPs on the Big Sioux River and its tributaries, including Medary Creek.

A 30-day public comment period was issued for the draft TMDL. A public notice letter was published in the Brookings Register and Tri City Star. 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 February 2, 2023 and ended March 7, 2023. No public comments were received during the 30-day comment period.

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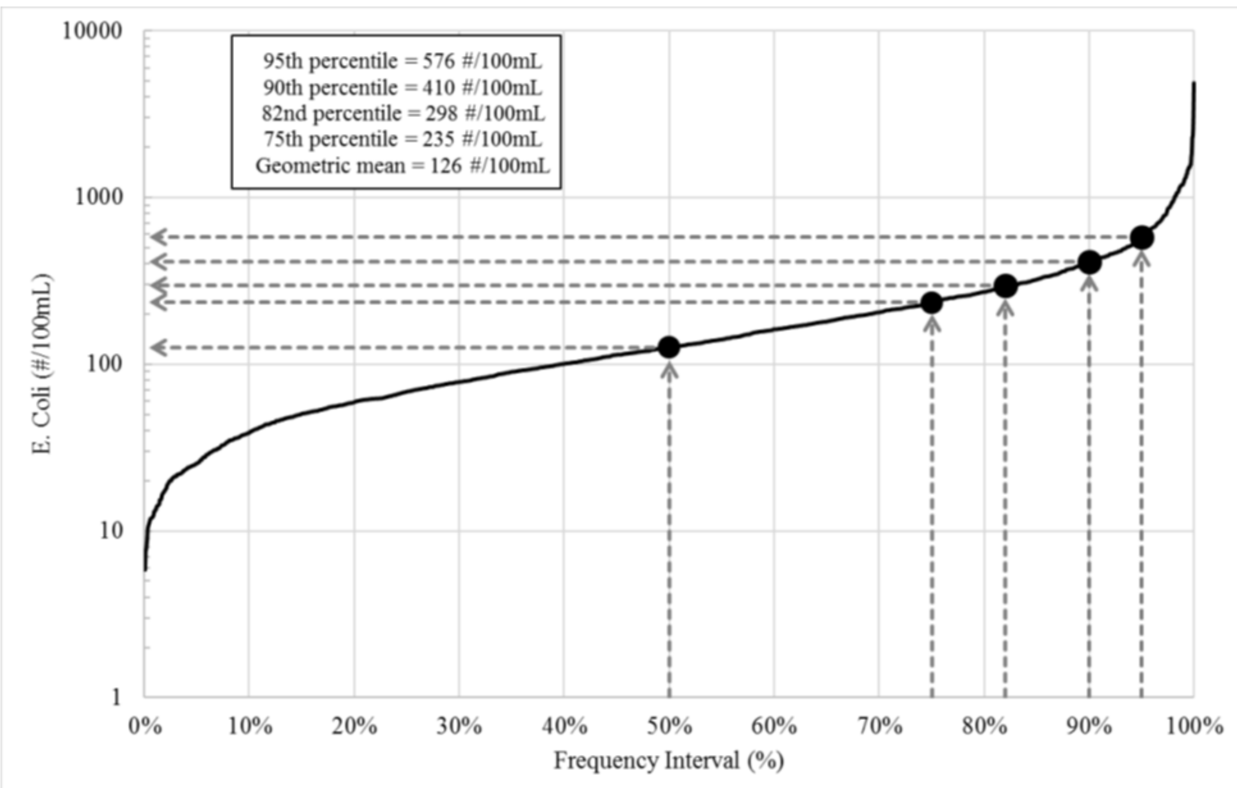
Appendix A – Measured Discharge and *E. coli* Data at WQM 187 2018-2022

ProjectID	SampleDate	SampleTime	StationID	E. coli (cfu)	Total Measured Discharge (cfs)	Percent %	Gauge Height (ft)
EDWQSPZ1	05/24/2018	08:35	CENTBSRWQM187	18.9	93.48	0.4669	82.96
EDWQSPZ1	06/06/2018	08:35	CENTBSRWQM187	687	51.46	0.6497	82.44
EDWQSPZ1	06/21/2018	09:20	CENTBSRWQM187	3460	241.94	0.1363	84.33
EDWQSPZ1	07/05/2018	08:50	CENTBSRWQM187	354	456.47	0.0535	85.84
EDWQSPZ1	07/18/2018	08:50	CENTBSRWQM187	369	70.04	0.5624	82.66
Ambient	07/24/2018	12:05	460187	206	489.53	0.0484	86.01
EDWQSPZ1	08/01/2018	08:35	CENTBSRWQM187	219	110.23	0.4108	83.15
Ambient	08/08/2018	12:15	460187	226	121.81	0.3707	83.27
EDWQSPZ1	08/15/2018	09:10	CENTBSRWQM187	231	67.2	0.5777	82.62
EDWQSPZ1	08/28/2018	09:30	CENTBSRWQM187	328	74.48	0.5401	82.72
Ambient	09/10/2018	12:50	460187	488	82.39	0.5089	82.83
EDWQSPZ1	09/12/2018	09:45	CENTBSRWQM187	411	72.22	0.5522	82.69
EDWQSPZ1	09/26/2018	09:25	CENTBSRWQM187	512	370.48	0.0796	85.27
Ambient	05/14/2019	11:30	460187	52	416.99	0.0643	85.56
EDWQSPZ1	05/21/2019	12:30	CENTBSRWQM187	41	515.24	0.0433	86.22
EDWQSPZ1	06/03/2019	13:50	CENTBSRWQM187	49.5	282.79	0.1083	84.66
EDWQSPZ1	06/17/2019	13:00	CENTBSRWQM187	413	387.43	0.0726	85.37
EDWQSPZ1	07/01/2019	13:00	CENTBSRWQM187	1780	193.82	0.1803	83.95
EDWQSPZ1	07/15/2019	13:20	CENTBSRWQM187	314	227.64	0.1478	84.24
Ambient	07/16/2019	12:30	460187	496	214.84	0.1567	84.13
Ambient	08/14/2019	12:30	460187	181	87.53	0.4949	82.89
EDWQSPZ1	08/19/2019	12:50	CENTBSRWQM187	214	516.12	0.0427	86.17
Ambient	09/04/2019	11:55	460187	295	94.96	0.4618	82.97
EDWQSPZ1	09/16/2019	13:00	CENTBSRWQM187	231	1235.12	0.0121	87.84
EDWQSPZ1	09/23/2019	13:05	CENTBSRWQM187	261	649.59	0.028	86.69
Ambient	05/06/2020	12:25	460187	364	142.35	0.3108	83.48
Ambient	06/02/2020	11:50	460187	291	89.57	0.4854	82.91
RTBNRIST	06/08/2020	13:25	CENTBSRWQM187	816	83.98	0.5032	82.85
RTBNRIST	06/22/2020	12:40	CENTBSRWQM187	980	88.2	0.4924	82.9
RTBNRIST	07/06/2020	13:15	CENTBSRWQM187	1730	62.3	0.6102	82.56
Ambient	07/14/2020	12:30	460187	768	40.57	0.6892	82.34
RTBNRIST	07/20/2020	13:50	CENTBSRWQM187	86.7	27.38	0.7357	82.22
RTBNRIST	08/03/2020	12:31	CENTBSRWQM187	259	72.4	0.549	82.69
Ambient	08/12/2020	12:20	460187	132	34.48	0.7083	82.28
RTBNRIST	08/17/2020	12:45	CENTBSRWQM187	57.6	19.34	0.7796	82.15
Ambient	09/03/2020	12:30	460187	1120	14.74	0.8178	82.1
RTBNRIST	09/08/2020	12:45	CENTBSRWQM187	1550	10.57	0.8439	82.05
RTBNRIST	09/21/2020	12:35	CENTBSRWQM187	1200	7.29	0.8662	82
RTBNRIST	05/03/2021	12:45	CENTBSRWQM187	21.6	53.33	0.642	82.46
Ambient	05/12/2021	12:20	460187	8.4	40.56	0.6898	82.34
RTBNRIST	05/25/2021	11:30	CENTBSRWQM187	58.1	22.55	0.7573	82.18
RTBNRIST	05/26/2021	09:15	CENTBSRT07	41	19.61	0.7752	82.15
Ambient	06/03/2021	10:50	460187	1200	19.51	0.7771	82.15
RTBNRIST	06/07/2021	13:50	CENTBSRWQM187	1080	10.65	0.8427	82.05
RTBNRIST	06/23/2021	13:50	CENTBSRWQM187	649	2.74	0.9299	81.87
Ambient	07/07/2021	12:00	460187	980	2.17	0.9478	81.8
RTBNRIST	07/12/2021	12:45	CENTBSRWQM187	184	2.53	0.9357	81.85
RTBNRIST	07/19/2021	12:10	CENTBSRWQM187	332	2.04	0.9599	81.77
Ambient	08/02/2021	17:55	460187	65.7	1.8	0.9885	81.71
RTBNRIST	08/16/2021	10:40	CENTBSRWQM187	127	1.58	0.9968	81.66
Ambient	09/09/2021	09:05	460187	169	1.98	0.9713	81.76
RTBNRIST	09/14/2021	13:05	CENTBSRWQM187	1200	2.76	0.9287	81.87
RTBNRIST	09/20/2021	12:00	CENTBSRWQM187	240	2.98	0.9217	81.88
Ambient	05/12/2022	10:00	460187	548	240.53	0.1389	84.32
EDWQSPZ1	05/23/2022	14:25	CENTBSRWQM187	8.5	104.18	0.4312	83.08
Ambient	06/08/2022	10:25	460187	166	92.28	0.4732	82.94
EDWQSPZ1	06/13/2022	12:50	CENTBSRWQM187	1730	72.05	0.5541	82.69
Ambient	07/06/2022	11:40	460187	687	23.97	0.7478	82.19
EDWQSPZ1	07/11/2022	13:05	CENTBSRWQM187	365	16.5	0.8019	82.12
Ambient	08/08/2022	09:20	460187	980	21.87	0.7611	82.17
EDWQSPZ1	08/15/2022	13:10	CENTBSRWQM187	579	3.57	0.9096	81.91
Ambient	09/01/2022	10:00	460187	326	2.1	0.9529	81.79
EDWQSPZ1	09/19/2022	13:40	CENTBSRWQM187	88	2.03	0.9637	81.77

Appendix B – 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.



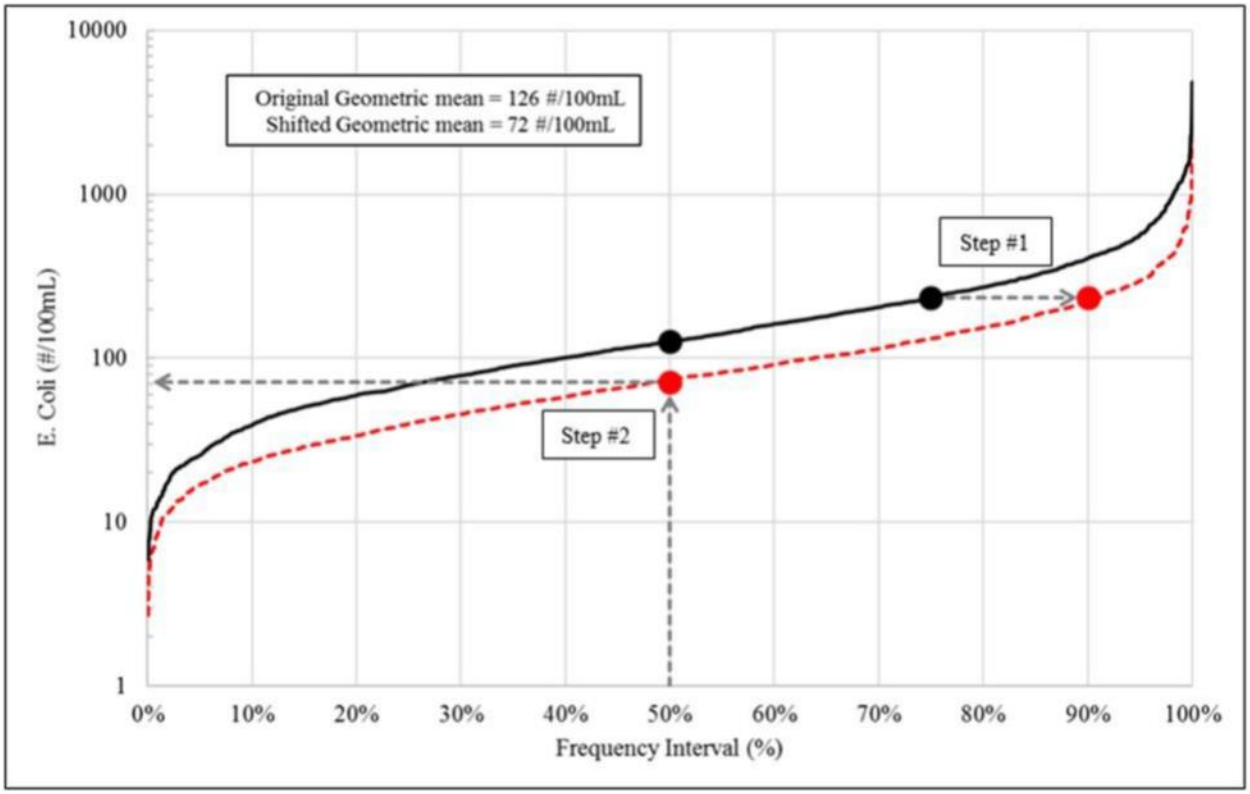
Log-Normal Frequency Distribution Used to Establish South Dakota's Immersion Recreation *E. coli* Criteria of 126 (GM) and 235 (SSM) #/100mL (EPA, 1986).

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 C – EPA Approval Letter and Decision Document

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region08

April 11, 2023

Ref: 8WD-CWS

SENT VIA EMAIL

Hunter Roberts, Secretary
South Dakota Department of Agriculture and Natural Resources
Hunter.Roberts@state.sd.us

Re: Approval of *Escherichia coli* (*E. coli*) Bacteria Total Maximum Daily Load Evaluation for Medary Creek, Brookings County, South Dakota

Dear Mr. Roberts:

The U.S. Environmental Protection Agency (EPA) has completed review of the total maximum daily load (TMDL) submitted by your office on March 27, 2023. In accordance with the Clean Water Act (33 U.S.C. §1251 *et. seq*.) and the EPA's implementing regulations at 40 C.F.R. Part 130, the EPA hereby approves South Dakota's TMDL for Medary Creek. The EPA has determined that the separate elements of the TMDL listed in the enclosure adequately address the pollutant of concern, are designed to attain and maintain applicable water quality standards, consider seasonal variation and include a margin of safety. The EPA's rationale for this action is contained in the enclosure.

Thank you for submitting this TMDL for our review and approval. If you have any questions, please contact Amy King on my staff at (303) 312-6708.

Sincerely,

Stephanie DeJong, Manager
Clean Water Branch

Enclosure: EPA Decision Rationale – Medary Creek *E. coli* TMDL

cc: Barry McLaury, Watershed Protection Program Administrator, South Dakota DANR
Paul Lorenzen, Environmental Scientist Manager – TMDL Team Leader, South Dakota DANR

EPA TOTAL MAXIMUM DAILY LOAD (TMDL) DECISION RATIONALE

TMDL: *Escherichia Coli* (*E. coli*) Bacteria Total Maximum Daily Load Evaluation for Medary Creek, Brookings County, South Dakota

ATTAINS TMDL ID: R8-SD-2023-01

LOCATION: Brookings County, South Dakota

IMPAIRMENTS/POLLUTANTS: The TMDL submittal addresses one river segment with a recreation use that is impaired due to elevated levels of *Escherichia coli* (*E. coli*) bacteria.

Waterbody/Pollutant Addressed in this TMDL Action

Assessment Unit ID	Waterbody Description	Pollutant Addressed
SD-BS-R-MEDARY_01	Medary Creek segment 01 (Minnesota Border to the confluence with the Big Sioux River)	*E. coli*

BACKGROUND: The South Dakota Department of Agriculture and Natural Resources (DANR) submitted to EPA the *E. coli* TMDL for Medary Creek with a letter requesting review and approval dated March 27, 2023. EPA previously reviewed and provided staff comments on draft versions of the report (December 2022 and January 2023) but did not submit comments during the subsequent public comment period (February 2, 2023 to March 7, 2023).

The submittal included:

- Letter requesting EPA's review and approval of the TMDL
- Final TMDL report for *E. coli* in Medary Creek with appendices

APPROVAL RECOMMENDATIONS: Based on the review presented below, the reviewer recommends approval of the final Medary Creek *E. coli* TMDL. All the required elements of an approvable TMDL have been met.

TMDL Approval Summary	
Number of TMDLs Approved:	1
Number of Causes Addressed by TMDLs:	1

REVIEWER: Amy King, EPA

The following review summary explains how the TMDL submission meets the statutory and regulatory requirements of TMDLs in accordance with Section 303(d) of the Clean Water Act (CWA), and EPA's implementing regulations in 40 C.F.R. Part 130.

EPA REVIEW OF THE MEDARY CREEK SEGMENT 1 *E. COLI* TMDL

This TMDL review document includes EPA's guidelines that summarize the currently effective statutory and regulatory requirements relating to TMDLs (CWA Section 303(d) and 40 C.F.R. Part 130). These TMDL review guidelines are not themselves regulations. Any differences between these guidelines and EPA's regulations should be resolved in favor of the regulations themselves. The italicized sections of this document describe the information generally necessary for EPA to determine if a TMDL submittal fulfills the legal requirements for approval. The sections in regular type reflect EPA's analysis of the state's compliance with these requirements. Use of the verb "must" below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation.

1. Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking

The TMDL submittal must clearly identify (40 C.F.R. §130.7(c)(1)):

- *the waterbody as it appears on the State's/Tribe's 303(d) list;*
- *the pollutant for which the TMDL is being established; and*
- *the priority ranking of the waterbody.*

The TMDL submittal must include (40 C.F.R. §130.7(c)(1); 40 C.F.R. §130.2):

- *an identification of the point and nonpoint sources of the pollutant of concern, including location of the source(s) and the quantity of the loading (e.g., lbs. per day);*
- *facility names and NPDES permit numbers for point sources within the watershed; and*
- *a description of the natural background sources, and the magnitude and location of the sources, where it is possible to separate natural background from nonpoint sources.*

This information is necessary for EPA's review of the load and wasteload allocations, which are required by regulation.

The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as:

- *the spatial extent of the watershed in which the impaired waterbody is located;*
- *the assumed distribution of land use in the watershed (e.g., urban, forested, agriculture);*
- *population characteristics, wildlife resources, and other relevant information affecting the characterization of the pollutant of concern and its allocation to sources;*
- *present and future growth trends, if taken into consideration in preparing the TMDL (e.g., the TMDL could include the design capacity of a wastewater treatment facility); and*
- *an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll a and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.*

Segment 1 of Medary Creek (SD-BS-R-MEDARY_01) is a 38-mile tributary to the Big Sioux River in northeast Brookings County, originating at the Minnesota Border (Figure 1). The entire drainage area includes five HUC12 watersheds (Figure 2) and is over 128,500 acres (200 square miles). Nearly 80 percent of the drainage is in South Dakota (~102,000 acres) and 26,500 acres of headwaters are located in neighboring Minnesota. Deer Creek is a major tributary, entering Medary Creek approximately 10 miles upstream of the confluence with the Big Sioux River. Figure 1 displays the general location of the Medary Creek watershed with the impaired segment, cities, and major roads.

Medary Creek was first identified as impaired by *E. coli* and placed on South Dakota's 303(d) list in 2020 and remained as an impairment in the subsequent cycle. It was assigned a high priority (i.e., 1) for TMDL development on the most recent EPA-approved 303(d) list in 2022. This priority ranking information is contained on page 7, which summarizes the TMDL components. This segment is not listed as impaired for any other parameters.

Section 2.0 (*Watershed Characteristics*) describes the watershed characteristics. Based on the most recent land use data, grassland and cropland are the dominant land use types (Figure 4; Section 2.6, *Land Use*). Cropland includes corn (32 percent), soybeans, and alfalfa as well as some areas growing small grains (oats, barley, and rye). Grasslands are near waterways and in the Upper Deer Creek subwatershed. Four percent of the watershed is developed. Urban development includes the city of Aurora (population 2,747 in 2020) in the western portion of the watershed and the town of Bushnell (population 71 in 2020), northeast of Aurora (Table 2; Section 2.5, *Demographics*).

Section 6.2 (*Nonpoint Sources*) characterizes the nonpoint sources into categories of agriculture, human (i.e., septic systems), and natural background/wildlife (particularly geese). DANR quantified *E. coli* production from these sources using population estimates, geographic information system (GIS) analysis, and the Bacterial Indicator Tool (USEPA, 2000) with input data provided by U.S. Department of Agriculture and South Dakota Game Fish and Parks (Table 6). Agriculture, including manure from livestock, was the dominant source of bacteria production (99 percent). Beef cattle contributed nearly 77 percent of the total bacteria production (Section 6.2.1, *Agriculture Sources*), while human and natural background sources contributed less than 1 percent each (Sections 6.2.2, *Human Sources*, and 6.2.3, *Natural Background Sources*).

Section 6.1 (*Point Sources*) describes the National Pollutant Discharge Elimination System (NPDES) point sources by facility name, permit number, and discharge characteristics. This information is included as a comprehensive watershed-scale accounting of potential sources and to evaluate whether each facility should be assigned a wasteload allocation (WLA) in the TMDL. The city of Aurora (SDG821661) and Newdale Colony (SDG829001) operate wastewater treatment facilities (WWTF), neither of which are permitted to discharge wastewater. Therefore, these WWTFs are not expected to contribute *E. coli* to Medary Creek. Valero Renewable Fuels Company (SD0027898) is an ethanol processing plant and, therefore, it is also not expected to be a source of bacteria. DANR concluded that WLAs are not applicable for any of these facilities; therefore, there are no WLAs in this TMDL.

Eleven permitted Concentrated Animal Feeding Operations (CAFOs) are located in the watershed (Section 6.1.1 and Table 5). Seven 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. The remaining facilities have coverage under the 2017 General Permit. DANR discusses the CAFO permit requirements in detail, including design standards, operation maintenance, inspections, and records/reporting requirements. DANR notes that *E. coli* contributions are unlikely if facilities are in compliance with their permit requirements; therefore, they were not assigned a WLA in this TMDL.

Potential *E. coli* sources from the headwaters in Minnesota include several CAFO's, Supreme Pork Inc., and Ash Grove Dairy. Under their NPDES permits, these facilities are not permitted to discharge into waters of the state. As a result, these facilities are not expected to contribute *E. coli* bacteria to Medary Creek segment 1 and were not assigned WLAs.

Assessment: EPA concludes that DANR adequately identified the impaired waterbody, the pollutant of concern, the priority ranking, the identification, location and magnitude of the pollutant sources, and the important assumptions and information used to develop the TMDL.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

The TMDL submittal must include:

- *a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the antidegradation policy (40 C.F.R. §130.7(c)(1)); and*
- *a numeric water quality target for each TMDL. If the TMDL is based on a target other than a numeric water quality criterion, then a numeric expression must be developed from a narrative criterion and a description of the process used to derive the target must be included in the submittal (40 C.F.R. §130.2(i)).*

EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

Section 3.0 (*South Dakota Water Quality Standards*) describes the water quality standards applicable to the impaired segment with citations to relevant South Dakota regulations. SD-BS-R-MEDARY_01 is designated the following beneficial uses:

- warmwater marginal fish life propagation,
- limited contact recreation,
- fish and wildlife propagation, recreation, and stock watering,
- irrigation waters.

Numeric criteria applicable to these uses are presented in Table 3. DANR determined that *E. coli* is preventing the creek's limited contact recreation use from being fully supported. Numeric *E. coli* criteria established to protect this recreation use are comprised of a 30-day mean criterion (≤ 630 colony forming units per 100 milliliters [CFU/100mL]) and a single sample maximum criterion (≤ 1,178 CFU/100mL) (Table 3 and Section 3.2.1, E. coli *Water Quality Criteria*). These criteria are seasonally applicable from May 1 to September 30.

The numeric *E. coli* criteria for limited contact recreation waters are applied directly as water quality targets for this TMDL (Section 4.0, *Numeric TMDL Targets*). DANR expects that meeting the numeric *E. coli* criteria will lead to conditions necessary to support any relevant narrative criteria. The TMDL numeric target applicable to the impaired segment is based on the limited contact recreation single sample maximum criterion (1,178 CFU/100mL) as monitoring is not of sufficient frequency to assess compliance with the geometric mean criterion. DANR demonstrates that attaining the single sample maximum target will also achieve the geometric mean criterion (Section 4.0, *Numeric TMDL Targets*, and Appendix B).

The TMDL is consistent with South Dakota antidegradation policies because it provides recommendations and establishes pollutant limits at water quality levels necessary to meet criteria and fully support existing beneficial uses.

Assessment: EPA concludes that DANR adequately described the applicable water quality standards and numeric water quality target for this TMDL.

3. Loading Capacity - Linking Water Quality and Pollutant Sources

The TMDL submittal must include the loading capacity for each waterbody and pollutant of concern. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

The TMDL submittal must:

- *describe the method used to establish the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model;*
- *contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling; and*
- *include a description and summary of the water quality data used for the TMDL analysis.*

EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation (40 C.F.R. §130.2).

The full water quality dataset should be made available as an appendix to the TMDL or as a separate electronic file. Other datasets used (e.g., land use, flow), if not included within the TMDL submittal, should be referenced by source and year. The TMDL analysis should make use of all readily available data for the waterbody unless the TMDL writer determines that the data are not relevant or appropriate.

The pollutant loadings may be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. §130.2(i)). Most TMDLs should be expressed as daily loads (USEPA. 2006a). If the TMDL is expressed in terms other than a daily load (e.g., annual load), the submittal should explain why it is appropriate to express the TMDL in the unit of measurement chosen.

The TMDL submittal must describe the critical conditions and related physical conditions in the waterbody as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). The critical condition can be thought of as the "worst case" scenario of environmental conditions (e.g., stream flow, temperature, loads) in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. TMDLs should define the applicable critical conditions and describe the approach used to estimate both point and nonpoint source loads under such critical conditions.

DANR relied on the load duration curve approach to define the *E. coli* loading capacity for Medary Creek segment 1. A load duration curve is a graphical representation of pollutant loads across various flows. The approach correlates water quality conditions with stream flow and provides insight into the variability of source contributions. EPA has published guidance on the use of duration curves for TMDL development (USEPA, 2007) and the practice is well established.

Using this approach, DANR set the TMDL equivalent to the loading capacity, which is the sum of the load allocations, wasteload allocations, and margin of safety (MOS), and expressed the TMDL in CFUs per day at different flow zones (i.e., high, moist, mid-range, dry, and low). The TMDL is not expressed as a load or mass, but instead as a number of organisms per day due to the nature of the pollutant. This approach is consistent with EPA guidance and the flexibility offered in 40 CFR §130.3(i) to express TMDLs in other appropriate, non-mass-based measures (USEPA, 2001).

The load duration curve is shown visually in Figure 7, including the loading capacity, calculated with the numeric TMDL target and estimated flow compared to instantaneous loads calculated from the monitoring dataset. The monitoring data used to develop the load duration curve and calculate existing loads are summarized in Section 7.0 (*Data Collection*) and provided fully in Appendix A. Table 7 summarizes the 95th percentile existing loads and loading capacity by flow regime for Medary Creek segment 1. DANR described conditions associated with each flow regime in sub-sections below this table.

DANR demonstrated the cause-and-effect relationship between sources and the water quality target at various flow conditions by supplementing the pattern of observed exceedances in each flow zone with known characteristics of various source categories as investigated and described in Section 6.0 (*Source Assessment and Allocations*). Loading sources were characterized and quantified using multiple approaches. Three NPDES permitted facilities were identified in the watershed but are not sources of *E. coli* loading and were not assigned WLAs. CAFOs were also not assigned WLAs as their permit requirements prohibit discharges (Section 9.2, *Waste Load Allocations*; Table 7). DANR estimated relative nonpoint source contributions, including agricultural, wildlife (natural background), and human sources, using bacteria production rates from the Bacterial Indicator Tool (USEPA, 2000; Table 6). Livestock was identified as the main source of bacteria loading in the watershed (Section 6.2.1, *Agriculture Sources*).

While the loading capacity is defined for multiple stream flow conditions, DANR described the critical conditions (when bacteria loading to segment 1 are greatest) as periods of mid-range/moderate and lower flows (Section 12.0, *Critical Conditions*). These flow conditions are typically associated with summer periods between precipitation events when bacteria sources are in or adjacent to the stream, including when livestock have direct access to the waterbody.

Assessment: EPA concludes that DANR's loading capacity was calculated using an acceptable approach, used observed concentration data and a water quality target consistent with water quality criteria, and has been appropriately set at a level necessary to attain and maintain the applicable water quality standards. The pollutant loads have been expressed as daily loads. The critical conditions were described and factored into the calculations and were based on a reasonable approach to establish the relationship between the target and pollutant sources.

4. Load Allocation

The TMDL submittal must include load allocations (LAs). EPA regulations define LAs as the portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution and to natural background sources. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Where possible, separate LAs should be provided for natural background and for nonpoint sources.

In the rare instance that a TMDL concludes that there are no nonpoint sources or natural background for a pollutant, the load allocation must be expressed as zero and the TMDL should include a discussion of the reasoning behind this decision.

As described in Section 9.3 (*Load Allocations*), DANR established a single load allocation (LA) as the allowable load remaining after accounting for the explicit MOS (i.e., LA = TMDL – MOS) because there were no WLAs in this TMDL. Table 7 presents the LA across the TMDL's different flow regimes in CFUs per day. This composite LA represents all nonpoint source contributions, both human and natural, as one allocation; however, individual nonpoint source categories, including agriculture, human, and wildlife, were characterized in Section 6.2 (*Nonpoint Sources*) and Table 6. Human and wildlife sources were considered negligible as nearly all of the bacteria production is associated with agriculture (livestock sources).

Assessment: EPA concludes that the LAs provided in the TMDL submittal are reasonable and will result in attainment of the water quality standards.

5. Wasteload Allocations

The TMDL submittal must include wasteload allocations (WLAs). EPA regulations define WLAs as the portion of a receiving water's loading capacity that is allocated to existing and future point sources (40 C.F.R. §130.2(h)). If no point sources are present or if the TMDL recommends a zero WLA for point sources, the WLA must be expressed as zero. If the TMDL recommends a zero WLA after considering all pollutant sources, there must be a discussion of the reasoning behind this decision, since a zero WLA implies an allocation only to nonpoint sources and natural background will result in attainment of the applicable water quality standards, and all point sources have no measurable contribution.

The individual WLAs may take the form of uniform percentage reductions or individual mass based limitations for dischargers where it can be shown that this solution meets WQSs and does not result in localized impairments. In some cases, WLAs may cover more than one discharger (e.g., if the source is contained within a general permit).

No WLAs are included in this TMDL submittal. There are no permitted point source facilities that discharge bacteria to Medary Creek segment 1; therefore, there are no point source contributors of *E. coli*. The rationale for this decision is outlined in Section 6.1 (*Point Sources*) and Section 9.2 (*Waste Load Allocations*).

Assessment: EPA concludes that the TMDL considered all point sources contributing loads to the impaired segment and upstream segments and tributaries in the watershed and the recommendation of a zero WLA was justified and reasonable.

6. Margin of Safety

The TMDL submittal must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load allocations, wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). The MOS may be ***implicit*** *or* ***explicit****.*

If the MOS is ***implicit****, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is* ***explicit****, the loading set aside for the MOS must be identified.*

The TMDL for Medary Creek includes an explicit MOS derived as 10 percent of the loading capacity (Section 9.1, *Margin of Safety*). The explicit MOS is included as a separate allocation in Table 7 and varies by flow regime.

Assessment: EPA concludes that the TMDL incorporates an adequate explicit margin of safety.

7. Seasonal Variation

The TMDL submittal must be established with consideration of seasonal variations. The method chosen for including seasonal variations in the TMDL must be described (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

The variability of measured stream flows and monitored *E. coli* concentrations are summarized in Section 11.0 (*Seasonality*). The load duration curve method used to establish the TMDL incorporates variations in stream flow, which in turn, is influenced by other climatic and human factors that change throughout the year. To account for these variations, DANR developed the TMDL for the different flow zones listed in Table 7. In addition to these flow and water quality patterns, the limited contact recreation water quality criteria have a seasonal component as they apply during the recreation season (May through September).

DANR noted that bacteria concentrations exceed the TMDL targets in four of the five flow regimes, suggesting that bacteria contamination can occur throughout the recreation season, particularly in the summer months. The existing loads did not exceed the loading capacity in the high and moist flow zones, suggesting that snowmelt and precipitation events are not transporting large loads from the greater watershed area. The highest load reductions are required during the mid-range flow zone, which is associated with mid- to late-summer conditions, typically between precipitation events.

Bacteria sources are likely from direct contamination in or near the channel. Exceedances were also observed during dry and low flow conditions, which have similar localized sources from the riparian zone and direct to the stream channel. Restoration efforts should account for seasonal patterns to achieve TMDL goals.

Assessment: EPA concludes that seasonal variations were adequately described and considered to ensure the TMDL allocations will be protective of the applicable water quality standards throughout any given year.

8. Reasonable Assurances

When a TMDL is developed for waters impaired by both point and nonpoint sources, EPA guidance (USEPA. 1991) and court decisions say that the TMDL must 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 EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement the applicable water quality standards (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

EPA guidance (USEPA. 1997) also directs Regions to work with States to achieve TMDL load allocations in waters impaired only by nonpoint sources. However, EPA cannot disapprove a TMDL for nonpoint source-only *impaired waters, which do not have a demonstration of reasonable assurance that LAs will be achieved, because such a showing is not required by current regulations.*

The TMDL contained in this submittal is for a nonpoint source-only impaired water. Still, nonregulatory, voluntary-based reasonable assurances are provided for the LA where the submittal discusses DANR's adaptive management approach to the TMDL process (Section 13.3, *Adaptive management*) and the monitoring commitment that will be used to gage TMDL effectiveness in the future (Section 13.1, *Monitoring Strategy*). These assurances also include the recommendation of specific activities and partners to focus implementation efforts, which are discussed in Section 13.2 (*Implementation*), including the watershed stewardship and interest from the East Dakota Water Development District (EDWDD) and the continued implementation of the Big Sioux River Watershed Implementation Project. In addition, DANR identifies several implementation measures including bacteria monitoring and livestock load reduction efforts that would be useful to reduce and evaluate bacteria loading to Medary Creek segment 1.

Assessment: EPA concludes that reasonable assurances are not required for this nonpoint source-only TMDL. Nonpoint source load reductions are expected to occur through the implementation of best management practices as described in the incentive and voluntary program plans in place, in progress or planned to begin in the near future.

9. Monitoring Plan

The TMDL submittal should include a monitoring plan for all:

- *Phased TMDLs; and*
- *TMDLs with both WLA(s) and LA(s) where reasonable assurances are provided.*

Under certain circumstances, a phased TMDL should be developed when there is significant uncertainty associated with the selection of appropriate numeric targets, estimates of source loadings, assimilative capacity, allocations or when limited existing data are relied upon to develop a TMDL. EPA guidance (USEPA. 2006b) recommends that a phased TMDL submittal, or a separate document (e.g., implementation plan), include a monitoring plan, an explanation of how the supplemental data will be used to address any uncertainties that may exist when the phased TMDL is prepared and a scheduled timeframe for revision of the TMDL.

For TMDLs that need to provide reasonable assurances, the monitoring plan should describe the additional data to be collected to determine if the load reductions included in the TMDL are occurring and leading to attainment of water quality standards.

EPA guidance (USEPA. 1991) recommends post-implementation monitoring for all TMDLs to determine the success of the implementation efforts. Monitoring plans are not a required part of the TMDL and are not approved by EPA but may be necessary to support the decision rationale for approval of the TMDL.

In Section 13.1 (*Monitoring Strategy*), DANR presents recommendations for future water quality monitoring efforts, including effectiveness assessment, loading analyses, and evaluating *E. coli* conditions in the watershed. In particular, they specify ongoing monitoring at WQM 187 by both DANR and the EDWDD to assess changes in *E. coli* concentrations over time. DANR will also maintain this site as part of their Streamflow Monitoring Network. This submittal is not considered a phased TMDL; however, DANR maintains the ability to modify the TMDL and allocations as new data become available using an adaptive management approach (Section 13.3, *Adaptive management*) in accordance with EPA's TMDL revision process.

Assessment: Monitoring plans are not a required element of EPA's TMDL review and decision-making process. The TMDL submitted by DANR includes a commitment to monitor progress toward attainment of water quality standards. EPA is taking no action on the monitoring strategy included in the TMDL submittal.

10. Implementation

EPA policy (USEPA. 1997) encourages Regions to work in partnership with States/Tribes to achieve nonpoint source load allocations established for 303(d)-listed waters impaired by nonpoint sources. Regions may assist States/Tribes in developing implementation plans that include reasonable assurances that nonpoint source LAs established in TMDLs for waters impaired solely or primarily by nonpoint sources will in fact be achieved. The policy recognizes that other relevant watershed management processes may be used in the TMDL process. EPA is not required to and does not approve TMDL implementation plans.

EPA encourages States/Tribes to include restoration recommendations (e.g., framework) in all TMDLs for stakeholder and public use to guide future implementation planning. This could include identification of a range of potential management measures and practices that might be feasible for addressing the main loading sources in the watershed (see USEPA. 2008b, Chapter 10). Implementation plans are not a required part of the TMDL and are not approved by EPA but may be necessary to support the decision rationale for approval of the TMDL.

In Section 13.2 (*Implementation*), DANR recommends collaboration with the ongoing 319 implementation projects as well as livestock-specific management activities, including Seasonal Riparian Area Management (SRAM) for eligible landowners. The Big Sioux River Watershed Implementation Project is a 319-funded project that can be expanded to address bacteria sources in the Medary Creek portion of the basin. DANR also describes potential implementation activities to reduce bacteria loading associated with grazing and manure management. These management measures include, but are not limited to, reduction in livestock access to streams, protection of riparian corridors to stabilize streambanks, and control of manure from feeding areas.

Assessment: Although not a required element of the TMDL approval, DANR discussed how information derived from the TMDL analysis process can be used to support implementation of the TMDL. EPA is taking no action on the implementation portion of the TMDL submittal.

11. Public Participation

EPA policy is that there must be full and meaningful public participation in the TMDL development process. Each State/Tribe must, therefore, provide for public participation consistent with its own continuing planning process and public participation requirements (40 C.F.R. §25.3 and §130.7(c)(1)(ii)).

The final TMDL submittal must describe the State/Tribe's public participation process, including a summary of significant comments and the State/Tribe's responses to those comments (40 C.F.R. §25.3 and §25.8). Inadequate public participation could be a basis for disapproving a TMDL; however, where EPA determines *that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.*

Public Participation (Section 13.4) explains the public engagement process DANR followed during development of the TMDL. A draft TMDL report was released for public comment from February 2, 2023 to March 7, 2023. The opportunity for public review and comment was posted on DANR's website and announced in several area newspapers: the Brookings Register and Tri City Star. DANR also noted the importance of coordinating with the Minnesota Pollution Control Agency (MPCA) to ensure upstream activities are protective of the downstream beneficial uses in South Dakota. No public comments were submitted.

Assessment: EPA has reviewed DANR's public participation process. EPA concludes that DANR involved the public during the development of the TMDL and provided adequate opportunities for the public to comment on the draft report. No comments were received.

12. Submittal Letter

The final TMDL submittal must be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute (40 C.F.R. §130.7(d)(1)). The final submittal letter should contain such identifying information as the waterbody name, location, assessment unit number and the pollutant(s) of concern.

A transmittal letter with the appropriate information was included with the final TMDL report submission from DANR, dated March 27, 2023 and signed by Paul Lorenzen, Environmental Scientist Manager – TMDL Team Leader, Watershed Protection Program.

Assessment: EPA concludes that the state's submittal package clearly and unambiguously requested EPA to act on the TMDL in accordance with the Clean Water Act and the submittal contained all necessary supporting information.

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