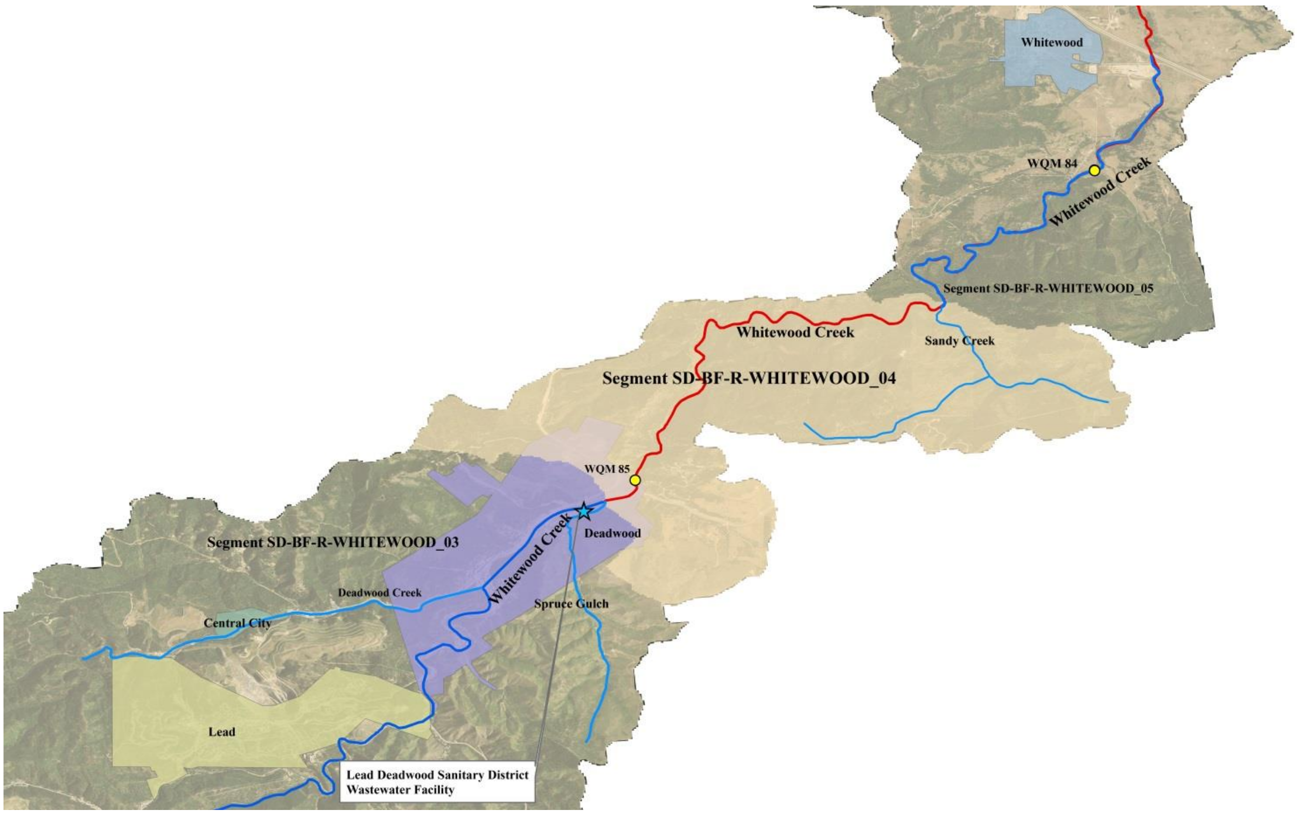
Escherichia coli (*E. coli*) Bacteria Total Maximum Daily Load (TMDL) for Whitewood Creek Segment 4, SD-BF-R-WHITEWOOD_04, Lawrence County, South Dakota



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South Dakota Department of Agriculture and Natural Resources Watershed Protection Program

2022

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List of Acronyms

ADB	Assessment Database
ARSD	Administrative Rules of South Dakota
AUID	Assessment Unit Identification
BIT	Bacteria Indicator Tool
BMP	Best Management Practice
BTWTF	Blacktail Water Treatment Facility
CAFO	Confined Animal Feeding Operation
CFU	Colony Forming Units
CFS	Cubic Feet per Second
DMR	Discharge Monitoring Report
ICIS	Integrated Compliance Information System
LA	Load Allocation
LDSD	Lead Deadwood Sanitary District
LDC	Load Duration Curve
MGD	Million Gallons per Day
MPN	Most Probable Number
MOS	Margin of Safety
NPDES	National Pollutants Discharge Elimination System
SDCL	South Dakota Codified Law
SD DANR	South Dakota Department of Agriculture and Natural Resources
SD DANR SWQP	South Dakota Department of Agriculture and Natural Resources Surface Water Quality Program
SD DANR FP	South Dakota Department of Agriculture and Natural Resources Feedlot Program
SD GF&P	South Dakota Game Fish and Parks
SOP	Standard Operating Procedures
SSM	Single Sample Maximum
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Wasteload Allocation
WQM	Water Quality Monitoring
WWTF	Wastewater Treatment Facility

Total Maximum Daily Load Summary

Whitewood Creek Basin - Segment SD-BF-R-WHITEWOOD_04

Waterbody Type: River/Stream

Segment Identification: SD-BF-R-WHITEWOOD_04

303(d) Listing Parameter: *Escherichia coli*

Designated Use of Concern: Immersion Recreation Use

Size of Impaired Waterbody: Segment length approximately 8.08 km

Size of Watershed: Sub watershed 2,362.5 hectares (HUC 12)

Indicator(s): *Escherichia coli* concentration (colony forming units per 100mL)

Analytical Approach: Load Duration Curve Framework

Location: Hydrologic Unit Codes (12-digit HUCs): 101202020207

TMDL Priority Ranking: Priority 1 (2022 IR)

Target (Water Quality Standards): *Escherichia coli* (*E. coli*) - Maximum daily concentration of ≤ 235 CFUs/100mL and a geometric mean of ≤ 126 CFUs/100mL based on a minimum of five (5) samples obtained during separate 24-hour periods for any 30-day period (calendar month).

***E. coli* (CFU/day)**

	High Flow Zone (0-10%)
Loading Allocation	1.16E + 12
Waste Load Allocation	0
Margin of Safety	1.29E + 11
TMDL	1.29E+12

1.0 Objective

The intent of this document is to clearly identify the components of the TMDL, support adequate public participation and facilitate the US Environmental Protection Agency (US EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the US EPA. This TMDL document addresses the *E. coli* impairment for assessment unit SD-BF-R-WHITEWOOD_04 (Spruce Gulch to Sandy Creek) or Whitewood Creek segment 4 in the Whitewood Creek watershed (Figure 1).

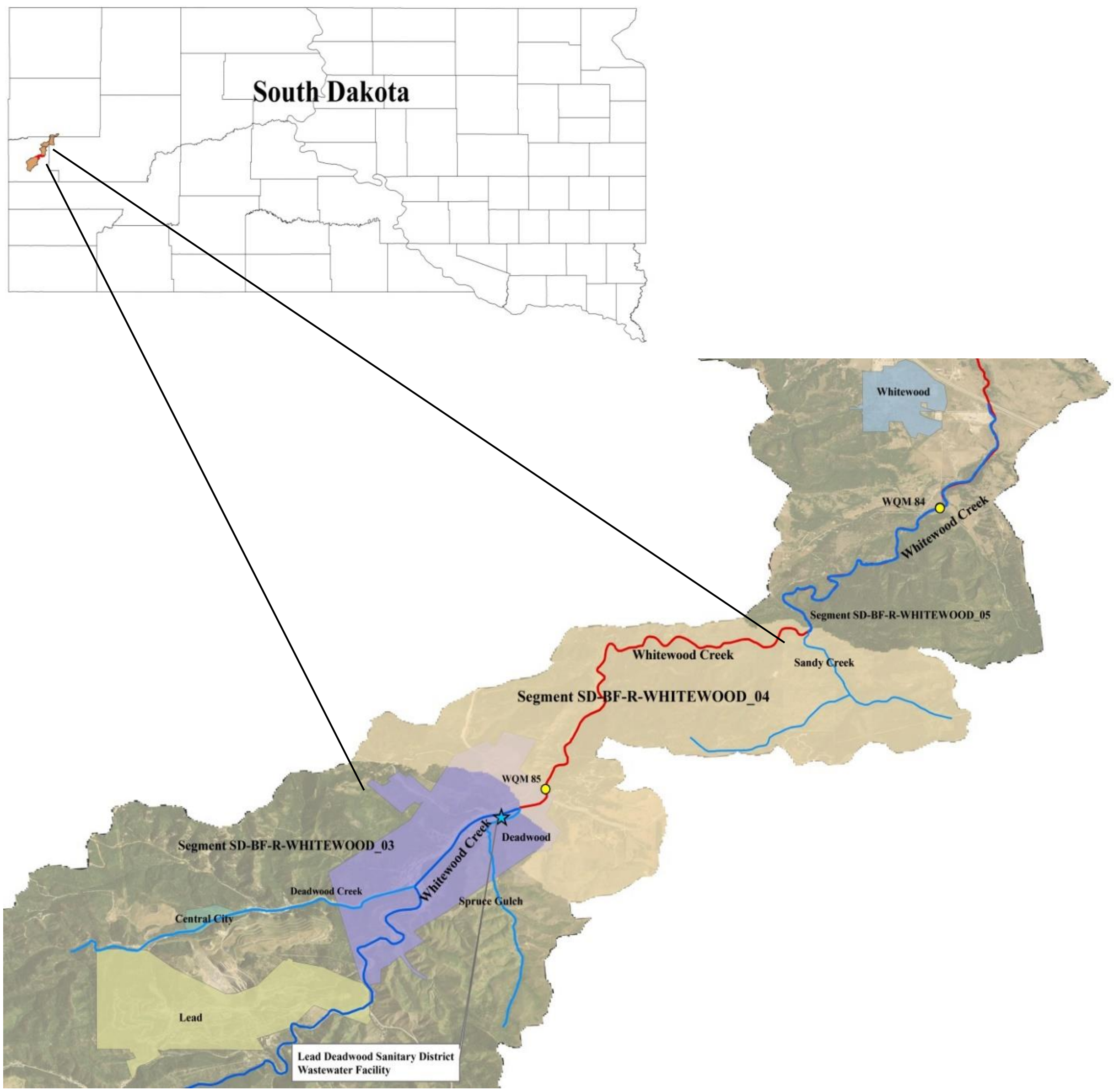

Figure 1 Location of the Whitewood Creek watershed and Segment SD-BF-R-WHITEWOOD_04 within South Dakota.

Segment SD-BF-R-WHITEWOOD_04 has a long history of bacteria impairment. Whitewood Creek Segment 4 was first identified as impaired for *E. coli* in South Dakota's Integrated Report (IR) for Surface Water Quality Assessment and placed on the 303(d) list of impaired waters during the 2012 reporting cycle. This impaired segment of Whitewood Creek has remained on the 303(d) list of impaired waters for not supporting the designated immersion recreation use due to *E. coli* in all subsequent IR cycles. The most recent 2022 IR considered Whitewood Creek segment 4 a High Priority (Category 1) for TMDL development.

2.0 Watershed Characteristics

Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 is a perennial mountain stream located in Lawrence County, South Dakota. Whitewood Creek is a tributary of the Belle Fourche River, which empties into the Cheyenne River. Drainage area of the Whitewood Creek Segment 4 watershed is approximately 9.1 square miles (23.7 square kilometers or 5,862 acres). The Whitewood Creek Segment 4 watershed has a maximum elevation of 5,400 ft (1,646 m) at the southeast edge of the of the watershed and a minimum elevation of 3,920 ft (1,194 m) near the confluence of Whitewood Creek and Sandy Creek. This impaired Segment of Whitewood Creek has a combined length of 5.02 stream miles (8.08 stream kilometers) beginning at the confluence of Spruce Gulch and ends where Sandy Creek enters Whitewood Creek (Figure 2 and Table 1).

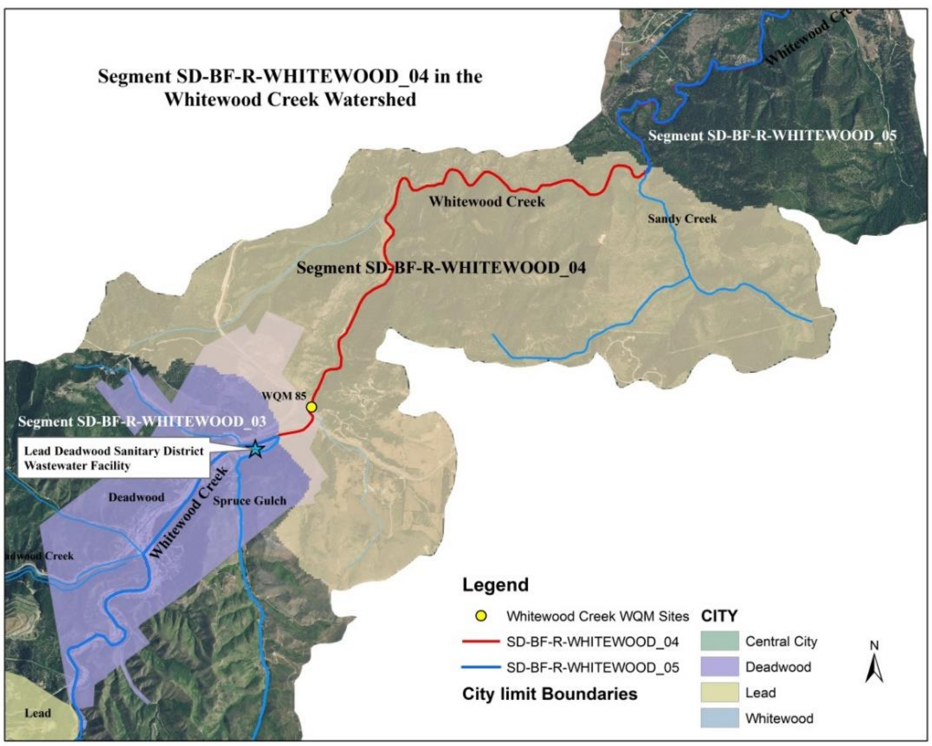

Figure 2 Deadwood Creek watershed with monitoring site, AUID identifier, current ADB Segment, and city limit boundaries WQ Discharge Outfall.

Table 1 Clean Water Act Section 303(d) Listing Information for Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 based on the 2022Integrated Report*

Waterbody AUID	From	To	Parameter
SD-BF-R-WHITEWOOD_04	Spruce Gulch	Sandy Creek	*E. coli*

*** See Figure 2 map for Segment location**

2.1 Monitoring Locations

E. coli bacteria was monitored at two locations within the Whitewood Creek Segment 4 watershed. Figure 3 depicts the monitoring locations on the impaired segment.

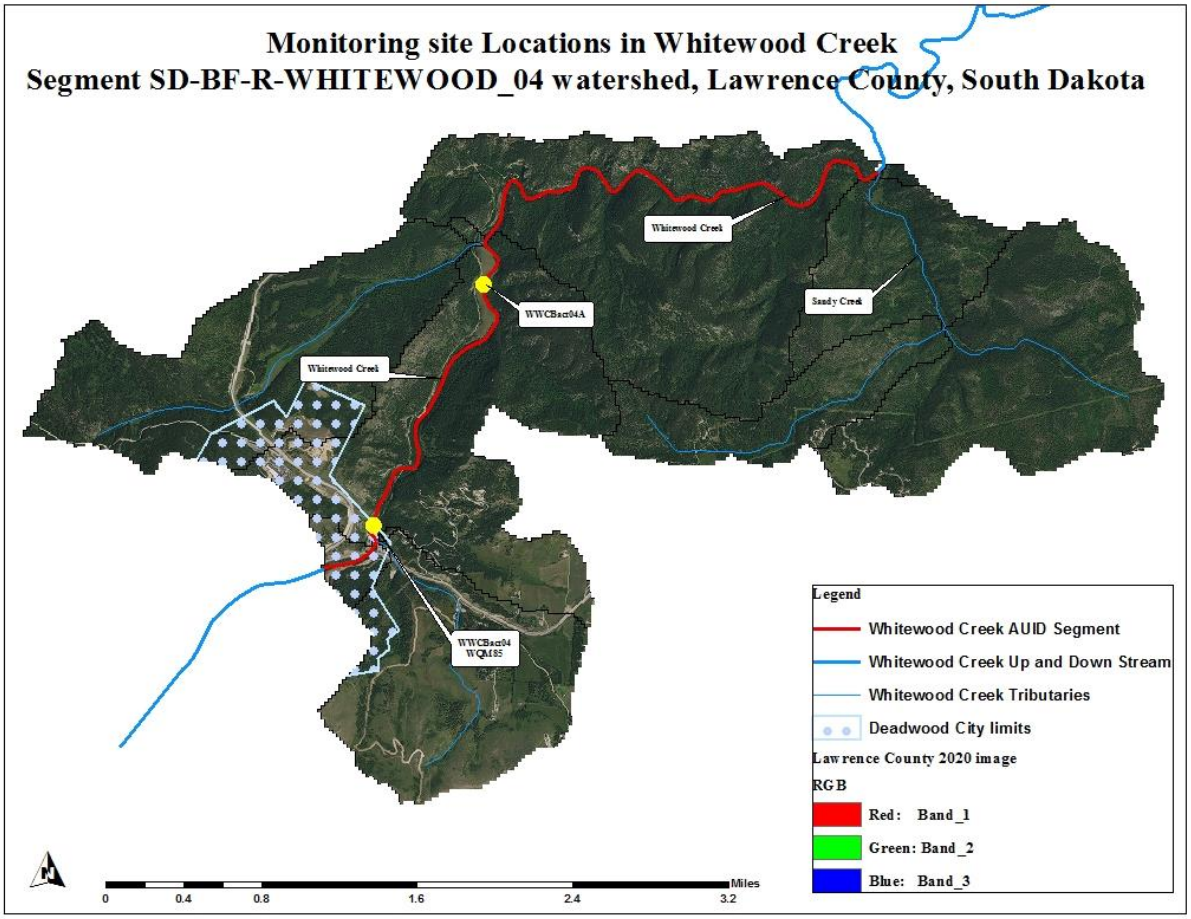

Figure 3 Whitewood Creek SD-BF-R-WHITEWOOD_04 watershed monitoring site locations

2.2 Geology

The underlying geology in the Whitewood Creek Segment 4 watershed is shown in Figure 4. The main geology consists of Pahasapa limestone, Englewood limestone, Whitewood limestone, Winnipeg and Deadwood Formations; (PP_m) made up of the Minnelusa Formation; and (T_r) trachytic intrusive rocks (Martin et al., 2004). The main watershed scale formations are described in Table 2.

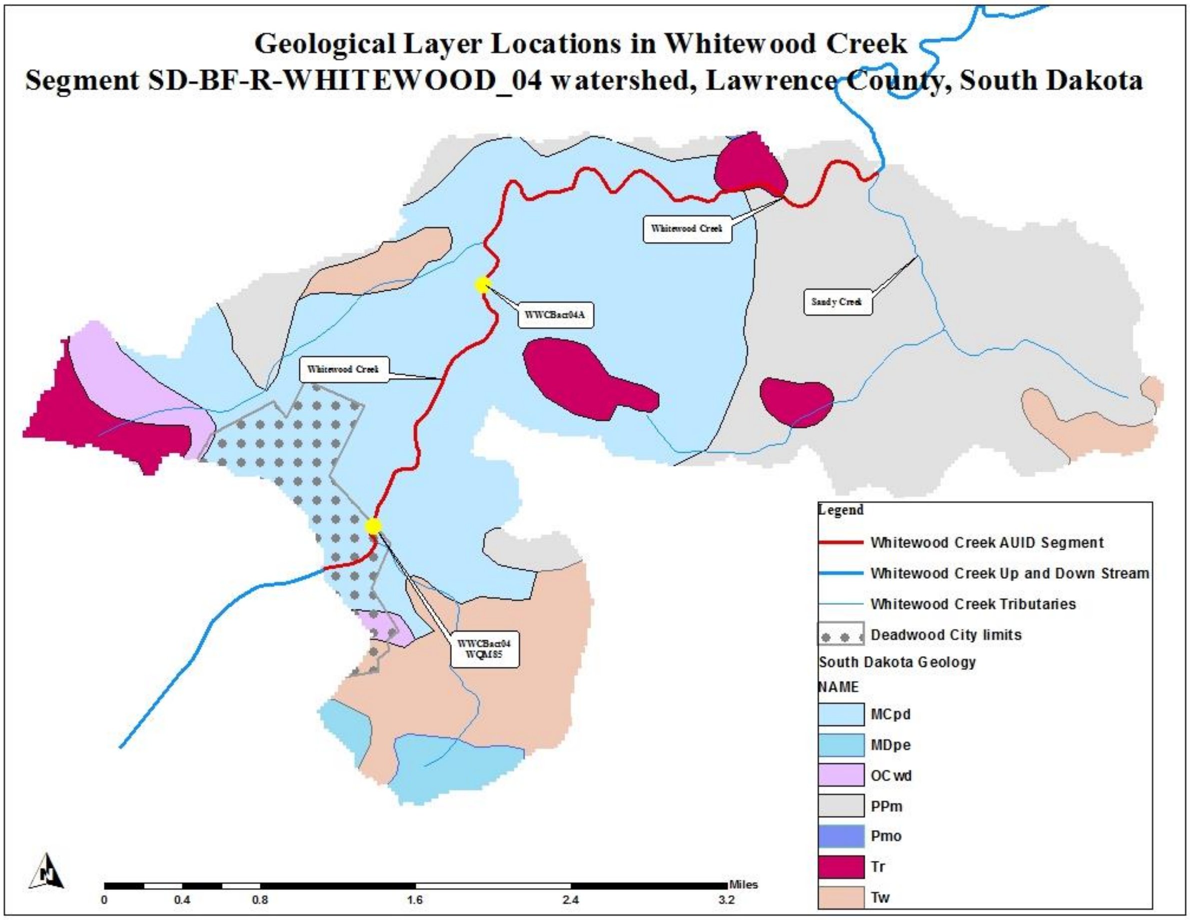

Figure 4 Underlying geology of Segment SD-BF-R-WHITEWOOD_04 in the Whitewood Creek watershed, Lawrence County, South Dakota.

Table 2 Table of geologic layers and descriptions within Segment SD-BF-R-WHITEWOOD_04 of Whitewood Creek.*

Layer	Constituents	Description
MC_{pd}	Pahasapa Limestone, Englewood Limestone, Whitewood Limestone, Winnipeg Formation, Deadwood Formation	Pahasapa limestone - White, light-gray to tan fine-to medium grained limestone and dolomite containing brown to gray chert. Solution features include collapse breccia, sink holes and caves.
		Englewood limestone - Pink to lavender to light-gray, thin- to medium- bedded, fine- to medium- grained, argillaceous, dolomitic limestone.
		Whitewood limestone – Mottled tan and gray to lavender, fine to medium-grained, fossiliferous limestone and dolomite.
		Winnipeg Formation – Tan calcareous siltstone and sandy shale with limestone lenses overlaying gray and light- green fissile shale.
		Deadwood Formation variegated, yellow to red, brown, grey, and green glauconitic conglomerate, sandstone, shale, dolomitic limestone, and dolomite.
MD_{pe}	Madison Group	Pahasapa Limestone - White, light-gray to tan fine-to medium grained limestone and dolomite containing brown to gray chert. Solution features include collapse breccia, sink holes and caves.
		Englewood Limestone - Pink to lavender to light-gray, thin- to medium- bedded, fine- to medium- grained, argillaceous, dolomitic limestone.
OC_{wd}	Whitewood Limestone, Winnipeg Formation, and Deadwood Formation	Whitewood limestone – Mottled tan and gray to lavender, fine to medium-grained, fossiliferous limestone and dolomite.
		Winnipeg Formation – Tan calcareous siltstone and sandy shale with limestone lenses overlaying gray and light- green fissile shale.
		Deadwood Formation variegated, yellow to red, brown, grey, and green glauconitic conglomerate, sandstone, shale, dolomitic limestone, and dolomite.
PP_{m}	Minnelusa Formation	Minnelusa Formation - Variegated, yellow to red, grey to brown, pink to purple, and black, interbedded sandstone, siltstone, shale, limestone, dolomite, calcarenite, chert, and brecciated beds.
P_{mo}	Minnekahta Limestone	Minnekahta Limestone - Purple to gray, fine-grained, thin- to medium-bedded limestone with varying of red shale.
	Opeche Shale	Opeche Shale - Red siltstone, argillaceous sandstone, and shale with interbedded caliche layers.
T_{r}	Rhyolitic intrusive rocks	Light tan to light -gray stocks and small laccoliths of rhyolite. Contains phenocrysts of oligoclase, quartz, and biotite in a fine-grained orthoclase or sanidine-quartz groundmass.
T_{w}	Brule, Chadron, Chamberlain Pass, and Slim Buttes Formations	Brule formation – White, pink, light-green, and light-brown, massive to thin-bedded, bentonitic claystone, tuffaceous siltstone, and well bedded, calcareous, tuffaceous quartz sandstone.
		Chadron formation – Upper beds are gray to light-brown to maroon bentonite, claystone, siltstone, and tuffaceous fine-grained sandstone, with local silicified carbonate lenses. Basal portion consists of poorly cemented, white, coarse-grained arkose and conglomerate.
		Chamberlain Pass formation – Pale-olive to pale-red, mottled mudstone containing white, cross-bedded channel sandstone with basal conglomerate.
		Slim Buttes formation – White, grayish- to yellowish-orange, and pale-red to pink siltstone, clayey siltstone, bentonitic claystone, medium-to fine-grained sandstone, and conglomerate.

* = from (Martin et al., 2004)

2.3 Soils

The major soil types in the Whitewood Creek Segment 4 watershed are composed of Vanocker-Sawdust, moist-Rock outcrop complex, 40 to 80 percent slopes 26.3 percent, Vanocker-Citadel complex, 10 to 40 percent slopes 18.9 percent, and Citadel-Tollflat-Danjay complex, 10 to 40 percent slopes, at 18.1 percent of this watershed (Table 3). These soils make up 63.2 percent of all soils within the impaired watershed of Whitewood Creek Segment 4.

Table 3 Whitewood Creek SD-BF-R-WHITEWOOD_04 USDA SSURGO soil map units, acres, and percentage of each soil in Whitewood Creek Segment 4 watershed.

Map Unit Symbol	Soil Unit Name	Acres	Percent of Soils in Whitewood Creek Segment 4
Q0108E	Grizzly-Mineshaft complex, 10 to 40 percent slopes	152.2	2.6%
Q0108G	Grizzly-Mineshaft complex, 40 to 80 percent slopes	330.4	5.7%
Q0110E	Grizzly-Rock outcrop complex, 10 to 40 percent slopes	9.9	0.2%
Q0110G	Grizzly-Rock outcrop complex, 40 to 80 percent slopes	91.0	1.6%
Q0112G	Grizzly-Rubbleland-Rock outcrop complex, 40 to 80 percent slopes	25.9	0.4%
Q0114E	Grizzly-Virkula complex, 10 to 40 percent slopes	15.3	0.3%
Q0219F	Typic Udarents-Rock outcrop complex, 6 to 60 percent slopes	13.1	0.2%
Q0229C	Rapidcreek very gravelly loam, noncalcareous, 1 to 9 percent slopes, rarely flooded	0.0	0.0%
Q0232G	Pactola-Pactola, shallow-Rock outcrop complex, 40 to 80 percent slopes	20.9	0.4%
Q0237F	Typic Udarents, reclaimed, 3 to 60 percent slopes	27.7	0.5%
Q0501B	Bullflat silt loam, moist, 3 to 6 percent slopes	0.6	0.0%
Q0502C	Bullflat, moist-Cordeston silt loams, 2 to 9 percent slopes	23.6	0.4%
Q0509C	Citadel-Tollflat complex, 2 to 12 percent slopes	34.6	0.6%
Q0510E	Citadel-Tollflat-Danjay complex, 10 to 40 percent slopes	1,056.3	18.1%
Q0514C	Citadel-Vanocker complex, 2 to 12 percent slopes	10.5	0.2%
Q0520C	Cordeston-Rapidcreek, rarely flooded complex, 2 to 9 percent slopes	4.7	0.1%
Q0528B	Hilger cobbly loam, moist, 0 to 6 percent slopes, cobbly	72.5	1.2%
Q0528E	Hilger cobbly loam, moist, 6 to 40 percent slopes, cobbly	167.0	2.9%
Q0553E	Rockerville, moist-Rock outcrop complex, 6 to 40 percent slopes	0.6	0.0%
Q0554F	Rockerville, moist-Vanocker-Rock outcrop complex, 10 to 60 percent slopes	12.5	0.2%
Q0560C	Rapidreek gravelly loam, 2 to 10 percent slopes, rarely flooded	43.3	0.7%
Q0568B	Roubaix silt loam, 0 to 6 percent slopes	17.1	0.3%
Q0568E	Roubaix silt loam, 6 to 40 percent slopes	449.6	7.7%
Q0576C	Tollflat-Vanocker complex, 2 to 12 percent slopes	49.9	0.9%
Q0584E	Vanocker-Citadel complex, 10 to 40 percent slopes	1,105.8	18.9%
Q0585G	Vanocker-Danjay-Hopdraw, moist complex, 40 to 80 percent slopes	576.2	9.9%
Q0589G	Vanocker-Sawdust, moist-Rock outcrop complex, 40 to 80 percent slopes	1,535.9	26.3%
Totals for Area in SD-BF-R-Whitewood_04		**5,847.1**	**100.0%**

2.4 Land Use/Land Cover

The watershed is located within the proclaimed boundary of the Black Hills National Forest. Approximately, 1,300 feet of segment 04 runs through lands administered by the Black Hills National Forest, most of it runs through either state-owned or privately owned land (Appendix B). The major land cover is predominantly evergreen forest (78.9 percent, 4,627.7 acres) consisting of ponderosa pine followed by Herbaceous plants (14.0 percent, 818.2 acres) and Shrub/Scrub (3.2 percent, 185.0 acres). High, medium and low intensity development and open developed land uses in the watershed only total 157 acres or 2.68 percent of the watershed. The majority of developed lands are within the portion of the City of Deadwood (314 acres) inside Segment SD-BF-R-WHITEWOOD_04 of Whitewood Creek (Figure 5 and Table 4).

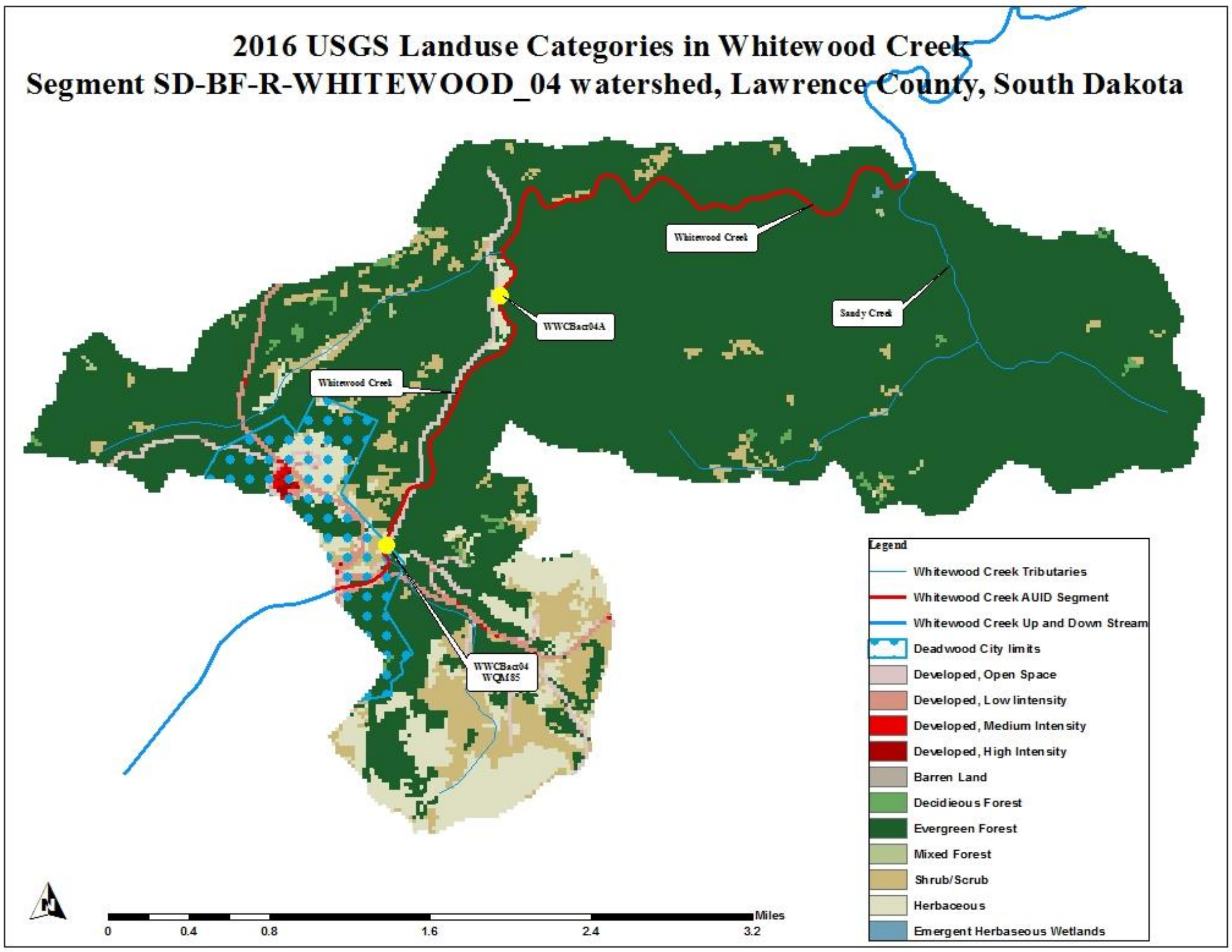

Figure 5 2016 Landuse categories in Whitewood Creek Segment SD-BF-R-WHITEWOOD_04, Lawrence County, South Dakota

Table 4 Land Use Categories Coverage by Acres for Whitewood Creek Segment SD-BF-R-WHITEWOOD_04)

Segment 4 Land Use

Color	Value	Count_	Land_Cover	Acres[1]	Percent
	21	183	Developed, Open Space	40.7	0.7%
	22	477	Developed, Low Intensity	106.1	1.8%
	23	27	Developed, Medium Intensity	6.0	0.1%
	24	19	Developed, High Intensity	4.2	0.1%
	31	71	Barren Land	15.8	0.3%
	41	174	Deciduous Forest	38.7	0.7%
	42	20,808	Evergreen Forest	4627.7	78.9%
	43	29	Mixed Forest	6.4	0.1%
	52	832	Shrub/Scrub	185.0	3.2%
	71	3,679	Herbaceuous	818.2	14.0%
	81	20	Hay/Pasture	4.4	0.1%
	95	44	Emergent Herbaceuous Wetlands	9.8	0.2%
Sum				5863.1	100.0%

[1] **acres = 0.2224 * pixel count for 30m*30m pixeels**

2.5 Climate and Precipitation

Daily precipitation, snowfall, minimum and maximum temperature data for Lead, South Dakota (Station ID:GHCND:USC00394834) from 2005 through 2020 was downloaded using the online National Climate Data Center (https://www.ncdc.noaa.gov/cdo-web/). The Whitewood Creek Segment 4 watershed receives approximately 31.5 inches of average annual precipitation (0.80 m) and averages approximately 163 inches (4.14m) of snowfall based on the last 15 years of data from the National Climate Data Center. The highest temperature was 100 °F (37.8 °C) in 2014 and the lowest temperature was -24 °F (-31.1 °C) in 2011 (Table 5). Over 70 percent of the annual precipitation in this watershed occurs during the months of April through September.

Table 5 Average annual precipitation, snowfall in inches, maximum and minimum temperatures, and yearly maximum and minimum temperatures in degrees Fahrenheit for Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 Watershed from 2005 through 2020.

Year	Days	Annual Precipitation (inches)	Annual Snowfall (inches)	Yearly Maximum Temperature (°F)	Yearly Average Maximum Temperature (°F)	Yearly Minimum Temperature (°F)	Yearly Average Minimum Temperature (°F)
2005	365	32.14	134.1	96	56.27	-12	35.34
2006	365	33.31	208.5	98	56.38	-22	35.54
2007	365	32.20	147.9	94	56.52	-13	35.25
2008	304	29.09	229.9	89	53.18	-22	31.97
2009	362	35.08	291.2	88	52.92	-12	32.07
2010	365	33.05	165.2	93	54.93	-13	33.93
2011	365	30.84	175.2	94	54.46	-24	33.10
2012	365	21.86	112.4	96	59.29	-8	35.81
2013	365	49.52	238.1	92	54.19	-17	33.81
2014	365	33.98	144.8	100	58.42	-15	36.76
2015	365	35.51	99.2	93	60.72	-6	36.85
2016	366	21.60	98.1	96	59.84	-18	37.23
2017	365	20.83	75.3	94	59.08	-16	35.86
2018	365	31.52	147.6	94	57.04	-12	34.56
2019	365	40.27	190.6	89	52.96	-18	32.53
2020	366	23.60	152.0	94	56.81	-6	35.33

***= Data collected from January 01, 2005 through December 31, 2020**

3.0 Water Quality Standards

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

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

3.1 Beneficial Uses

Waterbodies within South Dakota are designated specific beneficial uses. All waters (both lakes and streams) are designated the use of fish and wildlife propagation, recreation, and stock watering. All streams are assigned the use of irrigation. Additional uses are designated by the state based on a waterbody specific beneficial use attainability assessment.

Beneficial use classifications of surface waters of the state are established in ARSD §74:51:01:42 and waters of this section do not limit the actual use of such waters. The classifications designate the minimum quality at which the surface waters of the state are to be maintained and protected. The following are the beneficial use classifications for South Dakota (Table 6).

Table 6 Beneficial Use Classifications Assigned to Waters of the State

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

Shaded = Beneficial use classifications assigned to Whitewood Creek Segment SD-BF-R-Whitewood_04
Impaired use: red

Water quality standards consist of suites of criteria that provide physical and chemical benchmarks from which management decisions can be developed. Individual parameters determine the support of beneficial uses. Each designated beneficial use classification is assigned numeric criteria. Designated uses are considered impaired when water quality values exceed standards and criteria in accordance with 303(d) listing methods. Impaired waters require Total Maximum Daily Load (TMDL) development.

3.2 Narrative Criteria

In addition to physical and chemical standards, South Dakota has developed narrative criteria for the protection of aquatic life uses (ASRD § 74:51:01:12). *All waters of the state must be free from* *substances, whether attributable to human-induced point source discharge or non-point source activities, in concentration or combinations which will adversely impact the structure and function of indigenous or intentionally introduced aquatic communities*.

South Dakota has narrative standards that may also be applied to the undesired eutrophication of lakes and streams. ARSD § 74:51:01:05; 06; 08; 09 contains language that prohibits the presence of materials causing pollutants to form, visible pollutants, taste and odor producing materials, and nuisance aquatic life. Specific ARSD narrative languages for the above conditions are provided below.

§ **74:51:01:05. Materials causing pollutants to form in waters.** *Wastes discharged into surface waters of the state may not contain a parameter which violates the criterion for the waters' existing or designated beneficial use or impairs the aquatic community as it naturally occurs. Where the interaction of materials in the wastes and the waters causes the existence of such a parameter, the material is considered a pollutant and the discharge of such pollutants may not cause the criterion for this parameter to be violated or cause impairment to the aquatic community.*

§ **74:51:01:06. Visible pollutants prohibited.** *Raw or treated sewage, garbage, rubble, un-permitted fill materials, municipal wastes, industrial wastes, or agricultural wastes which produce floating solids, scum, oil slicks, material discoloration, visible gassing, sludge deposits, sediments, slimes, algal blooms, fungus growths, or other offensive effects may not be discharged or caused to be discharged into surface waters of the state.*

§ **74:51:01:08. Taste-and odor-producing materials.** *Materials which will impart undesirable tastes or undesirable odors to the receiving water may not be discharged or caused to be discharged into surface waters of the state in concentrations that impair a beneficial use.*

§ **74:51:01:09. Nuisance aquatic life.** *Materials which produce nuisance aquatic life may not be discharged or caused to be discharged into surface waters of the state in concentrations that impair an existing or designated beneficial use or create a human health problem.*

3.3 Numeric Criteria

South Dakota has adopted numeric *E. coli* criteria for the protection of the (7) immersion and (8) limited contact recreation uses (Table 6). 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 (#)/100mL, is used to identify fecal contamination and as an indicator for the likely presence of other pathogenic microorganisms. 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 immersion recreation beneficial use requires that 1) no single sample 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 (ARSD 74:51:01:50). The *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 of a minimum of 5 samples collected during separate 24-hour periods must not exceed 630 CFU/100 mL (ARSD 74:51:01:51). As noted, these limited contact criteria are five times the corresponding immersion criteria. *E. coli* criteria apply from May 1st through September 30th, which is considered the recreation season. The numeric *E. coli* criteria applicable to Whitewood Creek (SD-BF-R-WHITEWOOD_04) are the immersion recreation values listed in Table 7 ($\leq$ 235 CFU/100 mL SSM, $\leq$ 126 CFU/100mL 30-day geometric mean).

Table 7 Numeric surface water quality criteria for Whitewood Creek Segment SD-BF-R-Whitewood_04, Lawrence County, South Dakota 2022 IR.

	Segment		
	SD-BF-R-WHITEWOOD_04		
Parameter	**Criterion and units of measure**	**Special Conditions**	**Beneficial Use**
Total Suspended Solids	≤ 90 mg/L	30-day average	Coldwater marginal fish life propagation waters
	≤ 158 mg/L	daily maximum	
Total Ammonia Nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A, mg/L (SDCL§74:51:01)	30-day average May 1 – October 31	Coldwater marginal fish life propagation waters
	Equal to or less than the result from Equation 1 in Appendix A, mg/L (SDCL§74:51:01)	Daily maximum	Coldwater marginal fish life propagation waters
Dissolved Oxygen **(Anywhere in the water column of a Non-stratified water body)**	≥ 5 mg/L	Daily minimum	Coldwater marginal fish life propagation waters
Un-disassociated Hydrogen Sulfide	≤ 0.002 mg/L	Daily maximum	Coldwater marginal fish life propagation waters
pH	≥ 6.5 - ≤ 9.0 pH units	See SDCL §74:51:01:07	Coldwater marginal fish life propagation waters
Undisassociated hydrogen sulfide	≤ 0.002 mg/L	Daily maximum	Coldwater marginal fish life propagation waters
Water Temperature	≤ 75.2 °F	See SDCL §74:51:01:46.01	Coldwater marginal fish life propagation waters (Black Hills Trout Management Area)
Escherichia coli **(May 1 – September 30)**	≤ 126 CFU/100 mL	Geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period (calendar month, 2022 IR listing methodology)	Immersion recreation
	≤ 235 CFU/100 mL	In any one sample	
Escherichia coli **(May 1 – September 30)**	≤ 630 CFU/100 mL	Geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period (calendar month, 2022 IR listing methodology)	Limited contact recreation
	≤ 1,178 CFU/100 mL	In any one sample	
Total alkalinity as calcium carbonate	≤ 750 mg/L	30-day average	Fish and wildlife propagation, recreation, and stock watering
	≤ 1313 mg/L	Daily maximum	
Total Dissolved Solids	≤ 2,500 mg/L	30-day average	Fish and wildlife propagation, recreation and stock watering
	≤ 4,375 mg/L	Daily maximum	
Nitrates as N	≤ 50 mg/L	30-day average	Fish and wildlife propagation, recreation, and stock watering
	≤ 88 mg/L	Daily maximum	
pH	≥ 6.0 - ≤ 9.5	See SDCL §74:51:01:07	Fish and wildlife propagation, recreation, and stock watering
Total petroleum hydrocarbon	≤ 10 mg/L	See SDCL §74:51:01:10	Fish and wildlife propagation, recreation, and stock watering
Oil and grease	≤ 10 mg/L	See SDCL §74:51:01:10	Fish and wildlife propagation, recreation, and stock watering
Conductivity @ 25°C	≤ 2,500 µmhos/cm	30-day average	Irrigation waters
	≤ 4,375 µmhos/cm	Daily maximum	
Sodium adsorption ratio	≤ 10	Sodium adsorption ratio: a calculated value that evaluates the sodium hazard of irrigation water based on the Gapon equation and expressed by the mathematical expression: $\frac{Na^+}{\sqrt{\frac{Ca^{+2}+Mg^{+2}}{2}}}$ where Na^+, Ca^{+2}, and Mg^{+2} are expressed as milliequivalents per liter	Irrigation waters

pH Equation 1: For waters where salmonid fish are present. $(0.275/(1+10^{7.204-pH})) + (39.0/(1+10^{pH-7.204}))$

pH = the pH of the water quality sample in standard units.

pH Equation 3: For waters where early life stages are present. $(((0.0577/(1 + 10^{7.688-pH})) + (2.487/(1+10^{pH-7.688}))) * MIN(2.85, 1.45 * 10^{0.028 * (25-T)})$

MIN = use either 2.85 or the value of $1.45^{0.028 * (25-T)}$, whichever is the smaller value. T = the water temperature of the sample in degrees Centigrade.

pH = the pH of the water quality sample in standard units.

3.4 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.

3.5 SD-BF-R-Whitewood_04

Whitewood Creek segment SD-BF-R-WHITEWOOD_04 (Spruce Gulch to Sandy Creek) is designated the following beneficial uses: (3) Coldwater marginal fish life propagation, (7) Immersion recreation, (8) Limited contact recreation, (9) Fish and wildlife propagation, recreation and stock watering waters, and (10) Irrigation waters. Table 7 lists the most stringent criteria that must be met to support the designated beneficial uses. When multiple criteria exist for a particular parameter, the most stringent criterion was used.

TMDLs must consider downstream water quality standards. Therefore, TMDL developed for Whitewood Creek segment SD-BF-R-WHITEWOOD_04 will take into account water quality standards, discharge, and loading effects on the downstream segment Whitewood Creek SD-BF-R-WHITEWOOD_05 below Sandy Creek to Interstate 90. Whitewood Creek segment SD-BF-R-WHITEWOOD_05 is designated the same beneficial use classifications as Whitewood Creek Segment SD-BF-R-WHITEWOOD_04. Whitewood Creek segment SD-BF-R-WHITEWOOD_05 flows into Whitewood Creek segment SD-BF-R-WHITEWOOD_06 below Interstate 90 near Whitewood, South Dakota to Crow Creek and is designated the uses of (4) Warmwater permanent fish life propagation, (8) Limited contact recreation, (9) Fish and wildlife propagation, recreation and stock watering and (10) Irrigation waters. Whitewood Creek segment WHITEWOOD_07 flows from Crow Creek to the mouth of Whitewood Creek and is also assigned the same beneficial use classifications as Whitewood Creek segment SD-BF-R-WHITEWOOD_06. At this point, Whitewood Creek empties into the Belle Fourche River segment SD-BF-R-BELLE_FOURCHE_03 (Whitewood Creek to Willow Creek).

Segments SD-BF-R- WHITEWOOD_03 and SD-BF-R- WHITEWOOD_04 have never been listed for parameters associated with coldwater permanent fish life propagation waters, limited contact recreation, fish, and wildlife propagation, recreation, stock watering, and irrigation waters beneficial uses. Segment SD-BF-R- WHITEWOOD_03 was listed in the 2010, 2012, 2014, 2016, 2018, and 2020 303(d) impaired waterbodies lists for exceeding fecal coliform and *E. coli* bacteria standards for the immersion recreation use and has EPA approved TMDLs for these parameters (approved, July 2011). Downstream Segment SD-BF-R- WHITEWOOD_04, the focus of this report, was on the 2012, 2014, 2016, 2018, 2020 and 2022 303(d) lists for exceeding *E. coli* bacteria standards for immersion recreation. Waters from these impaired segments (Whitewood Creek Segment SD-BF-R-WHITEWOOD_03 SD-BF-R- WHITEWOOD_04) flow into Whitewood Creek Segment SD-BF-R-WHITEWOOD_05. This segment has never been impaired/listed for exceeding fecal coliform/*E. coli* bacteria standards for immersion and/or limited contact recreation uses (2000, 2002 (305(b) Reports and 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, and 2022 Integrated Reports). Because of this agreement, TMDLs established to meet Whitewood Creek’s water quality standards will also be protective of downstream (Segment SD-BF-R-WHITEWOOD_04 and Segment SD-BF-R-WHITEWOOD_05) water quality standards.

4.0 TMDL Targets

TMDLs are required to identify a numeric target to measure whether or not 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 criteria are the same. In these cases, selecting a TMDL target is as simple as applying the numeric criteria. Occasionally 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.

As seen from Table 7, there are two numeric *E. coli* criteria for TMDL target consideration. 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 elaborate how the criteria were derived.

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 75^{th}, 82^{nd}, 90^{th}, and 95^{th} percentiles of the expected water quality sampling distribution around the GM to account for different recreational use intensities (Figure 6). South Dakota adopted the most stringent recommendation, the 75^{th} percentile, into state water quality standard regulations as the SSM protective of designated beaches.

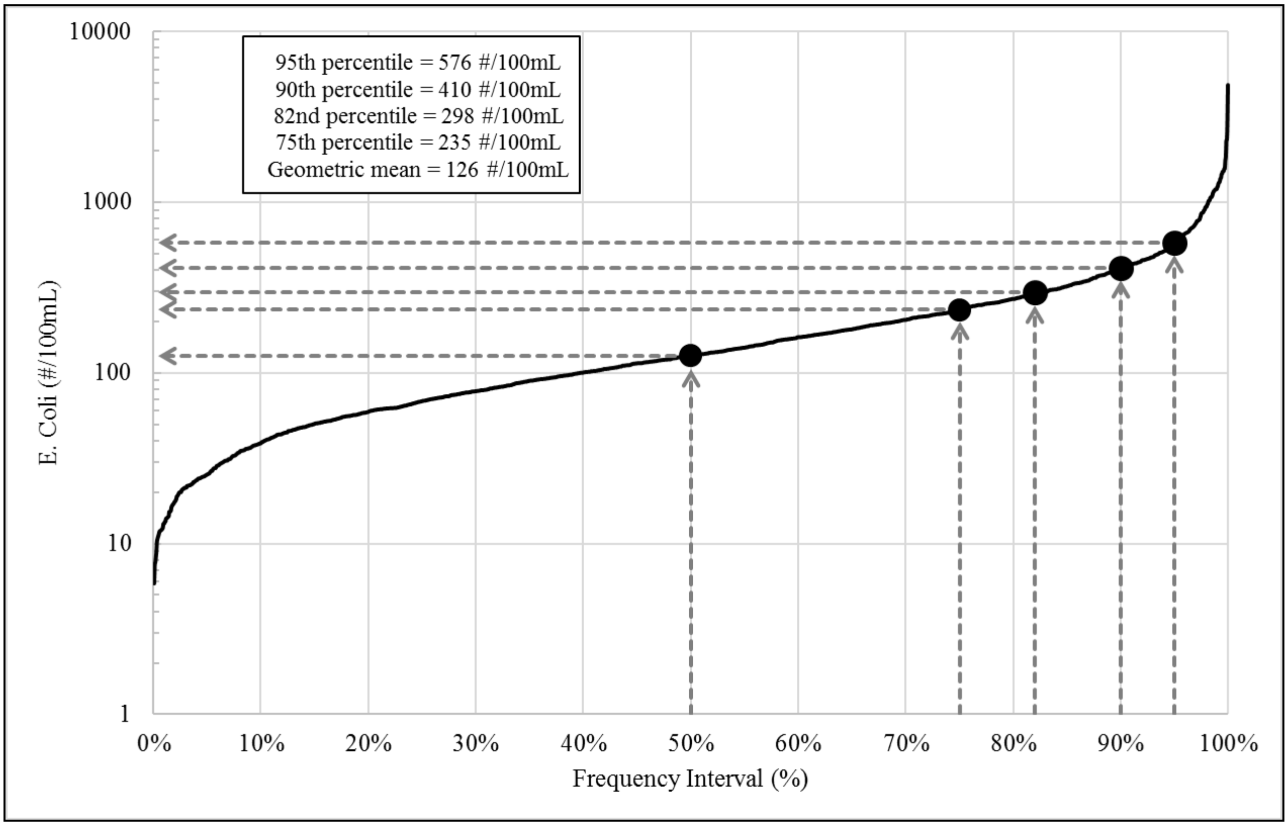

Figure 6 Log-Normal Frequency Distribution Used to Establish South Dakota's Immersion Recreation *E. coli* Criteria of 126 (GM) and 235 (SSM) #/100mL (EPA, 1986).

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 that 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.

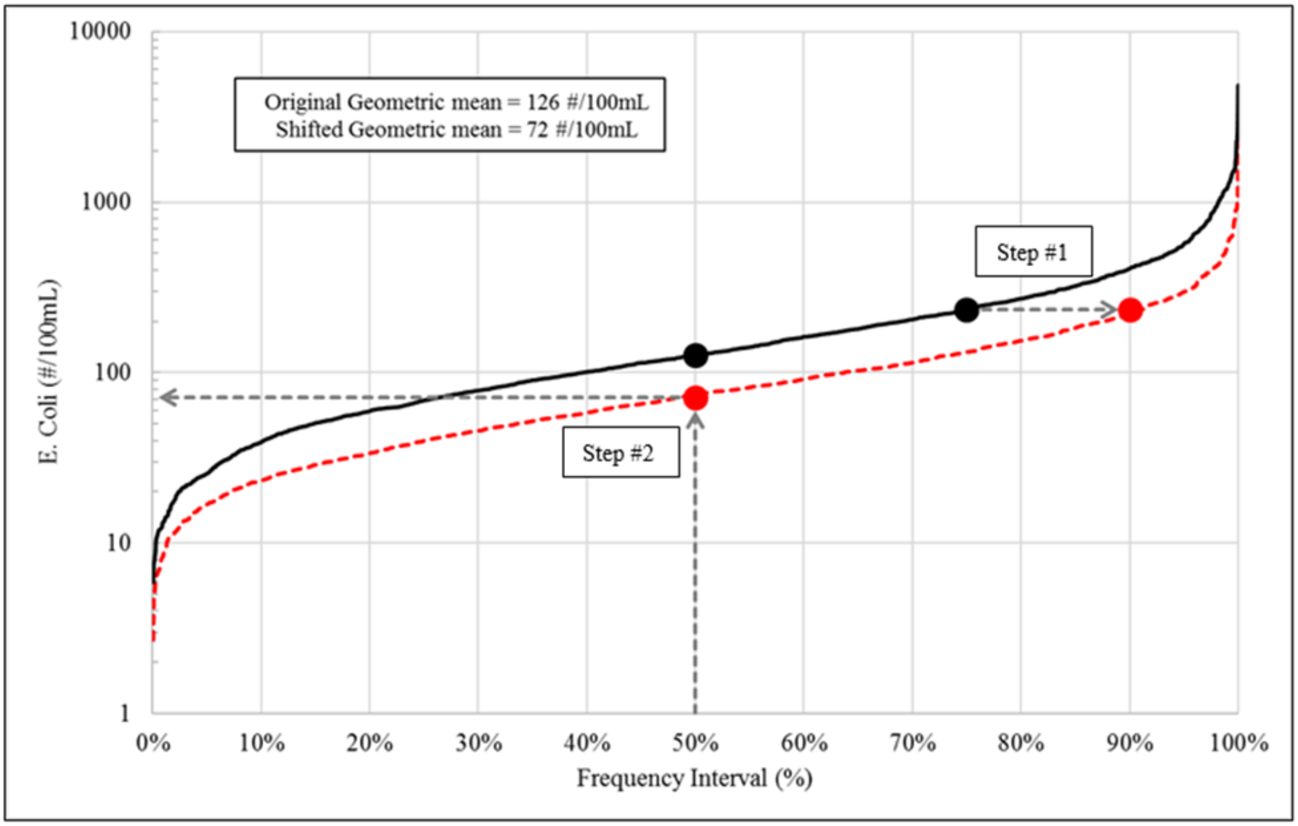

Figure 7 The Effective Impact of South Dakota's *E. coli* Assessment Method on the Criteria's Original Log-Normal Frequency Distribution (Black line = original; red dotted line = shifted)

When a proper GM cannot be calculated, 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. These methods are further discussed in section 5.0, however for this discussion, it is important to note that SD DANR allows a 10% exceedance frequency of both the SSM and GM. In other words, as long as the *E. coli* dataset meets other age and size requirements, a waterbody is considered impaired (i.e., not meeting water quality standards) when greater than 10% of samples exceed either the SSM or GM. Water quality standards are met if the exceedance frequency is 10% or less.

Returning to the original distribution used to establish South Dakota's Immersion Recreation *E. coli* criteria in Figure 6, 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 Figure 7 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 CFU/100mL (red dotted line), the corresponding 50th percentile (GM) is 72 CFU/100mL as shown in Step #2 of Figure 7.

The GM associated with this shifted distribution is more stringent than the GM of the original distribution (126 CFU/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. Once again, this outcome holds true for South Dakota's limited contact recreation *E. coli* criteria since they were simply derived as five times the immersion values.

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.

During the Whitewood Creek watershed assessment project in Segment SD-BF-R-WHITEWOOD_ 04, an attempt was made to collect enough bacteria samples to evaluate the SSM and the GM water quality criteria based on the immersion recreation waters beneficial use. As mentioned earlier, the GM and SSM are equally protective of the beneficial use (immersion recreation) because they are based on the same illness rate and that differ simply representing different statistical values and sampling timeframes. Assessment data indicate that enough *E. coli* bacteria samples were collected to calculate six separate (6) 30-day geometric mean values to evaluate the GM criterion based on the immersion recreation beneficial use criterion (GM ≤ 126 CFU/100mL) and a total of 120 daily samples were collected from to assess the Single Sample Maximum, SSM criterion, (SSM ≤ 235 CFU/100mL) throughout the Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 watershed assessment (2009 through 2020). Data show three (3) of the six (6) calculated GM values (50%) exceeded the ≤ 126 CFU/100 mL standard, and 36 of 120 of the daily *E. coli* bacteria samples (30%) exceeded water quality standards for immersion recreation waters ≤ 235 CFU/100mL (Tables 9 and 10). Impairment determination criteria followed those outlined in the 2022 Integrated Report (SD DANR, 2022). These data indicate that both GM and SSM criteria exceeded beneficial use based water quality standards for immersion recreation waters and show that whichever data collection method used to assess (GM to SSM) compliance in this watershed are equally representative (i.e., equally protective and appear to be sensitive to subtle natural variations in data collection techniques).

Based on these data, the immersion recreation SSM for *E. coli* criterion (235 CFU/100mL) was selected as the numeric TMDL target for the Whitewood Creek Segment SD-BF-R-WHITEWOOD_ 04 watershed assessment project because there were significantly more daily *E. coli* bacteria to assess the SSM criteria than all calculated GM *E. coli* bacteria values based on immersion recreation criteria (≤ 126 CFU/100mL). Refer to Section 6.0 for a thorough review of Whitewood Creek sampling and results.

5.0 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. Table 8 presents South Dakota's assessment method for *E. coli* bacteria and describes what constitutes a minimum sample size and how an impairment decision is made.

Table 8 Assessment Methods for Determining Support Status for Section 303(d) (SDDANR 2022).

IR Assessment Methods		
Description	**Minimum Sample Size**	**Impairment Determination Approach**
FOR CONVENTIONAL PARAMETERS (such as dissolved oxygen, TSS, *E. coli* bacteria, pH, water temperature, etc.)	STREAMS: a minimum of 20 samples (collected on separate days) for any one parameter are required within a waterbody reach. A 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 for reasons previously discussed, 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. In the next section, data collection activities are summarized, and monitoring results are evaluated using this assessment method.

6.0 Data Collection and Results

The South Dakota Department of Agriculture and Natural Resources (SD DANR) established a long-term Water Quality Monitoring (WQM) station within Whitewood Creek Segment 4 in 1977. This WQM station is identified as WQM 85 or DANR 460685. WQM 85 is located downstream of Deadwood, SD and is part of the Statewide Ambient Surface Water Quality Monitoring Program (Figure 2 and Appendix A, Tables A1 and Table A2). *E. coli* bacteria has been collected monthly during the recreation season (May 1st through September 30th) since May 2009.

Whitewood Creek segments 3 and 4 have a history of not supporting the designated immersion recreation use due to *E. coli* bacteria (i.e., impairment cause). This is not the case with the downstream segments, in particular, segment 5 located immediately downstream. An analysis of Whitewood Creek segments 3, 4 and 5 was conducted to describe the 303(d) impairment history with a focus on the 2010 to 2020 Integrated Report (IR) cycles (Table 9). Information includes water year data range, exceedance count, WQM site ID, total sample count, exceedance percentage and IR listing status for each AUID Segment; SD-BF-R-WHITEWOOD_03 (upstream), SD-BF-R-WHITEWOOD_04 (target Segment) and SD-BF-R-WHITEWOOD_05 (downstream).

Table 9 Integrated Report 303(d) listing status *E. coli* bacteria data for Whitewood Creek (Segment SD-BF-R-WHITEWOOD_03, WQM 123; Segment SD-BF-R-WHITEWOOD_04, WQM 85 and WWCBact04; Segment SD-BF-R-WHITEWOOD_05, WQM 84, WWCpH03) from 2004 through 2019

		Whitewood Creek											
		Upstream Segment				Target Segment				Downstream Segment			
		E. coli Bacteria											
Integrated Report	Water Years	Segment SD-BF-R-WHITEWOOD_03[1]				Segment SD-BF-R-WHITEWOOD_04[2,A]				Segment SD-BF-R-WHITEWOOD_05[3, A]			
Year	Oct. 1st -Sept. 30th	Exceedances	WQM 123 samples 0nly	Stantard Exceedance %	Listed	Exceedances	All Data WQM 85/ WWCBact04	Stantard Exceedance %	Listed	Exceedances	Data WQM 84/ WWCpH03	Stantard Exceedance %	Listed
2010	2004-2009	10	31	32.3%	Y	1	5	20.0%	N	0	5	0.0%	N
2012	2006-2011	8	30	26.7%	Y	4	14	28.6%	Y	1	15	6.7%	N
2014	2008-2013	9	30	30.0%	Y	8	25	32.0%	Y	1	25	4.0%	N
2016	2010-2015	13	30	43.3%	Y	25	66	37.9%	Y	2	54	3.7%	N
2018	2012-2017	12	30	40.0%	Y	24	66	36.4%	Y	1	54	1.9%	N
2020	2014-2019	6	30	20.0%	Y	24	77	31.2%	Y	2	54	3.7%	N

Red = Exceeds EPA Integrated Report listing criteria (≤ 10%exceedance of all samples collected within a 5-year time period)
Shadded = Current TMDL assessment segment
A =Data collection in these segments began in 2009
1 = Whitewood Creek Segment SD-BF-R-WHITEWOOD_03 from Deadwood Creek to Spruce Gulch, data collection began in 2004
2 = Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 from Spruce Gulch to Sandy Creek
3 = Whitewood Creek Segment SD-BF-R-WHITEWOOD_05 from Sandy Creek to I-90

Whitewood Creek segment 4 (target segment) has been listed as impaired in all IR cycles since 2012 with exceedance percentages ranging from 28.6 percent to 37.9 percent. Whitewood Creek segment 3, (upstream) has been listed as impaired or not supporting the recreation use due to *E. coli* in all IR cycles since 2010 with exceedance percentages ranging from 20.0 percent to 43.3 percent. The similarity in exceedance rates suggests *E. coli* originating from segment 3 contributes to the impairment in segment 4 (i.e., border condition). Whitewood Creek segment 5 (downstream) has never been listed as impaired in any IR cycle since 2010 with exceedance percentages ranging from 0.0 percent to 6.7 percent. Section 7.0 discusses the significant sources of *E. coli* production in the Whitewood Creek Segment 4 watershed.

A watershed assessment project was initiated by Watershed Protection Program (WPP) staff in 2014 and the project continued through 2020 to provide data and information required for TMDL development. The Surface Water Quality Program (SWQP) continued to collect ambient monthly *E. coli* samples at monitoring site WQM 85 during the assessment period. In addition, WPP established new monitoring sites (WWCBat04 and WWCBat04A) to further increase *E. coli* bacteria data capacity within the impaired segment (Figure 3). Continuous stream stage recorders were installed at the new monitoring sites and periodic discharge measurements were collected at both stations to quantify loading.

An analysis was conducted to examine *E. coli* bacteria exceedance rates from ambient monitoring (WQM85) during different timeframes within the recreation season (Table 10). A total of 25 *E.*

coli bacteria samples were available from ambient monitoring at site WQM 85 from 2009 to 2013 prior to the assessment project (2014-2020). Eight of the 25 samples (32%) exceeded the Single Sample Maximum (SSM) criteria for immersion recreation (≤ 235 CFU/100 ml). A total of 35 samples were collected at site WQM 85 by the SWQP during the assessment project (2014-2020) and 9 samples (25.7%) exceeded the criteria (Table 10). A further analysis was conducted to determine the difference in exceedance rates from pre assessment data, assessment data and all data combined to depict impairment characteristics in Whitewood Creek Segment 4 (Table 10).

E. coli bacteria samples collected at monitoring sites established during the assessment project (2014-2020) also exceeded the SSM criteria for immersion recreation. A total of 50 *E. coli* bacteria samples were collected at site WWCBact04 (55 meters downstream of WQM 85) during the assessment project and 17 of the 50 samples (34%) exceeded the SSM criteria (≤ 235 CFU/100 mL). An additional monitoring site (WWBact04A) was installed 2.5 kilometers downstream of WWCBat04 at the furthest accessible location within the impaired segment. A total of 10 *E. coli* bacteria samples were collected in 2018 and 2019 at WWBact04A within the assessment project period. Two of the 10 (20%) samples exceeded the SSM criteria (Table 10).

In total, 120 *E. coli* bacteria samples were collected from May 2009 to September 2020 in Whitewood Creek Segment 4. The entire data set (2009 through 2020) was used exclusively to make beneficial use support determinations and impairment decisions for the 2012 to 2020 IR cycles. Based on the cumulative *E. coli* bacteria dataset 36 of 120 samples (30%) exceeded SSM criteria (≤ 235 CFU/100 mL) for immersion recreation (Table 10). Only *E. coli* bacteria data collected during the recreation season during the 2014 to 2020 assessment project was used to develop the load duration curve based TMDL and allocations due to continuous flow availability.

Table 10 WQM 85 Pre-Assessment (2009 through 2013) assessment (2014 through 2020) and Assessment Only *E. coli* bacteria samples, exceedance, and percentages for Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 in South Dakota

Segment SD-BF-R-WHITEWOOD_04 Sites

Data Type	General Location	Monitoring Site	Date Range (Recreation Season only, May 1st - Sept 30th)	Assessment and Pre-assessment Samples	Assessment and Pre-assessment Exceedances	Assessment and Pre-assessment Precent Exceedance	Assessment only Samples	Assessment only Exceedances	Assessment only Percentages
WQM 85 Pre-Assessment	Whitewood Creek near Deadwood	WQM 85	2009, 2010, 2011, 2012, 2013	25	8	32.0%	-	-	-
WQM 85 Assessment	Whitewood Creek near Deadwood	WQM 85	2014, 2015, 2016, 2017, 2018, 2019, 2020	35	9	25.7%	35	9	25.7%
Assessment	55 meters downstream of WQM 85	WWCBact04	2014, 2015, 2016, 2017, 2018, 2019, 2020	50	17	34.0%	50	17	34.0%
Assessment	2.5 km downstrean of WWCBacto4	WWCBact04A	2018, 2019	10	2	20.0%	10	2	20.0%
All Data	Segment SD-BF-R-WHITEWOOD_04	All Data	2009, 2010, 2011, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020	120	36	30.0%	95	28	29.5%

Red = Exceeds Beneficial use based water quality criteria based on the 2020 IR Impairment Determination Approach (Table 8)

E. coli bacteria data collected exclusively during the watershed assessment project (2014 to 2020) at all monitoring sites displayed similar exceedance characteristics as the entire (2009 to 2020) dataset. A total of 28 of the total 95 *E. coli* bacteria samples (29.5%) exceeded water quality criteria (≤ 235 CFU/100 mL) for immersion recreation (Table 10). The overall distribution of *E. coli* bacteria samples (median, 25%-75% range, non-outlier range, outliers, and extremes) collected at the 3 monitoring sites during the assessment project are statistically similar ($KW\text{-}H_{(2, 95)} = 2.2071$, $p = 0.3214$) (Figure 8). Whitewood Creek Segment 4 is clearly impaired for *E. coli* bacteria based on calculated exceedance rates from pre-assessment and assessment data and 303(d) listing history confirming the need/requirement for TMDL development.

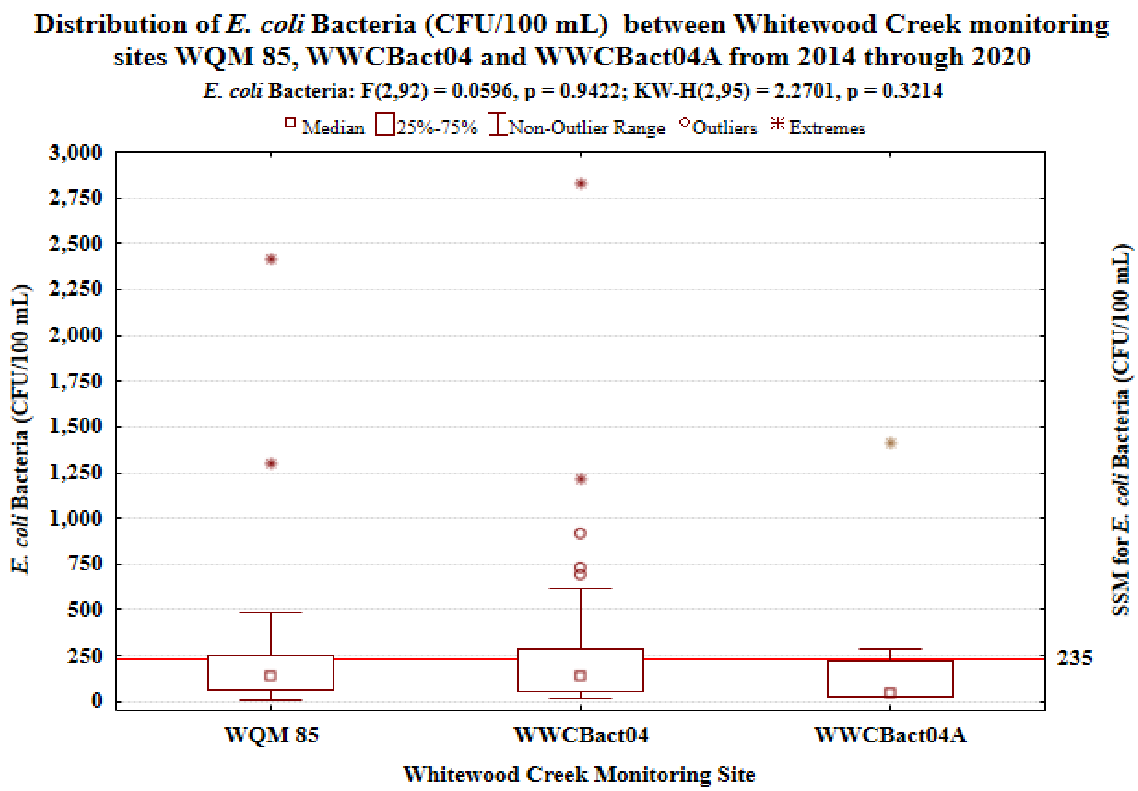

Figure 8 Distribution of *E. coli* bacteria between Whitewood Creek monitoring sites WQM 85, WWCBact04 and WWCBact04A from 2014 through 2020

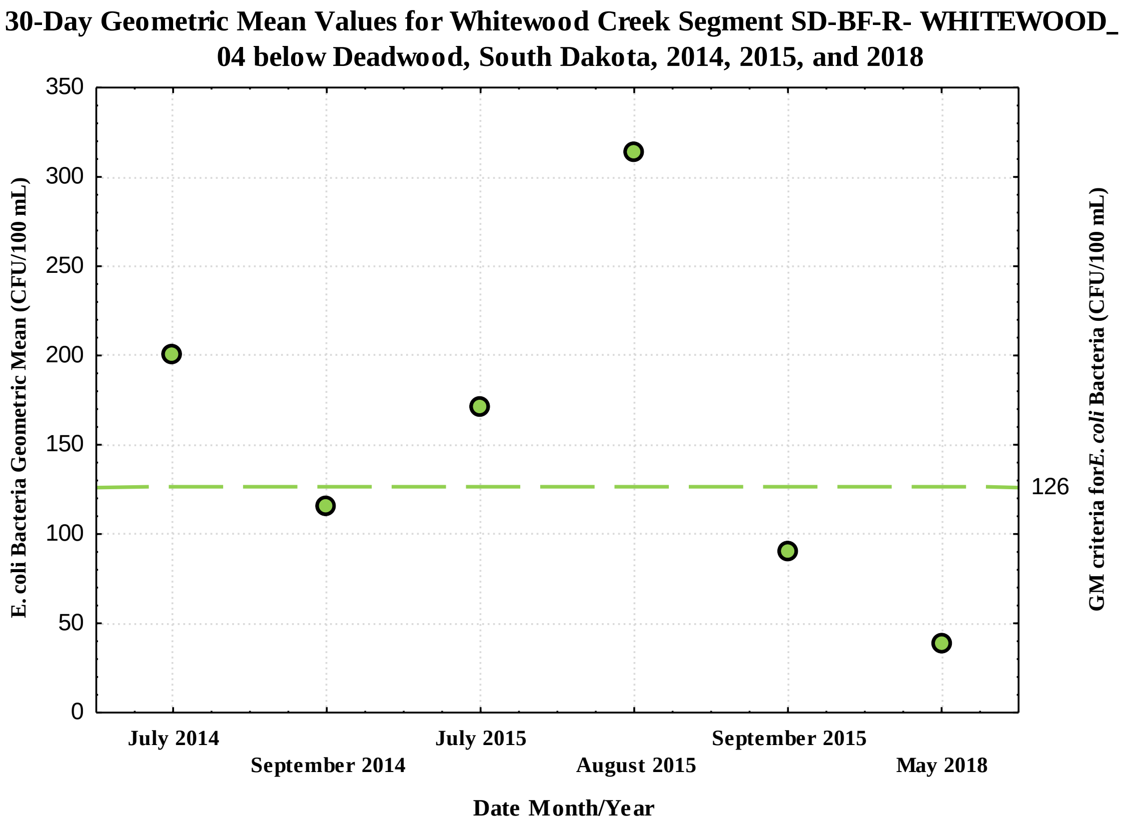

Figure 9 Assessment *E. coli* bacteria Geometric Mean Values for Whitewood Creek Segment SD-BF-R- WHITEWOOD_04 below Deadwood, South Dakota, 2014, 2015, and 2018

E. coli bacteria samples were collected at a frequency (minimum 5 samples in a 30-day period) required to calculate a Geometric Mean (GM) on 6 monthly occasions over 3 years during the assessment project at site WWCBact04 (Table 11). The GM criteria ($\leq$ 126 CFU/100mL) was exceeded 3 of the 6 months (Figure 10, Table 11, and Appendix A Table A4). Geometric mean and supporting *E. coli* bacteria data are summarized in Table 11, with individual sample counts (CFU/100 mL) and flow frequency percentages shown in Appendix A, Table A4.

Table 11 *E. coli* bacteria 30-day geometric mean values collected during the recreation season from Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 in 2014, 2015 and 2018 expressed in CFU/100 mL

Site	Date	Samples used to calculate	30-Day Geometric Mean[1,2]	Average Flow Frequency Disharge prcentage within each 30-Day Geometric Mean
WWCBact04	July 2014	6	**200**	21%
WWCBact04	September 2014	6	**115**	39%
WWCBact04	July 2015	6	**171**	12%
WWCBact04	August 2015	6	**314**	26%
WWCBact04	September 2015	5	**90**	47%
WWCBact04	May 2018	7	**38**	25%

[1] = Geometric mean for *E. coli* based on Immersion Recreation beneficial use standard < 126 CFU/100 mL.
[2] = Geometric mean based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period.
Red = Exceeds Geometric Mean and/or SSM criteria based on Immersion Recreation beneficial use.

Figure 10 shows the variability of *E. coli* bacteria data used to calculate each monthly GM value. *E. coli* bacteria data were more variable (25% - 75% quartiles) in 2014 than 2015 and 2018 but did not correlate with overall GM compliance (Table 11). Median values below the geometric mean criteria (< 126 CFU/100 mL) appear to be a key factor in determining GM compliance. When median values fall below the GM criteria (126 CFU/100 mL) compliance is evident, while median values above 126 CFU/100 mL exceed the GM criterion. Using the applicable SSM *E. coli* bacteria criteria as the TMDL target will ensure compliance with both criterion (SSM and GM) assigned to protect the immersion recreation use designated to Whitewood Creek Segment 4.

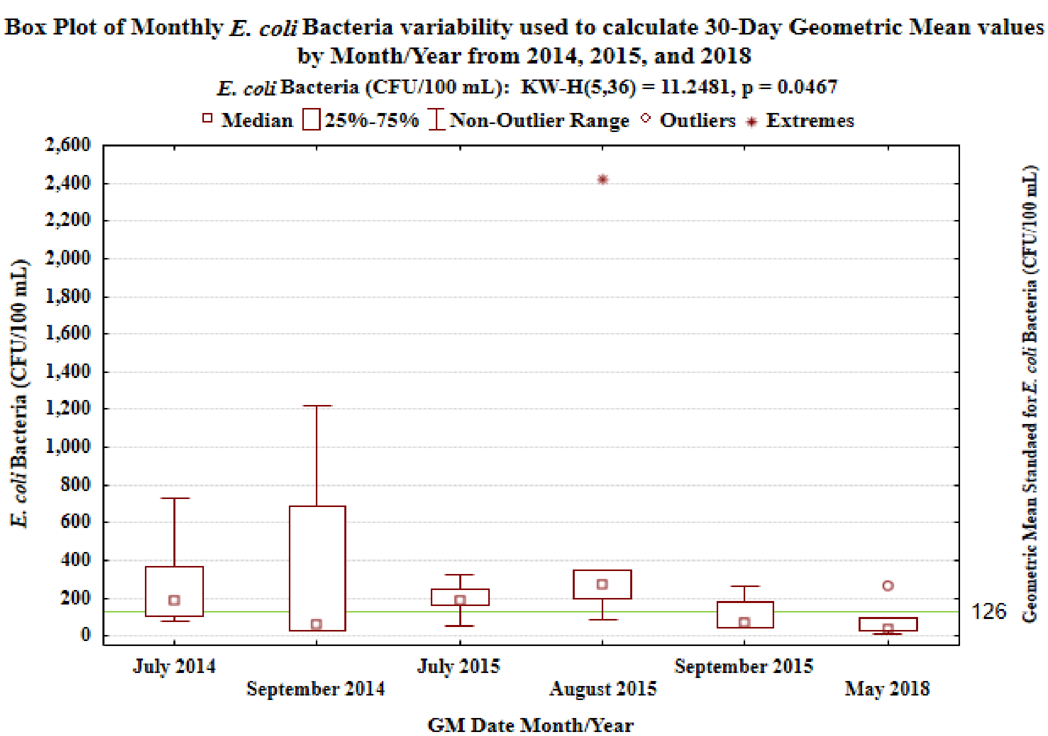

Figure 10 Monthly *E. coli* bacteria variability used to calculate 30-Day Geometric Mean values by Month/Year from 2014, 2015, and 2018

All sample data collected during this project followed SD DANR Watershed Protection Program Standard Operating Procedures (SD DANR WPP SOP, Volume I), SD NPS Program Quality Assurance Project Plan (QAPP), and Surface Water Quality Standard Operating Procedures (SWQP SOP) for proper field data collection and Quality Assurance/Quality Control (QA/QC) techniques (SD DANR, 2011, SD DANR 2016a, SD DANR, 2017, SD DANR, 2018b). QA/QC results for water quality sampling during this project are located in Appendix A, Tables A5 and A6 and indicate that all but one sample (09/09/2015) were within precision criteria based on log range and blank sample analysis techniques.

6.1 Discharge Data and Information

An OTT Orpheus Mini stream stage data logger was installed at monitoring station WWCBact04. The instrument was programmed to record continuous stream stage at 15-minute intervals from June 2014 to October 2020. Periodic instantaneous discharge measurements were collected at different levels of the hydrograph using a SonTec Flow Tracker® handheld ADV® (Acoustic Doppler Velocimeter) flowmeter. A continuous flow record was developed using Microsoft Excel® software. This program was used to generate a stage-discharge relationship (polynomial equation) for WWCBact04 (Figure 11.)

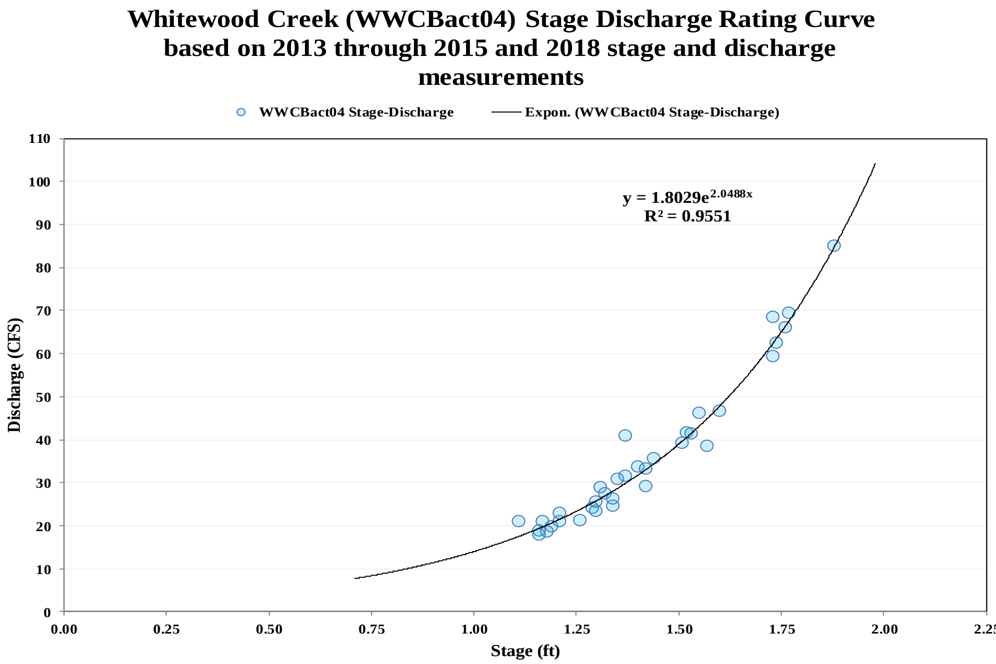

Figure 11 Rating curve for monitoring site WWCBact04 on Whitewood Creek Below Alternate Highway 14 with data from 2013 through 2019

Average daily discharge was calculated using SD DANR 15-minute stage data collected from SD DANR WPP monitoring site and the stage discharge equation developed for WWCBact04 from 6/14/2014 through 10/28/2020 (Figure 12 and Figure 13).

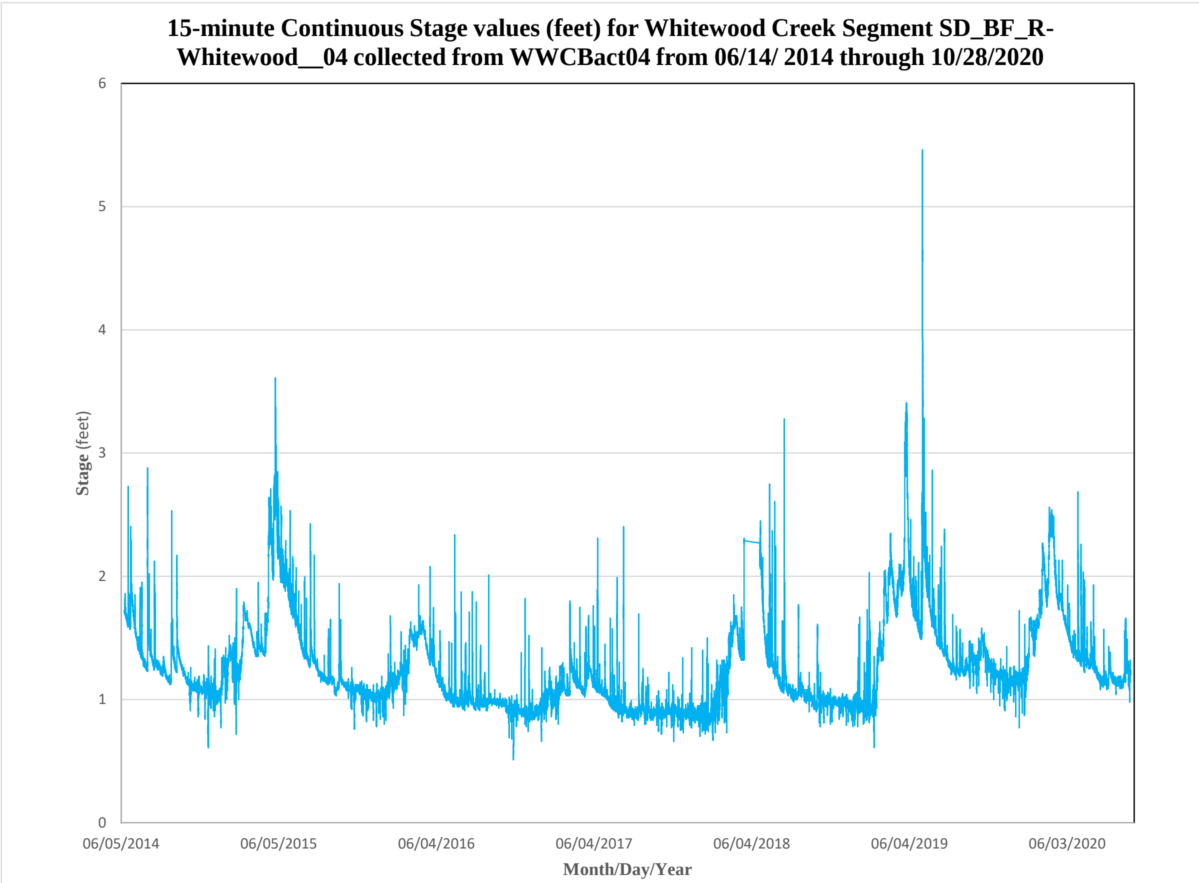

Figure 12 15-minute average daily stage (feet) for SD DANR monitoring site WWCBact04 from 6/14/2014 through 10/28/2020

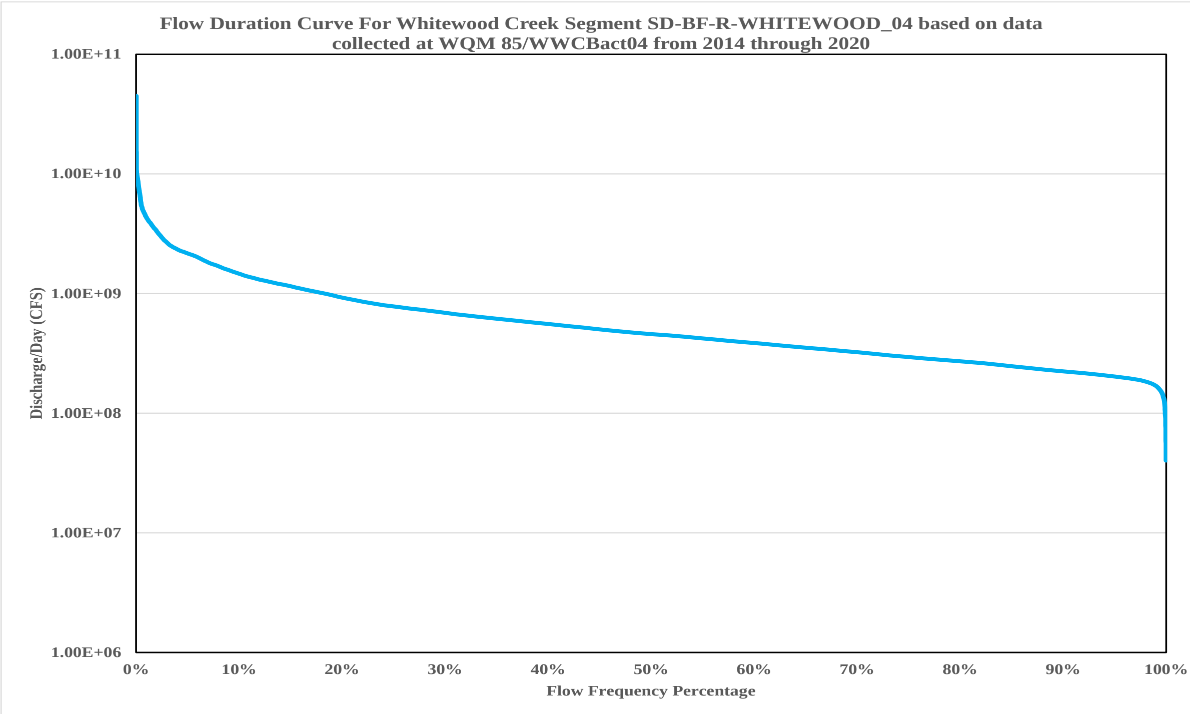

Figure 13 Flow frequency curve for Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 representing daily discharge collected at WWCBact04 from 2014 through 2020

The long-term discharge record developed from 15-minute stage data was used to calculate a flow frequency curve for Whitewood Creek Segment 4 (Figure 14). The flow frequency curve represents all daily average discharge (CFS) values sorted from low flows to high flows. Each daily discharge was assigned a percent ranking from low (100 percent of the discharges were higher than the lowest measured discharge) to high discharge (0 percent of the discharges were higher than the highest measured discharge) to represent the overall flow frequency in Whitewood Creek Segment 4 during the 2014 to 2020 assessment project.

Flow frequency curve discharge values were converted to loads by multiplying daily discharges by the SSM *E. coli* standard (< 235 CFU/100 mL) and GM standard (< 126 CFU/100 mL) times a conversion factor (24465715) represented by the black line and dashed green line, respectively (Figure 14). Figure 14 represents the *E. coli* bacteria load duration curve based TMDL expressed as *E. coli* bacteria CFU/Day for Whitewood Creek Segment 4.

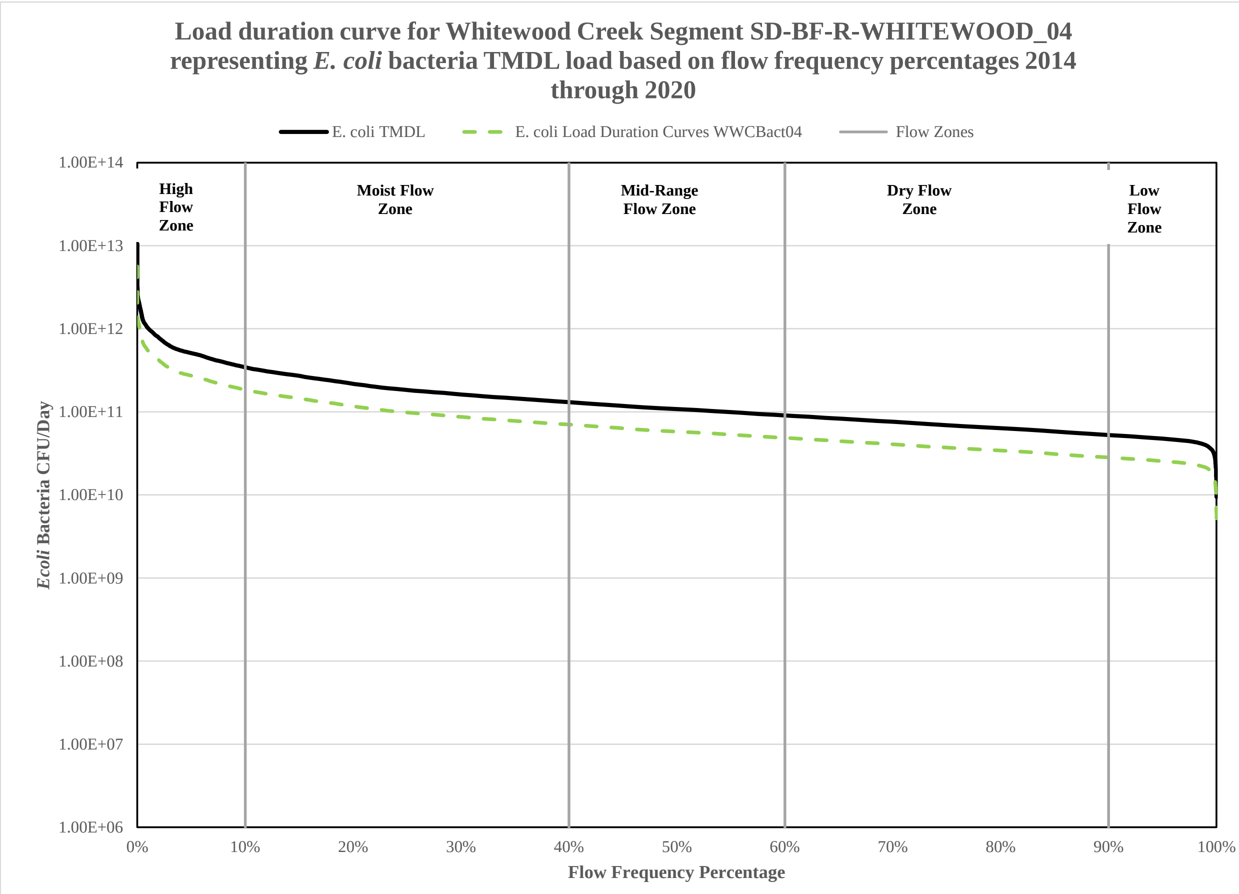

Figure 14 Load duration curve for Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 representing *E. coli* bacteria TMDL load based on flow frequency percentage from 2014 through 2020 data.

7.0 Significant Sources

7.1 Point Sources

Point sources are described as "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack" (Hill, 1997). Point sources are often linked to community wastewater treatment or industrial facilities with discernible, confined and discrete conveyances, such as pipes or ditches from which pollutants are being, or may be, discharged to a waterbody. There are twelve National Pollutants Discharge Systems (NPDES) permitted to discharge in the Whitewood Creek watershed upstream of Whitewood Creek segment 4. These point sources are documented here to provide a watershed scale account of the systems operational characteristics (discharge permits etc.), potential *E. coli* bacteria impact and Waste Load Allocation (WLA) consideration for TMDL development.

SD-BR-R-FANTAIL_01 (Headwaters to Nevada Gulch)

- Facility/NPDES permit ID: Golden Reward Mining Co., SD0026905 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SD0026905.

- Description: Reduce pollution runoff to Fantail Creek from mining activities-no *E. coli* effluent limits.
- WLA Decision Rationale: *E. coli* not a pollutant of concern. Indirect discharge to Whitewood Creek segment 4. WLA will be addressed in a TMDL, if warranted for Fantail Creek segment 01.

SD-BR-R-WHITETAIL CREEK_01 (Whitewood Creek to S18, T4N, R3E)

- Facility/NPDES permit ID: Terry Trojan Water District, SDG860076. https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SD0026905.
- Description: Potential overflow discharges from water distribution system to Whitetail Creek- no *E. coli* effluent limits.
- WLA Decision Rationale: *E. coli* not a pollutant of concern. Indirect discharge to Whitewood Creek segment 4. WLA will be addressed in a TMDL, if warranted for Whitetail Creek segment 1.

SD-BR-R-WHITEWOOD_01 (Whitetail Summit to Gold Run Creek)

- Facility/NPDES permit ID: Powder House Pass Wastewater Treatment Plant, SD0028615 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SD0028615.
- Description: Waste water treatment plant for Powder House Pass Community Improvement District. Authorized to discharge 25,000 gallons per day. Effluent limits consistent with *E. coli* TMDL target for Whitewood Creek segment 4.
- WLA Decision Rationale: Indirect discharge to Whitewood Creek segment 4. WLA will be addressed in a TMDL, if warranted for Whitewood Creek segment 1.
- Facility/NPDES permit ID: Thyssen Mining Inc., SDP000134 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SDP000134.
- Description: Wastewater treatment plant designed to treat waste water from construction activities at the Sanford Underground Research Facility before being discharged to the Lead Deadwood Sanitary District wastewater treatment facility-no *E. coli* effluent limits.
- WLA Decision Rationale: *E. coli* not a pollutant of concern. Indirect discharge to Whitewood Creek segment 4. WLA will be addressed in a TMDL, if warranted for Whitewood Creek segment 1.

SD-BR-R-WHITEWOOD_02 (Gold Run Creek to Deadwood Creek)

- Facility/NPDES permit ID: Deer Mountain Water, SDG860089 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBSearch.aspx.
- Description: Potential overflow discharges from Deer Mountain ski area's water distribution system to Gold Run Creek- no *E. coli* effluent limits.
- WLA Decision Rationale: *E. coli* not a pollutant of concern. Indirect discharge to Whitewood Creek segment 4. WLA will be addressed in a TMDL, if warranted for Whitewood Creek segment 2.

- Facility/NPDES permit ID: Homestake Mine, SD0000043 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SD0000043.
- Description: Wastewater treatment facility designed to treat wastewater from mine tailings-no *E. coli* effluent limits. Discharges to Gold Run Creek.
- WLA Decision Rationale: *E. coli* not a pollutant of concern. Indirect discharge to Whitewood Creek segment 4. WLA will be addressed in a future TMDL for Whitewood Creek segment 2.
- Facility/NPDES permit ID: Lead Water Distribution, SDG860019 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SDG860019.
- Description: overflow discharges from water distribution system to Gold Run Creek- no *E. coli* effluent limits.
- WLA Decision Rationale: *E. coli* not a pollutant of concern. Indirect discharge to Whitewood Creek segment 4. WLA will be addressed in a future TMDL for Whitewood Creek segment 2.
- Facility/NPDES permit ID: SD Science and Technology Authority, SD0028134
- https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SD0028134.
- Description: The authority took over the Homestake Mine. Wastewater treatment facility designed to treat wastewater from mine tailings-no *E. coli* effluent limits. Discharges to Gold Run Creek. WLA will be addressed in a future TMDL for Whitewood Creek segment 2.
- Facility/NPDES permit ID: City of Lead-CSO, SD0027481
- https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SD0027481.
- Description: The city of Lead's sewer flows are normally conveyed to the Lead-Deadwood Sanitary District's (SD0020796) waste water treatment facility. However, when the capacity of the collection system is exceeded, untreated sewer is discharged through the Combined Sewer Overflow (CSO) system to Gold Run Creek.
- WLA Decision Rationale: This source was given a zero WLA in the Deadwood Creek segment 1 (SD-BF-R-DEADWOOD_01) *E. coli* TMDL on the basis that the permit (SD0027481) requires the elimination of the CSO system. To date, only one CSO outfall is operational (004) out of five original outfalls. This source and WLA will also be addressed in the future *E. coli* TMDL for Whitewood Creek segment 2.

SD-BR-R-WHITEWOOD_03 (Deadwood Creek to Spruce Gulch)

- Facility/NPDES permit ID: City of Deadwood, SDG860023 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SDG860023.
- Description: Potential overflow discharges from Deadwoods water distribution system to Whitewood Creek segment 3- no *E. coli* effluent limits.
- WLA Decision Rationale: This permitted point source was not identified in the Whitewood Creek segment 3 *E. coli* TMDL. Because *E. coli* is not a pollutant of concern, it is hereby recognized that a WLA of zero should have been assigned to the segment 3 TMDL. This sources is not expected to have an impact on the Whitewood Creek segment 3 or 4 TMDLs.

- Facility/NPDES permit ID: Homestake Mining Company, SD0025933-SDP000119 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SDP000119.
- Description: Authorizes discharge from the open cut at home stake mine to Deadwood Creek, no *E. coli* effluent limits.
- WLA consideration: This source was assessed in the Deadwood Creek segment 3 *E. coli* TMDL. Because *E. coli* is not a pollutant of concern a WLA of zero was given in the TMDL.
- Facility/NPDES permit ID: Lead-Deadwood Sanitary District, SD0020796 https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/swdpermitting/wwDBResults.aspx?npid=SD0020796.
- Description: Waste water treatment facility for Lead, Deadwood and Central City and other unincorporated areas serving a total of 6,000 people. The point source section of the Whitewood Creek segment 3 TMDL did not identify the permit ID for this facility. It is hereby noted that NPDES permit ID SD0020796 corresponds to this WWTF addressed in the Whitewood Creek segment 3 *E. coli* TMDL.
- WLA consideration: A WLA was assigned to the Whitewood Creek segment 3 *E. coli*. TMDL.

SD-BR-R-WHITEWOOD_04 (Spruce Gulch to Sandy Creek)

There are no direct NPDES point source discharges to the Whitewood Creek segment 4 watershed. This includes concentrated animal feeding operations (CAFOs). It is highly unlikely for CAFOs to be established in the greater Whitewood Creek watershed especially in the Black Hills region due to geology and other factors. All South Dakota CAFOs are required to obtain a general permit, regardless if they require a NPDES permit. For more information about the general permit visit: (https://danr.sd.gov/Agriculture/Livestock/FeedlotPermit/default.aspx). As long as these facilities comply with the general CAFO permit requirements ensuring their discharges are unlikely and indirect loading events, the TMDL would assume a minimal *E. coli* contribution. A WLA of zero was assigned to the Whitewood Creek segment 4 TMDL based on this comprehensive point source assessment.

7.2 Non-point Sources

Nonpoint sources are associated with diffuse pollutant loading to a waterbody and are often linked to runoff from agricultural, urban, or forestry activities, as well as streambank erosion and groundwater seepage. Based on review of available information and communication with SD DANR Surface Water Quality Program: NPDES Surface Water Quality staff; South Dakota Game Fish and Parks (SD GF&P); City of Deadwood; and Lead Deadwood Sanitary District (LDSD) personnel; primary non-point sources of bacteria (*E. coli* bacteria) within Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 watershed are wildlife and human sources.

The Bacterial Indicator Tool (BIT) spreadsheet was used to estimate the bacteria contribution from multiple sources in the Whitewood Creek segment 4 watershed. The tool was originally developed to estimate fecal coliform production. Due to a lack of literature values for *E. coli* production of many livestock and wildlife species, source loading calculations were based on fecal coliform.

Fecal coliform concentrations are considered synonymous with *E. coli* based on the statewide bacteria relationship. The tool estimates the monthly accumulation rate of fecal coliform bacteria on four land uses (cropland, forest, built-up, and pastureland), as well as the asymptotic limit for accumulation, should no wash off occur.

The BIT also estimates the direct input of fecal coliform bacteria to streams from grazing agricultural animals and failing septic systems using coverage areas, locations, and count data available in GIS. This data is entered into the BIT to estimate bacteria contribution from multiple sources in this watershed. The output information generated for the BIT tool was presented to the Lead Deadwood Sanitary District (LDSD) personnel in person (early 2021) and by phone/e-mail in mid-2021, to verify all sources were accounted for in the watershed. Per acre bacteria production estimates by source type (build-up, pets, horses, humans, and wildlife) for the Whitewood Creek segment 4 watershed are presented in Table 12.

Table 12 Total Bacterial source production percentages by species for Whitewood Creek Segment SD-BF-R-WHITEWOOD_4, Lawrence County, South Dakota

Source Type	#/Acre	Bacteria/Animal/Day	Bacteria/Acre	Percentage
Build up	5.42×10^{-02}	9.68×10^{06}	5.25×10^{05}	1.3%
Pets[4]	1.36×10^{-03}	4.09×10^{09}	5.58×10^{06}	13.3%
Horses	5.12×10^{-03}	4.20×10^{08}	2.15×10^{06}	5.1%
Failing Septic	1.54×10^{-03}	5.96×10^{07}	9.15×10^{04}	0.2%
Humans in Watershed	3.41×10^{-03}	1.95×10^{09}	6.65×10^{06}	15.9%
All Wildlife	6.86×10^{-02}	3.33×10^{10}	2.69×10^{07}	64.2%
Total			4.19×10^{07}	100.0%

Wildlife Species	Lawrence Co.[5] #/Sq. Mile	#/Acre	Bacteria/Animal/Day	Bacteria/Acre
whitetail deer	12.55	1.96×10^{-02}	5.00×10^{08}	9.80×10^{06}
mule deer	3.76	5.88×10^{-03}	5.00×10^{08}	2.94×10^{06}
bighorn sheep	0.03	5.27×10^{-05}	1.41×10^{10}	7.41×10^{05}
mountain lion[4]	0.02	3.91×10^{-05}	4.09×10^{09}	1.60×10^{05}
elk[1]	1.25	1.95×10^{-03}	4.19×10^{08}	8.18×10^{05}
turkey (wild)	11.29	1.76×10^{-02}	9.30×10^{07}	1.64×10^{06}
mink[3]	0.56	8.75×10^{-04}	1.25×10^{08}	1.09×10^{05}
beaver	0.75	1.17×10^{-03}	2.50×10^{08}	2.93×10^{05}
muskrat[2]	0.25	3.91×10^{-04}	1.25×10^{08}	4.88×10^{04}
skunk[2]	0.25	3.91×10^{-04}	1.25×10^{08}	4.88×10^{04}
coyote[4]	0.19	2.97×10^{-04}	4.09×10^{09}	1.21×10^{06}
fox[4]	0.50	7.81×10^{-04}	4.09×10^{09}	3.20×10^{06}
raccoon	1.51	2.36×10^{-03}	1.25×10^{08}	2.95×10^{05}
bobcat[4]	0.56	8.75×10^{-04}	4.09×10^{09}	3.58×10^{06}
pine martin[2]	0.63	9.84×10^{-04}	1.25×10^{08}	1.23×10^{05}
cottontail rabbit[2]	7.53	1.18×10^{-02}	1.25×10^{08}	1.47×10^{06}
squirrel[2]	0.88	1.38×10^{-03}	1.25×10^{08}	1.72×10^{05}
partridge[3]	0.13	2.03×10^{-04}	1.36×10^{08}	2.76×10^{04}
sharptail grouse[3]	1.25	1.95×10^{-03}	1.36×10^{08}	2.66×10^{05}

[1] based on BIT beef cattle
[2] based on BIT raccoon
[3] based on BIT chicken
[4] based on BIT dog
[5] County Wildlife counts based on Huxoll, 2003

7.2.1 Build-up

The build-up source category incorporates commercial services, mixed urban, residential, transportation, communications and utilities. An estimated 318 acres of the watershed comprised of build-up sources (Table 13). BIT build-up source modeling in Whitewood Creek Segment 4 watershed showed these sources contributed a small percentage (1.3 percent) of the total production potential in the watershed on a per acre basis (Table 12).

Table 13 Bacterial Indicator Tool (BIT) Build-up source types, descriptions and acres in the Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 Watershed

Build-up Source Type	BIT Description type	Whitewood Acres
Commercial and Services	Commercial	101
Mixed Urban or Built-up	Road, Commercial, Single family low density, Single family high density, and Multifamily residential	90
Residential	Single family low density, Single family high density, and Multifamily residential	85
Transportation, Communications, Utilities	Road	42

7.2.2 Pets

The number of pets in the watershed was estimated using the number of residences within the watershed boundary (85) with approximately 10 percent of those residents having pets (n= 8 pets). BIT modeling estimated that 13.3 percent of the overall production in this watershed comes from pets.

7.2.3 Horses

During the assessment, 30 horses were observed along and just above Whitewood Creek upstream of the Highway 14 box culverts (Figure 15). Therefore, horses were included in the BIT source model. Results indicate horses account for 5.1 percent of the bacteria production in the Whitewood Creek Segment 4 watershed.

7.2.4 Humans

Human bacteria production in the Whitewood Creek segment 4 watershed was estimated using aerial imagery and tools available in ArcMap™. The Whitewood Creek Segment 4 watershed has approximately 175 residents based on a count of 87 rural residences in the watershed assuming two people per residence. This does not include residences connected to the Lead Deadwood Sanitary District (LDSD) collection system (red circle-Figure 16) because this facility does not discharge directly to the Whitewood Creek Segment 4. Based on BIT model estimates, human bacteria production accounts for 15.9 percent of the overall bacteria production in the Whitewood Creek Segment 4 watershed on a per acre basis (Table 12). Human bacteria production should all be delivered to a septic system, which if functioning correctly, would result in no bacteria contribution to Whitewood Creek segment 4.

Consideration was given to potential human bacteria contributions from failing septic systems. There is an estimated 87 septic systems based on the number of residences observed within the watershed. Assuming a 10% failure rate with two people per system, there is a potential for nine failing septic systems in the Whitewood Creek segment 4 watershed. BIT modeling results suggest 0.2 percent of the overall bacteria loading in the watershed results from failing septic systems. *E. coli* bacteria samples were collected in NoNameCreek in early May 2019 and late April 2021 (Appendix A3). Results showed that all *E coli* samples collected from NoNameCreek were below the criterion assigned to Whitewood Creek segment 4 (≤ 235 cfu/100 mL). This small tributary was chosen to validate septic system impacts because a significant number (approximately 51) of septic systems exist within the drainage (Figure 16). This supports the low failing septic system percentage (0.2%/acre) estimated by the BIT model.

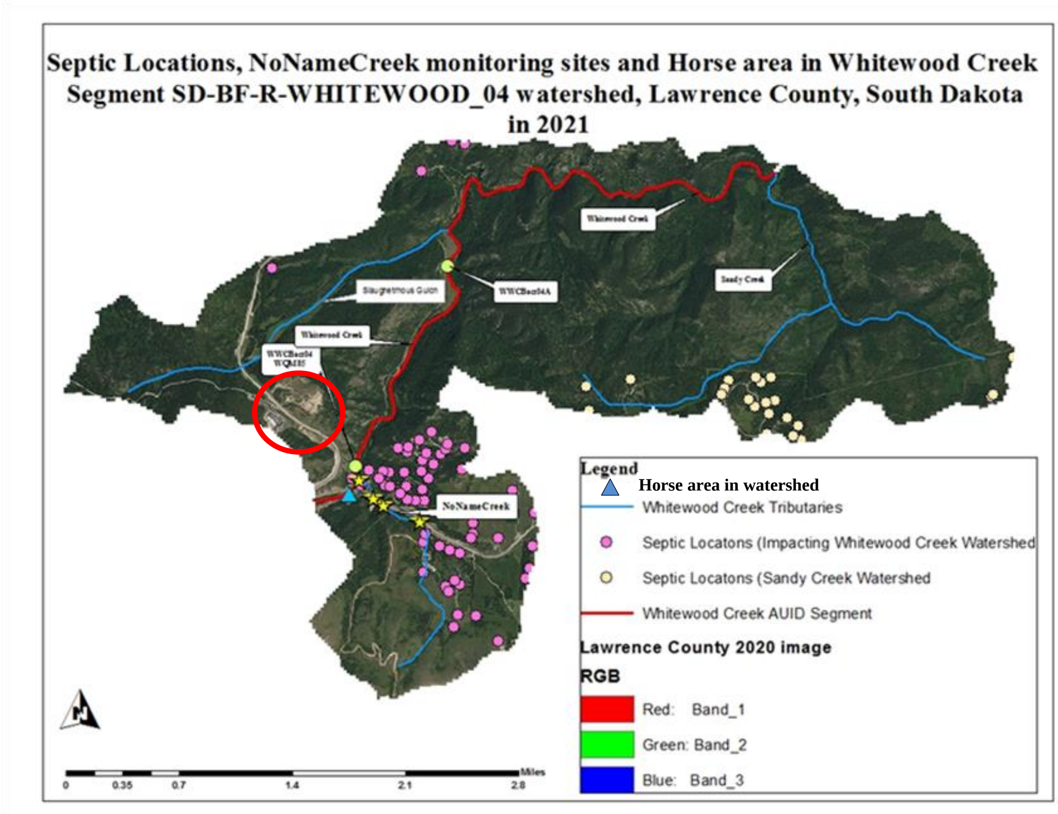

Figure 15 Septic locations. NoNameCreek sampling sites and Horse area in Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 watershed

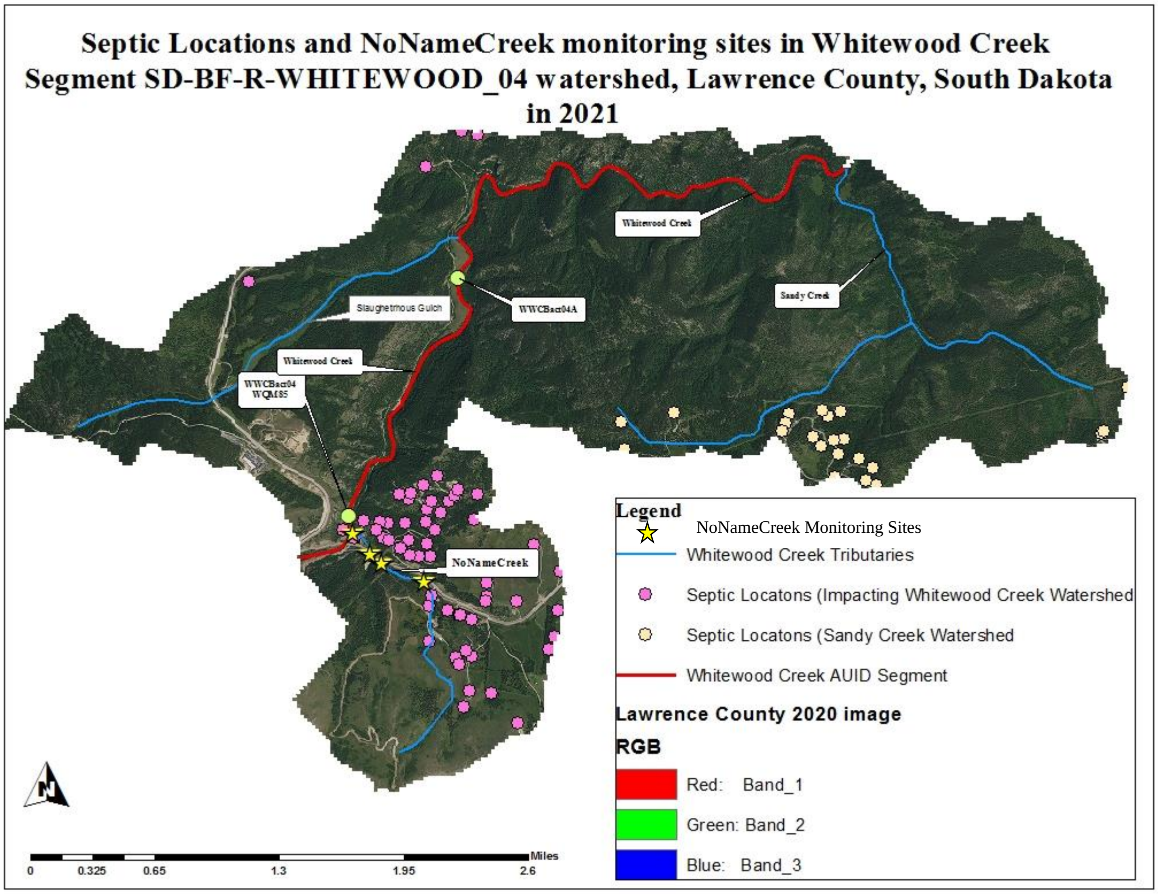

Figure 16 Septic locations and NoNameCreek sampling sites in Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 watershed

7.2.5 Wildlife/Natural background

Wildlife within the watershed is a natural background source of *E. coli* bacteria. Wildlife population density estimates were obtained from the South Dakota Department of Game, Fish, and Parks Report No 2003-11 (Huxoll, 2003). The estimated wildlife contribution of bacteria by species in the Whitewood Creek watershed was calculated by taking the number of each wildlife species counted in the Lawrence County by the total number of acres in the county to determine the number of animals per acre. The number of bacteria per animal per day was estimated using species specific values listed in the BIT model and species without values were assigned loading values indicated by species surrogates (Table 12). The total bacteria by species were calculated by multiplying the number of each species per acre by the total bacteria produced per animal per day. All wildlife species loading were summed to determine the overall wildlife contribution potential based on a per acre basis within the Whitewood Creek segment SD-BF-R-WHITEWOOD_04 watershed. The estimated total bacterial production potential for wildlife was 64.2 percent and was the largest contributing source in this watershed.

7.2.6 Grazing Allotments

The majority of the Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 watershed is comprised of mountainous terrane that is over 79.7 percent forested and 2.68 percent developed areas with soils and slopes that are not conducive to most agricultural pursuits. Figure 17 shows the United States Department of Agriculture Forest Service (USFS) grazing allotments acres (hashed yellow areas) in the watershed. The Polo Peak and Crook Mountain grazing allotments account for 425 acres and 2,314 acres, respectively. Both grazing allotments account for 46.7 percent of the Whitewood Creek Segment 4 watershed. Forest Service allotment data indicated that the Polo Peak grazing allotment was vacant (no grazing) and the Crook Mountain allotment was ungrazed (no livestock) in 2020. No livestock were observed in these grazing allotments during the assessment efforts (2014 through 2020). Therefore, livestock grazing in Whitewood Creek Segment 4 watershed is not considered a significant source of *E. coli* bacteria and was not listed in Table 12 as a source type. However, if at some point these allotments are utilized and grazing occurs, the Crook Mountain allotment has the greatest potential to impact (contribute *E. coli* bacteria) the lower portion of Whitewood Creek Segment 4 watershed based on proximity.

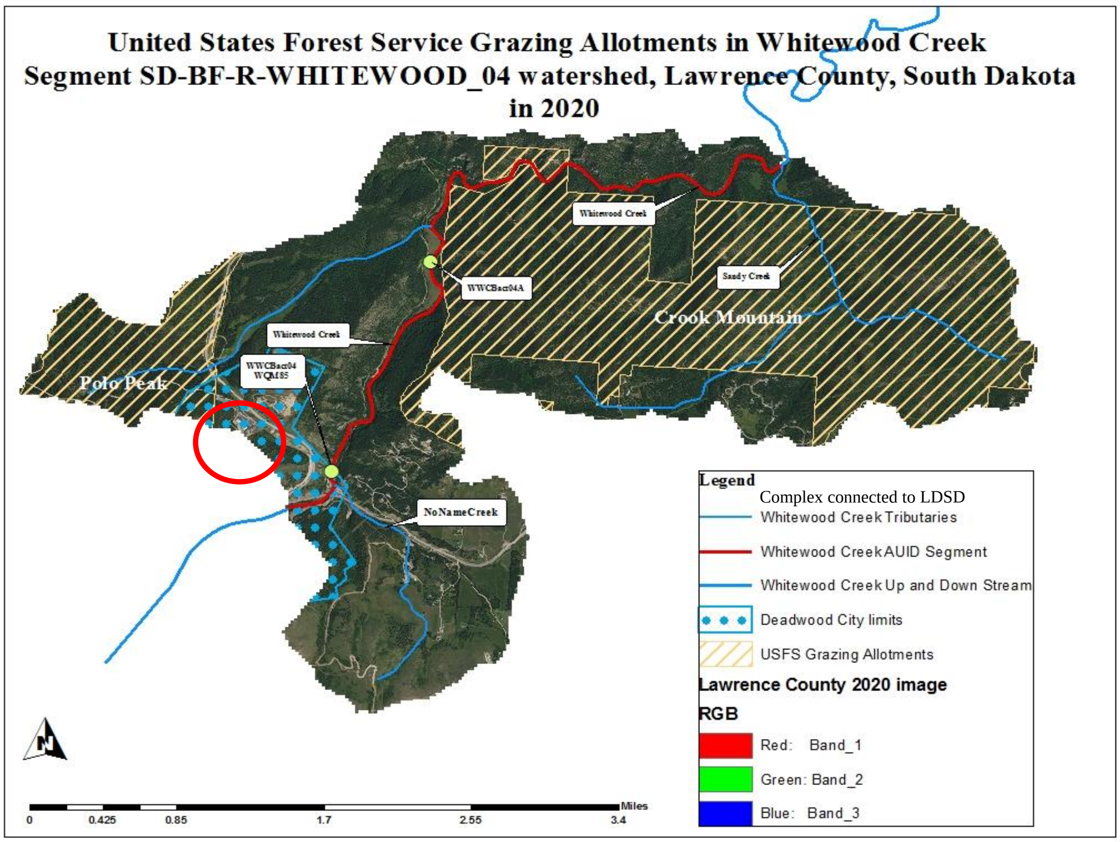

Figure 17 USFS Grazing Allotments and Deadwood City limit boundaries in the Whitewood Creek Segment SD_BF_R-WHITEWOOD_04 Watershed in 2020

7.2.7 Tributary Contributions

Several small drainages intermittently drain into Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 (Spruce Gulch, NoNameCreek, Slaughterhouse Gulch, and Sandy Creek) during the year. The furthest upstream tributary, Spruce Gulch, empties into Whitewood Creek in an undeveloped area below the LDSD water treatment facility and is the transition point from Whitewood Creek segment SD-BF-R-WHITEWOOD_03 watershed to Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 watershed. The Spruce Gulch watershed has not been monitored previously and was not monitored during this project. Therefore, the potential *E. coli* bacteria loading to Whitewood Creek could not be ascertained. The next small downstream tributary, NoName Creek, was sampled in the spring of 2019 and 2021 for *E. coli* bacteria samples with no exceedances detected (Appendix A). The NoName Creek tributary is not considered a significant source of *E. coli* bacteria to Whitewood Creek segment 4. Slaughterhouse Gulch is a small tributary that drains into Whitewood Creek from the western portions of the watershed and was not observed flowing during limited visits downstream of site WWCBact04A and potential impact to Whitewood Creek could not be evaluated. The furthest downstream tributary in Whitewood Creek segment 4 is Sandy Creek which flows into Whitewood Creek at the downstream boundary of Whitewood Creek segment 4 and the beginning of Whitewood Creek segment 5 (downstream). Therefore, Sandy Creek does not contribute to *E. coli* bacteria loading to Whitewood Creek Segment 4. As a side note, *E. coli* bacteria samples collected in receiving waterbody, Whitewood Creek Segment 5 at WQM 84/WWCpH03 have met numeric *E. coli* criteria and have never been listed as impaired for *E. coli* bacteria.

8.0 TMDL Load Analysis

The TMDL for Whitewood Creek Segment 4 was developed using a Load Duration Curve (LDC) framework resulting in a flow variable TMDL target considering the entire flow regime. The LDC generated for the impaired segment of Whitewood Creek was separated into five flow zones (Figure 18). Flow zones were defined according to the flow frequency structure and distribution of the observed data following guidance recommended by EPA (US EPA, 2007). Five distinct flow zones were established to facilitate interpretation of the hydrologic conditions and patterns associated with the impairment. The zones were segmented by high flows (0-10 percent), moist conditions (10-40 percent), mid-range flows (40-60 percent), dry conditions (60-90 percent) and low flows (90-100 percent). All available *E. coli* bacteria data was plotted on the LDC to depict load distribution over the flow regime (Figure 18). Whitewood Creek individual loads were calculated by multiplying *E. coli* bacteria concentrations collected from sites WQM 85, WWCBact04 and WWCBact04A with paired discharge data along the flow frequency curve.

When individual *E. coli* bacteria loads are plotted on the LDC, characteristics of the water quality impairment become evident. *E. coli* bacteria loads falling above the LDC exceed the TMDL and are out of compliance, whereas those falling at or below the LDC comply. *E. coli* bacteria samples collected from Whitewood Creek Segment 4 exceed the daily maximum and geometric mean criterion within the high, moist, and mid-range flow zones (Figure 18). Load exceedances in these flow zones indicate storm runoff from the watershed. *E. coli* bacteria originating in Whitewood Creek Segment 3 (SD-BF-R-WHITEWOOD_03) is likely transported downstream to Segment 4 during storm or run-off events. This is supported by the incidence of similar *E. coli* bacteria exceedance percentages between the two impaired segments (Table 9).

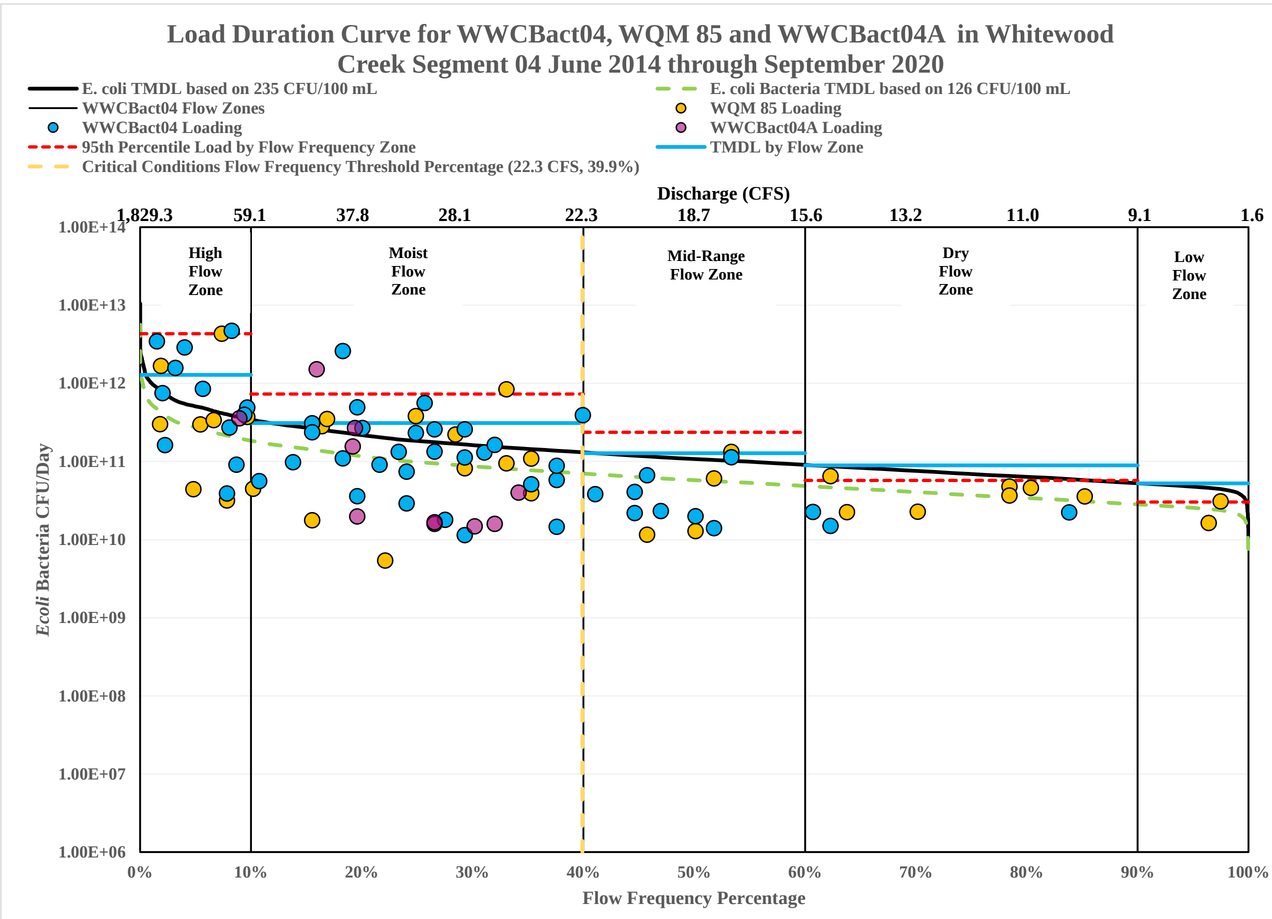

Figure 18 Load Duration Curve for Whitewood Creek Segment SD-BF-R-WHITEWOOD_04.

8.1 TMDL Load Duration Curve

All applicable *E. coli* bacteria data and associated flow acquired from sites WQM 85 and WWCBact04 during the 2014-2020 assessment project were used to develop the LDC based TMDL (Table 14). The current load was calculated by multiplying the 95th percentile flow and concentration for each individual flow zone. Reduction calculations were based on reducing the current load to the SSM TMDL target (≤ 235 CFU/100mL) to assure compliance with immersion recreation standards.

Table 14 *E. coli* TMDL for Whitewood Creek Segment SD-BF-R-WHITEOOD_04 based on the single sample maximum standard for immersion recreation

E. coli Bacteria Single Sample Maximum TMDL		Flow Zones				
		High Flows	Moist	Mid-Range	Dry	Low Flows
SD-BF-R-WHITEWOOD_04 TMDL		1,829.3 to 59.1 cfs	59.0 to 22.3 cfs	22.2 to 15.6 cfs	15.5 to 9.1 cfs	9.0 to 1.6 cfs
WLA	CFU/Day	0	0	0	0	0
LA	CFU/Day	1.16E+12	2.80E+11	9.72E+10	7.14E+10	3.93E+10
MOS	CFU/Day	1.29E+11	3.11E+10	1.08E+10	7.93E+09	4.37E+09
TMDL (95th Percentile Load)	CFU/Day	1.29E+12	3.11E+11	1.08E+11	7.93E+10	4.37E+10
Current Load - (95th Percentile Load)	CFU/Day	1.33E+13	1.45E+12	2.08E+11	5.81E+10	2.94E+10
Percent Load Reduction		90.3%	78.6%	48.1%	0.0%	0.0%

E. coli bacteria concentrations and loading in Whitewood Creek segment 4 ultimately discharge into segment 5 below the confluence. Whitewood Creek segment 5 has never been listed as impaired for E. *coli* bacteria. Meeting the TMDL will protect the downstream immersion recreation use and will also assure compliance with standards for limited contact recreation waters. No point source discharges contribute to the impaired segment so the WLA was set at zero for all flow zones. As a result, all reductions are required from nonpoint sources (LA). A description for the margin of safety (MOS) used for the TMDL is provided in section 8.2.2.

8.1.1 High Flows (<10% flow frequency)

The high flow zone represents extreme flows in Whitewood Creek. The flow rate for this zone was widely variable ranging from 1,829.3 to 59.1 cfs. Flows represented in this zone occur on an infrequent basis and are characteristic of significant run-off events typically during spring and early summer. High flows are commonly the product of spring snowmelt but may be generated by intense rainfall events. Bacteria sources across the watershed have an increased potential to be conveyed to the stream channel during high flow conditions. The 95th percentile bacteria concentration and flow for this zone was calculated at 2,420 CFU/100mL and 224.2 cfs, respectively. An *E. coli* load reduction of 90.3% is required to achieve compliance with the SSM criteria. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

8.1.2 Moist Conditions (10% to 40% flow frequency)

Moist conditions represent the portion of the flow regime that occurs following moderate storm events. Flows in this zone range from 59.0 cfs to 22.3 cfs. The flows in this zone occur in early to mid-summer near the peak of the recreation season. Sources of bacteria may be expected to be closer to the channel and somewhat easier to mitigate than those impacting the high flows. The 95th percentile bacteria concentration and flow for this zone was calculated at 1,099 CFU/100mL and 54.1, respectively. An *E. coli* load reduction of 78.6% is required to achieve compliance with the SSM criteria. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

8.1.3 Mid-range Flows (40% to 60% flow frequency)

Mid-range flow conditions represent flow rates between 22.2 cfs and 15.6 cfs. This portion of the flow regime likely occurs in mid to late summer. Run-off from storm events is minimized by mature vegetative growth present during the peak of the growing season. Flows in this zone may also represent conditions that occur in the fall during recovery periods of dryness. Mid-range flows

represent the transition from run-off to base flow conditions. Bacteria sources in this flow zone likely originated near the channel or within the riparian zone. The 95th percentile Bacteria concentration and flow for this zone was calculated at 455 CFU/100mL and 18.7 cfs, respectively. An *E. coli* bacteria load reduction of 48.1% is required to achieve compliance with the SSM criteria. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

8.1.4 Dry Conditions (60% to 90% flow frequency)

Dry conditions represent flow rates between 15.5 cfs and 9.1 cfs. Dry condition flows are best characterized as base flow conditions influenced by ground water sources. Bacteria sources likely originate in the stream channel during dry flow conditions. The 95th percentile bacteria concentration and flow for this zone was calculated at 172 CFU/100mL and 13.8 cfs, respectively. An *E. coli* load reduction of 0% is required to achieve compliance with the daily maximum criteria. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

8.1.5 Low Flows (90% to 100% flow frequency)

The low flow zone represents minimal flow conditions with flow rates between 9.0cfs and 1.6 cfs. Recreation uses and associated standards are applicable to all flow conditions. However, lower flows result in reduced recreational opportunities. Bacteria sources likely originate in the stream channel during low flow conditions. Data availability was minimal (n=2) for the lowest flow zone and was a product of reduced frequency of these flows during the recreational season. The 95th percentile bacteria concentration and flow for this zone was calculated at 158 CFU/100mL and 7.6 cfs, respectively. An E. coli load reduction of 0% is required to achieve compliance with the SSM criteria. In addition to the daily load, the geometric mean criteria must be attained on a longer (i.e., monthly) basis.

8.2 TMDL Allocations

8.2.1 Waste Load Allocation (WLA)

A comprehensive watershed scale point source assessment and associated WLA consideration discussion is provided in Section 7.1. Based on this assessment the WLA portion of the TMDL was set a zero.

8.2.2 Margin of Safety (MOS) – *E. coli* Bacteria

In accordance with 303(d) regulations, a margin of safety must be established to account for uncertainty in the TMDL analyses. A margin of safety may be provided (1) by using conservative assumptions in the calculation of the loading capacity of the waterbody and (2) by establishing allocations that in total are lower than the defined loading capacity. In the case of Whitewood Creek (Segment SD-BF-R-Whitewood_04), the latter approach was used to establish an MOS

An explicit MOS was calculated within the duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). Ten percent (10%) of the overall load capacity was allocated to each flow zone to assign the MOS as part of the TMDL. The remaining assimilative capacity was allocated to nonpoint sources (LA).

8.2.3 Load Allocation

Load allocation (LA) represents the portion of the TMDL allocated to nonpoint sources, including natural background. The LA is calculated by subtracting the WLA and MOS from the TMDL. The *E. coli* bacteria load capacity (TMDL) for Whitewood Creek Segment 4 is exclusively from nonpoint sources. A nonpoint source load reduction of 90.3 percent is required in the high flow zone to achieve full attainment. The moist and mid-range flow zones require a 78.6 and 48.1 percent reduction, respectively. The largest local source of *E. coli* bacteria production in the Whitewood Creek Segment 4 watershed was estimated to come from wildlife (i.e., background) (Table 14).

E. coli bacteria impairment in Whitewood Creek Segment 4 is the result of a border condition. E. coli bacteria exceedance rates (%) observed in Whitewood Creek Segment 3 (upstream) during the 2010 to 2020 IR cycles was similar to that observed at Whitewood Creek Segment 4 for the same reporting periods. In general, *E. coli* bacteria loading from Whitewood Creek Segment 3 contributes substantially to the impairment, especially in the upstream portion of Whitewood Creek Segment 4 where the monitoring sites are located. Meeting *E. coli* standards (TMDL) for the designated immersion recreation use in Segment 3 is warranted to achieve full attainment in Segment 4.

9.0 Seasonal Variation

Whitewood Creek is a perennial stream offering seasonal recreational opportunities in most years. The hydrology of Whitewood Creek Segment 4 is variable during the recreation season (May 1st to September 30th). The discharge record developed during the recreation season at site WWCBact04 displayed considerable seasonal variation during the 2014 to 2020 assessment period. The highest stream discharge (1,829 CFS) occurred in September 2017 (fall) and the lowest discharge (1.6 CFS) occurred July 2019 (summer). Individual discharge measurements were not a good predictor of *E. coli* bacteria counts ($r^2 = 0.0689$). In addition, *E. coli* bacteria counts poorly correlated with individual discharge measurements ($r = 0.2625$).

Seasonal variation is a component of the load duration curve framework. A LDC based on the SSM standard for immersion recreation was developed specifically to examine the seasonal (spring, summer, fall) exceedance pattern of individual *E. coli* bacteria loads during the recreation season (Figure 19). *E. coli* bacteria loads exceeded the LDC 18.8% (3 of 16), 38.8% (19 of 49) and 22.2% (4 of 18) in spring, summer and fall, respectively. *E. coli* bacteria loadings collected during the summer appear to exceed more often than in the spring or fall. Focusing restoration efforts to account for seasonal patterns is warranted to achieve attainment goals.

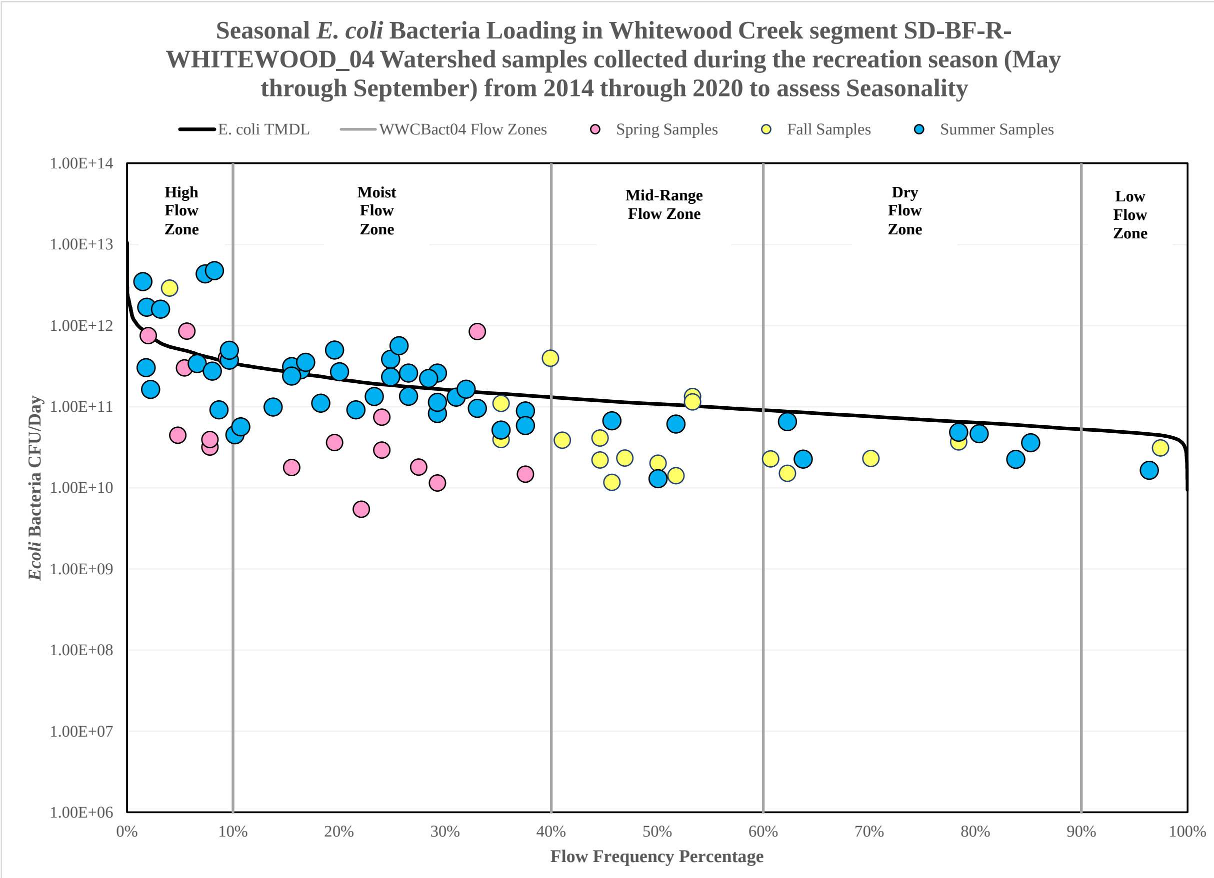

Figure 19 Seasonal *E. coli* bacteria Loading in Whitewood Creek Segment SD-BF-R-WHITEWOOD_04 from watershed samples collected during the recreation season (May through September) from 2014 through 2020 to assess seasonality

10.0 Critical Conditions

Critical conditions occur within the watershed during periods of increased run-off from storm events following seasonal patterns. *E. coli* bacteria concentrations/loading exceed SSM and GM criteria exclusively in the high flow, moist condition and mid-range flow zones. Flow conditions in these zones are more likely to transport *E. coli* bacteria from multiple nonpoint sources in the watershed including upstream sources associated with Whitewood Creek Segment 3. In general, bacteria impairment tends to occur at flows above baseflow condition (>15.5 cfs). Remediation efforts focused on reducing *E. coli* bacteria in Whitewood Creek Segment 4 should be implemented according to critical flow conditions associated with watershed-scale run-off and transport potential.

11.0 Monitoring Strategy

Continued monitoring for *E. coli* bacteria and continuous stream flow will be necessary to assure TMDL and standards attainment. Long-term monthly *E. coli* bacteria monitoring will continue at site WQM 85 through DANR's Ambient Surface Water Quality Monitoring Program. In addition, Whitewood Creek segment 4 will be assessed every two years in a ten-year rotation cycle as part of DANRs (Watershed Protection Program) Rotating Basin Project. Site locations will follow those used for TMDL development. DANR Watershed Protection staff will continue to maintain a long-term stream gage at site WWCBact04 as part of the Statewide Streamflow Monitoring Network (https://danr.sd.gov/Conservation/WatershedProtection/Projects/StreamflowMonitoringNetwork.aspx.).

Data and information collected as part of these monitoring efforts will be used to determine beneficial use support in accordance with 303(d) listing methods, evaluate TMDL effectiveness and to make potential future adjustments to the TMDLs, if necessary. 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 (http://www.epa.gov/sites/production/files/2015-10/documents/draft-tmdl_32212.pdf).

12.0 Public Participation

SD DANR provided financial support for the Whitewood Creek segment 4 TMDL assessment project and was the primary agency involved in the design, data collection, analysis, and completion of this TMDL document. *E. coli* data collected during the project was supplemented with *E. coli* data available from SD DANR's ambient water quality monitoring program.

SD DANR communicated with interested landowners and residents in the watershed during the field collection process to gain information about potential sources of *E. coli*. This also provided a pathway to inform interested parties of the project scope and activities being conducted to assess the impairment and address concerns.

A 30-day public comment period was issued for the draft TMDL. A public notice letter was published in the Black Hills Pioneer and Rapid City Journal. The draft TMDL document and ability to comment was made available on DANRs One-Stop Public Notice Page at: https://danr.sd.gov/public/default.aspx. The public comment period began June 1, 2022 and ended July 11, 2022. Comments and responses to the comments are addressed in Appendix B.

13.0 Implementation Strategy

It is concluded that *E. coli* bacteria impairment in Whitewood Creek Segment 4 is likely the result of upstream conditions. This is supported by results of the source assessment (wildlife highest production source) and similarity in exceedance rates between Whitewood Creek Segment 3 (upstream) and Whitewood Creek Segment 4 (Table 9). Implementation efforts should focus on a holistic watershed approach targeting sources in impaired watersheds upstream in addition to the direct Whitewood Creek Segment 4 watershed. Reducing *E. coli* bacteria loads in upstream impaired segments is necessary to achieve TMDL attainment goals. The following upstream watersheds (AUIDs) do not support *E. coli* standards and/or TMDL goals and should be targeted for nonpoint source implementation as part of an overall *E. coli* reduction strategy for Whitewood Creek Segment 4:

- SD-BF-R-WHITEWOOD_03; (SD DANR. 2011a and SD DANR. 2011b.)
- SD-BF-R-DEADWOOD_01; (SD DANR. 2020a).

EPA approved TMDLs for Whitewood Creek Segment 3 and Deadwood Creek Segment 1 recommend watershed-scale nonpoint source Best Management Practices and actions focused on meeting reduction goals and standards attainment. BMP implementation strategies are also recommended for Whitewood Creek Segment 4 (target segment):

Deadwood Creek Segment SD-BF-R-DEADWOOD_01

- *E. coli* bacteria monitoring should be conducted to refine and identify potential sources in otherwise unmonitored segments of the watershed, in particular, Blacktail Gulch to the confluence of Deadwood Creek and Deadwood Creek downstream of WQM 127 and DWCBact01.

- Enhancing the existing riparian vegetation width and density along all tributaries to and along Whitewood Creek watershed will provide erosion control and filter *E. coli* bacteria and other pollutant runoff to the stream.

- Reducing wildlife, domestic animals including pets and human sources access to the streams in the watershed.

- An assessment of progress will be part of every Section 319 implementation Segment, and revisions to the plan will be made as appropriate, in cooperation with the project sponsor and basin stakeholders.

Whitewood Creek Segment SD-BF-R-WHITEWOOD_03

A variety of BMPs could be considered in the development of a water-quality management implementation plan for the impaired portion of the Whitewood Creek Segment SD-BF-R-WHITEWOOD_03 watershed. While several types of control measures are available for reducing *E. coli* bacteria loads, the practicable control measures listed and discussed below are recommended to address the identified sources. These sources were combined and simulated using the HSPF framework (SD DANR 2011a).

- Complete replacement of the CSO system in Lead, South Dakota.
- Reduction of on-site wastewater treatment system failures and leaking sewer lines.
- Stormwater treatment programs for urban areas.
- Riparian buffers and filter strips, avian management practices, reduction of direct defecation, and reduction of overland load from forest, pasture, and cropland.

Whitewood Creek Segment SD-BF-R-WHITEWOOD_04

- Develop new and enhance existing riparian buffers along the impaired segment corridor and associated tributaries to decrease *E. coli* and other pollutant transport during high flow conditions (above base flow).

- Reduce in stream and riparian access to domestic animals in the watershed.

- Conduct additional *E. coli* monitoring at WQM 85 to track the border condition with consideration for genetic source tracking where appropriate.

There are several entities that provide watershed stewardship in the Black Hills area and may have vested interest in a Deadwood /Whitewood Creek watershed-scale implementation project. These include Black Hills Fly Fishers, Lawrence County Conservation District, South Dakota GF&P, Black Hills National Forest and Natural Resource Conservation Service. Municipalities with vested interest in the watershed area include Lead, Deadwood and Central City. Involvement by these entities is important to the success of any potential future implementation/restoration project(s) or partnerships that involve Deadwood and Whitewood Creek.

Funds to implement watershed water quality improvements can be obtained through SD DANR. SD DANR administers three major funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota. They include: Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Nonpoint Source program. There are no current implementation or watershed improvement projects underway in the watershed of the impaired segments of Deadwood Creek or Whitewood Creek.

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APPENDIX A:

Whitewood Creek *E. coli* Bacteria Samples and QA/QC Tables

Table A1 Whitewood Creek Segment SD-BF-R-Whitewood_04 *E. coli* bacteria sampled prior to the current assessment from WQW 85 by SD DANR SWQ staff during the recreation season (May 1 through September 30) from 2009 through 2013.

SampleDate	Sample Location	SampleTime	*E. coli* Bacteria	Count (CFU/100 mL)	Discharge (cfs)	Load (CFU/Day)	Percentile (flow frequency)	Sample Period
05/20/2009	WQM 85	12:00	Escherichia coli{}#/100mL	13				**Pre-Assessment**
06/23/2009	WQM 85	11:25	Escherichia coli{}#/100mL	116				**Pre-Assessment**
07/20/2009	WQM 85	13:35	Escherichia coli{}#/100mL	162				**Pre-Assessment**
08/20/2009	WQM 85	13:25	Escherichia coli{}#/100mL	119				**Pre-Assessment**
09/10/2009	WQM 85	9:00	Escherichia coli{}#/100mL	299				**Pre-Assessment**
05/05/2010	WQM 85	13:00	Escherichia coli{}#/100mL	26				**Pre-Assessment**
06/15/2010	WQM 85	13:30	Escherichia coli{}#/100mL	345				**Pre-Assessment**
07/20/2010	WQM 85	14:10	Escherichia coli{}#/100mL	137				**Pre-Assessment**
08/17/2010	WQM 85	9:40	Escherichia coli{}#/100mL	55				**Pre-Assessment**
09/16/2010	WQM 85	13:15	Escherichia coli{}#/100mL	387				**Pre-Assessment**
05/05/2011	WQM 85	12:30	Escherichia coli{}#/100mL	12				**Pre-Assessment**
06/15/2011	WQM 85	9:30	Escherichia coli{}#/100mL	34				**Pre-Assessment**
07/18/2011	WQM 85	14:25	Escherichia coli{}#/100mL	206				**Pre-Assessment**
08/22/2011	WQM 85	14:30	Escherichia coli{}#/100mL	461				**Pre-Assessment**
09/27/2011	WQM 85	9:35	Escherichia coli{}#/100mL	96				**Pre-Assessment**
05/22/2012	WQM 85	9:45	Escherichia coli{}#/100mL	517				**Pre-Assessment**
06/12/2012	WQM 85	9:20	Escherichia coli{}#/100mL	1990				**Pre-Assessment**
07/11/2012	WQM 85	13:20	Escherichia coli{}#/100mL	145				**Pre-Assessment**
08/14/2012	WQM 85	13:10	Escherichia coli{}#/100mL	166				**Pre-Assessment**
09/18/2012	WQM 85	9:45	Escherichia coli{}#/100mL	112				**Pre-Assessment**
05/09/2013	WQM 85	13:25	Escherichia coli{}#/100mL	55				**Pre-Assessment**
06/05/2013	WQM 85	9:45	Escherichia coli{}#/100mL	34				**Pre-Assessment**
07/23/2013	WQM 85	13:30	Escherichia coli{}#/100mL	222				**Pre-Assessment**
08/15/2013	WQM 85	13:25	Escherichia coli{}#/100mL	579				**Pre-Assessment**
09/11/2013	WQM 85	10:00	Escherichia coli{}#/100mL	411				**Pre-Assessment**

Red = Sample exceeded water quality standard based on immersion recreation criterion (≤235 CFU/100 mL)

Table A2 Whitewood Creek Segment SD-BF-R-Whitewood_04 *E. coli* bacteria sampled during current assessment from monitoring sites WQW 85 and WWCBact04 by SD DANR SWQ and SD DANR WP staff during the recreation season (May 1 through September 30) from 2014 through 2020.

SampleDate	Sample Location	SampleTime	*E. coli* Bacteria	Count (CFU/100 mL)	Discharge (cfs)	Load (CFU/Day)	Percentile (flow frequency)	Sample Period
05/06/2014	WQM 85	13:50	Escherichia coli{}#/100mL	29				Assessment
06/10/2014	WQM 85	9:05	Escherichia coli{}#/100mL	91				Assessment
07/08/2014	WQM 85	9:05	Escherichia coli{}#/100mL	260	44.71	2.84E+11	0.16	Assessment
08/14/2014	WQM 85	13:40	Escherichia coli{}#/100mL	308	29.49	2.22E+11	0.28	Assessment
09/16/2014	WQM 85	12:45	Escherichia coli{}#/100mL	23	20.67	1.16E+10	0.46	Assessment
05/12/2015	WQM 85	9:45	Escherichia coli{}#/100mL	142.1	86.04	2.99E+11	0.05	Assessment
06/02/2015	WQM 85	13:30	Escherichia coli{}#/100mL	85.5	143.86	3.01E+11	0.02	Assessment
07/06/2015	WQM 85	11:50	Escherichia coli{}#/100mL	248.9	61.20	3.73E+11	0.10	Assessment
08/18/2015	WQM 85	10:10	Escherichia coli{}#/100mL	2419.6	73.18	4.33E+12	0.07	Assessment
09/28/2015	WQM 85	9:20	Escherichia coli{}#/100mL	178	25.17	1.10E+11	0.35	Assessment
05/05/2016	WQM 85	12:47	Escherichia coli{}#/100mL	15.6	46.49	1.77E+10	0.16	Assessment
06/06/2016	WQM 85	13:12	Escherichia coli{}#/100mL	27.5	19.19	1.29E+10	0.50	Assessment
07/12/2016	WQM 85	11:31	Escherichia coli{}#/100mL	167	11.30	4.62E+10	0.80	Assessment
08/08/2016	WQM 85	11:51	Escherichia coli{}#/100mL	172	11.44	4.82E+10	0.78	Assessment
09/07/2016	WQM 85	12:54	Escherichia coli{}#/100mL	132	11.37	3.67E+10	0.78	Assessment
05/16/2017	WQM 85	14:55	Escherichia coli{}#/100mL	1300	26.52	8.43E+11	0.33	Assessment
06/20/2017	WQM 85	13:19	Escherichia coli{}#/100mL	62.4	14.77	2.26E+10	0.64	Assessment
07/20/2017	WQM 85	11:59	Escherichia coli{}#/100mL	145	10.11	3.59E+10	0.85	Assessment
08/23/2017	WQM 85	13:28	Escherichia coli{}#/100mL	83.9	7.99	1.64E+10	0.96	Assessment
09/14/2017	WQM 85	13:24	Escherichia coli{}#/100mL	162	7.82	3.10E+10	0.97	Assessment
05/17/2018	WQM 85	12:59	Escherichia coli{}#/100mL	6.3	35.14	5.42E+09	0.22	Assessment
06/21/2018	WQM 85	14:25	Escherichia coli{}#/100mL	488	140.32	1.68E+12	0.02	Assessment
07/19/2018	WQM 85	13:07	Escherichia coli{}#/100mL	115	29.16	8.21E+10	0.29	Assessment
08/13/2018	WQM 85	11:09	Escherichia coli{}#/100mL	172	15.43	6.49E+10	0.62	Assessment
09/18/2018	WQM 85	13:20	Escherichia coli{}#/100mL	69.1	13.53	2.29E+10	0.70	Assessment
05/13/2019	WQM 85	11:27	Escherichia coli{}#/100mL	20.1	90.22	4.44E+10	0.05	Assessment
06/13/2019	WQM 85	13:16	Escherichia coli{}#/100mL	30.9	59.50	4.50E+10	0.10	Assessment
07/18/2019	WQM 85	13:25	Escherichia coli{}#/100mL	179	77.46	3.39E+11	0.07	Assessment
08/14/2019	WQM 85	15:22	Escherichia coli{}#/100mL	326	43.98	3.51E+11	0.17	Assessment
09/05/2019	WQM 85	13:15	Escherichia coli{}#/100mL	63.3	25.39	3.93E+10	0.35	Assessment
05/19/2020	WQM 85	14:33	Escherichia coli{}#/100mL	18.3	70.93	3.18E+10	0.08	Assessment
06/22/2020	WQM 85	13:04	Escherichia coli{}#/100mL	488	32.12	3.84E+11	0.25	Assessment
07/22/2020	WQM 85	15:40	Escherichia coli{}#/100mL	148	26.25	9.51E+10	0.33	Assessment
08/18/2020	WQM 85	10:40	Escherichia coli{}#/100mL	133	18.71	6.09E+10	0.52	Assessment
09/22/2020	WQM 85	14:40	Escherichia coli{}#/100mL	299	18.18	1.33E+11	0.53	Assessment
06/17/2014	WWCBact04		Escherichia coli{}#/100mL	40	57.39	5.62E+10	0.11	Assessment
06/27/2014	WWCBact04		Escherichia coli{}#/100mL	272	46.65	3.10E+11	0.16	Assessment
07/01/2014	WWCBact04		Escherichia coli{}#/100mL	81	49.74	9.86E+10	0.14	Assessment
07/10/2014	WWCBact04		Escherichia coli{}#/100mL	109	41.37	1.10E+11	0.18	Assessment
07/15/2014	WWCBact04		Escherichia coli{}#/100mL	105	35.54	9.13E+10	0.22	Assessment
07/24/2014	WWCBact04		Escherichia coli{}#/100mL	727	31.61	5.62E+11	0.26	Assessment
07/31/2014	WWCBact04		Escherichia coli{}#/100mL	365	28.94	2.58E+11	0.29	Assessment
08/07/2014	WWCBact04		Escherichia coli{}#/100mL	517	39.22	4.96E+11	0.20	Assessment
08/14/2014	WWCBact04		Escherichia coli{}#/100mL	178	30.83	1.34E+11	0.27	Assessment
08/21/2014	WWCBact04		Escherichia coli{}#/100mL	2830	68.41	4.74E+12	0.08	Assessment
08/28/2014	WWCBact04		Escherichia coli{}#/100mL	99	24.05	5.82E+10	0.38	Assessment
09/03/2014	WWCBact04		Escherichia coli{}#/100mL	79	21.13	4.08E+10	0.45	Assessment
09/22/2014	WWCBact04		Escherichia coli{}#/100mL	31	18.57	1.41E+10	0.52	Assessment
09/24/2014	WWCBact04		Escherichia coli{}#/100mL	48	19.81	2.33E+10	0.47	Assessment
09/29/2014	WWCBact04		Escherichia coli{}#/100mL	690	23.34	3.94E+11	0.40	Assessment
09/30/2014	WWCBact04		Escherichia coli{}#/100mL	1220	96.73	2.89E+12	0.04	Assessment
05/05/2015	WWCBact04	13:44	Escherichia coli{}#/100mL	16	29.26	1.15E+10	0.29	Assessment
05/12/2015	WWCBact04	13:45	Escherichia coli{}#/100mL	411	84.91	8.54E+11	0.06	Assessment
05/19/2015	WWCBact04	10:30	Escherichia coli{}#/100mL	225	136.34	7.51E+11	0.02	Assessment
06/02/2015	WWCBact04	11:00	Escherichia coli{}#/100mL	52	128.19	1.63E+11	0.02	Assessment
06/04/2015	WWCBact04	13:25	Escherichia coli{}#/100mL	921	153.63	3.46E+12	0.02	Assessment
06/11/2015	WWCBact04	12:13	Escherichia coli{}#/100mL	613	105.64	1.58E+12	0.03	Assessment
07/01/2015	WWCBact04	15:55	Escherichia coli{}#/100mL	56.3	66.14	9.11E+10	0.09	Assessment
07/09/2015	WWCBact04	13:31	Escherichia coli{}#/100mL	161	69.49	2.74E+11	0.08	Assessment
07/15/2015	WWCBact04	13:40	Escherichia coli{}#/100mL	326	61.90	4.94E+11	0.10	Assessment
07/22/2015	WWCBact04	11:55	Escherichia coli{}#/100mL	210	46.22	2.37E+11	0.16	Assessment
07/27/2015	WWCBact04	14:30	Escherichia coli{}#/100mL	162	33.56	1.33E+11	0.23	Assessment
08/11/2015	WWCBact04	15:45	Escherichia coli{}#/100mL	194	27.54	1.31E+11	0.31	Assessment
08/13/2015	WWCBact04	9:30	Escherichia coli{}#/100mL	248	27.06	1.64E+11	0.32	Assessment
08/20/2015	WWCBact04	10:11	Escherichia coli{}#/100mL	291	32.66	2.33E+11	0.25	Assessment
08/25/2015	WWCBact04	13:40	Escherichia coli{}#/100mL	82	25.52	5.12E+10	0.35	Assessment
08/27/2015	WWCBact04	12:47	Escherichia coli{}#/100mL	345	30.71	2.59E+11	0.27	Assessment
09/09/2015	WWCBact04	14:26	Escherichia coli{}#/100mL	68.9	22.81	3.84E+10	0.41	Assessment
09/15/2015	WWCBact04	15:10	Escherichia coli{}#/100mL	42.8	21.00	2.20E+10	0.45	Assessment
09/21/2015	WWCBact04	12:15	Escherichia coli{}#/100mL	43.5	18.79	2.00E+10	0.50	Assessment
09/29/2015	WWCBact04	15:15	Escherichia coli{}#/100mL	261	17.86	1.14E+11	0.53	Assessment
05/08/2018	WWCBact04	14:15	Escherichia coli{}#/100mL	90.9	33.34	7.41E+10	0.24	Assessment
05/09/2018	WWCBact04		Escherichia coli{}#/100mL	24.1	30.48	1.80E+10	0.28	Assessment
05/16/2018	WWCBact04	15:00	Escherichia coli{}#/100mL	24.6	24.40	1.47E+10	0.38	Assessment
05/21/2018	WWCBact04		Escherichia coli{}#/100mL	38.3	38.54	3.61E+10	0.20	Assessment
05/24/2018	WWCBact04		Escherichia coli{}#/100mL	35.9	33.14	2.91E+10	0.24	Assessment
05/30/2018	WWCBact04		Escherichia coli{}#/100mL	260	62.47	3.97E+11	0.09	Assessment
09/06/2018	WWCBact04	14:25	Escherichia coli{}#/100mL	40.2	15.27	1.50E+10	0.62	Assessment
09/27/2018	WWCBact04	10:40	Escherichia coli{}#/100mL	59.4	15.59	2.27E+10	0.61	Assessment
05/02/2019	WWCBact04	13:51	Escherichia coli{}#/100mL	22.6	70.90	3.92E+10	0.08	Assessment
07/15/2019	WWCBact04	15:01	Escherichia coli{}#/100mL	88	10.38	2.23E+10	0.84	Assessment
08/14/2019	WWCBact04	13:20	Escherichia coli{}#/100mL	285	38.50	2.68E+11	0.20	Assessment
07/22/2020	WWCBact04	15:40	Escherichia coli{}#/100mL	148	24.40	8.84E+10	0.38	Assessment
07/30/2020	WWCBact04	12:00	Escherichia coli{}#/100mL	158	29.20	1.13E+11	0.29	Assessment
08/18/2020	WWCBact04	10:40	Escherichia coli{}#/100mL	133	20.50	6.67E+10	0.46	Assessment

Red = Sample exceeded water quality standard based on immersion recreation criterion (≤235 CFU/100 mL)

Table A3 Whitewood Creek Segment SD-BF-R-Whitewood_04A routine and event *E. coli* bacteria monitoring, instantaneous discharge, and water quality data collected during the recreation season (May 1 through September 30) from Whitewood Creek Assessment 2018 through 2019.

SampleDate	Sample Location	SampleTime	*E. coli* Bacteria	Count (CFU/100 mL)	Discharge (cfs)	Load (CFU/Day)	Percentile (flow frequency)	Sample Period
05/02/2018	WWCBact04A	12:25	Escherichia coli{}#/100mL	166	38.6	1.57E+11	19.18%	Assessment
05/08/2018	WWCBact04A	11:55	Escherichia coli{}#/100mL	21.8	30	1.60E+10	26.56%	Assessment
05/16/2018	WWCBact04A	9:59	Escherichia coli{}#/100mL	24.3	26.9	1.60E+10	31.99%	Assessment
05/21/2018	WWCBact04A	13:12	Escherichia coli{}#/100mL	21.6	37.7	1.99E+10	19.59%	Assessment
05/24/2018	WWCBact04A	12:44	Escherichia coli{}#/100mL	21.8	27.8	1.48E+10	30.18%	Assessment
05/30/2018	WWCBact04A	13:50	Escherichia coli{}#/100mL	219	67	3.59E+11	8.95%	Assessment
09/06/2018	WWCBact04A	15:15	Escherichia coli{}#/100mL	22.8	30	1.67E+10	26.56%	Assessment
07/07/2019	WWCBact04A	16:34	Escherichia coli{}#/100mL	**285**	38.5	2.68E+11	19.38%	Assessment
07/15/2019	WWCBact04A	15:30	Escherichia coli{}#/100mL	64.4	25.5	4.02E+10	34.14%	Assessment
08/14/2019	WWCBact04A	10:52	Escherichia coli{}#/100mL	**1410**	44.1	1.52E+12	15.92%	Assessment
04/22/2021	NoNameCreek04	14:00	Escherichia coli{}#/100mL	32.3				Assessment
04/22/2021	NoNameCreek03	14:20	Escherichia coli{}#/100mL	9.7				Assessment
04/22/2021	NoNameCreek02	14:40	Escherichia coli{}#/100mL	4.1				Assessment
05/02/2019	NoNameCreek01 (WWCBact04C)	15:30	Escherichia coli{}#/100mL	2				Assessment
04/22/2021	NoNameCreek01	15:15	Escherichia coli{}#/100mL	1				Assessment

Red = Sample exceeded water quality standard based on immersion recreation criterion (≤235 CFU/100 mL)

Table A4 Whitewood Creek Segment SD-BF-R-Whitewood_04 Geometric Mean *E. coli* bacteria monitoring, instantaneous discharge, and water quality data collected during the recreation season (May 1 through September 30) from Whitewood Creek Assessment 2014. 2015 and 2018.

Sample Date	Number of Samples used to Calculate	Number of Samples (> 235 CFU/100 mL)	Percentage of Daily Samples Exceeding SSM Criteria within the 30-Day period (> 235 CFU/100 mL)	E. coli Bacteria (cfu/100 mL)	Flow Frequency Disharge prcentage (%)	30-Day Geometric Mean (CFU/100 mL)	Average Flow Frequency Disharge prcentage within each 30-Day Geometric Mean
07/01/2014				81	13.8%		
07/08/2014				**260**	15.5%		
07/10/2014				109	18.3%		
07/15/2014				105	21.6%		
07/24/2014				**727**	25.7%		
07/31/2014	6	3	50%	**365**	29.3%	**200**	21%
09/03/2014				79	44.6%		
09/16/2014				23	44.6%		
09/22/2014				31	51.8%		
09/24/2014				48	47.0%		
09/29/2014				**690**	39.9%		
09/30/2014	6	2	33%	**1,220**	4.0%	**115**	39%
07/01/2015				56.3	8.7%		
07/06/2015				**248.9**	9.4%		
07/09/2015				161	8.1%		
07/15/2015				**326**	9.7%		
07/22/2015				210	15.5%		
07/27/2015	6	2	33%	162	23.3%	**171**	12%
08/11/2015				194	31.1%		
08/13/2015				**248**	32.0%		
08/18/2015				**2,419.6**	6.6%		
08/20/2015				**291**	24.9%		
08/25/2015				82	35.3%		
08/27/2015	6	4	67%	**345**	26.6%	**314**	26%
09/09/2015				68.9	41.1%		
09/15/2015				42.8	44.6%		
09/21/2015				43.5	50.1%		
09/28/2015				178	44.6%		
09/29/2015	5	1	20%	**261**	53.3%	**90**	47%
05/08/2018				90.9	24.0%		
05/09/2018				24.1	27.5%		
05/16/2018				24.6	37.6%		
05/17/2018				6.3	30.2%		
05/21/2018				38.3	19.6%		
05/24/2018				35.9	24.0%		
05/30/2018	7	1	14%	**260**	9.4%	**38**	25%

Red = Exceeds Single Sample Maximum (SSM, ≤ 235 cfu/100 mL) or Geometric Mean (GM ≤ 126 cfu/100 mL

Table A5 Quality Assurance Quality Control blank sample analysis for samples collected on Whitewood Creek and Blacktail Gulch during the recreation season (May 1st through September 30th from 2014, 2015, and 2018.

Laboratory	Station ID	Date Sampled	E. coli (MPN/100 mL) RL = 1	Fecal Coliform (CFU/100 mL) RL = 2
Energy	WWCBact04B	08/07/2014	0.5	1
MIDCONTINENT	WWCBact04B	05/19/2015	0.5	1
MIDCONTINENT	WWCBact04B	07/15/2015	0.5	1
MIDCONTINENT	WWCBact04B	09/09/2015	0.5	1
MIDCONTINENT	WWCBact04B	05/02/2018	0.5	
MIDCONTINENT	WWCBact04B	05/21/2018	0.5	
MIDCONTINENT	WWCBact04AB	05/02/2018	0.5	
MIDCONTINENT	WWCBact04AB	05/16/2018	0.5	
MIDCONTINENT	WWCBact04AB	05/24/2018	0.5	
Mean			0.5	1
Standard Deviation			0	0
QA/QC Criteria Met			TRUE	TRUE

Table A6 Quality Assurance Quality Control for precision using log range analysis for *E. coli* samples collected on Whitewood Creek in Segment 04 during the recreation season (May 1st through September 30th) from 2014, 2015, and 2018.

Whitewood Creek QA/QC Precision Analysis (Log Range Technique) for 2014, 2015, and 2018					
			E. coli Bacteria		Meets
Date	**Site**	**Sample Type**	**(CFU/100 mL)**	**Log_{10}**	**QA/QC**
08/07/2014	WCCBact04	Routine	517	2.71	
08/07/2014	WCCBact04R	Replicate	378	2.58	
Range				0.14	TRUE
05/19/2015	WCCBact04	Routine	225	2.35	
05/19/2015	WCCBact04R	Replicate	387	2.59	
Range				0.24	TRUE
07/15/2015	WCCBact04	Routine	326	2.51	
07/15/2015	WCCBact04R	Replicate	365	2.56	
Range				0.05	TRUE
09/09/2015	WCCBact04	Routine	69	1.84	
09/09/2015	WCCBact04R	Replicate	23	1.36	
Range				0.48	FALSE
05/02/2018	WCCBact04	Routine	64	1.80	
05/02/2018	WCCBact04R	Replicate	57	1.76	
Range				0.05	TRUE
05/21/2018	WCCBact04	Routine	38	1.58	
05/21/2018	WCCBact04R	Replicate	34	1.53	
Range				0.06	TRUE
05/02/2018	WWCBact04A	Routine	166	2.22	
05/02/2018	WWCBact04AR	Replicate	147	2.17	
Range				0.05	TRUE
05/16/2018	WWCBact04A	Routine	24	1.39	
05/16/2018	WWCBact04AR	Replicate	21	1.32	
Range				0.06	TRUE
05/24/2018	WWCBact04A	Routine	22	1.34	
05/24/2018	WWCBact04AR	Replicate	24	1.38	
Range				0.04	TRUE
Total Range				1.16	
Mean Range				0.13	
***E. coli* Precision Criterion**					**0.4**

APPENDIX B:

Response to Public Comments

USDA United States Department of Agriculture | Forest Service | Black Hills National Forest | 1019 North 5th Street
Custer, SD 57730
605-673-9200
Fax: 605-673-9350

File Code: 2500
Date: July 8, 2022

HUNTER ROBERTS
SECRETARY
SOUTH DAKOTA DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
WATERSHED PROTECTION PROGRAM
523 EAST CAPITOL AVE., JOE FOSS BUILDING
PIERRE, SD 57501-3182

Dear Secretary Roberts,

Thank you for the opportunity to review and provide comments on ***Escherichia coli (E. coli) Bacteria Total Maximum Daily Load (TMDL) for Whitewood Creek Segment 4, SD-BF-R-WHITEWOOD_04, Lawrence County, South Dakota.*** The Black Hills National Forest continues to be interested in working with the State on understanding water quality issues and improving water quality on National Forest System lands, therefore the Forest staff offer the following comments regarding the TMDL assessment:

Section 2.4 Land Use/Land Cover
Page 7

> States: *The entire watershed is located within the Black Hills National Forest.* It would be more correct to say the watershed is located within the proclaimed boundary of the Black Hills National Forest. Only about 1,300 feet of this segment of Whitewood Creek runs through lands administered by the Black Hills National Forest, most of it runs through either state-owned or privately-owned land.

Section 7.2 Non-point Sources
Page 33 Table 12

> Perhaps it would be more reliable to conduct a genetic analysis of the *E. coli* samples to determine the source? The *Implementation Strategy Section* (p 44-45) notes there is an upstream issue. We respectfully suggest that a genetic analysis, or further explanation of the BIT model that details how it was used to determine wildlife species are the major contributor, combined with the identification of the upstream source would help inform efforts to improve the water quality.

Section 7.2.6 Grazing Allotments
Page 37

> States: *Figure 17 shows United States Department of Interior Forest Service (USFS) private grazing allotments acres (hashed yellow areas) in the watershed.* The Forest Service is within the Department of Agriculture, rather than the Department of Interior, and grazing allotments are not considered privately held. That sentence should be corrected to …*United States Department of Agriculture Forest Service (USFS) grazing allotments acres (hashed yellow areas) in the watershed.*

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Section 13.0 Implementation Strategy
Page 46 Paragraph 2

> Please include the Black Hills National Forest as an entity that has an interest in and provides watershed stewardship in the headwater streams of this segment of Whitewood Creek (above Deadwood).

Again, thank you for the opportunity to review and comment. We look forward to continue working with the State of South Dakota. Please contact Cynthia Englebert, Forest Watershed Program Manager, with questions that you may have. Cynthia can be contacted at (605) 673-9296 or cynthia.englebert@usda.gov .

Sincerely,

JEFF TOMAC
Forest Supervisor

cc: Melissa Dempsey

DANR Response to Section 2.4 Land Use/Land Cover
Page 7:

The referenced sentence on page 7 was changed from "T*he entire watershed is located within the Black Hills National Forest"* to the language consistent with that provided in the comment.

DANR Response to Section 7.2 Non-point Sources
Page 33 Table 12:

The source of impairment appears to be isolated to the upper portion of segment 4 where a majority of the *E. coli* samples were collected and used for TMDL development. This is supported by the Deadwood Creek segment 1 and Whitewood Creek segment 3 *E. coli* TMDLs (referenced), which identified several sources of *E. coli* loading within the Lead-Deadwood area including Leads Combined Sewer Overflow (CSO). It was concluded based on the evidence that *E. coli* impairment in Whitewood Creek segment 04 is the result of a border condition given the close proximity to these upstream sources. This is further supported by the source assessment which indicated no significant sources in the segment 4 watershed.

The BIT model calculates bacteria production rates from various sources obtained from population density estimates distributed over different land use types. Natural background sources or wildlife are indicated as the main source of bacteria production in the Whitewood Creek segment 4 watershed (64.2%). This makes sense considering wildlife densities are much larger than other categories (humans, pets, horses etc.) and nearly 80% of the watershed is forested. Wildlife are not likely contributing to the impairment as supported by the lack of *E. coli* impairment at the upper end of Whitewood Creek segment 5 (downstream). For more detailed information about EPA's Bacteria Indicator Tool visit the User's Guide at: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100O179.PDF?Dockey=P100O179.PDF. Wildlife densities were obtained from the most recent population survey conducted by SD Game, Fish and Parks (Huxoll, 2003, section 7.2.5).

Results of the Whitewood Creek segment 4 source assessment conclude that humans and pets are the largest nonpoint source of *E. coli* production in the watershed. Human and pet production only account for approximately 30% of the overall production, mostly due to relative low density. These sources are also isolated to the upper portion of the watershed. Sampling efforts in the highest development area of the watershed (No Name Creek) indicated little impact, though monitoring was limited. BIT model results also indicate a low production percentage (0.2%) from failing septic systems based on an estimated 10% failure rate.

The Implementation Strategy Section incorporates recommendations documented in the Deadwood Creek segment 1 and Whitewood segment 3 *E. coli* TMDLs. Focusing reductions efforts on the upstream impaired segments is warranted to meet TMDL attainment goals for Whitewood Creek segment 4. The implementation strategies specific to Whitewood Creek segment 4 are considered secondary and focus on riparian health as a watershed scale practice to protect segment 4 and downstream segment 5. *E. coli* monitoring was added to the bulleted strategy list to include consideration for genetic source tracking to confirm specific sources associated with the border condition.

DANR Response to Section 7.2.6 Grazing Allotments
Page 37:

The original sentence in question on page 37 was corrected as per the recommendation.

DANR Response to Section 13.0 Implementation Strategy
Page 46 Paragraph 2:

The Black Hills National Forest was added to the list of entities which provide stewardship in the Deadwood/Whitewood Creek watershed.

DANR is appreciative of the comments provided by the Black Hills National Forest. The comments resulted in increased accuracy and beneficial additions. The department also looks forward to working with the Black Hills National Forest with regards to water quality assessment, improvement and protection. Please contact Paul Lorenzen with any questions you may have.

Paul Lorenzen
Environmental Scientist Manger I
Assessment Team Leader
Watershed Protection Program
(605) 773-4047
Paul.Lorenzen@state.sd.us

APPENDIX C:

EPA decision document and approval letter

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

August 1, 2022

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* Bacteria Total Maximum Daily Load (TMDL) for Whitewood Creek Segment 4, SD-BF-R-WHITEWOOD_04, Lawrence 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 July 27, 2022. 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 segment 4 of Whitewood 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 or king.amy@epa.gov.

Sincerely,

Judy Bloom, Manager
Clean Water Branch

Enclosure:
EPA Decision Rationale – Whitewood Creek Segment 4 *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* Bacteria Total Maximum Daily Load (TMDL) for Whitewood Creek Segment 4, SD-BF-R-WHITEWOOD_04, Lawrence County, South Dakota

ATTAINS TMDL ID: R8-SD-2022-05

LOCATION: Lawrence 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-BF-R-WHITEWOOD_04	Whitewood Creek segment 4 (Spruce Gulch to Sandy Creek)	*E. coli*

BACKGROUND: The South Dakota Department of Agriculture and Natural Resources (DANR) submitted to EPA the *E. coli* TMDL for segment 4 of Whitewood Creek with a letter requesting review and approval dated July 13, 2022. The TMDL report was subsequently withdrawn the following day before EPA began review. At the time of the initial submittal, DANR was unaware a comment letter was sent during the public notice period because its receipt at DANR had a minor delay. DANR responded to the comments, made associated edits to the TMDL report, and resubmitted for EPA review and approval on July 21, 2022. This July 21, 2022 version was also withdrawn to make a minor correction to state that a comment letter was received. DANR sent the final report with a letter requesting review and approval dated July 27, 2022. EPA previously reviewed and provided staff comments on draft versions but did not submit comments during the subsequent public comment period (June 1, 2022 to July 11, 2022).

The submittal included:

- Letter requesting EPA's review and approval of the TMDL
- Final TMDL report
- Public comments / responses to comments
- Data appendices

APPROVAL RECOMMENDATIONS: Based on the review presented below, the reviewer recommends approval of the final Whitewood Creek segment 4 *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 WHITEWOOD CREEK SEGMENT 4 *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 4 of Whitewood Creek, located in Lawrence County in western South Dakota, is the middle portion of Whitewood Creek, which is part of the larger Belle Fourche River Basin. Segment 4 extends from Spruce Gulch for approximately 5 miles to Sandy Creek and is identified as SD-BF-R-WHITEWOOD_04. The drainage area is a portion of HUC12 watershed 101202020207 (Figure 1) and has several small tributaries. Figure 2 displays the watershed with the impaired segment, the city of Deadwood, and the upstream segment. The TMDL figures accurately illustrate the impaired segment of Whitewood Creek from Spruce Gulch to Sandy Creek consistent with the segment description; however, the geospatial data associated with the 2022 Integrated Report have an upstream boundary that extends past Spruce Gulch to Spring Creek. EPA expects DANR will review South Dakota's geospatial files during the 2024 list cycle and make the necessary corrections to display segment 4 as beginning at the confluence with Spruce Creek.

Segment 4 was first identified as impaired by *E. coli* and placed on South Dakota's 303(d) list in 2012 and has remained as an impairment on subsequent list cycles. 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 2. No other known impairments exist for segment 4 of Whitewood Creek, but downstream segments 5 and 6 are listed as impaired for pH. Segment 3, which is immediately upstream, is placed in category 4a as it has an approved TMDL to address fecal coliform and *E. coli* impairments (ATTAINS Action ID #41058, #41059).

Section 2.0 (*Watershed Characteristics*) describes the watershed. Whitewood Creek segment 4 is a mountain stream with steep slopes in and near the Black Hills National Forest, ultimately draining to the Belle Fourche River, which empties into the Cheyenne River (Figures 2 and 5, Sections 2.0 and 2.4). Figure 5 illustrates and Table 4 quantifies the land use distribution draining into the impaired segment, which is predominantly evergreen forest (ponderosa pine; 78.9 percent) with herbaceous plants (14.0 percent) and shrub/scrub (3.2 percent) in the southeast portion of the headwaters. Urban development (2.68 percent) is largely at the upstream end of the segment (southwestern portion of the drainage) and includes the city of Deadwood.

Section 7.2 (*Non-point Sources*) characterizes the nonpoint sources as largely wildlife and human sources in the segment 4 drainage; however, DANR also notes that upstream loading from segment 3 contributes to the segment 4 impairment. DANR quantified *E. coli* production from these sources using population estimates, geographic information system (GIS) analysis, and the Bacterial Indicator Tool (EPA, 2000) populated with information from local municipalities, the South Dakota Department of Game, Fish, and Parks, and aerial imagery (Table 12). Wildlife (i.e., background such as deer, bobcats, and fox) was the dominant source of bacteria production (64.2 percent), followed by human sources (assuming a load on a per acre basis) and pets that account for 15.9 and 13.3 percent of production, respectively. Human and pet sources are primarily in the upper watershed area near the city of Deadwood. DANR also evaluated grazing allotments in the watershed and noted that slopes and terrain in the watershed are not conducive to agricultural pursuits. No grazing has been conducted on Forest Service land and no livestock were observed during 2014-2020 assessment efforts; therefore, livestock grazing was not considered a significant source of *E. coli*.

Section 7.1 (*Point Sources*) describes the twelve National Pollutant Discharge Elimination System (NPDES) permitted point sources discharging to the upstream drainage area. This comprehensive list provides a watershed-scale accounting of potential sources. DANR identified each upstream permittee by facility name, permit number, and description as well as including a wasteload allocation (WLA) decision rationale for each. None of these are located within the segment 4 drainage. Each permit is characterized as a source in the Whitewood Creek segment 3 TMDL or as a potential source if a TMDL is needed to address any future upstream *E. coli* impairments. DANR describes that there are no direct NPDES dischargers to the Whitewood Creek segment 4 watershed, including concentrated animal feeding operations (CAFOs); therefore, there are no WLAs in this TMDL.

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 (*Water Quality Standards*) describes the water quality standards applicable to the impaired segment with citations to relevant South Dakota regulations. SD-BF-R-WHITEWOOD_04 is designated the following beneficial uses:

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

Numeric criteria applicable to these uses are presented in Table 7. DANR determined that *E. coli* is preventing the river's immersion recreation use from being fully supported. Numeric *E. coli* criteria established to protect this recreation use are comprised of a 30-day geometric mean criterion (≤ 126 colony forming units per 100 milliliters [CFU/100mL]) and a single sample maximum criterion (≤ 235 CFU/100mL) (Table 7 and *Numeric Criteria* [Section 3.3]). These criteria are seasonally applicable from May 1 to September 30. DANR determined that these criteria are protective of downstream waterbodies that also have immersion recreation uses.

The numeric *E. coli* criteria for immersion recreation waters are applied directly as water quality targets for this TMDL (Section 4.0 [*TMDL Targets*]). DANR expects that meeting the numeric *E. coli* criteria will lead to conditions necessary to support all relevant narrative criteria. A Whitewood Creek watershed assessment project was performed, which provided an opportunity to calculate six separate monthly geometric means. The data from this study indicate exceedances of the geometric mean criterion (50 percent exceedance rate) have occurred. Exceedances of the single sample maximum criterion was observed in both this study and the longer-term sampling data (30 percent exceedance rate). The TMDL numeric target applicable to the impaired segment is based on the immersion recreation single sample maximum criterion (235 CFU/100mL) as long-term monitoring is expected to include monthly or bi-monthly sample frequencies, which is not of sufficient frequency to assess compliance with the geometric mean criterion. DANR demonstrates in Section 4.0 (*Numeric Targets*) that attaining the single sample maximum target will also achieve the geometric mean criterion.

The TMDLs are consistent with South Dakota antidegradation policies because they provide recommendations and establish pollutant limits at water quality levels necessary to meet criteria and fully support existing beneficial uses, including downstream 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 Whitewood Creek segment 4. 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 is 10 percent of the total loading capacity), 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, and TMDL based on the curve, is shown visually in Figure 18 with instantaneous loads calculated from the monitoring dataset. The monitoring data used to develop the curve and calculate existing loads are summarized in Section 6.0 (*Data Collection and Results*) and provided fully in Appendix A. This figure also illustrates the 95^{th} percentile existing and allowable loads. Table 14 summarizes the 95^{th} percentile existing loads and loading capacity by flow regime for Whitewood Creek segment 4. 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 7.0 (*Significant Sources*) and Section 6.0 (*Data Collection and Results*). Loading sources were characterized using multiple approaches. No NPDES permitted facilities were identified as sources to segment 4 (Section 7.1 [*Point Sources*] and Section 8.2.1 [*Waste Load Allocations (WLA)*]). DANR estimated relative nonpoint source contributions, including wildlife (natural background), human sources, and pets, using bacteria production rates from the Bacterial Indicator Tool (EPA, 2000; Table 12). Wildlife was identified as the main source of bacteria loading in the watershed (Section 7.2 [*Non-Point Sources*]).

While the loading capacity is defined for multiple stream flow conditions, DANR described the critical conditions when bacteria loading to segment 4 of Whitewood Creek are greatest as periods of high to mid-range flows (Section 10.0 [*Critical Conditions*]). These flow conditions are typically associated with snowmelt and heavy precipitation in the spring and early summer when bacteria is more likely to be transported from multiple nonpoint sources, including upstream sources associated with Whitewood Creek segment 3.

Assessment: EPA concludes that the loading capacity was calculated using an acceptable approach, used 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 limits. 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 8.2.3 (*Load Allocation*), DANR established a single LA as the allowable load remaining after accounting for the WLA (equal to zero) and explicit MOS (i.e., LA = TMDL – MOS – WLA or in this case LA = TMDL – MOS). Table 14 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 human and wildlife, were characterized in greater depth in Section 7.2 (*Non-Point Sources*) and Table 12. DANR estimated that wildlife was the largest local source of bacteria (i.e., natural background) and noted that the segment 4 impairment is the result of a border condition associated with *E. coli* exceedances in segment 3, which is immediately upstream, and achieving the upstream immersion recreation use is needed for full attainment in segment 4.

Assessment: EPA concludes that the LAs provided in the TMDL 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 to Whitewood Creek segment 4; therefore, there are no point source contributors of *E. coli*. The rationale for this decision is outlined in Section 7.1 (*Point Sources*) and Section 8.2.1 (*Waste Load Allocation [WLA]*).

Assessment: EPA concludes that the TMDL considered all point sources contributing loads to the impaired segment, 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 Whitewood Creek segment 4 includes an explicit MOS derived as 10 percent of the loading capacity (Section 8.2.2 [*Margin of Safety (MOS)* – E. coli *Bacteria*]). The explicit MOS is included as a separate allocation in Table 14 and varies by flow regime.

Assessment: EPA concludes that the TMDL incorporates an adequate 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 9.0 (*Seasonal Variation*). 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 at different flow zones as listed in Table 14. In addition to these flow and water quality patterns, the immersion recreation water quality criteria have a seasonal component since they apply during the recreation season (May through September).

DANR noted that bacteria concentrations exceed the TMDL targets during the higher flow regimes, suggesting that bacteria contamination is more likely to occur when flow is higher and readily transported from nonpoint sources and upstream. High flow conditions can occur throughout the recreation season, so DANR evaluated the samples along the load duration curve by spring, summer, and fall. The greatest *E. coli* loads are observed during higher flow (spring snowmelt or intense rainfall events) in the summer months (Figure 19). 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 and the monitoring commitment that will be used to gage TMDL effectiveness in the future (Section 11.0, *Monitoring Strategy*). These assurances also include the recommendation of specific activities and geographic areas to focus implementation, which are discussed in Section 13.0 (*Implementation Strategy*).

Assessment: EPA considered the reasonable assurances contained in the TMDL submittal and concludes that they are adequate to meet the load reductions.

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 11.0 (*Monitoring Strategy*) DANR presents recommendations for future water quality monitoring efforts, including effectiveness assessment, beneficial use support, and adaptive management. DANR commits to ongoing monthly *E. coli* sampling at WQM 85, assessing the segment every two years in a 10-year rotation cycle as part of DANR's Rotating Basin Project, and continued stream gage monitoring at WWCBact04. 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 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 13.0 (*Implementation Strategy*), DANR describes a range of implementation considerations for Whitewood Creek segment 4. Upstream conditions influence the impairment in segment 4; therefore, DANR presents a suite of implementation options associated with the upstream *E. coli* impairments and/or TMDL goals. Watershed-scale nonpoint source best management practices (BMPs) are recommended in Deadwood Creek segment 1, Whitewood Creek segment 3, and Whitewood Creek segment 4. Recommended BMPs for segment 4 include riparian buffers along the impaired segment and tributaries and reduced stream access for domestic animals. DANR also identifies potential project partners and funding opportunities to support BMP implementation in the Deadwood and Whitewood creeks watersheds.

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 12.0) explains the public engagement process DANR followed during development of the TMDL. A draft TMDL report was released for public comment from June 1, 2022 to

July 11, 2022. The opportunity for public review and comment was posted on DANR's website and announced in several area newspapers: the Black Hills Pioneer and Rapid City Journal. The United States Department of Agriculture Forest Service Black Hills National Forest submitted a comment letter dated July 8, 2022. DANR documented and responded to these comments in Appendix B and made the associated edits to the TMDL report.

Assessment: EPA has reviewed DANR's public participation process and 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.

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 July 27, 2022 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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