ESCHERICHIA COLI BACTERIA TOTAL MAXIMUM DAILY LOAD (TMDL) FOR THE BELLE FOURCHE RIVER, SEGMENT 1, BUTTE COUNTY, SOUTH DAKOTA

South Dakota Department of
Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

South Dakota Department of
Environment and Natural Resources
Water Resources Assistance Program

July, 2017

Total Maximum Daily Load Summary

Waterbody Type:	Stream
303(d) Listing Parameter:	*Escherichia coli* (*E. coli*) bacteria
Designated Uses:	Warmwater permanent fish life propagation waters, immersion recreation waters, fish and wildlife propagation, recreation, and stock watering, and irrigation water
Size of Impaired Waterbody:	Approximately 64.2 km in length
Size of Watershed:	55,926 acres
Indicator(s):	Concentrations of *E. coli* bacteria
Analytical Approach:	Load Duration Curve
Location:	Hydrologic Unit Codes (12-digit HUC): 101202020109
Goal:	Meet applicable water quality standards for *E. coli* bacteria
Target (Water Quality Standards):	Maximum daily concentration of ≤ 235 cfu/100mL and a geometric mean of 5 samples over a 30 day period ≤ 126 cfu/100mL. These criteria apply from May 1st through September 30th.
Reach Number:	SD-BF-R-BELLE_FOURCHE_01
Load Allocations based on Geometric Mean:	
High Flow Zone WLA (cfu/day):	0
High Flow Zone LA (cfu/day):	3.34E+12
High Flow Zone MOS (cfu/day):	4.87E+11
High Flow Zone TMDL (cfu/day):	3.83E+12

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1.0 Introduction

The intent of this document is to clearly identify the components of the Total Maximum Daily Load, support adequate public participation, and facilitate the United States 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 address *Escherichia coli* bacteria impairment of the Belle Fourche River from the Wyoming/South Dakota border to the Redwater River confluence (SD-BF-R-BELLE_FOURCHE_01), which was assigned priority category 5 (high-priority) in the 2010, 2012, 2014, and 2016 South Dakota Integrated Report for Surface Water Quality Assessments.

1.1 Watershed Characteristics

The Belle Fourche River is a natural stream that originates in Wyoming and drains portions of Butte, Lawrence, and Mead Counties in South Dakota. The Belle Fourche River flows into the Cheyenne River within Mead County and ultimately drains into the Oahe Dam portion of the Missouri River (Figure 1). Within Wyoming the Belle Fourche River drains portions of Crook, Weston, and Campbell Counties. The Belle Fourche River also drains a small portion of Carter County within Montana.

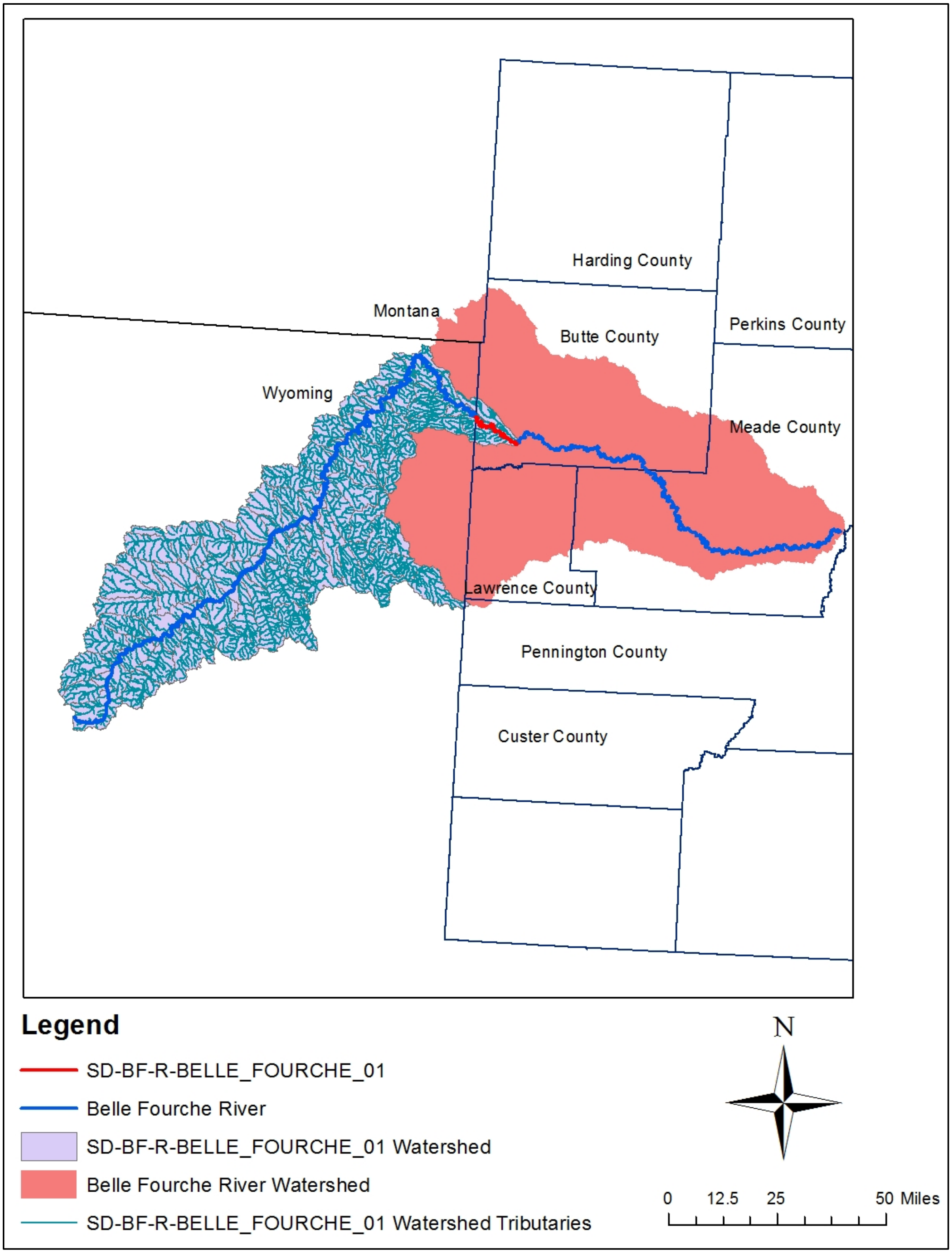

Figure 1. Impaired reach of the Belle Fourche River watershed in South Dakota and Wyoming.

The Belle Fourche River watershed is approximately 2,100,000 acres (3,300 sq. miles) in size in South Dakota and approximately 2,400,000 acres (3,700 sq. miles) in Wyoming. The majority of the Segment 1 watershed is comprised of range land (Table 1) with cropland making up the next largest land use.

Table 1. Land use characteristics (South Dakota GIS datahound land use boundary layer) for the Belle Fourche Segment 1 watershed.

	Percent	Area (acres)
Range	90.7	50725
Cropland	6.5	3635
Urban	1.2	671
Forest	0.9	503
Barren	0.7	392

The South Dakota portion of the Belle Fourche watershed, shown in Figure 2, is comprised of seven level IV ecoregions. Ecoregion designations include: Black Hills Foothills, Black Hills Plateau, Black Hills Core Highlands, River Breaks, Semiarid Pierre Shale Plains, Dense Clay Prairie, and Missouri Plateau (Figure 2).

Two level IV ecoregions (Semiarid Pierre Shale Plains and Black Hills Foothills) directly influence the impaired reach of the Belle Fourche River (Figure 3).

The Black Hills Foothills are un-glaciated features which comprise a ring of hills surrounding the Black Hills mountainous core. The Dakota Hogback separates the foothills from the plains and the Red Valley is inside the Hogback and encircles the Black Hills Dome. The geology is Mesozoic sandstone and shale. The Hogback is composed of Lakota Sandstone, Fall River Sandstone, Fuson Shale and Minnewasta Limestone. The Red Valley is composed of the Spearfish Formation and red sandy shale. The soil types are Butche, Canyon, Enning, Nevee, Spearfish, Grummit, Tilford, Vale and Rekop. The mean annual precipitation in this area is 15-17 inches, supporting a vegetation cover of ponderosa pine woodlands with a grass under story of little bluestem, grama grasses, and leadplant. Land use includes cattle grazing and ranching with low density suburban development.

The Semiarid Pierre Shale Plains are undulating to rolling plains and is the dominant ecoregion within the watershed, representing 40% of the area. Steep-sided, incised stream channels dominate this ecoregion. The geology is predominately Cretaceous Pierre Shale. The soils include Pierre, Samsil, Lismas, Satanta and Nunn. The mean annual precipitation is 14 inches. Vegetation includes short grass prairie grasses such as western wheat grass, green needle grass, blue grama and buffalo grass. Land use is predominantly cattle grazing, rangeland and dry land farming.

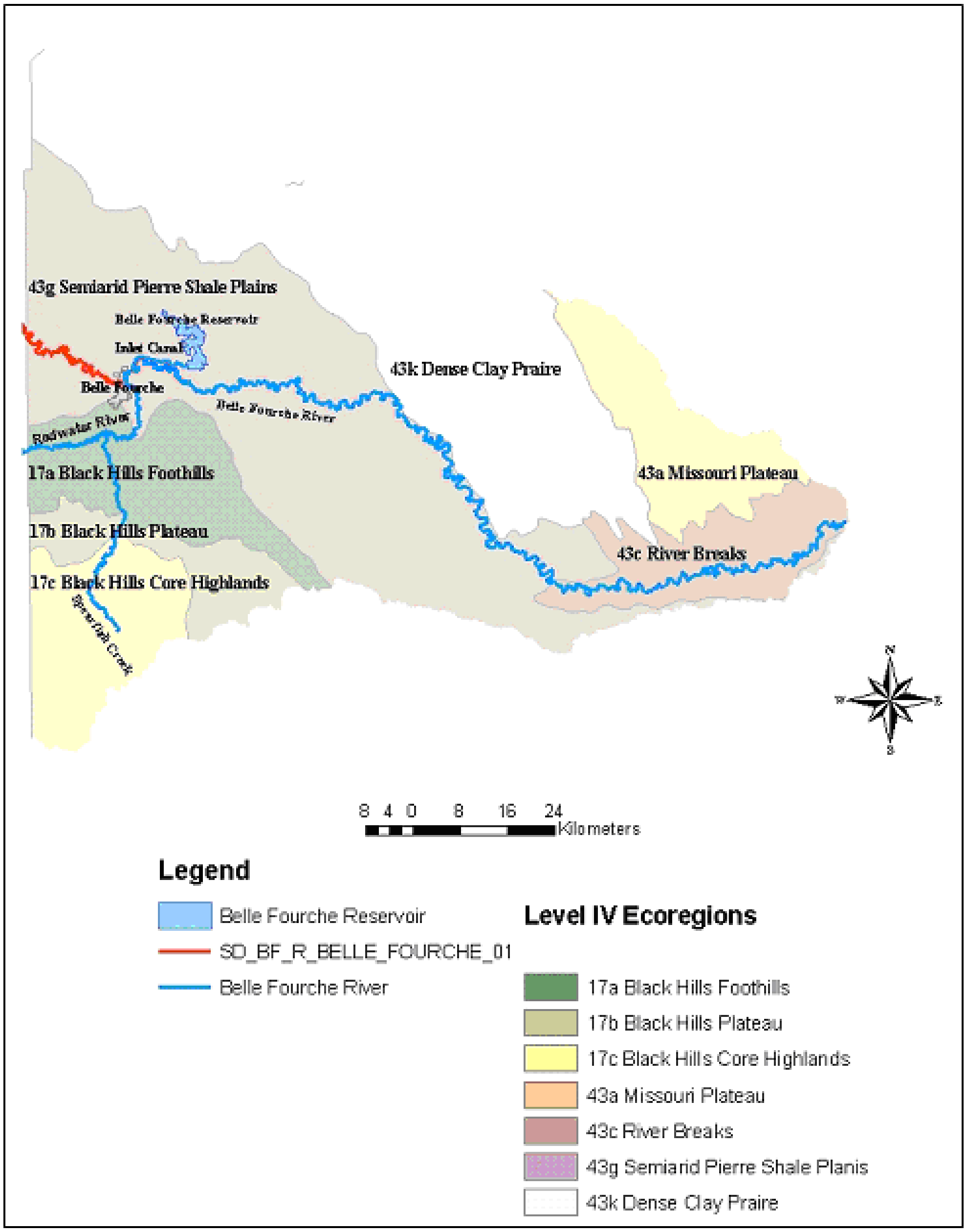

Figure 2. Belle Fourche River watershed in South Dakota including Level IV ecoregions.

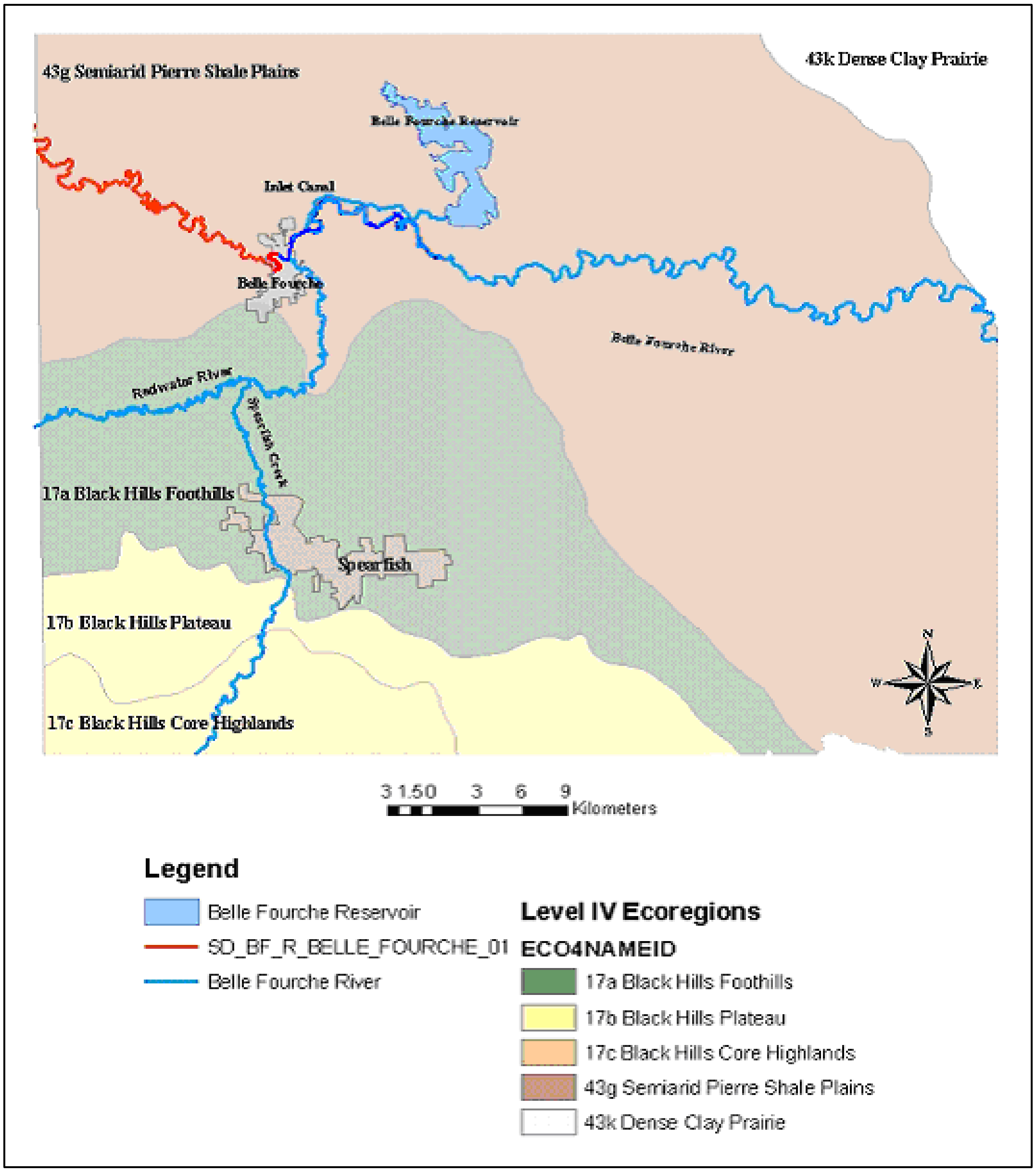

Figure 3. Level IV ecoregions influencing the *E. coli* impaired reach of the Belle Fourche watershed in South Dakota.

1.2 Problem Identification

Belle Fourche River Segment 1 was first listed for pathogens (fecal coliform bacteria) in the 2002 South Dakota Report to Congress 305(b) Water Quality Assessment (SD DENR, 2002) and continued to be listed for fecal coliform in successive Integrated Report (combined 305(b) and 303(d) reports) listing cycles (SD DENR 2004, 2006, 2008, and 2010). In 2001 through 2002, a watershed assessment and TMDL study of the Belle Fourche River in South Dakota was completed to evaluate existing and potential pollution problems and develop a TMDL for Total Suspended Solids (TSS) (SD DENR, 2005). During the assessment exceedances in the fecal coliform criteria were observed along the Belle Fourche River from the Wyoming border (monitoring sites BF01) to the assessment monitoring site (monitoring site BF02) just above the confluence with the Redwater River (Figure 3) (SD DENR 2011). In 2012 the segment was listed for *Escherichia coli* bacteria in the South Dakota Integrated Report to Congress 305(b) Water Quality Assessment (SD DENR, 2012). The Belle Fourche River in South Dakota has a US EPA approved TMDL for TSS (SD DENR, 2005) and fecal coliform (SD DENR, 2011).

Since 1999, the South Dakota Department of Environment and Natural Resources (SD DENR) have collected fecal coliform bacteria samples at WQM 460130 (Figure 4) in Belle Fourche. Since 2009 *E. coli* bacteria samples have been collected at WQM 460130 and paired fecal coliform and *E. coli* samples were used to model *E. coli* concentrations on unpaired fecal coliform data. Fecal coliform samples were collected at BF01 during the Belle Fourche River Watershed Assessment (Figure 4). SiteBF02 sampling occurred in the same location as WQM 460130. Stream discharge is measured by USGS site 06428500, which is co-located with BF02 and WQM 460130.

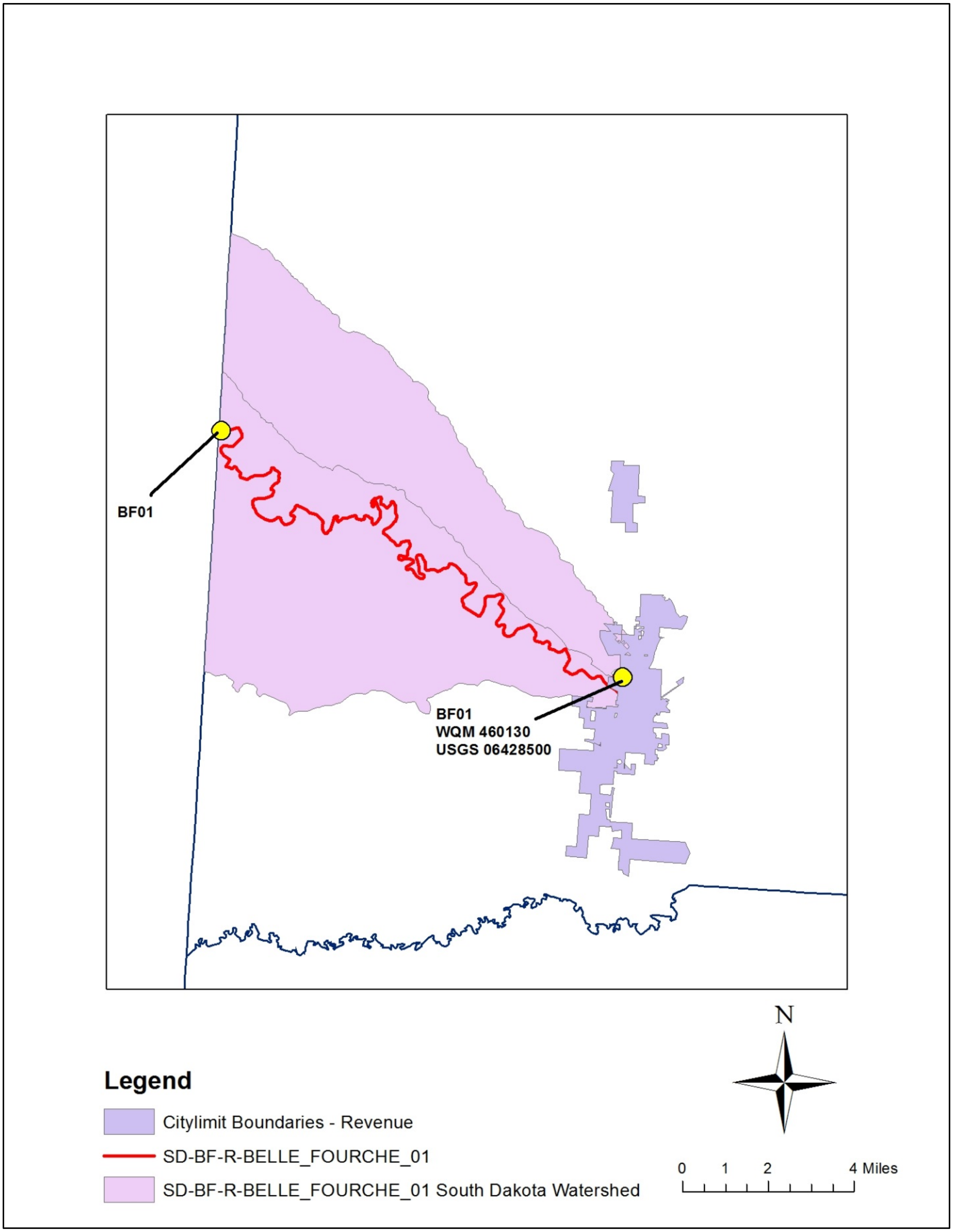

Figure 4. Locations of sampling sites within Segment 1 of the Belle Fourche Watershed.

1.3 Description of Applicable Water Quality Standards & Numeric Water Quality Targets

Each waterbody within South Dakota is assigned beneficial uses. All waters (both lakes and streams) are designated with the use of fish and wildlife propagation, recreation, and stock watering, while all streams and select lakes (to include Belle Fourche Reservoir) are assigned the use of irrigation. Additional uses are assigned by the state based on a beneficial use analysis of each waterbody. Water quality standards have been defined in South Dakota state statutes in support of these uses. These standards consist of suites of criteria that provide physical and chemical benchmarks from which management decisions can be developed.

Belle Fourche River has been assigned the following beneficial uses: warmwater permanent fish life propagation, immersion recreation, limited contact recreation, fish and wildlife propagation, recreation and stock watering, and irrigation. Table 2 lists the criteria that must be met to support the specified beneficial uses. When multiple criteria exist for a particular parameter, the most stringent criterion is used.

Individual parameters, determine the support of these beneficial uses. South Dakota has narrative standards that may be applied to the undesired eutrophication of lakes and streams. Administrative Rules of South Dakota (ARSD) Article 74:51 contains language that prohibits the presence of materials causing pollutants to form, visible pollutants, taste and odor producing materials, and nuisance aquatic life.

The numeric TMDL target established for SD-BF-R-BELLE_FOURCHE_01 reach of the Belle Fourche River is based on a 30-day geometric mean. Water quality criteria for the immersion recreation beneficial use requires that 1) no sample exceeds 235 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 126 cfu/100 mL. The acute standard is represented by the above mentioned 235 cfu/100 ml statement; the chronic standard is represented by the geometric mean figure of 126 cfu/100 ml. This criterion is applicable from May 1 through September 30 (SD DENR, 2002, ARSD § 74:51:01:50).

Of 65 recent *E. coli* samples that have been collected from Segment 1 of the Belle Fourche River, 20 percent exceeded the acute Immersion Recreation *E. coli* water quality standard from 2007 to the present.

The more stringent geometric mean criterion (126 cfu/100ml) was used, rather than the daily maximum criterion (235 cfu/100ml), because observed *E. coli* loads exceed the geometric mean criterion by flow zone. The geometric mean, as defined in ARSD § 74:51:01:01, is the n^{th} root of a product of n factors. The geometric mean *E. coli* criteria (ARSD § 74:51:01:50) applies only under special conditions, where a minimum of five samples are obtained during separate 24-hour periods for any 30-day period. Since only one or two samples were collected during any 30-day period, geometric means could not be calculated as defined by ARSD. However, a geometric mean concentration was calculated using all the samples within each flow zone to assess whether or not the geometric mean criterion would be exceeded within a flow zone if a sufficient number of samples are taken

This document will use the immersion recreation beneficial use chronic threshold value for *E. coli* of 126 cfu/100 ml as a water quality goal. By using the chronic threshold of immersion recreation there is increased confidence that acute and chronic water quality criteria for immersion recreation and limited contact recreation will be achieved.

Table 2. State surface water quality standards for the Belle Fourche River, Butte County, South Dakota.

Parameter	Criteria	Unit of Measure	Special Conditions
Total ammonia nitrogen as N (Warmwater Permanent Fish Life Propagation)	Equal to or less than the result from Equation 3 in Appendix A of ARSD 74:51:01	mg/L	30-day average March 1 - October 31
	Equal to or less than the result from Equation 4 in Appendix A of ARSD 74:51:01	mg/L	30 day average November 1 - February 29
	Equal to or less than the result from Equation 2 in Appendix A of ARSD 74:51:01	mg/L	daily maximum
[1]**Fecal coliform** (May 1 – September 30) (Immersion Recreation)	[1]≤ 400 [2]≤ 200	cfu/100 mL	geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period
[2]***Escherichia coli*** (May 1 – September 30) (Immersion Recreation)	[1]≤ 235 [2]≤ 126	cfu/100 ml	
Dissolved oxygen (Warmwater Permanent Fish Life Propagation, Immersion Recreation)	≥ 5.0	mg/L	
Undisassociated hydrogen sulfide (Warmwater Permanent Fish Life Propagation)	≤ 0.002	mg/L	
pH (Warmwater Permanent Fish Life Propagation)	≥ 6.5 - ≤ 9.0	units	see § 74:51:01:07
Total Suspended Solids (Warmwater Permanent Fish Life Propagation)	≤ 90	mg/L	30-day average
	≤ 158	mg/L	daily maximum
Total alkalinity as calcium carbonate (Fish, Wildlife, Propagation, Recreation and Stock Watering)	≤ 750	mg/L	30-day average
	≤ 1313	mg/L	daily maximum
Total dissolved solids (Fish, Wildlife, Propagation, Recreation and Stock Watering)	≤ 2,500	mg/L	30-day average
	≤ 4,375	mg/L	daily maximum
Conductivity at 25°C (Irrigation)	≤ 2,500	micromhos/cm	30-day average
	≤ 4,375	micromhos/cm	daily maximum
Nitrates as N (Fish, Wildlife, Propagation, Recreation and Stock Watering)	≤ 50	mg/L	30-day average
	≤ 88	mg/L	daily maximum
Total petroleum hydrocarbon (Fish, Wildlife, Propagation, Recreation and Stock Watering)	≤ 10	mg/L	see § 74:51:01:10
Oil and grease (Fish, Wildlife, Propagation, Recreation and Stock Watering)	≤ 10	mg/L	see § 74:51:01:10
Sodium Adsorption Ratio (Irrigation)	≤ 10		see § 74:51:01:01 (41)
Temperature (Warmwater Permanent Fish Life)	≤ 80	°F	see § 74:51:01:31

2.0 Pollutant Assessment

2.1 Boundary Conditions

BF01 is located along the Belle Fourche at the Wyoming/South Dakota border. Conditions at this site reflect land use within Wyoming and serve as a boundary condition for Segment 1 of the Belle Fourche River. Reductions needed to meet water quality standards were calculated by subtracting the current loading per flow zone (95th percentile of sample loads) from the total maximum daily load (95th percentile of chronic standard loading) and dividing this figure by the current loading, equation is as follows; reduction = (current loading – total maximum daily load)/current loading. The highest load reductions needed to meet water quality criteria occur in the top 60% of the flow regime (Figure 5). Reductions to meet the chronic threshold in the high flow, moist condition, and midrange flow were both 95, 95, and 96%, respectfully (Table 3). No reduction of *E. coli* loading is needed to meet the chronic threshold in the dry conditions and low flow zones. In Wyoming, the Belle Fourche River Segment WYBF101202010904_00 is listed for bacteria impairments as of the 2014 Wyoming Integrated Report.

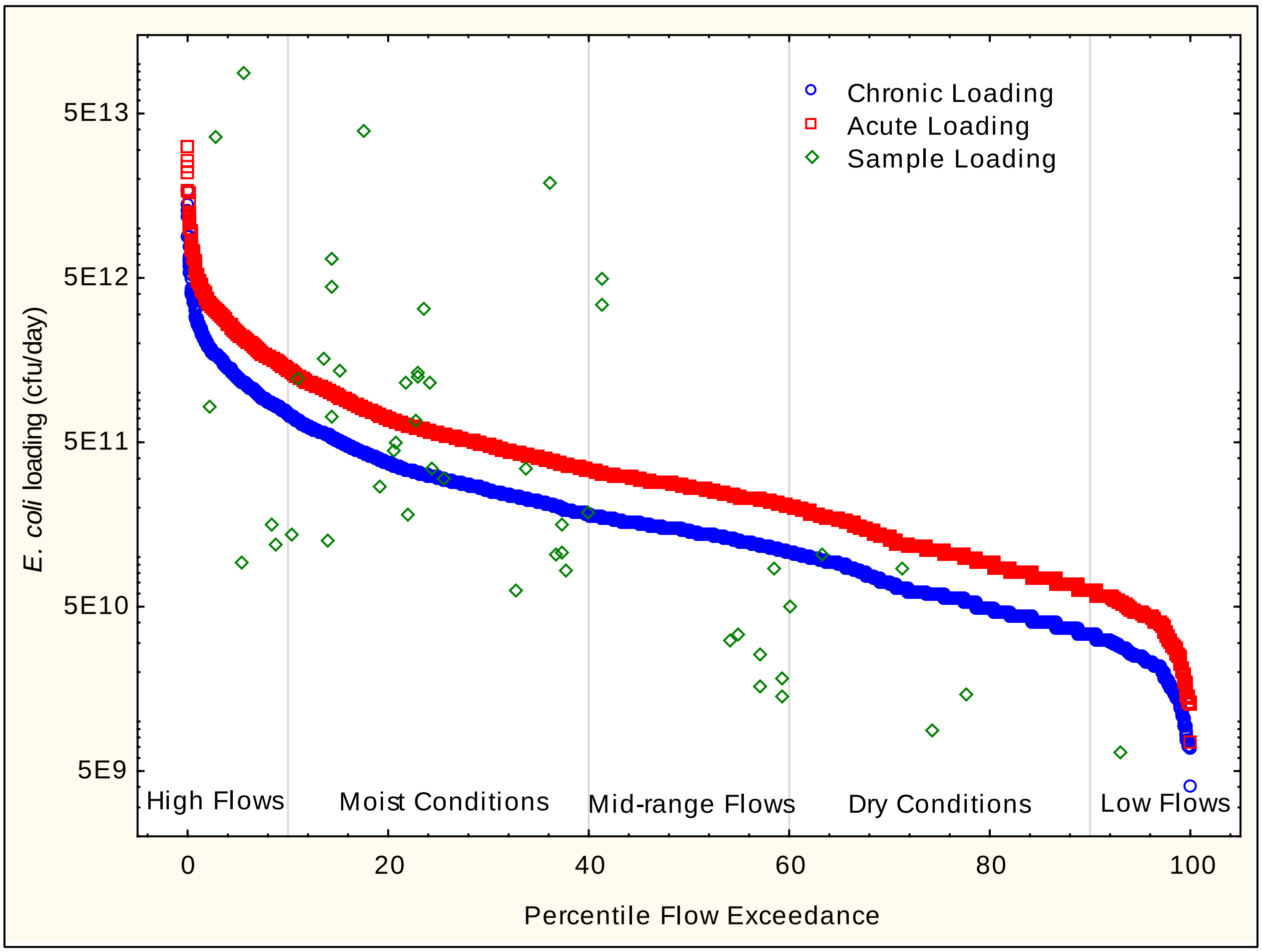

Figure 5. Boundary conditions for the Belle Fourche River Segment 1.

Table 3. Boundary *E. coli* conditions at the Wyoming/South Dakota border.

Flow Zone	High Flows	Moist Conditions	Mid-range Flows	Dry Conditions	Low Flows
CFS	≥242	59 - 242	35 - 59	11 - 35	0 - 11
TMDL (cfu/day)	3.83E+12	6.44E+11	1.76E+11	1.02E+11	3.39E+10
MOS (cfu/day)	4.87E+11	1.20E+11	3.70E+10	2.47E+10	2.07E+10
LA (cfu/day)	3.34E+12	5.24E+11	1.39E+11	7.71E+10	1.33E+10
Load Reduction (%)	95	95	96	1	0

2.2 Point Sources

Segment 1 of the Belle Fourche River does not have any permitted point discharges. The Belle Fourche Cattle Auction, located west of the City of Belle Fourche, has coverage under South Dakota's general concentrated animal feeding operation (CAFO) general permit. Normally these facilities will not discharge as the waste holding ponds are designed to contain the annual expected runoff plus a 25 year, 24-hour storm. The Belle Fourche Cattle Auction is not assigned a waste load allocation for the purposes of this document. A waste load allocation of 0 *E. coli* cfu/100 ml has been assigned to Segment 1 of the Belle Fourche River.

2.3 Nonpoint Sources

Based on review of available land use information and communication with local land owners and representatives from Belle Fourche, the primary nonpoint sources of *E. coli* within the impaired reach of the Belle Fourche River is agricultural. Urban runoff, as well as wildlife and human sources may also be present. Using the best available information, loadings were estimated from each of these sources based on the number of units (e.g. numbers of animals, failing septic systems, etc.) representative of each source (Table 4). Livestock numbers were derived from the National Agricultural Statistics Service (NASS) (2009) and Huxoll (2002). The numbers of animals were estimated by county from these sources and a density estimate was obtained.

Table 4. Belle Fourche River Segment 1 potential nonpoint sources of fecal coliform, fecal coliform served as an estimation for *E. coli* potential loading.

Species	#/sq mile	#/acre	FC/Animal/Day	Fecal Coliform/Acre/Day	Percent
Dairy Cow	0.51	< 0.01	1.01E+11	7.97E+07	1.59%
Cattle on Range	27.73	0.04	1.04E+11	4.51E+09	89.80%
Cattle on Feed	0.20	< 0.01	1.04E+11	3.31E+07	0.66%
Bison[6]	0.02	< 0.01	1.04E+11	2.89E+06	0.06%
Hog	0.23	< 0.01	1.08E+10	3.81E+06	0.08%
Sheep	18.72	0.03	1.20E+10	3.51E+08	6.99%
Horse	1.07	< 0.01	4.20E+08	7.00E+05	0.01%
Human	4.04	0.01	2.00E+09	1.26E+07	0.25%
All Wildlife	Sum of all Wildlife			2.82E+07	0.56%
Deer[3]	3.78	0.01	5.00E+08	2.95E+06	
Elk[6]	0.07	< 0.01	1.04E+11	1.08E+07	
Antelope[3]	3.65	0.01	5.00E+08	2.85E+06	
Turkey[1]	1.56	< 0.01	9.30E+07	2.26E+05	
Mink[5]	0.44	< 0.01	1.25E+08	8.69E+04	
Beaver[3]	0.89	< 0.01	2.50E+08	3.48E+05	
Muskrat[1]	0.78	< 0.01	1.25E+08	1.52E+05	
Skunk[5]	1.33	< 0.01	1.25E+08	2.61E+05	
Badger[5]	0.44	< 0.01	1.25E+08	8.69E+04	
Coyote[4]	0.06	< 0.01	4.09E+09	3.55E+05	
Fox[4]	0.18	< 0.01	4.09E+09	1.14E+06	
Raccoon[3]	2.00	< 0.01	1.25E+08	3.91E+05	
Bobcat[4]	0.11	< 0.01	4.09E+09	7.11E+05	
Jackrabbit[5]	8.89	0.01	1.25E+08	1.74E+06	
Mountain Lion[4]	< 0.01	< 0.01	4.09E+09	8.50E+03	
Cottontail Rabbit[5]	1.33	< 0.01	1.25E+08	2.61E+05	
Squirrel[5]	0.44	< 0.01	1.25E+08	8.69E+04	
Grouse[2]	1.76	< 0.01	1.36E+08	3.73E+05	
Partridge[2]	1.11	< 0.01	1.36E+08	2.36E+05	
Canada Goose[1]	0.07	< 0.01	4.90E+10	5.10E+06	
1 USEPA 2001					
2 FC/Animal/Day copied from chicken (USEPA 2001) to provide an estimate of background affects of wildlife					
3 Bacteria Indicator Tool worksheet					
4 Best professional judgment based off of dogs					
5 FC/Animal/Day copied from raccoon to provide a more conservative estimate of background effects of wildlife					
6 Best professional judgment based off of cattle					

2.4 Urban

Approximately 1.2 percent of the impaired study area is characterized as impervious area (urban). Most of the impervious area is located in the City of Belle Fourche; however, rural ranch areas located along the Belle Fourche River upstream of the City of Belle Fourche may also contribute to *E. coli* runoff to the Belle Fourche River during storm events.

2.5 Agriculture

Manure from livestock is a potential source of *E. coli* to the stream. Livestock in the basin are mainly beef cattle with sheep being the next abundant animals in the study area. Other livestock in the basin include dairy cattle, hogs, horses and chickens. Numbers of animals on private land were estimated through the NASS 2009 agricultural statistics in the watershed. The majority of the potential *E. coli* sources for livestock came from livestock on grass (sum of cattle on range, bison, sheep, and horse) and not from confined animal feeding operations (sum of cattle on feed, dairy cattle, and hogs), which were deemed insignificant (only 2.33%) (Table 5).

Table 5. *E. coli* source allocations to Belle Fourche River Segment 1, estimations are based on data presented in Table 4.

Source	Percentage
Livestock on Grass	96.86%
Feedlots	2.33%
Wildlife	0.56%
Human	0.25%

2.6 Human

The impaired HUC drainage contains an estimated 44 septic systems that are mostly located near tributaries to the Belle Fourche River (SD DENR, unpublished data). Septic systems located near drainages in the study area provide potential sources of human *E. coli* to the impaired segment of the Belle Fourche River. Limited information is available on the age and condition of these systems, a value of 0.25% of human fecal coliform contribution relative to total fecal coliform contribution was calculated dividing the total potential human fecal contribution per day by the total potential fecal contribution of warm blooded organisms. This is likely greater than a realistic human fecal load due to the majority of humans within the watershed residing in the City of Belle Fourche and their potential loadings would be addressed by the municipal sewage treatment system.

2.7 Natural background/wildlife

Wildlife within the watershed is a natural source of *E. coli* bacteria in the study area. County wildlife assessments provided the best available estimate of wildlife population densities. The wildlife assessment for Butte County was obtained from the South Dakota Department of Game, Fish and Parks. SD GF&P population estimates included counts of whitetail deer, mule deer, elk, antelope and turkey (Huxoll, 2002). Fecal coliform production rates were used as a surrogate for *E. coli* as there is a lack of published data for animal *E. coli* production rates and both serve as measures of fecal matter levels in water quality samples.

2.8 Bacterial Source Tracking

Samples were collected on three different dates for bacteria source tracking: August 23, 2004; May 9, 2005; and July 5, 2005. These samples were not subject to runoff from storm events. Samples were collected at WQM 460130, upstream, and downstream of the city of Belle Fourche. Three different methods were used for bacteria source tracking for this project. On August 23, 2004, an *E. coli* ID™ test was run on samples from all three locations. On May 9, 2005, a Human *Bacteroidetes* ID™ test was run on samples from all three locations. On July 5, 2005, a Human *Bacteroidetes* ID™ test and a Cow *E. coli* ID™ test was performed on samples collected from upstream and downstream of the city of Belle Fourche. No bacteria source tracking test was run on the sample collected at WQM 130 on July 5, 2005, since an additional test was run on samples from the other two sample locations. All bacteria source tracking samples were analyzed by Source Molecular located in Miami, Florida. Energy labs analyzed samples for bacteria counts (Table 6). Due to cost a limited number of bacterial source tracking samples were collected.

An *E. coli* ID™ test, often referred to as a ribotyping test, uses a genetic fingerprint that comes from genes that code for ribosomal ribonucleic acids of *E. coli* to identify the source as either human or animal. This test does not distinguish cattle from other animal sources. A Human *Bacteroidetes* ID™ test uses organisms from the phylum *Bacteroidetes* as indicator species, instead of *E. coli* to identify sources of bacteria. *Bacteroidetes* are anaerobes and are, therefore, indicative of recent fecal contamination. The Human *Bacteroidetes* ID™ test filters and identifies the bacteria from an entire sample versus identifying a sub-sample that is cultured on a Petri dish. Specifically, the Human *Bacteroidetes* ID™ test identifies contamination from human sources only. Similar to the *E. coli* ID™ test, the Cow *E. coli* ID test uses *E. coli* as indicator species. The Cow *E. coli* ID test specifically identifies certain strains of *E. coli* that are specifically pathogenic in cattle to identify fecal contamination from cattle.

Source tracking samples from August 23, 2004, from all three sample locations indicated no contamination from human sources. Two isolates, one from upstream and one from downstream of the city of Belle Fourche, were found to be indeterminate (bactia source tracking could not identify source of DNA). All other samples were identified as being from animal sources. Similar to the August 2004 samples, the source tracking samples from May 9, 2005, showed no human sources of contamination. The Cow *E. coli* ID test was added for the final source tracking sampling on July 5, 2005, in order to identify the loading originating from cattle. The samples from the final source tracking sampling indicated no contamination from cattle or human sources.

Table 6. Results of bacteria source tracking analysis; samples collected on 8/23/2004 were collected in the low flow zone, samples collected on 5/9/2005 were collected in the dry conditions flow zone, and samples collected on 7/5/2005 were collected in the mid-range flow zone.

Bacterial Source Tracking	Location	Energy Lab Fecal Coliform (Colony Forming Units/100 ml)	Fecal Coliform (most probable number/100ml)	Type of Test	Probable Source
08/23/2004	WQM 460130	2,800	1,100	*E. coli* ID™	5 isolates animal
08/23/2004	Upstream Belle Fourche	–	93	*E. coli* ID™	4 isolates animal and 1 isolate indeterminate
08/23/2004	Downstream Belle Fourche	–	1,100	*E. coli* ID™	4 isolates animal and 1 isolate indeterminate
05/09/2005	WQM 460130	46	–	Human *Bacteroidetes* ID™	No Human Gene Biomarker Detected
05/09/2005	Upstream Belle Fourche	–	–	Human *Bacteroidetes* ID™	No Human Gene Biomarker Detected
05/09/2005	Downstream Belle Fourche	–	–	Human *Bacteroidetes* ID™	No Human Gene Biomarker Detected
07/05/2005	WQM 460130	460	–	–	–
07/05/2005	Upstream Belle Fourche	–	455 (*E.coli*)	Cow *E. coli* ID	No Cattle Gene Biomarker Detected
07/5/2005	Downstream Belle Fourche	–	293 (*E.coli*)	Cow *E. coli* ID	No Cattle Gene Biomarker Detected
07/5/2005	Upstream Belle Fourche	–	–	Human *Bacteroidetes* "Quatification" ID™	No Human Gene Biomarker Detected
07/5/2005	Downstream Belle Fourche	–	–	Human *Bacteroidetes* "Quatificatio" ID™	No Human Gene Biomarker Detected

Based on the results of the bacteria source tracking, it appears that human sources of *E. coli* bacteria are not a major portion of the *E. coli* load in the Belle Fourche River. No samples were identified from either human or cattle sources. However, because of the small sample size and no storm events sampled, the results do not mean that there is no loading of *E. coli* bacteria from either human or cattle sources. Possible sources of *E. coli* contamination within samples tested for source tracking may come from domestic animals (pets) from the city of Belle Fourche as well as waterfowl and other avian life such as swallows occurring around bridges. Based on South Dakota Department of Agriculture (2009), cattle make up the majority of the *E. coli* source loading within the watershed. This data should be considered over bacteria source tracking in this case due to the small sample size of source tracking samples.

3.0 Technical Analysis

3.1 Data Collection

Water samples were collected from two sites, BF01 and BF02 during the 2001-2002 Belle Fourche Assessment and Implementation projects. The samples were collected monthly with some occasional "event" sampling included to supplement the routine schedule. Additionally, the SD DENR sampled these sites during 2009 on a weekly basis to provide more *E. coli* data for these sites. Water quality parameters collected include alkalinity, chlorophyll A, dissolved oxygen, fecal coliform, kjeldahl nitrogen, ammonia, total nitrogen, pH, phosphorus, specific conductance, temperature, total dissolved solids, total suspended solids, total solids, total volatile solids, and turbidity.

BF01 is located near the Wyoming/South Dakota Border. BF02 is located within the town of Belle Fourche at the Highway 85 Bridge. BF01 represented boundary conditions. BF02 and WQM 460130 located near BF02 served to represent Segment 1 of the Belle Fourche River. *E. coli* and fecal coliform samples have also been collected on a monthly basis from WQM 460130 from 2009-2015.

3.2 Sample Data

Paired *E. coli* and fecal coliform samples were used to create a relationship to model *E. coli* concentration from unpaired fecal coliform samples (Figure 6). Estimating E. coli concentrations from existing fecal coliform data help to generate a load duration curve by populating flow zones with data that would otherwise be lacking in sample data. Comparing flow and concentration resulted in a very weak relationship that was inadequate for use in predicting daily loads. Eight out of 36 measured *E. coli* samples exceeded the acute threshold for immersion recreation from sites BF02 (460130) (Table 7). Thirteen of 36 measured E. coli samples exceeded the immersion recreation chronic numerical value of 126 cfu/100 ml. Five of 33 *E. coli* samples exceeded the immersion recreation acute threshold from site BF01 (Table 8). Eleven of 33 E. coli samples collected from BF01 exceeded the immersion recreation chronic value.

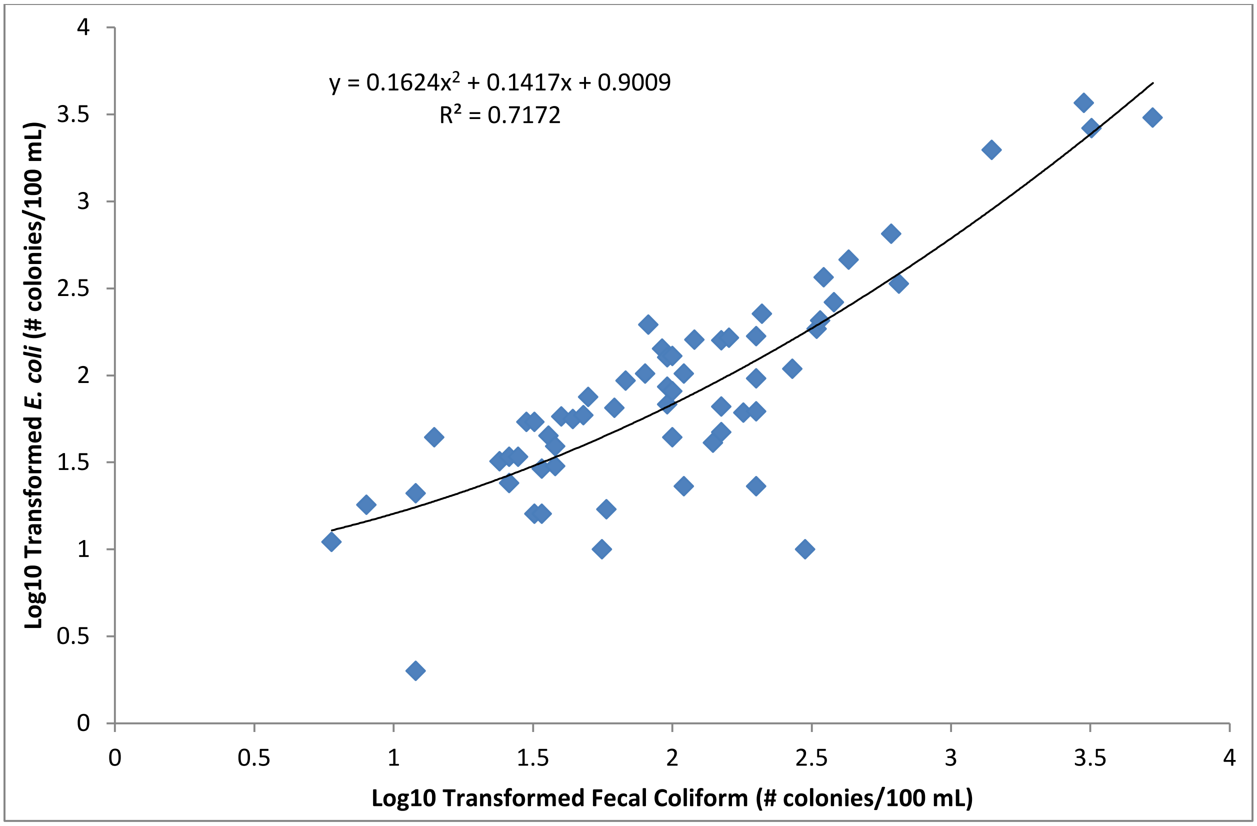

Figure 6. Fecal coliform/*E. coli* relationship.

Table 7. Samples obtained from site WQM 460130 and BF02; modeled *E. coli* concentrations indicated by red text, average daily flows derived from USGS gauging station 06428500.

Date	Sampling Time	Site	Average Daily Flow (cfs)	Fecal Coliform (# colonies/100 ml)	E. coli (# colonies/100 ml)
08/13/2013	14:00	WQM 460130	37	12	2
09/20/2006	13:10	WQM 460130	19	2	9
09/02/2014	14:00	WQM 460130	49	56	10
05/07/2013	14:30	WQM 460130	36	6	11
09/15/2009	14:58	WQM 460130	37	58	17
07/02/2012	13:00	WQM 460130	76	200	23
09/11/2007	15:11	WQM 460130	19	32	30
09/18/2012	12:40	WQM 460130	24	24	32
08/23/2011	14:00	WQM 460130	89	38	39
08/20/2014	12:30	WQM 460130	38	140	41
05/05/2009	15:11	WQM 460130	401	100	44
09/14/2011	12:45	WQM 460130	71	36	45
09/10/2008	16:17	WQM 460130	40	60	46
06/04/2003	11:00	WQM 460130	23	60	46
07/11/2014	13:20	WQM 460130	78	150	47
07/26/2006	09:10	WQM 460130	70	70	52
06/20/2006	08:00	WQM 460130	22	78	56
09/13/2010	18:15	WQM 460130	38	48	59
07/10/2007	16:29	WQM 460130	38	86	61
08/10/2010	15:00	WQM 460130	78	180	61
05/03/2010	18:00	WQM 460130	206	200	62
09/04/2013	13:45	WQM 460130	45	150	66
05/08/2003	08:40	WQM 460130	62	100	68
07/13/2005	12:10	WQM 460130	46	110	74
08/14/2007	16:07	WQM 460130	72	120	79
05/24/2005	13:25	WQM 460130	19	120	79
06/06/2012	14:00	WQM 460130	56	100	81
08/24/2005	14:15	WQM 460130	111	150	95
08/23/2006	08:00	WQM 460130	106	150	95
09/16/2003	10:05	WQM 460130	33	150	95
05/12/2004	10:55	WQM 460130	11	150	95
06/21/2005	11:50	WQM 460130	9.3	150	95
08/19/2009	06:31	WQM 460130	64	200	96
09/21/2005	11:10	WQM 460130	9	160	101
06/08/2004	11:35	WQM 460130	7.2	160	101
07/07/2011	14:30	WQM 460130	214	110	102
06/22/2010	08:00	WQM 460130	172	270	109
08/21/2003	09:05	WQM 460130	103	210	128
06/12/2007	16:20	WQM 460130	181	240	144
05/15/2012	14:00	WQM 460130	108	150	159
05/18/2011	12:20	WQM 460130	448	120	160
07/14/2004	12:50	WQM 460130	21	270	160
06/15/2011	14:30	WQM 460130	452	160	164

Table 7 continued. Samples obtained from site 460130 and BF02, modeled *E. coli* concentrations indicated by red text.

Date	Sampling Time	Site	Average Daily Flow (cfs)	Fecal Coliform (# colonies/100 ml)	E. coli (# colonies/100 ml)
07/14/2009	15:35	WQM 460130	113	330	185
06/24/2008	15:25	WQM 460130	273	320	188
05/17/2006	08:55	WQM 460130	87	330	194
09/14/2004	10:45	WQM 460130	52	340	200
07/10/2000	08:00	WQM 460130	14	340	200
08/16/2012	13:15	WQM 460130	106	340	206
07/17/2001	08:00	WQM 460130	112	440	257
08/13/2008	16:19	WQM 460130	72	440	257
06/11/2015	14:00	WQM 460130	255		290
05/08/2007	09:00	WQM 460130	576	500	293
07/16/2002	8:00	WQM 460130	179	500	293
07/09/2003	10:55	WQM 460130	113	570	335
07/14/2010	06:45	WQM 460130	113	350	365
07/08/2008	14:42	WQM 460130	113	1000	613
05/12/2014	14:30	WQM 460130	382	610	651
05/13/2008	15:57	WQM 460130	521	1100	682
05/20/2015	12:00	WQM 460130	142		821.2
08/23/2004	11:25	WQM 460130	2.3	1300	826
07/09/2013	14:30	WQM 460130	79	1400	1970
06/16/2009	15:56	WQM 460130	556	5300	3020
07/21/1999	08:00	WQM 460130	199	3800	3085
06/03/2013	14:30	WQM 460130	1990	3000	3680
06/06/2014	13:45	WQM 460130	159	5100	4839.2
09/22/2009	15:15	BF02	36	34	16
04/23/2002	12:10	BF02	38	10	16
10/25/2001	-	BF02	17	23	25
09/24/2009	15:00	BF02	36	14	44
08/28/2001	-	BF02	31	66	50
09/24/2009	10:45	BF02	36	30	54
09/22/2009	11:30	BF02	36	50	75
09/27/2001	-	BF02	9.2	250	149
06/14/2001	04:32	BF02	173	1500	975
07/24/2001	03:00	BF02	67	10000	11644

Table 8. Samples obtained from BF01, modeled *E. coli* concentrations indicated by red text.

Date	Sampling Time	Site	Average Daily Flow (cfs)	Fecal Coliform (# colonies/100 ml)	E. coli (# colonies/100 ml)
05/06/2009	14:28	BF01	382	300	10
10/11/2002	10:05	BF01	21	6	13
09/24/2009	13:15	BF01	36	32	16
04/23/2002	12:50	BF01	38	12	17
05/14/2009	14:45	BF01	272	8	18
10/23/2002	08:30	BF01	19	14	19
09/22/2009	13:00	BF01	36	12	21
05/13/2009	11:50	BF01	281	110	23
05/18/2009	13:30	BF01	231	26	24
03/28/2002	11:42	BF01	38	27	27
05/28/2009	11:15	BF01	180	34	29
09/27/2001	-	BF01	9.2	30	29
08/31/2009	13:30	BF01	42	38	30
07/30/2009	14:40	BF01	75	28	34
09/01/2009	14:30	BF01	41	26	34
10/25/2001	-	BF01	17	40	35
08/03/2009	11:30	BF01	63	32	54
05/01/2009	11:00	BF01	600	44	56
09/21/2009	14:30	BF01	35	40	58
08/18/2009	09:30	BF01	66	62	65
08/19/2009	14:40	BF01	64	96	68
08/27/2002	06:28	BF01	109	100	68
06/30/2009	09:00	BF01	127	96	86
09/08/2009	10:15	BF01	37	68	93
08/19/2009	14:45	BF01	64	80	102
07/08/2009	09:45	BF01	97	96	127
08/05/2009	08:45	BF01	59	100	129
08/28/2001	-	BF01	31	230	138
07/21/2009	13:15	BF01	100	92	142
09/13/2002	07:25	BF01	117	260	155
05/29/2002	11:04	BF01	21	280	166
06/04/2009	11:30	BF01	173	200	168
06/10/2002	12:00	BF01	115	300	177
07/28/2009	12:30	BF01	73	82	195
06/24/2009	14:40	BF01	219	210	226
07/20/2009	13:50	BF01	106	380	263
08/12/2009	10:45	BF01	164	650	336
07/30/2002	01:10	BF01	184	600	353
06/09/2002	12:00	BF01	110	710	422
07/16/2009	12:45	BF01	101	430	461
06/08/2002	12:00	BF01	105	810	486
06/08/2002	12:00	BF01	105	860	519
06/14/2001	03:27	BF01	173	1600	1052
06/07/2002	12:00	BF01	103	1900	1292
06/14/2001	03:13	BF01	173	2200	1545
06/06/2002	12:00	BF01	56	3200	2471
06/16/2009	10:15	BF01	556	3200	2630
06/06/2002	02:30	BF01	56	4300	3629
08/10/2009	10:00	BF01	375	15000	9678.4
07/13/2001	12:00	BF01	139	10000	11644
07/24/2001	02:00	BF01	67	10000	11644

4.0 Linkage Analyses

4.1 Load Duration Curve Analysis

The TMDL was developed using the Load Duration Curve (LDC) approach that results in a flow-variable target that considers the entire flow regime (Figure 7). Thus, the LDC approach was deemed an appropriate method for setting flow-variable *E. coli* bacteria TMDL for the Belle Fourche River.

The LDC is a dynamic expression of the allowable load for any given flow. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones representing 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) according to EPA's *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA, 2006). These percentages reflect that low flows, for example, are exceeded 90% of the time, dry conditions are exceeded 60% of the time, etc.

Loadings were calculated by multiplying sample and modeled concentrations by the average daily flow of the date of sampling using data from USGS site 06428500. The unit conversion factor is expressed as; 24,465,525 ml*s / ft3*day (USEPA 2007).

When the instantaneous loads are plotted on the LDC, characteristics of the water quality impairment are shown (Figure 7). Instantaneous loads that plot above the chronic standard loading curve are exceeding the TMDL, while those below the curve are in compliance. Loads exceeding the criteria in the low flow zone typically indicate point or in-stream load contributions, while loads exceeding the criteria in higher flows generally indicate nonpoint source contributions (USEPA, 2007).

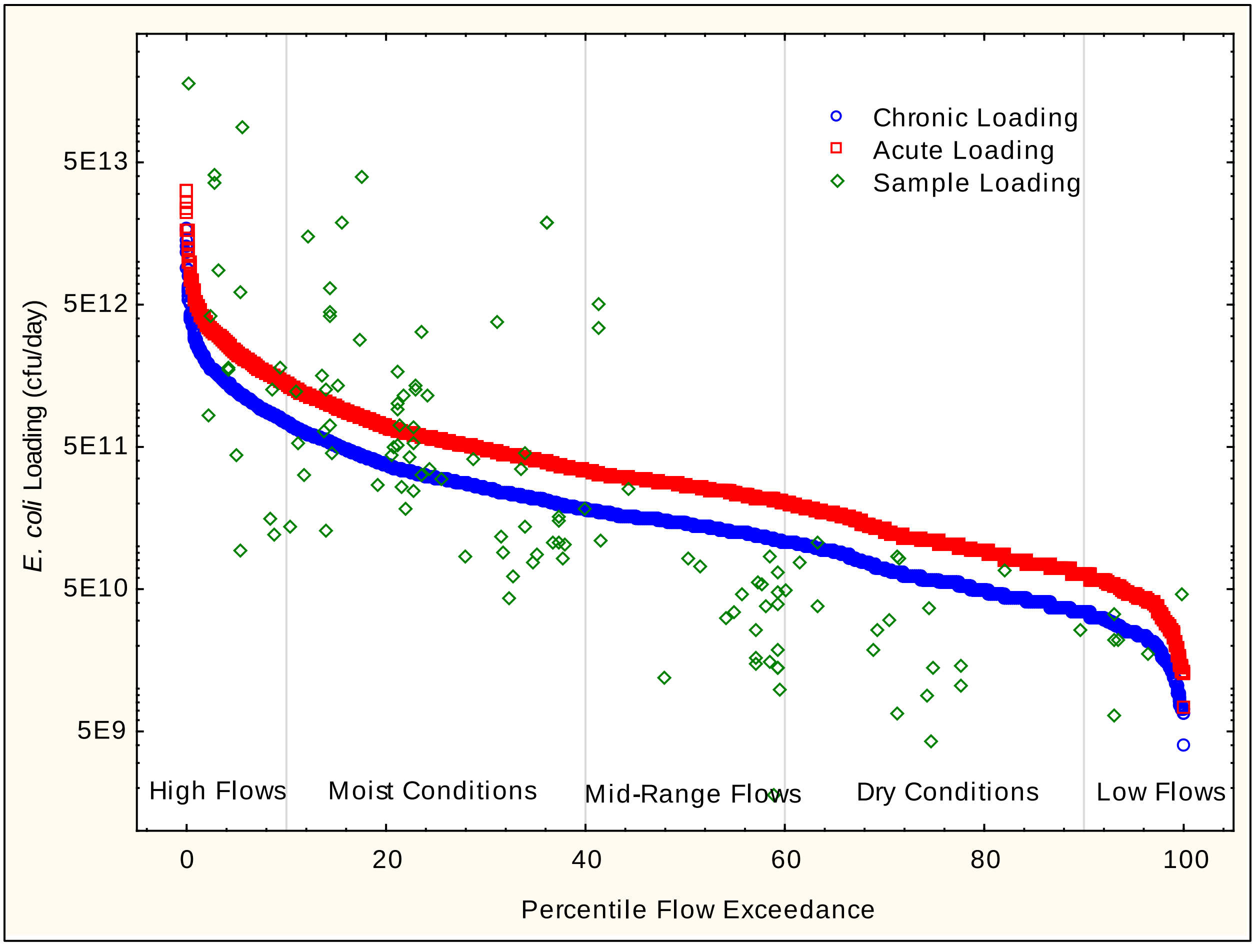

Figure 7. Load duration curve for the Belle Fourche Segment 1 using sites BF01, BF02, and WQM 460130.

4.1.1 High Flows

The high flow zone is composed of the highest 10% of flows that occur in Segment 1 of the Belle Fourche River. There were sixteen samples (modeled and actual) within this flow zone. Eleven were above both the chronic and acute standards and three were above the chronic but not the acute standard. The 95th percentile concentration of all samples in this zone was used to calculate the current load from which reductions were calculated. A load reduction of 97% will be needed to fully support designated beneficial uses to the chronic water quality standard. Table 9 depicts an example of a TMDL for a flow of 1,242 cfs (95% flow in this zone, derived from data obtained from USGS gauging site 06428500) within the high flow zone regime. Higher or lower flows within this zone may acceptably carry higher or lower loads as long as the concentration does not exceed the state standard.

The concentration of 235 cfu/100 ml represents the acute standard and may make an appropriate goal for this flow zone because flows in excess of 208 cfs typically only last for short periods of time (peak runoff events). However using the chronic water quality numeric value as a goal instead better ensures that neither water quality standard will be exceeded.

While the 235 cfu/100 ml goal may have made an acceptable goal, the chronic threshold of 126 cfu/100 ml was chosen for the TMDL. Chronic violations are not likely in this flow zone because this flow zones represents peak flows due to event runoff and are often of short duration, the chances of sampling five storm events generating high flows within a 30-day period is low. Using the 126 cfu/100 ml threshold assurance is provided that the water quality standard will not be exceeded.

Table 9. TMDL calculation for the high flow zone.

	Flow Zone (expressed as CFU/day)	
	High Flows	
	≥ 242 cfs	
LA	3.34E+12	Remaining load after deducting WLA and MOS from TMDL
WLA	0	
MOS	4.87E+11	Median chronic loading value minus minimum chronic loading value
TMDL @126 cfu/100 ml	3.83E+12	Standard multiplied by 95th % flow for zone
Current Load	1.11E+14	95th Percentile of observed and modeled *E. coli* bacteria load
Load Reduction	97%	Reduction required to reduce the current load to the load at the standard

4.1.2 Moist Conditions

Moist condition flows are characterized by above average moisture conditions in the watershed. Flows in this regime are generated by precipitation and snowmelt events. The moist condition flows extend from approximately 242 cfs down to 59 cfs. Table 10 depicts an example of a TMDL for a flow of about 209 cfs (95% flow in this zone) within the moist condition regime. Sixty one samples represent this flow zone. Thirty eight actual and modeled concentrations exceed both the acute and the chronic water quality thresholds. Fourteen exceed the chronic but not the acute water quality threshold. A load reduction of 97% is needed to meet the immersion recreation *E. coli* chronic threshold.

Table 10. TMDL calculation for the moist condition flow zone.

	Flow Zone (expressed as CFU/day)	
	Moist Conditions	
	242 - 59 cfs	
LA	5.24E+11	Remaining load after deducting WLA and MOS from TMDL
WLA	0	
MOS	1.20E+11	Median chronic loading value minus minimum chronic loading value
TMDL @126 cfu/100 ml	6.44E+11	Standard multiplied by 95th % flow for zone
Current Load	1.88E+13	95th Percentile of observed and modeled *E. coli* bacteria load
Load Reduction	97%	Reduction required to reduce the current load to the load at the standard

4.1.3 Mid-range Flows

The midrange flows extend from approximately 59 cfs to 35 cfs. Twenty six samples (modeled and actual) represented this flow zone. Two samples exceeded the acute water quality threshold. Three samples were above the chronic water quality threshold. A 93% load reduction is needed to meet designated beneficial uses to the chronic water quality standard. Table 11 depicts an example of a TMDL for a flow of 57 cfs (95% flow for this zone) within the midrange flow zone regime. Higher and lower flows within this zone may acceptably carry higher or lower loads as long as the concentration does not exceed the state standard.

Table 11. TMDL calculation for the mid-range flow zone.

	Flow Zone (expressed as CFU/day)	
	Mid-range Flows 59 - 35 cfs	
LA	1.39E+11	Remaining load after deducting WLA and MOS from TMDL
WLA	0	
MOS	3.70E+10	Median chronic loading value minus minimum chronic loading value
TMDL @126 cfu/100 ml	1.76E+11	Standard multiplied by 95th % flow for zone
Current Load	2.6E+12	95th Percentile of observed and modeled *E. coli* bacteria load
Load Reduction	93%	Reduction required to reduce the current load to the load at the standard

4.1.4 Dry Conditions

The dry condition flows extend from 35 cfs to 11 cfs. Eighteen samples (actual and modeled) were collected within this flow zone. No samples exceeded the acute threshold. Four samples exceeded the chronic threshold. A load reduction of 0% will be needed to fully support designated beneficial uses to the chronic water quality standard. Table 12 depicts an example of a TMDL for a flow of 33 cfs (95% flow for this zone) within the dry condition regime. Higher and lower flows within this zone may acceptably carry higher or lower loads as long as the concentration does not exceed the state standard.

Table 12. TMDL calculation for the dry conditions zone.

	Flow Zone (expressed as CFU/day)	
	Dry Conditions	
	35 - 11 cfs	
LA	7.71E+10	Remaining load after deducting WLA and MOS from TMDL
WLA	0	
MOS	2.47E+10	Median chronic loading value minus minimum chronic loading value
TMDL @126 cfu/100 ml	1.02E+11	Standard multiplied by 95th % flow for zone
Current Load	8.83E+10	95th Percentile of observed and modeled *E. coli* bacteria load
Load Reduction	0%	Reduction required to reduce the current load to the load at the standard

4.1.5 Low Flows

The low flow zone consists of flows at or below 11 cfs. Six samples (modeled and actual) were collected that occurred within this zone. Two samples exceed the chronic water quality standard value, One sample exceeded the acute standard. A load reduction of 22% will be needed to fully support designated beneficial uses to the chronic water quality standard. Table 13 depicts an example of a TMDL for a flow of 11 cfs (95% flow for this zone) within the low flow regime. Higher and lower flows within this zone may acceptably carry higher or lower loads as long the concentration does now exceed the state standard.

Table 13. TMDL calculation for the low flow zone.

	Flow Zone (expressed as CFU/day)	
	Low Flows 11 - 0 cfs	
LA	1.33E+10	Remaining load after deducting WLA and MOS from TMDL
WLA	0	
MOS	2.07E+10	Median chronic loading value minus minimum chronic loading value
TMDL @126 cfu/100 ml	3.39E+10	Standard multiplied by 95^{th} % flow for zone
Current Load	4.33E+10	95^{th} Percentile of observed and modeled *E. coli* bacteria load
Load Reduction	22%	Reduction required to reduce the current load to the load at the standard

5.0 TMDL Allocations

5.1 Waste Load Allocation (WLA)

There are no point discharges within the watershed of Segment 1.

5.2 Load Allocation (LA)

To develop the *E. coli* bacteria load allocation (LA), the loading capacity (LC) was first determined. The LC for the Belle Fourche River was calculated by multiplying the chronic *E.*

coli bacteria value by the daily average flow measured at USGS gaging station 06428500 Belle Fourche River at Belle Fourche.

Since the geometric mean criteria are exceeded in most flow zones, it was decided to use the geometric mean criterion to develop the loading capacity of the stream in order to ensure that the most stringent water quality standards are met. For each of the five flow zones, the 95th percentile of flow was used in calculating the TMDL. Bacteria loads experienced during the largest stream flows (e.g. top 5 percent) cannot be feasibly controlled by practical management practices. Setting the flow zone goal at the 95th percentile of the range of LCs will protect the immersion recreation beneficial use and allow for the natural variability of the system.

In this TMDL the WLA was zero. A portion of the LC was allocated to nonpoint sources as a load allocation (LA). A fraction of the LC was also reserved as a margin of safety (MOS) to account for uncertainty in the calculations of these load allocations. The method used to calculate the MOS is discussed below. The LA was determined by subtracting the MOS from the LC. Thus, the TMDL (and LC) is the sum of LA, and MOS.

6.0 Margin of Safety (MOS)

An explicit MOS was calculated as the difference between the loading capacity at the mid-point of each of the five flow zones and the loading capacity at the minimum flow in each zone. A substantial MOS is provided using this method, because the loading capacity is typically much less at the minimum flow of a zone as compared to the mid-point.

7.0 Monthly Variation

E. coli concentrations also displayed seasonal variation (Figure 8). June and July both had the highest *E. coli* concentration out of the months examined. During the month of May *E. coli* concentrations were higher at the reach endpoint than at the Wyoming/South Dakota border. June concentrations were higher at the boundary condition than at the end point (Figure 9). In addition, the TMDL is seasonal, as it is effective only during the period of May 1 through September 30. Since the *E. coli* criteria are in effect from May 1 through September 30, the TMDL is also applicable only during this time period. Using a load duration curve allows seasonal variation to be taken into account when developing TMDL load allocations.

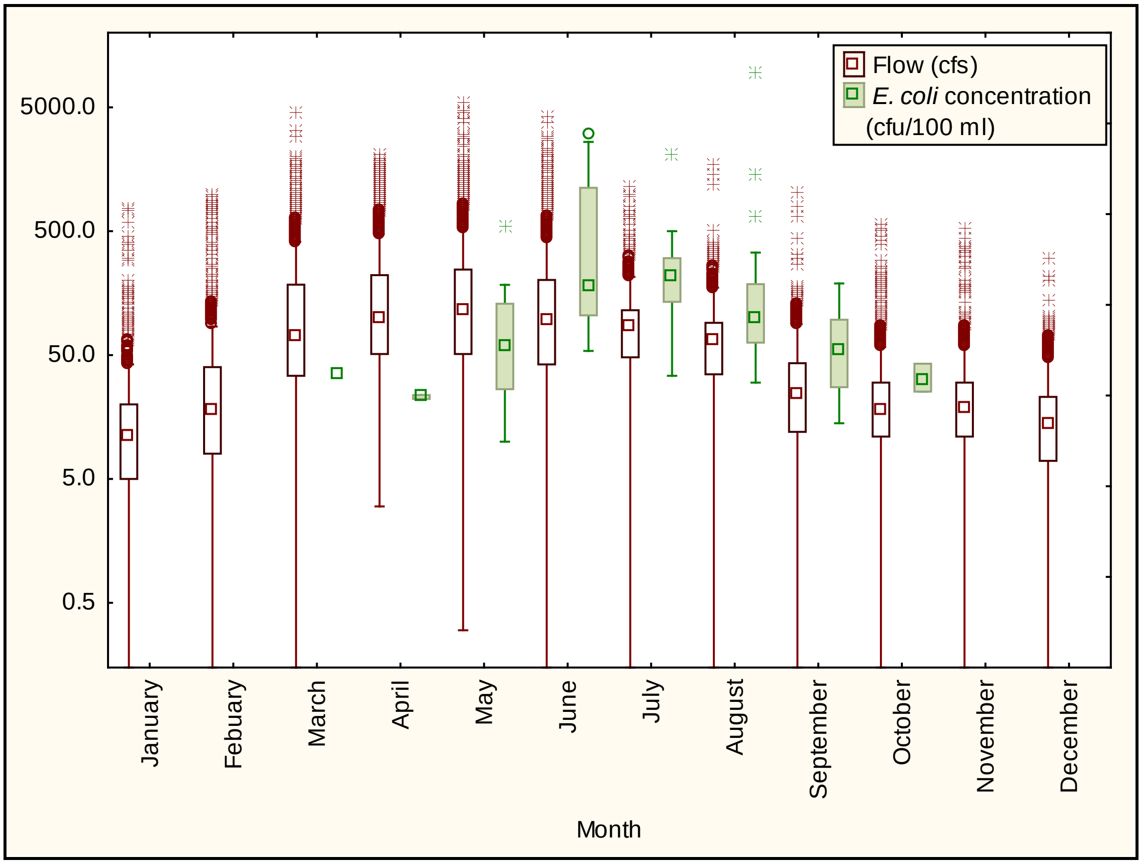

Figure 8. Monthly patterns in flow and *E. coli* concentrations.

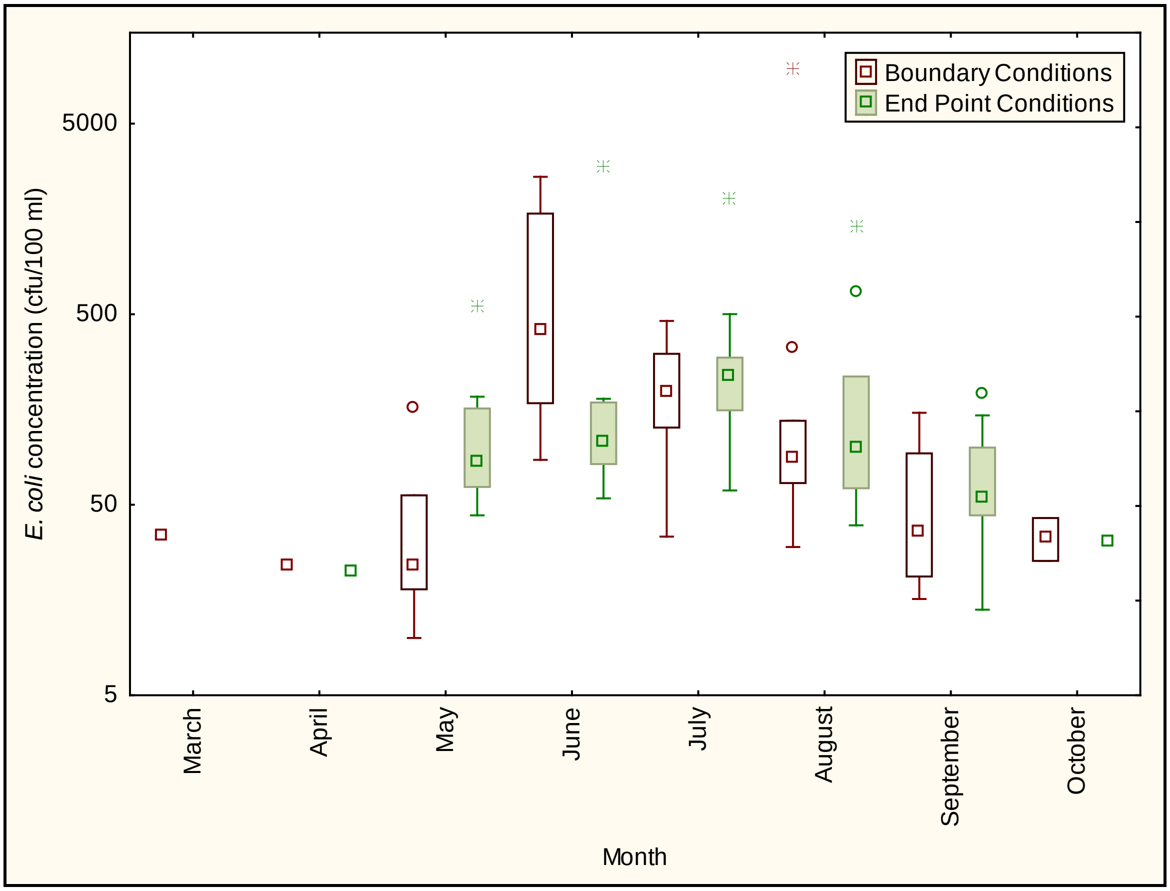

Figure 9. Monthly patterns in E. coli concentrations of boundary and segment end point sampling sites.

8.0 Critical Conditions

Critical conditions occur within the basin during the summer. Typically, greatest numbers of livestock and tourist activities are highest in the basin during the summer months. Combined with the peak in bacteria sources, high-intensity rainstorm events are common during the summer and produce a significant amount of *E. coli* load due to bacterial wash-off from the watershed.

9.0 Follow-Up Monitoring

The Department 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 notify EPA of any adjustments to this TMDL within 30 days of their adoption.

Monitoring will continue throughout the Belle Fourche River watershed and SDDENR WQM site 460130 will provide data for the upper reach of the river. Five other sites on the Belle Fourche River downstream of Segment 01 and one on Redwater Creek may also provide data to be used to judge the effectiveness of implementation activities. And the United States Geological Survey also has five sites within the Belle Fourche watershed that may provide additional water quality data.

10.0 Public Participation

Efforts taken to gain public education, review, and comment during development of the TMDL involved:

1. Four presentations to the Belle Fourche River Partnership on the findings of the assessment; two in 2001 and two in 2002.
2. A webpage was developed and used during the course of the assessment and is currently used for the implementation effort. See www.bellefourchewatershed.org
3. 30-day public notice period for public review and comment. A public notice was published in the Rapid City Journal, Black Hills Pioneer, and Butte County Post. This public notice and the TMDL document were posted on the SD DENR Webpage http://denr.sd.gov/dfta/wp/tmdl.aspx
4. This TMDL was originally submitted to the EPA in 2012. Comments were not received from the EPA until December of 2016. Given EPA's comments and the time lapse between the original submittal and EPA's comments, it was decided to redraft this TMDL to incorporate data collected after 2012. This warranted a new public notice and so a public notice was published during May, 2017 in the Rapid City Journal, the Black Hills Pioneer, and the Butte County Post (the same newspapers as the first public notice). Additionally, the public notice and revised TMDL document were again posted on DENR's Webpage http://denr.sd.gov/dfta/wp/tmdl.aspx. No comments were received in response to the public notice or Webpage posting.

The findings from these public meetings and Webpage have been taken into consideration in development of the Belle Fourche Segment 1 TMDL.

11.0 Implementation

Several types of BMPs should be considered in the development of a water quality management implementation plan for watershed draining the impaired segment of the Belle Fourche River.

- Livestock access to streams should be reduced, and livestock should be provided sources of water away from streams.
- Unstable stream banks should be protected by enhancing the riparian vegetation that provides erosion control and filters runoff of pollutants into the stream.
- Filter strips should be installed along the stream bordering cropland and pastureland.
- Animal confinement facilities should implement proper animal waste management systems.

Funds to implement watershed water quality improvements can be obtained through SD DENR. This includes the Section 319 Nonpoint Source program.

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& Technical Assistance

AUG 31 2017

Ref: 8WP-CWP

Mr. Jim Feeney
Director
Financial and Technical Assistance Division
South Dakota Department of Environment & Natural Resources
Joe Foss Building
523 East Capitol Ave
Pierre, South Dakota 57501-3181

Re: Approval of Belle Fourche River Segment 1 *E. coli* Total Maximum Daily Load

Dear Mr. Feeney,

The U.S. Environmental Protection Agency (EPA) has completed review of the total maximum daily load (TMDL) submitted by your office on July 25, 2017. 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 Belle Fourche River Segment 1 *E. coli* TMDL. The EPA has determined that the separate elements of the TMDL listed in the enclosure adequately address the pollutant of concern, is designed to attain and maintain applicable water quality standards, considers seasonal variation and includes 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 Peter Brumm on my staff at 406-457-5029.

Sincerely,

Darcy O'Connor
Assistant Regional Administrator
Office of Water Protection

Enclosure
EPA Region 8 TMDL Review Form and Decision Document

ENCLOSURE

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	*Escherichia coli* Bacteria Total Maximum Daily Load (TMDL) for the Belle Fourche River, Segment 1, Butte County, South Dakota
Submitted by:	South Dakota Department of Environment and Natural Resources (DENR)
Date Received:	7/25/2017
Review Date:	8/7/2017
Reviewer:	Peter Brumm
Rough Draft / Public Notice / Final Draft?	Final
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final draft review only):

- [x] Approve
- [ ] Partial Approval
- [ ] Disapprove
- [ ] Insufficient Information

Approval Notes to the Administrator: *Based on the review presented below, I recommend approval of the submitted TMDL.*

TMDL Summary	
Number of TMDLs:	*1*
Number of Causes Addressed by TMDL:	*1*
Number of Pathogen TMDLs:	*1*

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the TMDL review elements identified in the following 8 sections:

1. Problem Description
    1.1. TMDL Document Submittal
    1.2. Identification of the Waterbody, Impairments, and Study Boundaries
    1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
    4.1. Data Set Description
    4.2. Waste Load Allocations (WLA)
    4.3. Load Allocations (LA)

4.4. Margin of Safety (MOS)
4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered "impaired." When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum allowable pollutant loading rate. A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody can assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known sources of that pollutant. A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's review elements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in this review form denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review form is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 Document Submittal

When a TMDL document is submitted to EPA requesting review or approval, the submittal package should include a notification identifying the document being submitted and the purpose of the submission.

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☒ Each TMDL document submitted to EPA for final review and approval should 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. The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information ☐ N/A

Summary: This TMDL document was electronically submitted to EPA for final review and approval on July 25, 2017. An adequate submittal letter was included.

Comments: None.

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included.

Review Elements:

☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s).

☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map

☒ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity_ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: This TMDL was written to address an *E. coli* impairment for Segment 1 of the Belle Fourche River (SD-BF-R-BELLE_FOURCHE_01). The introduction section details the segment's 303(d) listing and TMDL history. In short, a total suspended solids (TSS) impairment originally listed in 1998 was addressed by a 2005 TMDL. Pathogen impairments date back to 2002 when fecal coliform was first listed and subsequently addressed by a 2011 TMDL. DENR added *E. coli* as a pathogen indicator to state water quality standards in 2009 and additional monitoring lead to an *E. coli* listing in 2012. With the completion of this 2017 *E. coli* TMDL, all known causes of impairment on Segment 1 have been addressed by TMDLs.

TMDL Waterbody Impairment Summary Table

Waterbody Description	Waterbody ID	Cause of Impairment	Pollutant Addressed	Resolution
Belle Fourche River, Wyoming border to Redwater River	SD-BF-R-BELLE_FOURCHE_01	*E. coli*	*E. coli*	2017 TMDL*
		Fecal Coliform	Fecal Coliform	2011 TMDL
		TSS	TSS	2005 TMDL

*Indicates current TMDL submitted by DENR which is addressed by this EPA approval action.

The TMDL's watershed description section briefly describes the boundaries, land use, ecoregion, and geology of the watershed. Numerous maps are provided, including Figure 4 which displays monitoring stations where water quality data was collected for TMDL analyses.

Comments: None.

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g. insufficient data were available to determine if this water quality criterion is being attained).

Review Elements:

☒ The TMDL 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 anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the identified sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)). *Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or* *assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.*

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: Section 1.3 of the TMDL introduces South Dakota water quality standards and references state regulations that establish beneficial uses, numeric, and narrative water quality criteria (ARSD 74:51). The unsupported beneficial use addressed by this TMDL is an immersion recreation use. Excessive amounts of fecal bacteria in surface waters used for recreation increases the risk of pathogen-induced illness to humans such as gastrointestinal, respiratory, and skin issues. *E. coli*, a subset of fecal bacteria, is a commonly used indicator of water quality and human health risk. A direct relationship exists between the pollutant of concern and the numeric criteria; both are *E. coli*. According to South Dakota water quality standards and assessment methods, a stream is deemed impaired if any *E. coli* sample exceeds 235 cfu/100ml or if greater than 10% of the *E. coli* samples exceed a 30-day geometric mean value of 126 cfu/100ml. The existing Belle Fourche River dataset fails both accounts. Lastly, this *E.* coli water quality standard only applies during the recreation season from May 1st to September 30th.

Comments: None.

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column sediment such as TSS, embeddedness, stream morphology, up-slope conditions and a measure of biota).

Review Elements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained. *Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.*

☒ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: The numeric geometric mean *E. coli* criterion (126 cfu/100ml) is applied directly as the TMDL target.

Comments: None.

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each identified source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each identified source (or source category) should be specified and quantified. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Review Elements:

☒ The TMDL should include an identification of the point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that the anthropogenic sources of the pollutant of concern have been identified, characterized, and quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: Land use in the segment basin is overwhelmingly rangeland (90.7%), distantly followed by cropland (6.5%). DENR began the source assessment by reviewing boundary conditions flowing out of Wyoming at site BF01. Here, based on the monitoring data, large load reductions are needed during high flow zones but none are needed during low flows zones. While Wyoming has developed fecal coliform TMDLs for several Belle Fourche River segments, the segment directly upstream of South Dakota has not been assessed. DENR then focused the TMDL investigation on potential pollutant sources within South Dakota such as point sources, agricultural nonpoint sources, natural background, human, and unregulated stormwater.

A Concentrated Animal Feeding Operation (CAFO) general permit is the only point source in the basin, but it is assumed to be a noncontributing source and given a WLA of zero because the permitted holding ponds are designed to retain a 25-year storm event. Nonpoint sources were investigated by reviewing land use information, communicating with local land owners, reviewing the U.S. Dept. of Agriculture's 2009 National Agricultural Statistics Service (NASS), and consulting South Dakota Game Fish and Park's (SD GFP) County Wildlife Assessments.

Species-specific bacterial production rates were combined with animal densities from NASS and SD GFP to estimate maximum potential loading (i.e., assuming all bacteria produced is transported to river) from livestock and wildlife, and to compare loading rates among various species. Loading from wildlife was considered natural. Cattle on rangelands account for nearly 90% of the animal-derived nonpoint source loading. Human loading was similarly estimated (population density x bacterial production rate), which is an overestimation that does not factor properly functioning septic systems and the City of Belle Fourche's municipal sewage treatment system. DENR also collected several bacteria source tracking samples that found no human markers. Stormwater is briefly discussed but given the rural makeup of the project area, it is assumed an insignificant source. In summary, livestock on grass contribute 97% of the existing nonpoint source loading, followed by feedlots (2%), wildlife/natural background (0.6%), and humans (0.3%).

Comments: None.

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the data set, and an appropriate level of technical analysis. This applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor → response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin Of Safety

Review Elements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. 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 total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify 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.

☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

- the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
- the distribution of land use in the watershed (e.g., urban, forested, agriculture);
- a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
- present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
- 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.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc…) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: This TMDL's technical analysis follows a load duration curve approach based largely on EPA's 2007 technical support document titled "An Approach for Using Load Duration Curves in the Development of TMDLs." A USGS gage (06428500) provides a long-term flow data set at the lower end of the river segment. DENR grouped flows from 1999 to 2016 into five flow zones: high flows, moist conditions, mid-range flows, dry conditions, and low flows. Next, this ranked flow data set was multiplied by the *E. coli* TMDL target (126 cfu/100ml) and a unit conversion factor (24,465,525 ml*s / ft^3*day) to produce a dynamic expression of the allowable load for any given flow in the form of a load duration curve. On top of this curve, DENR plotted existing conditions as instantaneous loads using the *E. coli* concentration data set.

TMDLs and allocations are presented separately for each of the five flow zones and set at the 95^{th} percentile flow of each zone. Point sources are given a WLA of zero for all zones. An explicit MOS is reserved and the remaining assimilative capacity is allocated to a combined nonpoint source LA. Required reductions are presented based on the difference between the 95^{th} percentile of the existing condition load and the TMDL load. Significant reductions are needed during the high flow, moist conditions, and mi-range flows zones; moderate conditions are needed in the low flows zone. All TMDL components clearly relate back to a balanced TMDL equation.

Comments: None.

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc…).

Review Elements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: The data set used in the TMDL analysis is contained in the main document. Table 6 presents the results of all bacteria source tracking samples and Tables 7 and 8 provide the bacteria concentration data and matched USGS gage flow values. Data collection dates span 1999 through 2015 and DENR derived a segment-specific translator to estimate *E. coli* concentrations from older fecal coliform samples. This allowed for a more complete data set that populated instantaneous *E. coli* loads across all five flow zones of the load duration curve.

Comments: None.

4.2 Waste Load Allocations (WLA)

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☒ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: The Belle Fourche Livestock Auction is the only permitted point source in the project area. Located west of the City of Belle Fourche, it has coverage under South Dakota's concentrated animal feeding operation (CAFO) general permit. Facilities covered under the general permit generally do not discharge to surface waters as the waste holding ponds are required to retain a 25 year, 24-hour storm event. Given these permit stipulations, the Belle Fourche Livestock Auction is assumed to be a noncontributing source and assigned a WLA of zero.

Comments: None.

4.3 Load Allocations (LA)

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Review Elements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that the anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: Load allocations are established separately for each of the five flow zones and are defined as the remaining TMDL load after subtracting the explicit MOS. While the source assessment characterized natural background loading from wildlife separately, the load allocations ultimately established represent all nonpoint sources, both natural and anthropogenic, as one combined load per flow zone. To understand the components of this composite LA and guide restoration efforts, refer to the source analysis findings.

Comments: None.

4.4 Margin of Safety (MOS)

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of an explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Review Elements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

☐ <u>If the MOS is implicit</u>, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.

☒ <u>If the MOS is explicit</u>, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.

☐ <u>If</u>, rather than an explicit or implicit MOS, the <u>TMDL relies upon a phased approach</u> to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

<u>Summary:</u> An explicit MOS was calculated as the difference between the loading capacity at the mid-point of each of the five flow zones and the loading capacity at the minimum flow in each zone which results in a substantial MOS. Additionally, numerous conservative assumptions were made such as choosing not to incorporate an *E. coli* die-off rate and selecting the 30-day geometric mean criterion as the TMDL target to establish daily load limits.

Comments: None.

4.5 Seasonality and variations in assimilative capacity

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Review Elements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: The load duration curve approach inherently accounts for seasonal variation in streamflow patterns and changes in water quality because the resulting dynamic expression provides the allowable load for any given flow. Additionally, basing the analysis on a longer-term data set ensures a more representative assessment, opposed to a short-term data set that captures an abnormally wet or dry period. DENR also provides insight into annual loading variations by analyzing conditions and assigning loads separately for the five flow zones. Finally, Section 7.0 further investigates seasonality by reviewing monthly patterns of *E. coli* concentrations. Critical conditions are described in the TMDL document as summer rainstorms when *E. coli* concentration spikes attributed to nonpoint source runoff are most likely to impact swimmers and other immersion recreationalists.

Comments: None.

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Review Elements:

☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☒ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: The public participation process is summarized in the TMDL document. This TMDL was initially released for public comment from April 9, 2012 to May 19, 2012. Following significant revisions, the TMDL was public noticed again from May 23, 2017 to June 26, 2017. Both opportunities for public review and comment were posted on DENR's website and announced in three area newspapers: the Rapid City Journal, the Black Hills Pioneer (Spearfish), and the Butte County Post (Belle Fourche). No comments were received during either comment period.

Comments: None.

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Review Elements:

☐ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☐ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:

☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: DENR has collected pathogen data at monitoring station WQM460130, co-located at USGS site 06428500, since 1999 and *E. coli* data since 2009. The document notes that monitoring will continue at this site to judge implementation effectiveness and to help determine whether TMDL revisions are needed.

Comments: None.

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality is not currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Review Elements:

☐ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable). A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☐ Approve ☐ Partial Approval ☐ Disapprove ☒ N/A

Summary: Section 11.0 of the TMDL document introduces a number of agricultural BMPs for future restoration efforts to consider and points to DENR's 319 grants as a possible funding source to implement water quality improvement projects. No action has been taken on this review element because EPA does not approve the restoration strategy or implementation plan aspects of TMDLs, however, EPA encourages the planning of future actions as contained in this TMDL.

Comments: None.

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Review Elements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: The TMDL and allocations are expressed in terms of colony-forming units (CFU) of *E. coli* per day.

Comments: None.