ESCHERICHIA COLI TOTAL MAXIMUM DAILY LOAD EVALUATION OF THE BIG SIOUX RIVER, CODINGTON AND HAMLIN COUNTIES, SOUTH DAKOTA

South Dakota Department of
Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

Completed by Jesse Wilkens

SOUTH DAKOTA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

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Total Maximum Daily Load Summary

Entity ID:	SD-BS-R-BIG_SIOUX_03
Location:	HUC Code: 10170201
Size of Watershed:	132,843 acres
Water body Type:	River/Stream
303(d) Listing Parameter:	*E. coli*
Initial Listing date:	2010 IR
TMDL Priority Ranking:	2
Listed Stream Miles:	22.25 miles
Designated Use of Concern:	Limited Contact Recreation
Analytical Approach:	Load Duration Curve Framework
Target:	Meet applicable water quality standards 74:51:01:55
Indicators:	*E. coli*
Threshold Value:	< 630 colonies/100 ml geometric mean concentration with maximum single sample concentrations of <1178 colonies/100 ml for *E. coli*
High Flow Zone LA:	1.18E+14 *E. coli* colonies
High Flow Zone WLA:	0 *E. coli* colonies
High Flow Zone MOS:	2.13E+13 *E. coli* colonies
High Flow Zone TMDL:	1.40E+14 *E. coli* colonies

1.0 Introduction

The intent of this document is to clearly identify the components of the TMDL submittal to support adequate public participation and facilitate the United States Environmental Protection Agency (EPA) review and approval. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the *E. coli* impairment of the Big Sioux River from the confluence with Willow Creek to the confluence with Stray Horse Creek, SD-BS-R-Big_Sioux_03.

1.1 Watershed Characteristics

The segment of the Big Sioux River addressed in this TMDL covers the 22 miles between Willow Creek and Stray Horse Creek of the approximately 400 mile long river. The entire Big Sioux River drains approximately 9,500 square miles of South Dakota, Minnesota, and Iowa (Figure 1). The immediate drainage area around the segment covers about 132,843 acres. The segment immediately upstream of segment 3 (segment 2) is not impaired due to bacterial contamination, indicating evaluation of the immediate watershed would provide the reductions necessary to reach full support of the beneficial uses.

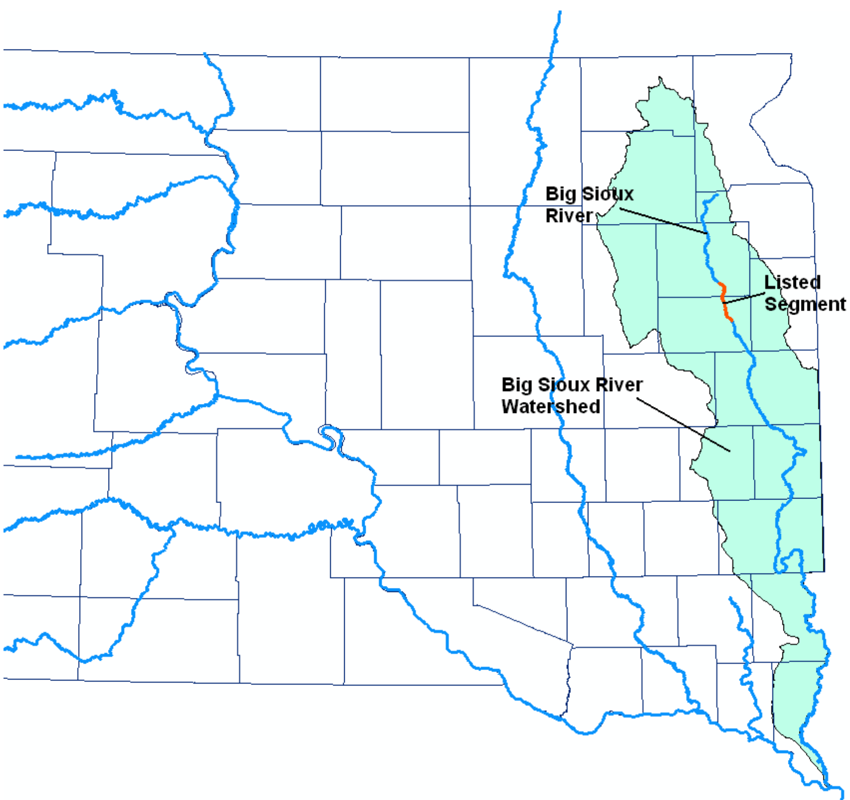


Figure 1. **Big Sioux River Watershed location in South Dakota.**

Table 1 lists the land uses present in the watershed and their percentages. Crop and grazing land are of nearly equal proportions in the watershed. Grazing areas are generally located near waterways on soils that are too steep for tillage. Cropland is predominantly located on more level soils in the watershed. Urban areas consist of the city of Castlewood.

Table 1. Land use in segment 3 of the Big Sioux River.

Land Use	Acres	Percent
Row Crop	49341	33%
Water	3574	2%
Small Grain	16593	11%
Fallow	23	0%
Grass	4435	3%
Wetland	1802	1%
Woods	646	0%
Open Space	7750	5%
Urban	1236	1%
Grazing/Herbacious	47442	32%
Total	132843	100%

The majority of the watershed is comprised of 2 primary soil associations. The first is the Lamoure-Rauville association. It is located on the bottom lands of the Big Sioux River and its tributaries. Both soil types are located on the level ground along the river and are prone to flooding. These soils have moderate potential for crop growth and produce high yields of forage plants (USDA, 1966).

The second association is the Estelline-Fordville-Renshaw Association. The Estelline soils are found on outwash plains and are well drained. The Fordville soils are found on stream terraces along the Big Sioux River and its tributaries and are moderately well drained. The Renshaw soils are droughty, somewhat excessively drained and low in fertility. Crop yields on the Estelline soils are moderate to high, and low to moderate on the Fordville and Renshaw soils (USDA, 1966).

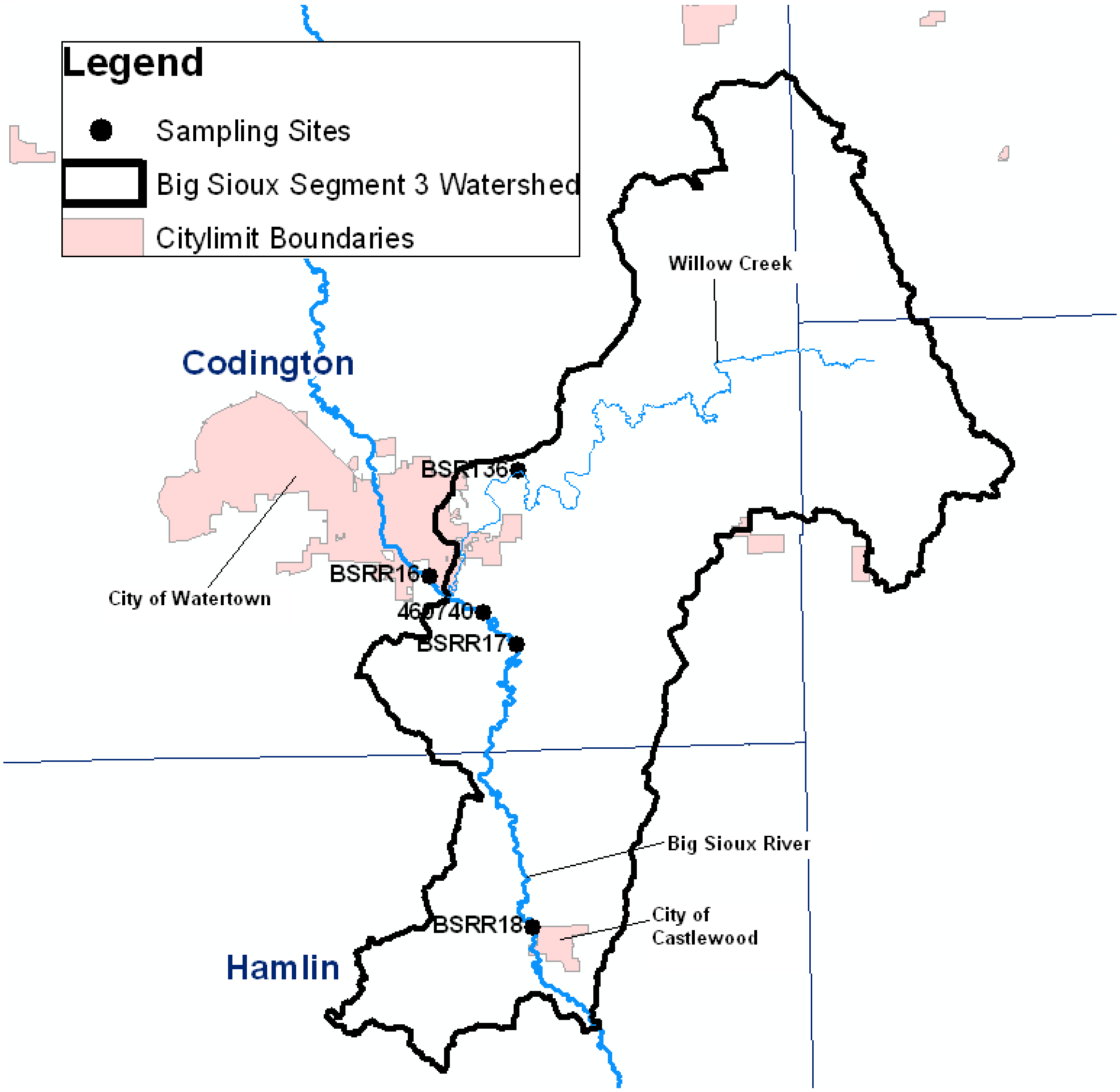


Figure 2. Big Sioux River Segment 3 watershed and sampling site locations.

The southeastern corner of the city of Watertown lies near the upstream boundary of segment 3 of the Big Sioux River. The city of Castlewood is located near the downstream boundary of segment 3 (Figure 2).

2.0 Water Quality Standards

Each waterbody within South Dakota is assigned beneficial uses. All waters (both lakes and streams) are designated the use of fish and wildlife propagation, recreation and stock watering. All streams are assigned the use of irrigation. Additional uses may be 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 numeric criteria that provide physical and chemical benchmarks from which management decisions can be developed.

Chronic standards, including geometric means and 30-day averages, are applied to a calendar month. While not explicitly described within the states water quality standards, this is the method used in the states Integrated Water Quality Report (IR) as well as in permit development.

Additional "narrative" standards that may apply can be found in the "Administrative rules of South Dakota: Articles 74:51:01:05; 06; 08; 09; and 12". These contain language that generally prohibits the presence of materials causing pollutants to form, visible pollutants, nuisance aquatic life and biological integrity.

The Big Sioux River from the confluence with Willow Creek downstream to its confluence with Stray Horse Creek has been assigned the beneficial uses of: warmwater semi-permanent fish life propagation, irrigation waters, limited contact recreation, and fish and wildlife propagation, recreation, and stock watering. 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.

The numeric TMDL target established for segment 3 of the Big Sioux River is 630 cfu/100 ml, which is based on the chronic standard for *E. coli*. The *E. coli* criteria for the limited contact recreation beneficial use requires that 1) no sample exceeds 1178 cfu/100 ml and 2) during a 30-day period, the geometric mean of a minimum of 5 samples collected during separate 24-hour periods must not exceed 630 cfu/100 ml. These criteria are applicable from May 1 through September 30.

Table 2. State Water Quality Standards for the Big Sioux River.

Parameters	Criteria	Unit of Measure	Beneficial Use Requiring this Standard
Total ammonia nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L 30 average March 1 to October 31	Warmwater Semipermanent Fish Life Propagation
	Equal to or less than the result from Equation 4 in Appendix A of Surface Water Quality Standards	mg/L 30 average November 1 to February 29	
	Equal to or less than the result from Equation c in Appendix A of Surface Water Quality Standards	mg/L Daily Maximum	
Dissolved Oxygen	≥4.0	mg/L	Warmwater Semipermanent Fish Life Propagation
Total Suspended Solids	≤90 (mean) ≤158 (single sample)	mg/L	Warmwater Semipermanent Fish Life Propagation
Temperature	≤32	°C	Warmwater Semipermanent Fish Life Propagation
Fecal Coliform Bacteria (May 1- Sept 30)	≤1000 (geometric mean) ≤2000 (single sample)	count/100 mL	Limited Contact Recreation
Escherichia coli Bacteria (May 1- Sept 30)	≤630 (geometric mean) ≤1178 (single sample)	count/100 mL	Limited Contact Recreation
Alkalinity ($CaCO_3$)	≤750 (mean) ≤1,313 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Conductivity	≤2,500 (mean) ≤4,375 (single sample)	µmhos/cm @ 25° C	Irrigation Waters
Nitrogen, nitrate as N	≤50 (mean) ≤88 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
pH (standard units)	≥6.5 to ≤9.0	units	Warmwater Semipermanent Fish Life Propagation
Solids, total dissolved	≤2,500 (mean) ≤4,375 (single sample)	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Total Petroleum Hydrocarbon	≤10	mg/L	Fish and Wildlife Propagation, Recreation and Stock Watering
Oil and Grease	≤10		
Sodium Adsorption Ratio	<10	ratio	Irrigation Waters

3.0 Significant Sources

3.1 Point Sources

Regionally, there are three point source discharges that were evaluated for potential impact to the listed segment of the Big Sioux River.

The city of Castlewood in Hamlin County has a surface water discharge permit, but only discharges under emergency conditions. There have been no reported discharges from the city of Castlewood therefore it will be included as a value of zero in the TMDL.

The city of Watertown discharges into segment 2 of the Big Sioux River. Segment 2 of the Big Sioux River is not listed as impaired in regard to *E. coli*. Contributions from the city of Watertown would be more appropriately addressed in any future documentation pertaining to segment 2 of the Big Sioux River.

3.2 Nonpoint Sources

Nonpoint sources of *E. coli* bacteria in the upper Big Sioux River come primarily from agricultural sources. Data from the 2010 National Agricultural Statistic Survey (NASS) and from the 2002 South Dakota Game Fish and Parks county wildlife assessment were utilized for livestock and wildlife densities, respectively. Animal density information was used to estimate relative source contributions of bacteria loads and is summarized in Table 3. *E. coli* loads for each type of animal were estimated from fecal coliform values using the method described in section 4.3 of this report. Total daily production for the segment 3 basin (based on an estimate of 208 square miles) is $1.7E^{16}$ CFU.

Table 3. Big Sioux River segment 3 non-point sources of *E. coli*.

Species	#/mile	#/acre	*E. coli* /Animal/Day	*E. coli* /acre	Percent
Dairy Cow	50.03	7.82E-02	3.40E+10	2.13E+09	16.15
Beef	181.87	2.84E-01	2.98E+10	6.76E+09	51.35
Hog	172.58	2.70E-01	8.24E+09	1.78E+09	13.49
Sheep	99.20	1.55E-01	1.50E+10	1.85E+09	14.08
Horse	10.31	1.61E-02	3.93E+10	5.06E+08	3.85
Human1	7.26	1.13E-02	1.49E+09	1.35E+07	0.10
All Wildlife				1.28E+08	0.97
Turkey (Wild)2	0.04	6.25E-05	8.39E+07	5.25E+03	0.00
Goose3	1.10	1.72E-03	6.10E+08	1.05E+06	0.01
Deer2	4.69	7.32E-03	2.65E+08	1.94E+06	0.01
Beaver2	0.76	1.18E-03	1.53E+05	1.80E+02	0.00
Raccoon2	7.18	1.12E-02	3.82E+09	4.28E+07	0.33
Coyote/Fox3	3.20	4.99E-03	1.34E+09	6.67E+06	0.05
Muskrat1	34.43	5.38E-02	1.91E+07	1.03E+06	0.01
Opossum4	0.14	2.19E-04	8.77E+08	1.92E+05	0.00
Mink4	2.30	3.59E-03	8.77E+08	3.15E+06	0.02
Skunk4	4.88	7.63E-03	8.77E+08	6.69E+06	0.05
Badger4	0.61	9.53E-04	8.77E+08	8.36E+05	0.01
Jackrabbit4	3.95	6.17E-03	8.77E+08	5.42E+06	0.04
Cottontail4	25.81	4.03E-02	8.77E+08	3.54E+07	0.27
Squirrel4	16.57	2.59E-02	8.77E+08	2.27E+07	0.17
1 Yaggow et. al. 2001					
2 USEPA 2001					
3 Bacteria Indicator Tool Worksheet					
4 Best Professional Judgment based off of Dogs					
5 FC/Animal/Day averaged based on other species of Wildlife					

3.2.1 Natural Background Sources

Wildlife within the watershed is a natural background source of *E. coli* bacteria. Wildlife population density estimates were obtained from the South Dakota Department of Game, Fish, and Parks. Best estimates suggest wildlife account for approximately 1% of the bacteria produced in the watershed.

3.2.2 Human Sources

The city of Castlewood does not contribute a load to the impaired segment. The entire watershed, including this community, has a combined population of 1832 people within the 132,843 acre drainage area (2010 Census). Castlewood accounts for 627 of the 1832 people in the watershed (2010 Census). Septic systems are assumed to be the primary human source for the rest of the population in the watershed. Table 3 includes all human produced *E. coli* that are not delivered to a community waste system. When included as a total load in the table, the remaining population produced *E. coli* accounting for approximately 0.1% of all *E. coli* in the watershed. These bacteria should all be delivered to a septic system, which if functioning correctly would result in no *E. coli* entering the river.

3.2.3 Agricultural Sources

Manure from livestock is a potential source of *E. coli* to the river. Livestock in the basin are predominantly beef cattle. Livestock can contribute *E. coli* directly by defecating while wading in the stream. They may also contribute by defecating while grazing on rangelands or in feeding areas, which is then washed off during precipitation events. Table 4 allocates the sources of bacteria production in the watershed into three primary categories. The summary is based on several assumptions. Feedlots numbers were calculated as the sum of all dairy, hog, and the NASS estimate of beef in feeding areas. All remaining livestock were assumed to be on grass.

Table 4. *E. coli* source allocation for segment 3 of the Big Sioux River.

Source	Percentage
Feeding Areas	62.3%
Livestock on Grass	36.7%
Wildlife	1.0%

SDDENR maintains a priority list of feeding areas that is available to implementation coordinators. There were 126 feeding operations screened in the watershed of segment 3 of the Big Sioux River. Fecal decay rates suggest that sources within 10 kilometers of the listed segment were most likely to contribute the largest portions of the load, therefore only feeding areas within 10 km of segment 3 of the BSR were considered. This reduced the number of feeding areas to be evaluated from 126 to 98. Of those 98 feeding operations, 27 are considered high priority for future implementation activities based on their size and proximity to a waterway. Reducing the contributions of these 27 feeding areas will result in the most efficient use of implementation resources to reduce *E. coli* loadings to segment 3 of the Big Sioux River.

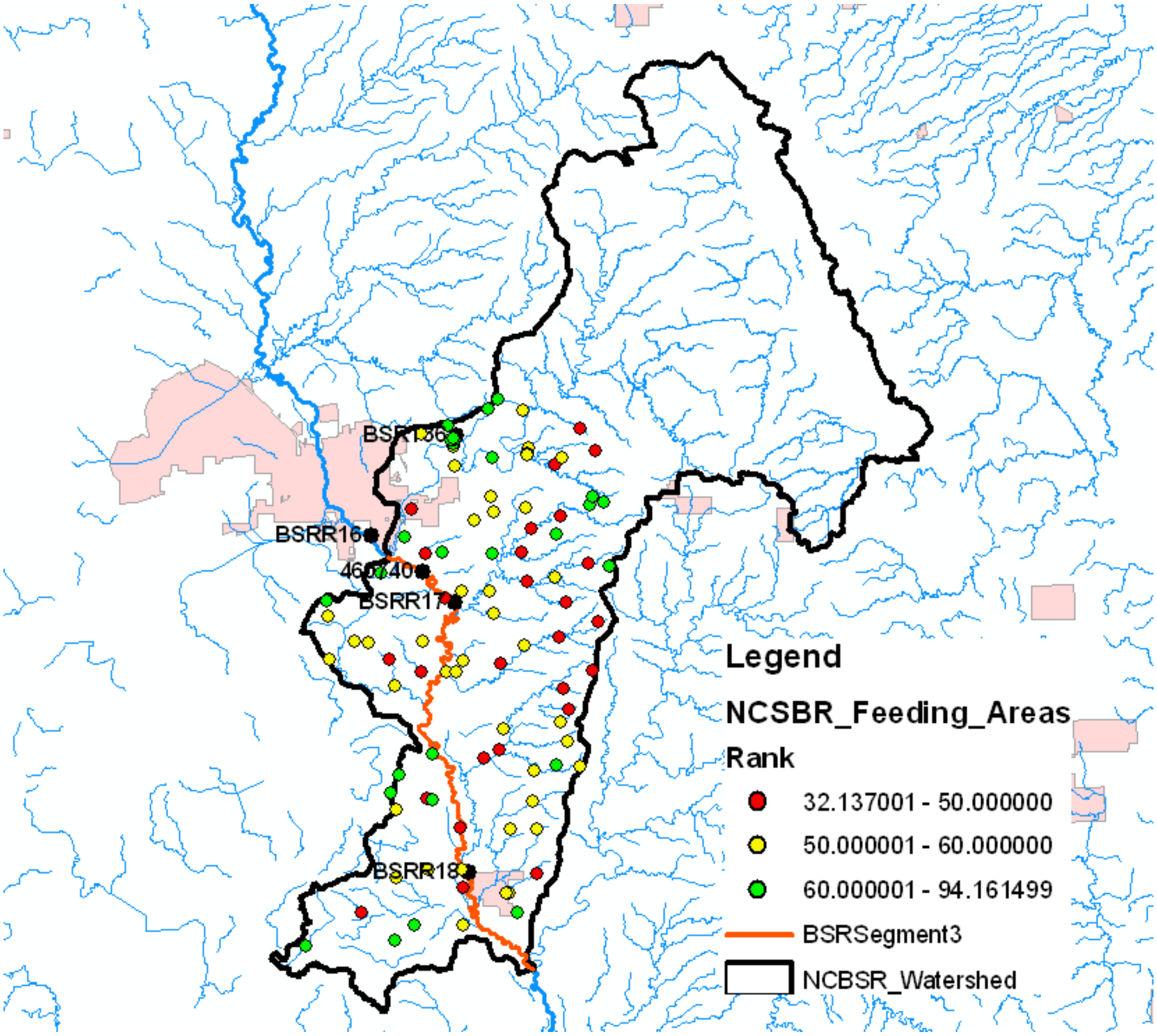


Figure 3. Prioritization of animal feeding areas in segment 3 of the Big Sioux River. High priority feeding areas are denoted by red symbols, medium priority by yellow symbols, and low priority by green symbols.

In addition to livestock feeding areas, livestock grazing areas may be a significant source of *E. coli*. Approximately one third of the watershed is grassland; however the majority of this is located in close proximity to stream corridors, increasing the likelihood that fecal material, and thus *E. coli*, may be washed off into streams.

4.0 Technical Analysis

4.1 Data Collection Method

To develop the TMDL, data from segment 3 of the Big Sioux River were collected from SDDENR ambient water quality monitoring site WQM 460740 and sites BSRR17, and BSRR18 from the North Central Big Sioux River Assessment Project. Flow data for segment 3 was retrieved from the United States Geological Survey (USGS) at one station.

The gauge data from Castlewood (06479525) was used for the period of record for which sample data was available. This gauge is at the same location as BSRR18. Site locations are displayed in Figure 2

Unless otherwise noted, analysis was completed with modeling programs according to the most recent version of the Water Quality Modeling in South Dakota document (SDDENR, 2009).

4.2 Flow Analysis

The USGS gauge at Castlewood is located near the lower end of segment 3 of the Big Sioux River, at the same location as site BSRR18. Because segment 3 of the Big Sioux River is relatively short at 22 miles, flows from this gauge are representative of conditions throughout the segment. The period of record was limited to 1976 through the end of 2010 to match the same timeframe from which sample data were collected. Only flows from the months of May through September were used to match the seasonal period when bacteria samples were collected. The hydrograph for the period of record may be found in Figure 4.

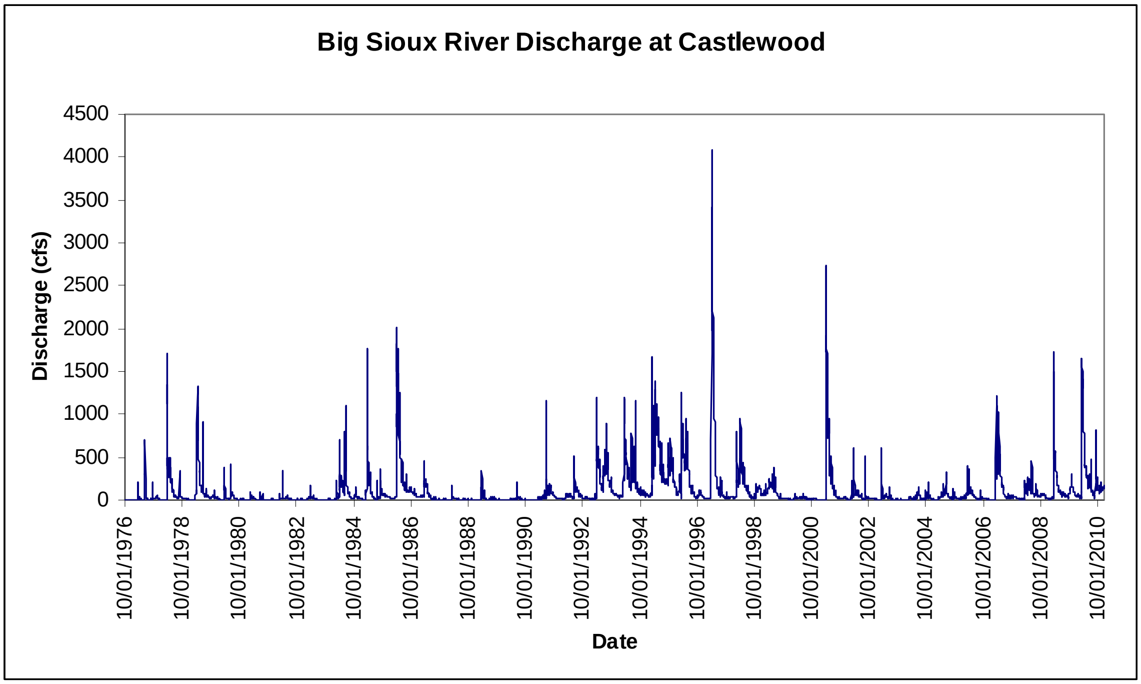


Figure 4. Big Sioux River daily streamflow at Castlewood.

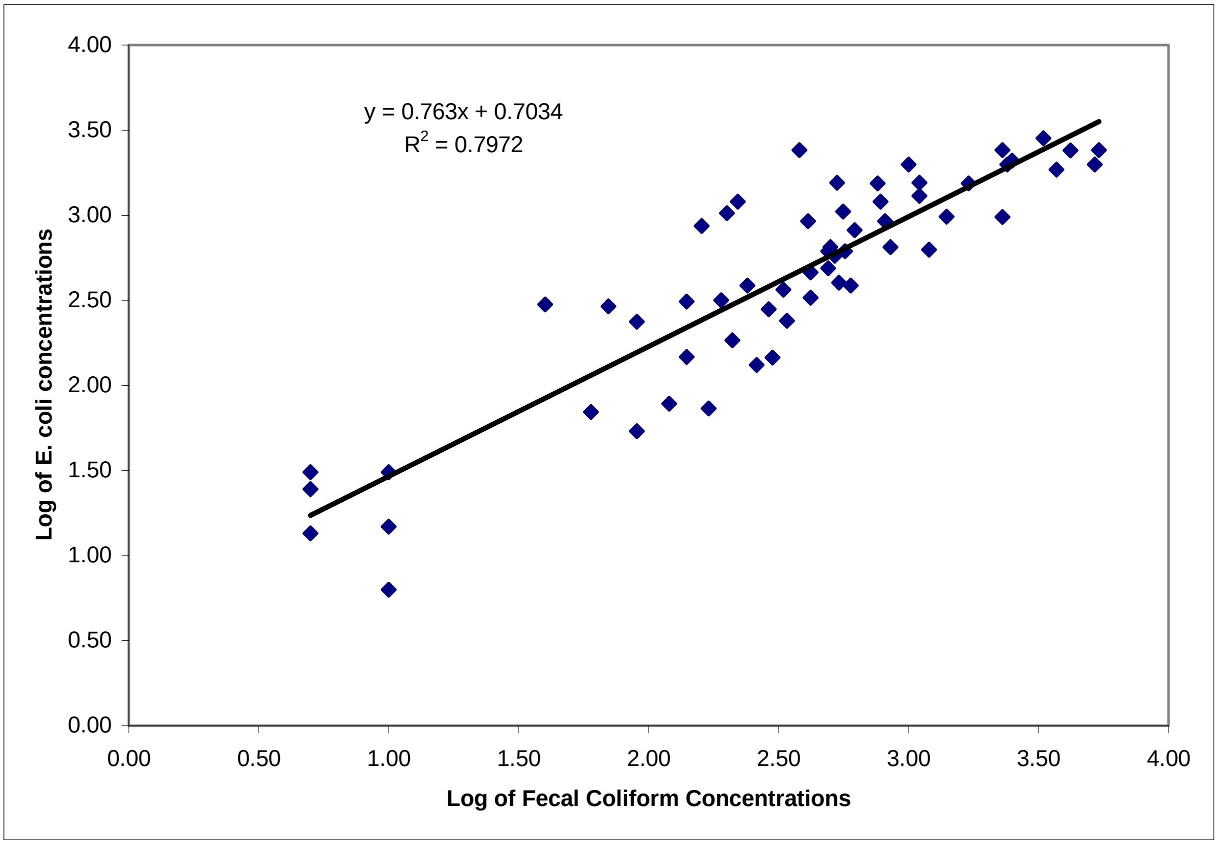
4.3 Sample Data

A total of 59 *E. coli* samples were collected at WQM site 406740. To create a more robust data set, fecal coliform data from 237 samples collected at WQM 406740 and sites BSRR17 and BSRR18 from the North Central Big Sioux River Assessment Project were used to estimate *E. coli* concentrations. This resulted in a dataset that includes 296 samples. This dataset was used to develop the TMDL.

Table 5. Paired *E. Coli* and fecal coliform concentration data from WQM 460740.

Sample Date	Fecal Coliform number/100mL	*E. coli* number/100mL	Sample Date	Fecal Coliform number/100mL	*E. coli* number/100mL
05/15/2001	90	53.8	05/08/2006	120	78
06/11/2001	560	1050	06/05/2006	530	1550
07/09/2001	260	132	07/10/2006	600	387
08/13/2001	210	184	08/07/2006	5200	1990
09/10/2001	520	579	09/05/2006	780	1200
05/13/2002	10	30.9	09/05/2006	1400	980
06/10/2002	410	921	05/07/2007	3700	1850
07/08/2002	810	921	06/11/2007	140	311
08/12/2002	1100	1553	07/09/2007	2500	2090
09/09/2002	240	387	08/06/2007	1000	1990
05/13/2003	10	14.8	09/10/2007	490	488
06/09/2003	330	365	05/05/2008	5	30.9
07/07/2003	2300	2420	05/05/2008	5	24.6
08/11/2003	300	146	06/09/2008	160	866
09/09/2003	2400	1990	07/07/2008	40	299
05/10/2004	60	69.7	08/11/2008	540	402
06/07/2004	420	461	08/11/2008	290	280
06/07/2004	620	816	09/09/2008	200	1030
07/12/2004	850	649	05/04/2009	5	13.5
07/12/2004	1100	1300	06/08/2009	380	2420
08/09/2004	1200	629	07/13/2009	90	237
09/13/2004	570	613	08/10/2009	420	328
05/09/2005	4200	2400	09/08/2009	760	1540
05/09/2005	220	1200	05/10/2010	10	6.3
06/13/2005	340	240	06/15/2010	2300	977
07/12/2005	170	73.3	07/12/2010	70	291
07/12/2005	140	147	08/09/2010	1700	1540
08/08/2005	490	613.1	08/09/2010	3300	2830
08/08/2005	500	648.8	09/13/2010	190	317
09/12/2005	5400	2420			

Fecal coliform and *E. coli* data were collected simultaneously at WQM site 406740 on approximately a monthly basis from 2001 to 2010 during the months from May to September (Table 5). Because *E. coli* is a fecal coliform bacterium and both indicators originate from common sources in somewhat consistent proportions, fecal coliform data can be used as a surrogate for *E. coli* data.



Fecal and *E. coli* concentrations from paired samples were transformed logarithmically and plotted. Fecal coliform concentration was plotted on the X-axis and *E. coli* concentration on the Y-axis. Applying a best fit line to these data sets yields a useful relationship with an r^2 value of 0.7972. The equation of this relationship can be used to estimate *E. coli* concentrations in segment 3 of the Big Sioux River.

Log of *E. coli* concentration = 0.763(log of fecal concentration) + .7034

The antilog of the resulting value is then calculated, yielding the estimated *E. coli* concentration.

Table 6. *E. Coli* concentrations in segment 3 of the Big Sioux River estimated from fecal coliform sample data.

Sample Date	Fecal Coliform number/100mL	Estimated *E. coli* number/100mL	Sample Date	Fecal Coliform number/100mL	Estimated *E. coli* number/100mL	Sample Date	Fecal Coliform number/100mL	Estimated *E. coli* number/100mL	Sample Date	Fecal Coliform number/100mL	Estimated *E. coli* number/100mL
05/08/2001	100	170	08/11/2008	300	392	07/11/1988	100	170	09/11/2000	80	143
06/15/2001	1800	1539	09/11/2008	250	341	08/08/1988	110	182	05/15/2001	90	156
07/25/2001	1000	983	09/11/2008	210	299	05/15/1989	100	170	06/11/2001	560	631
08/28/2001	800	829	09/11/2008	5	17	06/12/1989	860	876	07/09/2001	260	352
09/26/2001	1700	1473	05/20/2009	10	29	07/10/1989	380	470	08/13/2001	210	299
05/09/2002	480	561	06/22/2009	100	170	08/14/1989	5000	3355	09/10/2001	520	597
06/10/2002	6500	4099	07/21/2009	1800	1539	09/11/1989	6700	4195	05/13/2002	10	29
07/09/2002	11200	6208	08/18/2009	280	372	05/14/1990	200	288	06/10/2002	410	498
08/06/2002	5	17	09/23/2009	140	219	06/11/1990	2440	1941	07/08/2002	810	837
08/06/2002	16000	8150	05/18/1977	1900	1604	07/09/1990	560	631	08/12/2002	1100	1057
08/06/2002	17000	8536	06/15/1977	33000	14159	08/13/1990	480	561	09/09/2002	240	331
08/21/2002	410000	96818	07/07/1977	600	665	09/10/1990	520	597	05/13/2003	10	29
09/09/2002	2900	2214	08/03/1977	770	805	05/13/1991	70	129	06/09/2003	330	422
05/17/2004	3300	2444	09/21/1977	930	930	06/10/1991	780	813	07/07/2003	2300	1855
06/02/2004	70	129	05/11/1978	1000	983	07/15/1991	150	231	08/11/2003	300	392
06/16/2004	3200	2387	06/14/1978	83	147	08/12/1991	120	195	09/09/2003	2400	1916
07/01/2004	2800	2156	07/12/1978	1200	1129	09/09/1991	170	254	05/10/2004	60	115
07/14/2004	4400	3043	08/16/1978	110	182	05/11/1992	20	50	06/07/2004	420	507
07/27/2004	420	507	09/11/1978	250	341	06/08/1992	930	930	06/07/2004	620	682
08/09/2004	160	243	05/17/1979	23	55	07/13/1992	210	299	07/12/2004	850	868
08/25/2004	980	968	06/13/1979	140	219	08/10/1992	280	372	07/12/2004	1100	1057
09/08/2004	2500	1977	07/12/1979	330	422	09/14/1992	710	757	08/09/2004	1200	1129
09/27/2004	1100	1057	08/16/1979	270	362	05/10/1993	2400	1916	09/13/2004	570	640
05/08/2008	10	29	09/12/1979	1400	1270	06/15/1993	190	277	05/09/2005	4200	2937
06/12/2008	6800	4242	05/15/1980	5	17	07/12/1993	220	310	05/09/2005	220	310
07/09/2008	2400	1916	06/09/1980	980	968	08/09/1993	120	195	06/13/2005	340	431
08/11/2008	1100	1057	07/14/1980	900	907	09/13/1993	540	614	07/12/2005	170	254
09/11/2008	190	277	08/14/1980	43	89	05/09/1994	5	17	07/12/2005	140	219
05/20/2009	10	29	09/08/1980	240	331	06/13/1994	300	392	08/08/2005	490	570
06/22/2009	310	402	05/13/1981	5	17	07/11/1994	1000	983	08/08/2005	500	579
07/21/2009	800	829	06/10/1981	880	891	08/08/1994	240	331	09/12/2005	5400	3558
08/18/2009	150	231	05/07/1982	5	17	09/12/1994	420	507	05/08/2006	120	195
09/23/2009	6500	4099	06/08/1982	50	100	05/16/1995	30	68	06/05/2006	530	605
05/08/2001	1900	1604	07/14/1982	1400	1270	06/12/1995	330	422	07/10/2006	600	665
06/15/2001	1200	1129	08/11/1982	710	757	07/10/1995	500	579	08/07/2006	5200	3457
07/24/2001	2500	1977	09/07/1982	880	891	08/14/1995	1500	1339	09/05/2006	780	813
08/28/2001	2000	1668	05/11/1983	150	231	09/11/1995	270	362	09/05/2006	1400	1270
09/26/2001	13200	7037	06/16/1983	270	362	05/13/1996	40	84	05/07/2007	3700	2666
10/24/2001	470	552	07/14/1983	1500	1339	06/10/1996	80	143	06/11/2007	140	219
04/09/2002	5	17	08/11/1983	250	341	07/08/1996	360	451	07/09/2007	2500	1977
04/30/2002	5	17	09/08/1983	500	579	08/12/1996	450	534	08/06/2007	1000	983
05/09/2002	2000	1668	05/16/1984	5	17	09/09/1996	640	699	09/10/2007	490	570
06/10/2002	1600	1407	07/10/1984	900	907	05/12/1997	5	17	05/05/2008	5	17
08/07/2002	2600	2037	08/14/1984	230	320	06/09/1997	180	266	05/05/2008	5	17
08/21/2002	33000	14159	09/04/1984	450	534	07/14/1997	300	392	06/09/2008	160	243
09/09/2002	1300	1200	06/13/1985	250	341	08/11/1997	610	674	07/07/2008	40	84
05/17/2004	650	707	07/10/1985	30	68	09/08/1997	1100	1057	08/11/2008	540	614
06/02/2004	660	716	08/13/1985	1400	1270	05/11/1998	60	115	08/11/2008	290	382
06/16/2004	190	277	09/05/1985	1000	983	06/08/1998	160	243	09/09/2008	200	288
07/01/2004	460	543	05/14/1986	240	331	07/13/1998	230	320	05/04/2009	5	17
07/14/2004	370	460	06/11/1986	10000	5694	08/10/1998	280	372	06/08/2009	380	470
07/27/2004	310	402	07/16/1986	360	451	09/14/1998	520	597	07/13/2009	90	156
07/27/2004	340	431	08/13/1986	2100	1731	05/10/1999	130	207	08/10/2009	420	507
08/09/2004	300	392	09/08/1986	190	277	06/14/1999	520	597	09/08/2009	760	797
08/25/2004	2200	1793	05/13/1987	50	100	08/09/1999	170	254	05/10/2010	10	29
09/08/2004	500	579	07/13/1987	670	724	09/13/1999	470	552	06/15/2010	2300	1855
09/27/2004	600	665	08/10/1987	800	829	05/08/2000	1600	1407	07/12/2010	70	129
05/08/2008	10	29	09/14/1987	80	143	06/12/2000	1300	1200	08/09/2010	1700	1473
06/12/2008	7300	4478	05/11/1988	40	84	07/10/2000	5400	3558	08/09/2010	3300	2444
07/09/2008	220	310	06/13/1988	550	623	08/14/2000	860	876	09/13/2010	190	277

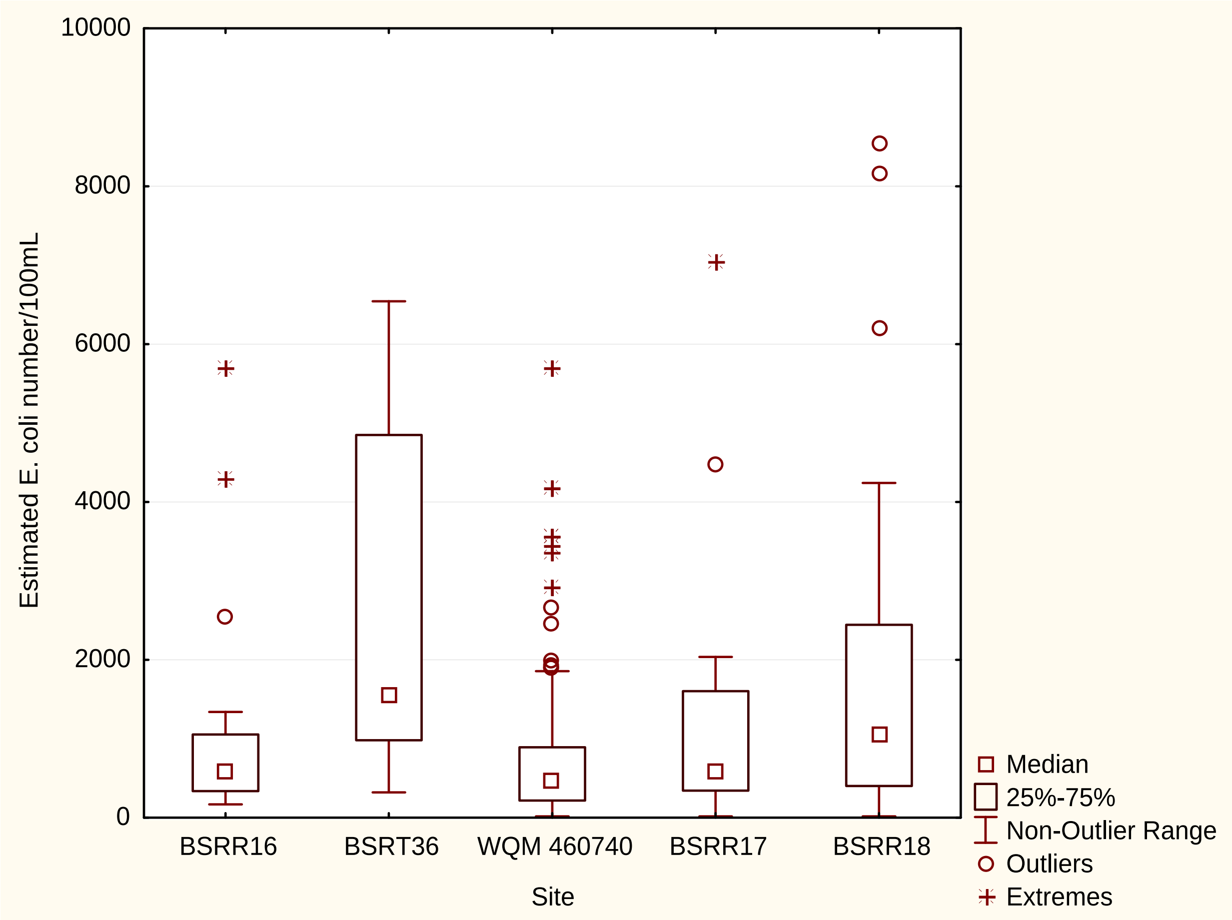


Figure 5. ***E. coli*** **concentrations plotted by sampling site.**

E. coli concentrations for each sampling site are plotted in Figure 5. Sampling site BSRR16 is located in segment 2 near the extreme upstream boundary of segment 3 and is representative of the upstream boundary conditions for segment 3. Data from BSRR16 was not included in the TMDL because it lies outside segment 3. Sampling site BSRT36 is located on Willow Creek, which flows into the Big Sioux River at the upstream boundary of segment 3. Data from BSRT36 was not included in the TMDL for segment 3.

E. coli concentrations generally increased from upstream to downstream. The concentrations observed at WQM 460740 did not match this trend. The most likely explanation is that data from assessment projects is typically biased toward flow events while sampling at WQM sites occurs on a monthly basis regardless of weather and flow. Data from WQM 460740 is not directly comparable to data collected at sites from the North Central Big Sioux River Assessment when comparing the magnitude of potential bacteria sources. The data from WQM 460740 is more indicative of average concentrations in segment 3 of the Big Sioux River, while sample data from the assessment project is more indicative of concentrations observed during high flows.

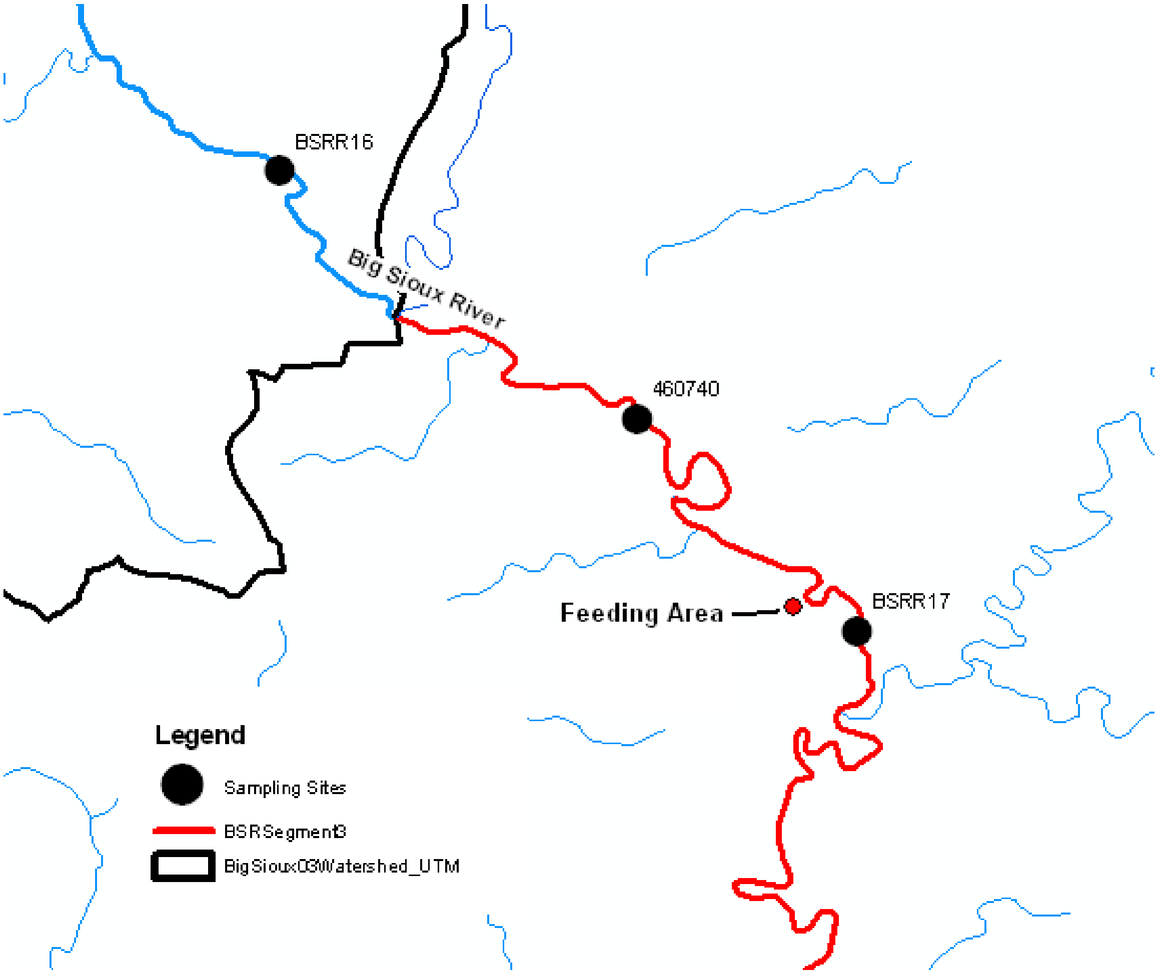


Figure 6. Sampling site locations.

For comparison, WQM 460740, which has an average *E. coli* concentration of 788 colonies/100mL, lies approximately 2.3 river miles upstream of BSRR17, which has an average *E. coli* concentration of 1486 colonies/100mL. There are minimal tributary inputs between the two sites. There is one source of possible bacterial contamination in the reach between the sites, which is a feeding area directly upstream of BSRR17. While this feeding area may contribute to higher concentrations at BSRR17, it does not explain why concentrations at BSRR16, which has an average *E. coli* concentration of 1127 colonies/100mL and is located 2.4 river miles upstream of WQM 460740, would also be greater than those observed at WQM 460740. The major tributary input between BSRR16 and WQM 460740 is Willow Creek, which typically experiences higher *E. coli* concentrations (average of 5093 colonies/100mL at BSRT36) than this portion of the Big Sioux River. This suggests that bacteria counts in the Big Sioux River would be expected to be greater downstream of this input, rather than lower as concentrations at WQM 460740 would otherwise lead one to believe.

Table 7. Average *E. coli* concentrations at sampling sites in segment 3 of the Big Sioux River.

Site	Average *E. coli* colonies/100mL	Number of Samples
BSRR16	1127	20
BSRT36	5093	11
WQM 460740	788	171
BSRR17	1486	33
BSRR18	4837	33

Except for at WQM 460740, *E. coli* concentrations increased between each sampling site, with the maximum average concentration occurring at BSRR18 (4837 colonies/100mL), the site located furthest downstream in segment 3 (Table 7). Reducing bacteria contributions in segment 2 will aid in attaining the TMDL in segment 3. However, significant additional reductions will be required within segment 3.

A total of 20 samples were collected at BSRR16 and a total of 33 samples were collected at BSRR17. *E. coli* concentration increased by 32% between these sites. Emphasis should be placed on contributing portions of the drainage between these points. Willow Creek accounts for a portion of the bacteria load entering this portion of the Big Sioux River and reductions in this tributary will aid in attaining the TMDL. Emphasis in Willow Creek should be focused on the lower reaches because fecal decay rates suggest that areas further up in the watershed are not a significant source of bacteria to the Big Sioux River.

A total of 33 samples each were collected at BSRR17 and BSRR18. With a 225% increase, the most significant change in *E. coli* concentrations was observed in this portion of the river. While reductions in this portion of the river alone will not achieve the TMDL goal because the river is not meeting water quality standards in upstream portions of segment 3, significant implementation efforts should be placed on contributing portions of the drainage between these points.

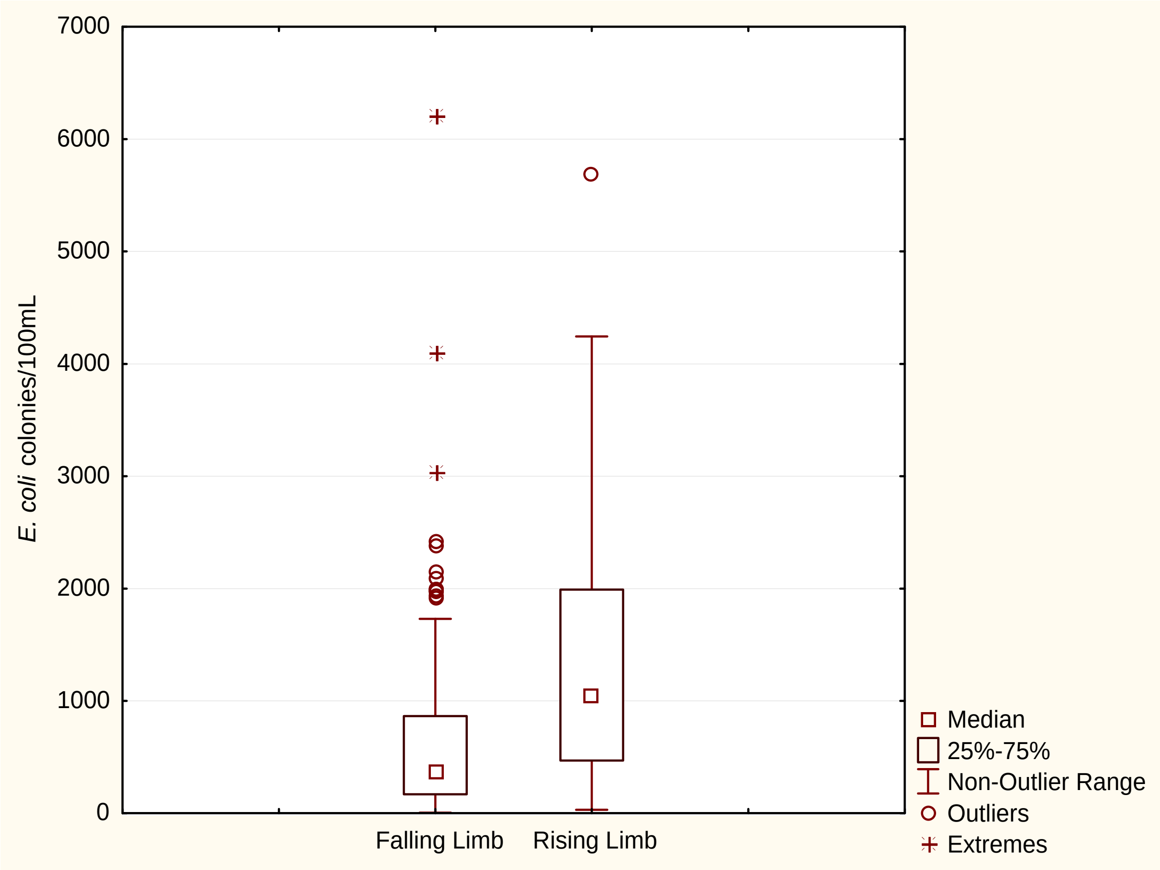


Figure 7. Comparison of *E. coli* samples collected on the rising and rising limb of the hydrograph for segment 3 of the Big Sioux River.

A comparison of samples collected on the rising limb of the hydrograph and samples collected on the falling limb of the hydrograph yielded insight into potential sources of *E. coli* in segment 3 of the Big Sioux River (Figure 7). Samples collected on the rising limb yielded an average *E. coli* concentration of 3577 colonies/100mL and a median concentration of 1050 colonies/100mL, while samples collected on the falling limb yielded an average *E. coli* concentration of 659 colonies/100mL and a median concentration of 362.

The presence of average *E. coli* concentrations approaching the chronic standard in the falling limb suggests that significant bacterial sources exist in close proximity to the stream corridor, and perhaps in the water itself such as stock animals defecating directly into the water.

Average *E. coli* concentrations in the rising limb were in excess of the daily standard and markedly higher than those in the falling limb, suggesting that while bacterial sources exist in close proximity to the stream, sources of greater significance likely exist further from the stream corridor. These sources contribute to loadings in the Big Sioux River during rain events that wash fecal matter from livestock feeding and grazing areas into small tributaries and the Big Sioux River.

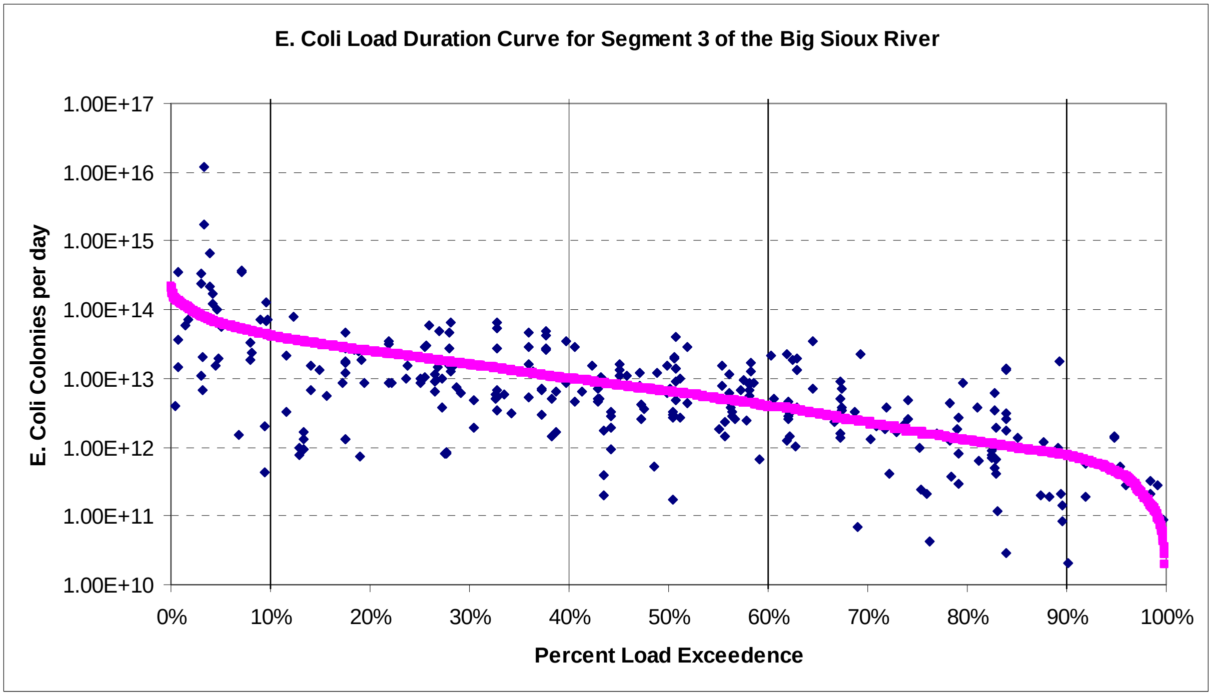


Figure 8. *E. coli* Load Duration Curve

The load duration curve in Figure 8 represents the 296 samples collected during the growing season (May 1 to September 30). The line represents the chronic standard for limited contact recreation which is 630 colonies/100mL. TMDL reductions will be based on the chronic standard to ensure the TMDL meets all applicable water quality standards.

Samples exceeded state standards in all five of the flow zones. Zone 5 had the fewest exceedences with the least magnitude. Zone 1 had exceedences of the greatest magnitude. Zones 2, 3, and 4 experienced consistent exceedences. All flow zones should be addressed during restoration efforts.

5.0 TMDL and Allocations

5.0.1 Flow Zone 1 (<10% flow frequency exceedence)

Flow zone 1 represents the high flows in the Big Sioux River. The lower limit of this zone is the 10th percentile, which corresponds to a flow rate of 261 CFS. Flows in this zone are typically short in duration, only lasting for a few days. Flows in this zone were most commonly the product of spring snowmelt events but may be generated by large rain events.

Table 8 depicts the components of the TMDL for this flow zone. Data in this zone will be used as the overall TMDL load for the segment. The current load is based on the 95th percentile flow in this flow zone and the 95th percentile *E. coli* concentration in this flow zone. The current load suggests an 89% reduction in loading is necessary to attain the standard.

The high flow zone is the most difficult zone in which to attain reductions. Elevated concentrations may be the result of upstream influences as well as contributions from numerous sources dispersed throughout the watershed. Animal feeding areas are a probable source of contamination within this flow zone, but manure spread on fields and livestock in pastures may also contribute. As a result of using the chronic standard to establish the TMDL target, reductions of less than 89% may fully attain the water quality standard. Reductions from sources contributing to other flow zones should help reduce concentrations within this flow zone.

Table 8. Flow zone 1 Total Maximum Daily Load

TMDL Component	High Flows (expressed as CFU/Day)
	>261 CFS
LA	1.19E+14
WLA*	0.00E+00
MOS	2.13E+13
TMDL @ 630 CFU/100mL	1.40E+14
Current Load**	1.26E+15
Load Reduction	88.94%
*Castlewood has a loading value of zero.	
**Current Load is based on the 95th sample and flow in each flow zone.	

5.0.2 Flow Zone 2 (10% to 40% flow frequency exceedence)

Flow zone 2 consists of flows that occur under moist conditions. For segment 3 of the Big Sioux River, zone 2 consists of the flows ranging from 63 to 261 cfs. These flows are associated with runoff events. Water velocities during these conditions are significantly slower than during high flows, reducing the distance *E. coli* bacteria may travel before dying off.

Table 9 depicts the components of the TMDL for this flow zone. The current load is based on the 95th percentile flow in this flow zone and the 95th percentile *E. coli* concentration in this flow zone. The current load suggests a 74% reduction in loadings will be necessary to attain the standard in this flow zone.

Potential sources of impairment in this flow zone include feeding areas, pastures, and crop land with manure spread on it. Due to the reduced transport velocities, impairments within this zone are less likely to be the result of loadings from upstream segments.

Targeting impairments to this flow zone may also help provide reductions for the high flow zone. Addressing the feeding areas should be an implementation priority to attain full support of the water quality standards for this flow zone.

Table 9. Flow zone 2 Total Maximum Daily Load.

TMDL Component	Moist Flows (expressed as CFU/Day)
	63 - 261 CFS
LA	2.74E+13
WLA*	0.00E+00
MOS	9.71E+12
TMDL @ 630 CFU/100mL	3.71E+13
Current Load**	1.42E+14
Load Reduction	73.75%
*Castlewood has a loading value of zero.	
**Current Load is based on the 95th sample and flow in each flow zone.	

5.0.3 Flow Zone 3 (40% to 60% flow frequency exceedence)

Flow zone 3 consists of mid-range flows. For segment 3 of the Big Sioux River, these flows range from 25 to 63 cfs. These flows may be associated with small runoff events or occur at the trailing end of a runoff event. Table 10 depicts the components of the TMDL for this flow zone. The current load is based on the 95th percentile flow in this flow zone and the 95th percentile *E. coli* concentration in this flow zone. A 71% reduction is necessary to attain the standard in this flow zone.

Potential sources of bacteria in this flow zone include areas within a short distance from the stream corridor or in the stream itself, such as cattle defecating directly into the stream. Feeding areas and pastures in close proximity to the stream may also contribute to loadings in this flow zone during small runoff events.

Targeting impairments in this zone can be accomplished by addressing potential areas contributing to bacterial contamination within a short distance from the stream corridor.

Table 10. Flow zone 3 Total Maximum Daily Load.

TMDL Component	Mid-Range Flows (expressed as CFU/Day)
	25 - 63 CFS
LA	6.94E+12
WLA*	0.00E+00
MOS	2.31E+12
TMDL @ 630 CFU/100mL	9.25E+12
Current Load**	3.16E+13
Load Reduction	70.77%
*Castlewood has a loading value of zero.	
**Current Load is based on the 95th sample and flow in each flow zone.	

5.0.4 Flow Zone 4 (60% to 90% flow frequency exceedence)

Flow zone 4 consists of flows that occur during dry conditions. For segment 3 of the Big Sioux River, these flows range from 4.8 to 25 cfs. These flows are indicative of drought conditions. Table 11 depicts the components of the TMDL for this flow zone. The current load is based on the 95th percentile flow in this flow zone and the 95th percentile *E. coli* concentration in this flow zone. A 90% reduction is necessary to attain the standard in this flow zone.

Sources of bacteria in this flow zone deliver *E. coli* directly to the stream. Potential contributing sources include livestock grazing or feeding areas with direct access to the river or a perennial stream that flows into the river.

Targeting impairments in this flow zone can be accomplished by addressing potential areas of bacterial contamination that allow stock animals direct access to the river or a tributary.

Table 11. Flow zone 4 Total Maximum Daily Load.

TMDL Component	Dry Flows (expressed as CFU/Day)
	4.8 - 25 CFS
LA	2.59E+12
WLA*	0.00E+00
MOS	9.56E+11
TMDL @ 630 CFU/100mL	3.55E+12
Current Load**	3.49E+13
Load Reduction	89.85%
*Castlewood has a loading value of zero.	
**Current Load is based on the 95th sample and flow in each flow zone.	

5.0.5 Flow Zone 5 (90% to 100% flow frequency exceedence)

Flow zone 5 consists of the lowest flows recorded on the river. They are representative of severe drought conditions both locally and regionally. Flows in this zone range from the lowest measured of less than 1 cfs to 4.8 cfs.

Table 12 depicts the components of the TMDL for this flow zone. The current load is based on the 95th percentile flow in this flow zone and the 95th percentile *E. coli* concentration in this flow zone. A 67% reduction is necessary to attain the standard in this flow zone.

Impairments in this flow zone are in direct contact with the waterway and are located in close proximity. Low flows also have low velocities, which allows for bacterial die off rates to take effect without the load traveling a significant distance. Out of 14 samples collected in this flow zone, 4 exceeded the daily standard and 7 exceeded the chronic standard, suggesting that significant bacterial sources with direct access to the river are contributing to the loadings in this flow zone. The most likely source of bacteria in this flow zone is livestock defecating directly into the river. Implementation efforts for this flow zone should focus on areas where livestock have direct access to the Big Sioux River.

Table 12. Flow zone 5 Total Maximum Daily Load.

TMDL Component	Low Flows (expressed as CFU/Day)
	1 - 4.8 CFS
LA	4.32E+11
WLA*	0.00E+00
MOS	2.62E+11
TMDL @ 630 CFU/100mL	6.94E+11
Current Load**	2.10996E+12
Load Reduction	67.13%
*Castlewood has a loading value of zero.	
**Current Load is based on the 95th sample and flow in each flow zone.	

5.1 Load Allocations (LAs)

Approximately 90% of the land use in the watershed is agricultural. All of the TMDL load has been allocated to these non-point source loads. An 89% reduction in *E. coli* bacteria from anthropogenic sources (livestock) is required in the high flow zone to fully attain the current water quality standards. A 74% reduction in *E. coli* is required in the moist conditions flow zone to fully attain current water quality standards. A 71% reduction is required in the mid range flow zone, a 90% reduction is required in the dry flow zone, and a 67% reduction is required in the low flow zone to fully attain current water quality standards. Reducing the 95th percentile samples in each flow zone below the chronic standards provides assurance that both acute and chronic standards will be met.

5.2 Waste Load Allocations (WLAs)

The city of Castlewood in Hamlin County has a surface water discharge permit, but only discharges under emergency conditions. There have been no reported discharges from the city of Castlewood, therefore it was included as a value of zero in the TMDL.

6.0 Margin of Safety (MOS) and Seasonality

6.1 Margin of Safety

An explicit MOS identified using a duration curve framework is basically unallocated assimilative capacity intended to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc). An explicit MOS was calculated as the difference between the loading capacity at the mid-point of each of the 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. Because the allocations are a direct function of flow, accounting for potential flow variability is an appropriate way to address the MOS.

6.2 Seasonality

Seasonality is important when considering bacteria contamination. Sample data was limited to the recreation season which begins in May and continues through September. Peak use is typically late in the season after temperatures increase. Monthly evaluations of the data showed no trend of a particular month generating higher or lower concentrations. The lack of a pattern further suggests numerous sources dispersed throughout the basin.

7.0 Public Participation

STATE AGENCIES
South Dakota Department of the Environment and Natural Resources (SD DENR) was the primary state agency involved in the completion of this assessment. SD DENR provided technical support and equipment throughout the course of the project. This TMDL was made available for public notice in the Watertown Public Opinion, Hamlin Country Republican, and the Brookings Register.

FEDERAL AGENCIES
Environmental Protection Agency (EPA) provided the primary source of funds for the completion of the assessment on the North Central Big Sioux River.

LOCAL GOVERNMENT, INDUSTRY, ENVIRONMENTAL, AND OTHER GROUPS AND PUBLIC AT LARGE
The primary local sponsor for this project was the East Dakota Water Development District. Board meetings for the district are held bi-monthly, with short updates on the assessment presented followed by a question and answer session for board members and public attendees. TMDL activities in this district have been presented and discussed at nearly every meeting since the project began.

During the summer sampling seasons, project personnel frequently met with landowners in the field. These meetings were most often facilitated through the landowners stopping to ask questions while data collection was occurring. Although informal in nature, these meetings provide and important medium for obtaining local landowner views and opinions.

8.0 Monitoring Strategy

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 north central Big Sioux River watershed. WQM site 460740 will be monitored monthly as part of the ambient water monitoring program. The results from this monitoring cycle can be used to supplement the modeling to judge project effectiveness or TMDL adjustments. The North Central Big Sioux River Implementation Project is currently assessing project effectiveness with models such as AnnAGNPS, RUSLE2, and STEPL.

9.0 Restoration Strategy

The North Central Big Sioux River Implementation Project is currently underway in segment 3 of the Big Sioux River. Best management practices (BMPs) should focus on the 27 feeding areas identified in section 3.2.3 of this report. Emphasis should also be placed on grazing areas within close proximity to the Big Sioux River and its tributaries, particularly those within a distance of 10 kilometers.

10.0 Literature Cited

Huxoll, Cory. 2002. South Dakota Game Fish and Parks; South Dakota Game Report No. 2003-11; 2002 Annual Report County Wildlife Assessments with a summary of the 1991-2002 Assessments.

SDDENR (South Dakota Department of Environment and Natural Resources). 2010. The 2010 South Dakota Integrated Report for Surface Water Quality Assessment Pierre, SD.

SDDENR (South Dakota Department of Environment and Natural Resources). 2009. Water Quality Modeling in South Dakota, May, 2009 Revision; Pierre, SD.

US Census Bureau. 2010. *U.S. Summary: 2010, Census US Profile*

USDA (United States Department of Agriculture). 1966. Soil Survey of Codington County, South Dakota.

Yagow, G., Dillaha, T., Mostaghimi, S., Brannan, K., Heatwole, C., and Wolfe, M.L. 2001. *TMDL modeling of fecal coliform bacteria with* HSPF. ASAE meeting paper No.01-2006. St. Joseph, Mich.

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Ref: 8EPR-EP

AUG 8 2011

Steven M. Pirner
Secretary
South Dakota Department of Environment & Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Re: TMDL Approvals
Big Sioux River, Segment 3; E. Coli;
SD-BS-R-BIG_SIOUX_03

Dear Mr. Pirner:

We have completed our review of the total maximum daily loads (TMDLs) as submitted by your office for the waterbodies listed in the enclosure to this letter. In accordance with the Clean Water Act (33 U.S.C. 1251 *et. seq*.), we approve all aspects of the TMDL(s) referenced above as developed for the water quality limited waterbodies as described in Section 303(d)(1). Based on our review, we feel the separate elements of the TMDL(s) listed in the enclosed table adequately address the pollutants of concern as given in the table, taking into consideration seasonal variation and a margin of safety.

Thank you for submitting these TMDLs for our review and approval. If you have any questions, the most knowledgeable person on my staff is Vern Berry and he may be reached at 303-312-6234.

Sincerely,

Carol L Campbell

Carol L. Campbell
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Enclosures

ENCLOSURE 1: APPROVED TMDLs

Escherichia Coli Total Maximum Daily Load Evaluation of the Big Sioux River, Codington and Hamlin Counties, South Dakota (SD DENR, April 2011)

Submitted: 6/3/2011

1	Pollutant TMDLs completed.
1	Causes addressed from the 2010 303(d) list.
0	Determinations that no pollutant TMDL needed.

Segment: Big Sioux River from Willow Creek to Stray Horse Creek

303(d) ID: SD-BS-R-BIG SIOUX 03

Parameter/Pollutant (303(d) list cause): E. COLI - 227

Water Quality Targets: <= 630 cfu/100 mL

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
LA	2.74E+13	CFU/DAY	
TMDL	3.71E+13	CFU/DAY	
MOS	9.71E+12	CFU/DAY	

Notes: The loads shown represent the loads during the moist flow regime as defined by the load duration curve for the Big Sioux River, Segment 3 (see Figure 8 of the TMDL). The moist range flows are when significant differences occur between the existing loads and the target loads, and represent the flow regime that is most likely to be targeted for BMP implementation.

* LA = Load Allocation, WLA = Wasteload Allocation, MOS = Margin of Safety, TMDL = sum(WLAs) + sum(LAs) + MOS

ENCLOSURE 2

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	**Escherichia Coli Total Maximum Daily Load Evaluation of the Big Sioux River, Codington and Hamlin Counties, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**June 3, 2011**
Review Date:	**July 25, 2011**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Final**
Notes:	

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

☒ Approve
☐ Partial Approval
☐ Disapprove
☐ Insufficient Information

Approval Notes to Administrator:

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 minimum submission requirements and TMDL elements identified in the following 8 sections:

1. Problem Description
   1.1. TMDL Document Submittal Letter
   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 is able to 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 minimum submission requirements 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 the minimum submission requirements 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 template 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 TMDL Document Submittal Letter

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

Minimum Submission Requirements.

- ☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.
- ☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.
- ☒ 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

SUMMARY: The Big Sioux River, Segment 3 E. coli TMDL was submitted to EPA for review and approval via an email from Cheryl Saunders, SD DENR on June 3, 2011. The email included the final TMDL document and a letter requesting final review and approval.

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.

Minimum Submission Requirements:

☒ 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: The Big Sioux River, Segment 3 is a portion of the mainstem stream located in Codington and Hamlin Counties, South Dakota. This segment is part of the larger Big Sioux River watershed in the Upper Big Sioux sub-basin (HUC 10170202). The listed river segment drains an area of approximately 132,843 acres in north eastern South Dakota, and includes approximately 22.5 miles of the Big Sioux River from Willow Creek to Stray Horse Creek (SD-BS-R-BIG_SIOUX_03). It is listed as a high priority for TMDL development.

The designated uses for Big Sioux River, Segment 3 include warmwater semipermanent fish life propagation waters, limited-contract recreation waters, irrigation, fish and wildlife propagation, recreation, and stock watering. The segment was listed on the 2010 303(d) list for E. coli. EPA approved a Big Sioux River, Segment 3 TMDL for fecal coliform in June 2008.

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).

Minimum Submission Requirements:

☒ 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 significant 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: The Big Sioux River, Segment 3 segment addressed by this TMDL is impaired based on E. coli concentrations for limited contact recreation. South Dakota has applicable numeric standards for E. coli that may be applied to this stream segment. The E. coli numeric standards being implemented in this TMDL are: a single sample maximum value of ≤ 1178 cfu/100 mL, and a 30-day geometric mean of ≤ 630 cfu/ 100 mL. Discussion of additional applicable water quality standards for the Big Sioux River, Segment 3 can be found on pages 7 - 9 of the TMDL document.

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, embeddeness, stream morphology, up-slope conditions and a measure of biota).

Minimum Submission Requirements:

☒ 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 water quality target for this TMDL is based on the numeric water quality standards for E. coli to achieve the limited contact recreation beneficial use for the Big Sioux River, Segment 3. The target for the Big Sioux River, Segment 3 segment included in the TMDL document is the E. coli standard expressed as the 30-day geometric mean of 630 cfu/100 mL during the recreation season from May 1 to September 30. While the standard is intended to be expressed as the 30-day geometric mean, the target was used to compare to values from single grab samples. This ensures that the reductions necessary to achieve the target will be protective of both the acute (single sample value) and chronic (geometric mean of 5 samples) standards.

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 significant source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each significant source (or source category) should be identified and quantified to the maximum practical extent. 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.

Minimum Submission Requirements:

☒ The TMDL should include an identification of all potentially significant 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 all significant anthropogenic sources of the pollutant of concern have been identified, characterized, and properly 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: The TMDL document identifies the land use in the watershed as predominately agricultural consisting of cropland (44%), grassland / rangeland (36%) and water/wetlands, developed or forest land (20%).

There are two point source discharges that were evaluated for potential impact to Segment 3 of the Big Sioux River. The city of Castlewood has a wastewater discharge permit, but only discharges under emergency conditions. There have been no reported wastewater discharges from the city of Castlewood's treatment system; therefore it was given a zero wasteload allocation. The city of Watertown discharges wastewater into Segment 2 of the Big Sioux River. Segment 2 of the Big Sioux River is not listed as impaired for E. coli. Contributions from the city of Watertown would be more appropriately addressed in any future TMDL document written for Segment 2 of the Big Sioux River.

Nonpoint sources of E. coli bacteria in the Big Sioux River, Segment 3 come primarily from agricultural sources. Data from the 2010 National Agricultural Statistic Survey (NASS) and from the 2002 South Dakota Game Fish and Parks county wildlife assessment were utilized for livestock and wildlife densities, respectively. Animal density information was used to estimate relative source contributions of bacteria loads as summarized in Table 3 of the TMDL document.

Livestock in the basin are predominantly beef cattle. Livestock can contribute E. coli bacteria directly to the stream by defecating while wading in the stream. They may also contribute by defecating while grazing on rangelands, which then get washed off during precipitation events. Table 4, excerpted from the TMDL document below, allocates the sources for bacteria production in the watershed into three primary categories. Feedlots include any type of livestock confined to un-vegetated areas including wintering operations. Livestock on grass encompass all remaining livestock within the watershed.

Table 4. *E. coli* source allocation for segment 3 of the Big Sioux River.

Source	Percentage
Feeding Areas	62.3%
Livestock on Grass	36.7%
Wildlife	1.0%

There are an estimated 126 animal feeding operations in the Big Sioux River, Segment 3 watershed, many of which are contributors to the bacteria load, particularly during runoff events. Pathogen decay rates suggest that sources within 10 kilometers of the listed segment were most likely to contribute the largest portions of the load, therefore only feeding areas within 10 km of the Big Sioux River, Segment 3 were considered. This reduced the number of feeding areas that were evaluated from 126 to 98. Of those 98 feeding operations, 27 are considered high priority for future implementation activities based on their size and proximity to a waterway. Reducing the contributions of these 27 feeding areas will result in the most efficient use of implementation resources to reduce E. coli loadings to Segment 3 of the Big Sioux River.

The entire watershed has a total population of 1832 people within the drainage area, of which Castlewood accounts for 627 based on the 2010 Census. Septic systems are assumed to be the primary human source of E. coli for the rest of the population in the watershed. Table 3 of the TMDL document includes all human produced E. coli sources that are not delivered to Castlewood's wastewater system. After subtracting Castlewood's population, the remaining population accounts for approximately 0.1 percent of all E. coli in the watershed. That bacteria load should all be delivered to septic systems, which if functioning correctly would result in no E. coli entering the river.

COMMENTS: None.

4. TMDL Technical Analysis

TMDL determinations should be supported by a robust 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:

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

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

MOS = The portion of the Load Capacity allocated to the Margin of safety.

Minimum Submission Requirements:

☒ 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:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) 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…;
(4) 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);
(5) 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: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Big Sioux River, Segment 3 TMDL describes how the E. coli loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segment.

Data for the Big Sioux River, Segment 3 was collected from the SDDENR ambient water quality monitoring site WQM 460740 and as part of the North Central Big Sioux River watershed assessment from two sampling sites (BSRR17 and BSRR18). The flow data for this TMDL came from the USGS flow gauge at Castlewood, SD located near the lower end of Segment 3 of the Big Sioux River. The flow record provided a sufficient data set to develop the load duration curve.

The TMDL loads and loading capacities were derived using the load duration curve (LDC) approach. The LDC was divided into 5 distinct flow regimes – high flow ($\geq$ 261 cfs), moist flow (between 261 cfs and 63 cfs), midrange flow (between 63 cfs and 25 cfs), dry flow (between 25 cfs and 4.8 cfs) and low flow ($<$ 4.8 cfs). The result is a flow-variable TMDL target across the flow regime as shown in Figure 8 of the TMDL document. The LDC is a dynamic expression of the allowable load for any given daily flow. Loading capacities were derived from this approach at the 95^{th} percentile of the observed E. coli bacteria load for each flow regime: high flow = 1.40E+14 cfu/day; moist flow = 3.71E+13 cfu/day; midrange flow = 9.25E+12 cfu/day; dry flow = 3.55E+12 cfu/day; and low flow = 6.94E+11 cfu/day.

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…).

Minimum Submission Requirements:

☒ 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 Big Sioux River, Segment 3 TMDL data description and summary are included mostly in the Technical Analysis section of the document. Data for Segment 3 of the Big Sioux River was collected from WQM 460740 and from 2 additional sites as part of the North Central Big Sioux River watershed assessment project.

A total of 59 E. coli samples were collected at WQM site 406740. Fecal coliform and E. coli data were collected simultaneously at WQM site 406740 on approximately a monthly basis from 2001 to 2010 during the months from May to September. Fecal and E. coli concentrations from paired samples were transformed logarithmically and plotted. Fecal coliform concentration was plotted on the X-axis and E. coli concentration on the Y-axis. Applying a best fit line to these data sets yielded a relationship with an r^2 value of 0.7972. Using this method the 237 fecal coliform samples collected at WQM 406740 and sites BSRR17 and BSRR18 were used to estimate E. coli concentrations. This resulted in a dataset that includes 296 samples which were used to develop the E. coli TMDL for the Big Sioux River, Segment 3.

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.

Minimum Submission Requirements:

☒ EPA regulations require that a TMDL include WLAs for all significant and/or NPDES permitted point sources of the pollutant. TMDLs must identify the portion of the loading capacity allocated to individual existing and/or 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 city of Castlewood in Hamlin County has a wastewater discharge permit, but only discharges under emergency conditions. There have been no reported wastewater discharges from the city of Castlewood's treatment system therefore it was given a zero wasteload allocation in this TMDL.

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.

Minimum Submission Requirements:

☒ 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 all significant 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: The Watershed Characteristics section of the TMDL explains that the landuse in the watershed is predominately agricultural consisting of cropland (44%), grassland / rangeland (36%) and water/wetlands, developed or forest land (20%). Livestock in the basin are predominantly beef cattle. Therefore the majority of the loading capacity has been allocated to the nonpoint sources in the form of load allocations. Tables 8 – 12 include the load allocations at each of the flow regimes – 1.19E+14 cfu/day at high flows; 2.74E+13 cfu/day at moist flows; 6.94E+12 cfu/day at midrange flows; 2.59E+12 cft/day at dry flows and 4.32E+11 cfu/day at low flow conditions.

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 a 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).

Minimum Submission Requirements:

☒ 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).

- ☐ If the MOS is implicit, 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.
- ☒ If the MOS is explicit, 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.
- ☐ If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach 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

SUMMARY: The Big Sioux River, Segment 3 TMDL includes an explicit MOS derived by calculating 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. The explicit MOS values are included in Tables 8 - 12 of the TMDL.

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.

Minimum Submission Requirements:

☒ 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: By using the load duration curve approach to develop the TMDL allocations, seasonal variability in E. coli loads are taken into account. Highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months.

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.

Minimum Submission Requirements:

☒ 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 section of the TMDL document describes the public participation process that has occurred during the development of the TMDL. In particular, the State has encouraged participation through public meetings in the watershed, and a website was developed and maintained throughout the project. The TMDL was available for a 30-day public notice period prior to finalization.

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.

Minimum Submission Requirements:

☒ 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: Post-implementation monitoring will be necessary to assure the TMDL target loads have been achieved and maintenance of the beneficial use occurs. Monitoring will continue in the north central Big Sioux River watershed. WQM site 460740 will be monitored monthly as part of the ambient water monitoring program. The results from this monitoring can be used to supplement the modeling to judge project effectiveness or TMDL adjustments. The North Central Big Sioux River Implementation Project is currently assessing project effectiveness with models such as AnnAGNPS, RUSLE2, and STEPL.

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.

Minimum Submission Requirements:

☒ 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 ☐ Insufficient Information

SUMMARY: The Restoration Strategy section of the TMDL document mentions that implementation activities for Big Sioux River, Segment 3 are underway as part of the North Central Big Sioux River Implementation Project. Best management practices should focus on the 27 feeding areas identified in the TMDL document. Emphasis should also be placed on grazing areas within close proximity to the Big Sioux River and its tributaries, particularly those within a distance of 10 kilometers.

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.

Minimum Submission Requirements:

☒ 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 Big Sioux River, Segment 3 E. coli TMDL includes daily loads expressed as cfu/day. The daily TMDL loads are included in TMDL and Allocations section of the TMDL document.

COMMENTS: None.